



Valve Gate Control

Installation and Setup

RJG, Inc.
© 2011



Safety Symbols

These operating instructions must be read, understood and implemented in all respects by all personnel who are responsible for the eDART System™. These operating instructions should be kept available so all personnel can quickly refer to them at any given time.



<i>Please refer to this table if you have any questions regarding the importance or meaning of the safety symbols used in this manual or on the eDART System™.</i>	
	This symbol is used as an operational safety symbol for all work that involves a risk of life and limb for personnel. This symbol also identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss. Where this symbol appears throughout this manual, please exercise particular care and caution while carrying out tasks.
CAUTION	This precautionary warning is shown at locations of particular sensitivity, in order to avoid any damage and/or destruction of the device or system and/or other parts of the installation.
NOTE	This sign draws attention to a particular technical feature.
	This symbol is used as an operational safety symbol for all work that involves risk of electrocution. For instance, it can represent areas of high voltage where power should be disconnected in advance of any servicing.

Table 1: Explanation of Symbols

Valve Gate Hardware Setup

Introduction

The *eDART®* has the capability to control valve gates directly while it is doing other monitoring and control functions. To do this, it must be purchased with the Valve Gates control tool option and enough Relay Output (OR2-D) modules to operate the number of gates required.

Once installed, you can set up a process to open and close each gate independently using pressure, position, time, temperature, or the operation of other valve gates. This makes the process more capable by more precisely controlling pressures, flow lines or knit lines or allowing reduced clamp tonnage through alternate filling and packing.



Attention: The Valve Gate power source must be interrupted by the machine's E-Stop! This is the responsibility of the installer and failure to do so may result in serious injury and/or death.

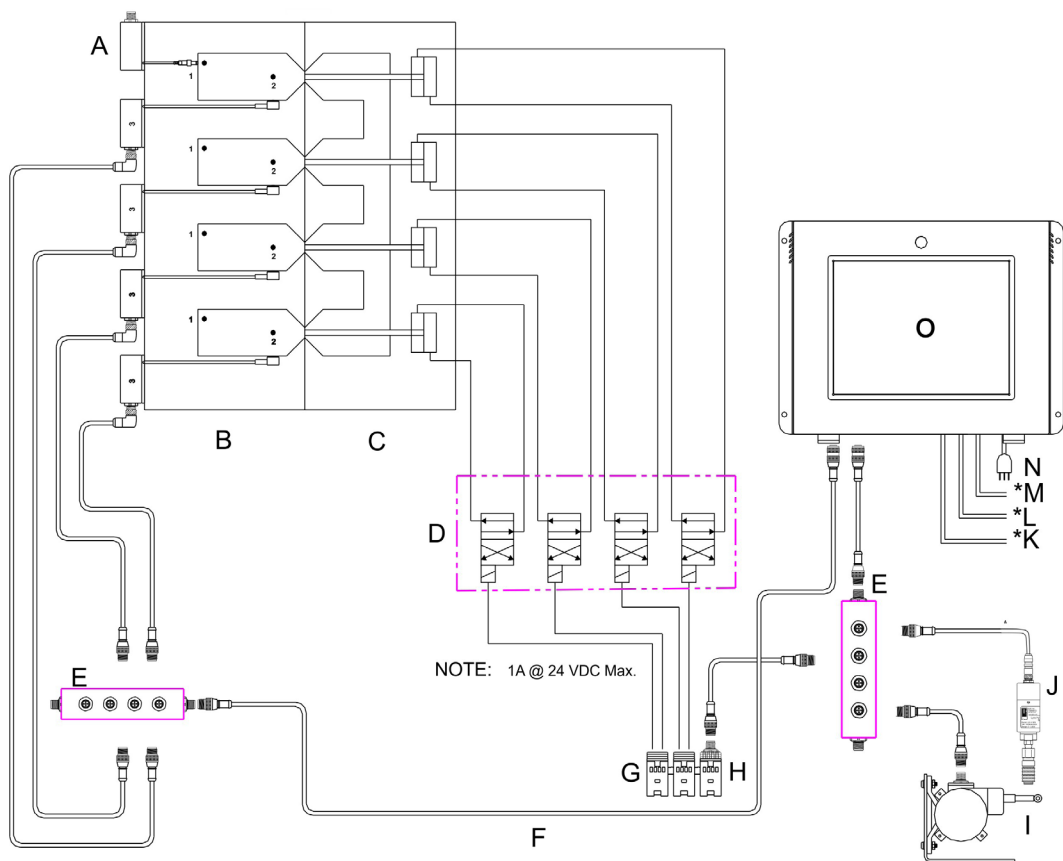


Figure 1: Valve Gate/*eDART®* Connections

A	Lynx Sensors - In Cavity Control	E	J-LX5	H	ID7-D Seq	L	Keyboard
B	Cavity Half	F	Lynx Cable to Lynx port 2 on <i>eDART®</i>	I	Stroke	M	Mouse
C	Valve Gate Manifold	G	OR2-D	J	Hydraulic	N	Power
D	Valve Gate Solenoid			K	Video	O	<i>eDART®</i>

Table 2: Valve Gate/*eDART®* Connections

Inputs to eDART®

Lynx Device	Input	Function	Required
Sequence Input Module (ID7-D-SEQ)	Injection Forward	Master sequence for start at cycle and opening and closing gates.	Yes
	Screw Run	Stroke direction, zero and material variation information.	Yes
	Mold Clamped	Gate close backup. Accurate cycle time and integration limit.	Yes
	Machine in Manual	User configuration determines whether valve gates are prevented from opening or forced to open during purges. Prevents parts counts/data storage when machine is in manual.	No*
	Valve Pressure Supply	When ON this signals the eDART® valve gate control that the hydraulic or air pressure to operate the gates is working, When OFF the eDART® assumes that it cannot operate the valves and puts up an alert message to that effect.	No*
Stroke Velocity Encoder (LE-R-30)	---	Monitors screw position and speed. Used to sequence valves open or closed on volume.	Yes
Injection Pressure	Hydraulic, nozzle pressure or analog input	Measures injection pressure, sets backups and detects viscosity variations.	No*
Cavity Pressure Sensor	---	Controls valve gates by cavity pressure - results can be monitored (Go to www.rjginc.com for more information).	No*

Table 3: Inputs

Outputs from eDART®

Lynx Device	Output	Function	Required
Dual Relay Output Module (OR2-D)	Velocity to Pressure (V -> P Transfer) Contact Closure	External transfer to the machine to switch from velocity control to pressure control once all of the valves have closed.	Yes
	Inject Enable Contact Closure	The eDART® will open this contact if anything fails. This should stop the machine from injecting before mold damage can occur.	No*
Open Valve Relay Output	Contact closure to valve solenoid**	Each contact closure operates one valve solenoid.	Yes

Table 4: Outputs

* While listed as not required, these are recommended for successful valve gate implementation.

** RJG does not currently supply the solenoid or the air or hydraulic supply.

Installation and Checkout

Wiring

A	+24V DC Power
B	OR2-D Relay Contacts (& Arc Suppressor)
C	Valve Gate Solenoid
D	DC Common (Ground)
E	Shown wired to the normally open contacts

Table 5: Wiring

NOTE: Max Current 1 A @ 24 VDC. If Solenoid requires more - use auxiliary relay.

DC power supplied by customer machine or valve power pack.

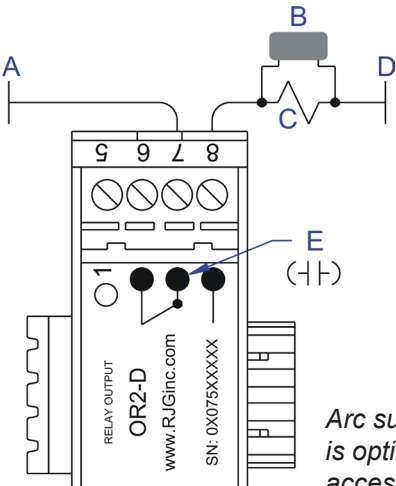


Figure 2: Wiring Diagram

Arc suppressor location shown is optimum. If there is no access to common (D), then it may be wired across the normally open contacts of the OR2D.

CAUTION: Valve power source (A) must be interrupted by the machine's E-Stop.

CAUTION: Place an arc suppressor such as an ITW Paktron "Quencharc" #504M06QA100 across each set of contacts on the OR2-D module to prevent damage to the relay contact over time.

You can control two (2) valve gates with one (1) OR2-D module. As you wire each set of contacts, record the valve gate to which it goes by serial number and "signal" number (side 1 or side 2 of the module). A maximum of 14 output devices (currently OR2-D's or analog outputs OA1-D) can be connected to each Lynx port on the eDART®.

For each valve gate, you can set the function that is performed when the relay in the OR2-D module becomes energized. You can tell the system that the valve gate opens or that it closes when energized. You will set this when you first name the OR2-D module in the Sensor Locations tool.

When Contact Close	On Failure, the Gate Should...	Wire to Relay Contacts...	"Location" Selection in Sensor Locations Tool	Use with Application...
Gate Opens	Close	N.O.	"Open Gate"	Hot Runner
Gate Opens	Open	N.C.	"Close Gate"	Cold Runner Pinch Gate

Table 6: Wiring and Choosing Valve Direction

NOTE: For specialized configurations, contact RJG.



Attention: Hot Runner Valve Gates must be wired so that E-Stop or power loss causes the gates to close.

Dual Solenoid Systems

Some valve gate actuation systems have two solenoids per gate: one to open the gate and one to close it.

If you have a dual solenoid system, please refer to the diagram for the best wiring practices.

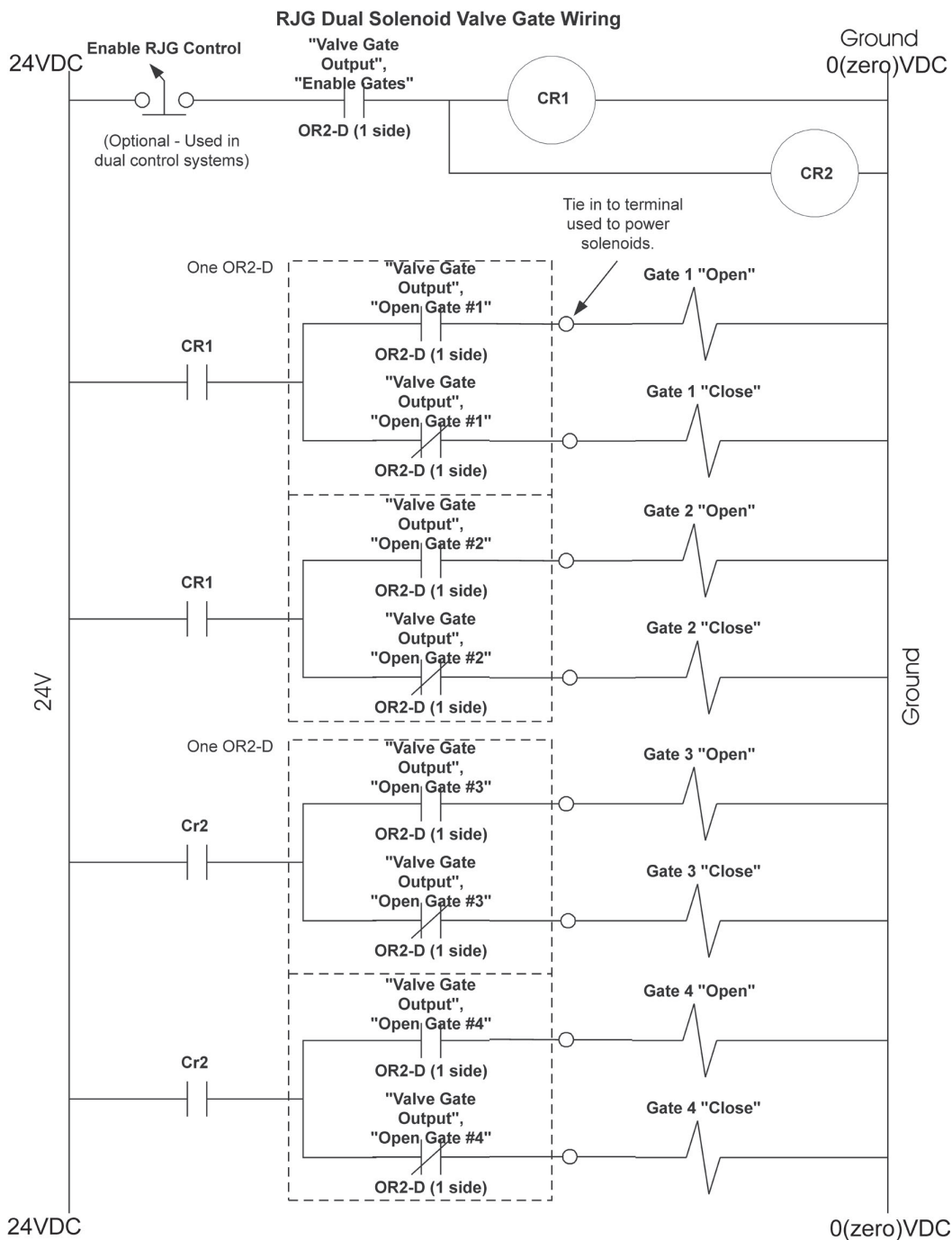


Figure 3: RJG Dual Solenoid Valve Gate Wiring



Attention: The Valve Gate power source must be interrupted by the machine's E-Stop! This is the responsibility of the installer and failure to do so may result in serious injury and/or death.

Software Setup

Figure 4: Job Setup

“Select sensor locations and scaling” tool

- A. Start the job by selecting or entering mold and machine names. Then click the *Accept* button on the Job Setup tool. After accepting the job, the Sensor Locations tool appears - see B - F below.
- B. **Sensor Type:** In the Sensor Locations tool, select the types and locations for each of the control outputs. Change the “type” for each valve gate contact closure from *Control Output* to *Valve Gate Control* using the drop down menu.

Figure 5: Select Sensor Locations

- C. **Sensor Location:** Change the “location” for each to represent what the control does when the relay energizes: *Open Gate* or *Close Gate*. You should use Open Gate for Hot Runner systems and Close Gate for Cold Runner Pinch Gates. (See Table 6 on Page 4)
- D. **Cavity Identifier:** Enter a cavity name or number in the Identifier column for each control. Use the same ID that you used for the cavity when you named the cavity pressure sensors. If a cavity has more than one gate, choose an ID that represents both the cavity and location of the gate in it; e.g 1-End or 2-End

“Select sensor locations and scaling” tool, cont.

- E. The “Signal” number to the right of the colon (1 or 2) indicates the side of the OR2-D to which the row refers. So each OR2-D has a serial number and two rows in the table, one for each side.
- F. **Accept:** Click the *Accept* button and start the rest of the job (machine size, pin sizes, etc.).

Valve Gates Tool

Once the software has started, “attach” the Valve Gates tool to this mold. Open the Architect from the Main Menu, make sure that the large Mold button (1) is clicked. Select the Controls tab on the right then click and drag the Valve Gates tool onto the blue workspace. Now drag the V to P Transfer tool onto the workspace and save changes. Close the Architect when you have finished. Now the tools you have selected will automatically start the next time you run this mold.

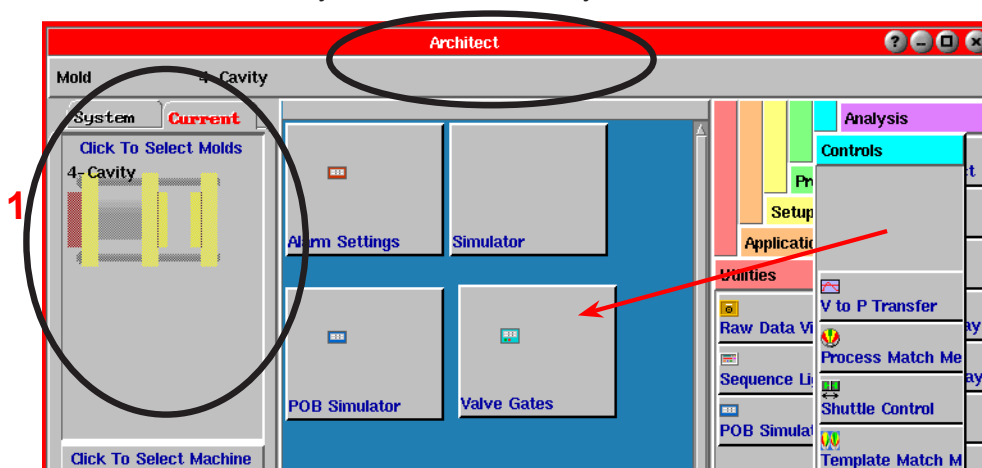


Figure 6: Activating Valve Gate Tool through Architect



Figure 8: Valve Gates Application Button

- G. You should now see the *Valve Gates* button (see below) on the toolbar at the bottom of the screen. Click on the button to bring up the Valve Gates tool.

Valve Gates Tool

H. Each row represents one valve gate with the ID that you gave it in the Sensor Locations tool.

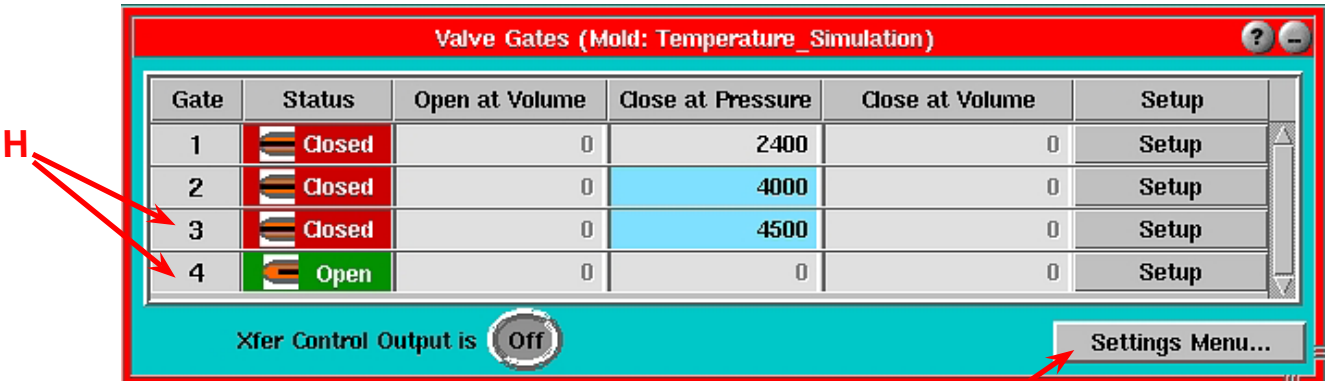


Figure 7: Valve Gates tool

Valve Gate Test

To test the valves, select Settings Menu and then Test All Valves. Here you can test all valve gates at once.



Figure 8: Tests All Valves

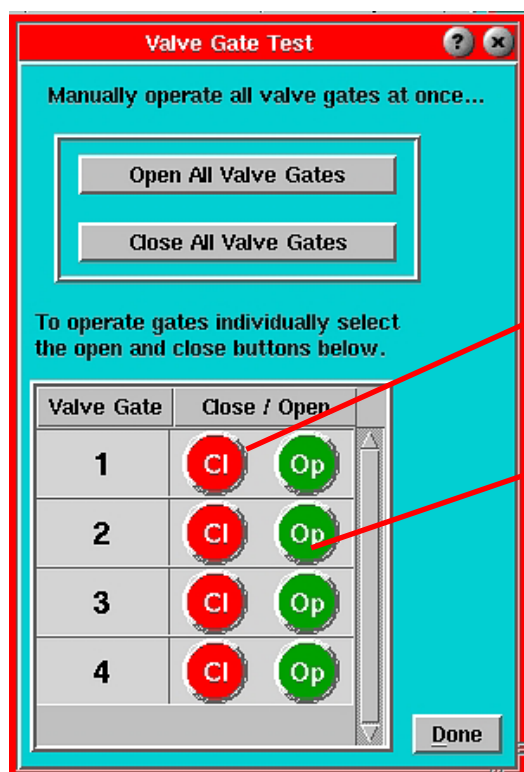


Figure 9: Valve Gate Test

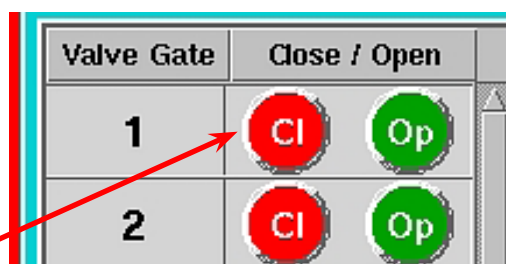




Figure 10: Test Individual Gates Tool

(The eDART® automatically closes this window when the press cycles.)

- I. Open All Valve Gates:** Click this button to switch all valve gate controls to “Open” simultaneously.
Do NOT use this control on cycle because it overrides your control settings for open and close.
- J. Close All Valve Gates:** Click this button to switch all valve gate controls to “Closed” simultaneously.
Do NOT use this control on cycle because it overrides your control settings for open and close.
- K. Close one valve at a time.** You can also test individual gates from the Valve Gate Tool by clicking on the Setup button in the row for that specific gate. *See figure 10.*
Do NOT use this control on cycle because it overrides your control settings for open and close.
- L. Open one valve at a time.** You can also test individual gates from the Valve Gate Tool by clicking on the Setup button in the row for that specific gate. *See figure 10.*
Do NOT use this control on cycle because it overrides your control settings for open and close.
- M. Done:** When clicked, this button will close this window and return control to the valve gate controller using its setpoints, etc.

Velocity to Pressure Settings

- N. From the Valve Gates Menu main window:
- Click on the Settings Menu button from the Valve Gates tool and select General Settings from the menu to bring up the V -> P Machine Transfer Settings screen.
- O. Make sure that the box is checked to transfer the press when all valve gates have closed. The only case in which you would un-check this box is when the valve gate control was operating powered vents and you wanted the machine to pack with velocity control after the vents have closed.
- P.  If you intend to purge through the mold and the valve gates, you should check the box so that the gates open even in manual mode and allow the material through.
-  If you do not purge through the mold, uncheck the box so the gates stay closed during purges and thus prevent drool and extra gate operations while in manual mode.
- Q. This only applies to the “Re-open after transfer” function (set separately for each valve gate). Only uncheck this box for specialized applications for which the gate must open very late in the cycle.
- R. Volume backup - The “Convert to Pressure” feature turns on the volume shut-off automatically at the percentage shown above the volume at close.

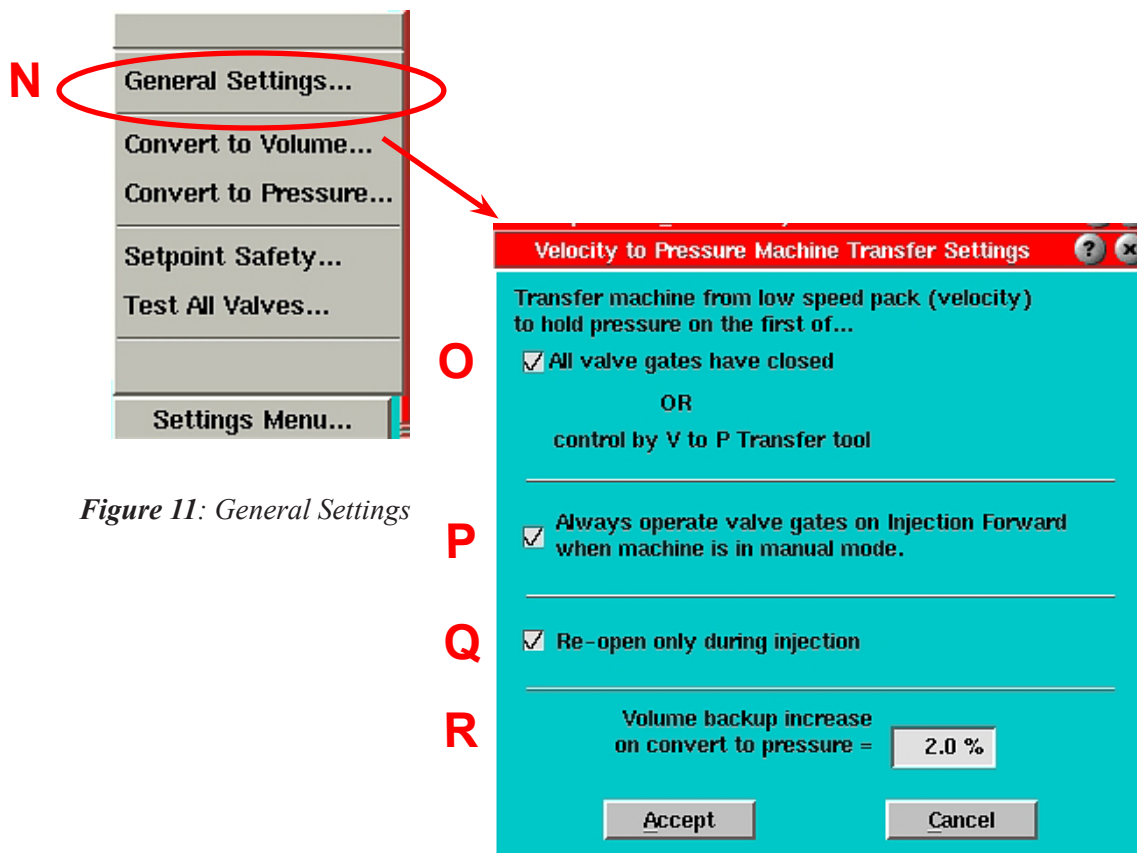


Figure 11: General Settings

Figure 12: V -> P Machine Transfer Settings screen

Valve Gates Control Tool Reference

The basic function of the Valve Gates control tool is to open valve gates at specific events during the cycle and close them again at other events. Usually the most powerful scheme for part quality is to use cavity pressure. The Valve Gates control tool will also allow you to set open and close events by in cavity temperature, injected volume (stroke) or time.

The main Valve Gates screen (below) lists each valve gate that the system has found by name (or number). The names are given to the valve gates when the valve gate OR2-D modules are first identified by the eDART® at start-up. These are set up in the Sensor Locations tool.

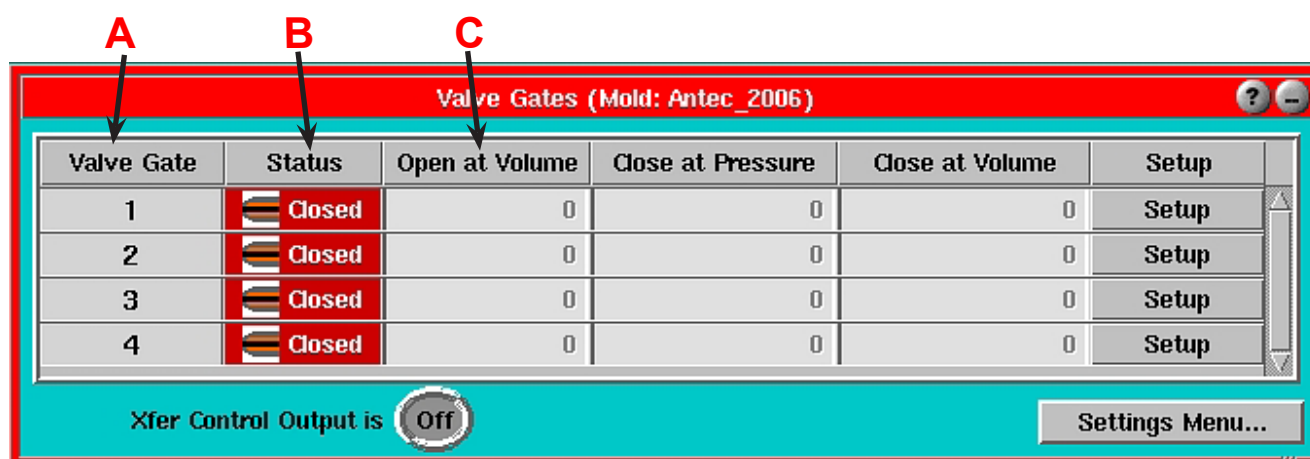


Figure 13: Valve Gates Control Tool

NOTE: Set up the method or methods for opening and closing the valves. To do this, use the individual row Setup button and then choose the Open Control and Close Control selections from the menu.

- A. Valve Gate Number (or name):** This is the ID given to the valve gate when you selected the location in the Sensor Locations tool. Any valve gate can be controlled by several different inputs so a valve gate is not always associated directly with a sensor. Also, there may be more than one gate in a cavity.
- B. Status - Open or Closed:** This column shows the status of each valve gate during the cycle (open or closed). Red is used for closed, green for open (plus an icon). If the status shows “No Ctl.”, the OR2-D module for it is disconnected or the name has been changed in Sensor Locations.
- C. Open at Volume:** This column shows the volume above zero at which the valve gate is set to open. Zero is the position of the screw when the screw motor stops. The volume increases as the screw moves forward (material injected). Use this feature to balance family tools that have dramatically different cavities.

This field shows grey and blocks entry if the “Open on Volume” tick box is not ticked in the “Setup” dialog for the specific valve gate. It shows blue at the end of the cycle if the valve gate actually opened at this volume. It shows black and white if it opened for some other reason before it reached the open volume.

NOTE: If you do not have cavity pressure sensors for control, the valve gate can be set to close on a shot volume (See “Close Valve at Volume”).

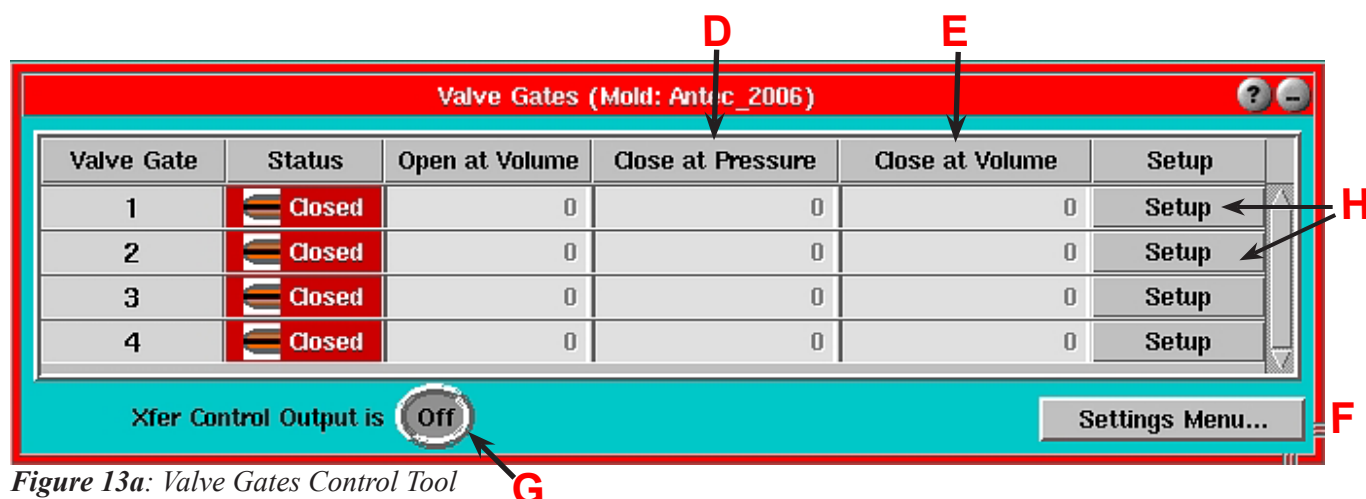


Figure 13a: Valve Gates Control Tool

Valve Gates Control Tool, con't.

- D. Close Valve at Pressure Level:** When the pressure reaches this level at the selected sensor, the valve will close. If this field is highlighted in blue, the valve closed on cavity pressure. If the value is gray and cannot be set, cavity pressure control is not enabled.
- E. Close Valve at Volume:** When the volume (from the stroke/screw area) reaches this level, the valve will close. If this field is highlighted in blue, the valve closed on volume. The value in this column is shown in the units selected on the Valve Gate Close Control screen (Figure 14).
- If you are also using cavity pressure, the first to reach its setting (cavity pressure or volume) will close the valve. Thus the volume setting can be used as a backup in case the cavity pressure never reaches its setting.
- If the value is gray and cannot be set, the Close on Volume control is not enabled. Open the Valve Gate setup screen (Figure 14) and check the "Injection volume reaches" box.
- F. Settings Menu:** The Settings menu contains the general settings for this Valve Gate Control.
- G. Control Output Light:** This light is on (and says so) whenever the output relay contacts to transfer the machine are on (closed). You will see that once the program has transferred the machine from pack (low velocity) to hold (pressure control), the output stays on until the end of injection. The "On" time may be quite short if the machine responds quickly and there is no hold time set up.
- H. Setup:** Each valve gate has separate settings for open and close controls. You can set them by clicking the Setup button for each specific valve gate and choosing either Valve Open Control or Valve Close Control from the menu. In addition, you can test the operation of the valve gate control contacts by selecting "Test this valve". (See Figure 14)

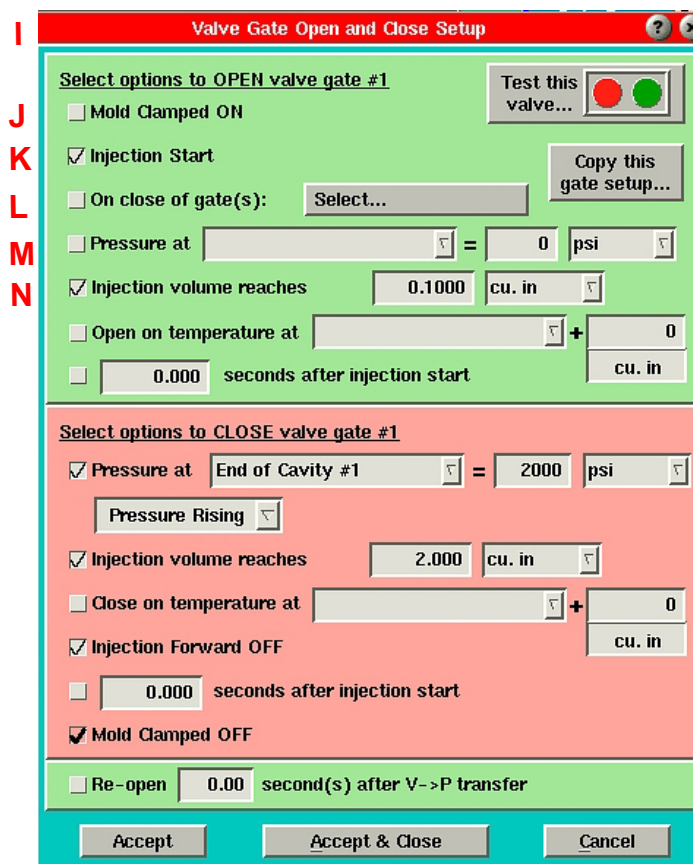


Figure 14: Valve Gate Open and Close Setup tool

Valve Gate Open

- I. **Valve Gate Open Control:** To bring up this screen, select Valve Open Control from the Setup see "H" in figure 13a page 12. Here you can choose when the selected valve gate should open. Note that you can select more than one option or none if you want to keep a cavity closed during process setup.
- J. **Open on Mold Clamped:** If checked, the valve gate will open when the mold clamps. It is especially useful for pre-heating valve pins in polycarbonate applications.
- K. **Open on Injection Start:** If checked, the valve gate will open at start of injection (if not already opened by mold clamped). This function can be used as a backup in case the Mold Clamped signal does not come on for some reason. When starting a new job, this box is always checked.
- L. **Open on Other Valve Gate Closed - See Applications Manual for details on alternate cavity sequences**
- M. **Open on Pressure - See Applications Manual for details - Sequential knitline control**
 Open Gate Sensor: Name of pressure sensor to set open gate
 Open at Pressure: Open when pressure reaches set value
 Pressure Units: Units for the pressure value
- N. **Open on Injection Volume - See Applications Manual for details - Balance or sequential knitline control**
 Volume Setpoint: See letter 'C' on page 11
 Volume Units: Units in which volume is displayed

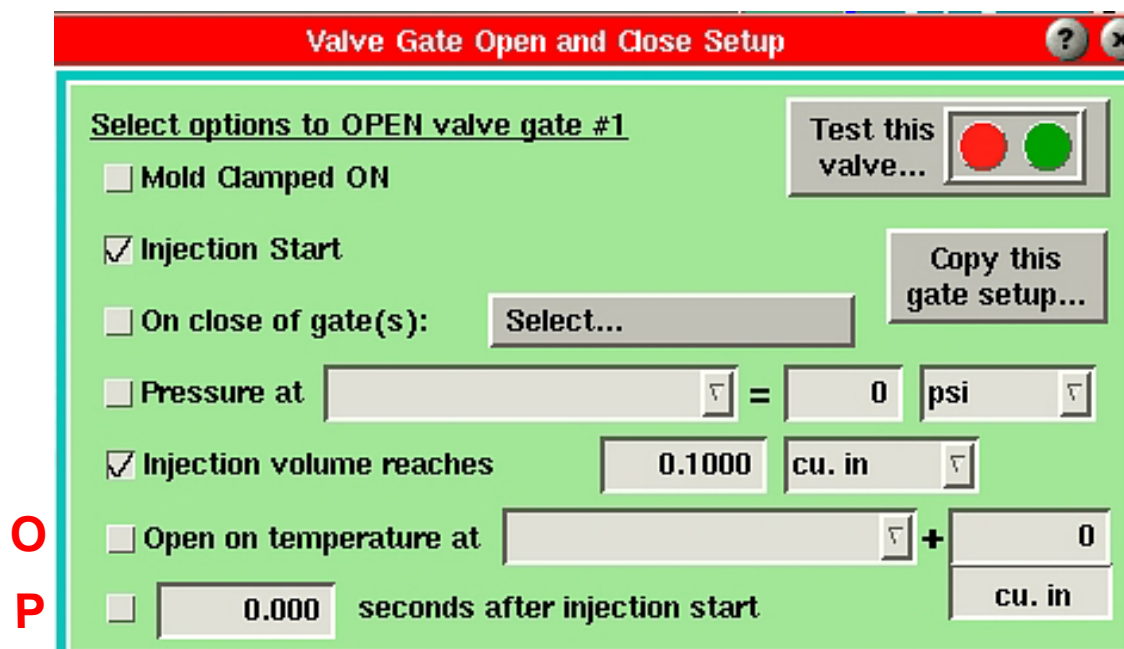


Figure 15: Valve Gate Open Setup tool, con't.

Valve Gate Open, Con't.

- O. Open on Temperature:** If you have a cavity temperature sensor installed in the mold then you may use it to open the valve gate. This is particularly useful in processes such as structural foam or coining in which there is no pressure in the material as it flows past the sensor. The *eDART*® picks up the quick rise in temperature even without pressure.

Since temperature detector only detects a quick rise the value that you enter to the right is actually a volume of screw travel AFTER the flow front reaches the sensor. Thus if the sensor is installed in a position slightly upstream of when you want the gate to open you can tell the controller to allow the screw to advance by a certain volume before opening the valve gate. The volume number is the increase in volume from what it was when the flow front reached the sensor.

- P. Open on Time:** We do not recommend using time for opening because it is not robust. However if you are replacing an older valve gate control that was based on time with the *eDART*® control you may wish to enter the old time settings as a starting point. Then, once the process has stabilized you can use the "Convert to Pressure" selector (from the main window's "Settings" menu) to turn off the time based controls and begin controlling on pressure. If you do not have cavity pressure sensors you can use the "Convert to Volume" to create volume based setpoints and turn off the time control.

Select options to CLOSE valve gate #1

Q ☒ Pressure at End of Cavity #1 = 2000 psi

Pressure Rising

R ☒ Injection volume reaches 2.000 cu. in

☐ Close on temperature at + 0 cu. in

☒ Injection Forward OFF

☐ 0.000 seconds after injection start

☒ Mold Clamped OFF

Figure 16: Valve Gate Open Close

Valve Gate Close

- Q. Close at Pressure Enable:** Check the “Pressure at” box to cause the valve gate to close when the sensor pressure at the right reaches the level set. If enabled, the value can be set from the main Valve Gates screen (Figure 7).

Sensor for Valve Gate Close: Select the sensor (plastic pressure) that you wish to use to close the valve gate at the pressure level to the right.

Close at Pressure: The valve gate will close when the pressure (plastic) on the sensor selected reaches the set level. You can adjust this value quickly from the main Valve Gates screen under the Close at Pressure column. Note that if you use “Injection”, the pressure shown is NOT hydraulic pressure, but plastic pressure (hydraulic X intensification ratio).

Close Pressure Units: These are the units for the pressure setting to the left. The pressure value shown on the main Valve Gates screen is also set in these units (even though the units are not shown there).

Close During: See Applications Manual

- R. Close on Volume:** Check “Injection volume reaches” box to cause the valve gate to close when the injection volume reaches a certain level.

Use this feature for a backup to the pressure control in case pressures are never reached. This is especially important in alternate cavity systems where the first cavity must close to open the second cavity before the machine speeds up for its next fill stage.

You can also use volume close control if you have no cavity pressure sensors. The process will be controlled fairly well except for check ring leakage variations and variations in material compressibility.

Close at Volume Setpoint: Set this to the volume (stroke X screw area) at which you want the valve gate to close (shown in units at right). You can adjust this value quickly from the main Valve Gates screen under the Close at Volume column.

Volume Units: These are the units for the volume setpoint at the left. The volume value shown on the main Valve Gates screen is also set in these units (even though the units are not shown here).

S
T
U
V
W

Select options to CLOSE valve gate #1

☒ Pressure at End of Cavity #1 = 2000 psi

Pressure Rising

☒ Injection volume reaches 2.000 cu. in

☐ Close on temperature at + 0 cu. in

☒ Injection Forward OFF

☐ 0.000 seconds after injection start

☒ Mold Clamped OFF

☐ Re-open 0.00 second(s) after V->P transfer

Accept Accept & Close Cancel

Figure 17: Valve Gate Close Setup tool, con't.

Valve Gate Close, con't.

- S. Close on Temperature:** If you have a cavity temperature sensor installed in the mold then you may use it to close the valve gate. This is particularly useful in processes such as structural foam in which there is no pressure in the material as it flows past the sensor. It may especially useful for be useful for closing a power vent valve. The eDART® picks up the quick rise in temperature even without pressure.

Since temperature detector only detects a quick rise the value that you enter to the right is actually a volume of screw travel AFTER the flow front reaches the sensor. Thus if the sensor is installed in a position slightly upstream of when you want the gate to close you can tell the controller to allow the screw to advance by a certain volume before closing the valve gate. The volume number is the increase in volume from what it was when the flow front reached the sensor.

- T. Close on Injection Forward Off:** This is a sort of “last resort” to close the valve gate at the end of injection forward before the screw starts running. It defaults to “On” as a backup in case pressure and volume are not reached or not set. Turn off to add or discharge material during hold.
- U. Close on Time:** This control will close the valve gate at the time after the start of injection. This is a backup in case pressure and volume do not operate. However, if machine speeds change, the amount of material injected in the set time can vary and cause flash or shorts. Generally time should only be used when transferring from an older time-based sequence.
- V. Mold Clamped Off:** This is shown in bold because it cannot be turned off. All valves must close at the end of the cycle to prevent drool or discharge on an operator.
- W. Re-open at Time After Transfer:** In some process (e.g. thick-walled parts) you may wish to place hold pressure on the material after all of the valves have closed and the machine transfers to hold. Activate this “re-open” feature by ticking the box to the left. You may then enter a time after transfer at which you want a valve to re-open. In most cases this would be zero to re-open at transfer. But some valves may not have actually closed right at transfer, especially if they are slow moving ones. So you may wish to delay the re-opening slightly to prevent bleed-back from one cavity to another. In that case you can increase the time after transfer at which you want the valve to re-open.

Setpoint Security

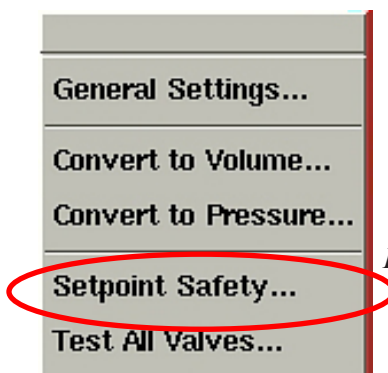


Figure 18: Setpoint Safety

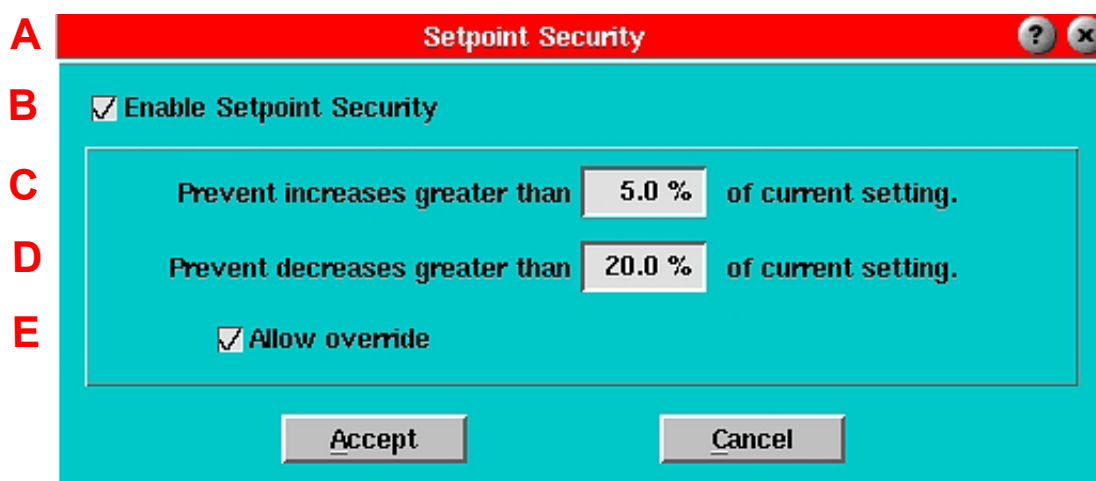


Figure 19: Setpoint Security

A. Setpoint Security: To bring up this screen, select Setpoint Safety from the General Settings menu on the Valve Gate tool. Here you can enable security on numeric settings such as setpoints.

B. Enable Setpoint Security: When this box is checked, the security features below are in effect. When unchecked, you can change cavity pressure and other setpoints by any amount you wish.

We recommend that you use security to help prevent overpacking a mold caused by, for example, the addition of an extra zero to the number you are entering.

C. Increase Prevent Level: When security is enabled, if you increase a setting by more than the given percentage of current setting a message pops up requesting confirmation.

D. Decrease Prevent Level: When security is enabled, if you decrease a setting by more than the given percentage of current setting a message pops up requesting confirmation.

E. Allow Override: If security is enabled and you exceed one of the change limits, this program presents a question to that effect. If you check the “Allow override” box, you will be allowed to make the change anyway. If the “Allow override” box is unchecked, the message simply says that you have exceeded the safety settings and the change will not be applied.

Frequently Asked Questions

Q. I have finished setting up the job to run valve gate control. But I cannot find the Valve Gate Control page, what gives?

- A.
1. Click on the Main Menu, choose Architect.
 2. Click on Controls tab and locate Valve Gate control icon.
 3. Drag and drop the Valve Gate control icon into the blue area with your mouse.
 4. Save Changes, and exit by clicking on the X button.

Q. I do not see Valve Gate control icon under the Controls tab in the Architect.

- A. Install the Valve Gate control software from the Optional Tools CD you received from RJG. You will need to establish a network connection with a computer from which you are going to install the software.

Q. What machine triggers must I have in order to run the Valve Gate control application?

- A. You MUST have Injection Forward, Screw Run, and Mold Clamped signals, at a minimum.

Q. Is V -> P transfer required?

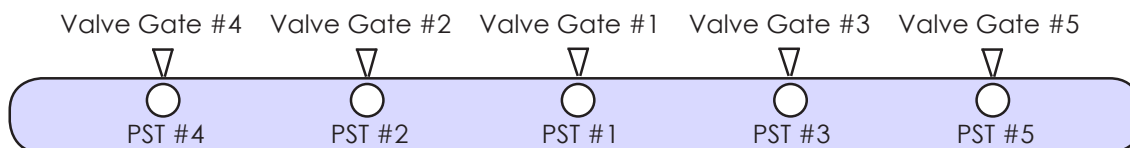
- A. Generally: Yes. If the *eDART*® cannot transfer the press out of velocity control once all gates close, then the press will continue to try to inject. This can build up pressure and cause leaks or can damage the manifold.

Also, you can set backups on the *eDART*®'s V -> P transfer tab to prevent over-pressurizing the manifold or any or all cavities in the tool.

For more information or help, contact the Customer Support department at RJG, Inc. by calling 231-947-3111 or emailing support@rjginc.com.

A Sequential Valve Gate Application

We propose three different schemes for controlling valve gates sequentially in a long flat part. Note that we speak in “volume” instead of screw position whenever possible. This “normalizes” your molds across all machines so that the control settings will be the same regardless of the screw diameter.



A. Shot Volume Control

While the example above shows sensors just past each gate (“PST” is “Post Gate”), let’s assume that you don’t have them on a particular mold. To prevent knit lines, you would shoot a series of short shots, recording the volume at each shot (“Peak, Shot Volume”) that just passes the next gate. Then you would set the open control for each gate to open at the volume found (plus a little for good measure). The open controls would look like this:

- ◆ Gate #1 opens at injection forward. This would be the only gate marked with the “Injection Start” check box in the Valve Gate Open Control screen.
- ◆ Gates #2 and #3 open at the volume where material has flowed past them.
- ◆ Likewise gates #4 and #5 open at almost full volumes.
- ◆ After the material has nearly reached the end of the cavity (at high speed), you would slow the machine to a pack speed, say about 10% of fill speed for an initial value.
- ◆ Each valve would then be set to close at a certain volume. By experiment you should be able to find a volume for each that will properly pack that area of the mold, assuming the balance does not change from shot to shot. Finally, once all gates close, the valve gate control transfers the machine to hold pressure. Alternatively, you could use a holding stage to pack the part out. Here you would close the valve gates at the end of injection forward by checking the “Injection Forward goes Off” box on the Valve Close Control screen.
- ◆ Since all of the gates are closed, you can remove hold pressure long enough to cool around any pulling cores and then end injection (by time) and start the screw.

B. Cavity Pressure Pack Control

If you have cavity pressure sensors, you can enter setpoints to close each valve at a specific pack pressure. You could still use volume settings to open the valves in sequence, but this may still cause variation with check ring leakage. To prevent this, you can use the cavity pressure knit line control discussed as the third approach.

In this scheme, each gate is set to close when its associated sensor reaches a setpoint. In the Valve Close Control screen, you would select the sensor location closest to the control point for that valve. It would not have to be post gate if the sensor were actually located at mid cavity or elsewhere. You can enter a volume setpoint in the Valve Close Control screen as a backup in the event that the pressure at that sensor never reaches its setpoint.

Note that cavity pressure control can operate on either rising or falling signals. Thus you can allow a cavity to pack to a higher pressure than required and then discharge some before closing the gate. If you use this scheme, you can get lower pressure gradients across the part, but you must transfer the machine once all of the valve gates have closed.

C. Cavity Pressure Knit Line Control

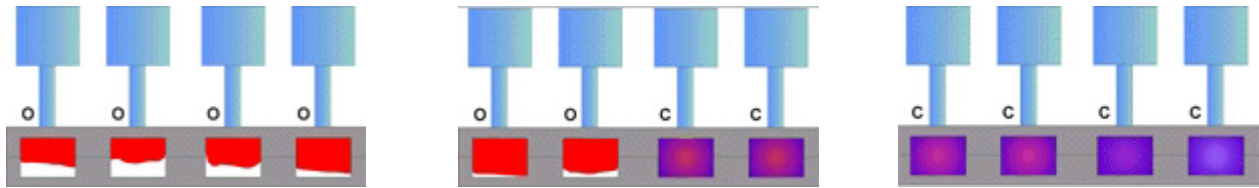
Finally, you could use cavity pressure to open and close the valve gates (except for #1, which will need to open on injection forward). You could set the open setpoint to “detect” the flow front and open the valve gate as it passes. Do this by setting the valve to open at a low pressure, say 100 psi, at the sensor near the gate. Enter a volume setpoint on the Valve Gate Open Control screen as a backup.

You can still close the gates as in section B for packing control.

This last scheme promises to make the most consistent parts possible, avoiding knit lines and packing all portions of the part to the same or specified pressure.

Independent Cavity Control

In this control method, all cavities are filled and packed simultaneously. The *eDART*® controls the valve gates for each cavity individually using the pressure in each cavity. This controls the final pack pressure, typically improving dimensional control in multi-cavity parts.



Valve Gate Control Setup

For each row on the main Valve Gates screen, click the *Setup* button, select Valve Open Control, and make sure “Injection Start” is checked. Other methods can be used, but this is the starting point.

Start by checking the “Injection Start” method for opening valve gates.

Figure 8: Setup Valve Gate Open Control screen

Then for each row on the main Valve Gates screen, click the *Setup* button and select Valve Close Control. Check the “Pressure at” method for closing the gates then choose which pressure sensor you will use to control each valve gate closing. We recommend that you use Post Gate control sensors and match the cavity number to the valve gate number (“Post Gate #1” closes gate #1 in our example).

Now check the pressure method for closing the valve gates.

Check this box as a backup.

Start your setup with a high pressure.

Figure 9: Setup Valve Close Control screen

Also note that we have chosen a very high pressure on the sensor to start our process setup. This prevents the valve gate control from closing any gates during our process setup until we have done the rheology study and set the machine ‘fast fill to slow pack’ position.

NOTE: Normally you should leave the box for “Injection Forward goes OFF” checked. This will always close the gate when injection is over so that it is ready to open on the next cycle.

Process Setup

Here, you will set up the basic process using machine volume control and then take over with valve gate cavity pressure control. This will take a few extra steps, but is the safest way to set up the process.

1. Initial Press Setup

Because you will be filling at a high speed (V1) then transferring to a slower speed (V2) when you near the end of the cavity, you will need to set up at least two velocity profiles on the press. For now, set the position where you transfer from V1 to V2 at the same position where you transfer out of 1st Stage (V -> P transfer). This way, you will not be using V2 until later when you set the pack speed.

2. Establish a Fill Speed Setting

Conduct an in-mold rheology test to find a fill speed range where the process will run most consistently. Generally, it is best to use a fill speed set as fast as possible without damaging the mold or sacrificing part quality.

3. Reestablish the V1 -> V2 Transfer Position on the Machine

Depending on the fill speed used in the previous step, your part may be too short. To fill the part to 95% at transfer, set the V1 -> V2 position and the V -> P transfer position on the press so that the part is filling on V1 only. This can be done by setting up the process to make a fill-only part then adjusting the transfer position until the first fill-only part is 90-95% full. To make a fill-only part, set the hold pressure and hold time to zero. When the press transfers to 2nd Stage, injection forward will end immediately causing the valve gates to close.

4. Adjust Cavity to Cavity Balance

Adjust tip temperatures to tune out imbalances once you have chosen the fill speed. This can be done by making short shots and adjusting tip temperatures until the fill-only part weights are the same in each cavity.

5. Set the Pack Speed Setting (V2) on the Machine

Set up a 2nd Stage velocity profile on the press. Initially, this will be set to approximately 10% of the fill speed setting. To start, don't change the transfer position. In a moment, you will increase the V -> P transfer, but you'll want to test the eDART® controls first.

6. Test the eDART® Controls

Note the "Peak, Shot Volume" value on the Cycle Values tool or the cursor value on the Cycle Graph where the volume curve reaches its peak. On the V to P Transfer tool, check the "Injection Volume" method of transferring and enter the "Peak, Shot Volume" as the setpoint value. Next, go back to the press and gradually increase the V -> P transfer position. The eDART® should take over control of the V -> P transfer and the press should continue to transfer at the same position, making the same size fill-only part. If you really want to be sure, reduce the V -> P transfer position on the eDART® significantly and see if the fill-only part gets smaller.

7. Set the Press Transfer Position so that the eDART® Controls V -> P Transfer

Once you are confident that the press is transferring correctly using the eDART®'s V to P Transfer tool, you can set up the V -> P transfer position on the press to a point where the eDART® will always transfer first. Once you have finished setting up the process, you will want to bring this back to a position where it will act as a backup in case eDART® control fails for any reason.

8. Pack the Cavities using the V to P Transfer Tool

Now increase the volume setpoint on the V to P Transfer tool until one of the cavities is properly packed. Once this happens, note the peak pressure for that cavity using the cursor value on the cycle graph or the value displayed on the Cycle Values tool. For example, if cavity #4 packs first, you can look up the "Peak, Post Gate #4" value. You will use this in the next step.

9. Enter the Cavity Pressure Values on the Valve Gates Tool (Cavity 1)

On the Valve Gates tool, find the valve gate that controls the cavity that is now fully packed. In the example in step 8, this would be cavity #4. In the Close at Pressure column, enter a value slightly lower than the peak cavity pressure for that cavity (in the example in step 8, this was the "Peak, Post Gate #4" value). The valve gate should now be closing via cavity pressure.

10. Enter the Cavity Pressure Values on the Valve Gates Tool (Remaining Cavities)

Repeat the previous two steps for each cavity. This is done by increasing the volume setpoint in the V to P Transfer tool, and as each cavity packs out, entering in the cavity pressure setpoint for that cavity on the Valve Gates tool. Continue this process until all cavities are transferring using cavity pressure control. You may notice that as cavities begin to close, the pack rate on the remaining ones will increase. You may want to set additional slower velocity profiles on the machine toward the end of packing to slow down packing on the cavities that have not yet closed.

The main Valve Gates screen should now look like this (after all valves have closed):

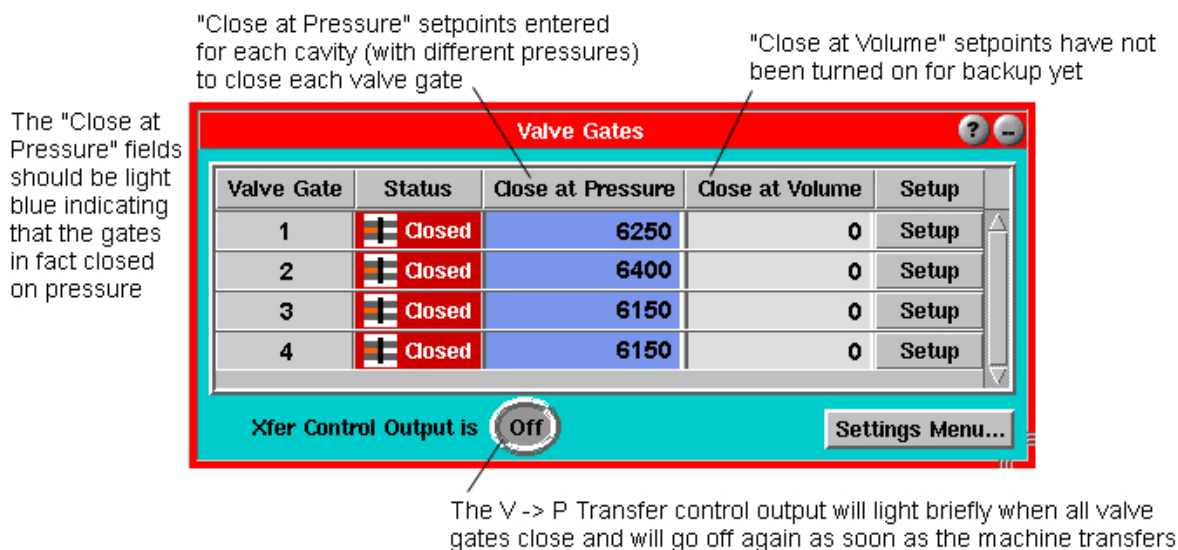


Figure 10: Enter Cavity Pressure Setpoints on the Valve Gates Screen

The Cycle Graph may look something like this:

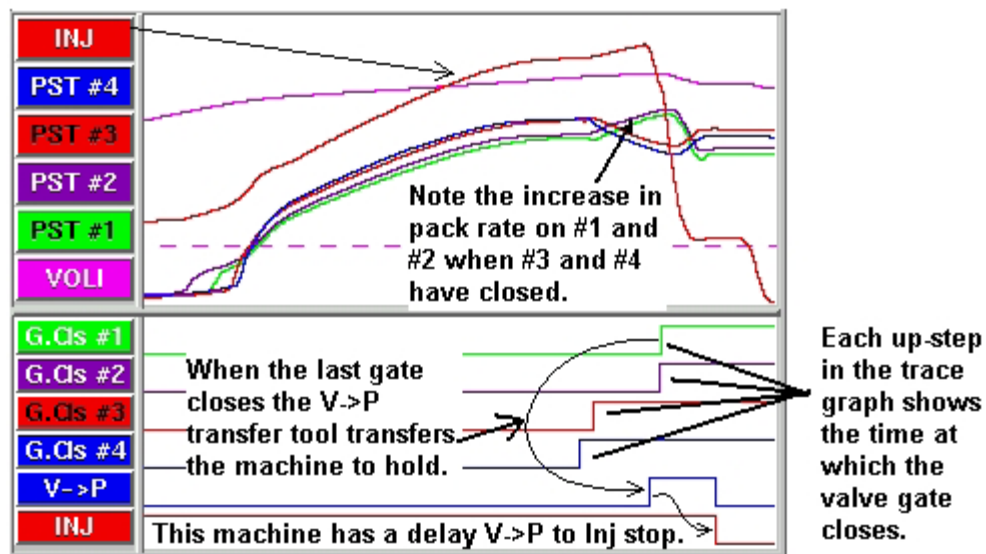


Figure 11: Cavity Pressure Curves Shown on the Cycle Graph

Setting Backups

Injection Volume

Set a backup injection volume setpoint in the V to P Transfer tool in case none of the valves fire (Appx. 10% above the last setting you had on this tool for volume transfer). Supposing during setup that the last valve gate to close (#1 in the example) had its pressure set to the 6250 psi shown when the shot volume was 1.48 cu. in. Then you would enter 1.6 cu. in. as the injection volume to transfer as shown.

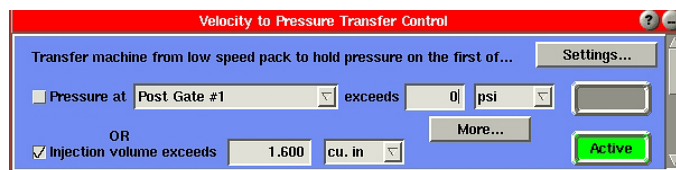


Figure 12: Injection Volume Backup (V to P Transfer Screen)



Once running, the *Active* light for volume on the V to P Transfer tool should NOT come on (green) under normal conditions. The transfer of the machine from velocity to pressure is driven by all valve gates closing, not by reaching 1.6 cu. in. of shot volume.

Cavity Pressure

Now that the valve gates are closing on cavity pressure, it is important that you set backups to prevent damage if for some reason the sensor does not see pressure (due to a mechanical problem, for example). To do this, enter a backup injection volume setpoint in the Valve Close Control screen. This setpoint should be slightly above the actual shot volume at which the gate is currently closing. Find the shot volume where each gate is closing (using the Cycle Graph) and set each cavity's injection volume backup about 10% above that. This keeps check ring and material variation from causing early transfer but still prevents damage if the pressure is not sensed.

As an example, gates #3 and #4 close when shot volume is 1.455 cu. in. and gates #1 and #2 close near 1.48 cu. in. In this case, you would set the injection volume backup for #3 and #4 to 1.6 cu. in. and #1 and #2 to 1.63 cu. in. The screen below shows the last (gate #4) injection volume backup settings.

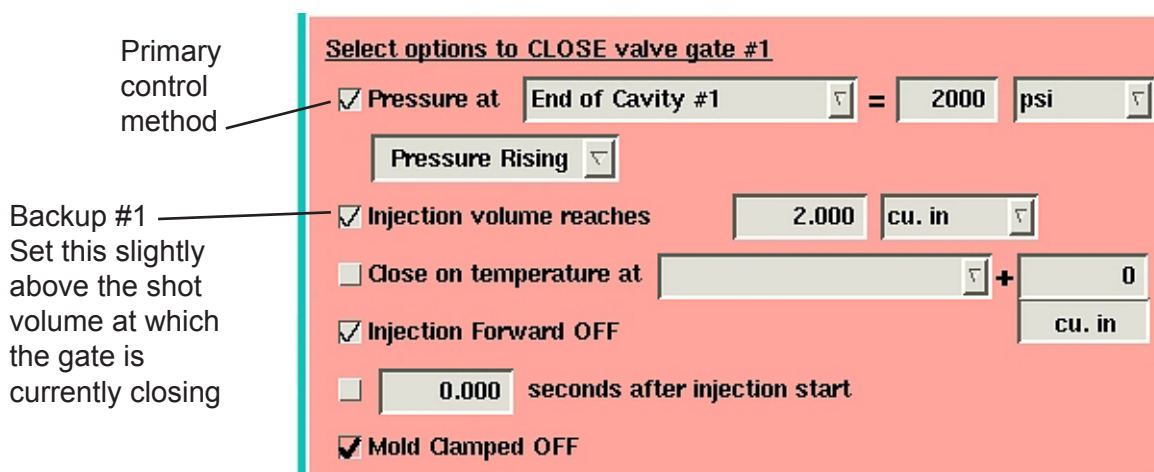


Figure 13: Cavity Pressure Backup (Valve Close Control Screen)



IMPORTANT: Once operating, look at the main Valve Gates screen and make sure that the numbers in the Close at Pressure column light up blue. If they do not, the process is not being controlled by cavity pressure, which will cause more variation.

Preventing Inter-Cavity Variation: “Range” Control

There can be a case where a cold slug blocks the material from entering a cavity. In this case, the blocked cavity will not reach its pressure setpoint and the full amount of material will not be injected. In a two-cavity situation, this drives all of the material into one cavity before any of the backups can fire, possibly badly damaging that cavity.

To prevent this, we use the eDART®’s multi-cavity feature to set a backup on a “phantom” pressure level called the “Range”. The “Plastic Pressure, Post Gate #Rng” value is always the difference between the highest and lowest Post Gate sensor value at each instant. The example below is from a mold with only End of Cavity (EOC) sensors.

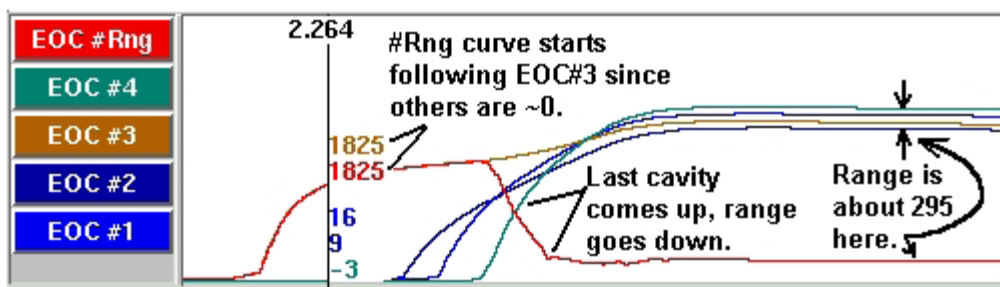


Figure 14: “Plastic Pressure, Post Gate #Rng” Curves shown on the Cycle Graph

So you can set a machine transfer setpoint on “Plastic Pressure, Post Gate #Rng” (in the V to P Transfer tool) just as if it was a real sensor. This would prevent the spread between cavities from exceeding a certain range. In our valve gate example, we set the range to 2500 psi, a value never exceeded under normal circumstances.

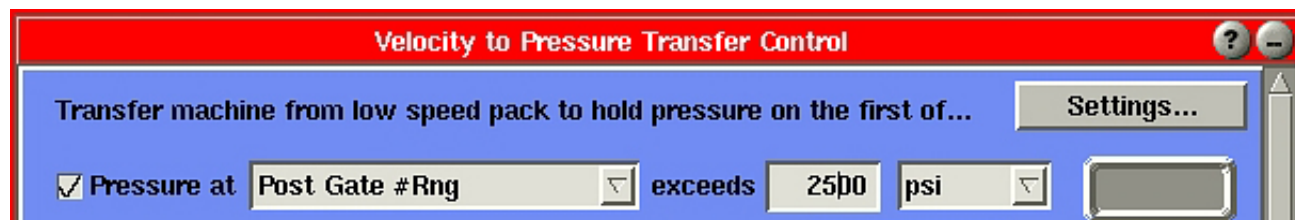


Figure 15: Enter a Transfer Setpoint on Post Gate #Rng (V to P Transfer Screen)

If the difference between any two cavities exceeds 2500 psi, the machine will transfer before any damage can be done.

Valve Gates Control Tool Reference

The basic function of the Valve Gates control tool is to open valve gates at specific events during the cycle and close them again at other events. Usually the most powerful scheme for part quality is to use cavity pressure. The Valve Gates control tool will also allow you to set open and close events by injected volume (stroke) or time. This tool also transfers the machine from velocity to pressure (hold) once all of the valve gates have closed. This allows you to drop hold pressure and begin recovery (screw run) early, which may either shorten cycle time or improve mix and melt (if the cooling time is still required).

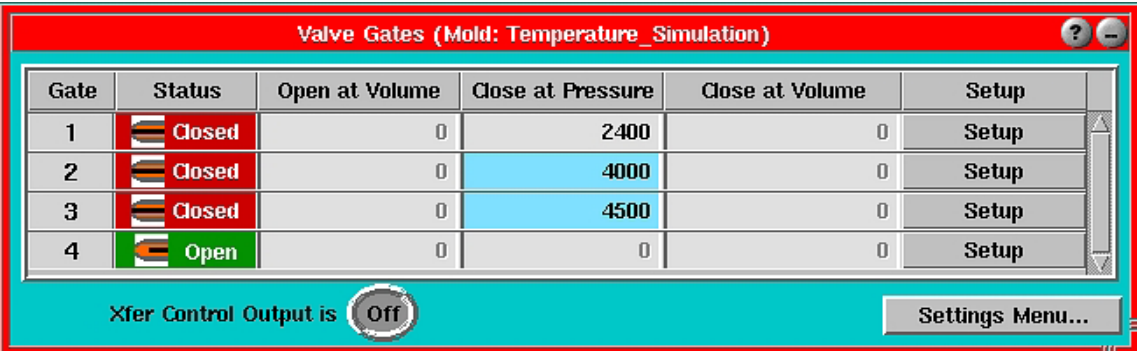


Figure 42: Valve Gates Control Tool

The main Valve Gates screen (above) lists each valve gate that the system has found by name (or number). The names are given to the valve gates when the valve gate OR2-D modules are first identified by the eDART® at start-up. These are set up in the Sensor Locations tool.

Valve Gate

Valve Gate Number (or name)

This is the ID given to the valve gate when you selected the location in the Sensor Locations tool. Any valve gate can be controlled by several different inputs so a valve gate is not always associated directly with a cavity.

Status

Status

This column shows the status of each valve gate during the cycle (open or closed). Red is used for closed, green for open (plus an icon). If the status shows “No Ctl.”, the valve gate has not been operated yet or the OR2-D module for it is disconnected.

Open at Volume

Settings Menu...

Settings Menu

The Settings menu contains the general settings for this Valve Gate Control.

General Settings...

Convert to Volume...

Convert to Pressure...

Setpoint Safety...

Test All Valves...

Settings Menu...

Close at Pressure

Close Valve at Pressure Level

When the pressure reaches this level at the selected sensor cavity, the valve will close. If this field is highlighted in blue, the valve closed on cavity pressure.

The pressure must also be going in the direction selected on the Valve Gate Close Control screen (Figure 44). You can use falling pressure to close a gate if you want a controlled discharge after packing. The value in this column is shown in the units selected on the Valve Gate Close Control screen (Figure 44).

If you do not have cavity pressure sensors for control, the valve gate can be set to close on a shot volume (See “Close Valve at Volume”).

If the value is gray and cannot be set, cavity pressure control is not enabled. Bring up the Valve Gate Close Control screen (Figure 44) and check the “Pressure at” box.

Close at Volume

Close Valve at Volume

When the volume (from the stroke * screw area) reaches this level, the valve will close. If this field is highlighted in blue, the valve closed on volume.

The value in this column is shown in the units selected on the Valve Gate Close Control screen (Figure 44).

If you are also using cavity pressure, the first to reach its setting (cavity pressure or volume) will close the valve. Thus the volume setting can be used as a backup in case the cavity pressure never reaches its setting.

If the value is gray and cannot be set, the Close on Volume control is not enabled. Open the Valve Gate Close Control screen (Figure 44) and check the “Injection volume reaches” box.

Setup

Setup

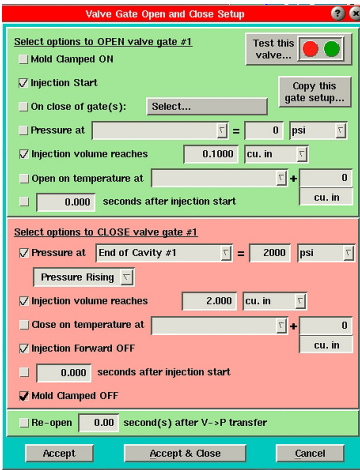
Each valve gate has separate settings for open and close controls. You can set them by clicking the *Setup* button for each specific valve gate (See pages 36-39).

In addition, you can test the operation of the valve gate control contacts by selecting “Test this valve” on the top of the Valve Gate Open and Close Setup (See page 44).



Control Output Light

This light is on (and says so) whenever the output relay contacts to transfer the machine are on (closed). You will see that once the program has transferred the machine from pack (low velocity) to hold (pressure control), the output stays on until the end of injection.



☒ Valve Gate Open Control

To bring up this screen, select Valve Open Control from the Setup menu. Here you can choose when the selected valve gate should open. Note that you can select more than one option or none if you want to keep a cavity closed during process setup.

☒ Open on Mold Clamped

If checked, the valve gate will open when the mold clamps. This is probably the best method since the valve gate stays closed until just before injection and then opens after there is any chance of drool.

☒ Open on Injection Start

If checked, the valve gate will open at start of injection (if not already opened by mold clamped). This function can be used as a backup in case the Mold Clamped signal does not come on for some reason.

☒ Open on Other Valve Gate Closed

Use this function for alternate cavity valve gate control in which one cavity fills and packs before the next one begins.

Valve Gate at which to Open on Close

From the combo box, select the valve gate at which, when closed, will open this one.

☒ Open on Pressure

This check box enables valve gate opening on pressure. This can be used in a sequential valve gate system for removing knit lines by opening a gate when the flow front reaches a sensor. It can also be used for a sort of “running start” by selecting injection pressure build up to a certain level before opening the gate.

Open Gate Sensor

Select the sensor (plastic pressure) that you wish to use to open this valve gate.

Open at Pressure

Select the pressure level at which you wish the valve gate to open (using plastic pressure at the sensor shown to the left). Note that if you use “Injection”, the pressure shown is NOT hydraulic pressure, but plastic pressure (hydraulic * intensification ratio).

Pressure Units

These are the units for the plastic pressure level to the left.

☒ **Open on Injection Volume**

This method will open the valve gate when the injection volume (stroke * screw cross sectional area) reaches the value shown to the right. This can be used for a sort of “running start” in which the machine begins injecting and gets a certain compaction of the melt before the gate opens. Leaving the setpoint at zero will cause the valve gate to open just when filling begins (after using up the decompress length).

Volume Setpoint

This is the volume level at which the valve gate opens (shown in the units to the right).

Volume Units

These are the units for the volume shown to the left.

Valve Gate Open and Close Setup

Select options to OPEN valve gate #1

☐ Mold Clamped ON

☒ Injection Start

☐ On close of gate(s): Select...

☐ Pressure at [] = 0 psi

☒ Injection volume reaches 0.1000 cu. in

☐ Open on temperature at [] + 0

☐ 0.000 seconds after injection start

Test this valve... [Red] [Green]

Copy this gate setup...

Select options to CLOSE valve gate #1

☒ Pressure at End of Cavity #1 = 2000 psi

Pressure Rising []

☒ Injection volume reaches 2.000 cu. in

☐ Close on temperature at [] + 0

☒ Injection Forward OFF

☐ 0.000 seconds after injection start

☒ Mold Clamped OFF

☐ Re-open 0.00 second(s) after V->P transfer

Accept Accept & Close Cancel

Valve Gate Close Control

To bring up this screen, select Valve Close Control from the Setup menu. Here you can choose when the selected valve gate should close. Note that you can select more than one option.

☒ Close at Pressure Enable

Check this box to cause the valve gate to close when the sensor pressure at the right reaches the level set. If enabled, the value can be set from the main Valve Gates screen (Figure 7). Typically, you would use this for packing control. Each valve gate can be controlled separately to make consistent pack pressures at different gate locations or cavities.

Sensor for Valve Gate Close

Select the sensor (plastic pressure) that you wish to use to close the valve gate at the pressure level to the right.

Close at Pressure

The valve gate will close when the pressure (plastic) on the sensor selected reaches this level. You can adjust this value quickly from the main Valve Gates screen under the Close at Pressure column. Note that if you use "Injection", the pressure shown is NOT hydraulic pressure, but plastic pressure (hydraulic * intensification ratio).

Close Pressure Units

These are the units for the pressure setting to the left. The pressure value shown on the main Valve Gates screen is also set in these units (even though the units are not shown there).

Close During

If you select "Pressure Rising", the valve gate closes when pressure at the sensor above reaches the level selected while the pressure is increasing (before the peak). If you select "Pressure"

the valve gate closes after the peak when the pressure falls below the setting selected. This is useful for controlled discharge after packing to reduce pressure and dimensional gradients.

If you use this method and the pressure never gets as high as the setpoint, the valve gate will NOT close on pressure.

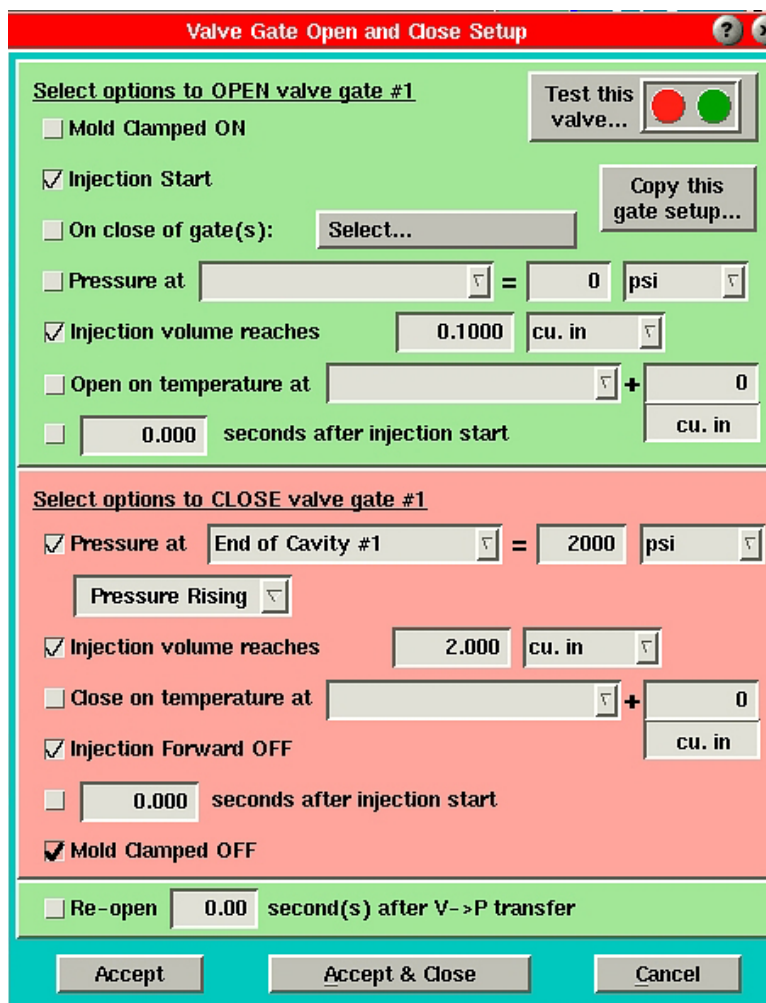
Once a valve gate closes, it does not open again until the next "open event" (e.g. Mold Clamped or other selected open control).

☒ Close on Volume

Check this box to cause the valve gate to close when the injection volume reaches a certain level.

Use this feature for a backup to the pressure control in case pressures are never reached. This is especially important in alternate cavity systems where the first cavity must close to open the second cavity before the machine speeds up for its next fill stage.

You can also use volume close control if you have no cavity pressure sensors. The process will be controlled fairly well except for check ring leakage variations and variations in material compressibility.



The dialog box is titled "Valve Gate Open and Close Setup" and is divided into two main sections: "Select options to OPEN valve gate #1" (green background) and "Select options to CLOSE valve gate #1" (red background). At the top right, there are buttons for "Test this valve..." (with red and green indicator lights) and "Copy this gate setup...".

Open Section:

- ☐ Mold Clamped ON
- ☒ Injection Start
- ☐ On close of gate(s): Select...
- ☐ Pressure at [] = 0 psi
- ☒ Injection volume reaches 0.1000 cu. in
- ☐ Open on temperature at [] + 0 cu. in
- ☐ 0.000 seconds after injection start

Close Section:

- ☒ Pressure at End of Cavity #1 = 2000 psi
- Pressure Rising []
- ☒ Injection volume reaches 2.000 cu. in
- ☐ Close on temperature at [] + 0 cu. in
- ☒ Injection Forward OFF
- ☐ 0.000 seconds after injection start
- ☒ Mold Clamped OFF

Bottom Section:

- ☐ Re-open 0.00 second(s) after V->P transfer

At the bottom are three buttons: "Accept", "Accept & Close", and "Cancel".

Figure 43: Valve Gate Open/Close Control screen

Close at Volume Setpoint

Set this to the volume (stroke * screw area) at which you want the valve gate to close (shown in units at right). You can adjust this value quickly from the main Valve Gates screen under the Close at Volume column.

Volume Units

These are the units for the volume setpoint at the left. The volume value shown on the main Valve Gates screen is also set in these units (even though the units are not shown here).

☒ Close on Injection Off

This is a sort of "last resort" to close the valve gate at the end of injection before the screw starts running. It defaults to "On" as a backup in case pressure and volume are not reached or not set.

☒ Close on Time

This control will close the valve gate at the time after the start of injection. This is a sort of last ditch backup in case pressure and volume do not operate. However, if machine speeds change, the amount of material injected in the set time can vary and cause flash or shorts.

Velocity to Pressure Machine Transfer Settings

To bring up this screen, select General Settings from the Settings menu. Here you can choose when to transfer from low speed pack (velocity) to hold pressure.

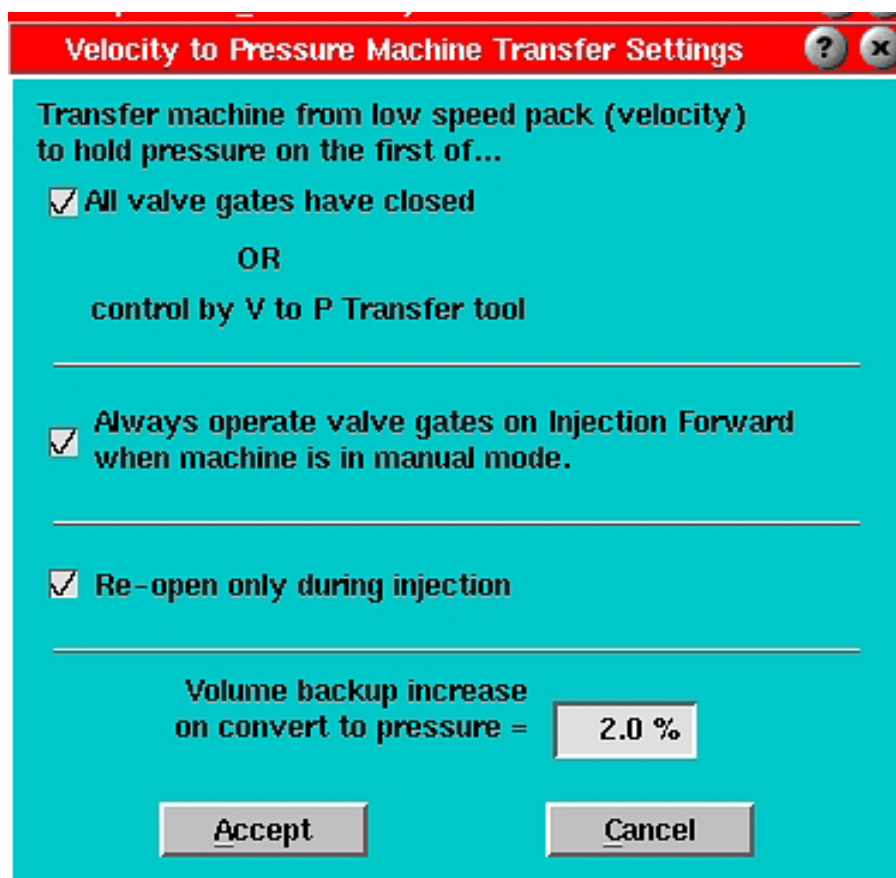


Figure 45: V -> P Machine Transfer Settings screen

☒ Transfer on all Valve Gates Closed

In order for this to work, you must use the V to P Transfer tool to transfer the machine from speed to pressure. Then, if you check this box, the machine transfer will occur when all the valve gates have closed (or sooner if some other V -> P transfer control happens first).

☒ Operate with Machine in Manual Mode

If you have wired a “Seq. Module Input, Machine in Manual” input, this switch can be used to control what the valve gates do when the machine is in manual. If you purge through the mold, you should leave this switch on and set the valve gates to open and close on Injection Forward On and Off.

If you want the gates to stay closed in manual mode (to prevent drool, for example), then turn this switch off. You can then retract the carriage and purge without the gates open.

Setpoint Security

To bring up this screen, select Setpoint Safety from the Settings menu. Here you can enable security on certain settings such as setpoints.

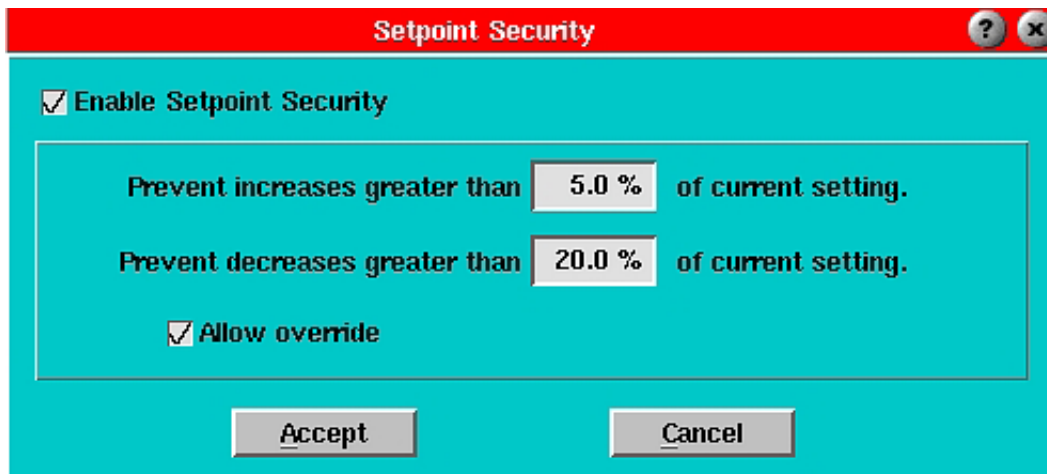


Figure 46: Setpoint Security

☒ Enable Setpoint Security

When this box is checked, the security features below are in effect. When unchecked, you can change cavity pressure and other setpoints by any amount you wish.

We recommend that you use security to help prevent overpacking a mold caused by, for example, the addition of an extra zero to the number you are entering.

Increase Prevent Level

When security is enabled, you cannot increase a setting by more than the given percentage of current reading.

Decrease Prevent Level

When security is enabled, you cannot decrease a setting by more than the given percentage of current reading.

☒ Allow Override

If security is enabled and you exceed one of the change limits, this program presents a question to that effect. If you check the “Allow override” box, you will be allowed to make the change anyway. If the “Allow override” box is unchecked, the message simply says that you have exceeded the safety settings and the change will not be applied.

Valve Gate Test

To bring up this screen, select Test All Valves from the Settings menu. Here you can test all valve gates at once.

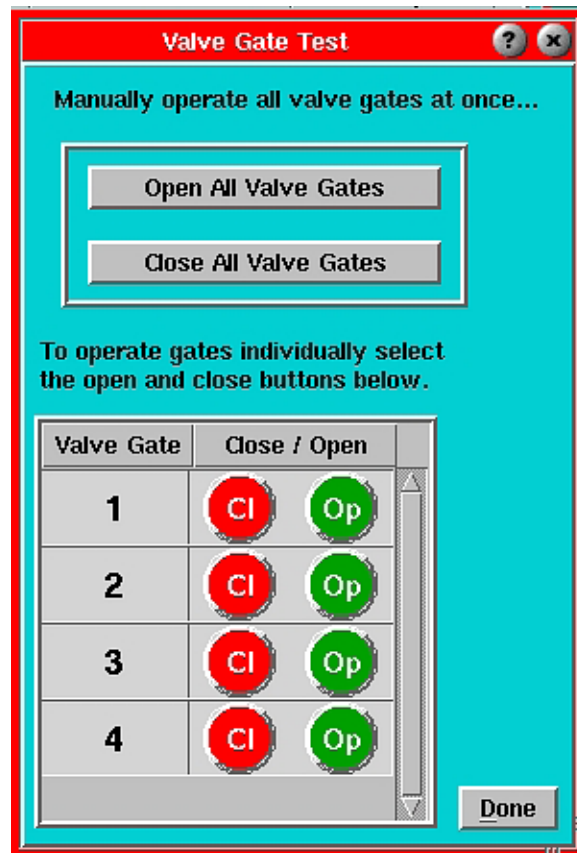


Figure 47: Valve Gate Test

Open All Valve Gates

Open All Valve Gates

Click this button to switch all valve gate controls to “Open” simultaneously.

Do NOT use this control on cycle because it overrides your control settings for open and close.

Close All Valve Gates

Close All Valve Gates

Click this button to switch all valve gate controls to “Closed” simultaneously.

Do NOT use this control on cycle because it overrides your control settings for open and close.

Done

Done

When clicked, this button will close this window and return control to the valve gate controller using its setpoints, etc.

Test Individual Valve Gates

To bring up this screen, select Test This Valve from the Setup menu. Here you can test each valve gate individually.

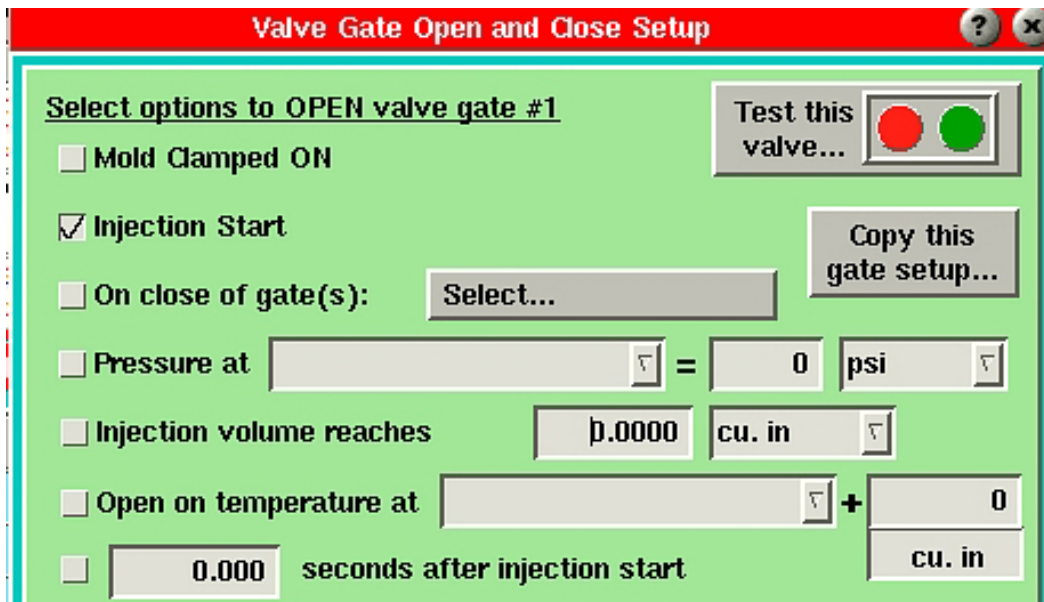


Figure 48: Test Each Valve Gate

Close Gate

Click this button to force the gate closed to test it.

Do NOT use this control on cycle because it overrides your control settings for open and close.

Open Gate

Click this button to force the gate open to test it.

Do NOT use this control on cycle because it overrides your control settings for open and close.

Additional Valve Gate Control Techniques

“Running” Start

It has been proposed that some high-speed valve gate applications might work best if all possibility of drool or slow injection at the start is prevented by opening the valve gates late. The valve gate control provides two methods of doing this.

Open on Volume

This is probably the most consistent method. A good starting point is zero volume that will be crossed once the ram is up to speed. This requires that you use some decompress on the process. It is important to note that if you are using high injection velocities and have a significant delay in the opening of the valve gates, this approach may over-pressurize the manifold. Before setting a late open control, the cycle graph might look like this:

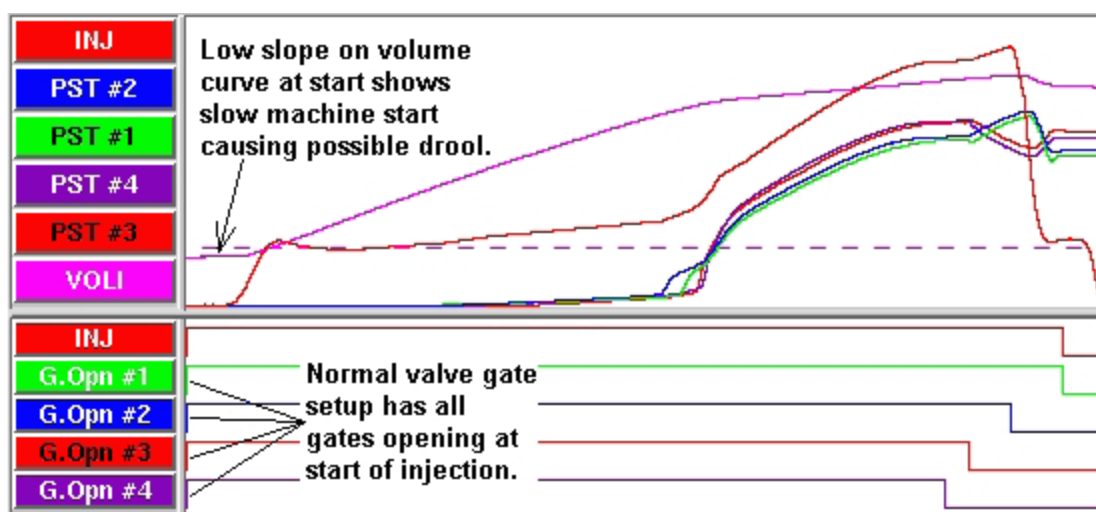


Figure 34: Cycle Graph without “Late Open Control” Set

To set this up early (opening on volume), set the open control for each valve gate as follows:

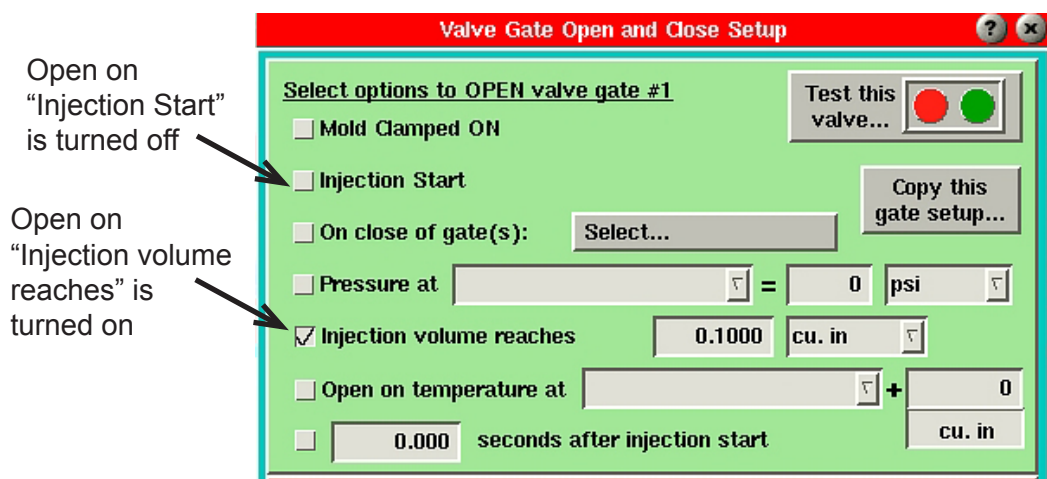


Figure 35: Set up Valve Gate Open Control (Open on Volume Method)

Now the cycle graph will show the gates opening late as follows:

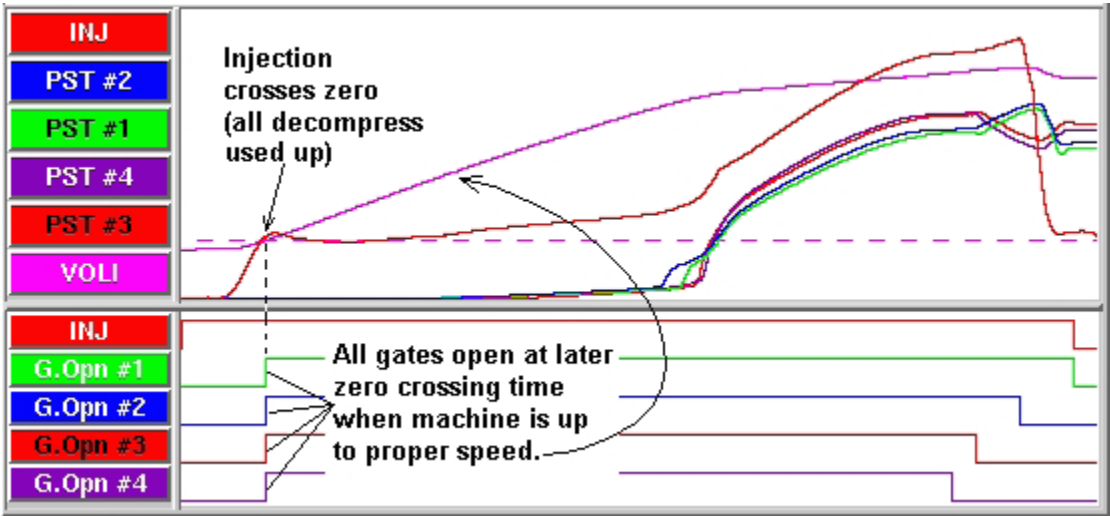


Figure 36: Cycle Graph with “Late Open Control” Set

Open on Pressure

This technique is similar to the “open at zero volume” on the previous page except you could use pressure to “pre-pressurize” the barrel and force an initial very fast injection due to the built-up pressure. The only difference is that you would select open on “Pressure at Injection” as shown below.

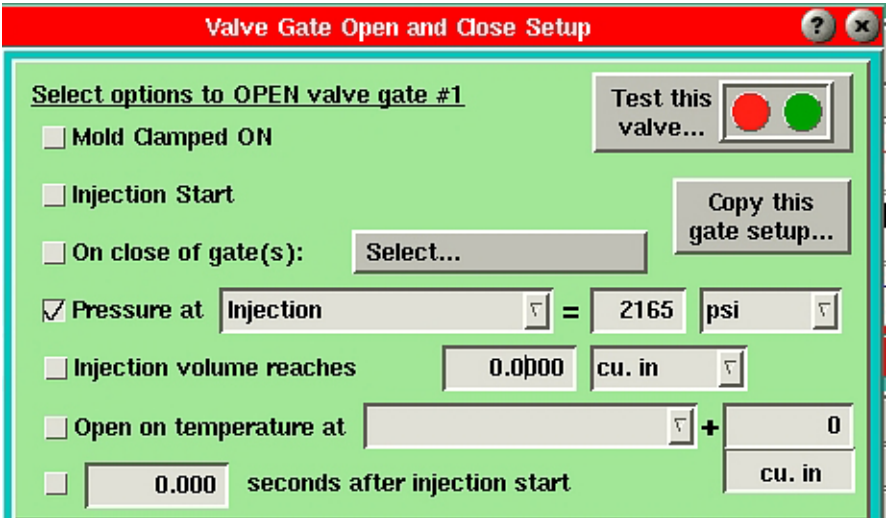


Figure 37: Set up Valve Gate Open Control (Open on Pressure Method)

These techniques have not yet been tried in the field. We supply them here as suggestions for various unusual and flexible ways you can use the valve gate control.

Pressure Discharge

In some parts, it is important to reduce the pressure gradient across the part as much as possible. This can reduce dimensional variations from end to end.

In a normal process, we set up a fast fill and slow pack to a pressure. This will leave the pressure at the gate considerably higher than the pressure at the end of the cavity after the gate closes. The cycle graph normally would look something like this:

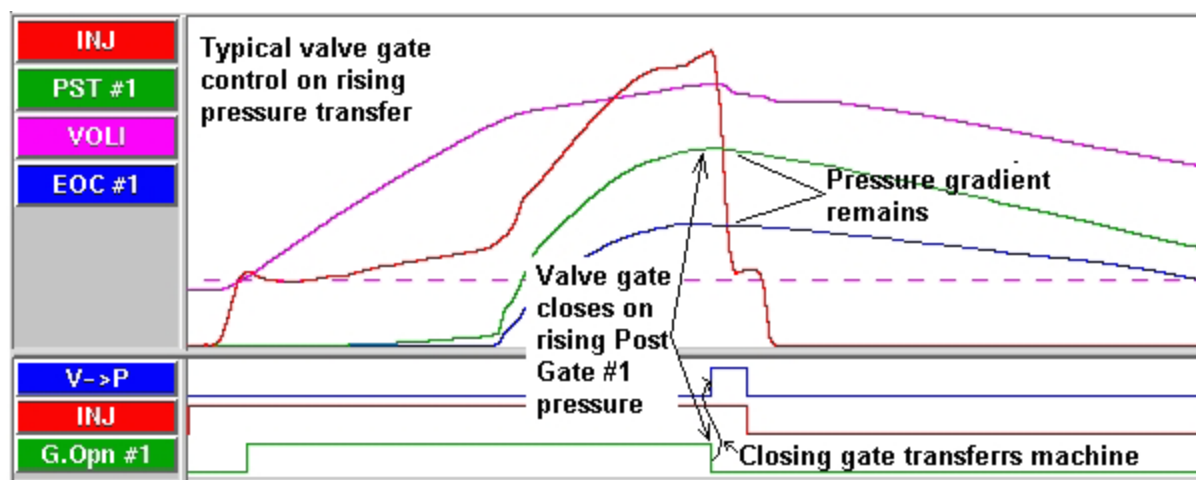


Figure 38: Cycle Graph Showing Cavity Filled and Packed to a Pressure

The closing of the valve gate causes the machine to transfer.

To reduce the pressure gradient, we can allow the machine to transfer to hold using the eDART®'s V -> P Transfer tool. This tool is set to transfer the machine to hold at the maximum pack pressure desired as follows:

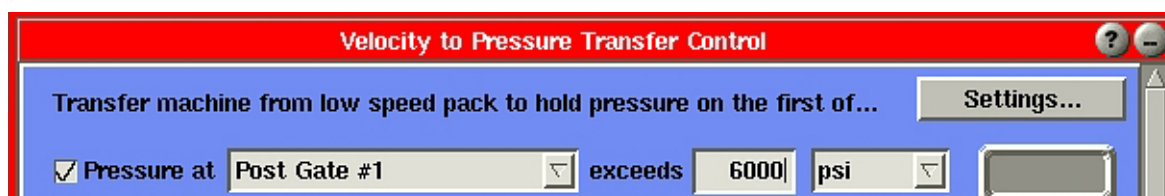


Figure 39: Enter Transfer Setpoint on the V to P Transfer Tool

Alternate Cavity Control

This is a technique for reducing the clamp tonnage by filling, packing, and closing the gates on cavities in sequence. By this we mean that each cavity is completely finished (fill, pack, close) before the next gate opens. With more than two cavities, this can be done in groups if necessary. The drawback to this method is that some cycle time will be lost.

Two methods have been developed to accomplish this technique. In the first method, one velocity is set to fill and pack all cavities. Valve gates are opened and closed using cavity pressure setpoints. In the second method, cavity pressure setpoints are also used to open and close the valve gates, but multiple speeds are used to fill and pack each cavity.

Method #1: Single Velocity

This method utilizes a single velocity during first stage. With a slower fill velocity, one cavity is packed to a cavity pressure setpoint, the valve gate shuts, and the next cavity opens. This process continues until all of the cavities have been filled and packed. The advantage of this method is the simplicity of process setup. A disadvantage of using the method is that the process is running at a slower velocity, which may not be capable of producing quality parts.

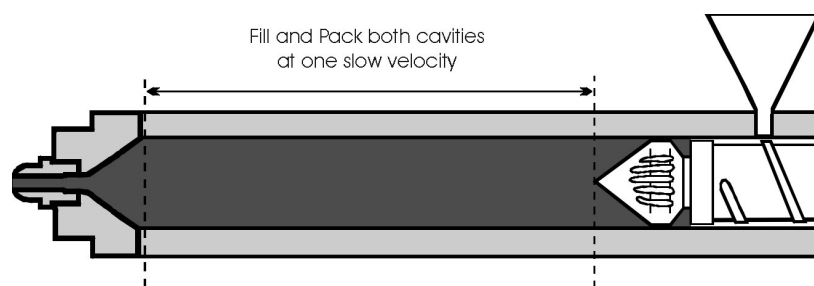


Figure 16: Method #1: Single Velocity

Method #2: Multiple Velocity

With this method, multiple velocities are set in the injection unit. Each cavity has a fast velocity to fill the part (to 90%) and a slow velocity to pack the part. Once the first cavity is packed, the valve gate is closed and the valve gate for the next cavity opens. This process continues until all of the cavities are filled and packed. The advantages of this method include greater flexibility to optimize control and the ability to use a high primary fill speed, without overshooting the setpoint. The disadvantages include a more complex process setup, more adjustments to transfer setpoints (due to process variations), and manual coordination of the velocity control with the valve gate control. There is also more chance of error using this method if a larger number of cavities are being used.

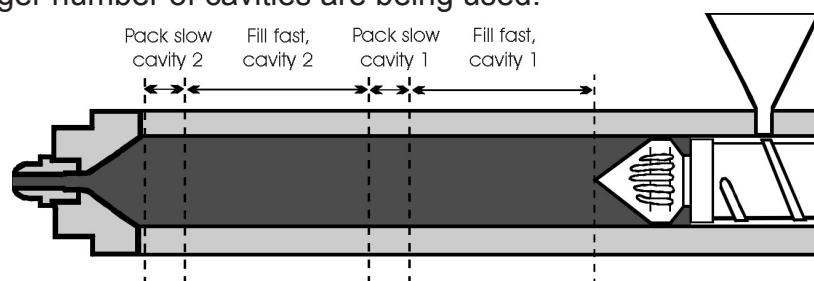


Figure 17: Method #2: Multiple Velocity (Showing screw velocity at each screw position)

Process Setup (Method #1)

Setting up an alternate cavity process requires both press control settings and eDART® control settings in a sort of marriage. Here is a step-by-step method for setting up the process with two alternate cavities, one gate in each cavity. This procedure assumes that you have set up and tested the Valve Gates tool and the V -> P Transfer tool on the eDART® as described on pages 5 and 6.

1. Build the Shot Size

Load enough material ahead of the screw to fill and pack both cavities. Initially, you may want to start by filling all cavities simultaneously to determine your shot size. To do this, set the valve gate controls for both cavities to open at Injection Start and close when Injection Forward goes Off. Then set up a fill-only shot (short shot) using a low-mid fill speed. Gradually increase your shot size until both cavities are capable of filling. Make sure you have

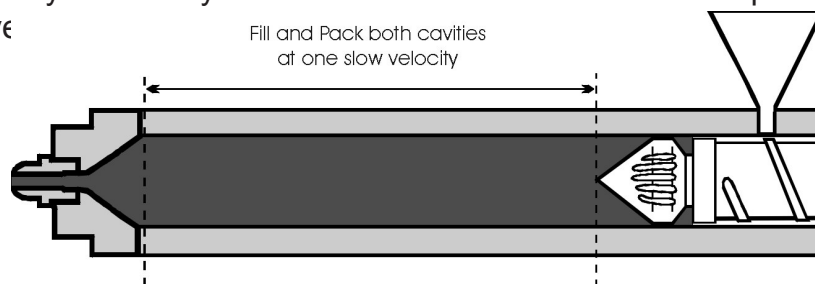


Figure 18: Shot Built for Single Velocity Control Method

2. Setup Cavity 1 Valve Gates

Bring up the Valve Gates tool in the eDART® software. Click the *Setup* button for the valve gate that controls the first cavity to fill. Select the Valve Gate Open Control and check the “Injection Start” box. Next, choose the Valve Close Control and check the “Pressure at” method for closing the gates, then choose which pressure sensor you will use to control the valve gate (“Post Gate #1” in the example below). Initially, we will enter a low cavity pressure setpoint, such as 1000 psi. Also, check the “Injection volume reaches” box and enter and high value, which cannot be reached. Finally, check the “Injection Forward goes Off” box.

Set up each remaining valve gate the same as the first cavity, except that the Valve Open Control will be set to open when the previous valve gate closes. For example, the setup for the 2nd valve gate would be set to open when valve gate 1 closes.

Figure 19: Setup Valve Gate Open/Close Controls (Cavity 1)

3. Set the Fill Speed on the Press

With the Valve Gates tool configured, set a low fill speed and low injection pressure on the press. These should be set low enough that if the valve gates do not close, the mold will not be damaged.

4. Find a Fill Speed and Pressure Where Parts can be Made

Shoot the first several shots. Sometimes it will take several shots for the gates to begin flowing correctly. It is likely that the first cavity will not reach its cavity pressure setpoint due to the low fill speed and pressure. If so, you will need to determine which of these two settings to adjust. On the Cycle Graph, watch the Injection Pressure curve to see if it reaches the injection pressure setting (reaches a peak pressure then flattens out). If so, gradually increase your injection pressure setting on the press. Otherwise, gradually increase your injection speed. Continue to do this until the first cavity reaches its cavity pressure setpoint. This should cause the valve gate for the first cavity to close and the second cavity to open. If the part is still short, increase the cavity pressure setpoint (on the main Valve Gates screen) for that cavity until the part is just full.

Repeat this process for each cavity. When this is done, all parts should be mostly full, filling one at a time.

Increase the cavity pressure setpoint until the part is just full

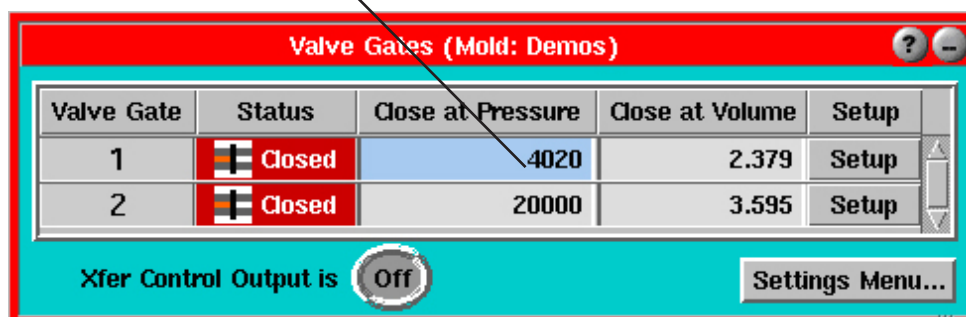


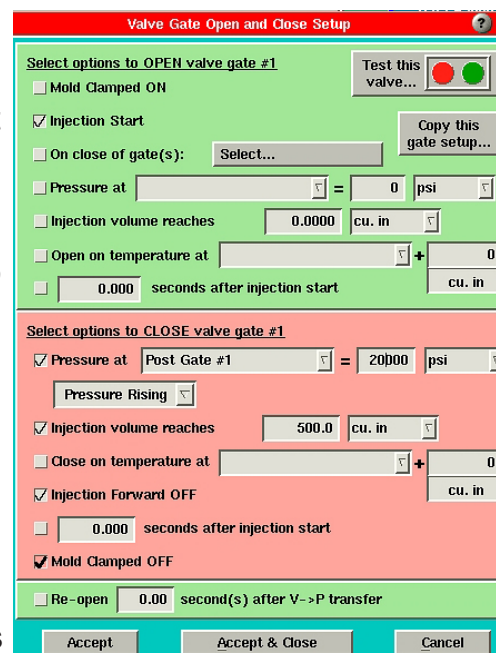
Figure 20: Optimize the Cavity Pressure Setpoint

5. Pack Out the Parts

One cavity at a time, increase the cavity pressure setpoint (on the main Valve Gates screen) until that cavity is fully packed out. You may need to further increase the injection pressure setting on the press to do this. The press should maintain a constant speed even if more injection pressure is required to do so.

Set Backups

6. On the bottom of the Cycle Graph, find the point where the first valve gate closes. Place your cursor at that point and read the Injection Volume value displayed. Add 5-10% and enter this value into the Close at Volume column on the main Valve Gates screen. This will ensure that the valve gate will close if for any reason the cavity pressure sensor is not able to read pressure in the cavity. Repeat this for each cavity.



Process Setup (Method #2)

Setting up an alternate cavity process requires both press control settings and eDART® control settings in a sort of marriage. Here is a step-by-step method for setting up the process with two alternate cavities, one gate in each cavity. This process assumes that you have set up and tested the Valve Gates tool and the V -> P Transfer tool on the eDART® as described on pages 5 and 6.

1. Build the Shot Size

Load enough material ahead of the screw to fill and pack both cavities. Initially, you may want to start by filling all cavities simultaneously to determine your shot size. To do this, set the valve gate controls for both cavities to open at Injection Start and close when Injection Forward goes Off. Then set up a fill-only shot (short shot) using a low-mid fill speed. Gradually increase your shot size until both cavities are capable of filling. Make sure you have enough material for packing and cushion.

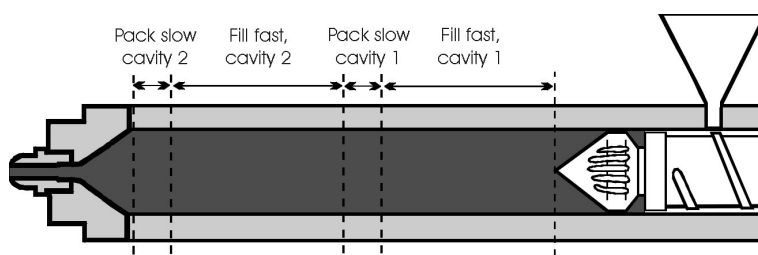


Figure 21: Shot Built for Multiple Velocity Control Method

2. Setup Cavity 1 Valve Gates

Bring up the Valve Gates tool in the eDART® software. Click the *Setup* button for the valve gate that controls the first cavity to fill. Select the Valve Gate Open Control and check the Injection Start box. Next, choose the Valve Close Control and check the "Pressure at" method for closing the gates, then choose which pressure sensor you will use to control the valve gate ("Post Gate #1" in the example below). Initially, enter a cavity pressure setpoint high enough that it will never be reached, such as 20000 psi. Also check the "Injection volume reaches" box and enter a high value which cannot be reached. Finally, check the "Injection Forward goes Off" box.

3. Turn Off Other Cavities

For each remaining cavity, open the Valve Open Control screen and deselect all boxes. This will prevent the valve from opening, allowing you to set up cavity 1 only at this time.

Figure 22: Setup Valve Gate Open/Close Controls (Cavity 1)

4. Set Transfer Method

Set the press to transfer on external contact closure or position, whichever comes first.

5.

Find the Transfer Position to Slow Speed Pack

With a low-mid fill speed, find the transfer position on the press where the part is 90% full. For example, with a 2-cavity mold, the transfer position should be less than half of the whole shot size.

6. Set Fast Fill Speed

Conduct an in-mold rheology test using the machine controls and decide on the best fill speed for cavity 1. When running the rheology study, you must run fill-only parts (must be short, even at the highest fill speed). Once you have chosen a fill speed, select a transfer position that makes the part 90-95% full.

7. Test the External Transfer (Optional)

Take note of the “Peak, Shot Volume” value on the Cycle Values tool when you make a single cavity short shot. Enter a value approximately 30% lower than this in the Close at Volume column for gate 1 on the main Valve Gates screen. This should cause the eDART® to transfer the press before its transfer position is reached, resulting in a shorter part and a lower “Peak, Shot Volume” value on the Cycle Values tool. If the press doesn’t transfer earlier, you will need to check the setup of the hardware and software that control the valve gates.

Set the Close at Volume value (on the main Valve Gates screen) back to its original level again.

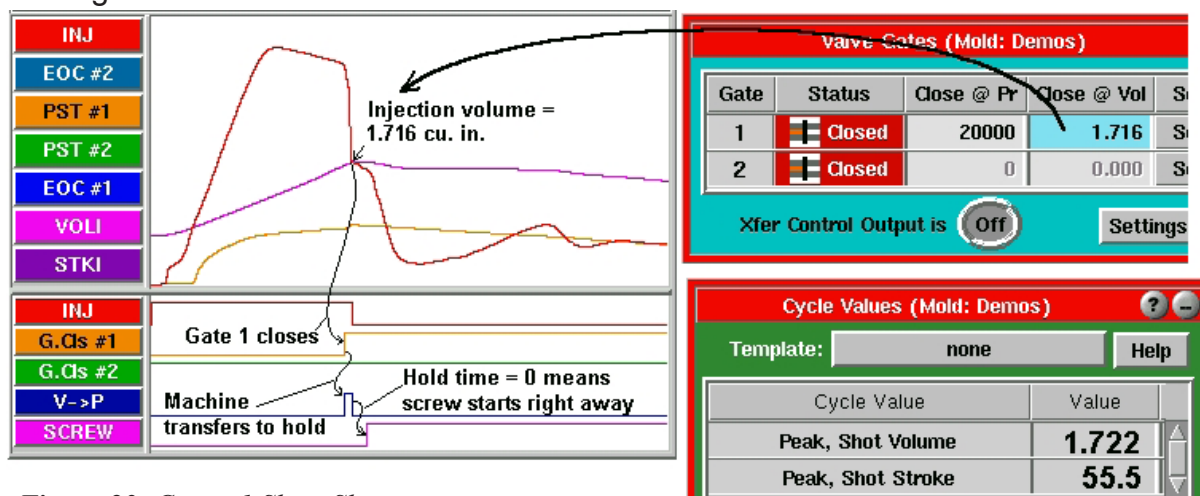


Figure 23: Cavity 1 Short Shot

NOTE: The numbers shown on the machine are usually relative to screw bottom. The numbers on the eDART® are relative to the screw position when the screw stopped turning. This is so we can think in terms of how much material is put into the mold.

The following 4 steps are setup only - do not make parts yet

8. Set Slow Pack Speed

Add a second injection speed profile on the press, which slows down to about 10% of fill speed when the part is about 90% full. This second profile will then continue until the valve gate is closed by the “Injection Forward” setpoint (See Figure 22).

9. Increase the Transfer Position on the Press

Adjust the transfer position on the press so that it will not cause transfer. At this point, we want the *eDART®* to control the transfer of the valve gates and we cannot do this if the machine's transfer position is reached first. The easiest way is to set the machine's transfer position at screw bottom.

10. Set Hold Pressure/Time

Set the machine's hold pressure to zero and, if no core controls need any extra cooling time, set the hold time to zero as well. Then the machine can begin recovery (screw run) as soon as all valves have closed.

11. Record Fill-only Volume

Open the Sequence Settings tool and make sure that the *Machine Fill* tab is highlighted. Then either enter the "Peak, Shot Volume" value into the "End fill" box or click the *Set fill volume... as fill only shot* button. This records the amount of material in a fill-only part on the first cavity. We do this so that the *eDART®* can calculate effective viscosity and other useful numbers.

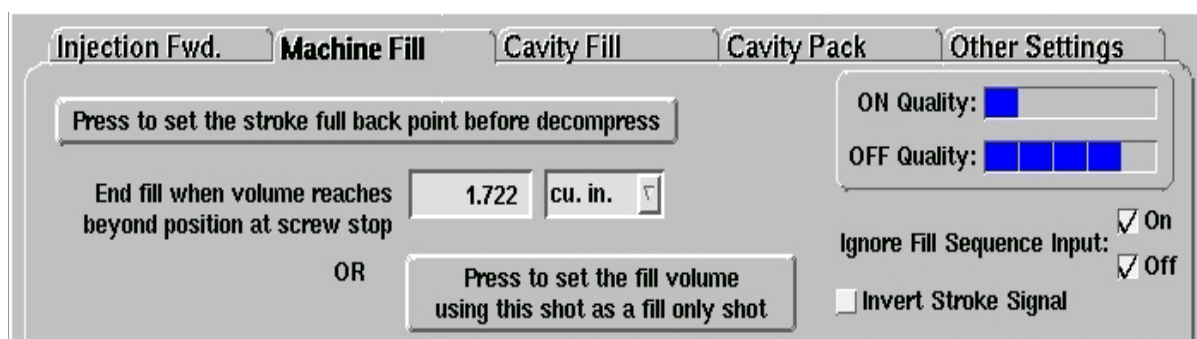


Figure 24: Setup the Sequence Settings tool to Calculate Effective Viscosity

12. Pack Cavity 1

Steadily (over several shots) increase the Close at Volume value for gate 1 until cavity 1 is properly packed. Make a note of this volume for later, when you will use it for setting backups.

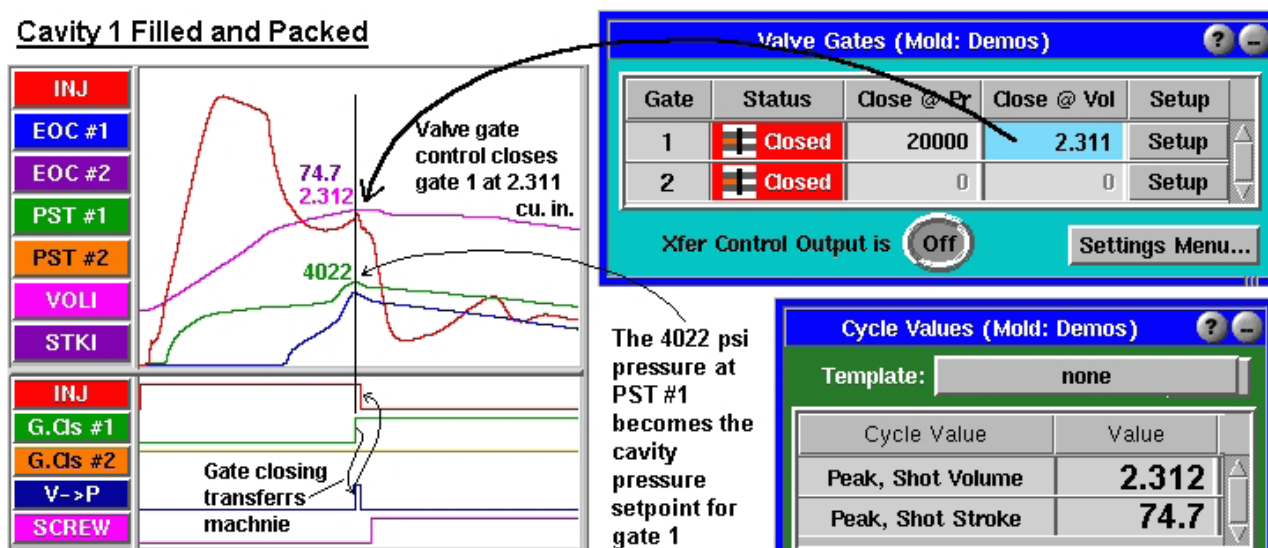


Figure 25: Cavity 1 Filled and Packed

13. Set Backups for Cavity 1 Valve Gate Closing

- * Place the cursor on the Cycle Graph in line with the closing of valve gate 1 and read the cavity pressure for the control sensor ("PST 1", or Post Gate #1 in our example). Either make a note of this value or leave the cursor in that position as you find the volume backup in the next step. We will use this value soon to set the cavity pressure setpoint for this valve gate.
- * Now increase the Close at Volume value for gate 1 *gradually* by about 3% (or less to avoid over-packing the part). Continue shooting parts while adjusting the Close at Volume value until you are getting the maximum pressure in the cavity where you are still not damaging the mold. This position will become the backup position for closing the valve gate in case you don't transfer successfully off of cavity pressure.

Cavity 1 slightly over-packed to find backup

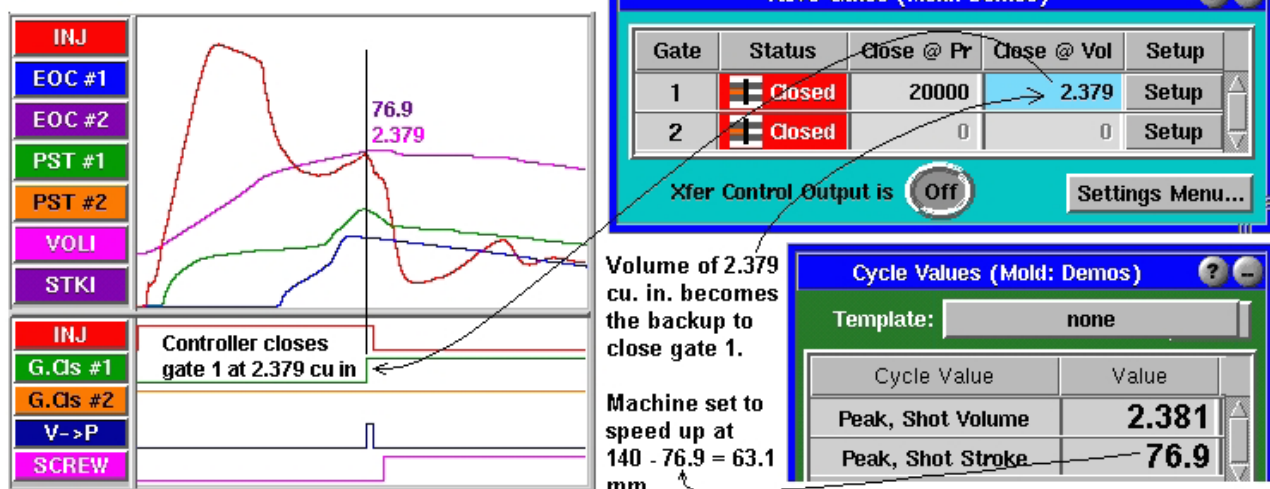


Figure 26: Cavity 1 Slightly Overpacked to Find Backup

14. Close Valve Gate 1 Using Cavity Pressure

Enter the pressure at the cursor for PST #1 (the 4022 psi pressure noted in Figure 26) in the Close at Pressure column for gate 1. The valve gate for this cavity should now begin closing off of cavity pressure instead of Injection Volume. If this is the case, the Close at Pressure column for this valve gate will turn blue when the valve gate closes.

NOTE: We recommend saving a template at this time (named "Fill and Pack Cavity 1" for example). While we won't use this here, you may find it useful later when you go to set up the process again.

15. Prepare to Setup Cavity 2

At this point, you should be making a good part in one cavity. Now it's time to set up the next cavity. Stop the press as we set up the next steps.

16. Setup Cavity 2 Valve Gates

On the Valve Gates Open Control screen, set up gate 2 to open when gate 1 closes. Then set up gate 2 to close on Injection Volume, when Injection Forward goes Off, and Pressure at Post Gate #2. The initial pressure setting can be quite high or you may use it to prevent damage by setting above the pressure found for the first cavity.

Figure 27: Setup Valve Gate Open/Close Controls (Cavity 2)

Next we will set the initial Close at Volume to close gate 2. This should be at a point where cavity 2 is more than half full but still short. One way to do this is to take the Close at Volume value for cavity 1 and add the fill-only part volume (which we set in the Sequence Settings tool earlier). This should give you a partially full part on which you can steadily adjust shot volume until the part is 90% full.

17. Setup Next Injection Velocity on the Press

On the press, add a third velocity profile. This will become the fast fill speed for cavity 2 so you can set it to the same speed as the fast fill speed for cavity 1. As you are setting this up, you will need to choose the position where the previous speed (slow pack speed for cavity 1) ends. We will call this the V2-V3 transfer position. Your objective is to set this *just after* the point where valve gate 1 closes. You will have to do this by trial and error, but following these steps will help:

- * On the Cycle Values tool, add the “Peak, Shot Stroke” value. Make sure its units are displayed in the same units as the stroke on the press.
- * Subtract the “Peak, Shot Stroke” value from the Shot Size on the press. Enter this value as the V2-V3 transfer position on the press.
- * Shoot a shot. The first cavity should fill and pack, then the 2nd cavity should fill part way before the valve gate for the 2nd cavity closes via the Close at Volume setting on the Valve Gates tool.
- * On the Cycle Graph, you should see something similar to the graph shown in Figure 28. Place your cursor at the point where valve gate 1 closes. Now look at the Injection Volume curve. The kink in the graph where V2 changes to V3 should happen slightly after this. Adjust the V2-V3 transfer position on the press until it occurs just after the first valve gate has closed.

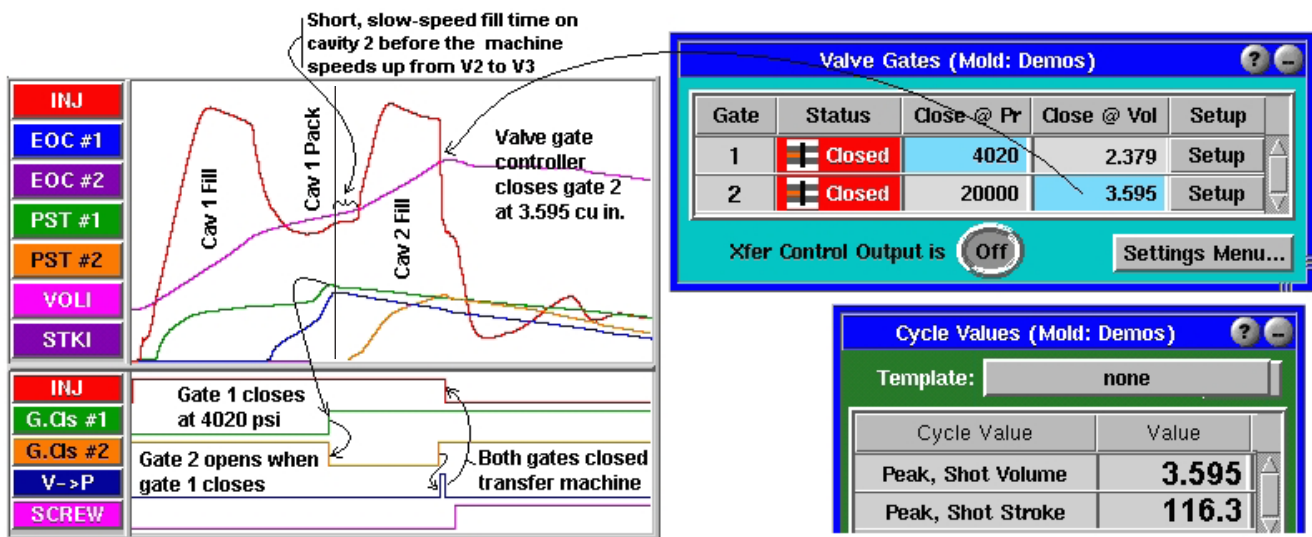


Figure 28: Cavity 2 Short Shot

18. Adjust the Fill Only Shot Size on the eDART®

Steadily adjust the Close at Volume value for gate 2 until you get a 90% full part in cavity 2.

19. Pack Cavity 2

- * Next, you need to add a fourth velocity profile, which will be the slow pack speed for the second cavity. The speed setting should be the same as the slow pack speed for cavity 1. However, you will need to find the position to transfer from V3 to V4 (fast fill to slow pack for the second cavity). To do this, note the “Peak, Shot Stroke” value on the Cycle Values tool. Subtract this from the Shot Size on the press (Speed Change Position = Shot Size - “Peak, Shot Stroke”). Enter this value as the V3 to V4 transfer position on the press.

- * Now return to the Valve Gates tool. Continue increasing the Close at Volume value for gate 2 until the part in cavity 2 is fully packed as you did with cavity 1.

20. Set Backups for Cavity 2 Valve Gate Closing

- * On the Cycle Graph, place the cursor in line with the closing of gate 2 and read the cavity pressure for the control sensor for the second cavity (in our example, “PST 2”, or Post Gate #2). Either make a note of this value or leave the cursor in that position as you find the volume backup in the next step. We will use this soon to set the Close at Pressure value for the second cavity.
- * Now increase the Close at Volume value for gate 2 *gradually* by about 3% (or less to avoid over-packing the part). Continue shooting parts while adjusting the Close at Volume value until you are getting the maximum pressure in the cavity where you are still not damaging the mold. This position will become the backup position for closing the valve gate in case you don’t transfer successfully off of cavity pressure.

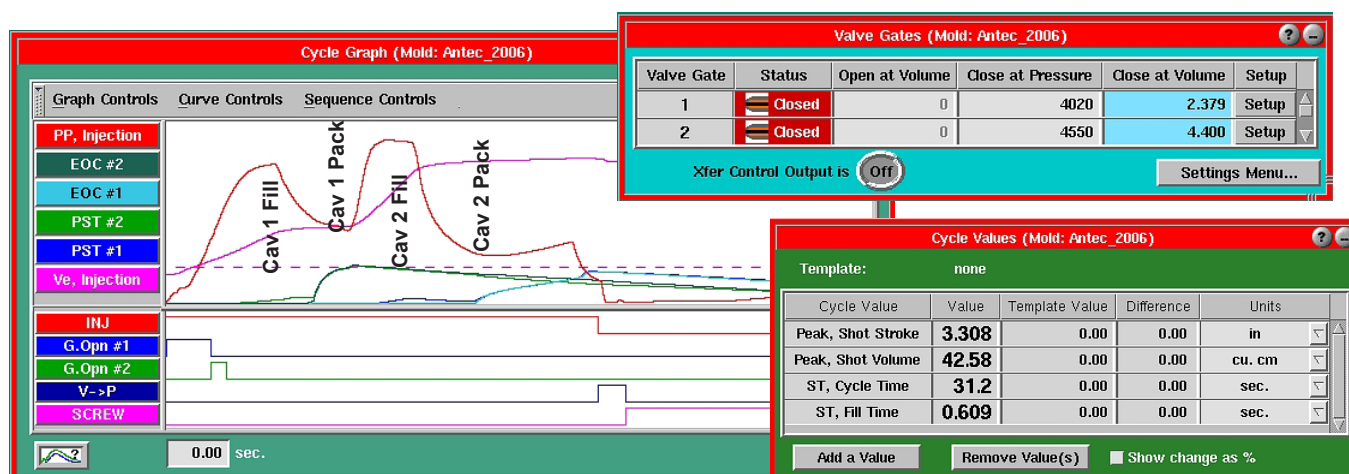


Figure 29: Cavity 2 Filled and Packed

21. Close Valve Gate 2 Using Cavity Pressure

- * Enter the pressure at the cursor for the second valve gate (which we noted earlier) in the Close at Pressure column for gate 2. The valve gate for this cavity should now begin closing off of cavity pressure instead of Injection Volume. If this is the case, the Close at Pressure column for this valve gate will turn light blue when the valve gate closes.
- * At this point, you should be making good parts in two cavities. We recommend saving a template at this time (named "Fill and Pack Cavity 2" for example). While we won't use this here, you may find it useful later when you go to set up the process again.

If you have more cavities, repeat the process for the second cavity until all cavities are in production. When this is done, adjust the mold clamped time to get the required cooling on the final cavity (the one with the least time available). Slow the screw RPM to stop the screw near the end of the mold clamped time with a little time to spare for screw run time variation.

Making Process Adjustments

Because this process builds two parts in sequence, you must give careful thought to making adjustments to the process. Making changes to one part can have an effect on the other. Here are a few ideas that bear attention.

1. Large pressure increases on cavity 1 pack pressure:

As you increase the pack pressure on cavity 1, more shot volume will be required to reach the new pressure. Eventually gate 1 will close when it reaches its backup volume and no longer be controlled by pressure. Do not increase the backup volume for gate 1. The machine is set to speed up at that backup position so, if you did this, it would start packing cavity 1 at 80% speed. If cavity 1 needs more pack pressure, both the machine position for speed up and the backup volume need to be increased simultaneously. It is best in this case to return to the end of the cavity 1 setup steps, closing cavity 2 and completing cavity 1 as if you were starting from the beginning.

2. Cushion too small:

If the ram is hitting bottom before or very close to when cavity 2 is finished, you will need to add cushion. This is simply a matter of adding the same amount to the transfer position for each machine profile on the machine control only. Be sure to run the screw to charge up to the new shot size. When the screw stops, the eDART® will find the new zero for starting injection and all of the shot volume backups on the Valve Gate control will remain the same.

3. Cushion too large:

Reducing the cushion is the reverse of adding to it as described above. Subtract the extra cushion from each step on the machine settings. However, if the barrel is charged to 145 mm and you reduce the shot size to 140 mm, there is still 5 extra mm in the barrel. In order not to overfill the cavities, you will need to purge and recharge the screw so that the eDART® knows the new zero (screw stop) and so that you have removed excess material from the barrel.

Notes on Summary Values

- * Since the Fill Volume (set in the Sequence Settings tool) only gives you the first cavity's fill time, the "Effective Viscosity, Fill" value only applies to that cavity. The "Average Value, Fill Speed" and "Fill Rate" values also similarly apply.
- * The "Average Value, Pack Speed" and "Pack Rate" values will only be valid when filling cavity 1 only (cavity 2 never opening). You can still use these values to transfer the process to another machine and match the pack rate, at least for cavity 1.
- * The "Process Time, Cavity Fill" value for the second cavity has little meaning. But the "Process Time, Cavity Pack" value should work on the second cavity because this is the time between a full cavity (1000 psi at the end of the cavity, Sequence Settings default) to a packed cavity (98% of peak at post gate).
- * Peaks and integrals by cavity function as they would normally.
- * Note that the cooling time for cavity 1 is much higher than cavity 2. So you need to use the shorter cooling time on cavity 2 as the "worst case". The "Sequence Time, Plastic Cooling" value only applies to cavity 1.

Pre-Open of Slow Gates

The cycle graphs in the previous process setups show the valve gates operating instantaneously. This is not usually true in the "real" world. There is always some solenoid delay time even with hydraulics. With pneumatic valves, it is possible to have 1/4 second or longer delays between the time the eDART® tells the valve to open or close and the time it actually does so.

In one case example, the opening of gate 2 took so long after gate 1 closed that there was a period during which both gates were closed. Since the machine did not slow down it continued to compress material in the barrel. When the second gate opened this buildup of pressure caused a sort of "burst" of material and so blush appeared at the gate.

In order to prevent this, we wanted to open the second gate early. So we added another method of opening gate 2, specifically open gate 2 when gate 1 reaches a cavity pressure. The setting shown at the right controls the cycle graph at the left (see Figure 30).

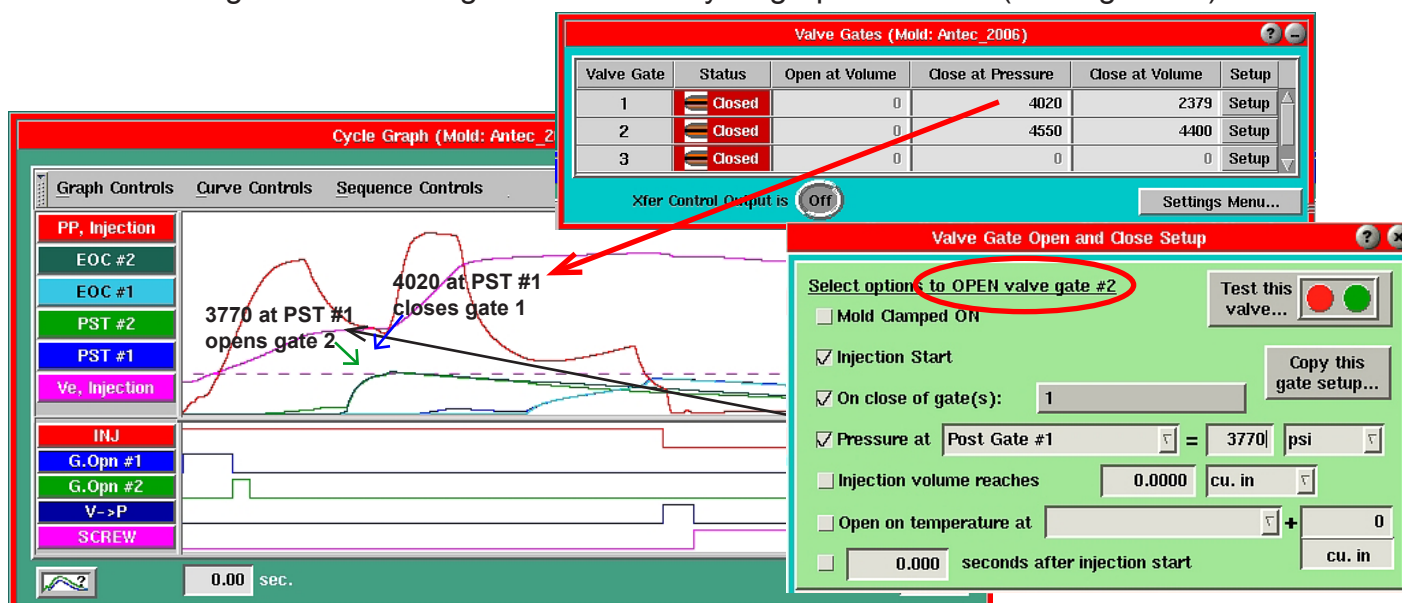


Figure 30: Cavity 2 Opening Before Gate 1 Closes

We have set the opening of gate 2 at 250 psi below the closing of gate 1 (3770 psi). So if you adjust gate 1's pressure closing setpoint, you will probably want to adjust gate 2's pressure opening setpoint to keep the "pre-open" timing correct.

Blush Control

In addition to the "slow gate" situation described on the previous page, there is often a need for a slow start to the filling portion of each cavity's process. This is easily done for cavity 1 by adding an initial slow speed at the start as follows:

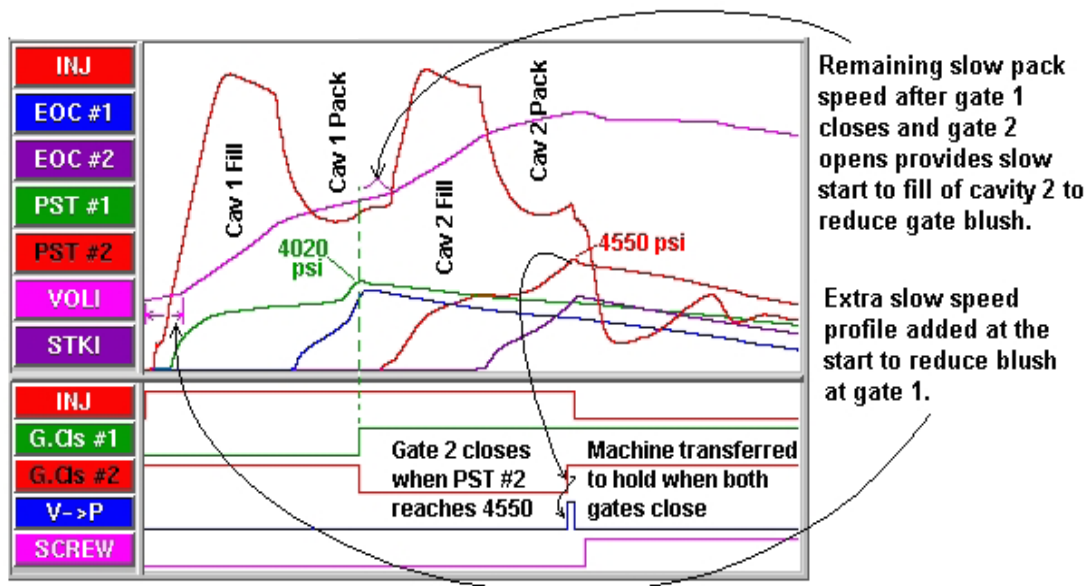


Figure 31: Gate Blush Reduction

If the pack speed for cavity 1 is the same as the slow speed required to reduce blush in cavity 2, usually you can use that little extra slow pack at the beginning of cavity 2's fill will cover what is necessary. If not, you might have to insert a slow profile there. If slower than cavity 1's pack, it will become a problem since you do not know exactly where in the machine's control profile the gates switch over.

Control on Mitsubishi Presses with Valve Gate Option

Mitsubishi Machine has added a valve gate control option to their machines which is designed to run with the eDART®. There is one basic difference in the control setup, however and that is that the machine actually does the switching of the gates.

- The outputs should all be set in the Sensor Locations tool to be Valve Gate Control, Close Gate #1 (2, 3, etc.).
- All gate open controls must be set to open on at least "Mold Clamped goes ON". In the alternate cavity scheme, the "Close" signal to the machine controller must be off at the start of the cycle. As the eDART® closes each valve in sequence, the machine opens the next one. So the cycle graph looks as the example in Figure 32.

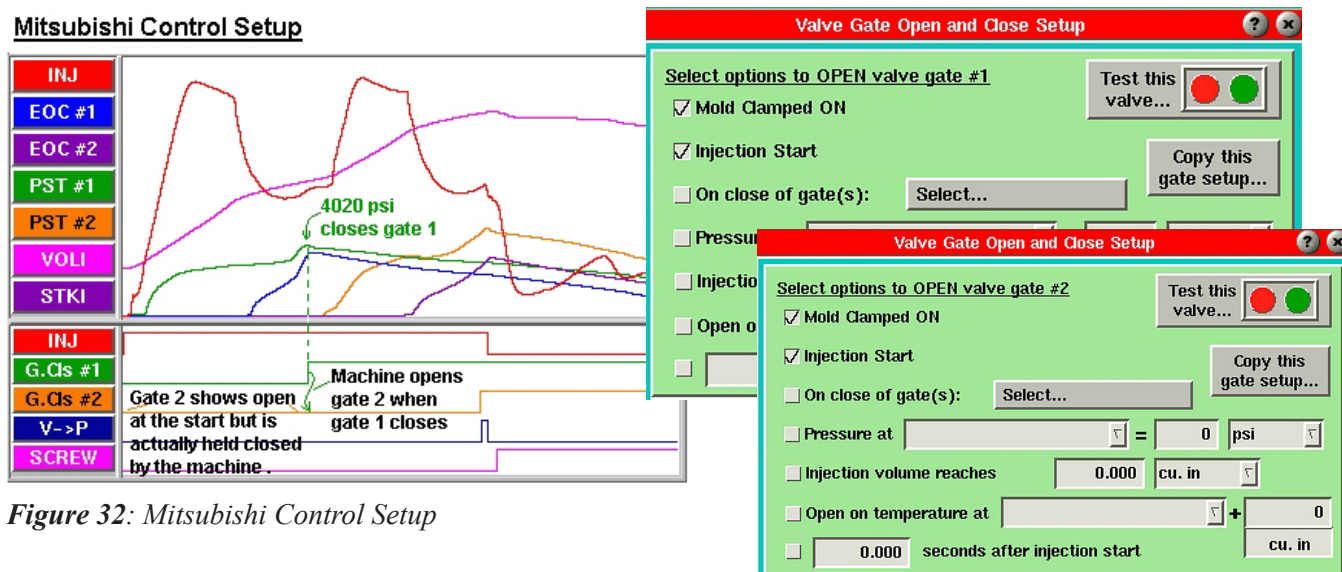


Figure 32: Mitsubishi Control Setup

Multi-Gate & Multi-Cavity Issues

When you fill and pack four cavities in two pairs, you will need to set the valve gates for the second pair of cavities to open when the valve gates for the first two cavities have both closed. To do this, follow the steps below.

Setup the open control for gate #3

On the Valve Gate Open Control screen for gate #3, click the *Select* button. An “Open on Close List” screen will appear. Here you will choose the gates that must be closed in order for gate #3 to open. In this four-cavity example, you would select gates #1 and #2.

Setup the open control for gate #4

On the Valve Gate Open Control screen for gate #4, click the *Select* button. An “Open on Close List” screen will appear. Here you will choose the gates that must be closed in order for gate #4 to open. In this four-cavity example, you would select gates #1 and #2.

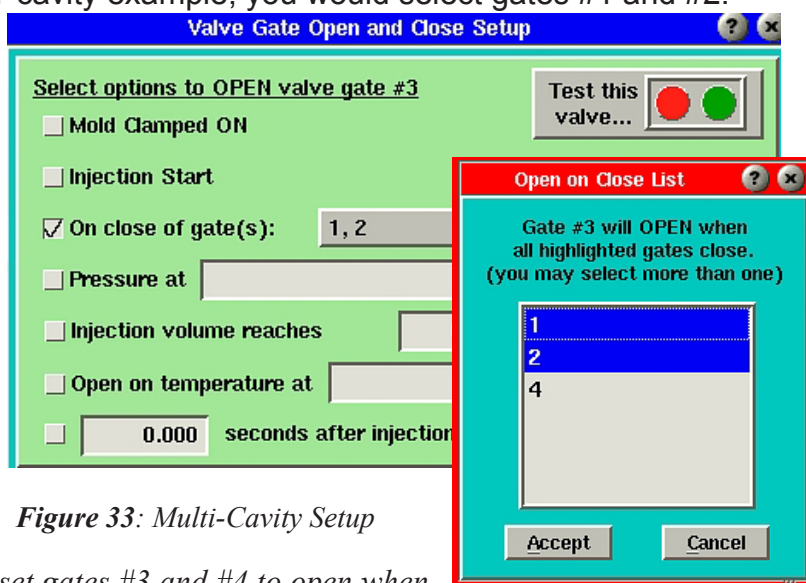


Figure 33: Multi-Cavity Setup

NOTE: In our example, we have set gates #3 and #4 to open when gates #1 and #2 have both closed. If you are running a similar four-cavity application, note that the gates can be opened and closed in any combination.

NOTE: This setup can also apply to multiple cavity applications where each cavity contains two or more gates.

As with independent cavities, as cavities begin to close off, the pack rate on the remaining open ones will increase.