

## MODEL #70 MINI-JECTOR

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## INTRODUCTION

Dear Owner:

Thank you for choosing the model #70 Mini-Jector injection-molding machine. As with all Mini-Jector machines, it represents over 40 years experience in designing and building injection molding machinery. This model has a 10 ton clamp capacity, as well as the choice of 1 or 2 ounce injection units. Because of the versatility of its design, it is frequently built to special customer requirements, which may differ from those outlined in this manual.

Although this is a small machine as injection-molding machinery goes, it has many control features both for the protection of the operator and the machine itself. **IT IS RECOMMENDED THAT EVERY OPERATOR OR USER OF THIS MACHINE READ THIS MANUAL THOROUGHLY.** Additional manuals are available from the factory at a modest price.



It is suggested that any subsequent owner of this machine call the factory to discuss any changes in either equipment features or possible up-dated safety features that may be available. This machine was built with safety features corresponding to the latest Society of the Plastics Industry (**SPI**) recommended guidelines and applicable American National Standards Institute (**ANSI**) safety standards prevailing at the time. Since these standards and guidelines are reviewed on a regular basis, any significant changes will be brought to the attention of the owner of record of this machine by mailings from our factory. If any questions are not answered by this manual, feel free to contact our customer service department for clarification. Contact:

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## MINI-JECTOR MODEL OVERVIEW

There are many different Mini-Jector models available for a variety of injection-molding applications. Each model is given a unique identifier that tells you exactly what type of machine it is. This model code comes in two parts: the machine model followed by shot size. For example, model #55-1 is simply a model #55 machine with a one-ounce shot capacity. To specify a one-ounce model #55 with a “C-frame” option, simply adding a “C” after the model denotes this specification and it becomes #55C-1 (the “C-frame” option is summarized on page 35, Appendix C). Note that while the “C-frame” option is available for every shot size offered for the model #45 and #50 machines (as shown in **Table 1**), it is only available in the one and two ounce model #55 machines, and it is not available at all on the #60, #70, or #75 machines (as shown in **Table 2**). Also note, every Mini-Jector model is available with the wide mold option (no matter the shot size) for any application that would require an extra wide mold.

Table 1

Model	45	50
<b>Features</b>		
<b>Shot Sizes</b>		
0.33 oz.	X	X
0.50 oz.	X	X
0.75 oz.	X	X
1.00 oz.	X	X
1.50 oz.	X	X
<b>C-Frame</b>	X	X
<b>Wide Mold Option</b>	X	X

Table 2

Model	55	60	70	75
<b>Features</b>				
<b>Shot Sizes</b>				
1 oz.	X	X	X	X
2 oz.	X	X	X	X
4 oz.	X			
<b>C-Frame (1 &amp; 2 oz. Only)</b>	X			
<b>Wide Mold Option</b>	X	X	X	X

In addition to the model coding system, it is also helpful to be familiar with the serial number on a Mini-Jector machine. The Mini-Jector serial number is a unique nine-digit number that is broken down into four sections. The first two numbers represent the month the machine was manufactured in. Each machine is also given a sequence number that increases by one for each new machine that is shipped; this is represented by the next three numbers. After that comes the two-digit model number and the final two numbers tell the year of manufacture. With this complete serial number, MPM engineers will be able to quickly locate a large resource of information on a machine that may have been manufactured many, many years earlier.

## GENERAL SAFETY PRECAUTIONS

**(1) POINT OF OPERATION GUARDING** - The model #70 Mini-Jector is equipped with a point of operation automatic guard opening system that permits the guard to open automatically and is a pneumatically operated gate that has both manual controls and operates automatically when cycling. A barrier guard covers the left side of the clamp area. **NEVER OPERATE THE MACHINE WITH ANY GUARDS REMOVED OR INTERLOCKS DEFEATED.** The guarding is designed for both operator protection and utility of operation.

**(2) SAFETY INTERLOCKS** - The point of operation guard has (3) independent interlocking systems that prevent certain machine functions to operate with the guard opened. Only “eject” and “shuttle in or out” may occur with the safety gate opened. All other machine motions require that the guard be closed and the interlocks activated. The three systems of interlocks are: electrical, mechanical, and hydraulic. These are explained in greater detail elsewhere in this manual.

**(3) MACHINE GROUNDING** - It is recommended that an independent earth ground be provided for this machine to protect its sophisticated electronics. Some common shop grounds may transport voltage “spikes” and other electrical “noise”. A ground lug is provided next to the main disconnect.

**(4) ELECTRICAL DISCONNECT(S)** - A 30 Amp fused disconnect is provided at the machine’s electrical console. This may be locked in the “off” position during maintenance procedures that require “lock out-tag out” steps as recommended by OSHA. It is suggested that a second disconnect at the power source be provided so the main power can be shut off to the console when work is being done inside the console. **ALWAYS SHUT OFF THE MAIN DISCONNECT WHEN WORKING ON THE MACHINE.**

**(5) SAFETY EQUIPMENT** - Operators should use safety glasses with lenses of material approved by ANSI. When heated molds are used, the operator should be provided with gloves of a proper insulating material.

**(6) PURGING** - Always purge the machine when shutting down according to “purging procedures” covered elsewhere in this manual. **NEVER LEAVE THE MACHINE’S HEATERS ON FOR EXTENDED LENGTHS OF TIME WHEN THE MACHINE IS NOT BEING OPERATED.** The machine has a heater shut-down feature described elsewhere in the manual, but it operates only when the machine is set in the “semi-automatic” operating mode.

**(7) DRYING MATERIAL** - Many materials require pre-drying to remove moisture absorbed during exposure to the air. Even sealed containers do not prevent moisture from being absorbed on certain materials. Dry according to the manufacturer’s recommendations. **CAUTION: WET MATERIALS MAY CAUSE VOLATILES TO BE**

**RELEASED WHEN HEATED.** Material may burst from the material feed slot or hopper or through the nozzle.

**(8) EMERGENCY STOP BUTTON** - The machine is equipped with an emergency stop button, located on the operator's control panel, which will stop all motion and functions of the machine. It is of the twist to release type that requires that the button be twisted in the direction of the arrow on the mushroom type button to release the switch once it has been pushed in.

**(9) GENERAL SAFETY RECOMMENDATIONS** - Even though the machine is carefully guarded, by reaching over guards into areas with potential pinch points an operator may be exposed to hazards. **NEVER REACH INTO THE MACHINE WHEN IT IS OPERATING.** The machine is designed to be used by one operator. If your operation requires the use of additional operators, consult the factory for recommended additional safety features that may need to be added. **NEVER ALLOW MORE THAN ONE OPERATOR TO RUN THE MACHINE AT THE SAME TIME.** Always shut the machine pump motor off when working inside the clamp area of the machine to install molds or remove stuck sprues and/or parts.

## INSTALLATION OF THE #70 MINI-JECTOR

The model #70 Mini-Jector is shipped on hardwood skids, which allow the machine to be moved to its location in your shop. A cross brace is provided in the front left to support that corner of the machine when being transported. It is removed after installation to provide additional legroom for the operator.

If the machine is equipped with the regular machine stand, it may be moved without re-skidding the machine. Provision is made in the base frame to use five leveling pads mounted to the holes on the frame.

**(1) Electrical Power** - The machine runs on 208-230 volt, three-phase power unless ordered with either of the single-phase motor or the 460-480 volt three-phase power options and requires a service of a minimum of 30 amps. A hole is provided in the upper rear top of the control console to bring in your shop power. **IT IS HIGHLY RECOMMENDED THAT AN INDEPENDENT EARTH GROUND BE USED.** A ground is needed to protect the sophisticated electronics of the machine from electrical “noise”. It is also recommended that a separate wall disconnect be provided on the incoming service to permit shutting all power to the console off.

**(2) Water or Coolant Supply** - The machine requires bringing in cooling water or media from a chiller at both the hydraulic system heat exchanger and the hopper tube that joins the hopper to the screw barrel. Neither requires a large volume of coolant for efficient operation. You may wish to purchase one of the commercially available water manifolds to also provide cooling for your molds. It is recommended that the return water line from the hopper tube have a needle valve, or other control mechanism, to retain water in the tube for better heat transfer. The heat exchanger is built into the hydraulic reservoir and has two NPT ports.

**(3) Guarding the Rear of the Machine** - If the rear of the machine faces an aisle or other easy access to bystanders, we recommend that a barrier be placed to prevent bystanders from reaching into any of the machine’s mechanisms. The barrier should still allow access to the hydraulics for maintenance purposes.

**(4) Ventilation** - A system of ventilating the area around the machine should be provided to remove gasses present from materials such as PVC.

## OPERATIONAL PRINCIPLES - MODEL #70 MINI-JECTOR

**(1) General Machine Operation** - The model #70 Mini-Jector is classified as a vertical clamp, vertical reciprocating screw injection, single station injection-molding machine of the straight hydraulic clamp type. When equipped with the optional shuttle table, it remains classified as a single station machine. The mechanical portion of the machine consists of a clamp assembly, injection assembly, base and safety guard assembly, and an ejector assembly. The systems operating these mechanical components are controlled by hydraulic and electrical components. This section of the manual will also familiarize your operators with the various industry nomenclatures for various machine components and functions.

**(2) Clamping System** - The clamp assembly is of a 4 tie-rod construction and consists of the lower, or stationary platen, moveable platen and clamp cylinder plates. The mold is attached to the moveable (upper) platen and the stationary (lower) platen. If the machine is equipped with the optional shuttle table, the table is mounted to the lower platen and the lower mold half is mounted to the shuttle. The moveable platen is raised and lowered by two 2.5" bore clamping cylinders. These are plumbed to allow simultaneous movement of both cylinders. The moveable platen moves on the 4 tie bars, guided by greaseless bronze bushings. The platens are designed to mount the DME, National, Master Unit Die, and other commercial mold bases in the 8" x 8" size that have mold mounting holes of 1/2-13 thread on 6.75 " centers and use a 2.00" diameter locating ring (actually, the outside diameter of the sprue bushing itself). Some machines also are designed to mount custom 1" x 1" tooling. The model #75 uses 6" x 8" shuttle bases and 5" x 6" or 5" x 8" N DME bases.

**(3) Ejection System** - The ejector mechanism mounts beneath the stationary platen. A 1.5"x2" cylinder is attached to a rectangular ejector bar and also to the stationary platen. When activated, the cylinder pushes the ejector bar up toward the platen and the stripper bolts screwed into the bar strike the ejector plate in the mold. The ejector is returned hydraulically to the down position after the ejection cycle is complete. A limit switch verifies that the ejector has returned before the shuttle can move.

**(4) Injection System** - The injection assembly is mounted on two guide rods that are attached to the injection saddle at the lower end and the carriage cylinder plate at the upper end. The carriage cylinder serves to move the entire injection unit down to seat the nozzle over the sprue bushing in the mold, and hold it there under pressure during the injection and extrusion cycles. It also retracts the injection unit slightly to break the nozzle contact when "sprue break" is turned on. If the injection unit needs to be serviced, the carriage cylinder can withdraw the injection unit up into the "service" position to allow the barrel to be removed. The injection cylinder plate mounts the two injection cylinders that pull the thrust housing (which, through a coupling, mounts the feed screw) down to inject material into the mold as well as raise the housing to "de-compress" the material when that feature is turned on. The screw motor is a direct drive hydraulic motor that drives the screw coupling that runs in two steep row Timken roller bearings. Two tie bars guide the thrust housing.

If the machine equipped with a **non-drool** nozzle, it will not be able to inject, or purge, any material unless the injection unit is pressed firmly against a mold or purge fixture. This nozzle type acts as a simple valve to avoid any messy “drooling” of material from the nozzle in between injection cycles. If a standard nozzle has been selected, the machine may inject and purge without any pressure applied to the tip of the nozzle.

**(5) Safety Guard System** - The machine has a **Power Guard** assembly that uses a small air cylinder to open or close the guard. On hydraulic shuttle machines, the operator must push the two hand start buttons until the shuttle has pulled the mold into the molding position, engaging the “shuttle in” switch. The guard then closes and a new cycle continues. It opens after “die open” is completed. The guard (as well as the left side guard) is made from 0.250“ thick polycarbonate sheet. The side guard remains on the machine unless it needs to be temporarily removed to perform a mold change.

**(6) Hydraulic System** - The machine’s hydraulic power unit is mounted directly behind the clamp unit at floor level when using the regular stand. The motor (5HP 1725 RPM) is mounted vertically, permitting the gear pump to be immersed in the oil reservoir to reduce pump noise. The reservoir holds about 12 gallons of hydraulic oil; the level of which can be seen in the sight gage on the side of the reservoir. A return line oil filter is mounted on the reservoir with a bypass system. The system will illuminate the alarm light when the filter is dirty. The heat exchanger is located in the reservoir (see installation). The pump has a suction line filter to compliment the return line filter. The pump housing contains the main relief valve, which protects the system. Pressures of the various hydraulic functions of the machine are regulated by a proportional pressure relief valve (an electronically controlled relief valve) mounted either on top of the power unit or on the main hydraulic manifold. The manifold contains the various directional valves that produce the machine motions, the check valves that hold clamp tonnage and prevent drifting, backpressure control, a regenerative clamp valve, and speed controls for injection and extrusion speed. There are various pressures assigned to various machine functions that are permanently programmed into the control. These are pre-set at values that produce the smoothest machine operation without sacrificing speed. Those pressures are listed under machine specifications. All hydraulic fittings are of the “o” ring face seal type. The clamp and carriage cylinders use poly-pack lip seals on the pistons to prevent drifting.

**(7) Manual Hydraulic Controls** - There are several manual hydraulic adjustments that can be made to regulate screw speed, injection speed, and screw back pressure. These controls are located in the various valve “stacks” on the main hydraulic manifold on the back of the machine. The screw speed flow control valve is mounted under the “extrude/eject” directional valve. Turning the knob in will reduce screw speed. Turning it out will increase it. Under the “inject/retract” directional valve is a similar flow control valve for injection speed. In the same stack is an aluminum counterbalance valve for screw backpressure adjustment. Turning the setscrew out will reduce backpressure during injection plasticizing; turning it in will increase it. The backpressure can be read on the pressure gauge.

**(8) Electrical Control System** - The Mini-Jector model #70 uses a Mitsubishi programmable logic controller (PLC) with thermocouple inputs and analog inputs and outputs added. The operator interface is a Mitsubishi LCD “touch screen” display and has switches and pushbuttons for all motion functions (in manual mode) and a mode selector switch to select either manual or semi-automatic mode of operation on the “Display” page. An emergency stop button, an alarm light, and motor start, and stop buttons are mounted on the panel. The console door may be opened by first turning the disconnect off and using a screwdriver to unlatch clamps on the sides of the console door. The various input and output lights may be observed for trouble shooting by first tripping the disconnect (see maintenance section). Machines using 460VAC power have a 3KVA step-down transformer mounted on the back of the control console. The operator interface is where all positions, times, heats, and optional functions are controlled. A serial port is provided at the back of the operator interface panel to connect to a host computer to record information. There are six limit switches on the machine. One to determine carriage back travel on sprue break, one to serve as a back-up mold protection verification, a third monitors the position of the mechanical safety interlock, a fourth verifies ejector return, and (on shuttle machines) the other two indicate shuttle is either in or out. Linear potentiometers control the motion of the injection and clamp axis.

**(A) “Alarms” Screen** - Whenever an alarm condition exists, a flashing “Alarm Bell” will appear in the upper right corner of the particular screen you are observing. Pressing the bell will take you to the Alarm screen to identify the problem. The various alarm conditions are:

**Empty** - This indicates that the screw did not return during a semi-automatic cycle due to the material hopper being empty.

**Filter** - This indicates that the return line oil filter is dirty and it is being bypassed. The machine will run under this alarm condition, but the filter needs to be replaced.

**Cutback** - Automatic temperature cutback has occurred. This only occurs when the operator has turned the “Cutback” feature ON.

**Temp High** - Indicates that one or more heat zones are 15° above set point. The machine will still run under this alarm condition.

**Temp Low** - Indicates that one or more zones is 15° below set point. The inject, retract, or extrude functions are disabled under this alarm condition. If you wish to dry cycle the machine with an empty barrel, adjust the set temperatures on **Temperature** screen to match ambient temperatures shown on “actual”. This feature is designed to prevent damage to the screw during cold starts.

**Extrude Back** - Screw did not return to position, most likely due to an empty barrel.

**Shuttle** - Ejector did not return within 5 seconds of eject timer timing out.

**Safety** – Safety gate is not closed and not making proximity switches, or when machine has an automatic opening gate, the switch on the mechanical interlock has not been made and released.

**Clamp** - Clamp position potentiometer has failed (it will see a zero reading)

**Inject** - Injection potentiometer has failed (seeing a zero reading)

**Car-Bk** - Sprue break is turned on and carriage is not in the raised position at the start of a cycle.

Remember, that as the machine comes up to operating temperatures, the low heat alarm will turn on the alarm light.

**(B) Contrast Screen** - This screen allows you to adjust screen contrast for clarity.

## OPERATING THE MACHINE

The machine is always drained of oil before shipping. Fill it with ISO 32, or any other quality grade of hydraulic oil. Use only oils specifically formulated for hydraulic use. Do not use any combination of oils. The reservoir holds about 12.5 gallons, and the level may be observed in the combination level and temperature sight gage on the side of the hydraulic reservoir.

**Motor Rotation** - If the pump motor is running in the wrong direction, it will not produce hydraulic flow or pressure. Turn the main disconnect on and observe whether the operator interface screen display lights up, indicating the machine is under power. Press the motor start button to start the motor, and press **DISPLAY** to see that the machine is in “Manual” mode. Close the safety gate. Press the **Clamp Open** switch and the mold will open fully. If the mold is already fully open, press the “**Eject**” button, and the ejectors should extend. If neither of these functions operate, the pump is running backwards. To reverse the rotation, swap any two of the motor leads on the motor starter or at the independent wall disconnect if provided. If the oil was drained before shipment, there may be some air in the system and motion may be jerky until all of the air has been forced out. If the system seems very noisy, it may be necessary to bleed air out of the proportional relief valve (see maintenance section for procedure).

**Installing a Mold** - Before you install your mold be sure that the mold protection limit switch tripper on the left side of the clamp unit is backed out far enough to not contact the switch when the mold is closed. Open the mold to the full open position and be sure the carriage is out far enough so that the nozzle is above the moveable platen. If you are using standard 8” x 8” tooling, place the mold on the stationary platen (or shuttle table) with the sprue or top half in place. Align the sprue bushing with the centering hole in the moveable platen, **close the safety gate**, and carefully close the mold with the manual control. In manual cycle, the clamp will only close at mold protect pressure. Using ½” -13 x 2” socket head screws, bolt the mold to the stationary platen (or shuttle) and the moveable platen and install all water or heater lines to the mold. Press **Position** screen and observe the **Clamp Actual** reading. If, for example, it reads 4.35”, set the **Clamp Closed** position to 4.36”.

**Preparing to Mold** - Fill the material hopper with the appropriate resin, and set all parameters to proper settings as explained in the section on the operator interface. If you do not have cooling connected to the feed hopper tube, do not put material in until the machine has reached its operating temperatures. The material may bridge the opening into the screw barrel if it sits there for a prolonged length of time. Remember, you cannot operate any of the injection functions until all heater zones are within 15° of the set point. When the machine is up to temperature and the hopper has been filled with material, you are ready to plasticize and prepare the first shot. To charge the first shot (if the machine has a shut-off nozzle) be sure the nozzle is away from the sprue bushing allowing the shut-off nozzle plug to drop. With the safety gate closed, press manual “extrude”, and hold it until the screw housing travels back the distance required to produce the desired shot size. The 1 ounce, 7/8” diameter screw contains about 0.6

in<sup>3</sup> of material for each inch of extrusion distance (or 0.33 ounces), whereas the 2 ounce, 1 1/8" diameter screw displaces 0.994 cubic inches of material per inch of extrusion distance. If the machine does not have a shut-off nozzle, turn the manual "retract" switch to retract the screw upward the desired distance, then press the "extrude" button until material begins to flow out of the nozzle. The machine is now ready for a manual cycle.

## Manual Cycle

**(1) Machines without a shuttle** - With the safety gate closed, turn the "carriage in" switch until the nozzle is seated in the sprue bushing. Turn the switch "mold close" until the mold closes completely. Remember that in manual mode the clamp only closes at low pressure and the mold will no doubt flash the first shot. Accordingly, set **Inject Boost** pressures low for experimental shooting of the mold. Turn the "inject" switch until the mold has filled. The screw will stop moving forward or down when the mold is filled or all material is displaced. Press the "extrude" button and extrude until the next shot is prepared. If you normally use sprue break, turn the "carriage out" switch until the nozzle pulls away slightly from the sprue bushing. Press "mold open" until the mold has opened fully. Now press the "ejector" pushbutton enough to extend the ejectors fully. When they automatically return, open the safety gate and remove the part.

**(2) Machines with Optional Shuttle** - Before the procedure outlined above is performed, press the two "shuttle in-Start Cycle" pushbuttons and the shuttle will travel in until it hits the adjustable stop. Continue on with the procedure outlined above. When the ejectors have returned, push the two "manual shuttle out" buttons, releasing them when the shuttle reaches the "out-stop". These buttons have an "anti-tie-down, anti-repeat" feature, and must be pressed simultaneously.

**Semi-Automatic Cycle** - During the above procedure, the left side mold protection switch has not yet been adjusted. Go to the **DISPLAY** screen and press the displayed **Manual** button and then when displayed, press **Semi-Auto** and use one of the following methods of initiating the cycle.

**(1) Machines without shuttle** - Press the two "Cycle Start" buttons simultaneously and the front safety gate will close. Release the two buttons when the gate has closed, and the mold will start closing. It will close completely, but only at low pressure. Since the low-pressure switch has not tripped, none of the rest of the cycle will start. Once it is closed, turn the mold protection threaded tripper cam down until it is about to contact the limit switch plunger. Very carefully and gradually turn the cam until it just trips the limit switch. It takes 0.020" of travel to trip the switch, and you want it to just make contact. When the switch has made the hydraulic noise will increase as it increases the clamping tonnage and the injection portion of the cycle will start. After the machine has made a complete

cycle, replace the side guard if it was removed. It is now ready to operate on a production cycle.

- (2) **Machines with Hydraulic Shuttle** - The cycle is started by pressing the two “shuttle in, cycle start” buttons and holding them until the shuttle has made the “shuttle in” limit switch. The gate will close automatically and the mold will then close under low pressure. Repeat the former procedure for setting mold protection.

**Interrupting the Cycle** - If at any time during a cycle you wish to stop the machine from continuing its cycle, simply press the **Emergency Stop** button. This will stop all movement as well as the pump motor. The emergency stop button triggers an input into the control. The machine must be put back into the **Manual** mode, the motor restarted, the mold opened, and (if using sprue break) the carriage retracted to its tripped position. The machine can then be returned to Semi-Automatic mode.

**If Certain Functions Do Not Operate** - This machine has many interlocks in its software to protect your operators, tooling, and the machine’s mechanisms. The following are a list of checks to make.

- (1) **Clamp will not close** - Check on the alarm screen **or press blinking alarm bell on screen** to see if “safety” is blinking. Make sure shuttle is in, safety gate is closed completely (the proximity switches have a red LED that indicates whether the switches are made by the targets), and on machines with the automatic guard opening the mechanical interlock monitor switch must be tripped and released.
- (2) **Ejector will not extend** - The mold must be fully open to have the ejectors extend in either manual or semi-automatic mode. On machines with a shuttle table, it must be in the “In” position, making the limit switch. If the machine is in semi-automatic mode, on the **Set-Up** screen be sure that the ejector is turned “on”.
- (3) **Carriage will not operate** - The safety gate must be closed for the carriage to move in either direction.
- (4) **Inject, Retract, & Extrude will not operate** - The set temperatures cannot be more than 15° below the set point for these functions operate. The safety gate must also be closed.
- (5) **Machine will not recycle** - Check to make sure that the ejector has returned, the shuttle is in, the gate is closed, and (if sprue break is turned on) the carriage has returned to the tripped position. Also, remember that with automatic gate opening the mechanical safety switch must be tripped and released.

## SHUTTING DOWN

**(1) Purging** - When shutting down after a production run, or when changing materials, it is sometimes necessary to purge the resin from the screw barrel. First, empty the material hopper by loosening the 5/16" pivot bolt and removing the 1/4" mounting bolt on the hopper flange. Place a box under the dump tube in the hopper mounting plate and swivel the hopper against the roll pin stop. The contents of the hopper will empty into the box. Use an air nozzle to blow out any "fines" or particles left in the hopper. There will be about 6 cubic inches of material remaining in the hopper tube. The tube can be removed, but it is difficult to catch the material that will fall out. It is easier to purge that material out. Place the machine in "manual" mode. If the machine has a non-drool nozzle, bring the carriage "in" until the nozzle seats in the sprue bushing. **Never attempt to purge with the non-drool nozzle pulled away from the sprue bushing because the material is unable to flow out in that position.** Open the mold fully and push the "inject" button. After the screw has bottomed, press the "extrude" button and hold it in while material purges through the sprue. When the material has been completely removed from the screw barrel and the hopper tube, the screw motor will speed up and material will stop oozing out of the sprue. Sometimes materials with high viscosities will not flow through the sprue by extruding, and the screw will return up as it would in regular operation. Under that condition, purge by alternately injecting and extruding until the barrel is empty. Use the air nozzle to blow any leftover pellets down the hopper tube. If you are shutting down, press **Temperature** to bring up the temperature screen and shut down each heat zone. If you are not going to run the machine any more you may shut down the heats prior to the purging process. Return the "carriage" to the out position and withdraw the nozzle to the service position.

**Straight Orifice Nozzle** - If your machine has the straight orifice nozzle you may withdraw the nozzle to the service position to purge the machine. When you remove the purgings from the top of the moveable platen, **turn off the pump motor.**

**Purging Compounds** - There are many commercial purging compounds that can be used to clean the screw and barrel when changing materials. **Consult the manufacturer of the material before selecting purging compounds.** Remember that a small amount of the original material will remain in the metering zone and nozzle body after purging, and will appear when you start running again. Two shots usually clears out these residuals.

**Shutting Off Power** - After you have purged the machine and shut the motor off, the operator interface screen will remain illuminated. This will not harm or shorten the life of the unit. To shut the screen down simply turn off the main disconnect on the control console.

## MAINTAINANCE

**Hydraulic Oil** - It is a good policy to replace hydraulic oil after a few years of use. Use high-grade hydraulic oil and not general-purpose oil, as the latter tend to have a higher viscosity (the system holds about 12 gallons when full). When possible, run the new oil through a filter when pumping it into the tank because it may contain some impurities, such as fine lint, that are created during the refining process. Filtering the oil will help increase the life span of the return line filter, which is built into the machine's power unit and not easy to replace. **Do not run the machine with the oil level below the top of the sight gage.**

**In-Line Filter** - The in-line filter on the hydraulic power unit has an automatic bypass feature that allows oil to flow around the filter when it is plugged. The system has a monitor that checks whether the filter is being bypassed. The alarm light will indicate an alarm condition, and it can be checked on the alarm screen **F5**. Change the element as soon as possible.

**Bleeding System Air** – If, for any reason, air has worked its way into the hydraulic system from either disassembly or low oil levels, the pump will make noise when the system pressures are in the higher range. The noise will show a pressure oscillation. After the reservoir is brought up to its level, locate the proportional pressure relief valve on either the power unit or on the main manifold. With the machine running, loosen one of the socket head screws in the round, silver part of the valve body. Oil and air will come out of the orifice. Tighten the screw down, but be sure that it is out enough to allow oil to pass out of the bleed hole. It may be necessary to remove the screw entirely.

**Removing the Screw Barrel** - To remove the screw barrel as a unit, inject the screw to its bottom position. It may be necessary to have the heaters on to allow the unit to inject. Press the "carriage out" button and move the carriage to its uppermost position. Remove the shoulder bolt coupling-pin to detach the screw from the drive coupling and retract the thrust housing all the way back to its full up position. Now turn off the heats and allow the unit to cool down. Unplug the three heater twistlock plugs as well as the three thermocouples. There is a #10-32 set screw locking the large barrel retainer nut, you will need to loosen it and the ½" socket head screw in the back of the injection cylinder plate (this screw acts as a key to keep the barrel from turning). Removing the hopper tube and hopper makes the heavy barrel much easier to handle. Use channel lock pliers to remove the large barrel nut, it should not be very tight. The unit should fall freely at this point.

**Lubrication** - The machine is equipped with eight (8) greaseless bushings lubed at the factory. There are four in the moveable platen, two in the injection cylinder plate, and two in the thrust housing. It is only necessary to grease these fittings once a year using clear lithium type grease. Wipe off any excess after greasing.

## GENERAL PRINCIPLES OF INJECTION MOLDING

Injection molding owes its origins to the die casting industry. It is a similar type of thermal process where the material changes its physical state from a solid to a liquid back to a solid again. An excellent analogy would be ice melted into water and frozen back into ice again but in a different shape. Thermoplastics are actually a semi-liquid when melted, having the viscosity of maple syrup. Resins that can undergo physical change such as described are referred to as "Thermoplastics". Resins such as phenolics and epoxies that undergo permanent chemical change are referred to as "Thermosetting Resins". This chemical change occurs under heat and pressure and the plastic is liquid for a very short period of time when it flows into the cavity of the mold. The chemical change continues until the part solidifies. Thermosetting material cannot be re-heated and used again. These materials are un-suited for processing in plunger type injection molding machines.

Thermoplastic materials are usually supplied in a pellet or granular form. Certain materials prepared under laboratory conditions are in a powder form, much like talcum. These must be calendared into a ribbon or pellet form, as they do not mold well in the powder form. Pellets are made by extruding the resin into strands, adding color concentrates to enhance appearance, and then chopping the strands into pellets as they are cooled at the end of the extruder line.

Thermoplastics can be fully re-cycled by grinding the scrap or used material into pellet like chunks. The "re-grind" can be used for molding or extrusion again. If similar materials of different color are blended during re-grinding, screw plasticizing machines will homogenize the mix into a single color, where a plunger machine like the Mini-Jector will produce a product with a marbled appearance. The number of times a material can be re-used is dependent largely on the nature of the resin itself. Some contain stabilizers and volatiles that can be lost during re-processing. Even the most stable resins have a finite processing life, and eventually become un-useable.

Most thermoplastics are excellent insulators and consequently resist rapid heating and cooling. The plastic pellets are metered by the hopper and feed mechanism into the funnel and through a feed slot, into the heating cylinder itself. The pellets contact the heated walls of the cylinder and begin to melt or plasticize. To further assist melting, the material is forced to flow around a device called a spreader, or torpedo in the nozzle end of the heating cylinder. This spreads the material into thinner layers, exposing more pellets to heated surfaces. The fins on the spreader also produce a shearing effect on the pellets as they are forced through the cylinder. The spreader is heated by contact with the walls of the heating cylinder and has a very close fit with it.

Electrical resistance heaters controlled by "pyrometers", or heat controllers, heat the heating barrel and nozzle. Thermocouples feed the barrel and nozzle temperatures back to the pyrometer where it makes adjustments necessary to maintain proper temperatures. Unlike a screw plasticizing machine, a plunger machine transfers most of

its heat energy through conduction, where a screw machine converts mechanical energy to heat.

There are two types of injection molds: the “center sprue” type where a radius tipped nozzle injects through a sprue bushing in the center of the stationary mold half. And then there is the “parting line “ type where the material is injected at the parting, or split line of the mold. Mini-Jector machines utilize the parting line system. The orifice where the hot material enters the mold is referred to as the “sprue”. Off shoots to various cavities from the sprue are called “runners”. Between the mold cavity and the runner is a much smaller passage called a “gate”. This assists breaking off the finished part from the runner, and also increases flow velocity. New molds are generally built with gates that are smaller than needed so they can be enlarged later. The gate freezes before the runner, preventing material flow back that would cause “sinks”, or voids in the part.

When the hot material enters the mold, it begins to cool immediately. Most injection molds are operated at room temperature or below to speed cooling. Some materials require some mold heat to process. Pressure is maintained on the injection screw after the mold is filled to prevent sinking, mentioned above, that is caused by the rapid cooling of the piece. It is held only long enough to prevent sink and to freeze off the gates. Excess pressure dwell can over pack the mold cavity, making the part more difficult to remove from the mold. As a general rule, the longer the injection pressure dwell time is, the less the shrinkage by the molded part.

The efficiency of the injection molding cycle is usually limited by the ability of the screw barrel to melt the plastic. That rating is known as the “plasticizing capacity” and is usually rated in pounds per hour. The mold cooling cycle may also limit the molding cycle. Liquid media can be used to cool the mold more rapidly, and hot liquids or electrical heaters used to raise the mold temperature when needed.

During the injection cycle, the hot plastic entering the mold is under a very high pressure. Although injection pressures of 20,000 PSI or greater are common, the actual pressure inside the mold cavity is considerably less due to the pressure losses in the nozzle or gates and the inefficiency of the pressure transmission by the granular material. This actual pressure is usually in the 4,000 to 5,000 PSI range. This force tries to work against the projected area of the mold (the area on the same plane as the parting line) to pry the mold halves apart. This can produce “flash” where material squirts out from between the mold parting line. A good rule of the thumb is to have at least two tons clamping pressure available for every square inch of projected area. Up to 5 tons per square inch is recommended when running very low viscosity resins or very thin mold sections. Clamp tonnage is produced by the wedging action of the “V” mold caused by the nozzle force in “Wasp” Mini-Jectors. The Model #60, #70 and #75 machines use a hydraulic clamp that stretches the machine tie rods producing stored clamp energy.

After the part cools in the mold, it is removed manually when the mold is removed from the machine in the "Wasp" Mini-Jector, or in the #60, #70 & #75 model Mini-Jectors it is ejected by ejector pins in the mold that are mechanically, hydraulically, or pneumatically driven. Mold release sprayed on the surface of the mold assists part removal. A certain amount of draft on the side of the part also assists part removal.

## RECIPROCATING SCREW

The reciprocating screw plasticizer as used in the model #55, #60, #70, and #75 series Mini-Jectors, is based on combining the principle of the extruder and the plunger system. The screw is extremely efficient as it adds shear heat converted from the mechanical energy produced by the hydraulic motor turning the screw within the barrel. This shearing and mixing allows dry color or color concentrates to be used in your materials, so you can color natural resin with color concentrates right in your machine. The screw also permits lower material temperatures, especially with engineering materials.

The screw is separated into three flight zones: the rear or “feed” zone is deeper to permit efficient feeding of pellets and is about 1/2 the length of the flighted section. The second, or “transition” zone is where shear is introduced and the flights here become gradually shallower. The material is compressed in this zone, which usually has 1/4 of the total number of flights. Last is the “metering” zone which is the final depth of the transition zone and occupies the remaining 1/4 of the total flights. Its purpose is to filter any remaining un-melted pellets from the melt stream.

Unlike an extruder, which is operated in a fixed position, the reciprocating screw is able to “reciprocate” back as plastic is discharged ahead of the tip. The material fills the void created when the resin pressure pushes the screw assembly back. Backpressure is applied by a hydraulic counterbalance valve to insure that the material is properly kneaded. The amount of material for the next shot is regulated by electrically stopping the screw return with a limit switch or potentiometer when sufficient material is discharged ahead of the screw tip.

The screw tip consists of a sliding ring assembly, which allows material to flow through it during plasticizing, and seals off during injection when the screw acts as a plunger to fill the mold. The tip is made of extremely hard & durable materials.

## APPENDIX A

### GENERAL PROCEDURES FOR MOLDING COMMON THERMOPLASTICS ON MINI-JECTOR SCREW TYPE INJECTION MACHINES

#### (1) Polyolefins (Polyethylene, Polypropylene)

As there is a broad range of material densities and melt indexes available in these resins, a variety of molding parameters exist. *Polypropylene* generally is an inferior conductor of heat, and the maximum plasticizing capacity of the machine should be de-rated to about 65% of its rating in *polystyrene*. *Polyethylene* processes in direct proportion to its density. The low-density materials require less pressure and heat than the high density or linear grades. All *polyolefins* have a low melt viscosity and should be molded at as low a pressure as possible to avoid flashing. Clamp tonnage should be set at maximum regardless of the size of the molded part. The low-density *polyethylenes* should be molded at very low pressures with minimal plunger dwell under pressure to prevent warpage. Molding temperatures may be anywhere from 325° to 650° F, however, only high enough to eliminate cloudiness and weld lines in the finished part is a good rule of the thumb.

If the machine is equipped with an injection speed control valve, set it for maximum flow to eliminate weld lines where two walls of flowing resin meet. Dies can be cooled to a great degree. Non-silicone type mold releases should be used. Do not use any mold release unless it is specifically recommended for *polyolefins*. These resins can be re-ground and recycled many times. Pre-drying of the resin is not necessary.

#### (2) Polystyrene

*Polystyrene* resins in general are among the easiest to mold. General-purpose materials can be molded anywhere from 325° to 550°F, but high impact grades must be molded at 450°F or less to avoid losing its high impact properties. Several problems can be experienced running *polystyrene*. One is difficulty in ejecting from the die. Over packing the mold by using excessive injection pressure is one cause of this. Since *polystyrene* experiences very little shrinkage during the cooling cycle, adequate draft or taper on the molded parts are needed. Extra long injection dwell after the mold is filled will aggravate the problem.

If the machine has hydraulic ejection, set the cylinders to “push” rather than strike the parts due to its brittleness. Mechanical ejection can be softened by using the cushion adjustment on the clamp cylinder.

Another problem with *polystyrene* is “silver streaking” of the part. This is generally caused by excessive material heat or long inventory time. When running very small shots, compensate by lowering temperature settings.

Small gates can generally be used as they can always be enlarged. Most mold releases can be used, and drying is not usually necessary. Die components such as cavities, runners, and gates should be hardened, as *polystyrene* is somewhat abrasive. It makes a good purging compound for that reason. Die heat is usually not necessary.

### **(3) Nylons (Polyamides)**

The molding of *nylon* can be summed up in one statement: **be sure the material is dry!** Most problems in molding *nylon* are the result of excessive moisture in the material. It is very hygroscopic and sealed containers as supplied by the resin manufacturer contain sufficient moisture to affect molding. When a can or bag is opened, the contents will immediately start to absorb moisture. Before molding, either dry the material in an oven for 10-12 hours or use a desiccant type dryer. Hopper dryer/loaders also are useful.

If the material has too much moisture, it will bubble and boil and many bubbles will appear in the finished part. Excessive stringing and drooling at the nozzle will also result. *Nylon* can be molded at temperatures from 500°F and up, but best results are obtained in the very small “window” where the *nylon* is actually resinous. This is usually between 500-520°F. Above that temperature, it becomes very watery, and tends to flash in the mold. If your cycle is fast and residence time of the material is short, higher temperatures may be necessary to plasticize quickly. Brown streaks indicate the temperature is set too high. Experimenting with nozzle temperatures can help to control drooling, but a non-drool shut off nozzle is almost a necessity. Some added die heat might be necessary in some cases. Pressures of over 10,000 PSI are also needed.

### **(4) Cellulosics (Acetate, Acetate Butyrate, & Propionate)**

*Cellulosics* are not particularly hard to mold but tend to be somewhat unstable, especially *acetate*. *Cellulosics* were the first successfully molded thermoplastics, and are still popular for eyeglass frames and similar items. Careful control of temperatures must be maintained, and nozzles, screws and barrels must be cleaned regularly to prevent accumulation of burnt residue. This can be done by physically cleaning the components or frequent purging. Cleaning is important as *butyrate* in particular releases gasses that could be corrosive to cylinder components. Pre-drying of *acetate* is advisable, and good surface finishes may be obtained by using a little die heat and as little injection pressure as possible. A speed control on the injection cycle may be helpful in eliminating “skid” marks on the part surface. Avoid overheating *acetate*, as its plasticizer will boil. Pressures over 10,000 PSI are usually not necessary.

### **(5) ABS Resins**

ABS resins require higher injection pressures than the *cellulosics* and may require some die heat. These materials mold in a fashion similar to high impact *polystyrene*. It also must not be overheated, or it will lose its high impact properties. Do

not use gates that are too small, as the material will freeze quickly before the cavity(s) get completely filled. Pressures over 10,000 PSI may be necessary.

Beside the impact properties, one of the most desirable features of ABS resins is their ability to be chrome plated. If your part will be chrome plated, the results will be much better if the material is pre-dried before molding.

## **(6) Acrylic Resins**

*Acrylic* resins are not difficult to mold and are very popular for applications such as lenses. The optic grades in particular make clear lenses. The melt viscosity of acrylics is very high, and to get a good surface finish the filling speed of the mold should be consistent, since the consistency seems more important than the actual rate. Some die heat improves surface finishes by preventing material “skid” during filling. During injection, if undersized gates are used a resistance is created before the filling begins. This resistance causes an unwanted “spurting” of the material through the gates. To eliminate this spurting, gate sizes may be gradually increased on a new mold. A speed control on injection may be helpful in injecting at a consistent speed. Pre-drying, especially when using optic grades, is beneficial. A simple assist when using material put in the hopper from a desiccant dryer or oven is to mount an infrared heat lamp on the hopper with the light directed at the material. Large gates and high injection pressures are usually needed. Do not use a mold release compound on optic grade parts. Temperatures over 450° F should also be avoided.

## **(7) Polycarbonates**

*Polycarbonates* have extremely high melt viscosities even at the high (up to 550° F) temperatures they sometimes require to mold. The injection pressures required are usually over 12,500 PSI and some die heat is necessary. Die heat requirements of up to 250° F are not uncommon. Large gates promote good flow but may also require cutting, rather than breaking off due to the toughness of the material.

*Polycarbonates* are even more hygroscopic than *nylons*, and absorb moisture as soon as they are exposed to the air. If your dryer is independent of the machine, it is advisable to dry small quantities at a time to avoid moisture absorption. The material can be kept dry in the hopper by using the infrared lamp as described in the above section on *acrylics*. Hopper/dryer units may actually assist plasticizing by pre-heating the material.

If die or material temperatures are too low, surface scratches will appear. Excessive moisture will appear as bubbles in the material and cause uncontrollable drooling from the nozzle. Overheating will also cause excessive drool and if noticed, the cylinder should be purged immediately. Filling speed may have to be reduced if splay marks appear around the gate area. To prevent sink marks in parts with heavy sections, the part can be ejected into a pail of cold water. This also adds a little moisture back to the finished part to avoid brittleness caused by the excessive drying

required for these resins. Nozzle temperatures set too high may also increase the occurrence of drooling.

### **(8) Polyvinyl Chloride (PVC) Resins**

Plasticized PVC resins can be extremely easy to mold providing reasonable care is taken during the processing. Rigid, or unplasticized, PVC resin is more difficult to mold due to its heat sensitivity. However, the relatively low capacity of Mini-Jector barrels makes it less difficult. Be sure to purge material whenever the residence time would start degradation or burning. Rigid PVC processes much like ABS but at lower temperatures.

Plasticized PVC is also heat sensitive but to a much lesser degree. The hardness or “durometer” of the resin determines the processing pressures and temperatures. Low durometer (up to 80) materials are extremely flexible and require very little heat and pressure to mold. This increases proportionately as durometer increases, but for very low durometer materials molding temperatures can start at less than 300° F. When PVC degrades, it emits chlorine gas, which unites with any water present to form hydrochloric acid. This can corrode molds, cylinders, and any unprotected metals in the molding area. It is a good practice to provide a fan type ventilation system over the machine if PVC will be the primary molding material. When it degrades, carbon residue remains in the spreader channels and may have to be removed by disassembly and cleaning. If plasticizing seems reduced, a spreader channel may be plugged. Purging with *polystyrene* when degradation occurs may remove the residue, but remember that PVC degrades on a time-temperature exposure pattern. If left in residence at low temperatures for a long time, degradation may still occur. The first signs will be smoking at the nozzle and a chlorine smell. Commercial purging compounds contain styrene, mineral oil, and Fuller’s earth. Consult PVC manufacturer for purging compound recommendations.

For best molding results, start at low temperatures and increase them until the surface of the finished part starts to appear glossy. If gate restrictions are too great (or pressures too high) some degradation due to frictional heat may occur. This is indicated by localized discoloration.

### **(9) Acetal Resins (Delrin, Celcon, Etc.)**

*Acetals* are relatively hard flow resins that require some of the cautions observed in molding PVC as outlined above. *Acetals* emit formaldehyde gas when overheated which can be noxious, so follow the manufacturers’ temperature setting recommendations and purge when you suspect overheating (or over exposure) of the material. The same purging procedures as used in processing PVC should be used here as well, but temperatures below 400° F are usually safe from overheating. Due to the high flow resistance of the resin, pressures over 12,000 PSI may be necessary. Some die heat may be required to produce smooth, glossy surface finishes. Rapid

mold filling, which requires adequate venting of the cavities, enhances the molding of acetals.

Do not use restrictive runner systems in your dies for this material as it may “pipe”, or chill, prematurely in the small runners. Small gates do not seem to affect molding as much as small runners do. “Worming” of the material, or a spiral pattern leading away from the gates, would indicate undersized gate diameters.

Mold releases are usually not required with *acetal* resins, as these materials are self-lubricating. Use caution when purging, as unmelted pellets may burst through the nozzle. Reverse taper or restrictive nozzles seem to drastically reduce effective injection pressures. Venting of machine areas when *acetals* are being molded is recommended.

### **(10) Fluorocarbons (Teflon, Kel-F, Etc.)**

These resins are not commonly molded, and require melt temperatures in the 800° F range and die temperatures of up to 450° F. A minimum pressure of about 20,000 PSI is required to mold these materials. Using a slow mold filling process usually helps with part quality. If the granular resin contacts an un-plated or non stainless steel ferrous part in the injection system, it may discolor the melt. Consult with the factory prior to running these materials.

### **(11) Elastomers (Polyurethanes, Thermoplastic Rubbers [TPR's])**

There are as many grades and durometers (hardnesses) of elastomers as there are in PVC resins. Processing low durometer *urethanes* or TPR's is similar to molding plasticized PVC with several exceptions: *urethanes* are hygroscopic and must be thoroughly dried prior to molding, and when overheated, become very watery, causing flashing and drooling. Temperatures are generally much higher than PVC (425° F or more). Some TPR's have thermosetting properties and may prematurely harden in the heating barrel. Rough finishes or excessive drooling indicates that the material is not dry enough.

### **(12) Thermoplastic Polyesters (TPE's)**

These resins can be processed with ease if only a few precautions are used. If the material is allowed to remain in the barrel under heat too long, it may “carbonize” or solidify in the screw flights in the transition zone, blocking material plastification. This is usually indicated by inability to feed material. Common *polyesters* or bulk molding compounds are not recommended in these machines.

### **(13) Glass Filled Materials**

Fiberglass strands or balls are frequently used to strengthen molded parts by being mixed (in proportions up to 40%) with the parent resin. Always use processing

parameters as recommended for the parent resin. Filled materials shrink less, requiring more draft on mold cavities. Occasionally, nozzles must be disassembled and physically cleaned to remove accumulations of filler. Non-drool nozzles in particular tend to have one or more of the converging passages block after prolonged use with filled materials. These resins are also abrasive and the strands can wear down screw flights, nozzle bodies, and other cylinder components. Using higher than normal rear zone heat settings tends to “soften” the glass strands and minimize wear.

#### **(14) Ceramic Materials**

Ceramic patterns can be molded by mixing ceramic powders with plastic or wax “vehicles”. They then are heated to a high temperature to evaporate the plastic (usually *polystyrene*) or wax, leaving the ceramic piece. *Styrene* based materials process much like ordinary *polystyrene* plastics, but the ceramic is extremely abrasive. Mini-Jector screws and barrels can be made of very durable materials for ceramic use. Consult the factory if you expect to run ceramics.

#### **(15) Investment Waxes**

Investment waxes used in the “lost wax” casting process can be molded on Mini-Jectors with no problems. Lower watts/density heater bands should be used to prevent overshoot of temperatures, which are very low (200° F). Very low pressures are also required. Large screws with a smaller hydraulic injection cylinder are recommended. Investment wax can be thought of as a low temperature, low pressure *thermoplastic*. The more the raw material resembles a plastic pellet in shape or size, the better it feeds through the hopper system. Use cooling on the hopper tube. **THIS IS A MUST!**

#### **(16) Thermosetting Resins**

Molding of *thermosets* on a screw type Mini-Jector requires a zero compression ratio screw and a water-jacketed screw barrel and the nozzle must also be water-cooled. Do not attempt to run thermosetting resins in your Mini-Jector, as they will harden in the screw barrel and may be impossible to remove.

## APPENDIX B

### TROUBLESHOOTING COMMON MOLDING PROBLEMS

(1) Problem: Flashing of Molded part

Reasons:

- (a) Injection pressure too high
- (b) Material temperature too high
- (c) Injection dwell too long
- (d) Irregularities or damage to die faces

(2) Problem: Sink marks in molded part

Reasons:

- (a) Injection pressure too low
- (b) Insufficient screw forward time to allow gates to freeze under pressure
- (c) Gates too small or large
- (d) Material temperature too high to permit cooling during allotted time
- (e) Cycle time too short

(3) Problem: Burned or discolored molded parts

Reasons:

- (a) Material temperature too high
- (b) Nozzle temperature too high
- (c) Injection speed too great
- (d) Material remaining in inventory too long for temperature setting
- (e) Failure to purge or reduce temperatures during machine stoppage
- (f) Accumulation of residue from previous material
- (g) Material has been exposed to excessive pre-drying
- (h) Gates in mold too small causing frictional burning.

(4) Problem: Short or incomplete shots

Reasons:

- (a) Injection pressure too low
- (b) Material temperature too low
- (c) Die temperature too low
- (d) Insufficient material feed setting (extrude back)
- (e) Shot size exceeds machine capacity
- (f) Gates too small

(5) Problem: Small voids or unfilled areas in thin sections

Reasons:

- (a) Gates too small
- (b) Die temperature too low
- (c) Injection pressure or heats too low
- (d) Insufficient venting of mold cavity trapping air or gases
- (e) Injection rate of fill too high trapping gases in mold

(6) Problem: Drooling or stringing of material from nozzle

Reasons:

- (a) Material insufficiently dried
- (b) Nozzle or material temperature too high
- (c) Use de-compress feature if using straight orifice nozzle.
- (d) Use of incorrect type of nozzle-nozzle orifice too large
- (e) Nozzle plug and seat full of glass or other filler, or burned material preventing proper shut-off. Clean plug and seat.

(7) Problem: Splays or surface blemishes

Reasons:

- (a) Incorrect material temperature
- (b) Die temperature too low
- (c) Injection rate too fast or slow
- (d) Gates too small
- (e) Moisture in material

(8) Problem: Bubbles or internal voids

Reasons:

- (a) Material insufficiently dried
- (b) Improper venting of mold
- (c) Injection rate too high trapping bubbles
- (d) Injection pressure too low

(9) Problem: Parts difficult to eject

Reasons:

- (a) Insufficient draft on cavities
- (b) Injection pressure too high
- (c) Screw forward dwell too long (packs cavity)
- (d) Insufficient shrinkage allowance in die
- (e) Ejector travel too short
- (f) Lack of proper mold release spray

(10) Problem: Cloudiness in molded part

Reasons:

- (a) Contamination or moisture in resin
- (b) Material temperature too low
- (c) Excessive or improper mold lubricant
- (d) Improper purging procedure