COPILOT®

SOFTWARE USER GUIDE

RJG®
MOLD SMART

Training and Technology for Injection Molding

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Introduction

Read, understand, and comply with all following instructions.

Disclaimer

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Alerts

The following alert types are used as needed to further clarify or highlight information presented in this document:

DEFINITION *A definition or clarification of a term or terms used in the text.*

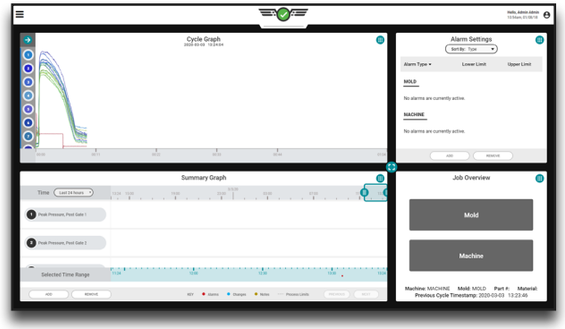
NOTE *A note provides additional information about a discussion topic.*

CAUTION *A caution is used to make the operator aware of conditions that can cause damage to equipment and/or injury to personnel.*

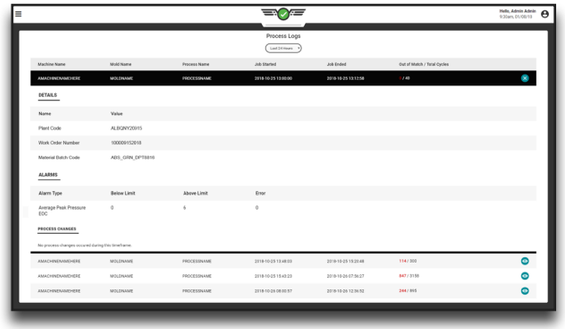
Product Overview

The CoPilot® software provides the following:

- Process Performance Overview



- Process Change Log



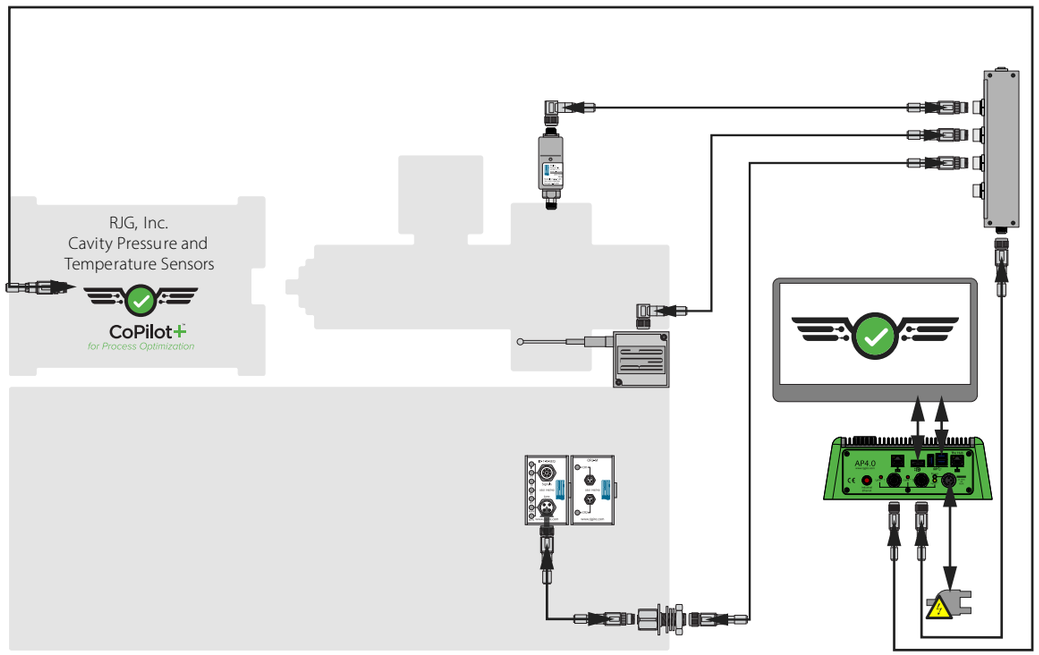
Introduction (*continued*)

Requirements

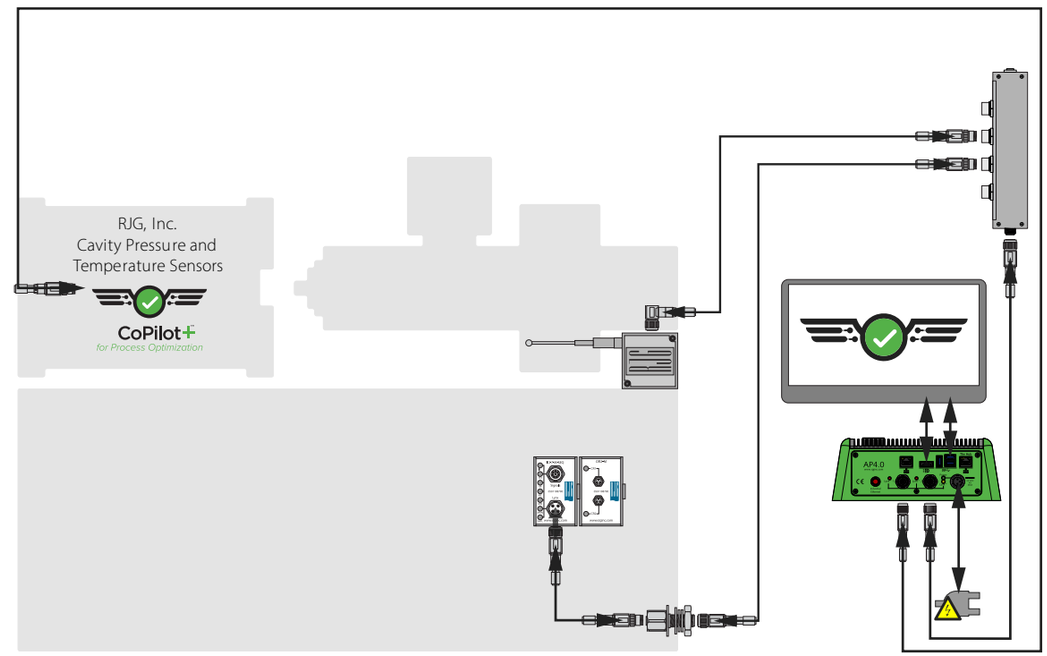
To use this product, the following is required:

RJG, Inc. CoPilot hardware including the AP4.0 Application Processor with built-in Lynx™ sensor interfaces and necessary Lynx-to-injection molding machine interface components. Refer to the *CoPilot Hardware Installation and Setup Guide* for more information on components.

Hydraulic Machine Setup



Electric Machine Setup



Introduction (*continued*)

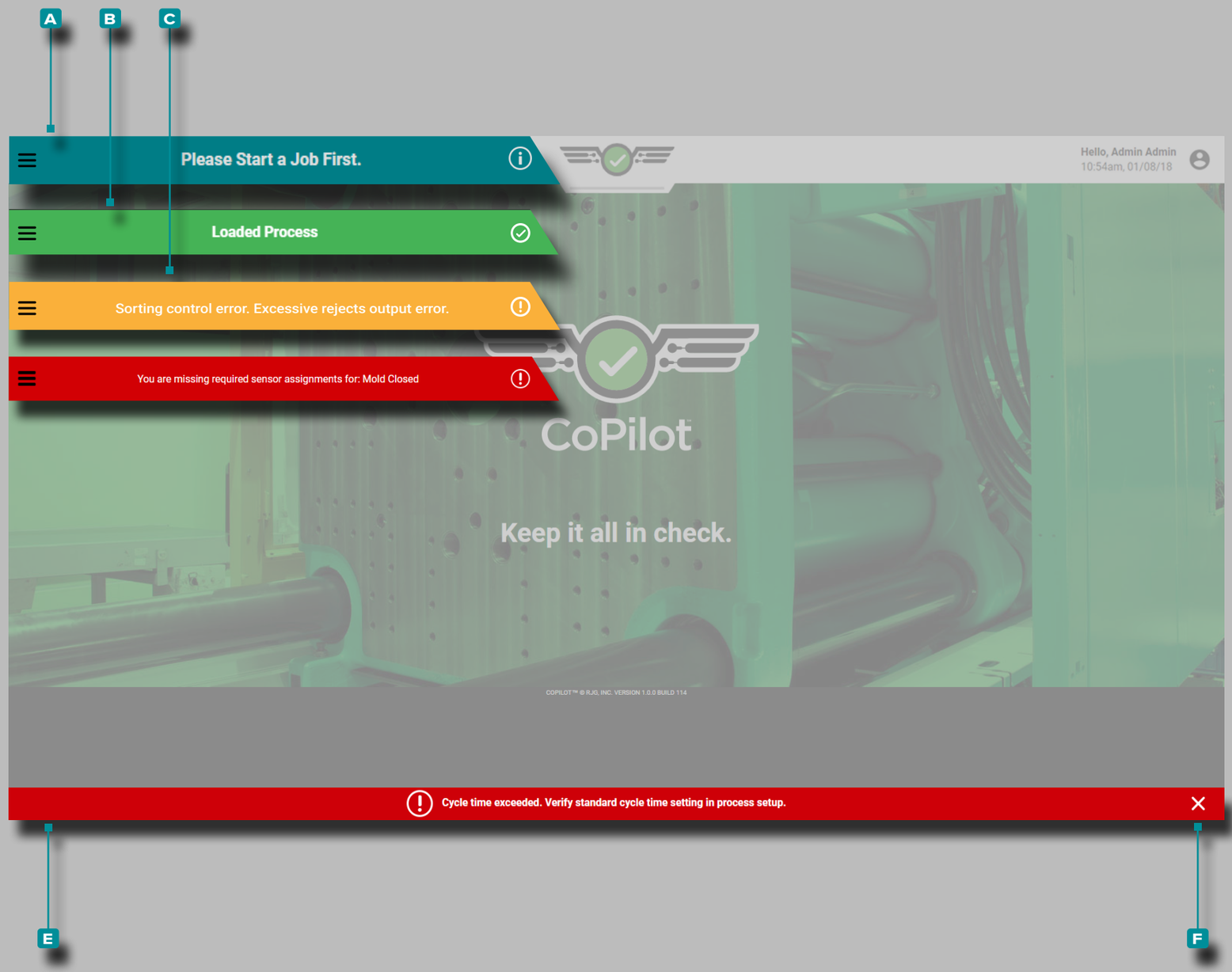
Software Icons and Navigation

The following details commonly used symbols and their functions in the CoPilot software.

User	Tap the object to view user information.	Settings	Tap the object to view or edit settings.	Error	The object indicates an error has occurred.
Menu	Tap the object to open the software menu.	Help	Tap the object to view the software or hardware user guides, or to report a problem.	Create New	Tap the object to create a new machine, mold, or process.
Setup	Tap the object to open the setup dashboard.	Exit Window	Tap the object to exit an open window or menu.	Deselect	Tap the object to dismiss/deselect the item.
Job Dashboard	Tap the object to view process.	Edit Object	Tap the object to edit.	Collapse/ Expand	Tap the up arrow to collapse the window; tap the down arrow to expand the window.
Process Change Log	Tap the object to view the process log.	Information	Tap the object to view more information.	Filter	Tap the field which contains the object, then enter a term or phrase to filter results.
Note Entry	Tap the object to enter a process note while a job is running.	Success	The object indicates a successful operation.	Time Range Selection	Tap, hold, and drag one end to widen/shorten selected time frame; tap, hold, and drag middle to move selected time frame.

Introduction (*continued*)

CoPilot Hardware	The icon designates the CoPilot hardware.
Machine	The icon designates machines and machine settings.
Mold	This icon represents molds and mold settings.
Process	This icon represents processes and process settings.
Sequence Module	The icon represents the machine sequence module.
Analog Input Module	The icon represents analog inputs.
Output Relay Module	This icon represents the Output Relay module for sorting and control outputs.
Hydraulic Pressure	This icon represents the hydraulic pressure sensor.
Limit/ Proximity Switch	This icon represents the LS-S limit switch or the L-PX proximity switch.
Sensor	This icon represents a cavity pressure sensor or sensor adapter.
Stroke/ Velocity Input	This icon represents the stroke/ velocity input.
Stroke/ Velocity Input	This icon represents the stroke/ velocity input.
Plastic Pressure	This icon represents the plastic pressure type location.
Sorting	This icon represents sorting outputs.
Control	This icon represents control outputs.



Introduction (*continued*)

Software Notification Types

Software notifications may either be temporary notifications or peristent notifications.

Temporary Notifications

Temporary notifications **A**, **B**, **C**, & **D** appear on the top left section of the menu bar, and will disappear without user acknowledgment.

Persistent Notifications

Persistent Notifications **E** appear across the bottom of the screen, and will remain until the user acknowledges the message; this may require the user to perform certain actions described in the message.

NOTE *Notifications that contain too many characters to fit within the top menu bar area will be displayed like persistent notifications—across the bottom of the screen.*

Software Notification Categories

Among the two types of notifications (temporary and persistent), the notifications are further divided into the following categories:

- Information
- Success
- Error
- Warning

Information **A** notifications provide additional information for user assistance; information notification are blue.

Success **B** notifications appear as a confirmation of any changes or commands that have been made in the software; success notifications are green.

Error **C** and Warning **D** notifications appear due to missing or incorrect inputs, missing or incorrect outputs, or general software errors; *error and warning notifications may be red or yellow, depending upon the required action's urgency*. Read the error to determine the error type; if necessary perform the corrective action required.

Tap the **F** exit icon to dismiss the persistent notification from the screen.

User Log In

The CoPilot software requires users to log in with a username and password before use. A user may **tap** the **A** monitor process button while a job is running to monitor the process, however, no changes are permitted until login is complete.

Enter a **B** username and **C** password, then **tap** the **D** sign in button to complete login and view the Dashboard, ***OR*** **tap** the **A** monitor process button to view the current process.

ⓘ **NOTE** *Individual access to features and functions is determined by the user role assigned during setup of the CoPilot system and The Hub software. If a feature or function is not available, please check user role permissions before submitting an error report. User role permissions for the CoPilot system are managed on The Hub software; refer to The Hub Software User Guide for full user role permissions.*

Introduction (*continued*)

CoPilot Dashboard

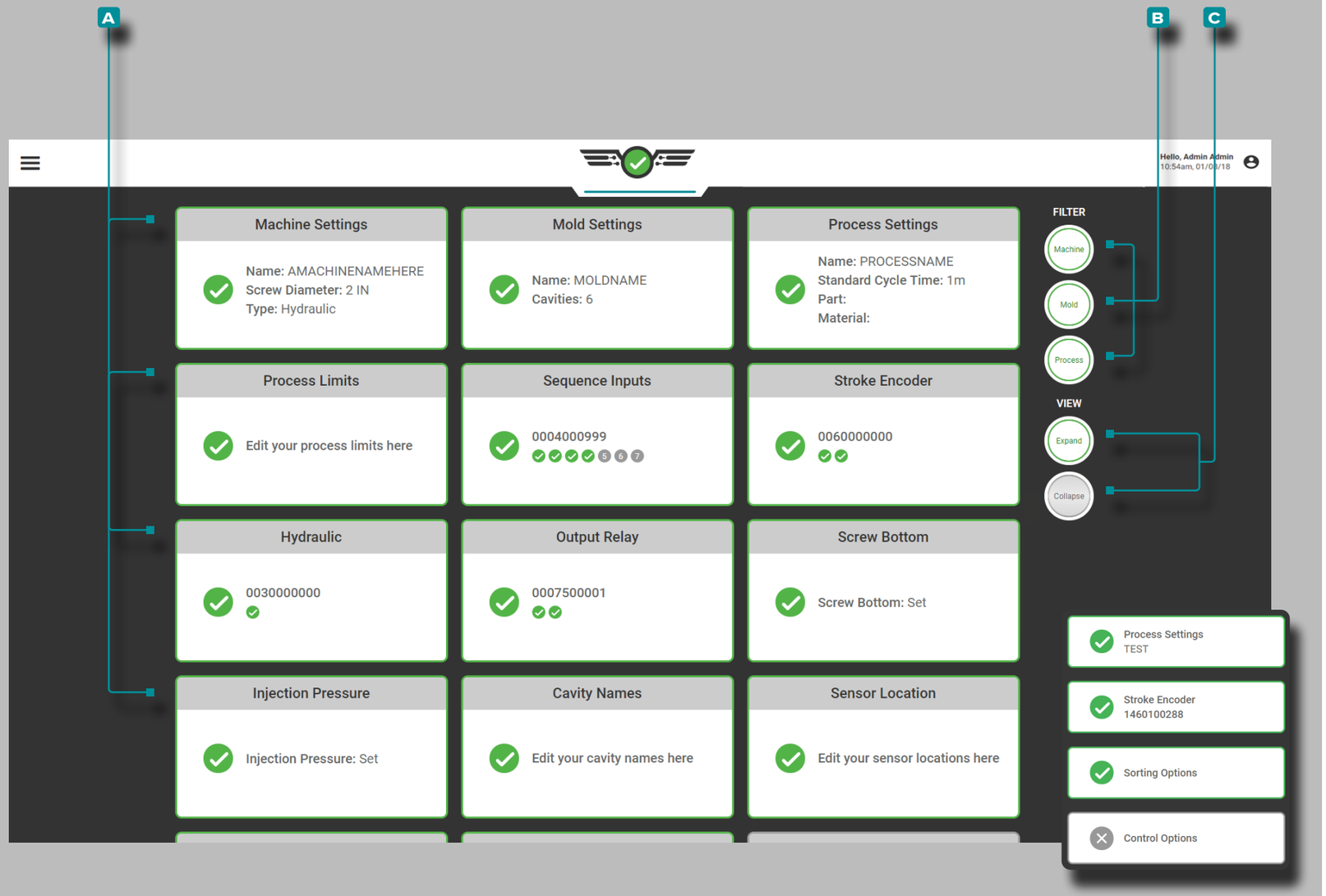
The CoPilot Dashboard provides access to Setup utilities (Machine, Mold, and Process), the Job Dashboard (process Monitor), the Process Log, software Settings, and software Help.

Tap, hold, and drag the **A** pull down menu then select **B** a Machine, Mold, Part, or Process to load a saved setup, or to create a new Machine, Mold, or Process.

Tap the **C** menu button, then select the **D** Setup to view the Setup Dashboard, or **tap** the **E** Job Dashboard to view a running process and values, or **tap** the **C** menu button, then select the **F** Process Logs to view or export process change logs.

Tap the **C** menu button, then select **G** Note Entry *while a job is running* to enter a process note.

Tap the **C** menu button, then select **I** Settings to access software settings. **Tap** the **C** menu button, then select **H** Help to access software help.



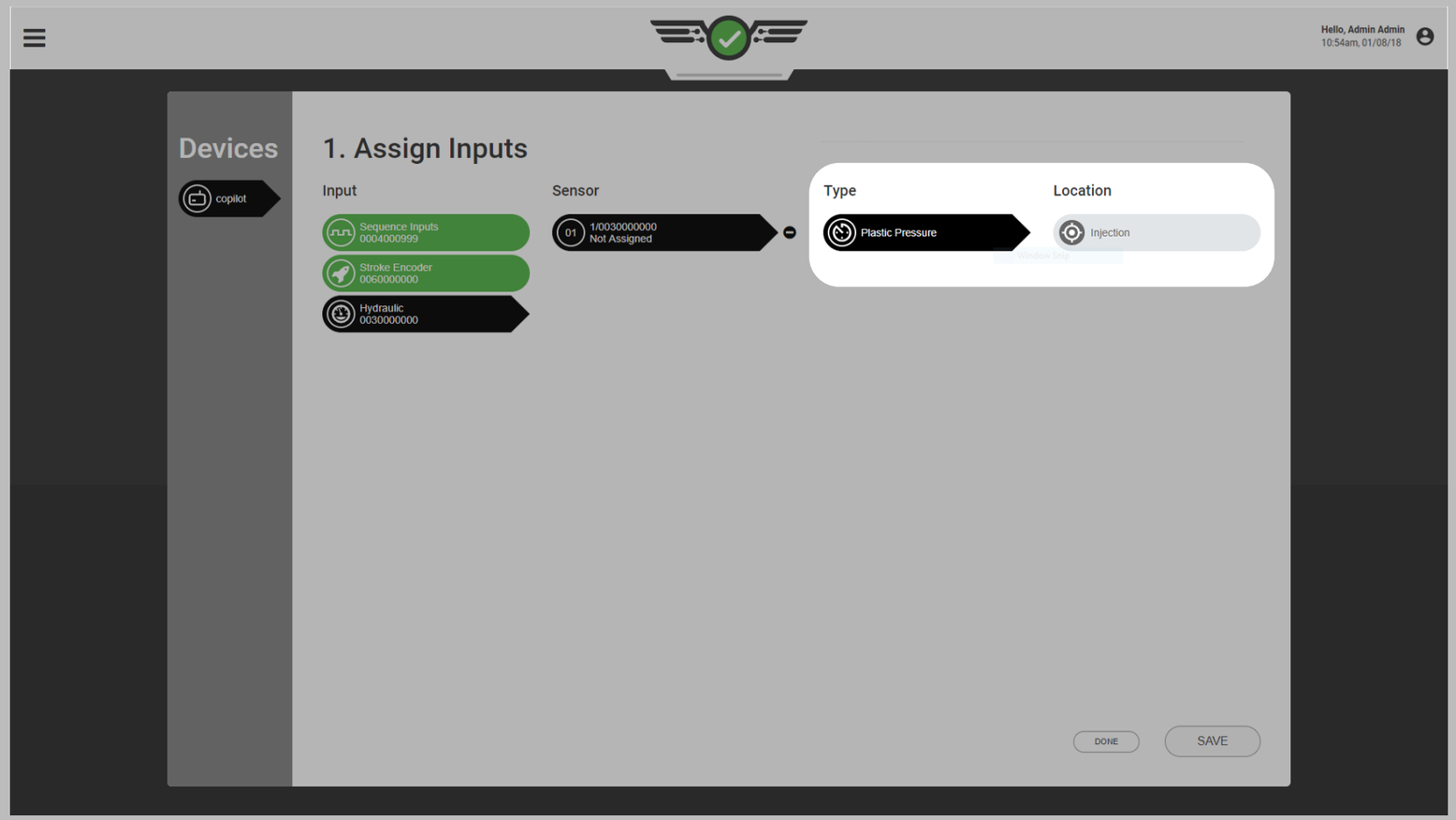
Introduction (*continued*)

CoPilot Dashboard (continued)

The Setup Dashboard will display **A** cards that detail the current Machine, Mold, and Process settings.

Tap a **A** card to quickly view and/or edit the selected setting.

Tap the Machine, Mold, or Process **B** Filter button(s) to view or hide related cards; **tap** the Expand or Collapse **C** View buttons to view more or less information on the cards.



Introduction (*continued*)

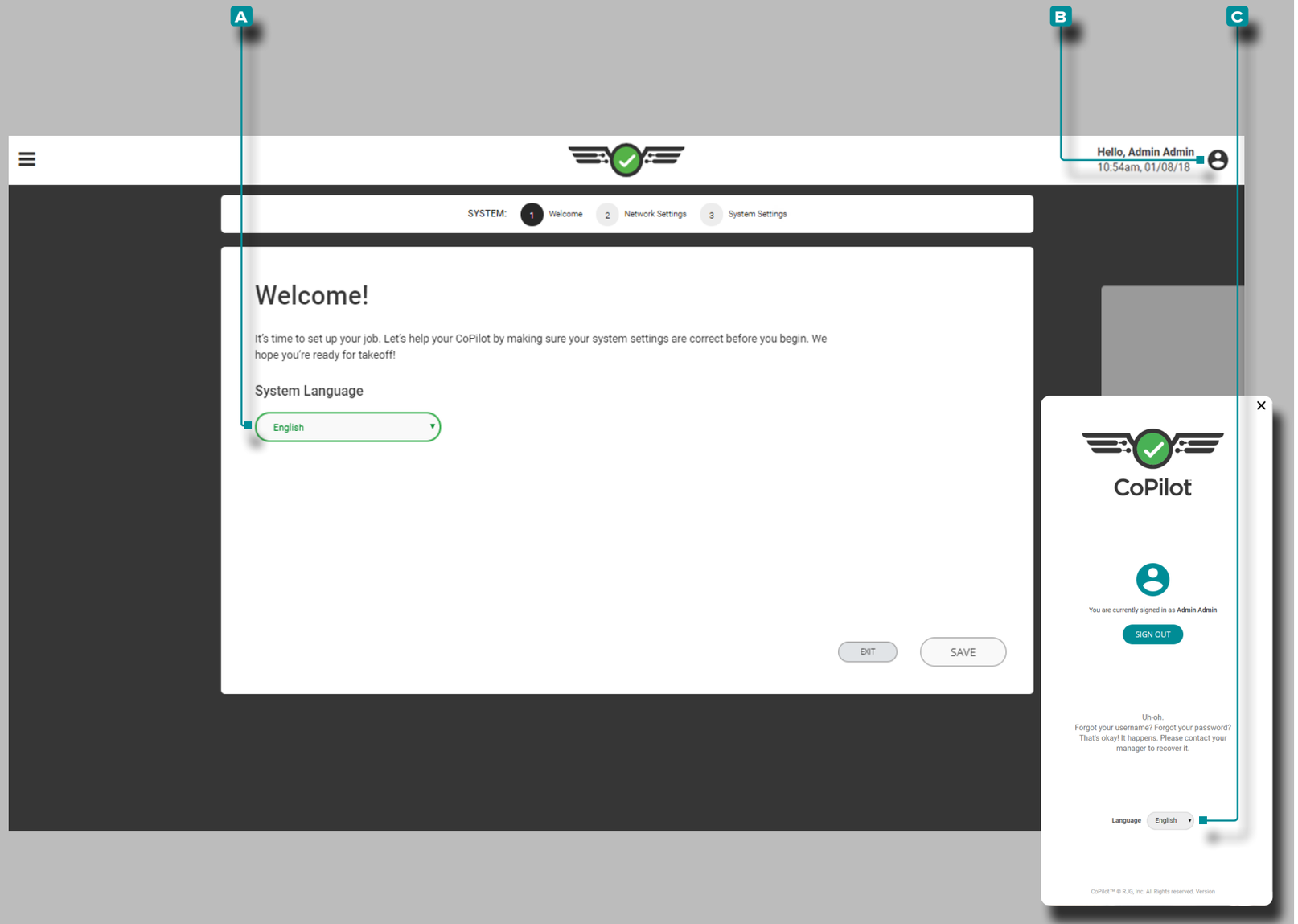
Machine, Mold, and Process Naming Conventions

It is recommended a naming standard for entering machine, mold, and process names in the software is created. A mold named “M 248” (with a space) is different than mold “M248” (without a space); the same is true for machines, cavities, sensor IDs, and processes. If setup is not consistent, the alarm settings and process limits will not be available when a job is restarted with a slightly different name.

Inputs & Outputs “Type” and “Location”

Every input or output “sensor” must be set up with a Type and Location in the software. These two items enable the software to decide what to do with the data coming from the sensor using scaling and calibration details.

The Type what value is measured by the sensor. For example, a hydraulic sensor type is “plastic pressure” because it measures hydraulic pressure and converts it into plastic pressure. The Location is where the sensor is physically located; for example, a hydraulic sensor location is “injection” because it is located



Setup

First Time Setup

Upon initial start-up, the CoPilot software will begin a guided, first-time system setup. First time setup includes system language, network settings, and system software.

System Language

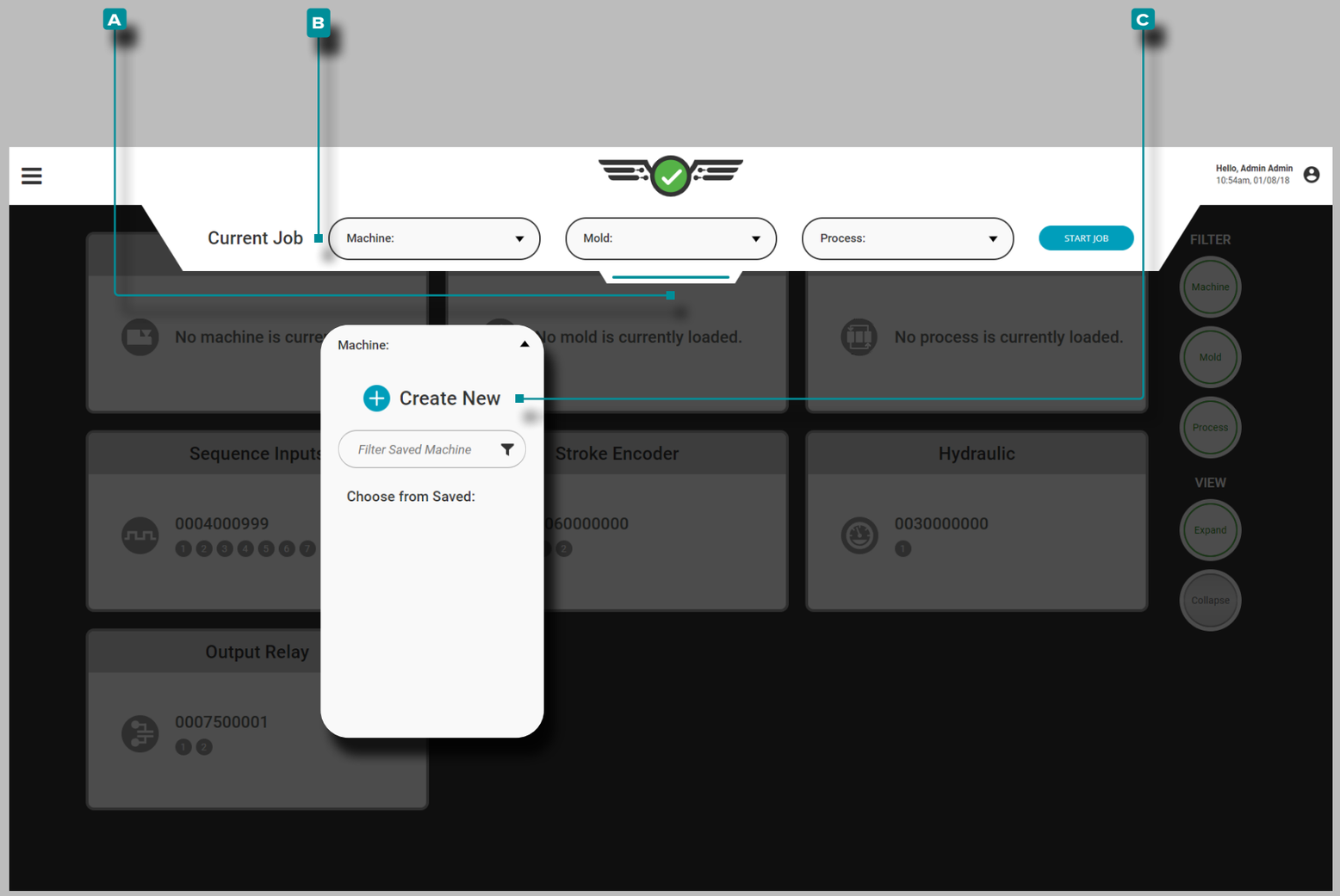
The CoPilot software is available for use in the following languages: English, Chinese (Simplified), French, German, and Spanish (Mexico).

Initial Setup

The desired system software language is selected upon initial start-up during first time setup. **Tap** to select the desired software **A** language from the provided drop-down box.

Language Change

To change the selected system software language after setup is complete, **tap** the **B** user icon, then select the desired software **C** language from the provided drop-down box.

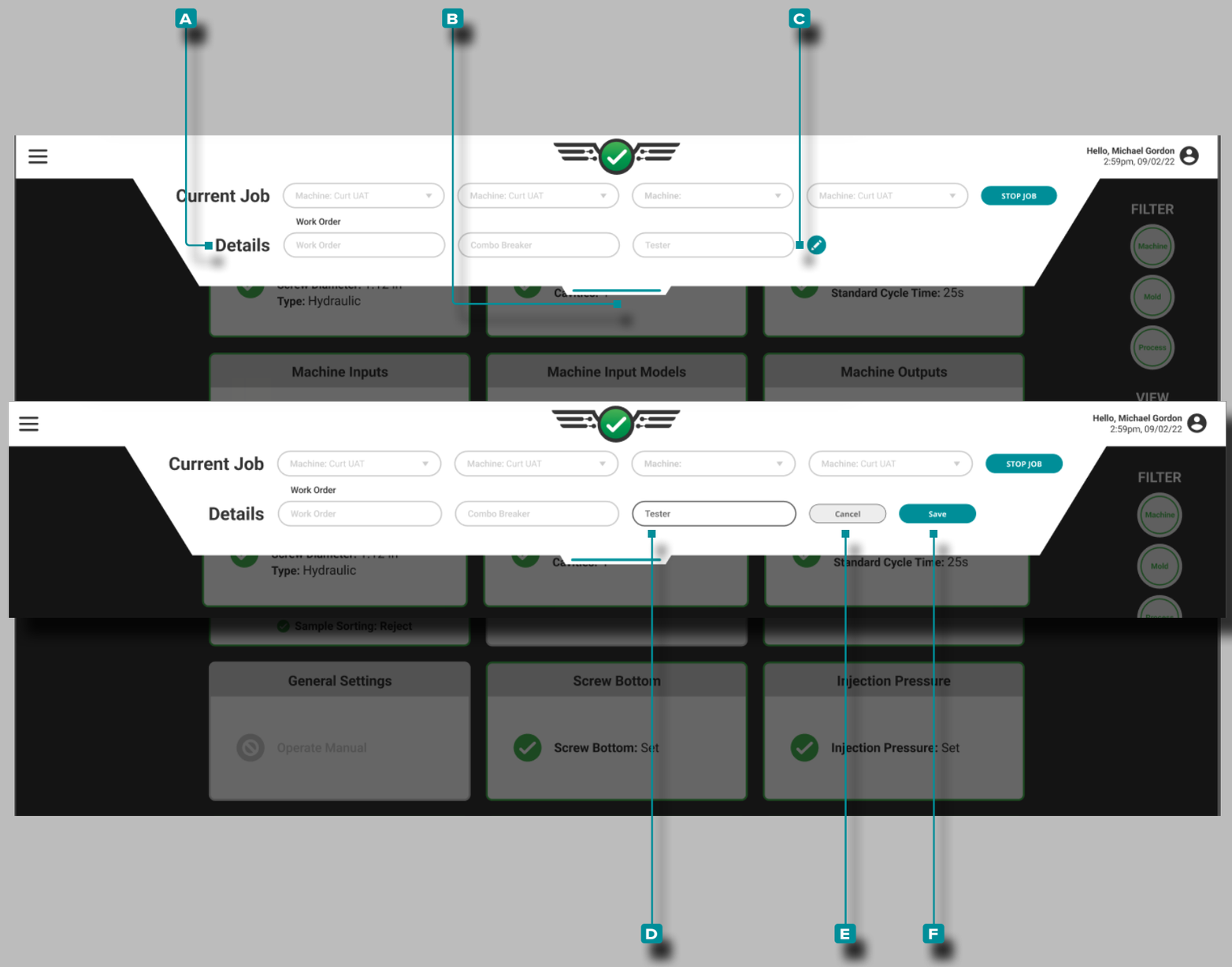


Setup (*continued*)

Machine Setup

Tap 👆, hold, and drag the pull-down **A** menu to access machine setup. **Tap** 👆 the **B** Machine drop-down menu, then **Tap** 👆 to select the **C** Create New machine option.

Machine Setup includes settings, inputs, outputs, screw bottom, and—if applicable—zeroing of injection pressure (hydraulic machines only). Once a Machine is set up, it may be loaded or saved for future use.



Setup (*continued*)

Custom Fields

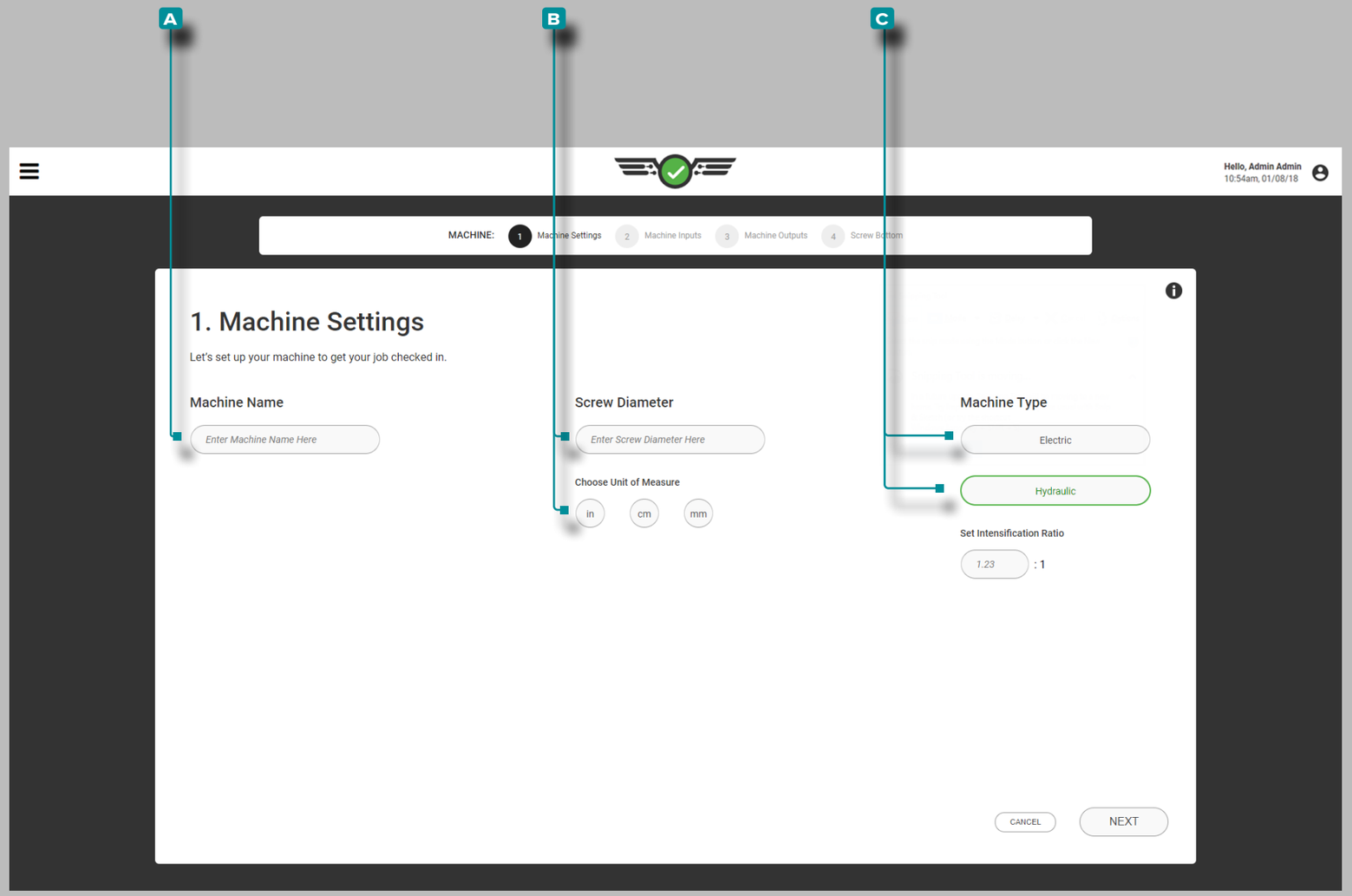
Custom Fields **A** may be added from The Hub® to the setup, located on the pull-down **B** menu; **A** Custom Fields are used to record additional information from CoPilot systems for display on The Hub. The completion of **A** Custom Fields may or may not be required depending upon settings configured on The Hub.

CAUTION *A maximum of three (3) custom fields may be displayed on the CoPilot system dashboard.*

Editing Custom Fields

Custom Fields may be edited/updated without stopping the currently-running job, *if enabled on The Hub software*. The changes are noted on the summary graph and notes widgets.

Tap the **C** edit icon, then **tap** a **D** field to **enter** any edits/updates. **Tap** the **E** Cancel button to cancel any changes, or **tap** the **F** Save button to save any changes.



Setup (*continued*)

Machine Settings

Complete Machine Settings each time a new setup is created. Machine settings include name, screw diameter, and machine type.

Name, Screw Diameter, Machine Type

Machine names are required, must be unique, and may be one to twenty characters in length including uppercase, alphanumeric, spaces, and special characters - or #. **Tap** the field and **enter** a **A** Machine Name.

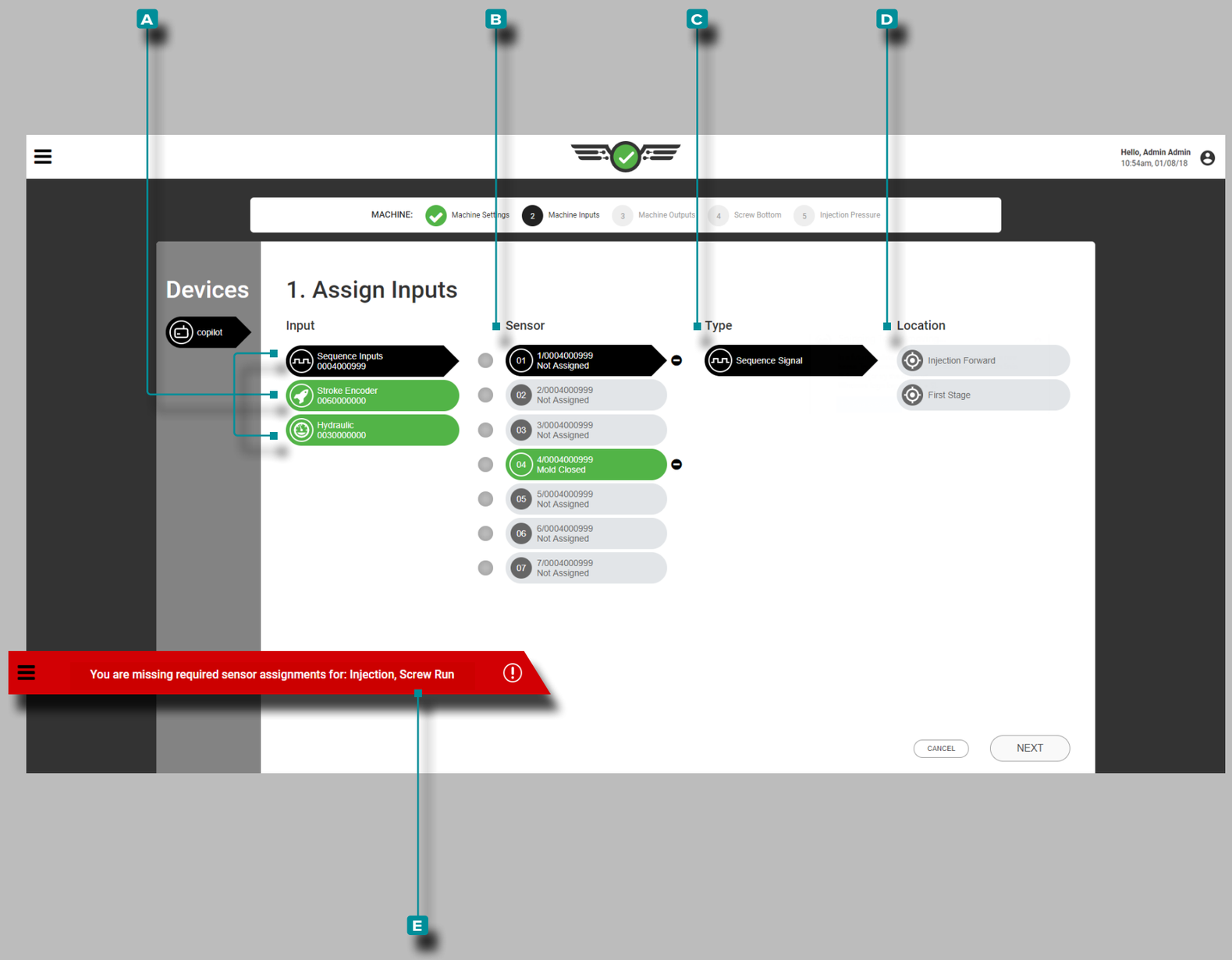
Screw diameter is required and may be a value of 0.1+ using only one decimal place (tenths "0.0"). **Tap** the field to **enter** the **B** Screw Diameter, then **tap** to enter the screw diameter unit of measure.

Tap to select the **C** Machine Type (required). **Tap** the field to **enter** the Intensification Ratio for hydraulic machines .

NOTE *If the machine's intensification ratio is 10:1, enter "10"; a machine's Ri cannot be edited while a job is running.*

DEFINITION *Intensification ratio (Ri) is the comparison of hydraulic input pressure on the injection cylinder versus the plastic pressure output from the front of the screw. (Ri)=Injection Cylinder Area ÷ Screw Area.*

CAUTION *Electric or hybrid machines have a controller setting for Pack Velocity which must be set correctly in order for the CoPilot to properly and consistently calculate hold pressure, and for the cavity to be packed well before hold time is complete.*



Setup (*continued*)

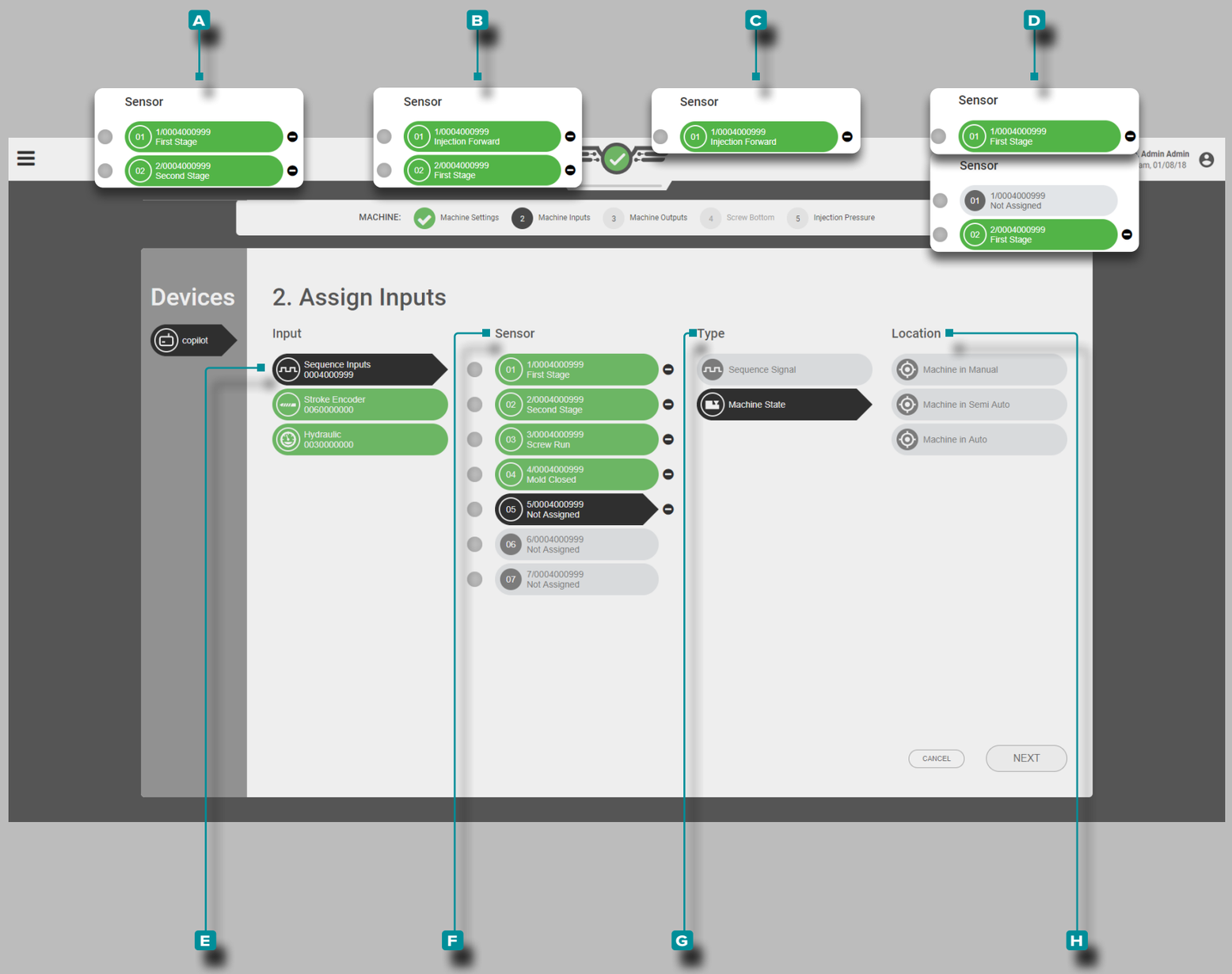
Assigning Inputs

Assign inputs each time a new Machine setup is created. Inputs include sequence inputs, injection stroke and velocity positions, injection pressure, screw recovery signal (if one cannot be obtained for the sequence module from the machine), mold closed signal (if one cannot be obtained for the sequence module from the machine), and—optionally—coolant flow rate and temperature, and water flow rate and temperature.

ⓘ **NOTE** *If sequence inputs are not available, the CoPilot system can be utilized with a mold closed or mold clamped signal AND a stroke/velocity sensor at a reduced functionality of some features; this operation is referred to as "CoPilot Go". Refer to "CoPilot Go" on page 12 for setup and processing information of CoPilot Go.*

Each connected **A** input is displayed on the left. **Tap** ☝ an **A** input to assign a **B** sensor, **C** type (the input type), and **D** location (the input's physical location or function) for the input.

Each connected input must be assigned. If an input assignment is not completed, an **E** error notification will indicate that the input has not been set up and requires assignment before continuing machine setup.



Setup (*continued*)

Assigning Inputs (continued)

Sequence Inputs

Machine sequence inputs for injection forward, screw run, and mold clamped are required. Injection forward may be derived from the following combinations:

A ⓘ **Sensor Channel 1:** First Stage **& Sensor Channel 2:** Second Stage *or*

B ⓘ **Sensor Channel 1:** Injection Forward **& Sensor Channel 2:** First Stage *or*

C ⓘ **Sensor Channel 1:** Injection Forward *or*

D ⓘ **Sensor Channel 1:** First Stage *or* **Sensor Channel 2:** First Stage

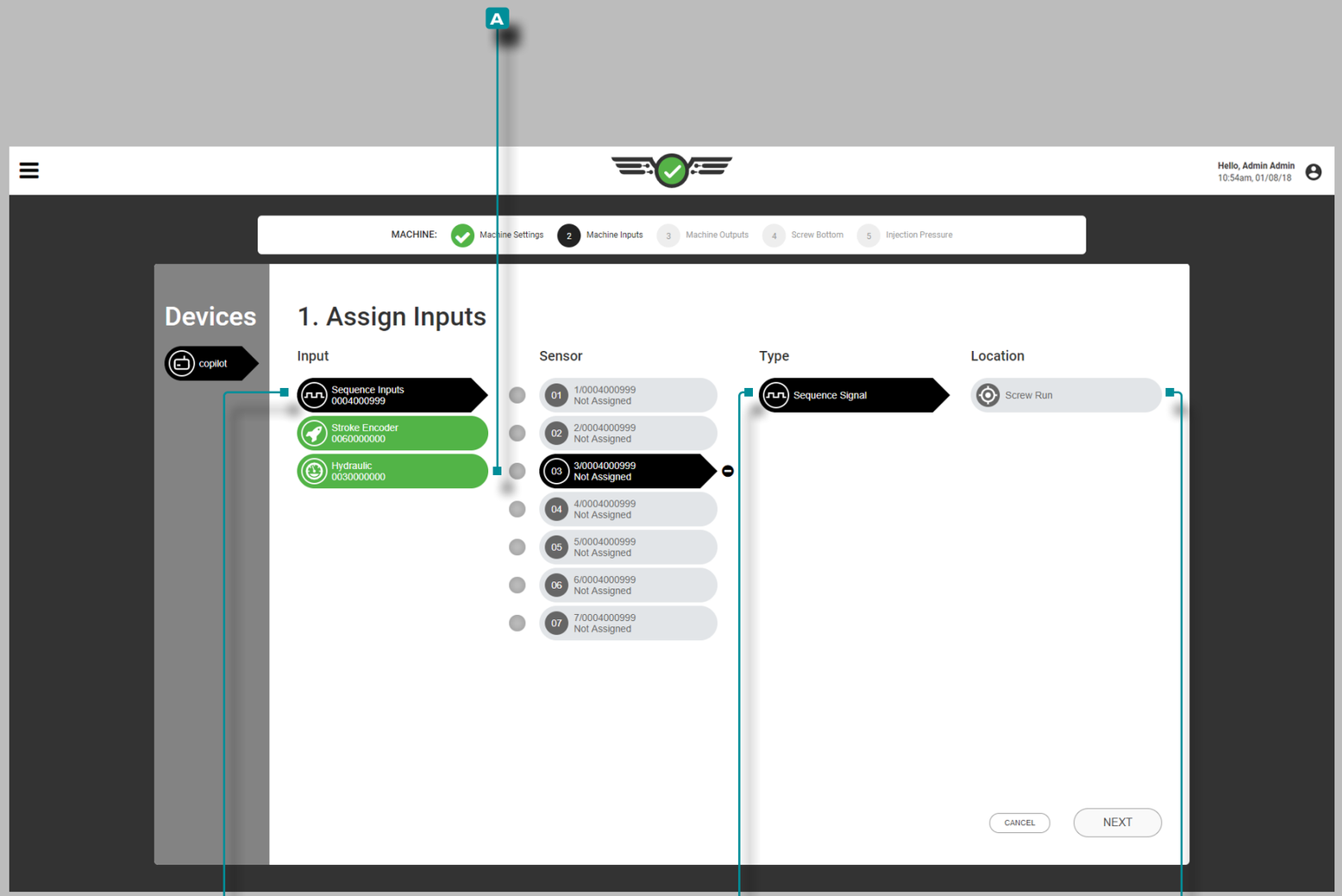
ⓘ **NOTE** *A* **A** *recommended, followed by* **B**, *with others being acceptable but not optimal.*

ⓘ **NOTE** *A 1st and 2nd stage sequence input is required for cycle times that result in fast fill times/fill times less than 0.1 seconds, OR users will be required to utilize the Set Fill Volume at Cursor function to calculate fill time. Refer to "Advanced Setting: Enabling Fast Fill Time" on page 180, and "Set Fill Volume at Cursor" on page 76.*

Tap ☝ **the** **E** sequence input, then select the **F** sensor channel(s) to assign the **G** type and the **H** location(s) for the injection forward sequence input.

If running a DECOUPLED II® or DECOUPLED III® process, the fill sequence signal can be set up using the "Set Fill at Cursor" function on the Cycle Graph (refer to "Set Fill Volume at Cursor" on page 76).

📖 **DEFINITION** *The Sequence Input Module ID7-M-SEQ is a DIN rail-mounted module which is wired directly to the molding machine in order to collect 24 V DC timing signals for use with the CoPilot software.*



Setup (*continued*)

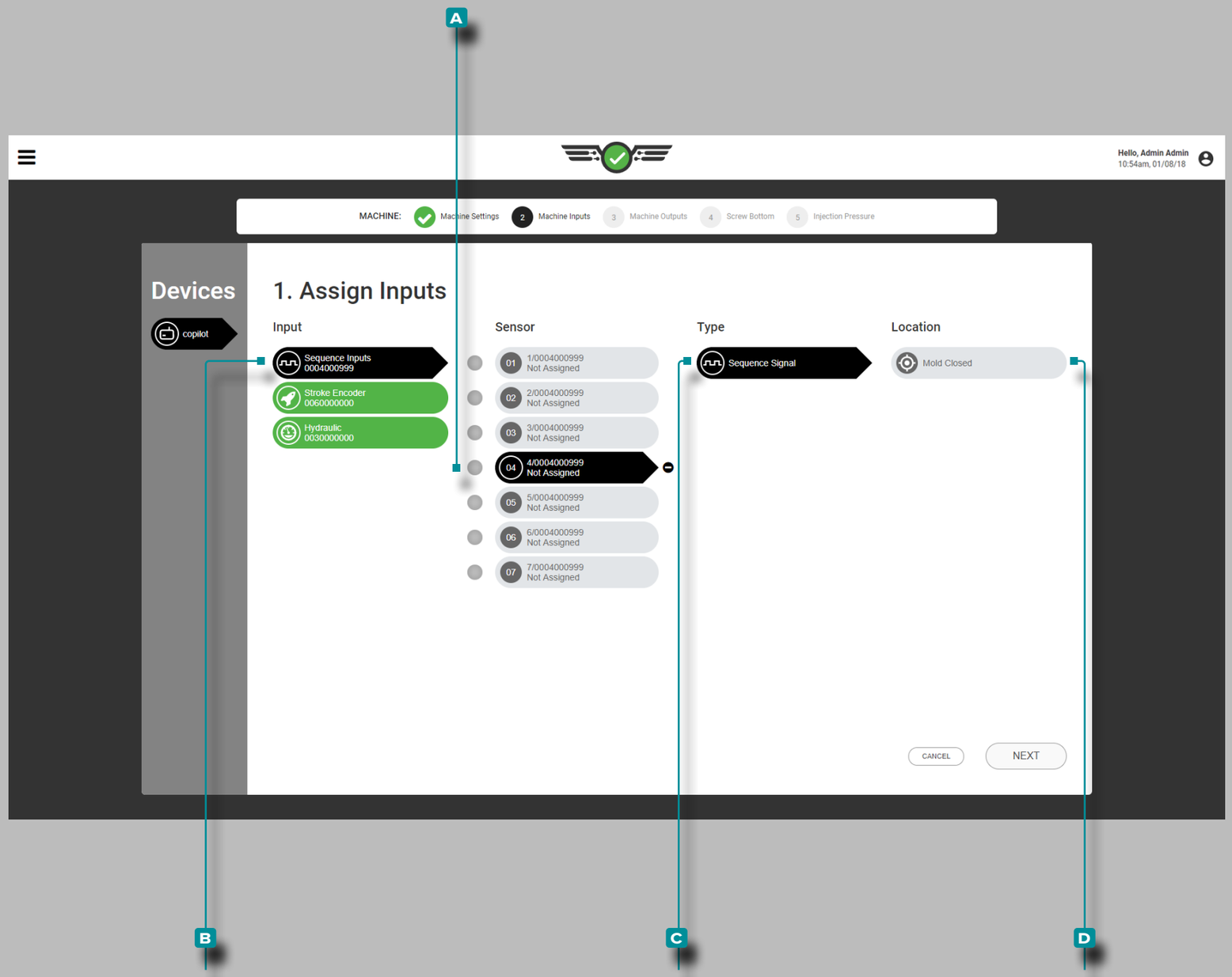
Assigning Inputs (continued)

Screw run may be derived from the Sequence Module
A ⓘ**Sensor Channel 3:** Screw Run, ***OR***

Analog Input: Analog Screw RPM.

If a screw run signal is acquired from the Sequence Module, **tap** 👆 the B sequence input, then A sensor channel 3 to assign the C type and D location for screw run sequence input.

ⓘ **NOTE** *If the screw run signal is acquired by an analog input from a analog screw rpm, it will be assigned later (“Assign Analog Screw RPM to Screw Run Sequence Signal” on page 9).*



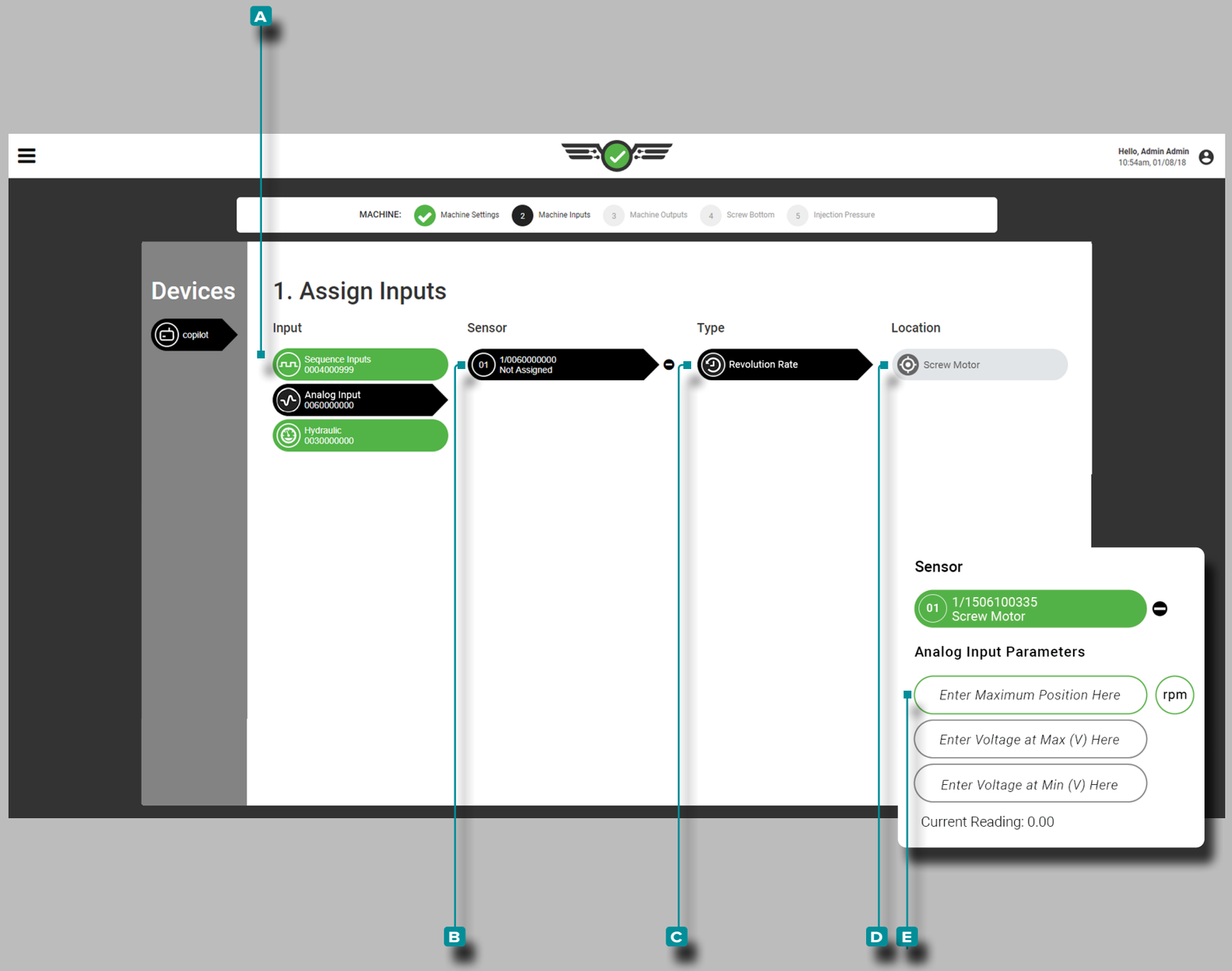
Setup (*continued*)

Assigning Inputs (continued)

Mold closed may be derived from the Sequence Module **A** ⓘ **Sensor Channel 4:** Mold Closed, ***OR*** Input Proximity Switch, ***OR*** Input Limit Switch.

If a mold closed signal is acquired from the Sequence Module,
tap ☝ the **B** sequence input, then **A** sensor channel 4 to assign the **C** type and **D** location for mold closed sequence input.

ⓘ **NOTE** *If the mold closed signal is acquired by an input from a proximity or limit switch, it will be assigned later ("Assign Proximity Switch Input to Mold Closed Sequence Signal" on page 10).*



Setup (*continued*)

Assigning Inputs (continued)

Assign Analog Screw RPM to Screw Run Sequence Signal

Tap the A analog input, then B sensor channel 1 to assign the C type and D location for analog input screw RPM sequence input screw run.

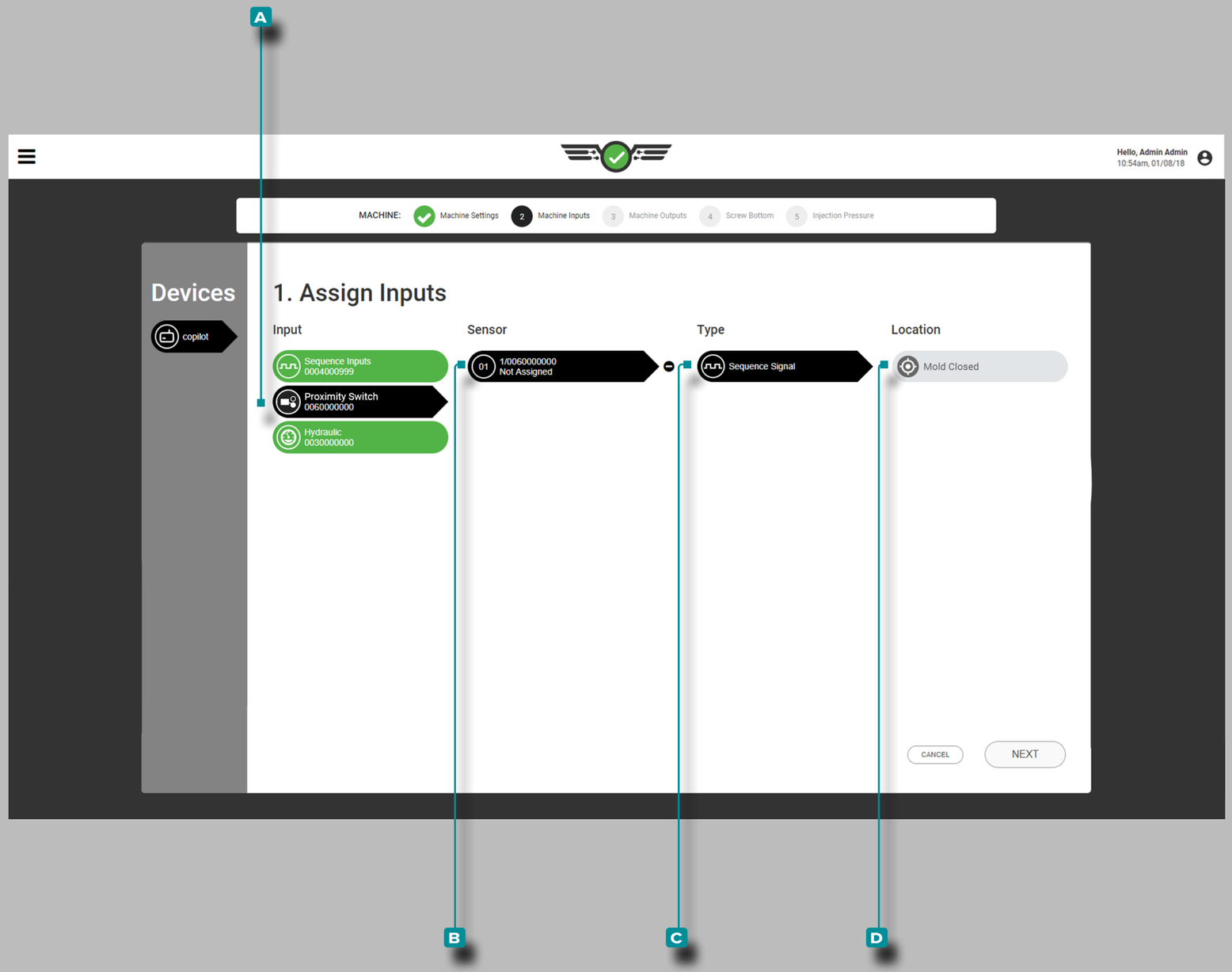
DEFINITION ANALOG INPUT SCREW RPM *Screw RPM can be derived by the analog input from an electrical signal (electric machines) if no screw run signal is available.*

Tap the E fields to **enter** analog input for screw rpm maximum and voltage at minimum and maximum values.

DEFINITION ANALOG INPUT VOLTAGES (MIN/MAX) *The electrical signal for screw rpm is usually 0–10 V, with a low voltage (not always zero) representing screw off and a high voltage (not always 10 V) representing screw on. Measure the actual voltages for screw run on/off.*

Screw maximum rpm and voltage at minimum and maximum values is required and may be a value of zero to fifteen, with two decimal places (hundredths “0.00”).

NOTE *The Analog Input: Screw Run scaling cannot be set up or edited while a job is running/the machine is cycling.*



Setup (*continued*)

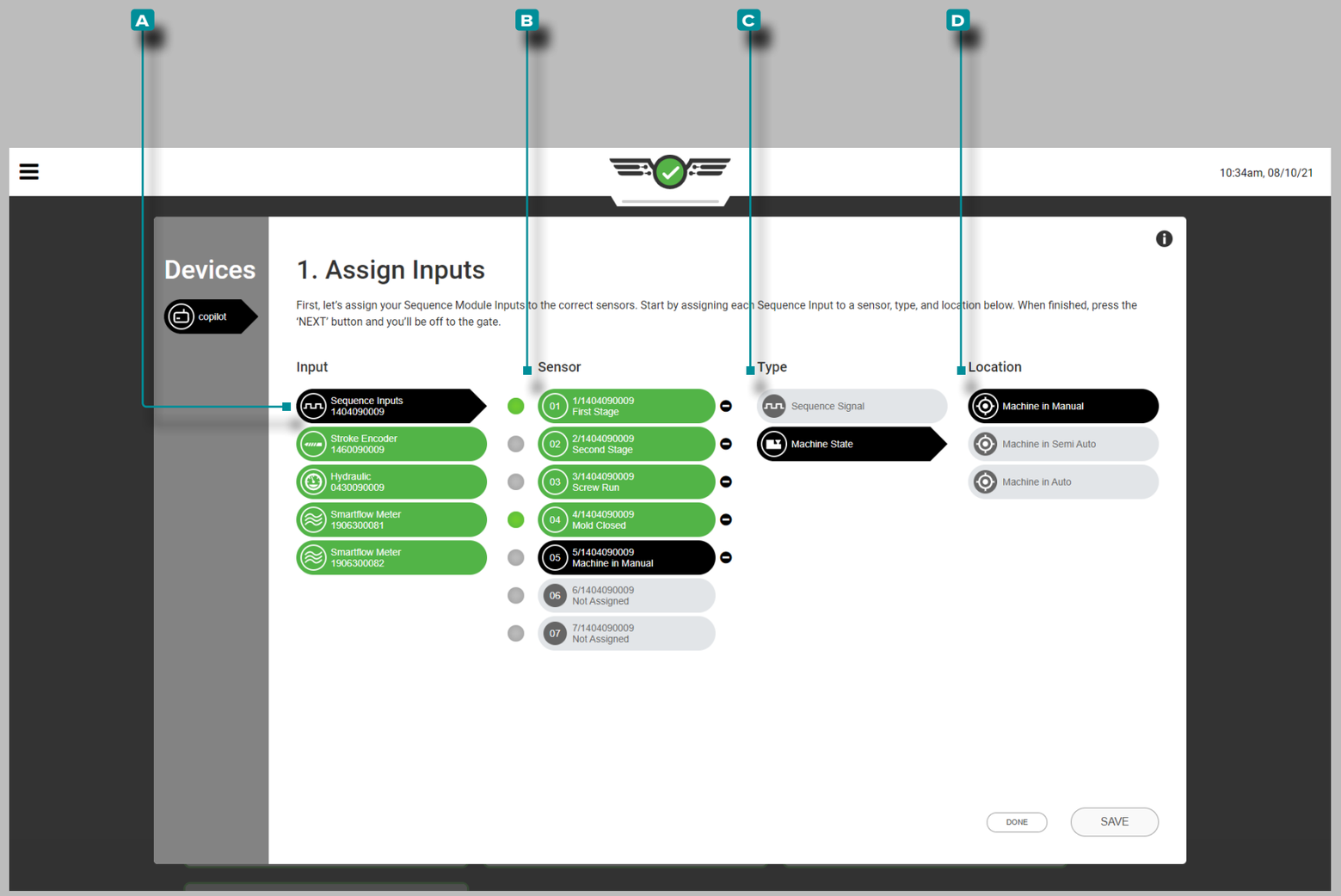
Assigning Inputs (continued)

Assign Proximity Switch Input to Mold Closed Sequence Signal

Tap the A input, then B sensor channel 1 to assign the C type and D location for proximity switch sequence input mold closed.

OR

Tap the A input, then B sensor channel 1 to assign the C type and D location for limit switch sequence input mold closed.



Setup (*continued*)

Assigning Inputs (continued)

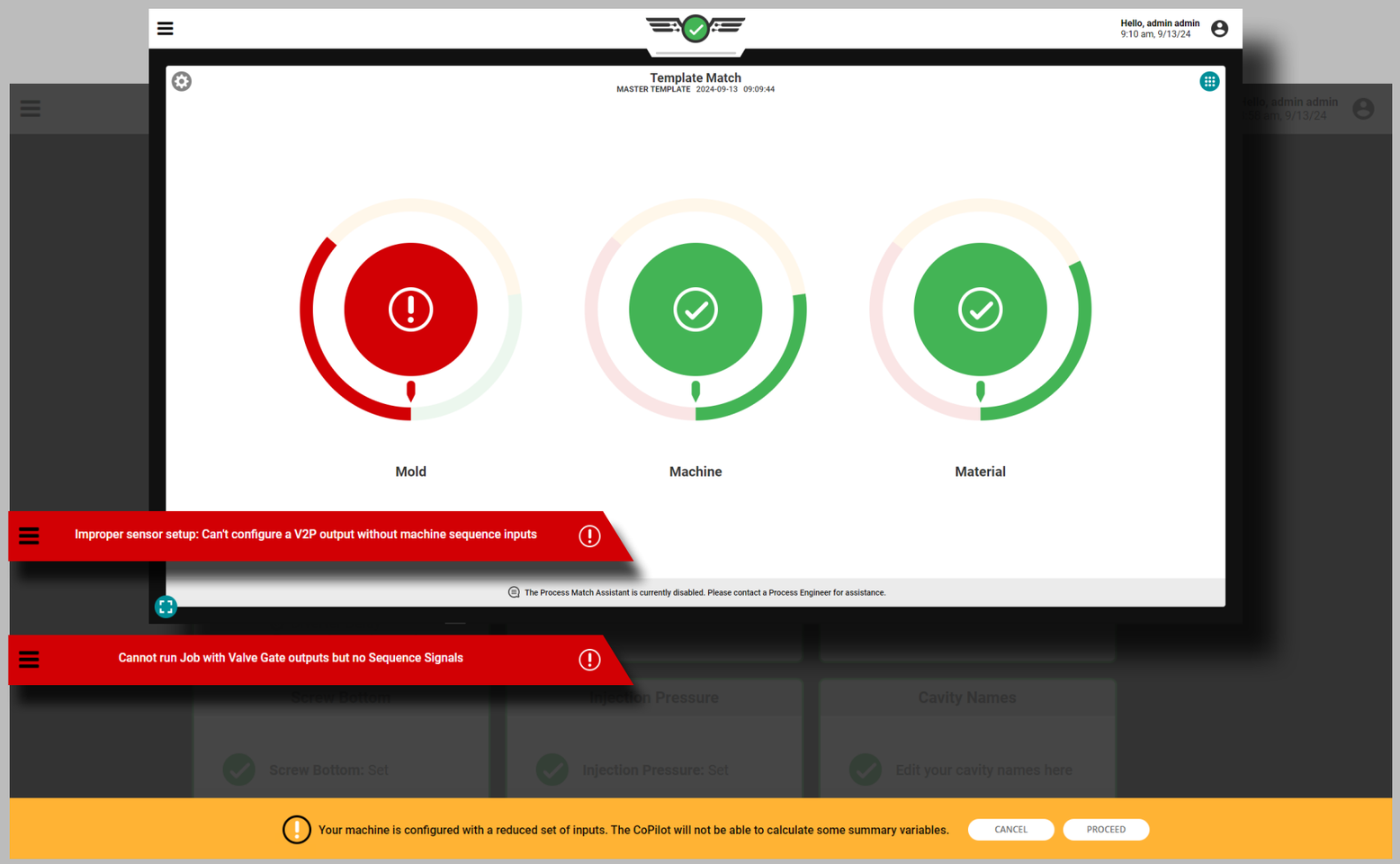
Optional Sequence Inputs—Machine State

Machine sequence inputs for machine states in manual, machine in semi-auto, and machine in auto are optional. These sequence inputs provide the current machine state to the CoPilot system.

Tap the **A** input, then **B** sensor channel to assign the **C** type and **D** location for the machine state sequence input.

The machine in manual sequence input machine state can be used in conjunction with valve gate control as a means to open all gates to purge through the mold; for more information on valve gate control, refer to ”General Settings” on page 45 or “Valve Gate Control General Settings” on page 140 for more information on valve gate/machine in manual control options, “Mold Setup” on page 28 for valve gate cavity assignment and setup, and “Valve Gate Control” on page 131 for valve gate control open and close assignment and monitoring.

ⓘ **NOTE** *Valve Gate Control is an optional tool and is only available to licensed users.*



Setup (*continued*)

Assigning Inputs (continued)

CoPilot Go

CoPilot Go enables the configuration of a machine without injection forward (IF), first stage (FS/1st), second stage (SS/2nd), or screw run (SR) sequence signals **as long as a mold closed or mold clamped (MC) signal and stroke/velocity sensor are assigned**. Injection pressure (INJ) can also be configured when only using CoPilot Go, but also does not have to be assigned.

To use CoPilot Go, assign MC using a proximity switch when assigning inputs (refer to "Assign Proximity Switch Input to Mold Closed Sequence Signal" on page 10) ***and*** the Lynx stroke/velocity sensor LE-R-50-REVB. Optionally, injection pressure may also be assigned (refer to "Injection Pressure (Electric Machines)" on page 16 or "Injection Pressure (Hydraulic Machines)" on page 17).

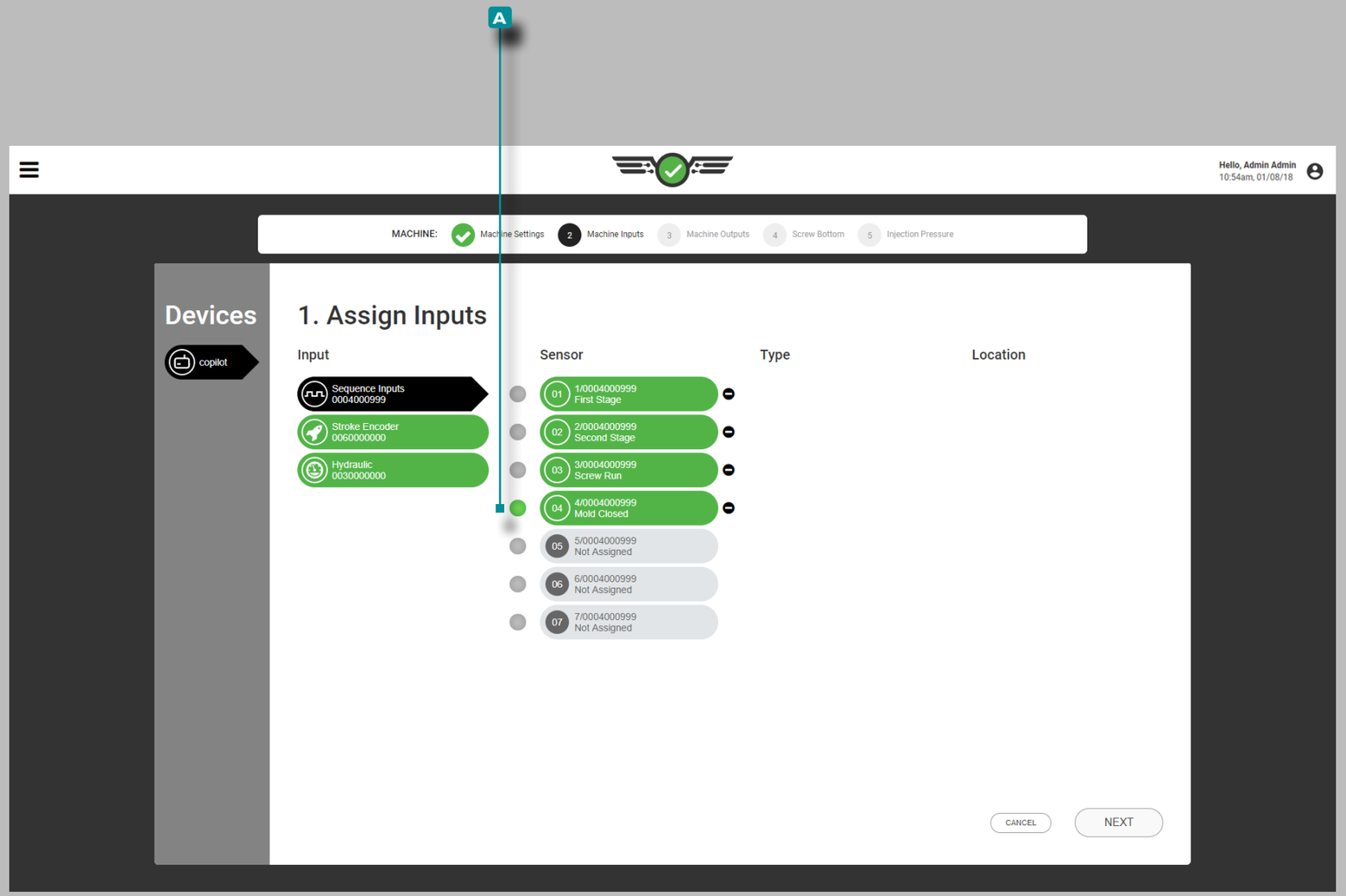
When using CoPilot Go, the following summary variables used to detect and sort short shots and flash are available:

- Peak Cavity Pressure (including Average Range and Balance peak)
- Cavity Pressure Cycle Integral
- Cycle Time
- Part Out Time
- Cushion
- Fill Pressure (only when INJ is configured)
- Peak Integral (Fill and Pack Integral)
- Pack Rate and Cooling Rate
- Peak, Minimum, and Average Temperatures
- Temperature Rise
- Peak Mold Deflection
- Average Flow Rate

ⓘ **NOTE** *Template Match will operate without machine sequence signals, even with missing summary variables.*

If no sequence signals or INJ are assigned, some functionality and data will not be available:

- Sorting will work only on the end of mold clamped timing
- Valve gate control will not operate.
- V→P outputs cannot be configured and will not operate.
- Processes with alarms set on unavailable variables will not operate; a new process must be created.
- MAX (process assistance) will not operate.



Setup (*continued*)

Test Sequence Inputs

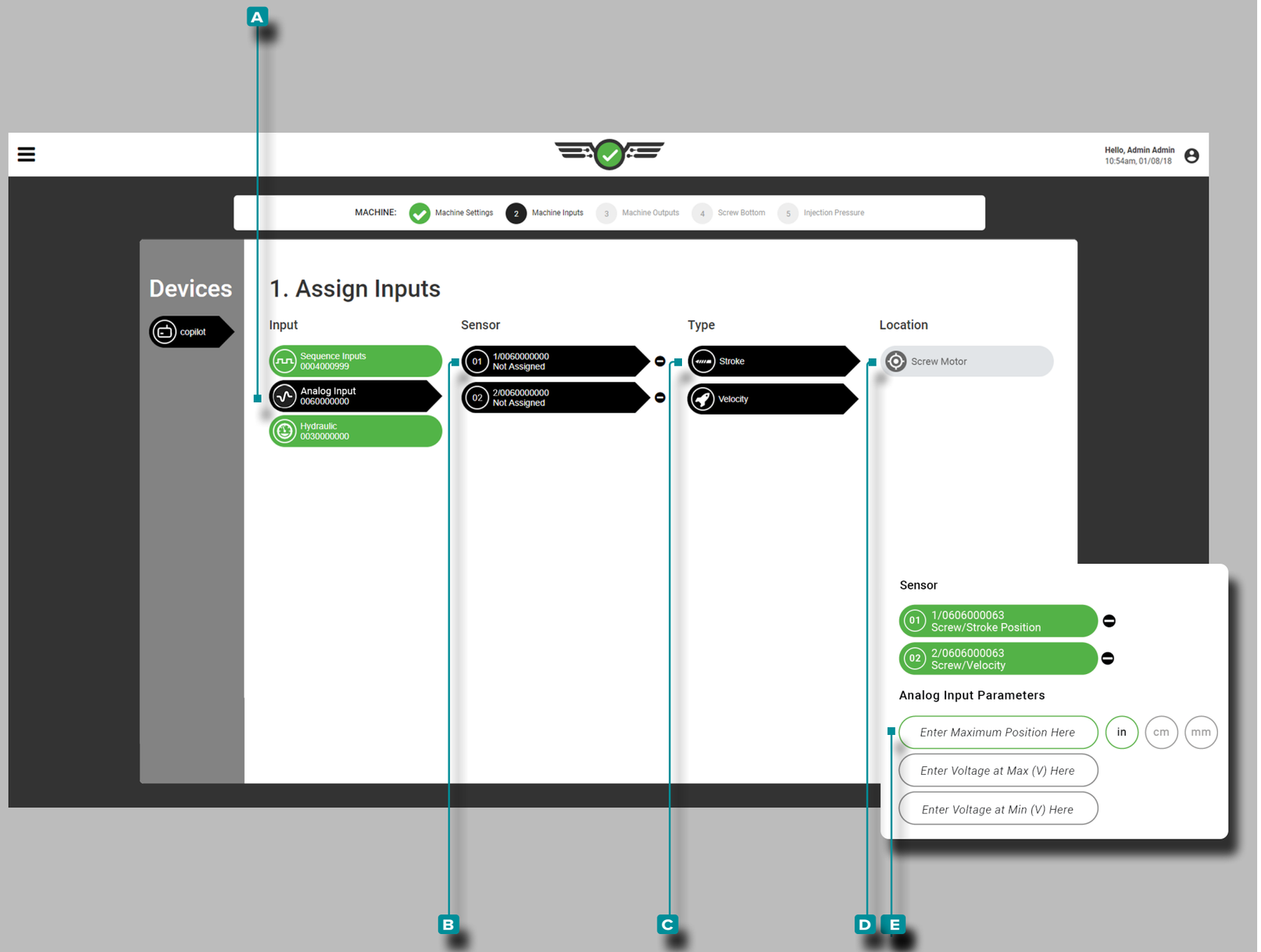
Verify sequence module inputs are correctly assigned.

Observe that the corresponding light on the physical ID7-M-SEQ illuminates when the correct sequence is performed, as well as the A corresponding light next to the input on the screen; verify that the sequence inputs occur in the order of normal operation.

CAUTION *The sequence input signals must be assigned correctly. Failure to comply will result in failure of software to operate as intended.*

With the machine in manual mode, perform the following:

1. Run the machine in manual to inject; the corresponding injection forward/first stage/second stage light should illuminate.
2. Rotate the screw; the corresponding screw run light should illuminate.
3. Close the mold; the corresponding mold closed light should illuminate.



Setup (*continued*)

Assigning Inputs (continued)

Stroke Position/Velocity (Electric Machines)

Analog input for maximum ⓘ 📖 stroke position/velocity is required for electric machines, and may be a value of zero and up with no constraint for decimal places. The position unit of measurement is required.

Tap 👆 the **A** analog input, then the **B** sensor channel to assign the **C** type and **D** location for both stroke position and velocity.

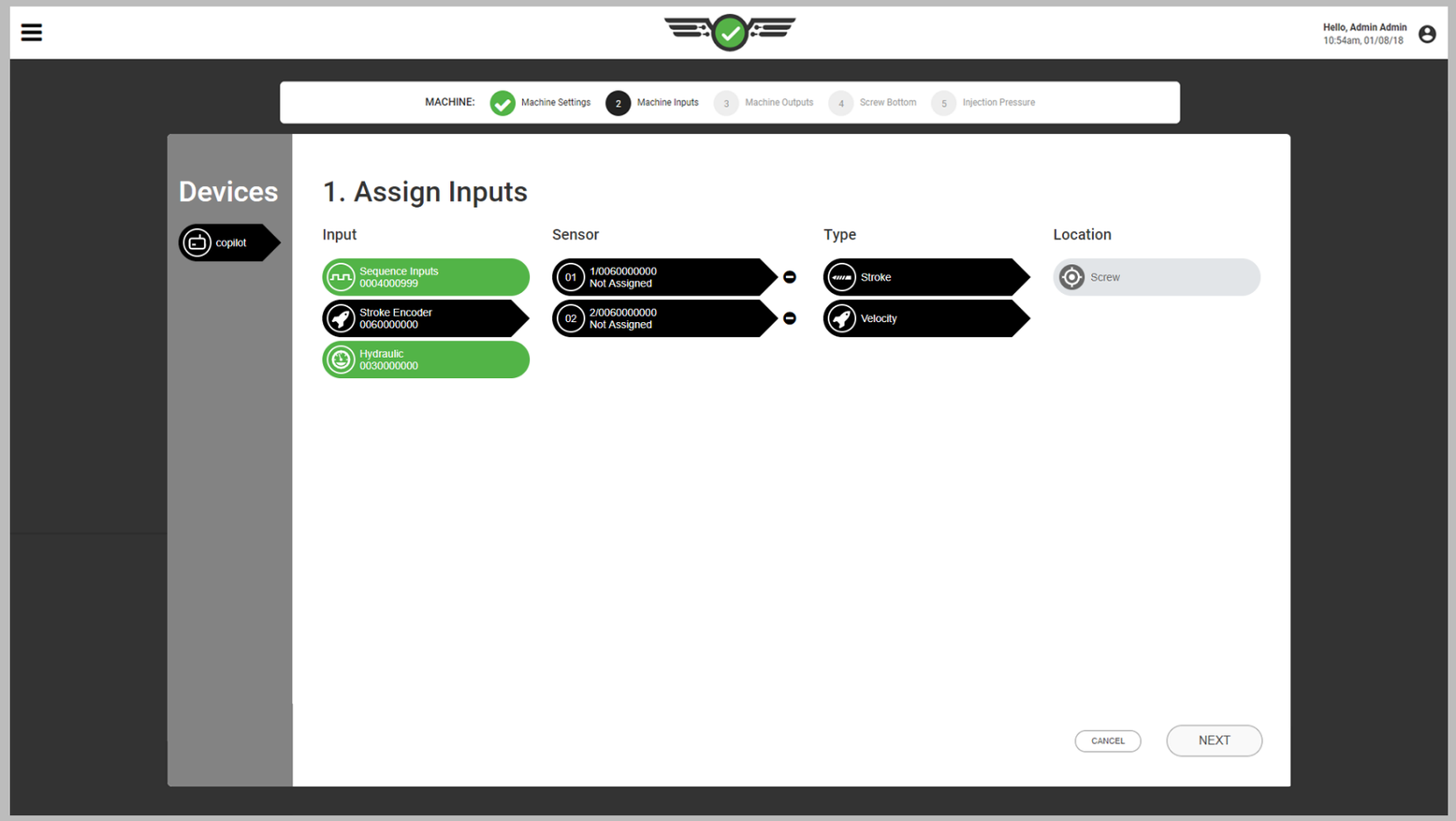
Tap 👆 the **E** fields to **enter** ⌨ 📖 analog input voltages at minimum and maximum values for electric machine stroke position.

ⓘ **NOTE** *The Analog Input: Stroke Position/Velocity scaling cannot be edited while a job is running.*

Stroke position/velocity voltage at minimum and maximum values is required and may be a value of zero to fifteen, with two decimal places (hundredths “0.00”).

📖 **DEFINITION** ANALOG INPUT STROKE POSITION/VELOCITY *Stroke position and velocity are derived by the analog input from electrical signals (electric machines).*

📖 **DEFINITION** ANALOG INPUT VOLTAGES (MIN/MAX) *The electrical signal for stroke position usually is 0–10 V, with a low voltage (not always zero) representing screw bottom and a high voltage (not always 10 V) representing maximum shot size. Measure the actual voltages at screw bottom and maximum shot size.*



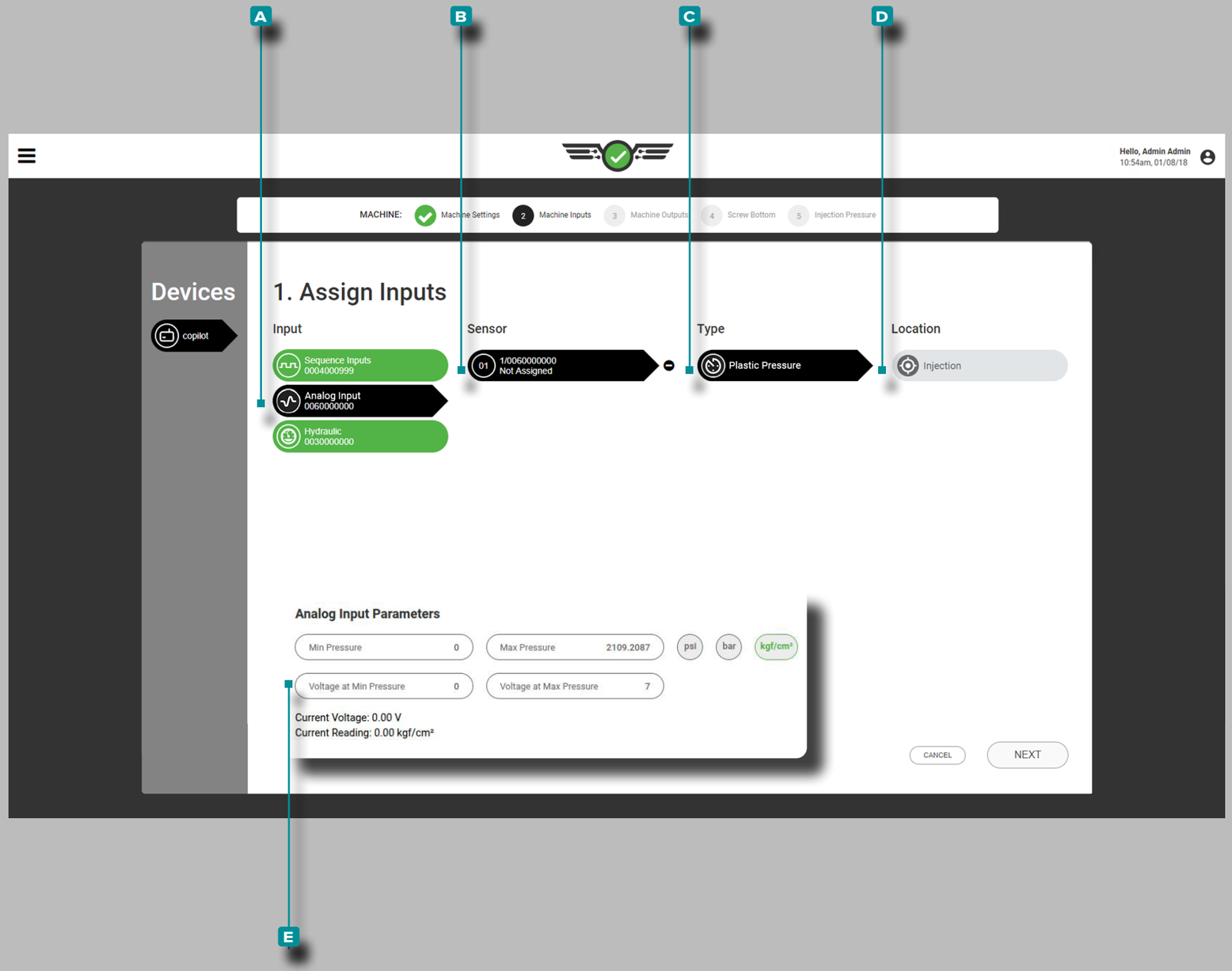
Setup (*continued*)

Assigning Inputs (continued)

Stroke Position/Velocity (Hydraulic Machines)

Analog input for stroke position/velocity is required for hydraulic machines and is automatically assigned if the proper equipment (Lynx™ Stroke/Velocity Encoder LE-R-50) is installed.

DEFINITION ANALOG INPUT STROKE POSITION/VELOCITY *Stroke position/velocity is derived by the analog input by the LE-R-50 Stroke Encoder (hydraulic machines).*



Setup (*continued*)

Assigning Inputs (continued)

Injection Pressure (Electric Machines)

Analog input for ⓘ 📖 maximum injection pressure is required for electric machines and may be a value of zero and up with no constraint for decimal places. The pressure unit of measurement is required.

Tap 👆 the **A** analog input, then the **B** sensor channel to assign the **C** type and **D** location for injection pressure.

Tap 👆 the **E** fields and **enter** ⌨ 📖 analog input voltages at minimum and maximum values for electric machines. Voltages may be a value of zero to fifteen, with two decimal places (hundredths “0.00”).

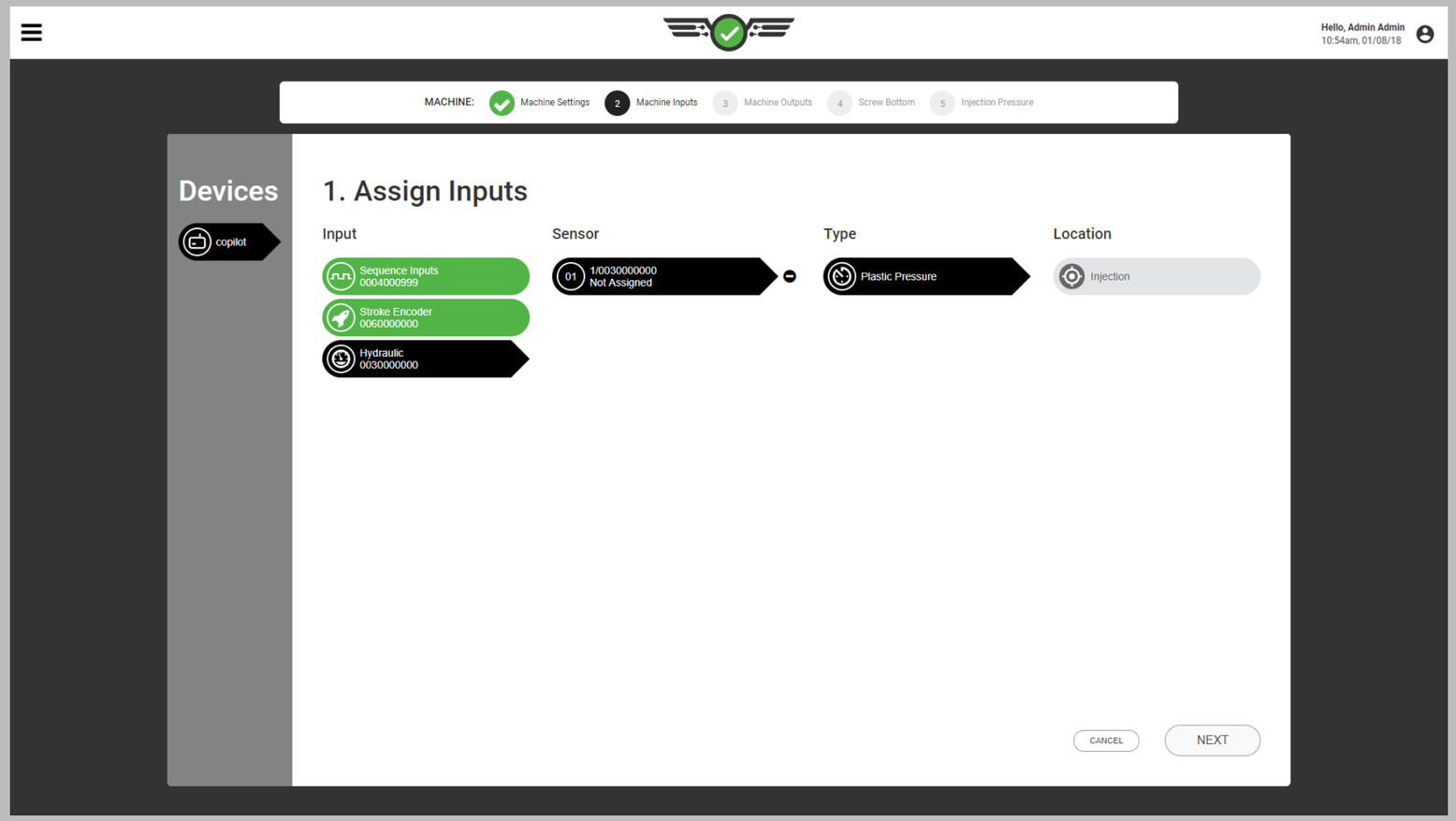
📖 **DEFINITION** ANALOG INPUT MAXIMUM INJECTION PRESSURE *Maximum injection pressure is derived by the analog input module from an electrical signal (electric machines).*

📖 **DEFINITION** ANALOG INPUT VOLTAGES (MIN/MAX) *The electrical signal for pressure usually is 0–10 V, with a low voltage (not always zero) representing zero pressure and a high voltage (not always 10 V) representing maximum pressure. Measure the actual voltages at zero and maximum pressure.*

To determine electric machine output voltages:

1. With the motor off or machine in standby, record the voltage shown to two decimal places.
2. Set a hold pressure and—with the machine in manual—purge until the screw is bottomed. Record the machine’s actual pressure and record the voltage shown.
3. Enter the Maximum Pressure (machine’s actual pressure), the Voltage at Max (recorded voltage 2), and the Voltage at Min (recorded voltage 1).

ⓘ **NOTE** *The Analog Input: Injection Pressure scaling cannot be edited while a job is running.*



Setup (*continued*)

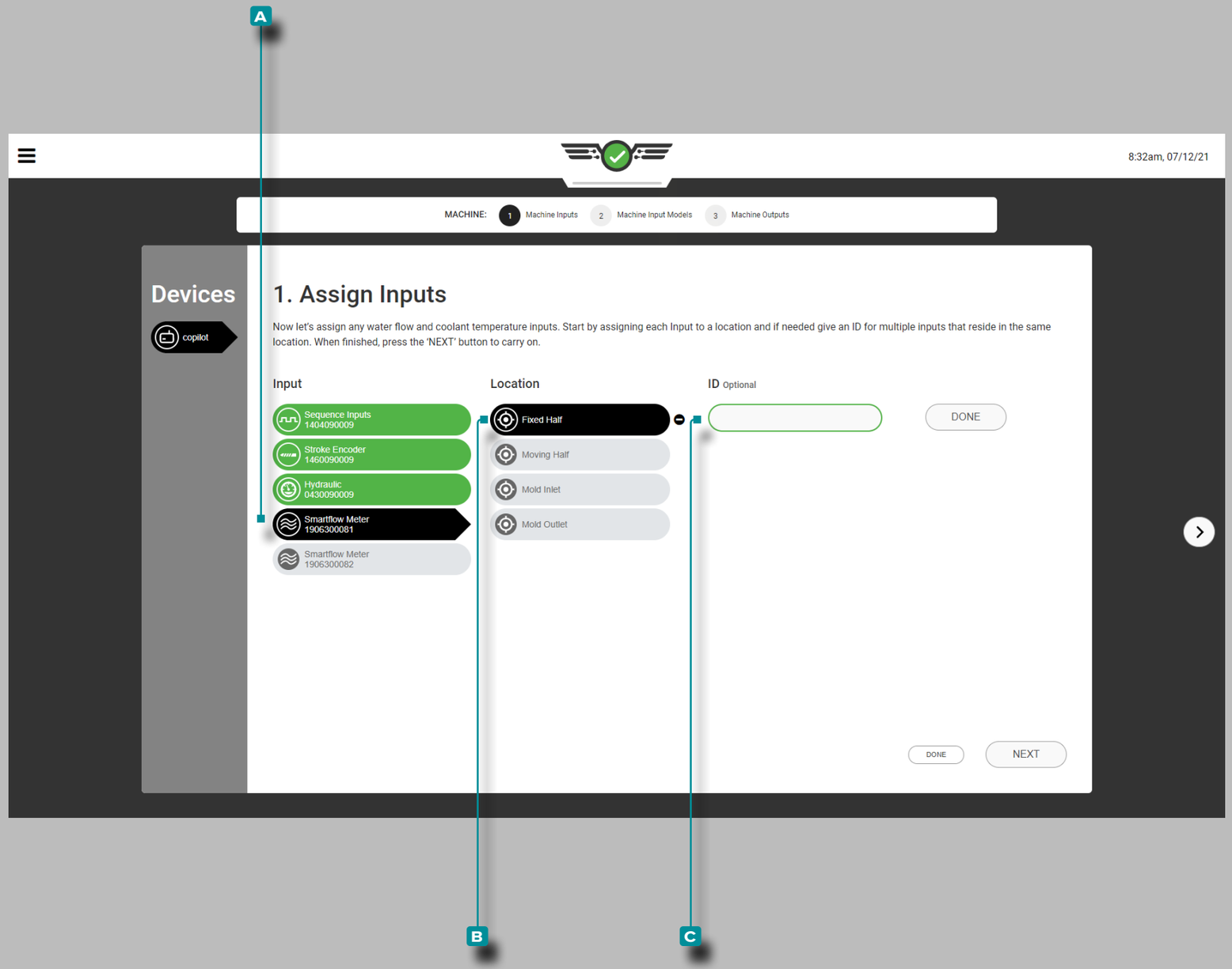
Assigning Inputs (continued)

Injection Pressure (Hydraulic Machines)

Input for injection pressure is required on hydraulic machines and is automatically assigned if the proper equipment (Lynx™ 3,000 psi Hydraulic Sensor LS-H-1/4NPT-3K) is installed. No calibration is necessary as the sensor is an RJG, Inc. pre-calibrated sensor.

DEFINITION INPUT MAXIMUM INJECTION PRESSURE

Maximum injection pressure is derived by the LS-H-1/4NPT-3K Hydraulic Sensor (hydraulic machines).



Setup (*continued*)

Assigning Inputs (continued)

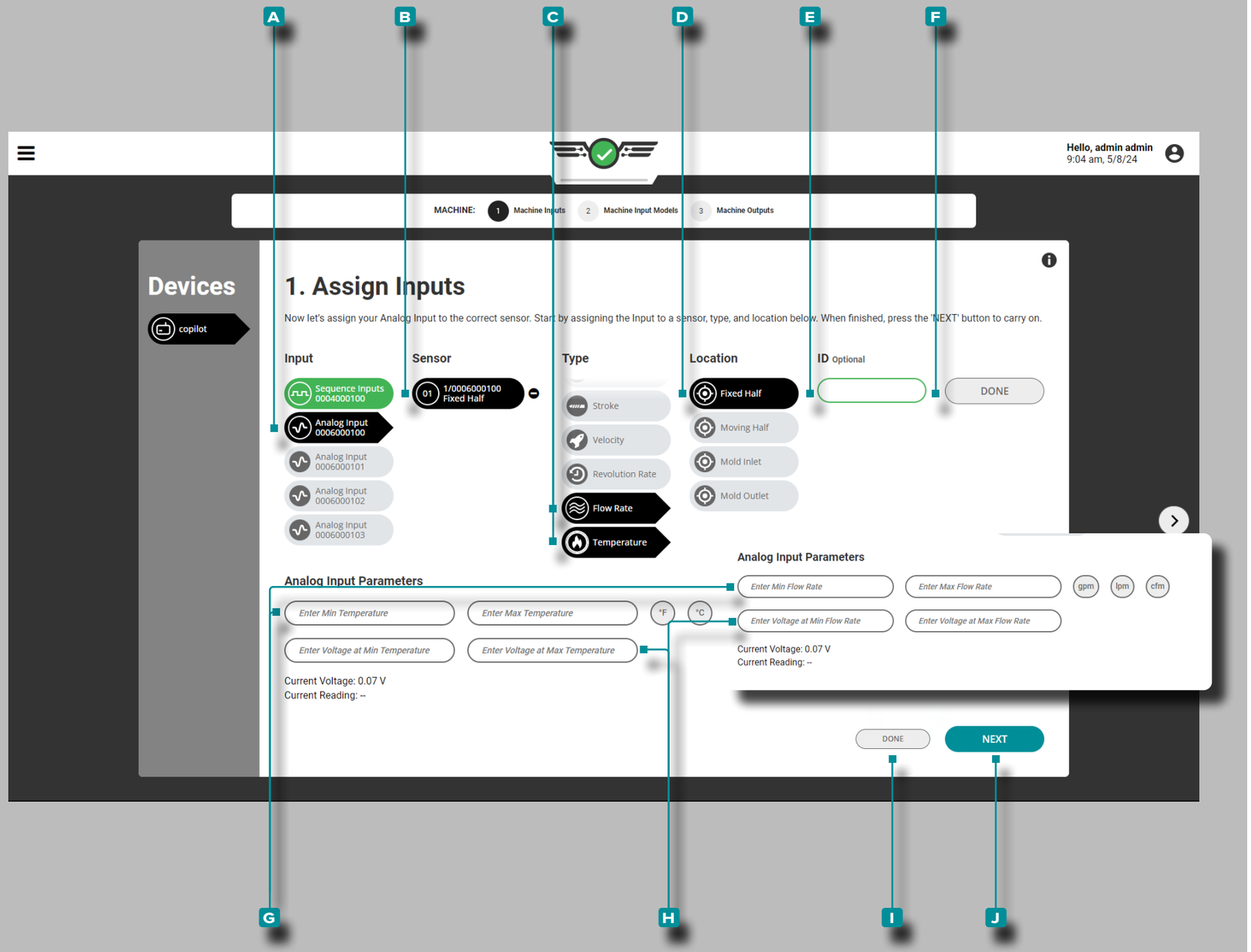
Coolant Flow Rate and Coolant Temperature (Optional)

Input for coolant flow rate and coolant temperature is optional. If a Smartflow® TracerVM™ flowmeter from Burger and Brown Engineering, Inc. is connected, input sensor and location assignments must be completed.

Tap the **A** input, then the **B** sensor location for each flowmeter. Flowmeter location can be assigned to the fixed half, moving half, mold inlet, or mold outlet.

Tap the **C** field to **enter** the ID if multiple sensors will be located in the same location.

No calibration is necessary as the sensor is an RJG, Inc. pre-calibrated sensor. Coolant flow rate and temperature data from set up flowmeters will be available to view and set alarms on in the Alarms widget, Cycle Graph, and Summary Graph.



Setup (*continued*)

Assigning Inputs (continued)

Water Flow Rate and Temperature (Optional)

Input for water flow rate and coolant temperature is optional. If a water flow or temperature device is connected to an analog input module IA1-M-V, input sensor and location assignments must be completed. View or set alarms on water flow rate and temperature data in the Alarms widget, Previous Cycles Values widget, Cycle Graph, and Summary Graph.

Tap the **A** input, **B** sensor location, **C** type, and **D** location for each water flow or temperature device. Type **C** can be assigned to flow rate or temperature. Location **D** can be assigned to the fixed half, moving half, mold inlet, or mold outlet.

Tap the **E** field to **enter** the ID if multiple assignments will be made in the same location. **Tap** the **F** DONE button to complete assignments.

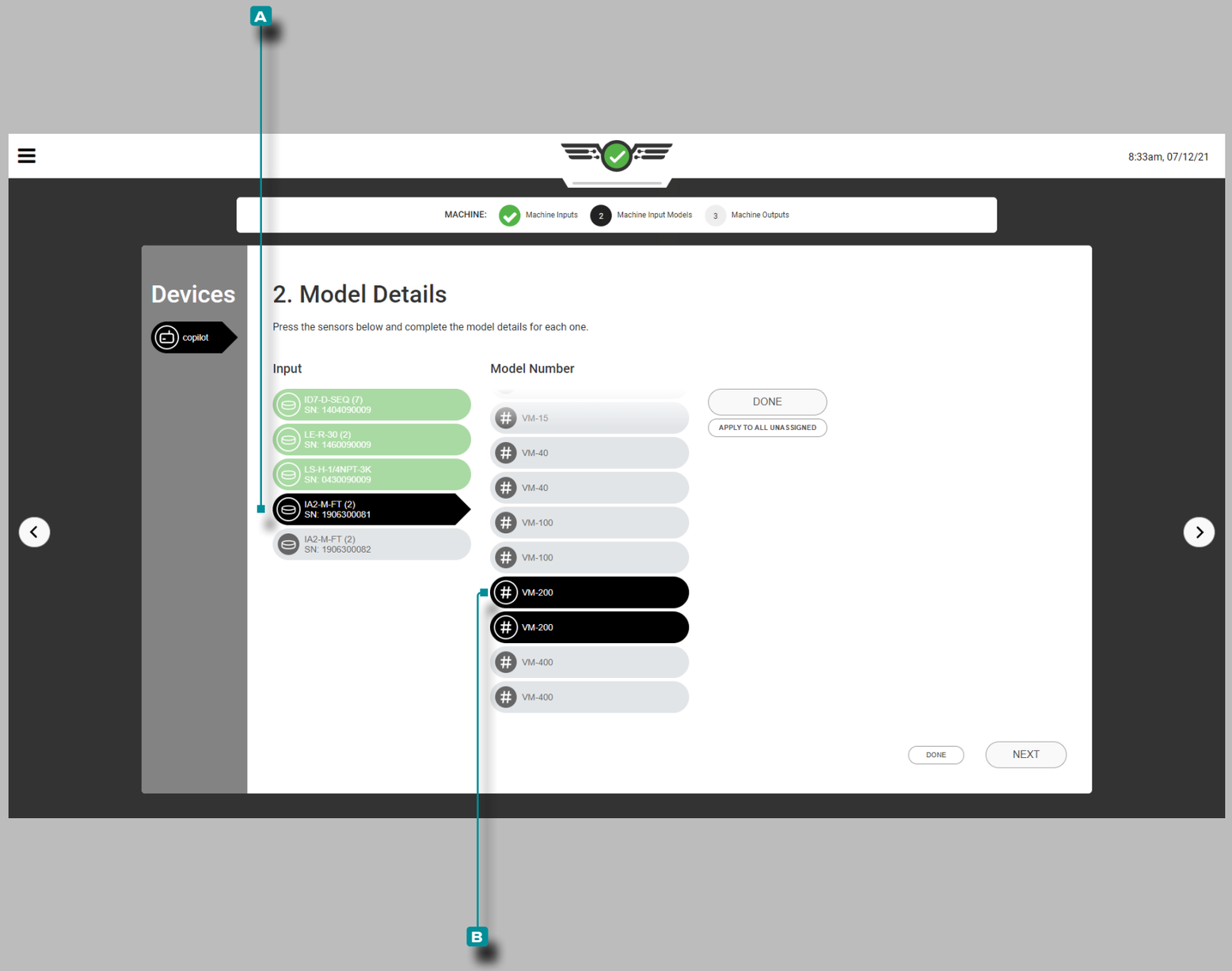
Tap the **G** fields to **enter** the minimum and maximum values for flow rate or temperature; **tap** to select the associated unit of measurement—degrees Fahrenheit or Celsius, OR gallons per minute, liters per minute, or cubic feet per minute.

NOTE *Analog Input scaling cannot be edited while a job is running.*

Tap the **H** fields to **enter** analog input voltages at minimum and maximum values for flow rate or temperature. Voltages may be a value of zero to fifteen, with two decimal places (hundredths "0.00").

Tap the **I** DONE button to complete water flow or temperature input assignment, or **tap** the **J** NEXT button to complete machine input assignments and continue to machine output setup.

DEFINITION ANALOG INPUT VOLTAGES (MIN/MAX) *The electrical signal usually is 0–10 V, with a low voltage (not always zero) representing zero and a high voltage (not always 10 V) representing maximum. Measure the actual voltages at zero and maximum.*



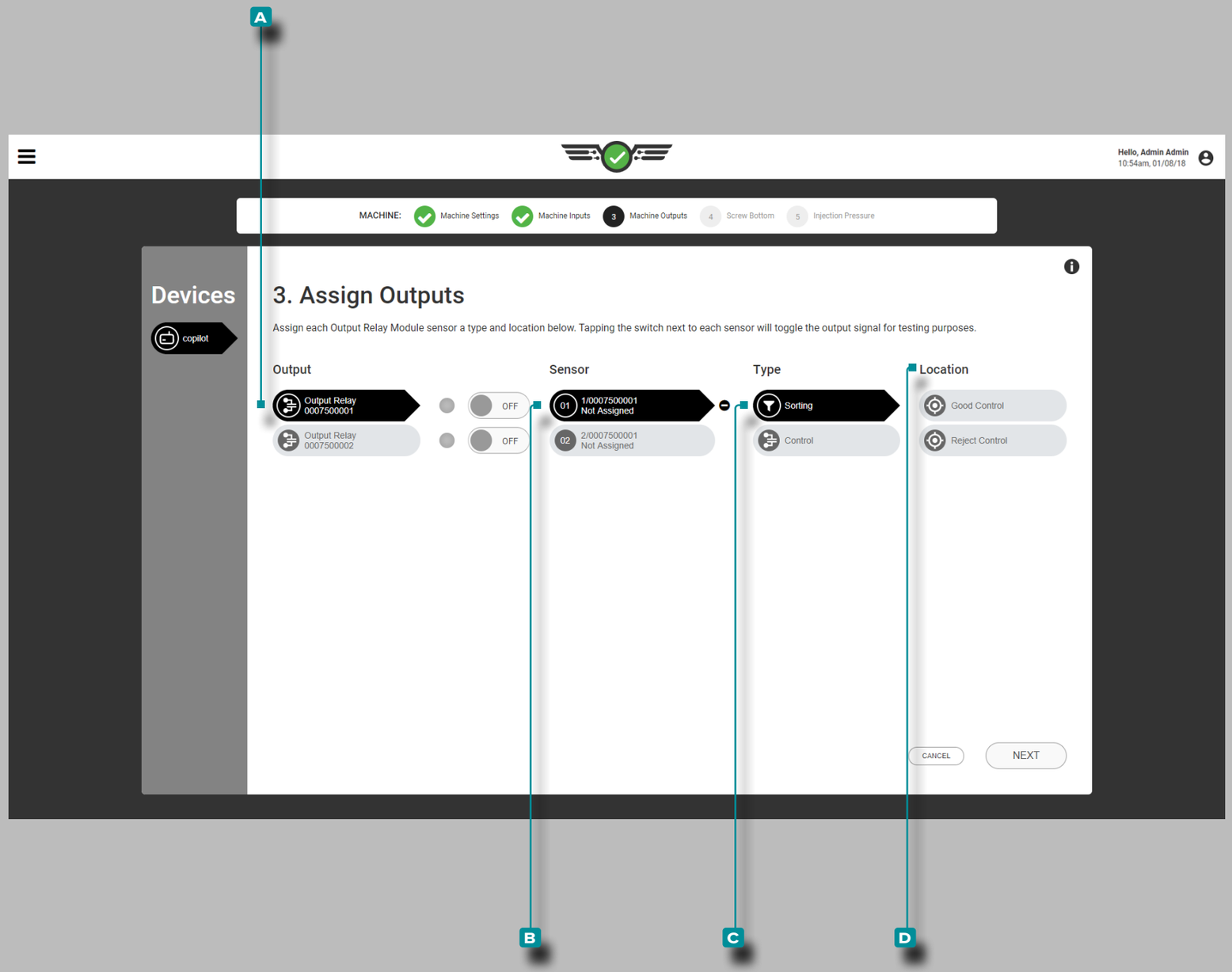
Setup (*continued*)

Assigning Model Details

Most machine interface sensor model details will be automatically-assigned by the system in the software; some sensors will require model selection.

Smartflow Flowmeter Setup

Tap the **A** input, then **tap** the **B** model number for each flowmeter; a model is chosen for both channel 1: coolant flow rate and channel 2: coolant temperature.



Setup (*continued*)

Assigning Outputs

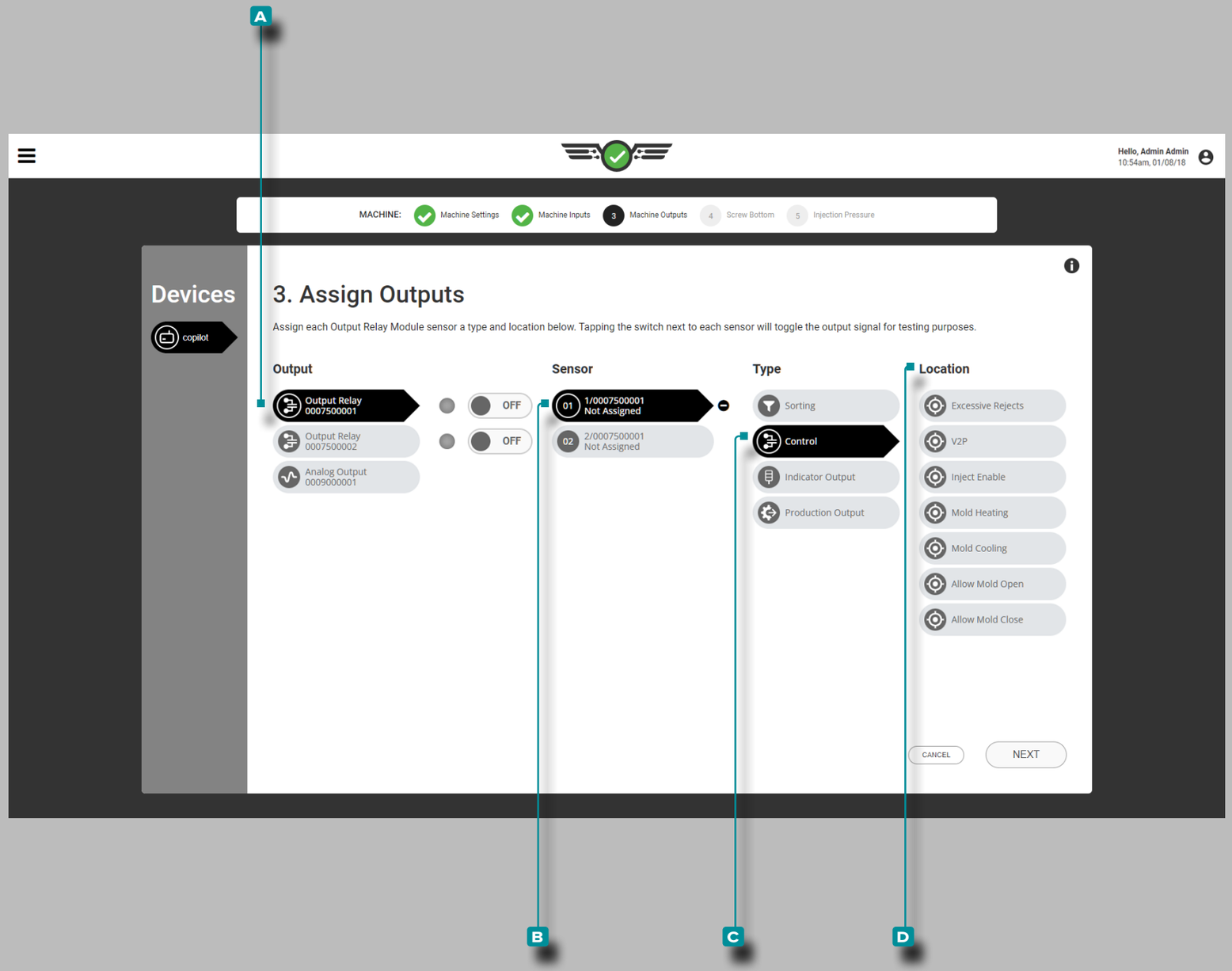
Sorting Outputs

If applicable, assign 📖 sorting outputs each time a new setup is created. Assign sorting outputs to the Output Relay module channels which they are wired physically.

Tap 👆 the **A** Output Relay, then the **B** sensor channel to assign the **C** type and **D** location for sorting.

📖 **DEFINITION** SORTING OUTPUTS—GOOD CONTROL *A relay contact closure output that is connected to sorting equipment and can be used to move a good part to a "Good" location when "ON" (contacts are closed) or a "Failsafe" location when "OFF" (contacts are open) at the end of a cycle. Analog output sorting prevents bad parts from being sorted as "Good".*

📖 **DEFINITION** SORTING OUTPUTS—REJECT CONTROL *A relay contact closure output that is connected to sorting equipment and can be used to move a bad part to a "bad " location when "ON" (contacts are closed) and a "good" location when "OFF" (contacts are open) at the end of a cycle.*



Setup (*continued*)

Assigning Outputs (continued)

Control Outputs

If applicable, assign control outputs each time a new setup is created. Assign control outputs to the Output Relay module channels which they are physically wired.

Tap the **A** Output Relay, then the **B** sensor channel to assign the **C** type and **D** location for control (refer to the CoPilot Hardware Installation and Setup Guide for more information on Output Relay module wiring).

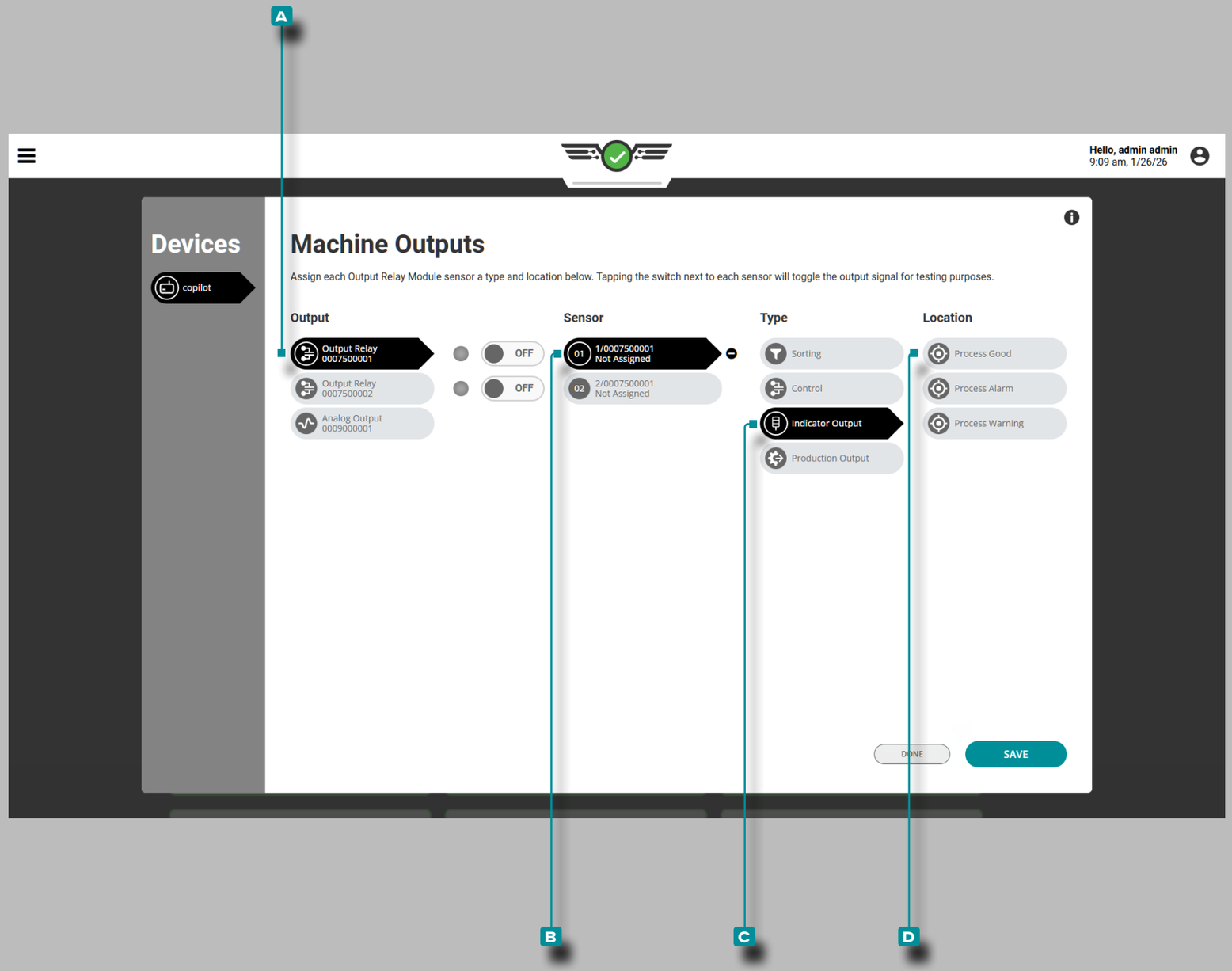
Control outputs include excessive rejects control, velocity to pressure (V2P or V→P) control, inject enable control, and allow mold open, allow mold close, mold heating, and mold cooling (for use with Heat and Cool function—refer to page page 141 for Heat and Cool setup and operation.)

DEFINITION CONTROL OUTPUTS—EXCESSIVE REJECTS *A relay output that detects either instability/sporadic rejects or a string of rejects and can be connected to equipment to activate an alarm or shut down the molding machine to prevent excessive rejects.*

DEFINITION CONTROL OUTPUTS—V2P *An output that provides a control to velocity to pressure (V→P) transfer the machine based on cavity pressure or time after fill begins—can be a relay output or an analog output.*

DEFINITION INJECT ENABLE *A relay output that allows the machine to run until one of the following occurs: a control sensor fails or stops communication with the CoPilot system; any module used for control or sequencing fails to communicate with the CoPilot system; the output relay module associated with the Inject Enable control is disconnected; or the power to the CoPilot system is disconnected.*

DEFINITION HEAT AND COOL CONTROL *A set of relay outputs that allow the mold to open, the mold to close, the connected mold temperature controller to heat, and the connected mold temperature controller to cool, in order to control the heating and cooling of a mold. Refer to "Heat and Cool" on page 141.*



Setup (*continued*)

Assigning Outputs (continued)

Indicator Outputs

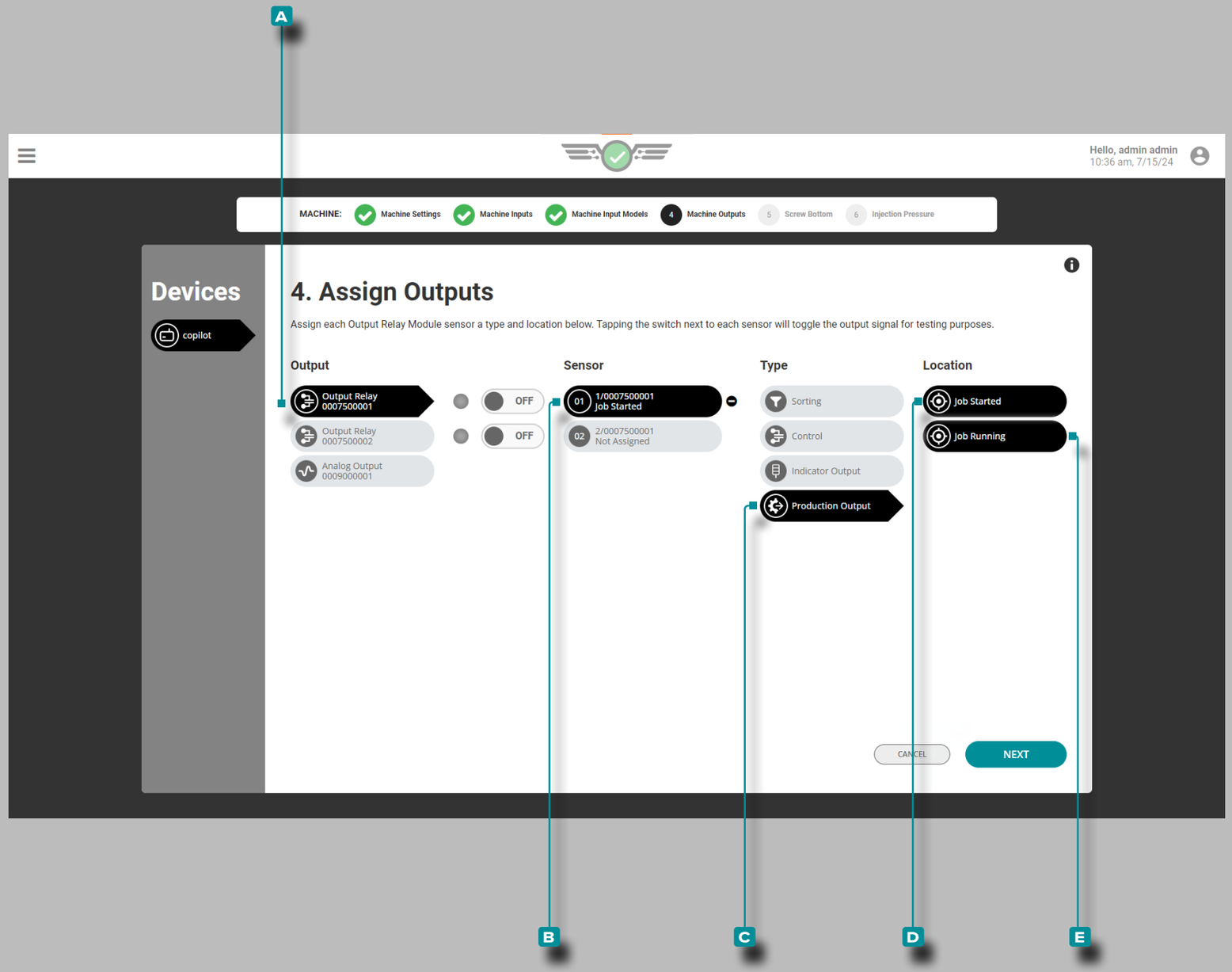
If applicable, assign indicator outputs each time a new setup is created. Assign indicator outputs to the Output Relay module channels which they are physically wired.

Tap the **A** Output Relay, then the **B** sensor channel to assign the **C** type and **D** location for the indicator output (refer to the CoPilot Hardware Installation and Setup Guide for more information on Output Relay module wiring).

Indicator output location includes Process Good, Process Alarm, and Process Warning; these outputs correspond to any alarm and warning settings.

If applicable, indicator outputs Process Good and Process Alarm are assigned automatically when an RJG Lynx™ Indicator Light Tree LT3-L is connected.

DEFINITION INDICATOR OUTPUT *A relay output that allows a connected indicator (such as a light tree or bell) to indicate if the process is running within limits.*



Setup (*continued*)

Assigning Outputs (continued)

Production Output Job Started

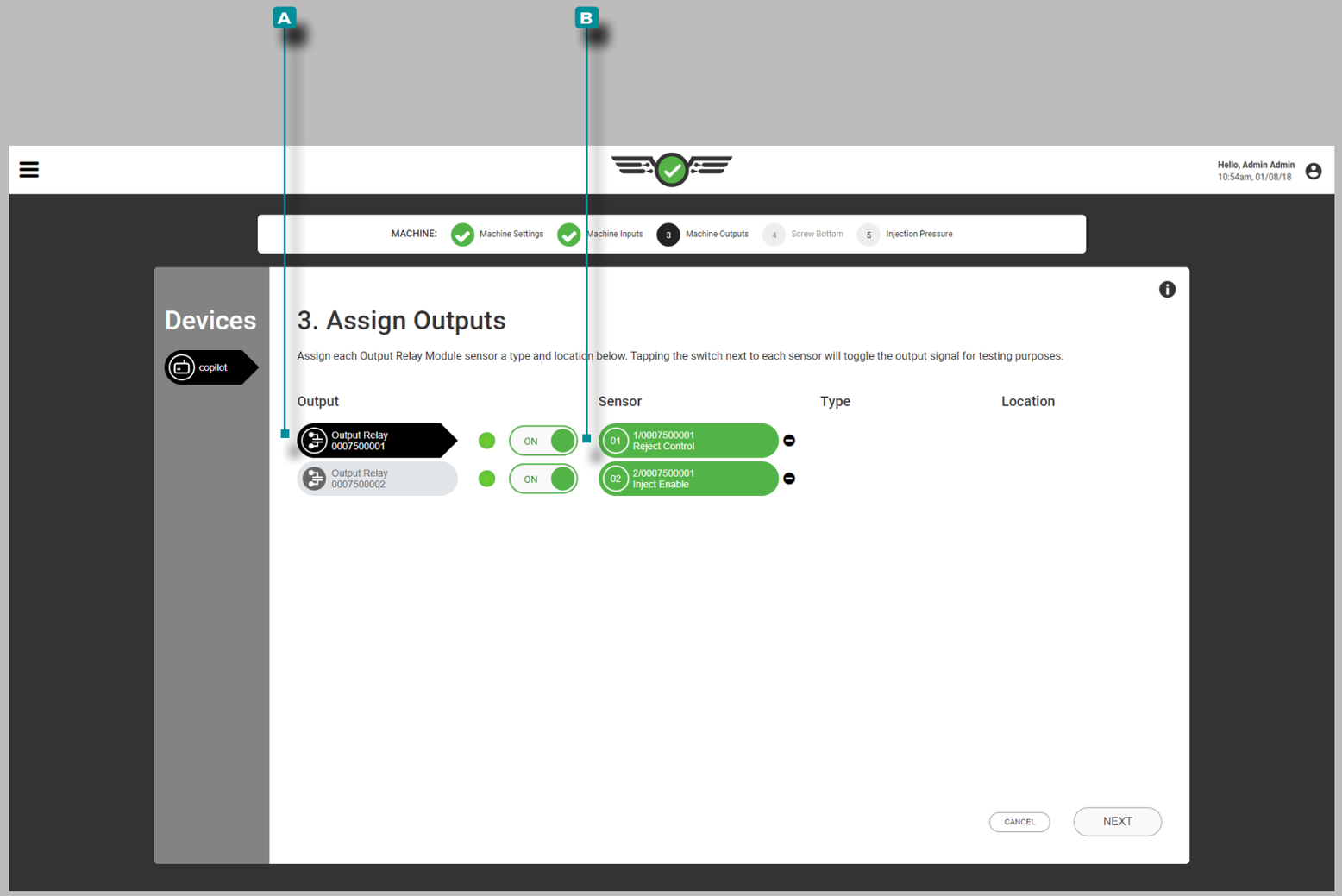
Production Output Job Started is assigned to a physical dual-relay output module (OR2-M) connected to the CoPilot system and the injection molding machine (IMM). The Job Started production output enables the relay output to turn on and the IMM to cycle when the CoPilot system is powered on and a job is started.

Tap the **A** Output Relay, then the **B** sensor channel to assign the **C** Production Output type and **D** Job Started location for the indicator output (refer to the CoPilot Hardware Installation and Setup Guide for more information on Output Relay module wiring).

Production Output Job Running

Production OutputJob Running is assigned to a physical dual-relay output module (OR2-M) connected to the CoPilot system and the injection molding machine (IMM). The Job Running production output enables the relay output to turn on and the IMM to cycle when a job is running on the CoPilot system and turn off/shut the IMM down if the job enters a down state.

Tap the **A** Output Relay, then the **B** sensor channel to assign the **C** Production Output type and **E** Job Running location for the indicator output (refer to the CoPilot Hardware Installation and Setup Guide for more information on Output Relay module wiring).



Setup (*continued*)

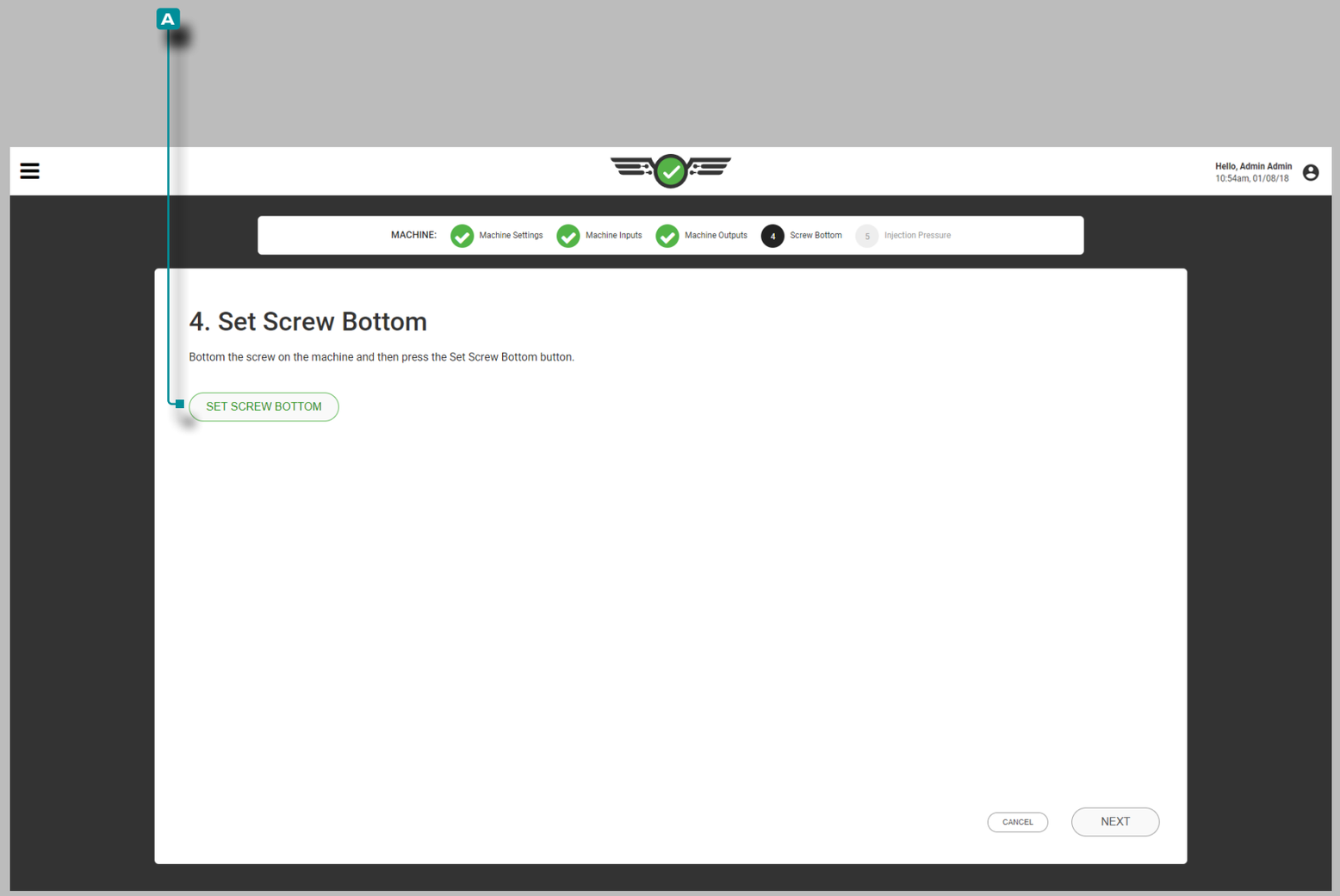
Assigning Outputs (continued)

Test Sorting and Control Outputs

Test outputs for sorting and control operation.

Tap the **A** output relay to select it.

Tap the **B** ON / OFF button next to the channel assigned to Sorting or Control to verify that the attached control device or machine performs the appropriate action.



Setup (*continued*)

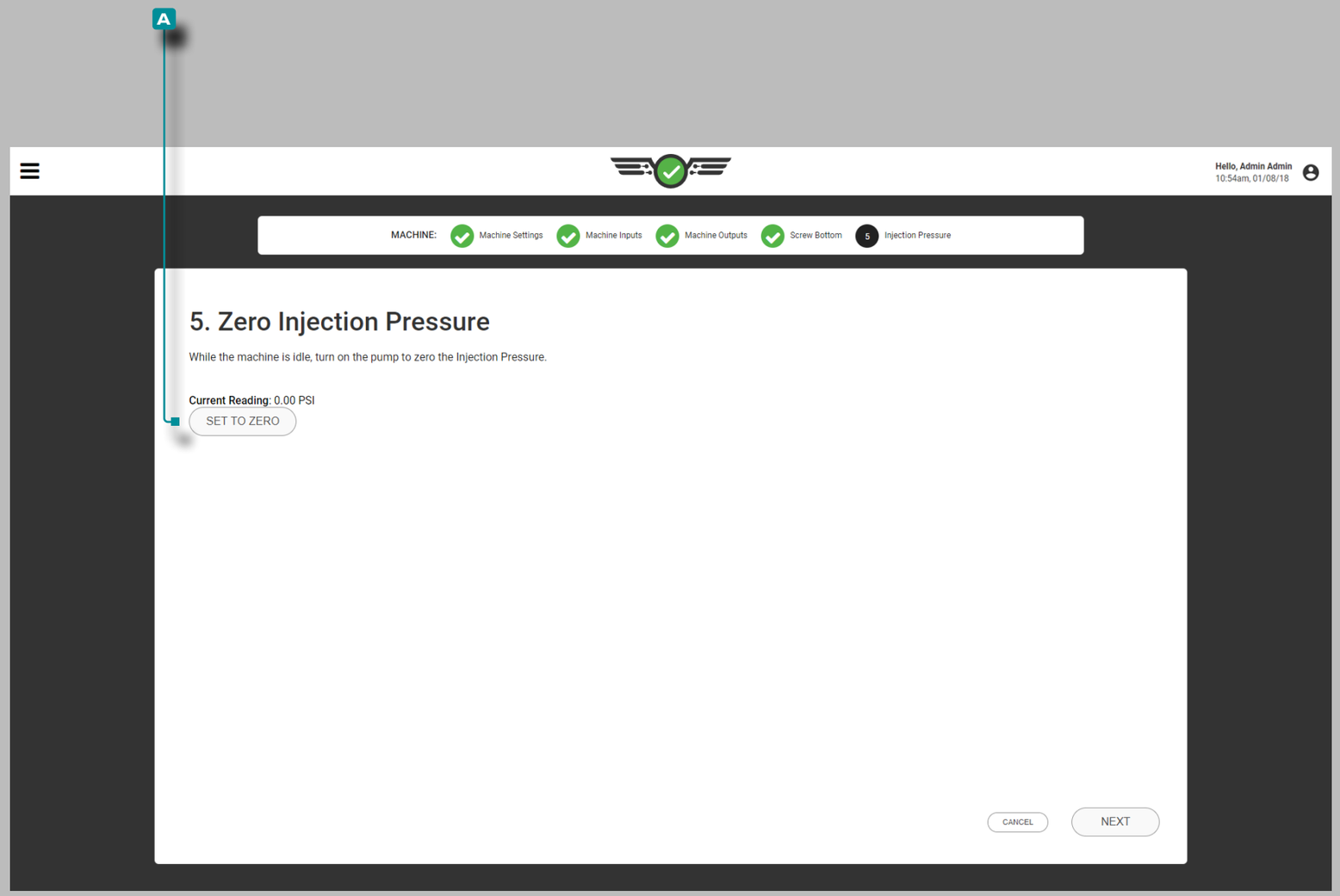
Screw Bottom

The software calculates shot stroke and shot volume from the set screw bottom and the stroke indicator (LE-R-50 or IA1-M-V). Screw bottom is the zero point of the machine stroke indicator.

Set screw bottom each time a new setup is created. Physically bottom out the screw on the machine, then **tap** to select the A ⓘ set screw bottom button.

Alternatively, screw bottom may be set from the Setup Dashboard; refer to “Set Screw Bottom from the Setup Dashboard” on page 50.

ⓘ **NOTE** *Screw bottom must be set each time a setup is created. The CoPilot does not store this position, and cushion will not be correctly calculated if screw bottom is not set after each time the machine is started, the job is changed, or the CoPilot system is powered down.*



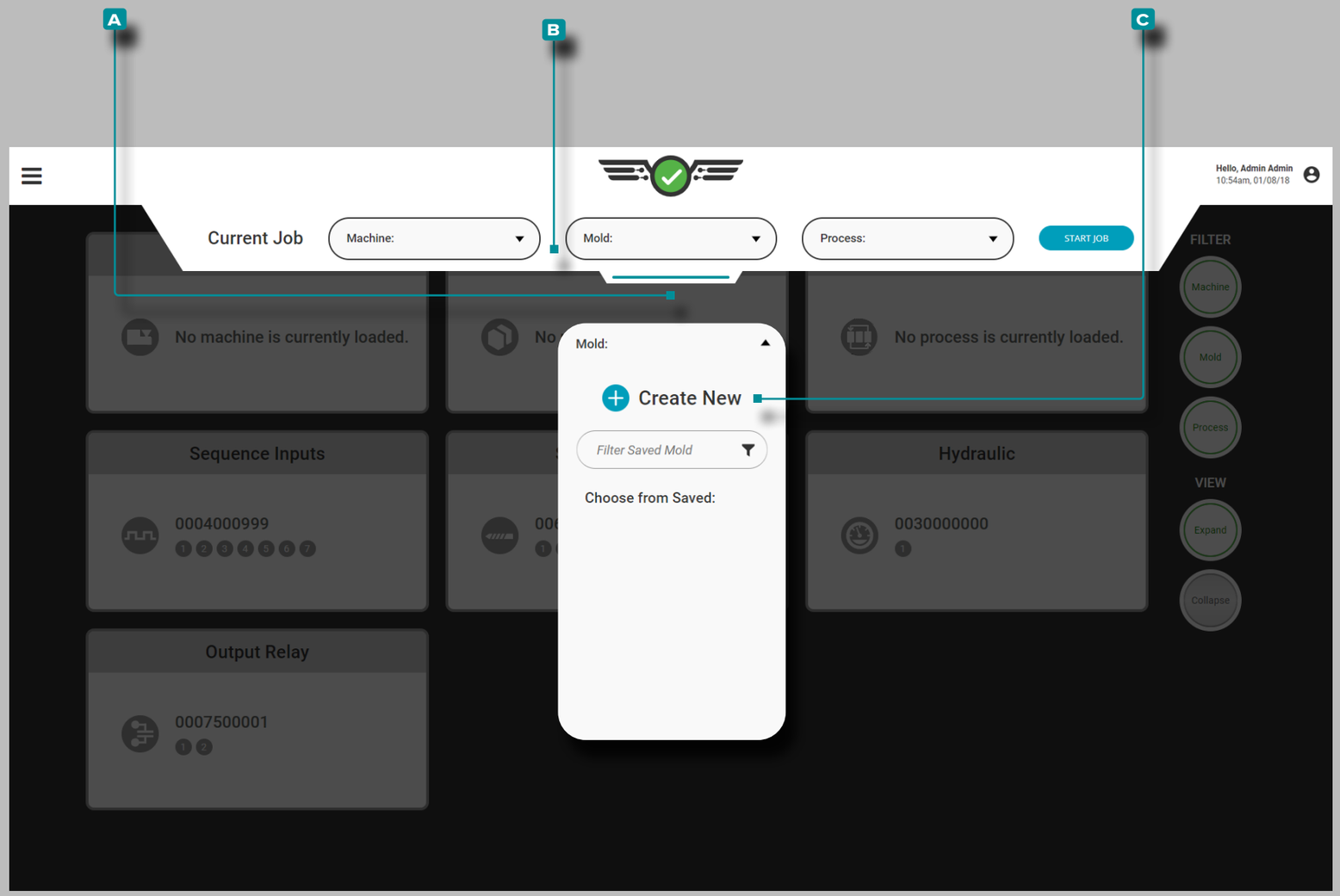
Setup (*continued*)

Injection Pressure

Zero the injection pressure each time a new setup is created (hydraulic machines only).

1. Place machine in idle.
2. Turn on the hydraulic pump.
3. Tap to select the A set to zero button.

NOTE *Hydraulic injection pressure during idle is normally higher than zero due to residual, negligible pressure. The CoPilot software uses the residual value as the zero value for computations.*

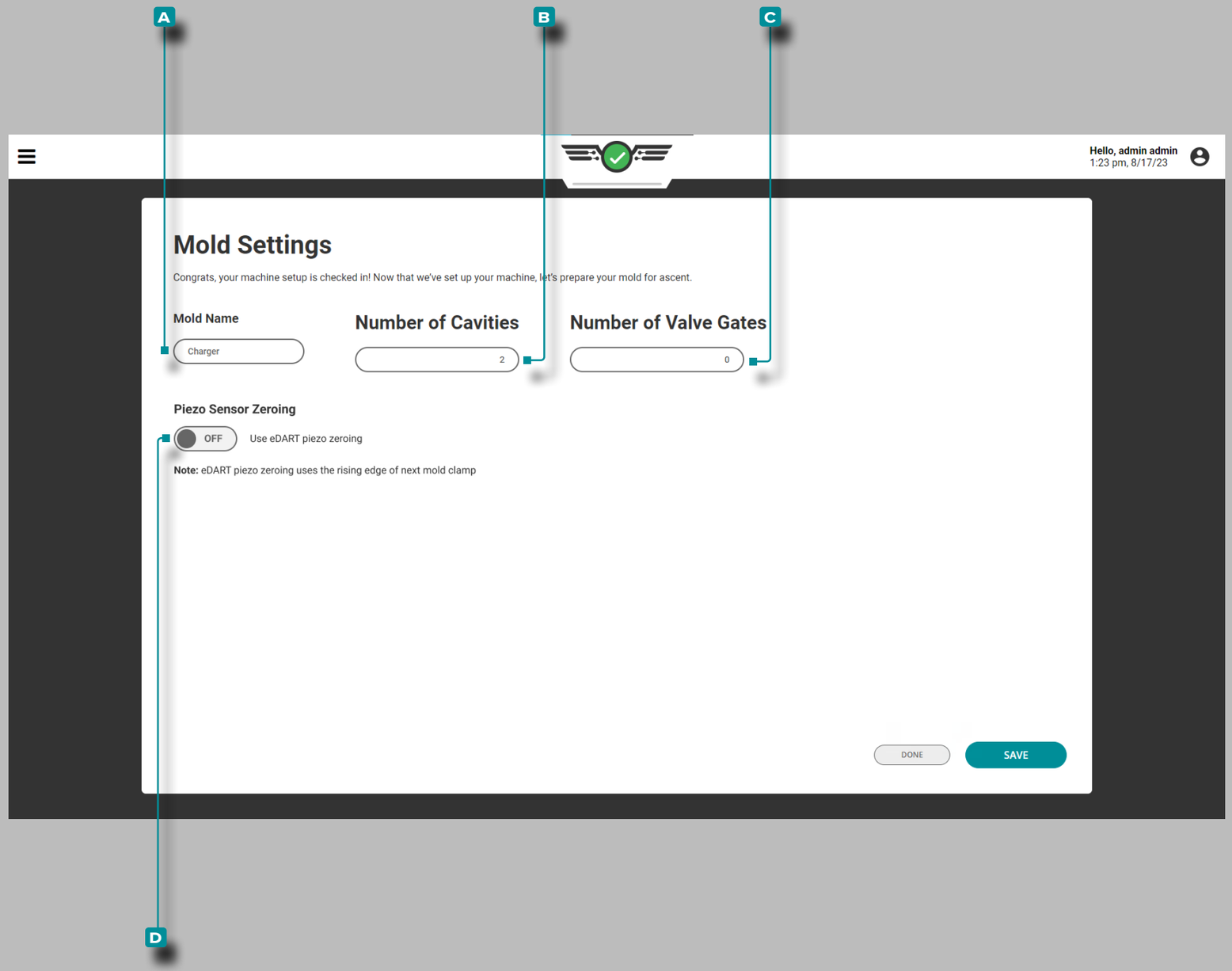


Setup (*continued*)

Mold Setup

Tap 👆, hold, and drag the pull-down **A** setup menu to access machine setup. **Tap** 👆 the **B** Mold drop-down menu, then **Tap** 👆 to select the **C** Create New mold option.

Complete Mold Setup each time a new setup is created. Mold Setup include mold settings, cavity names, mold plates, mold inputs, model details , ejector pin details, and a setup summary.



Setup (*continued*)

Mold Settings

Complete Mold Settings each time a new setup is created. Mold Settings include mold name and number of cavities with sensors, and—if applicable—number of valve gates and valve gate states. Valve gate information will only be displayed if a Valve Gate license has been purchased.

Mold Name, Number of Cavities with Sensors

Tap the field and **enter** the **A** mold name in the provided field. Mold names are required, must be unique, and may be one to twenty characters in length including uppercase, alphanumeric, spaces, and special characters - or #.

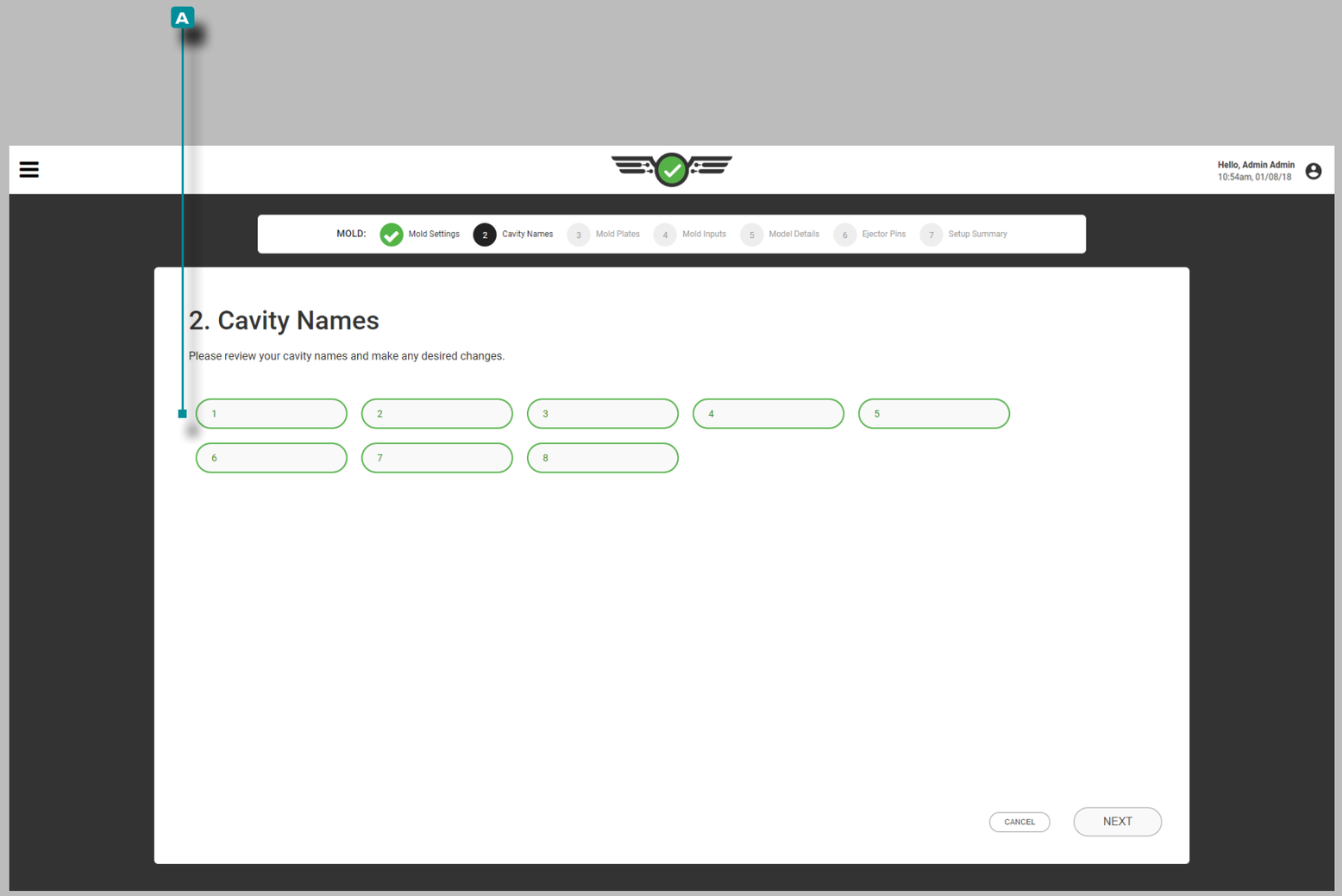
Tap the field and **enter** the **B** number of cavities with sensors. Number of cavities with sensors quantity is required and may be any whole number between 1 and 512.

Number of Valve Gates (if Applicable)

Tap the field and **enter** the **C** number of valve gates. Number of valve gates quantity is required for valve gate users and may be any whole number between one and ninety-nine.

Piezo[electric] Sensor Zeroing

Tap the slider to select **D** ON/OFF; ⓘON will enable the delayed piezoelectric sensor zeroing option during mold setup, while OFF will retain the default the piezoelectric sensor zeroing. Refer to “Advanced Setting: Piezoelectric Sensor Zeroing” on page 181 for more information on this option.

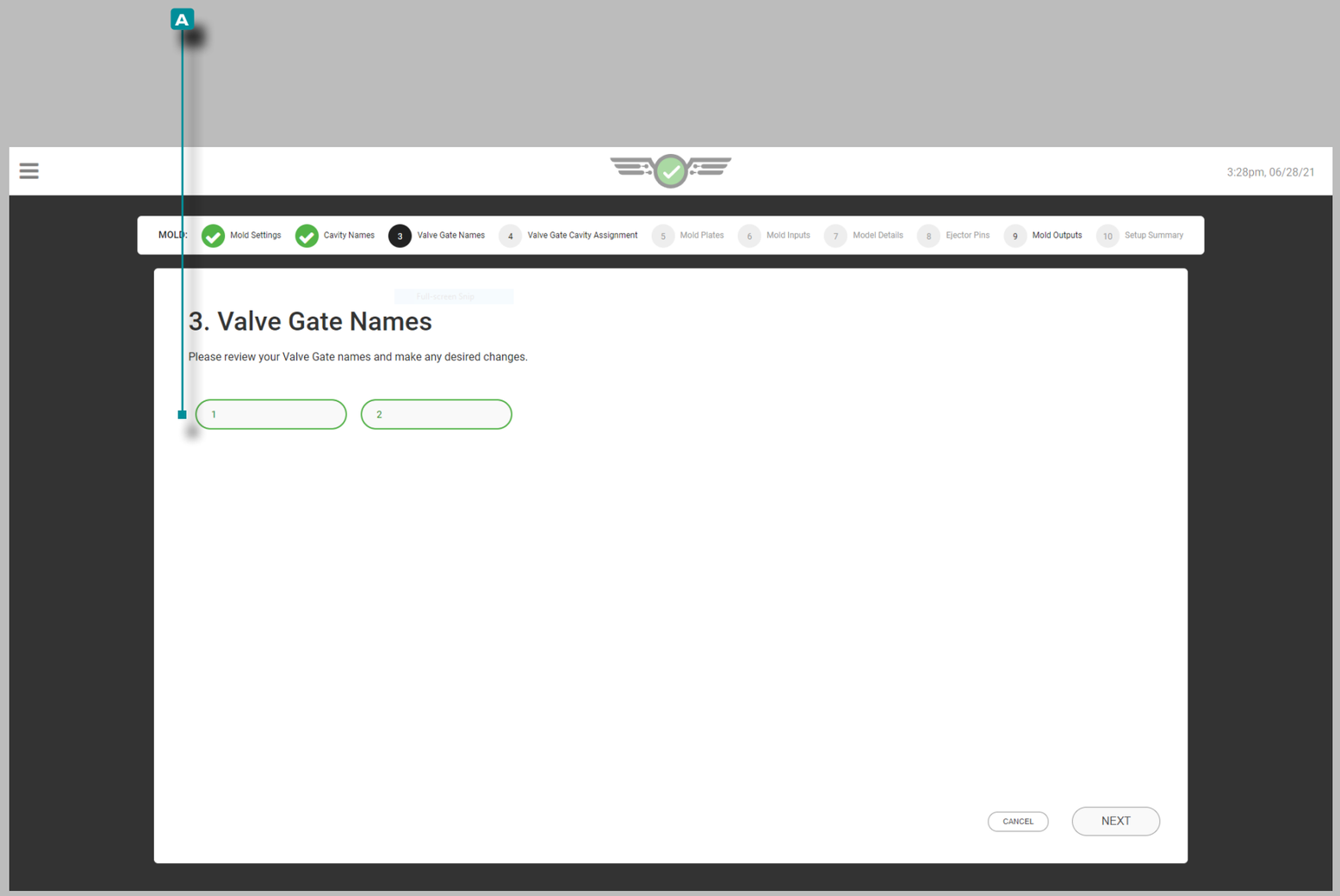


Setup (*continued*)

Cavity Names

Cavities must be named before assigning sensors to cavities. The system will automatically fill the fields with numerals in ascending order.

To change the system-assigned cavity names, **tap** a field and **enter** the A cavity name(s) in the provided field(s). Cavity names are required, must be unique, and may be between one and twenty characters in length including uppercase, alphanumeric, spaces, and special characters - or #.

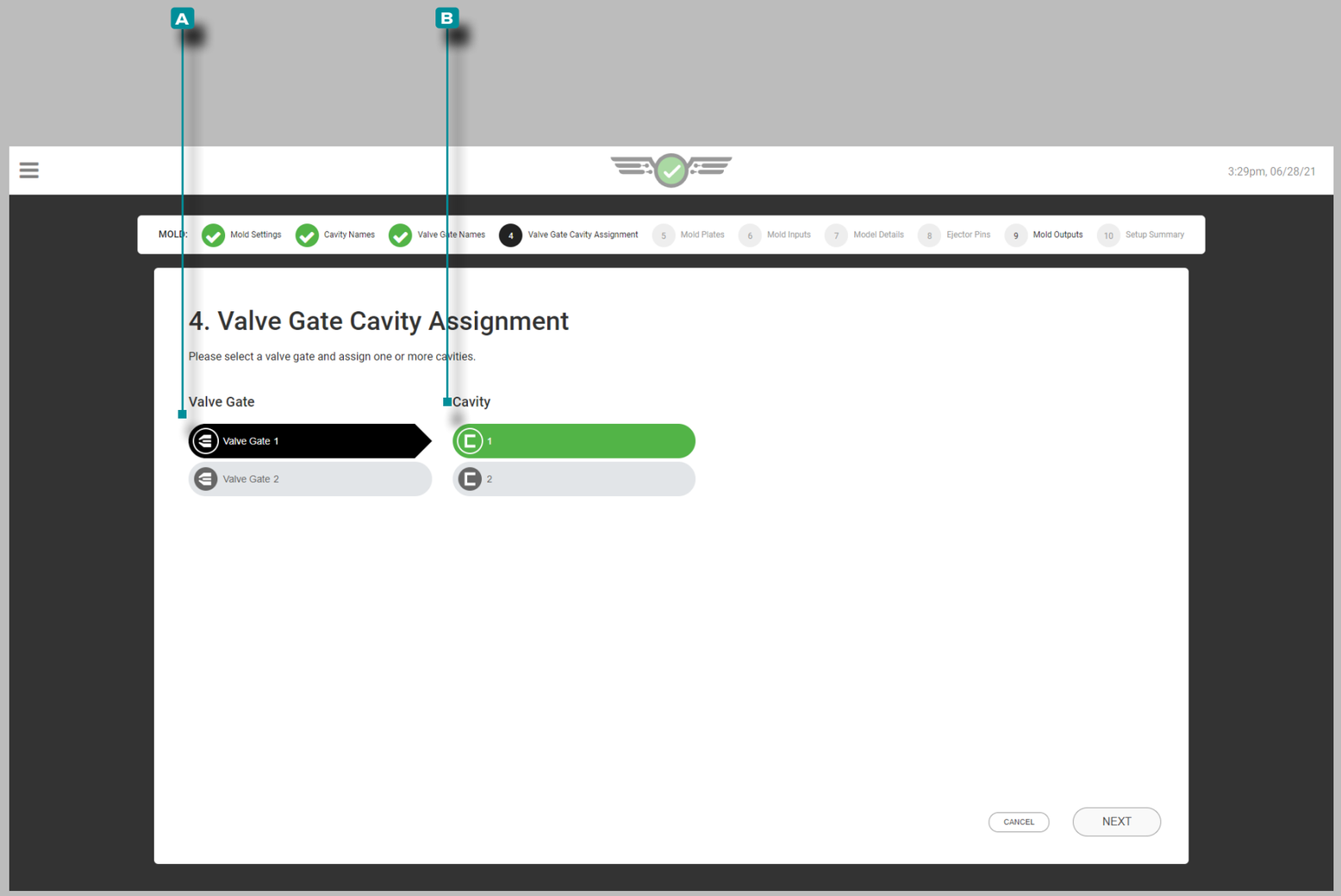


Setup (*continued*)

Valve Gate Names

Valve gates must be named before assigning sensors to valve gates. The system will automatically fill the fields with numerals in ascending order.

To change the system-assigned valve gate names, **tap** a field and **enter** the A valve gate name(s) in the provided field(s). Valve gate names are required for valve gate users, must be unique, and may be between one and ten characters in length including uppercase, alphanumeric, spaces, and special characters - or _.



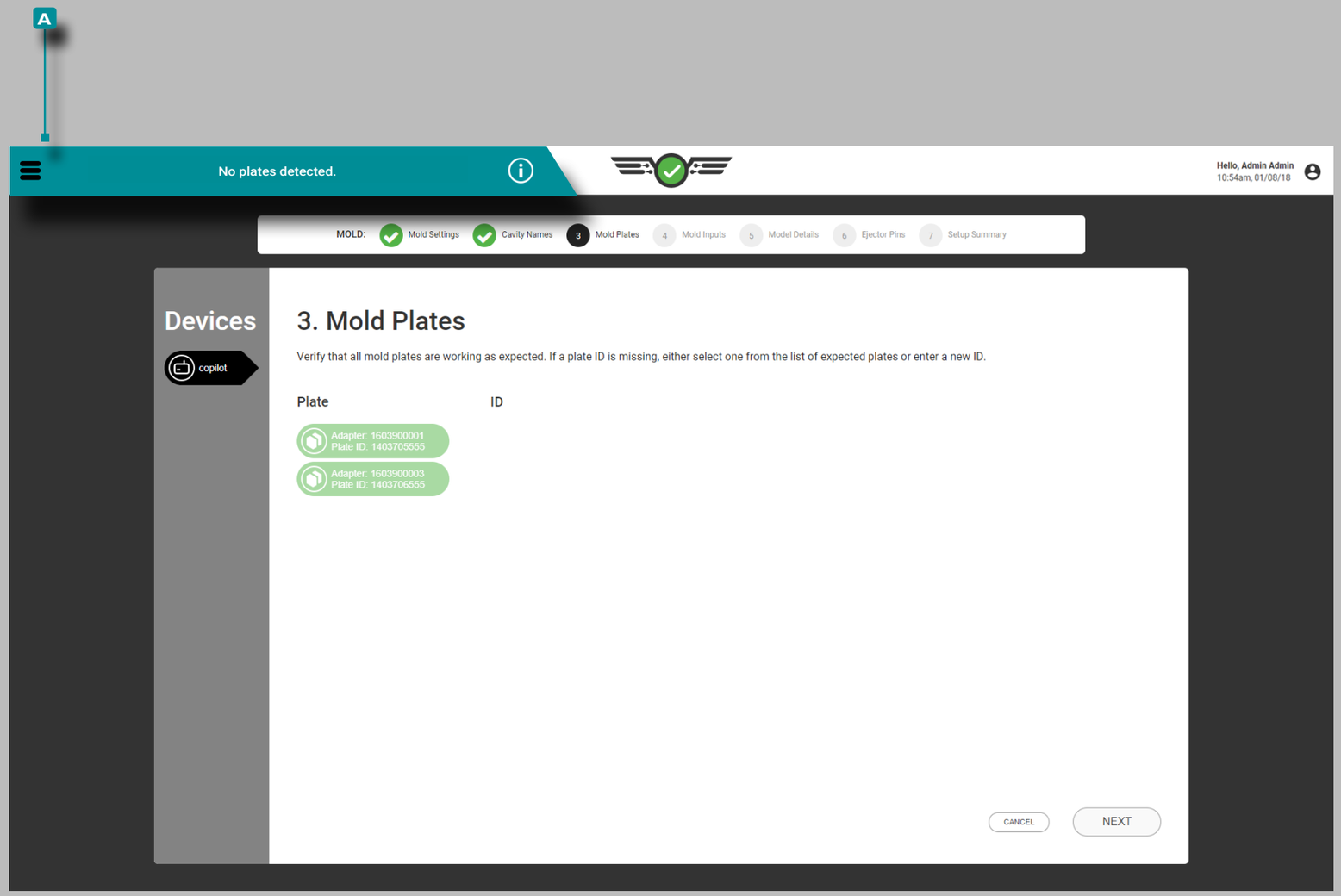
Setup (*continued*)

Valve Gate Cavity Assignments

If valve gates are being utilized, tap the **A** Valve Gate from the input list, then **tap** a **B** Cavity from the list to assign the selected valve gate to the selected cavity. Each valve gate must be assigned to a cavity; a single valve gate can be assigned to more than one cavity, and multiple valve gates can be assigned to a single cavity.

If a previously-set-up mold is moved to a different machine with OR2-M modules, the valve gate cavity assignments must be reassigned.

NOTE *Valve gate assignments cannot be changed while a job is running.*



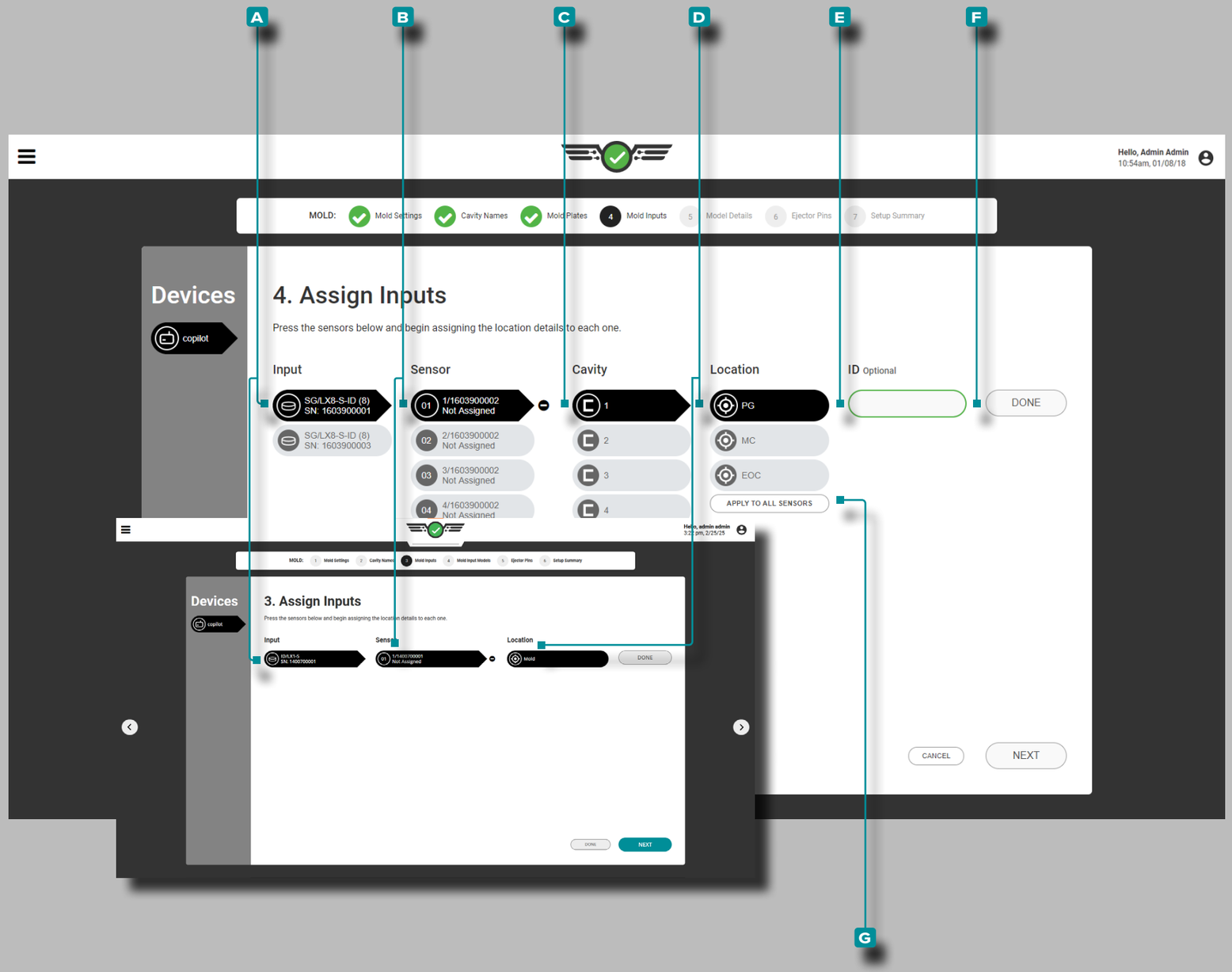
Setup (*continued*)

Mold Plates

Confirm that all connected mold sensor connector plates are functioning properly; if a connected sensor connector plate does not appear on the list, enter a new plate ID or select one from the plates listed.

If no mold plates are connected, a A notification will indicate that no plates were detected.

NOTE *Temperature sensor adapters will not appear on the mold plates page, and will instead be present on the Mold Inputs page.*



Setup (*continued*)

Mold Inputs

Complete Mold Inputs each time a new setup is created. Assign each cavity pressure sensor in the software to the location which it is physically located in the mold and cavity. Cavity pressure sensors can be assigned to a post-gate (PG), mid-cavity (MID), or end-of-cavity location (EOC) within a cavity; temperature sensors can be assigned to a Mold Surface, Water In, and Water Out location in addition to the PG, MID, and EOC locations; mold deflection sensors can be assigned to the mold parting line location; and mold identifier (ID) modules ID/LX1-S can be assigned to a mold.

Sensors, Cavity, Location, and ID

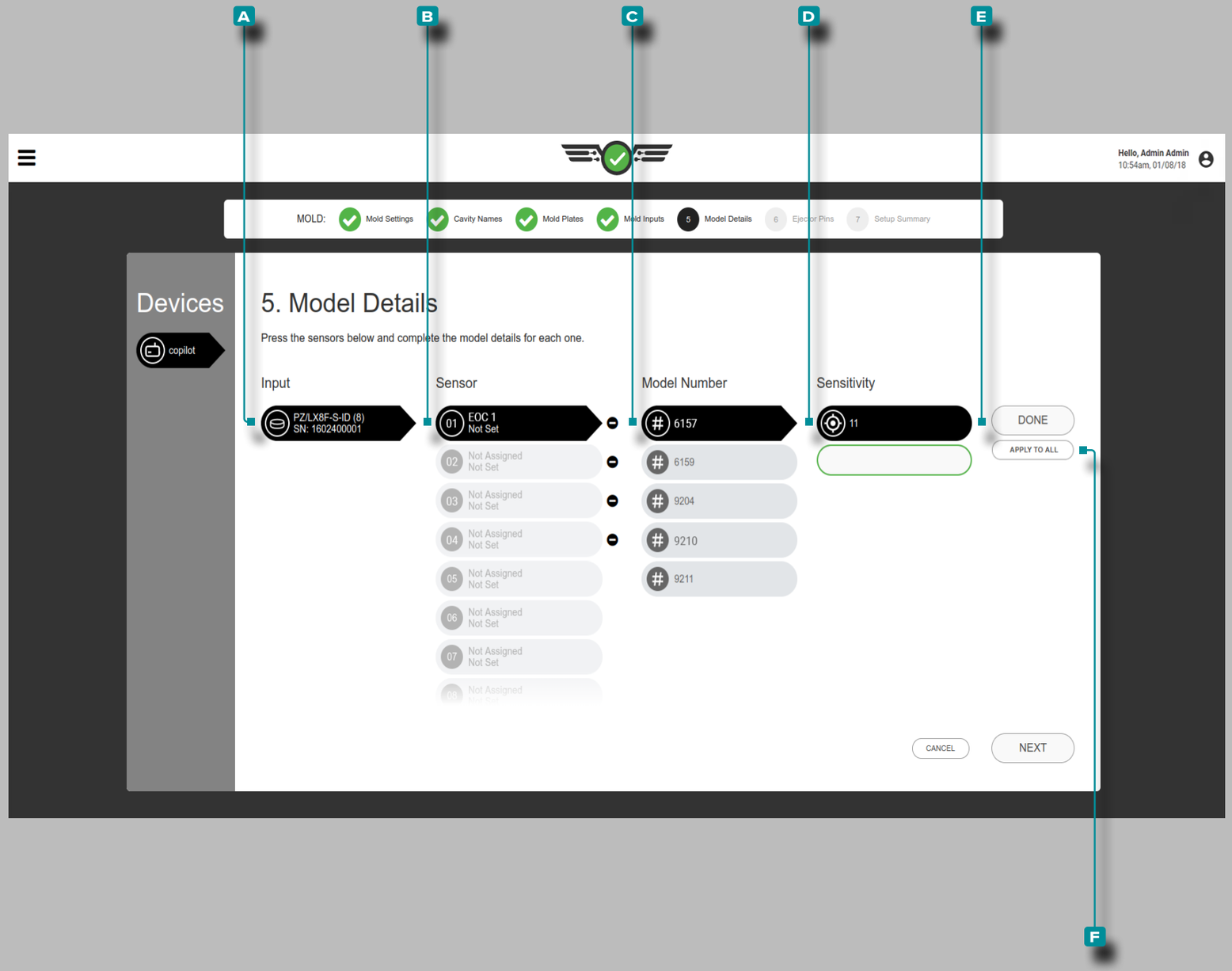
Tap the **A** input from the input list, then **tap** a **B** sensor from the list, then **tap** to select a **C** cavity from the drop-down menu; **tap** to select a **D** Location from the options to assign the sensor to a cavity location.

If multiple sensors are present in the same location in a cavity, a sensor ID is required. **Tap** the **E** ID field and **enter** the desired ID. The sensor **E** ID must be unique, and may be between one and twelve characters in length including uppercase, alphanumeric, spaces, and special characters - or _. **Tap** the **F** DONE button to save the sensor location setup.

Optionally, **tap** the **G** APPLY TO ALL SENSORS button to apply the selected location to all cavity pressure sensors connected to the selected mold input; each sensor must still be assigned to a cavity.

CAUTION *Modifying a previously-assigned sensor's Cavity ID OR Location (PG, MID, or EOC) will delete all Process Limits and Process Alarms associated with that sensor's previously-assigned Cavity OR Location; the Process Limits and Alarms must be set up again for the new Cavity OR Location.*

NOTE *Sensor location/type assignments cannot be edited while a job is running.*



Setup (*continued*)

Model Details

Complete ⓘ sensor model details each time a new setup is created. The system uses the information to calculate scaling and display the correct cavity pressures on the process Monitor, Cycle Values table, and Cycle Graph.

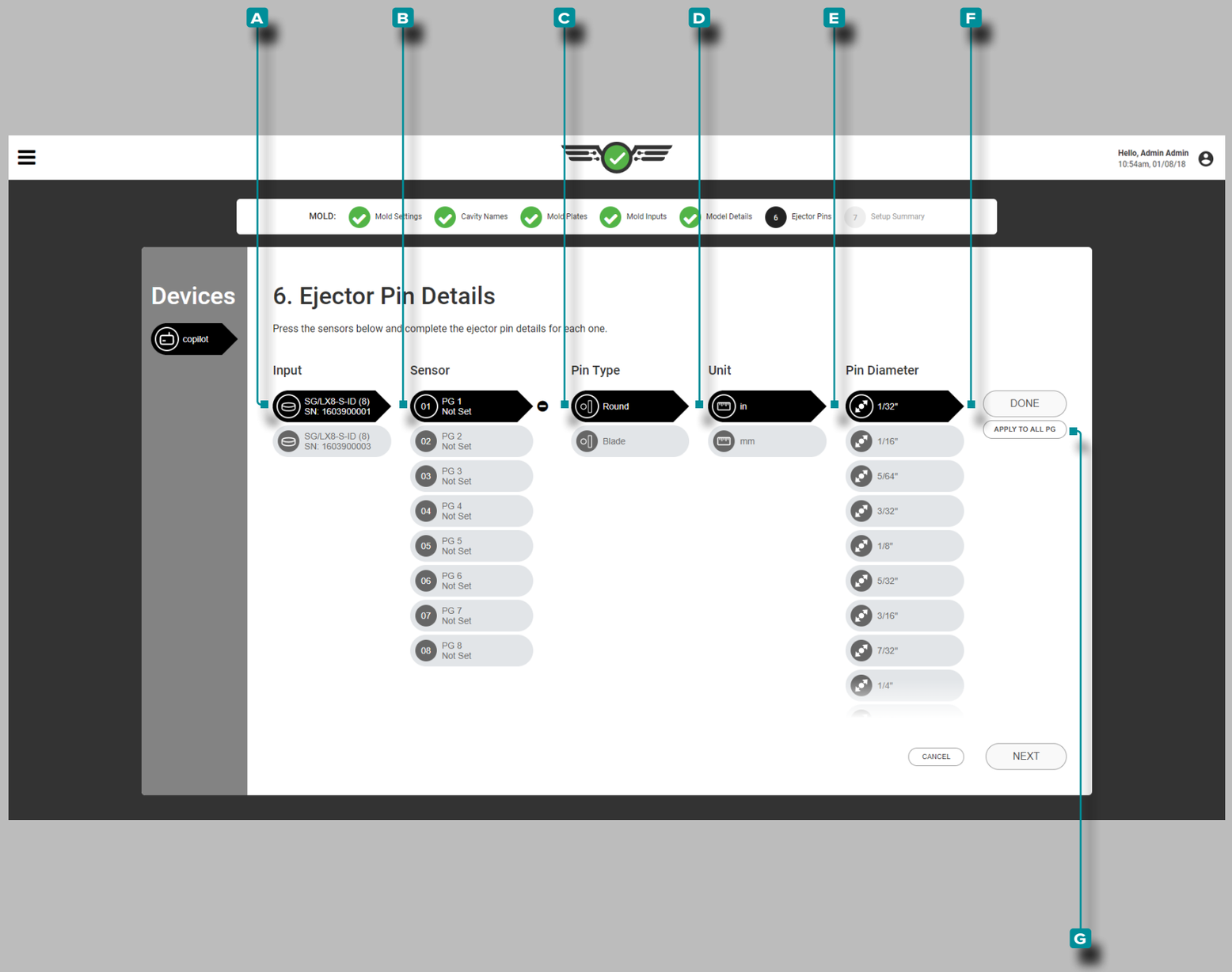
ⓘ **NOTE** *Sensor model cannot be edited while a job is running.*

Sensors, Model Number, and Sensitivity

Some sensors are automatically detected by the software and given the correct sensor model, and others must be assigned a sensor model.

Tap 👆 the **A** sensor/adapter from the input list, then **tap** 👆 to select a **B** sensor and **C** Model Number from the drop-down menu. If the sensor is a piezoelectric sensor, **tap** 👆 the **D** sensitivity listed for the sensor, ***OR* enter** the sensitivity listed on the sensor calibration certificate (shipped with each sensor).

Tap 👆 the **E** DONE button to save the sensor location setup. Optionally, **tap** 👆 the **F** APPLY TO ALL button to apply the selected model to all sensors.



Setup (*continued*)

Ejector Pin Details

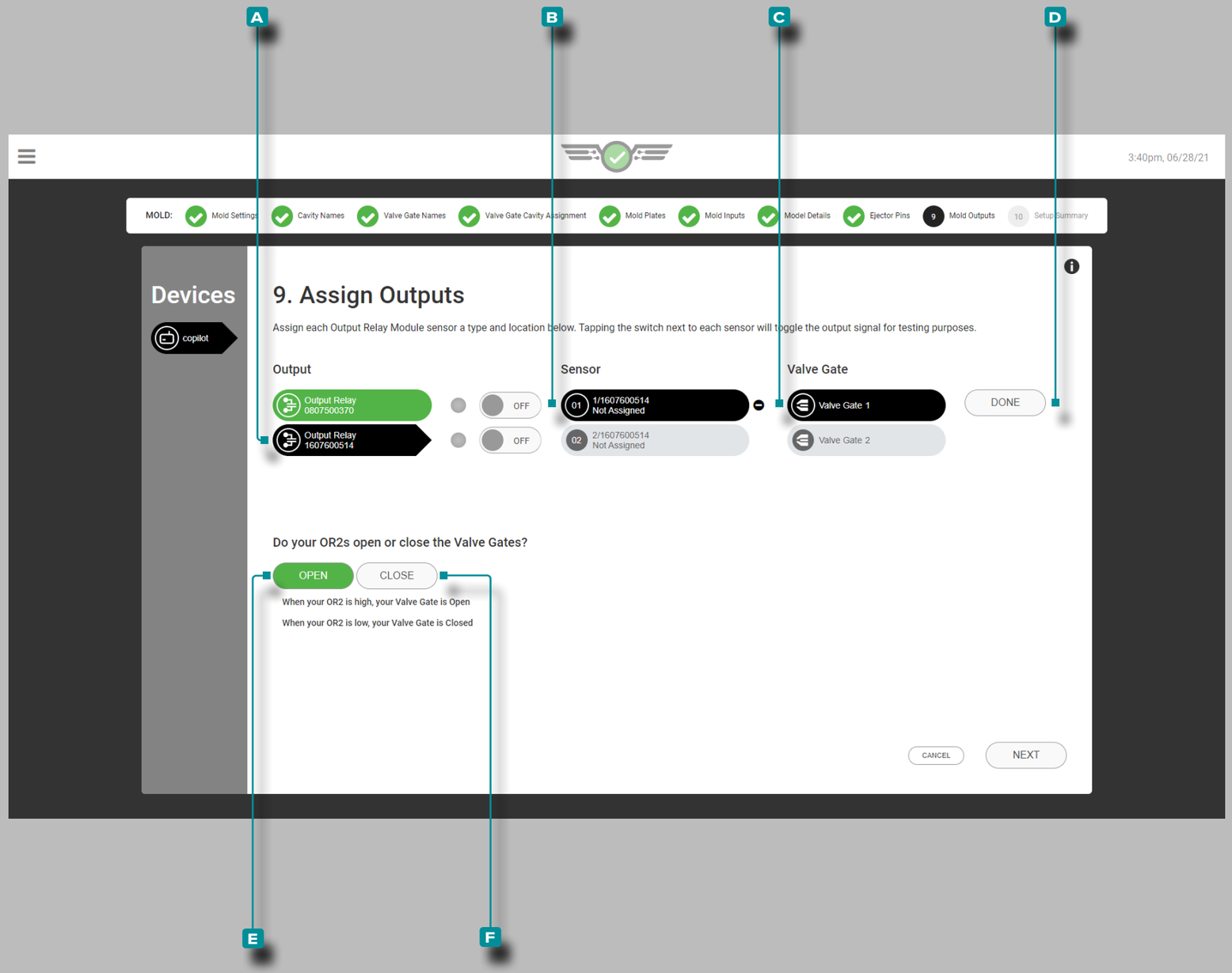
Complete Ejector Pin Details ⓘ each time a new setup is created. The system uses the corresponding sensor, pin type, and pin diameter to calculate scaling and display the correct cavity pressures on the process Monitor, Cycle Values table, and Cycle Graph.

ⓘ **NOTE** *Ejector pin scaling cannot be edited while a job is running.*

Sensors, Pin Type, Units, Pin Diameter

Tap 👆 the **A** input from the input list, then **tap** 👆 the **B** sensor from the sensor list, then **tap** 👆 to select a **C** Pin Type; **tap** 👆 to select the pin's **D** Units (of Measurement) , then **tap** 👆 to select or **enter** ⌶ the **E** ⓘ Pin Diameter.
Tap 👆 the **F** DONE button to save the sensor location setup. Optionally, **tap** 👆 the **G** APPLY TO ALL button to apply the selected ejector pin type and diameter or area to all sensors in the same location (PG, MID, EOC).

ⓘ **NOTE** *Temperature, flush-mount cavity pressure, and mold deflection sensors do not require a pin type selection or the related unit of measurement and diameter required for other button-style sensors.*



Setup (*continued*)

Mold Outputs

Complete ⓘ mold outputs each time a new valve gate setup is created. Mold outputs are dual-relay output modules (OR2-M) that are assigned to a sensor and valve gate to open or close the valve gate.

ⓘ **NOTE** *Valve gate and sensor locations cannot be edited while a job is running.*

📖 **DEFINITION** OUTPUT—VALVE GATE *A relay output that allows the assigned valve gate to open or close using pressure, position, temperature, time, sequence inputs, or the operation of other valve gates.*

Sensor and Valve Gate

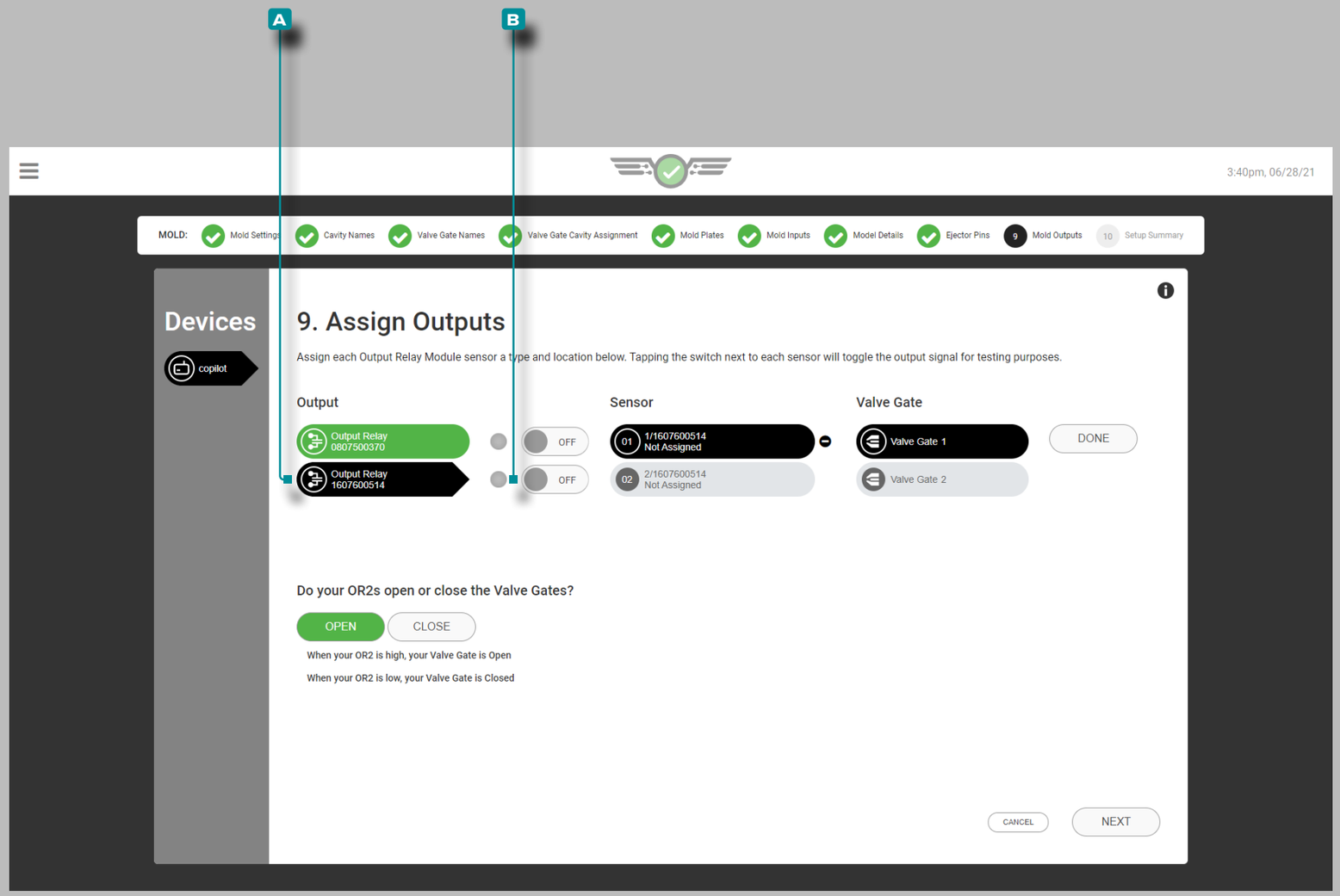
Tap 👆 the **A** output from the output list, then **tap** 👆 a **B** sensor from the list, then **tap** 👆 to select a **C** valve gate to assign the valve gate to a sensor.

Tap 👆 the **D** DONE button to save the sensor location setup.

Tap 👆 the **E** OPEN or **F** CLOSED button to select valve gates that are normally open (NO) or normally closed (NC). Valve gate states selection is required for valve gate users.

Some valve gate solenoids default position is closed—the controls need to open the gate. Some valve gate solenoids default position is open—the controls need to close the gate.

All gates will be assigned either open gate or close gate. Users cannot assign one side of an OR2-M to open gate and the other side to close gate.



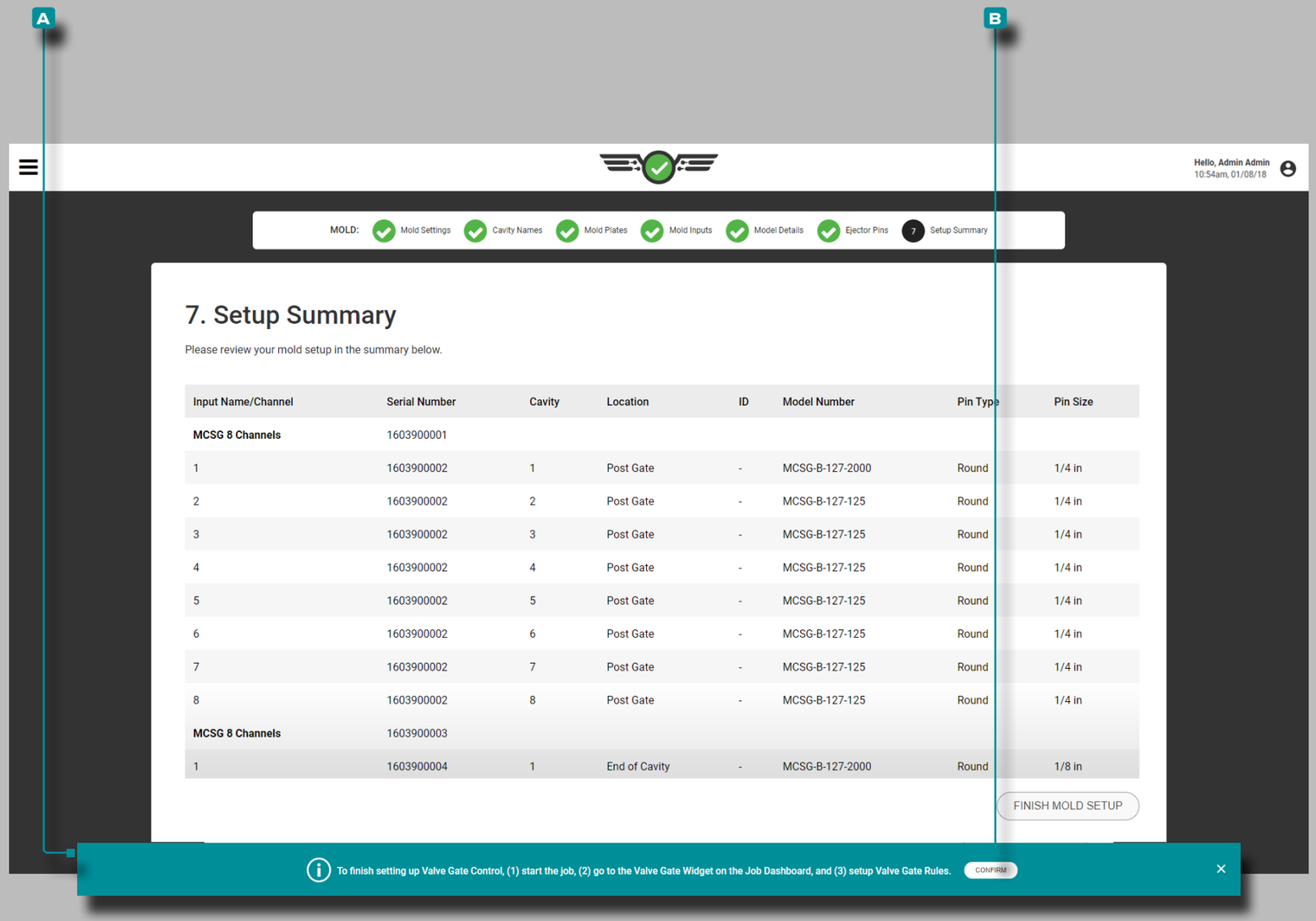
Setup (*continued*)

Test Valve Gate Outputs

Test outputs for valve gate operation.

Tap the **A** output relay to select it.

Tap the **B** ON / OFF button next to the assigned output to verify that the attached control device performs the appropriate action.



Input Name/Channel	Serial Number	Cavity	Location	ID	Model Number	Pin Type	Pin Size
MCSG 8 Channels	1603900001						
1	1603900002	1	Post Gate	-	MCSG-B-127-2000	Round	1/4 in
2	1603900002	2	Post Gate	-	MCSG-B-127-125	Round	1/4 in
3	1603900002	3	Post Gate	-	MCSG-B-127-125	Round	1/4 in
4	1603900002	4	Post Gate	-	MCSG-B-127-125	Round	1/4 in
5	1603900002	5	Post Gate	-	MCSG-B-127-125	Round	1/4 in
6	1603900002	6	Post Gate	-	MCSG-B-127-125	Round	1/4 in
7	1603900002	7	Post Gate	-	MCSG-B-127-125	Round	1/4 in
8	1603900002	8	Post Gate	-	MCSG-B-127-125	Round	1/4 in
MCSG 8 Channels	1603900003						
1	1603900004	1	End of Cavity	-	MCSG-B-127-2000	Round	1/8 in

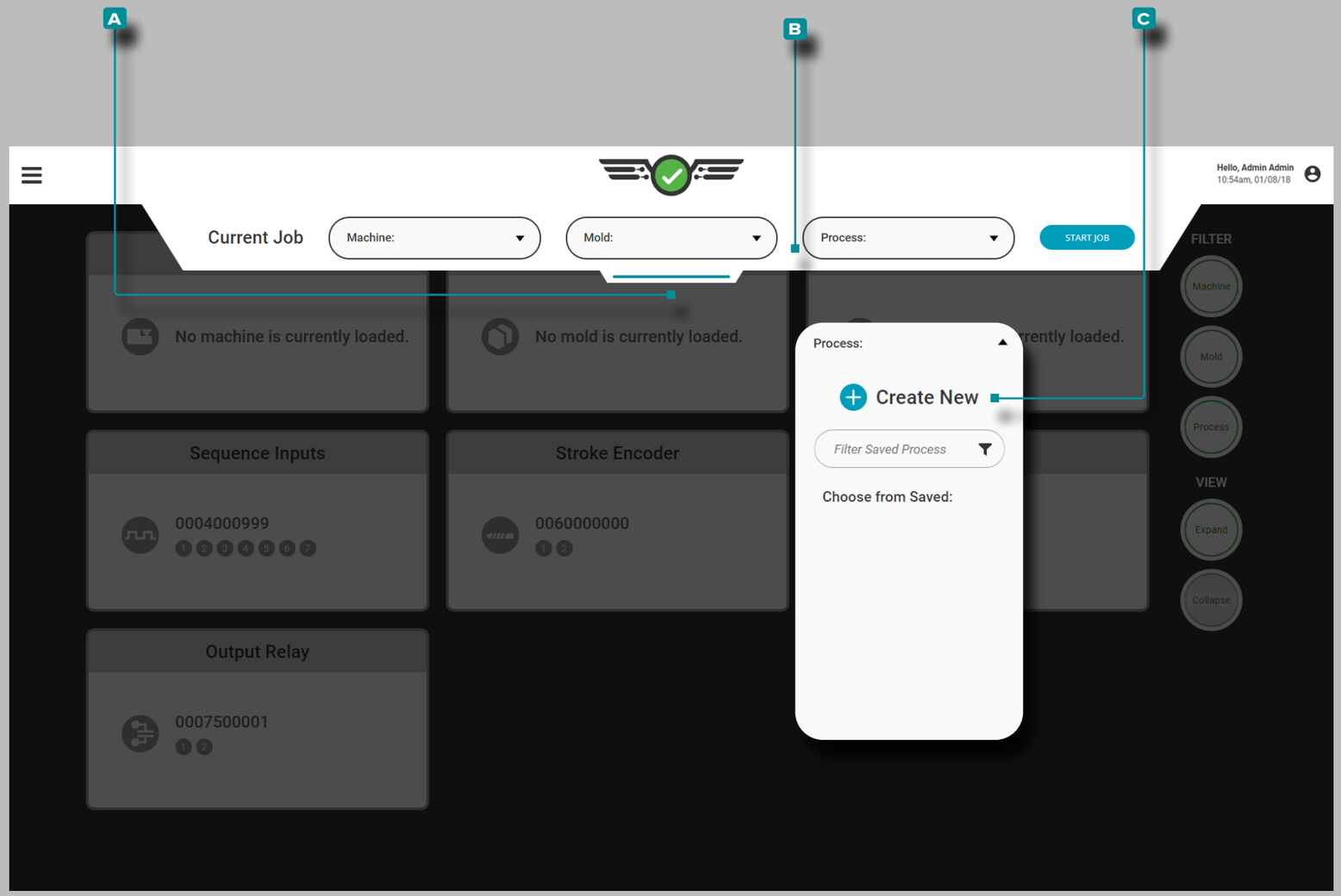
Setup (*continued*)

Setup Summary

The mold Setup Summary provides an overall view of each mold sensor setup item, including input name/channel, serial number, cavity, location, ID (if assigned), model number, pin type, and pin size.

If valve gates are assigned, output name/channel, serial number, location, valve gate, and ID will be displayed. A **A** notification will be displayed with instructions to complete the valve gate setup; read the instructions and then **tap** 👆 the **B** CONFIRM button to continue with setup.

Verify that all information is correct in the mold setup summary before finishing mold setup.

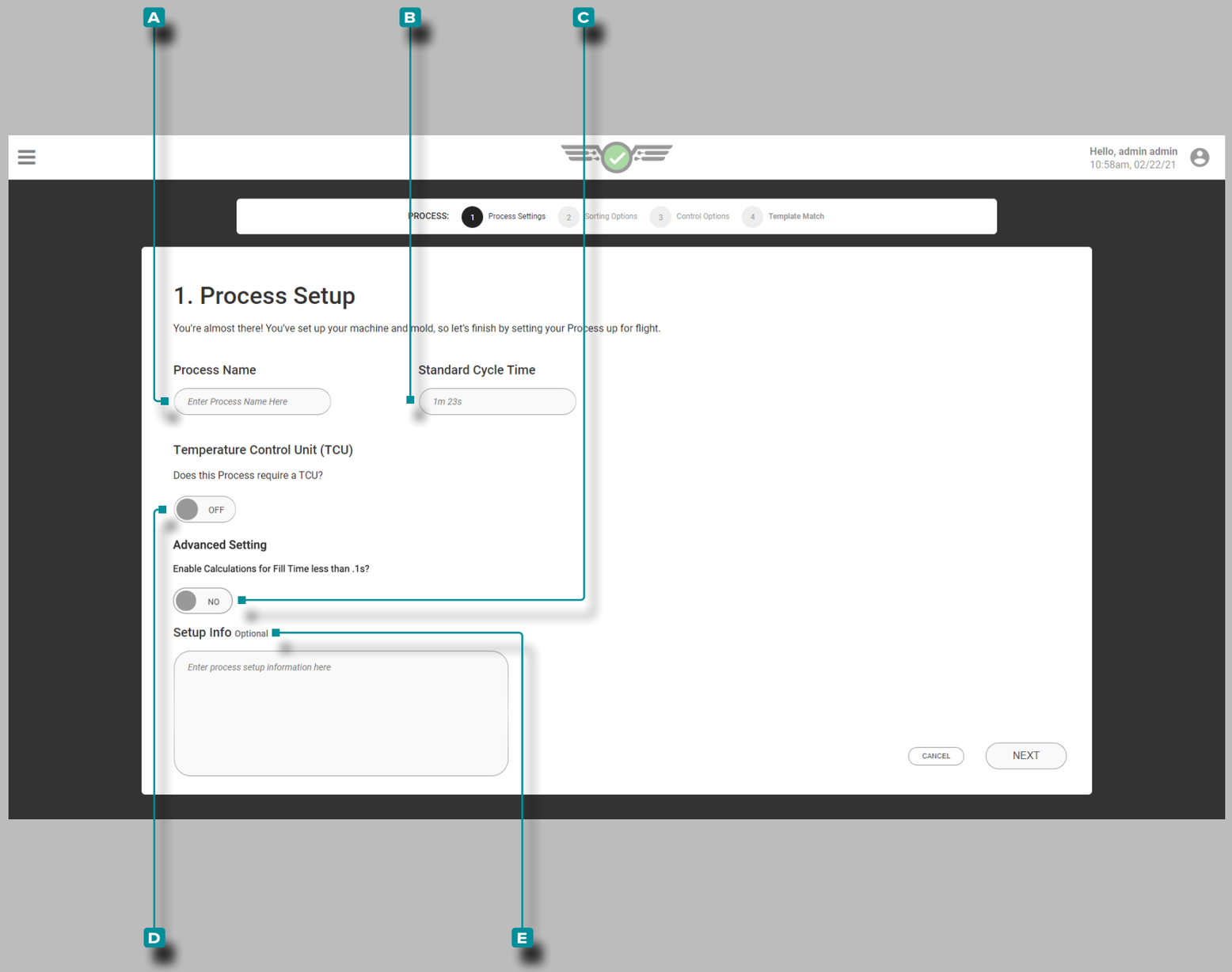


Setup (*continued*)

Process Setup

Tap 👆, hold, and drag the pull-down **A** menu to access machine setup. **Tap** 👆 the **B** Process drop-down menu, then **Tap** 👆 to select the **C** Create New process option.

Complete Process Setup each time a new setup is created. Process Setup include process settings, sorting options, general settings (if using valve gate control), control options, and template match options.



Setup (*continued*)

Process Settings

Complete Process Settings each time a new setup is created. Process settings include name, standard cycle time; optionally, setup info, TCU, and fast fill time selections are also available from the Process Settings page.

Process Name, Standard Cycle Time, TCU Connection, and Setup Info

Tap then **enter** the **A** process name in the provided field. Process names are required, must be unique, and may be between one and twenty characters in length including uppercase, alphanumeric, spaces, and special characters - or #.

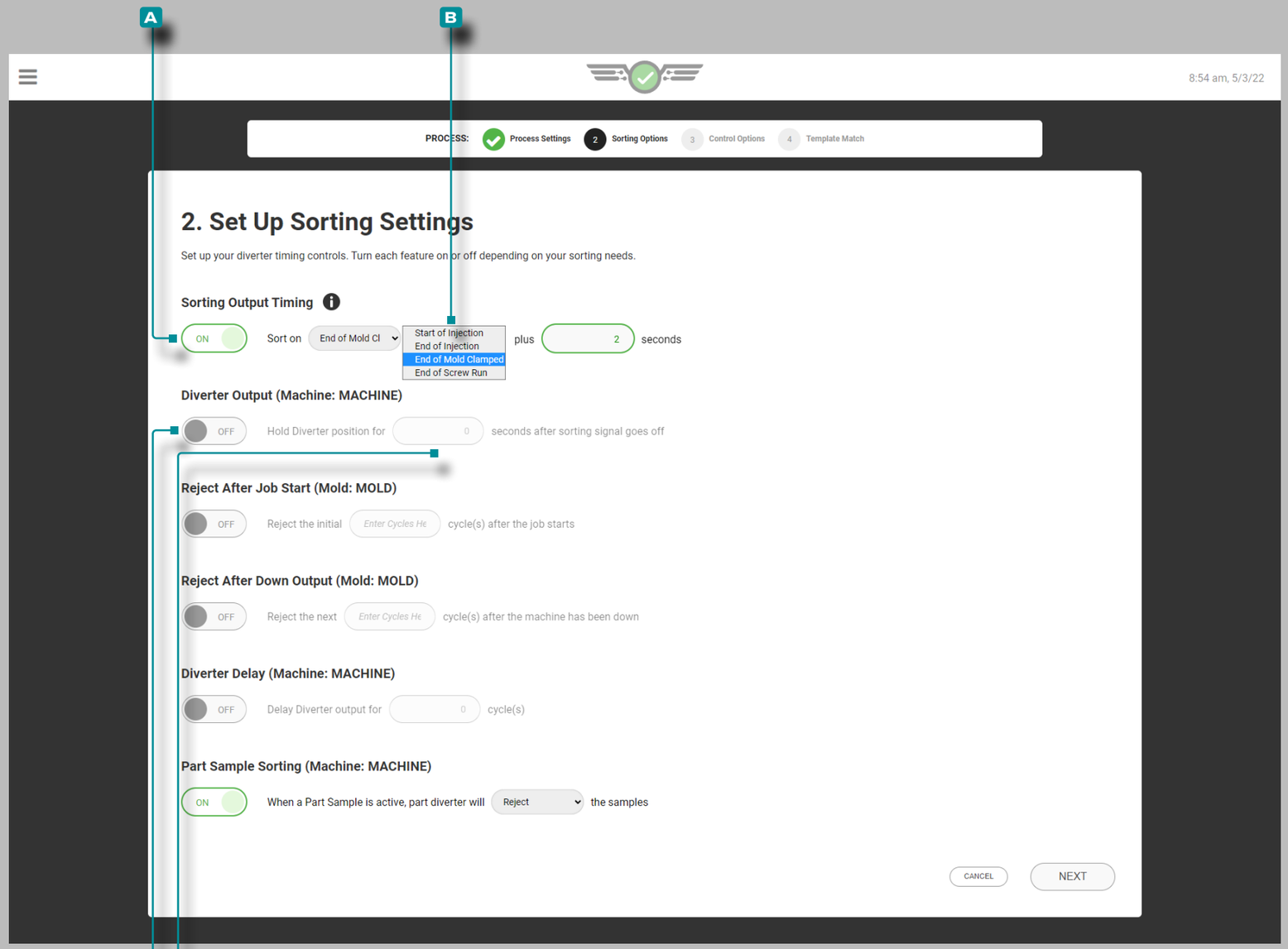
Tap then **enter** the **B** standard cycle time in the provided field. Standard cycle time is required and may be any time value of one second or higher. If a fast fill time less than 0.1 seconds is being used, **tap** to select **C** ON or OFF to enable calculations; if no toggle is displayed, refer to "Advanced Setting: Enabling Fast Fill Time" on page 180.

CAUTION *Cycle time must be accurate; failure to comply will result in the computation of inaccurate values by the software.*

NOTE *If a short cycle time resulting in a fast fill time/fill times less than 0.1 seconds is entered, a 1st and 2nd stage signal must be assigned in machine sequence settings,* ***OR*** *users will be required to utilize the Set Fill Volume at Cursor function to calculate fill time. Refer to "Advanced Setting: Enabling Fast Fill Time" on page 180, and "Set Fill Volume at Cursor" on page 76.*

If a temperature control unit (TCU) is connected, **tap** to select **D** ON or OFF to enable the viewing and setting of alarms for the TCU from the CoPilot system. The TCU serial channel must be set to 0, and the baud rate must be set to 9600. Refer to page 59 for information on setting alarms.

Tap the field and **enter** any **E** setup info in the provided field. Setup info is optional and may be between 0 and 300 characters in length. Setup info is accessible on the Process Monitor page.



Setup (*continued*)

Sorting Options

Complete Sorting Settings each time a new setup is created. Sorting settings include sorting output timing, diverter output with diverter hold timing, reject after job start, reject after down timing, diverter output delay timing, and part sample sorting.

Sorting Output Timing

Tap to select A ON or OFF to adjust sorting output timing; **tap** to select a B sorting option (start of injection, end of injection, end of screw run, or end of mold clamped the field), then **enter** the number of seconds to add to the selected B sorting option.

NOTE *When sorting output timing is OFF, the system will default to sort at End of Mold Clamped; when sorting output timing is ON, the system will sort on the End of Injection plus the entered number of seconds. If the End of Injection plus the entered number of seconds is longer than End of Mold Clamped, the End of Mold Clamped will be used.*

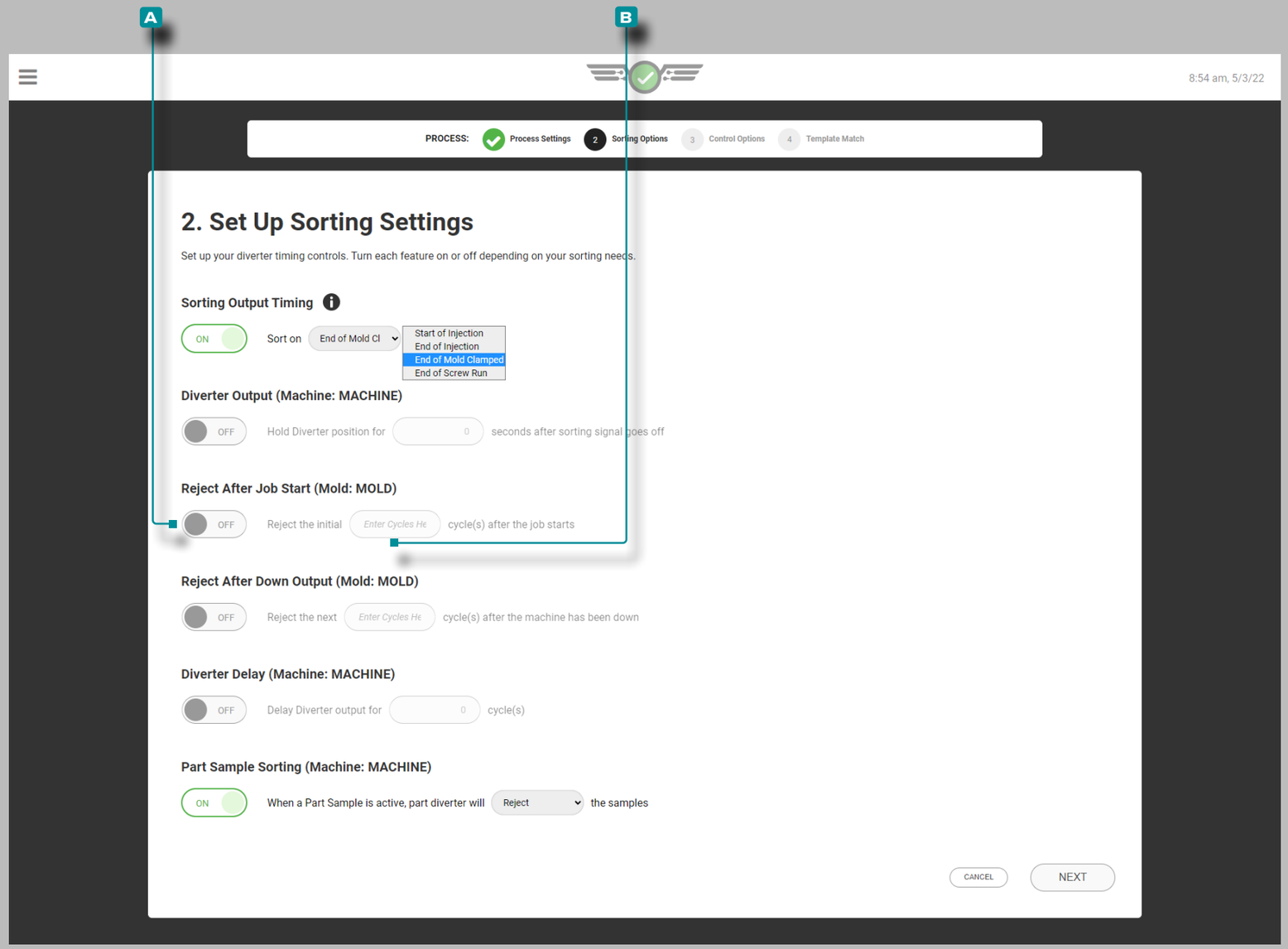
NOTE *Sorting output timing defaults to End of Mold Clamped when CoPilot Go is utilized; refer to "CoPilot Go" on page 12 for more information on CoPilot Go.*

CAUTION *When sorting output timing other than End of Mold Clamped is selected, the cooling time alarm will be unavailable. If sorting output timing other than End of Mold Clamped is added after a cooling alarm is present, an error message will be displayed and all cycles will be rejected until the cooling time alarm is removed.*

Diverter Output

Tap to select C ON or OFF for diverter position; **tap** the field and **enter** the diverter D hold timing.

NOTE *Sorting equipment must be set up so that any parts in the queue arrive in the same sequence in which the out of match values are computed.*



Setup (*continued*)

Sorting Options (*continued*)

Reject After Job Start

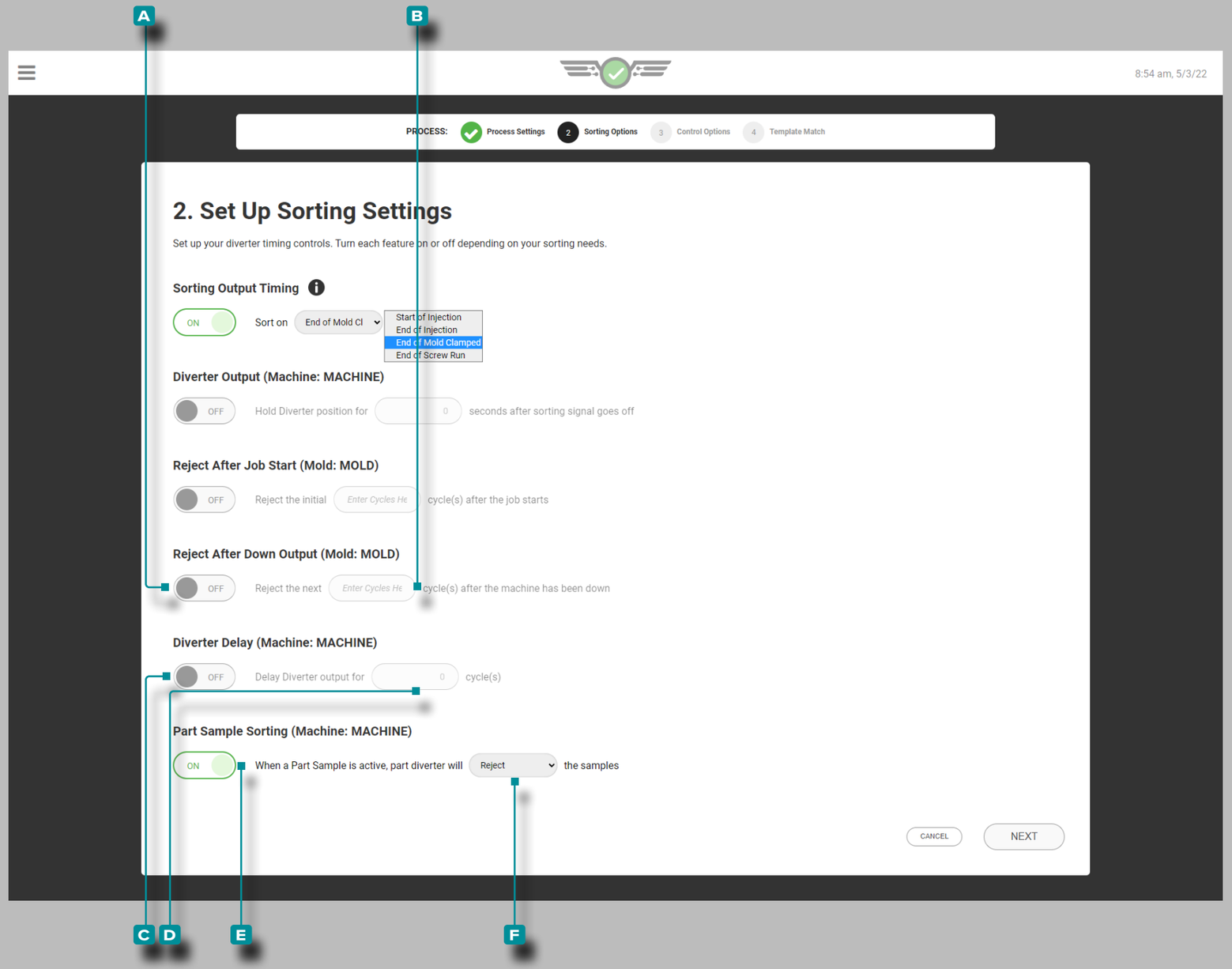
The reject after job start sorting option will reject the specified number of parts/cycles upon job start, if enabled. If the number of Reject After Job Start is changed while Reject After Job Start is active, the count will be reset to the new entry. The system will reject the newly entered number of cycles even if it had previously rejected some cycles based on the previous setting.

Tap to select A ON or OFF to enable or disable reject at job start; **tap** the field and **enter** the B number of parts/cycles to reject upon job start.

If the CoPilot system goes down or does not cycle at the start of the job, reject the higher number of cycles from either Reject After Job Start or Reject After Down if both are enabled.

If the user starts a sample during the Reject After Job Start State, the Sampler Widget will display waiting for the next cycle until the Reject After Job Start Count is expired.

NOTE *Only users with an assigned Process Engineer role can edit this setting.*



Sorting Options (*continued*)

Reject After Down Output

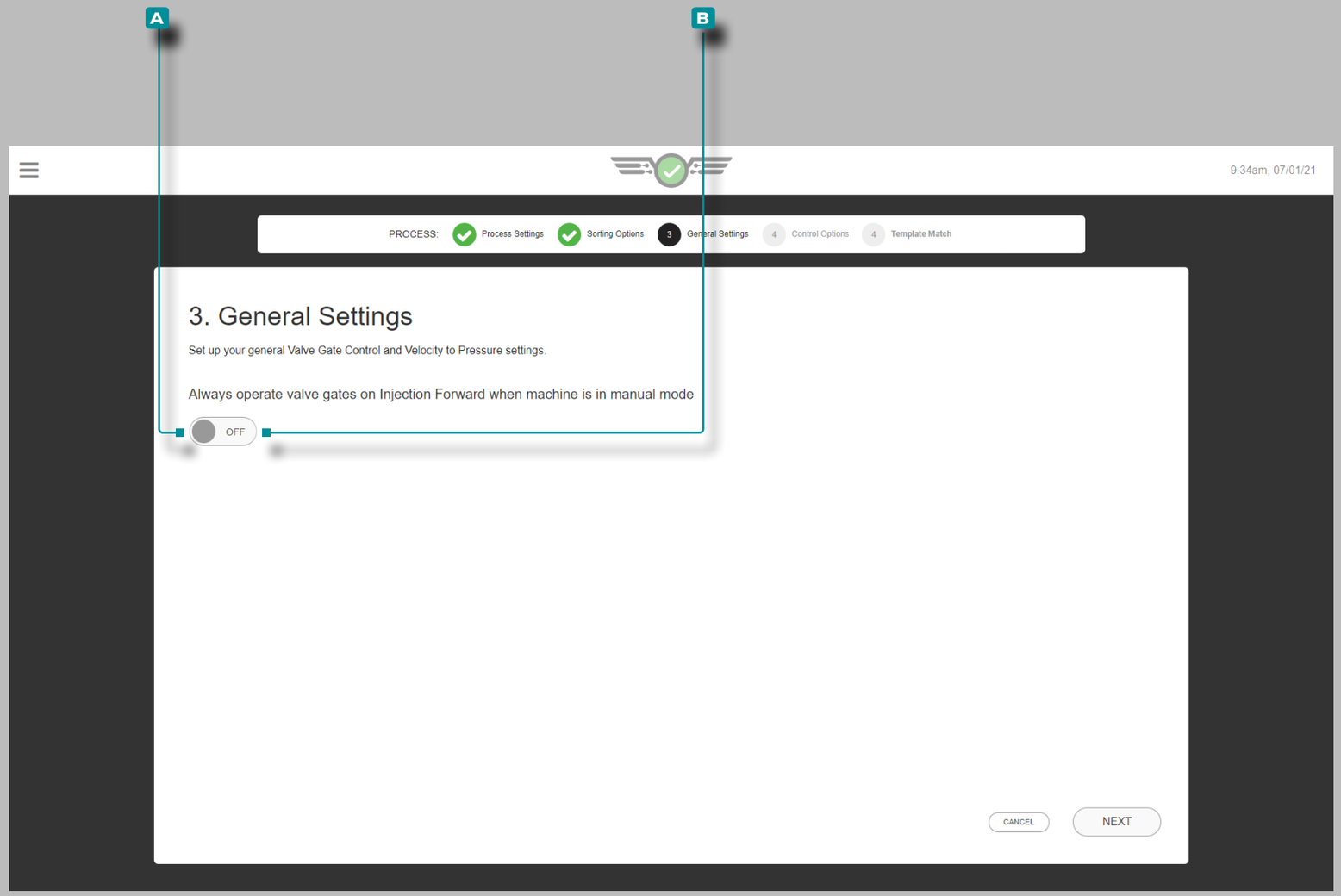
Tap to select **A** ON or OFF for reject cycles; **tap** the field and **enter** the **B** reject after down timing.

Diverter Delay

Tap to select **C** ON or OFF for diverter delay. If desired; **tap** the field and **enter** the diverter **D** output delay timing.

Part Sample Sorting

Tap to select **E** ON or OFF for part sample sorting, then **tap** the drop-down menu to select whether the to **F** keep or reject the samples when part samples are active. Refer to “Part Sampler” on page 147 for part sampler information and instructions.



Setup (*continued*)

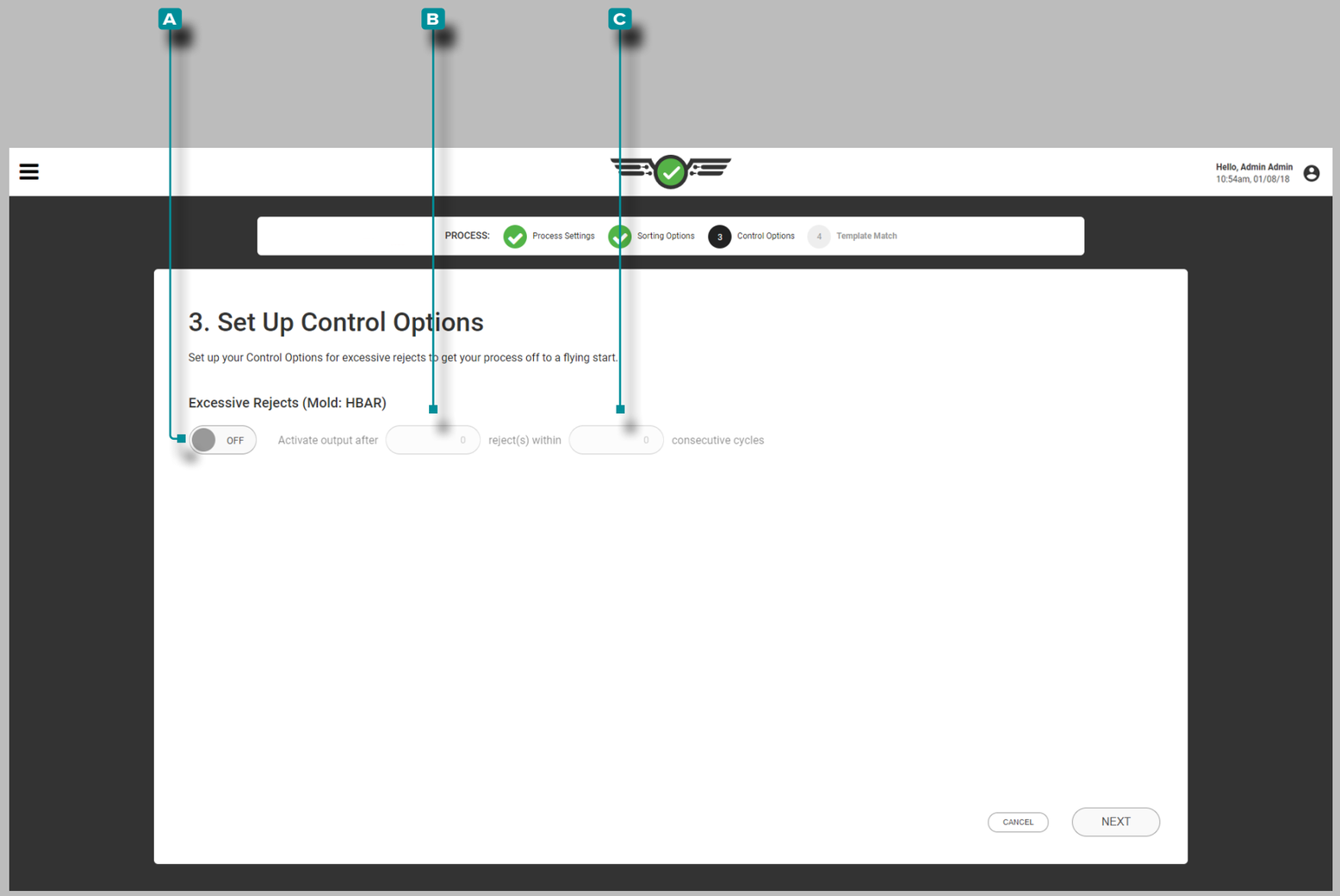
General Settings

This option is for valve gate control users only. Complete general settings each time a new valve gate control process setup is created.

To be able to purge through the mold and the valve gates, **tap** 👆 to select A ON so that the gates open even in manual mode and allow the material through; **tap** 👆 to select B OFF if this is not desired.

A machine-in-manual sequence signal must be connected and assigned in the machine setup in order to operate valve gate controls in manual mode.

This setting can also be activated after setup while a job is running from the valve gate control General Settings dashboard card; refer to “Valve Gate Control General Settings” on page 140.

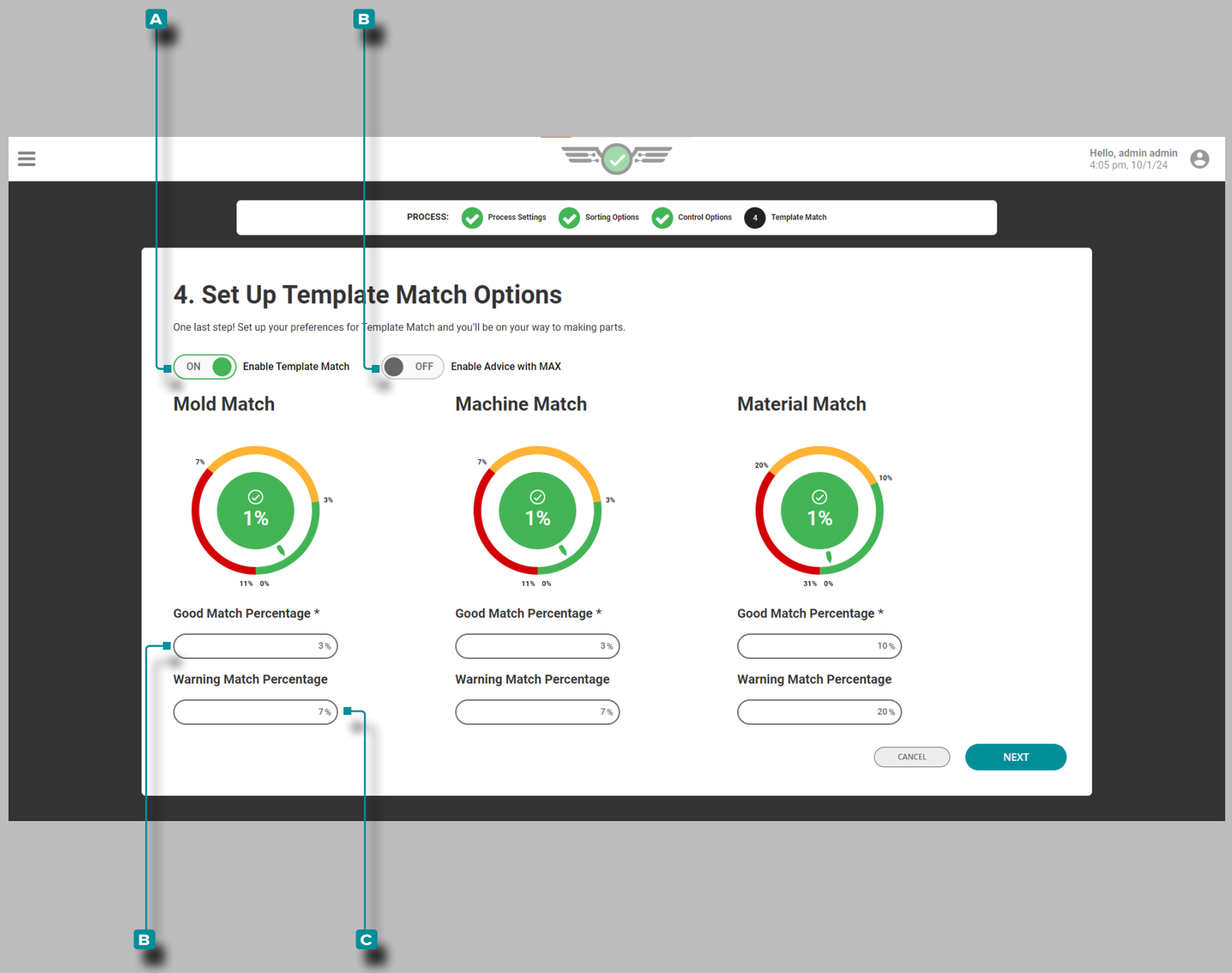


Setup (*continued*)

Control Options

Complete Control Options each time a new setup is created. Control options determine excessive rejects settings including timing for active output and consecutive cycles value.

If desired, **tap** to select **A** ON or OFF for excessive rejects control; **tap** the field and **enter** the **B** active output reject timing and **C** consecutive cycles value.



Setup (*continued*)

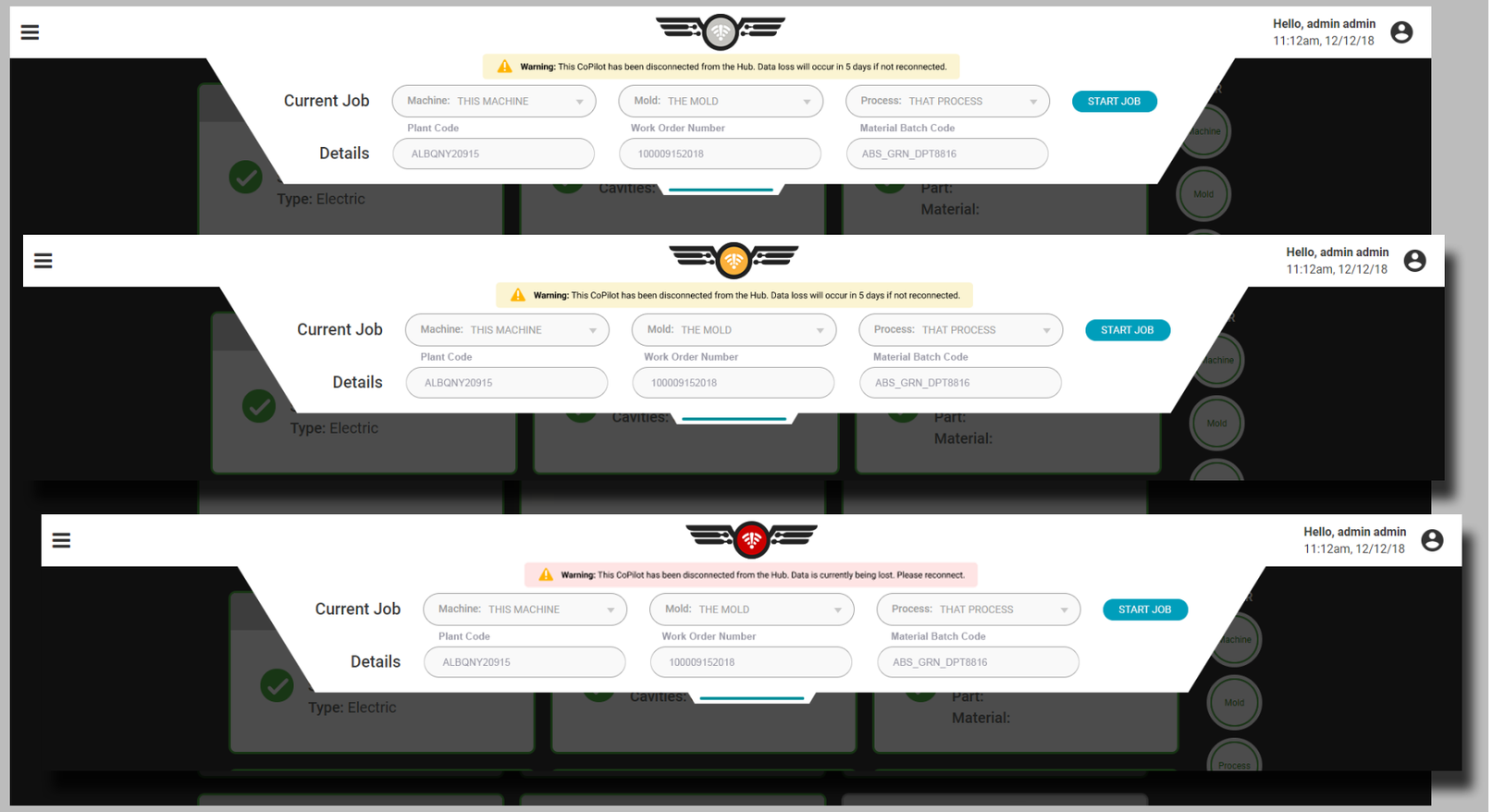
Template Match and Advice with MAX

Complete Template Match options each time a new setup is created. Template Match options determine good and warning percentages that will be used to compare to Cycle Graph process template values for mold, machine, and material process values.

Mold and Machine Match settings are defaulted to 3% for good match percentage and 7% for warning match percentage. Material Match settings are defaulted to 10% for good match percentage and 20% for warning match percentage. If no values are entered for good and warning match percentages, the dial(s) will not be active on the Job Dashboard when the job is started.

If desired, **tap** to select **A** ON or OFF to turn Template Match on or off; **tap** a field and **enter** the **C** good match percentage and **D** warning match percentage for Mold, Machine, and/or Material values.

If desired, **tap** to select **B** ON or OFF to turn Advice with MAX on or off (refer to page 99 for information on Advice with MAX).



Setup Errors

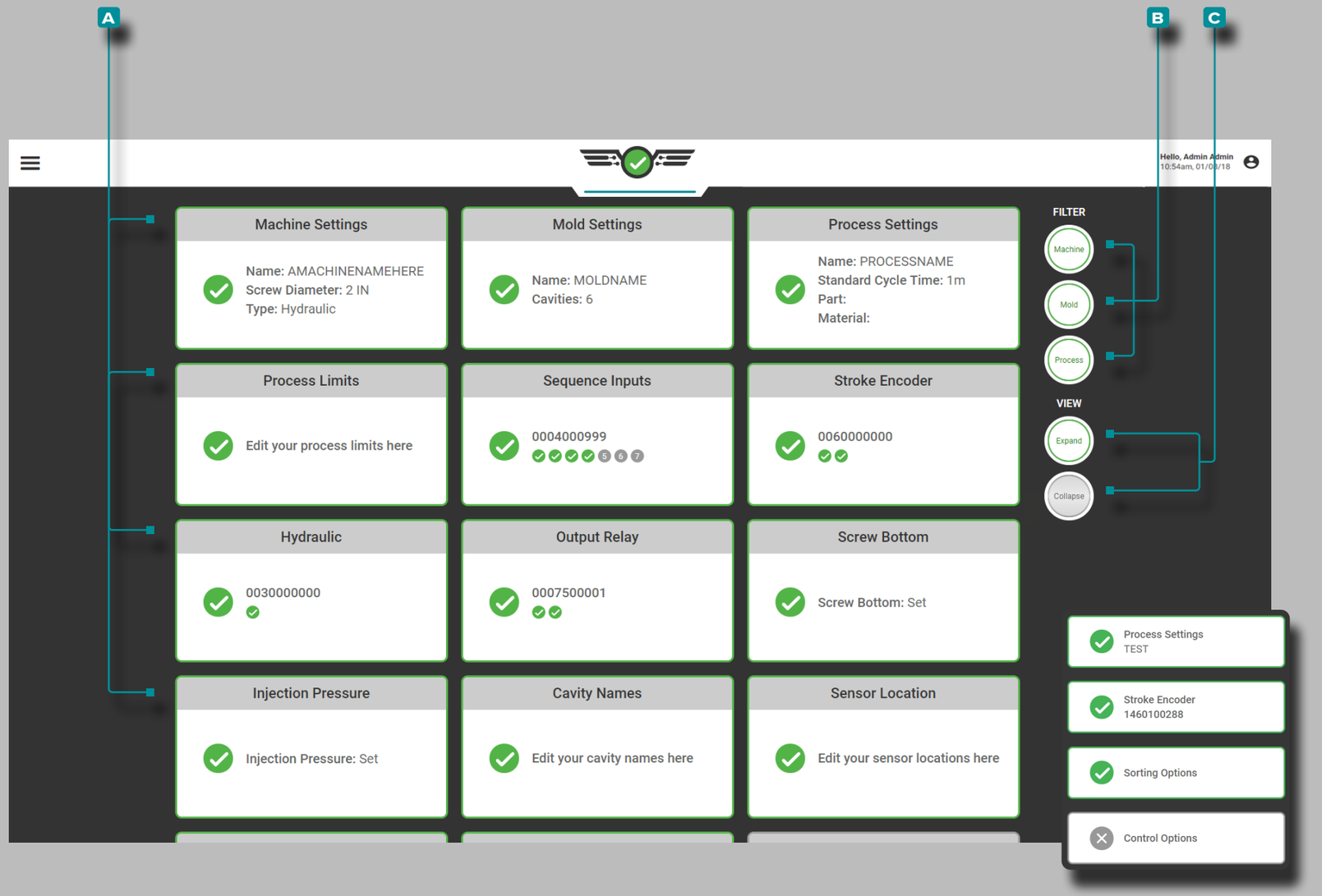
Disconnection from The Hub

In the event that the CoPilot system becomes disconnected from The Hub software, the CoPilot system icon will change depending on how long its been disconnected. The record(s) that are unavailable will be grey. Records can be used with old configuration data, but if changes are made during the disconnection, the existing record on The Hub will be replaced when the connection is reestablished.

The icon will change when the CoPilot system has been disconnected

- less than 12 days,
- more than 12, but less than 14 days, and
- more than 14 days.

A warning message also will be revealed that indicates how soon the connection must be restored before losing data when the job configuration pane is expanded.



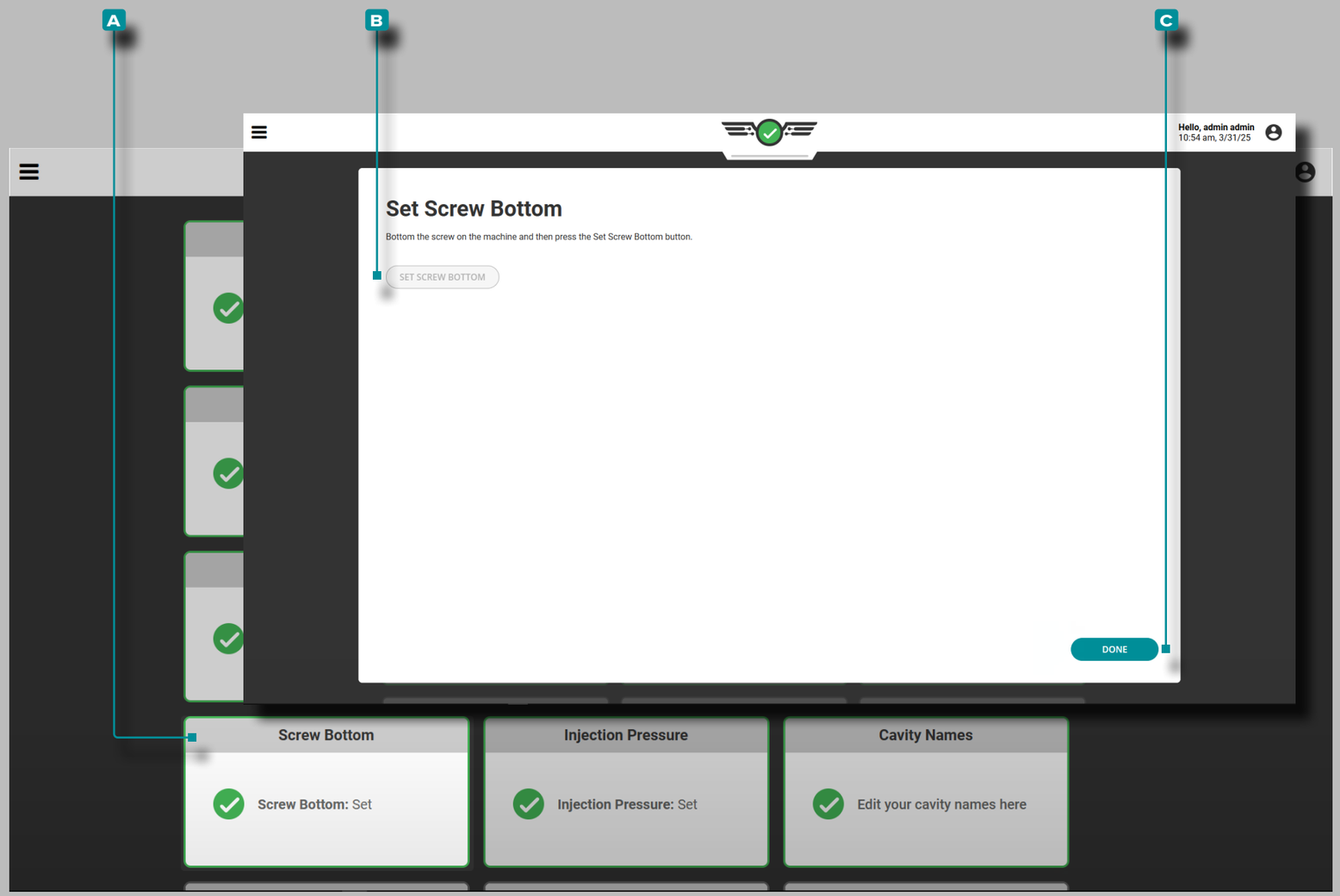
Setup Dashboard

Setup Dashboard Cards

The Setup Dashboard will display **A** cards that detail the current Machine, Mold, and Process settings.

Tap a **A** card to quickly view and/or edit the selected setting.

Tap the Machine, Mold, or Process **B** Filter button(s) to view or hide related cards; **tap** the Expand or Collapse **C** View buttons to view more or less information on the cards.



Setup Dashboard (*continued*)

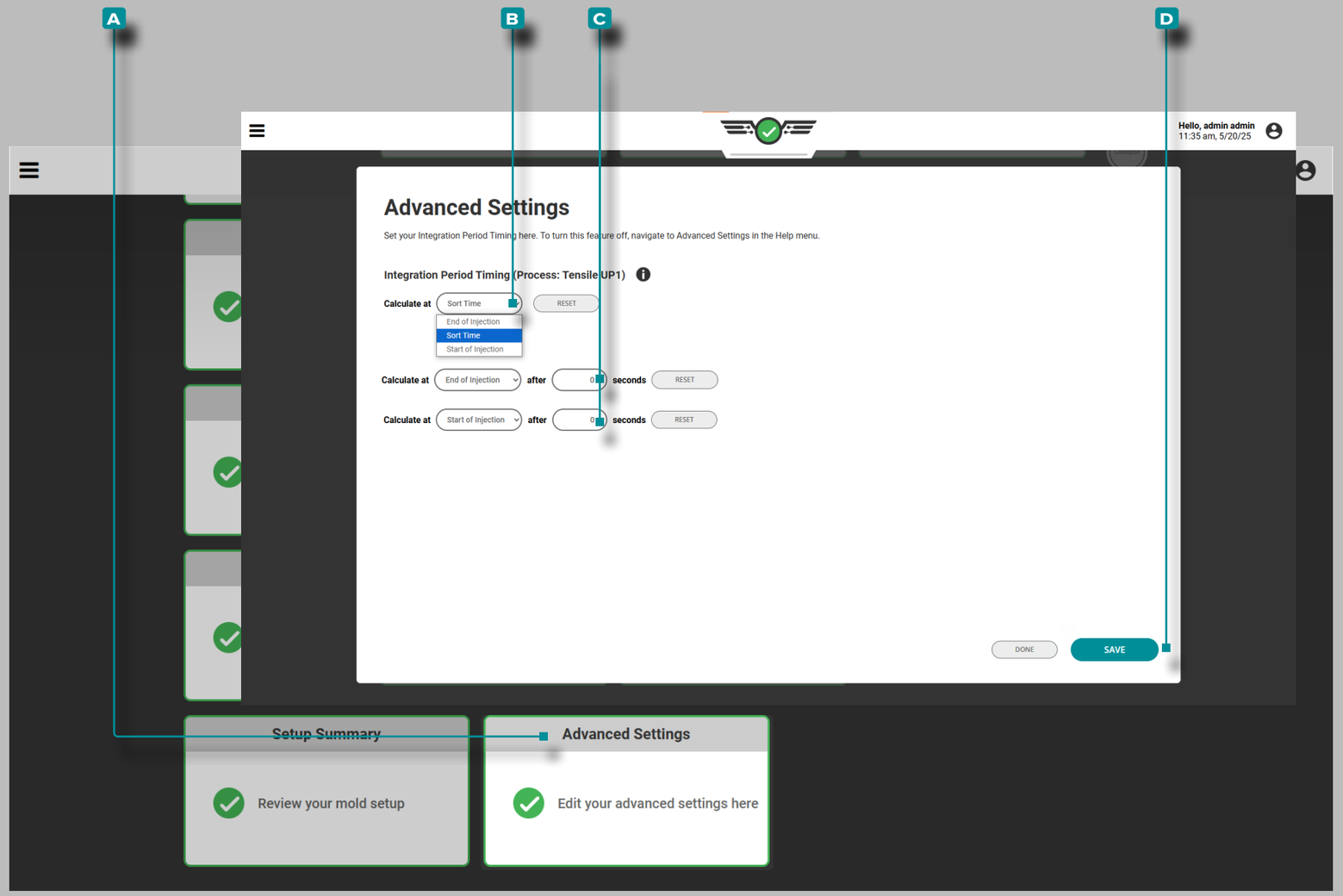
Set Screw Bottom from the Setup Dashboard

If screw bottom was not set during machine setup, or if screw bottom needs to be reset, use the **A** Screw Bottom card on the Setup Dashboard to set screw bottom.

The software calculates shot stroke and shot volume from the set screw bottom and the stroke indicator (LE-R-50 or IA1-M-V). Screw bottom is the zero point of the machine stroke indicator.

From the Setup Dashboard, **tap** the **A** Screw Bottom card, then physically bottom out the screw on the machine, and **tap** the **B** ⓘ set screw bottom button. **Tap** the **C** DONE button to exit the set screw bottom setup dashboard card.

ⓘ **NOTE** *Screw bottom must be set each time a setup is created. The CoPilot does not store this position, and cushion will not be correctly calculated if screw bottom is not set after each time the machine is started, the job is changed, or the CoPilot system is powered down.*



Setup (*continued*)

Set Integration Period Timing from the Advanced Settings, Setup Dashboard Card

The CoPilot system uses the end of injection for the integration limit, but with certain applications it may be neccesary to use a time before injection ends to compute data in order to negate a spike in cavity pressure later during injection that is not critical to part quality.

By default, the CoPilot system uses start of injection through end of injection for integration calculations.

Integration limits can be set ***by a Process Engineer*** to the start of injection through the start of injection plus a time (in seconds), end of injection plus a time (in seconds), or reverted to the default by selecting “sort time”.

The integration time affects the following summary variable calculations; ***all other summary variable calculations are unaffected***:

- Peak End of Cavity, Post Gate, Mid Cavity
- Cycle Integral End of Cavity, Post Gate, Mid Cavity
- Fill and Pack Time for End of Cavity, Post Gate, Mid Cavity
- Fill and Pack Integral for End of Cavity, Post Gate, Mid Cavity

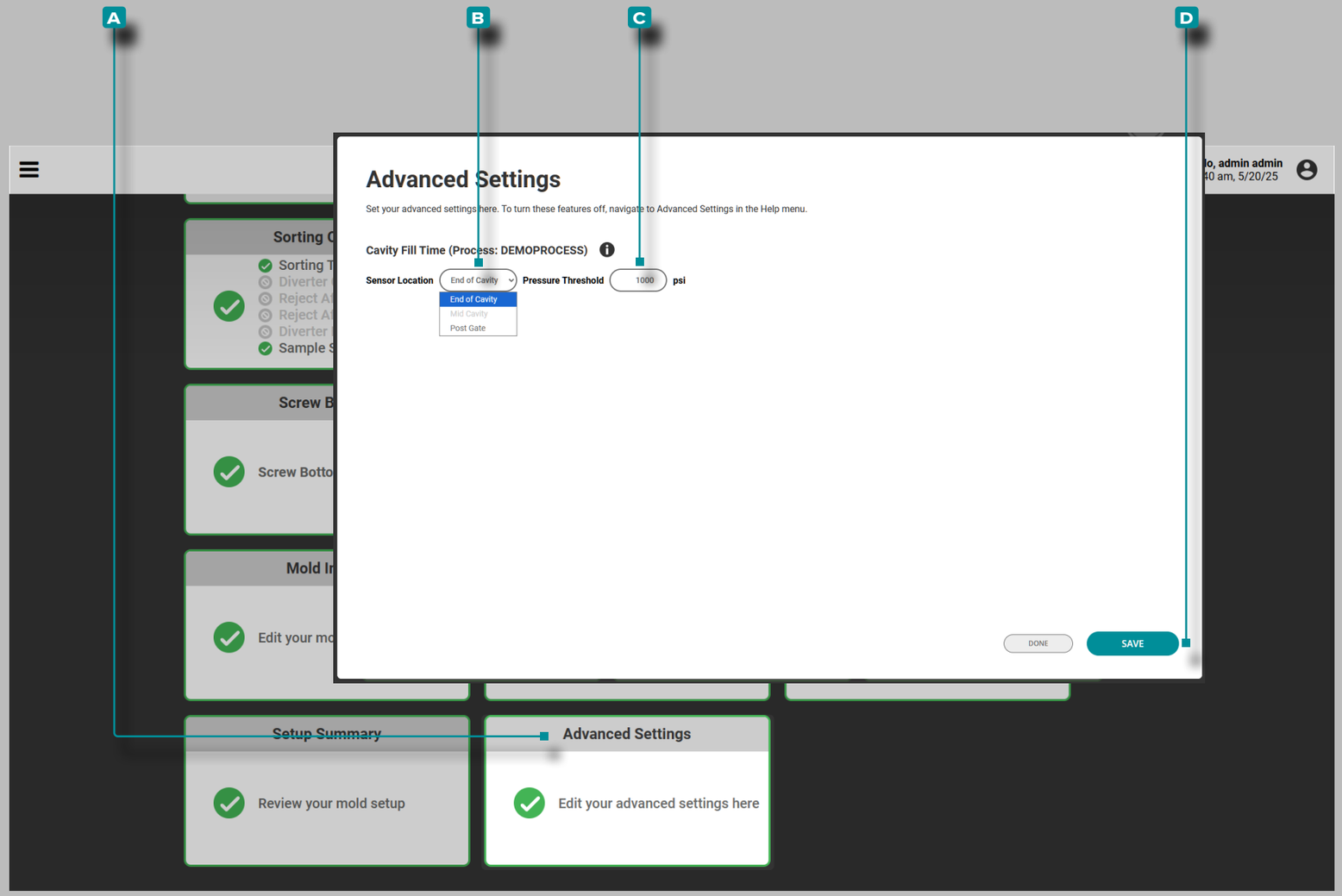
If the start of injection plus a time is longer than the injection time, summary variables will be computed at the start of injection plus a time.

If specified integration limit time does not occur before sorting time, integration limit time is calculated until sorting time.

From the Setup Dashboard, **tap** the **A** Advanced Settings card, then **tap** the **B** desired integration timing from the dropdown menu; if selected, enter the **C** seconds after start or end of injection.

Tap the **D** DONE button to exit the **A** Advanced Settings dashboard card.

ⓘ **NOTE** *The Advanced Settings Dashboard card will only be availabe if the user has turned on Advanced Settings: Integration Period Timing in the Diagnostics>Advanced Settings page; refer to “Advanced Setting: Integration Period Timing” on page 182.*



Setup (*continued*)

Set Cavity Fill Timing from the Advanced Settings, Setup Dashboard Card

The CoPilot system calculates cavity fill time using the end of cavity sensor location when it reaches 1000 psi, but with certain applications it may be neccesary to use a lower pressure threshold. The cavity fill time adjustment allows users to enter a different cavity pressure threshold, and select a cavity location (EOC, MID, or PG) for the calculation.

If no EOC sensors are assigned, cavity fill time will not calculate unless a MID or PG sensor is assigned and selected.

The following widgets will display the selected sensor location, and cavity fill information:

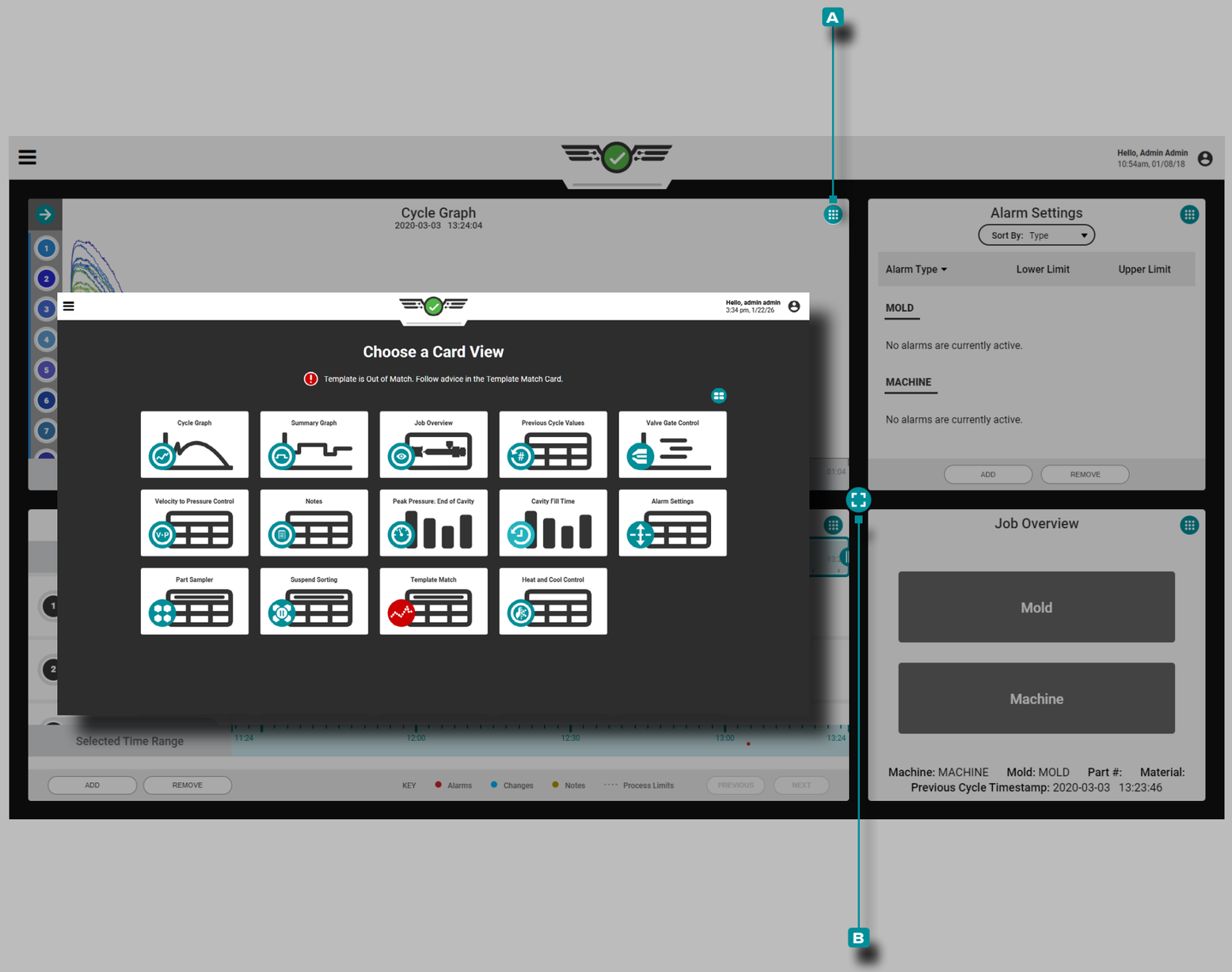
Alarm Settings	Add/remove alarms and warning limits on the cavity fill time for the selected sensor location (EOC, MID, or PG). **Users with designated role Process Engineer can set alarms on cavity fill time for the selected location.**
Cavity Fill Time	Displays Cavity Fill Time for the selected sensor location (EOC, MID, or PG).
Previous Cycle Values	Add/remove the cavity fill time for the selected sensor location (EOC, MID, or PG).
Summary Graph	Displays the cavity fill time for the selected sensor location (EOC, MID, or PG).
Template Match	Mold Match uses the selected sensor location (EOC, MID, or PG)

From the Setup Dashboard, **tap** the **A** Advanced Settings card, then **tap** the **B** desired sensor location (EOC, MID, or PG) from the dropdown menu; enter the desired **C** Pressure Threshold. **Tap** the **D** SAVE button to save the settings.

ⓘ **NOTE** *Users cannot select a specific cavity pressure sensor within the mold, only a location.*

ⓘ **NOTE** *The Advanced Settings Dashboard card will only be availabe if the user has selected Advanced Settings: Enable Adjustable Cavity Fill Time in the Diagnostics>Advanced Settings page; refer to "Advanced Setting: Cavity Fill Time Adjustment" on page 183.*

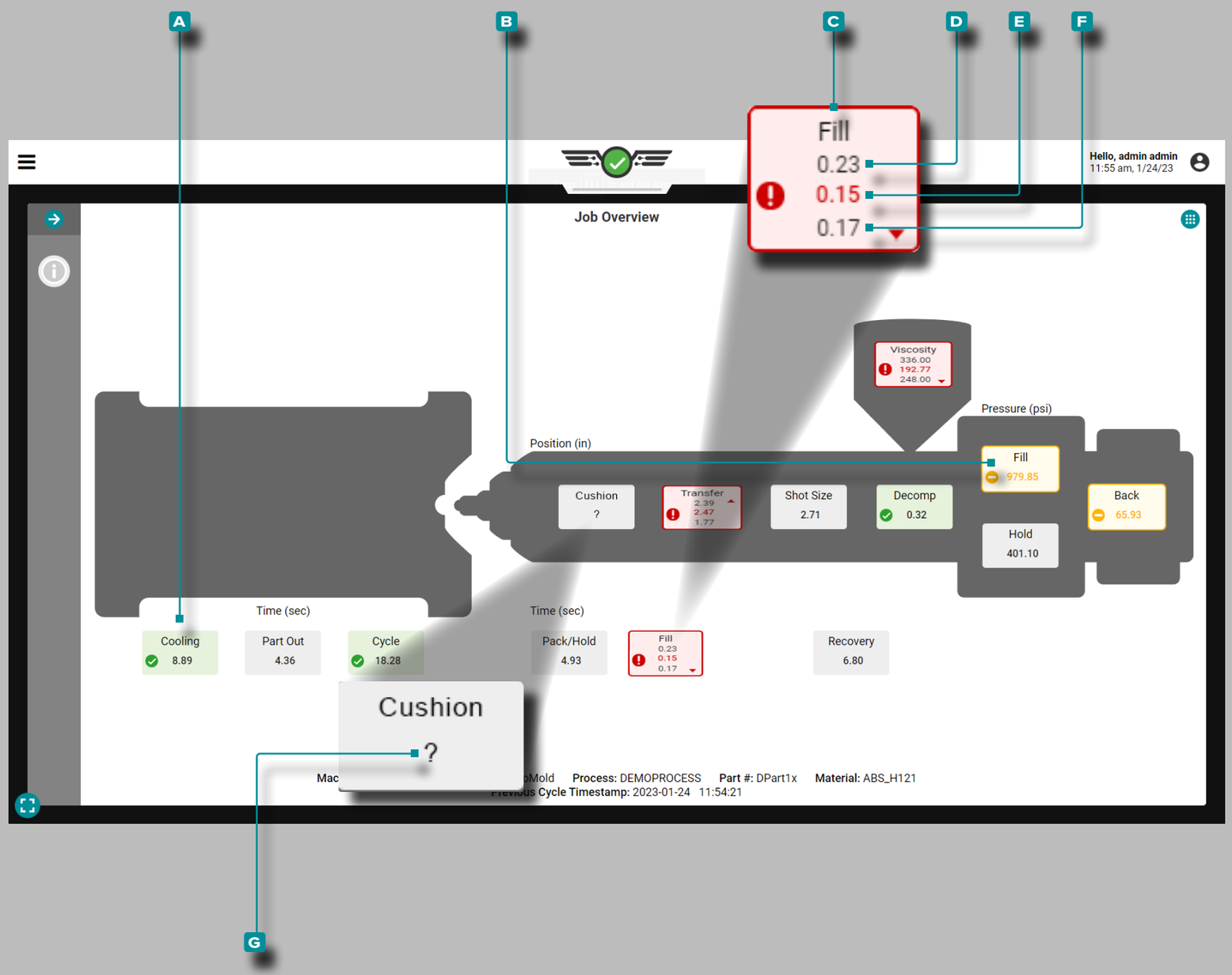
Job Dashboard



The Job Dashboard view provides space for up to four widgets to be viewed simultaneously; selectable widgets include the Job Overview, Alarm Settings, Cycle Graph, Template Match, Advice with MAX, Summary Graph, Previous Cycle Values, Cavity Fill Time, Peak Pressure: End-of-Cavity, Velocity to Pressure (V→P) Control, Valve Gate Control (if licensed), Part Sampler, Suspend Sorting, and Notes views. The Cycle Graph and Summary Graph widgets may be displayed multiple times on the Job Dashboard.

To select which widget to display in a quadrant, **tap** the A display view button located in the top right-hand corner of each view, then **tap** to select the desired widget. To resize visible widgets, **tap**, **hold, and drag** the B resizing button up, down, left, or right; to expand a widget to full screen, either drag the B resizing button until the widget reaches full size, or double **tap** the widget.

When Alarm Limits are set, a template is selected, the Template Match is not selected, and the template is out-of-match, the A display view button and the B resizing button will turn red to visually notify the user that the template is out-of-match.



Job Dashboard (*continued*)

Job Overview

Process Values

Process Values—including timers, positions, pressures, and material viscosity—are displayed on the Job Dashboard Job Overview, with lower limits, target values, and upper limits (if limits are set).

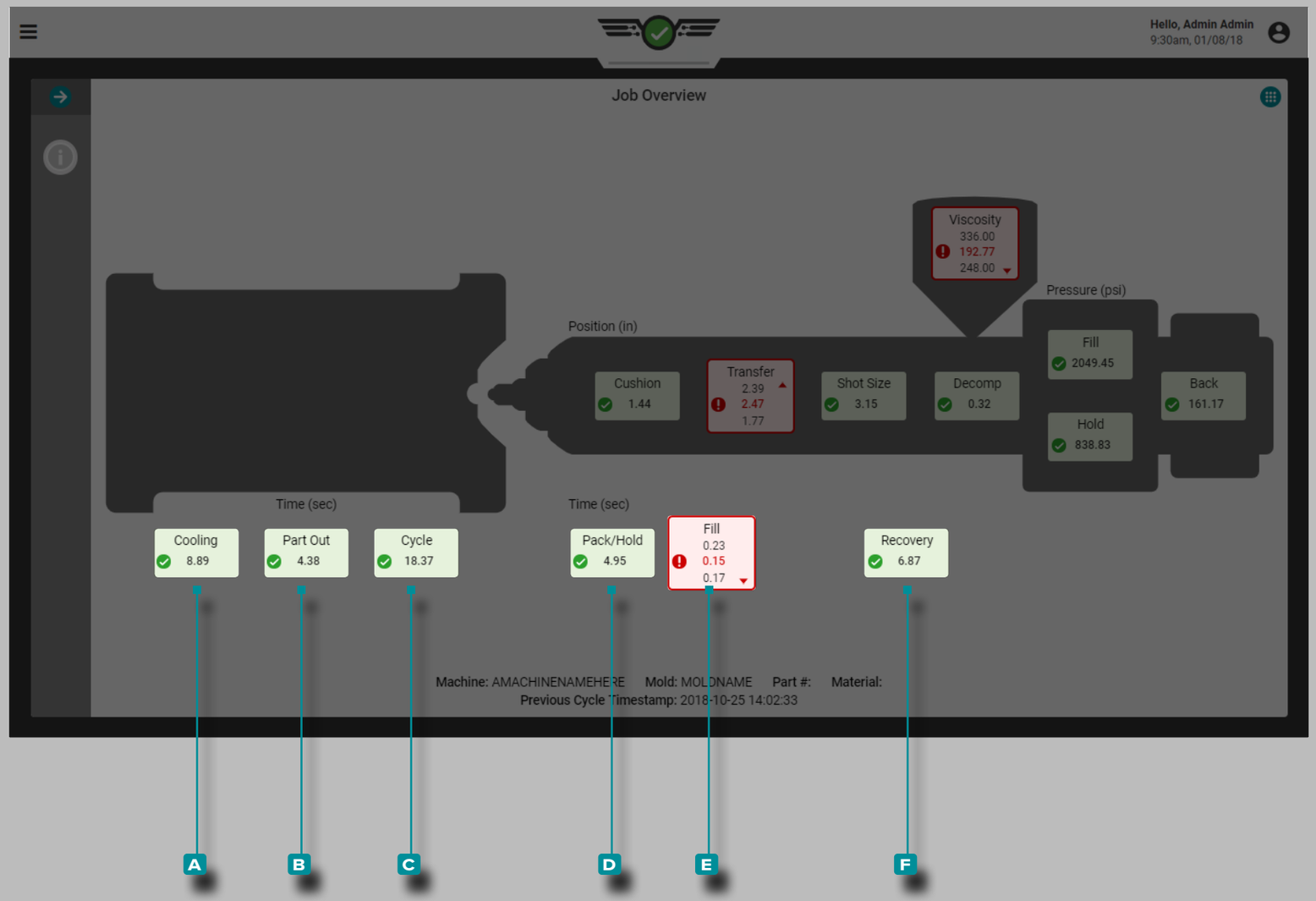
If the process is in within the upper and lower alarm limits, it is “in match” or “good”; in-match/good process value boxes are A green. If the process is within the warning limits, the process value boxes are B yellow. If the process is outside of the upper or lower limits, it is “out of match”; out-of-match process value boxes are C red. **If a process value does not have corresponding alarm limits set, the process value box is grey.**

Tap and hold on a process value to view the set upper and lower alarm limits. Each value’s D upper alarm limit, E current value, and F lower alarm limit are displayed on the Job Overview.

An icon within each box indicates whether the process value is within the target range, in warning, out of range, above the upper limit, or below the lower limit.

If the CoPilot system cannot calculate a process value(s), a G quesiton mark (?) will be displayed within the process value box(es).

Job Dashboard (*continued*)



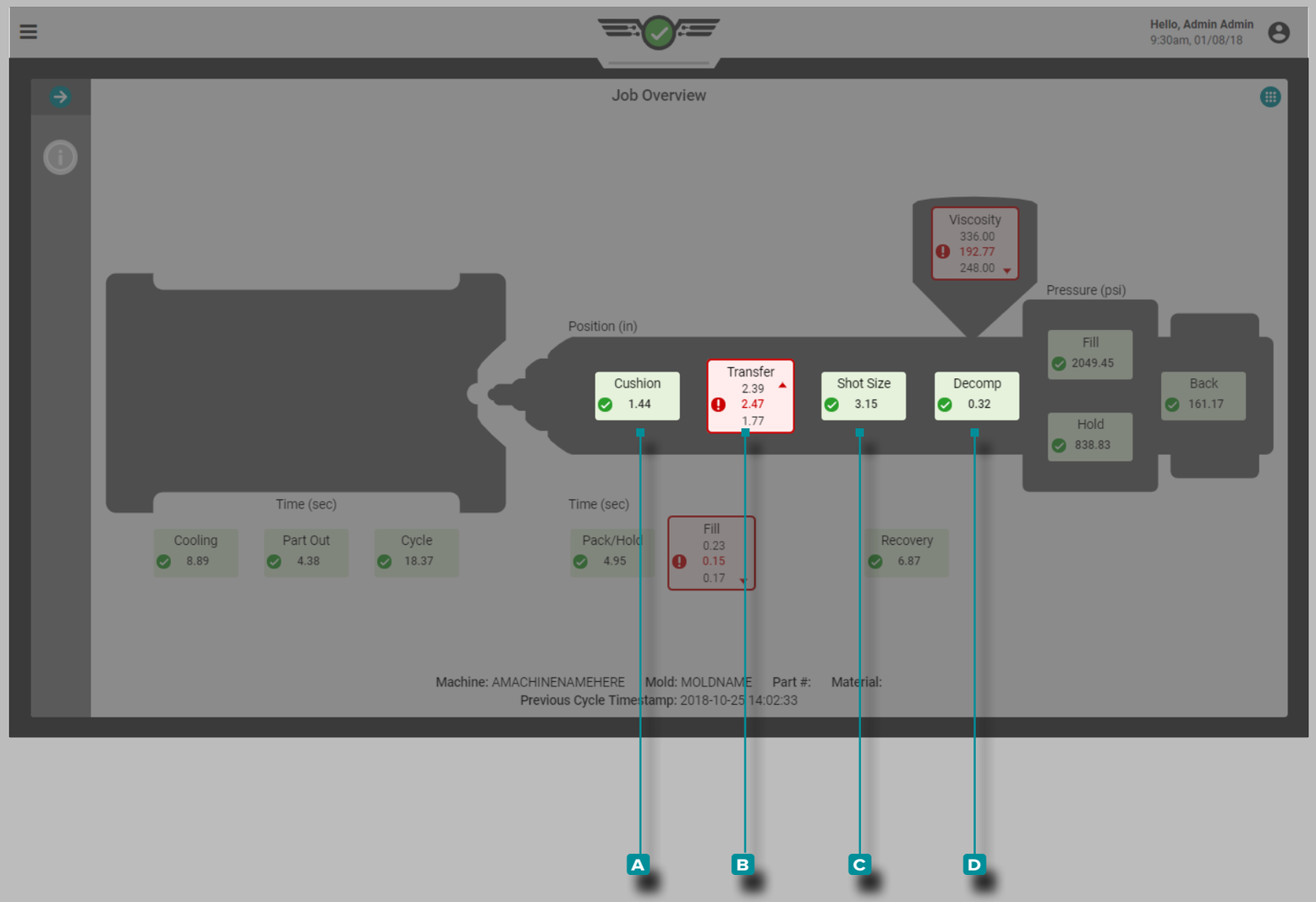
Process Values (continued)

Times

Times include **A** cooling, **B** part out, **C** cycle, **D** pack/hold, **E** fill, and **F** recovery.

Refer to “Glossary” on page 194 for definitions and additional information on timers.

Job Dashboard (*continued*)

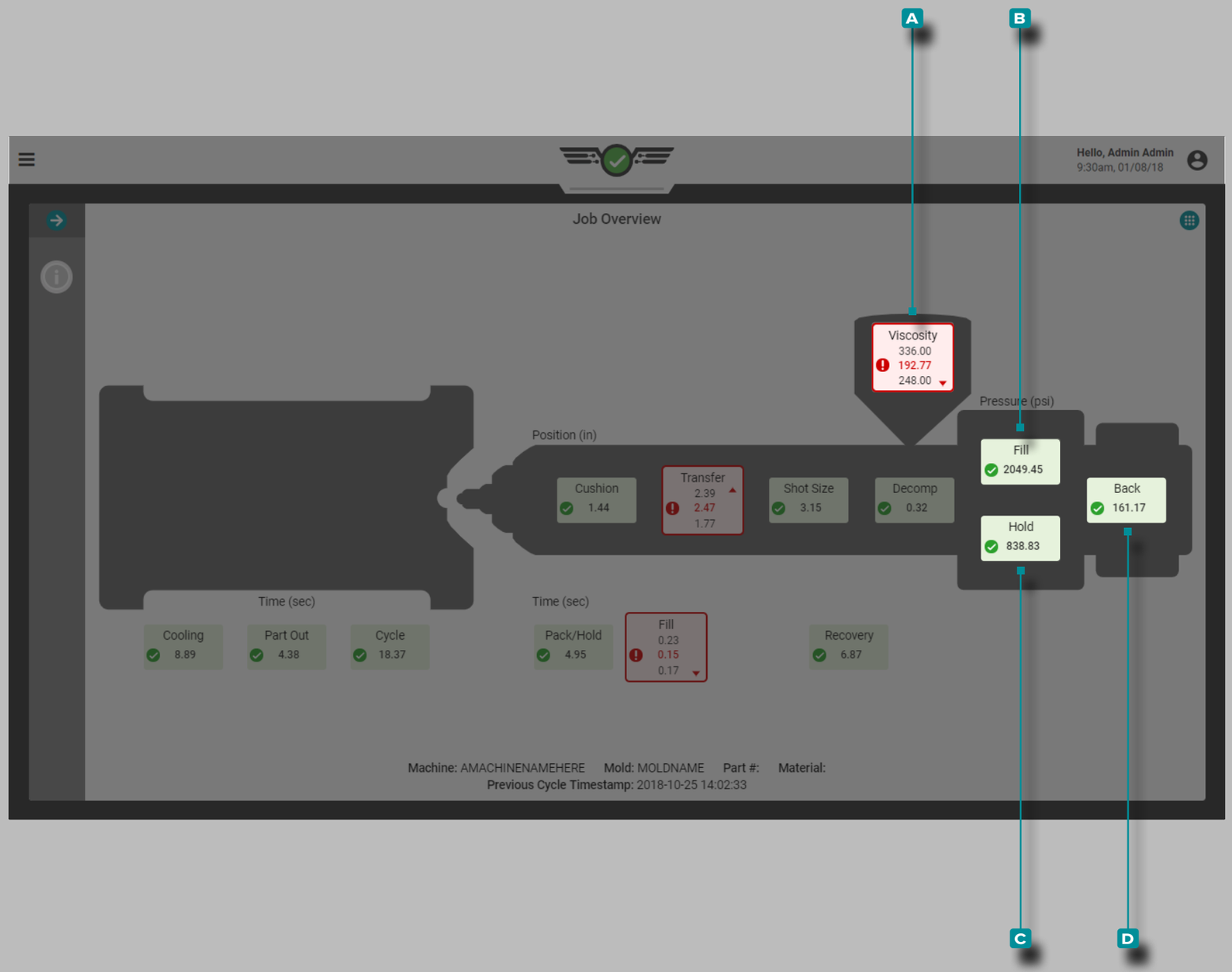


Process Values (continued)

Positions

Positions include **A** cushion, **B** transfer, **C** shot size, and **D** decompression.

Refer to “Glossary” on page 194 for definitions and additional information on positions.



Job Dashboard (*continued*)

Process Values (continued)

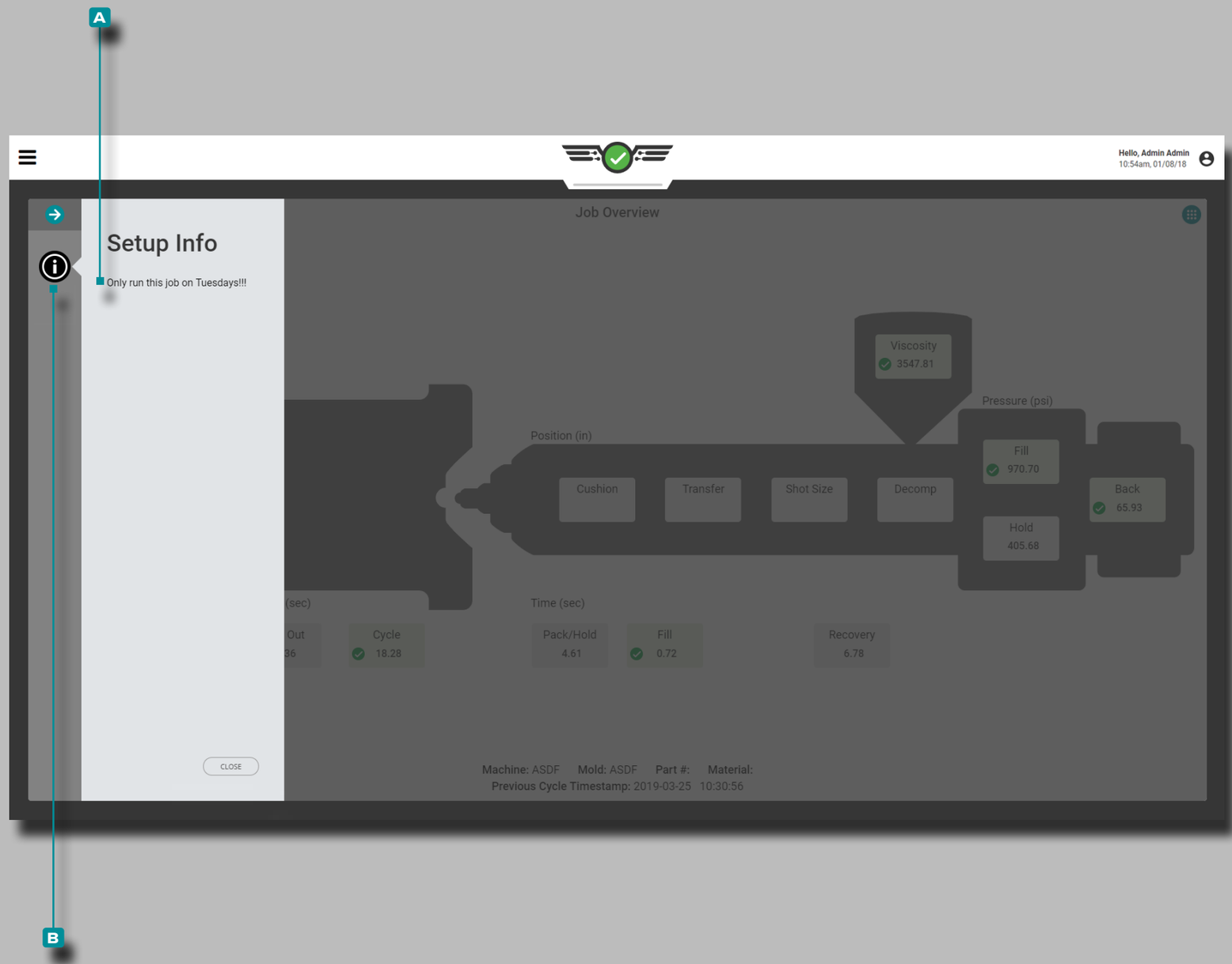
Viscosity

Viscosity A is included on the process Job Overview screen. Refer to “Glossary” on page 194 for additional information on viscosity.

DEFINITION VISCOSITY *Material viscosity fluctuations indicate changes in fill rate, incoming material, and temperature.*

Pressures

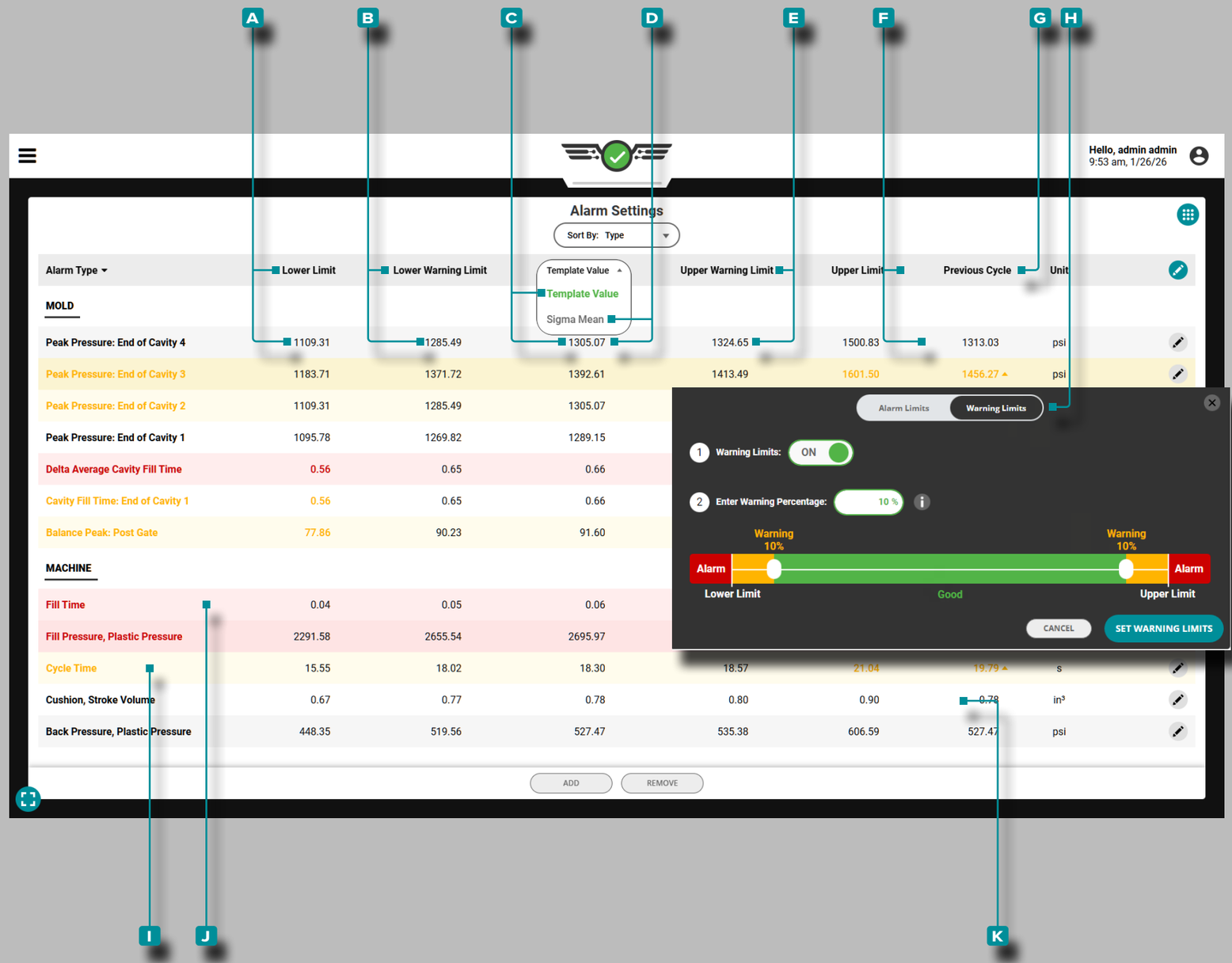
Pressures include B fill, C hold, and D back. Refer to “Glossary” on page 194 for definitions and additional information on pressures.



Job Dashboard (*continued*)

Setup Info

Setup info **A** can be entered during process setup to be used as an operator resource. **Tap** the **B** Setup info button on the Job Overview screen to view process setup info if entered at setup.



Job Dashboard (*continued*)

Alarm Settings

The Alarm Settings widget provides the selection and setting of process alarms and warning limits for both machine and mold values. Alarm settings include a **A** lower limit, **B** lower warning limit, **C** template value or **D** sigma mean, **E** upper warning limit, **F** upper limit, and **G** previous cycle value for each process value monitored; limits must be based off of proven, stable process values. Alarm limits can be set manually, by percentage, or using sigma.

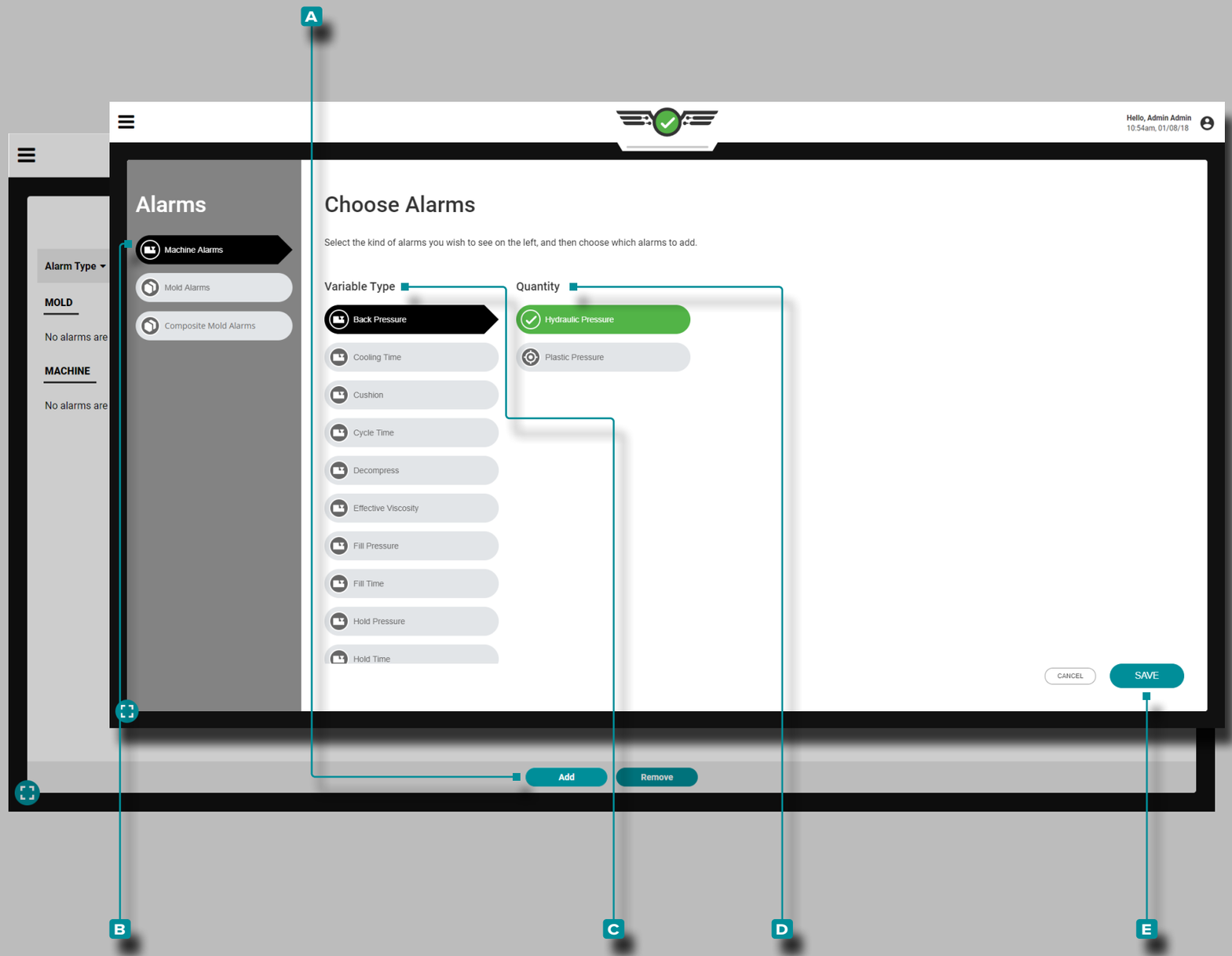
Warning limits settings include an adjustable **H** warning limit percentage value above/below the set lower alarm limit/upper alarm limit, or individually-set, manual limits. **Always set alarm limits before setting warning limits.**

If a TCU is connected and selected within the Process Settings, mold alarms for minimum, average, and peak temperature from the process, to the process, and process setpoints can be set and viewed for the TCU directly from the Alarms Settings widget. The data may also be graphed on the Cycle Graph.

ⓘ **NOTE** *Refer to The Hub Software User Guide "Choosing Alarm Settings with the CoPilot System and The Hub Software" on page 119 for more information on choosing alarms settings.*

The displayed **I** process values that are in warning state will be highlighted in yellow, while the displayed **J** process values that are in alarm state will be highlighted in red.

If the CoPilot system cannot calculate a previous cycle machine or mold value(s), a **K** question mark (?) will be displayed in the previous cycle value column for that value.



Job Dashboard (*continued*)

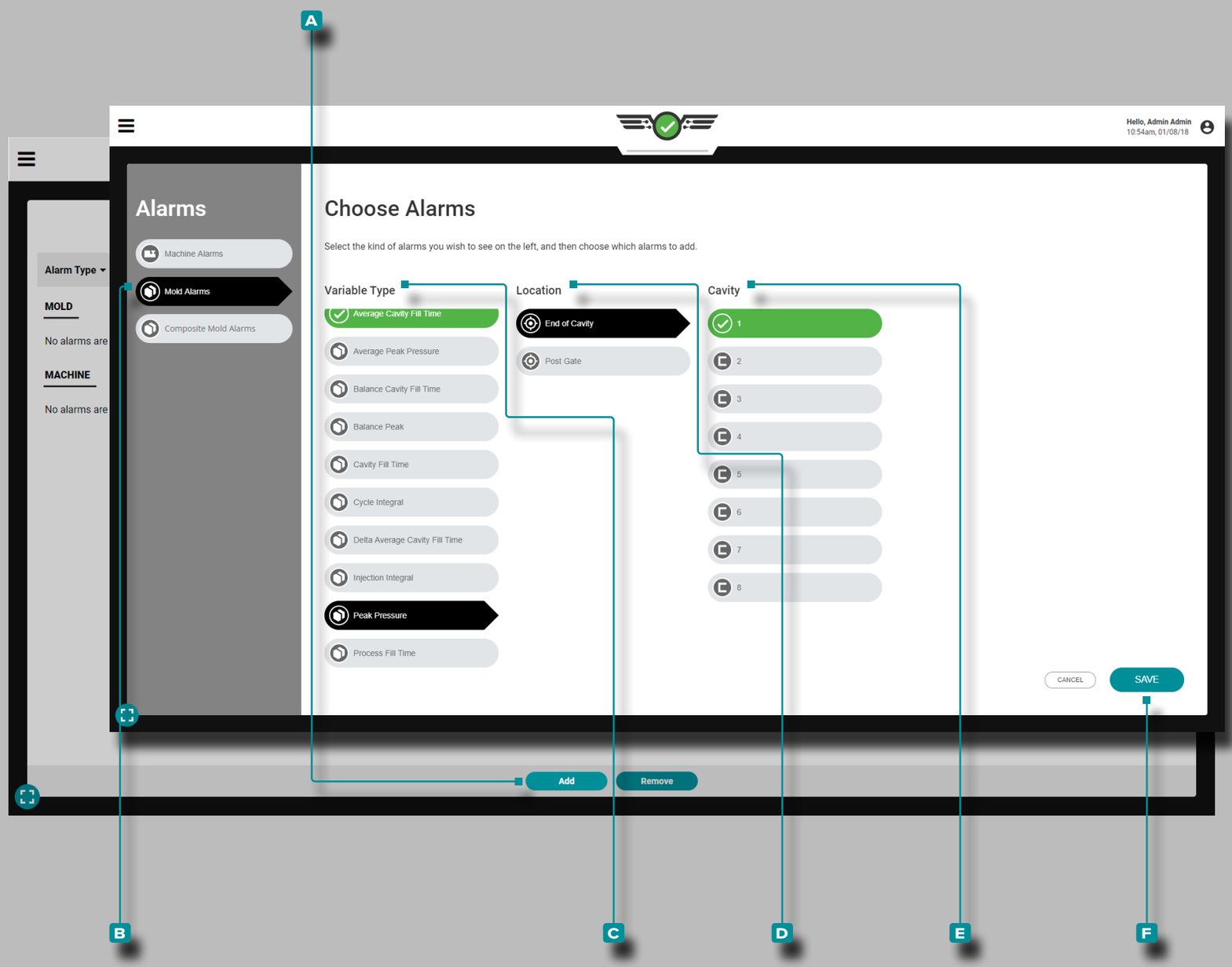
Alarm Selection

Add alarms to the Alarm Settings widget; after adding alarms, set alarm limits.

Add Machine Alarms

Machine alarms are calculated from machine-interface sensor data based on timers, positions, pressures, and material viscosity (refer to the"Glossary" on page 194 for more information on timers, positions, pressures, and material viscosity).

Tap the **A** add button on the Alarm Settings widget, then **tap** to select **B** Machine Alarms; **tap** to select or deselect a machine **C** variable, then **tap** to select the **D** quantity desired (machine or normalized), and then **tap** to select the **E** SAVE button when finished. The **C** variable and **D** quantity selected will be displayed in the corresponding format on the Monitor; refer to "Normalizing Process Values" on page 158 for more information on machine versus normalized values.



Job Dashboard (*continued*)

Alarm Selection (continued)

Add Mold Alarms

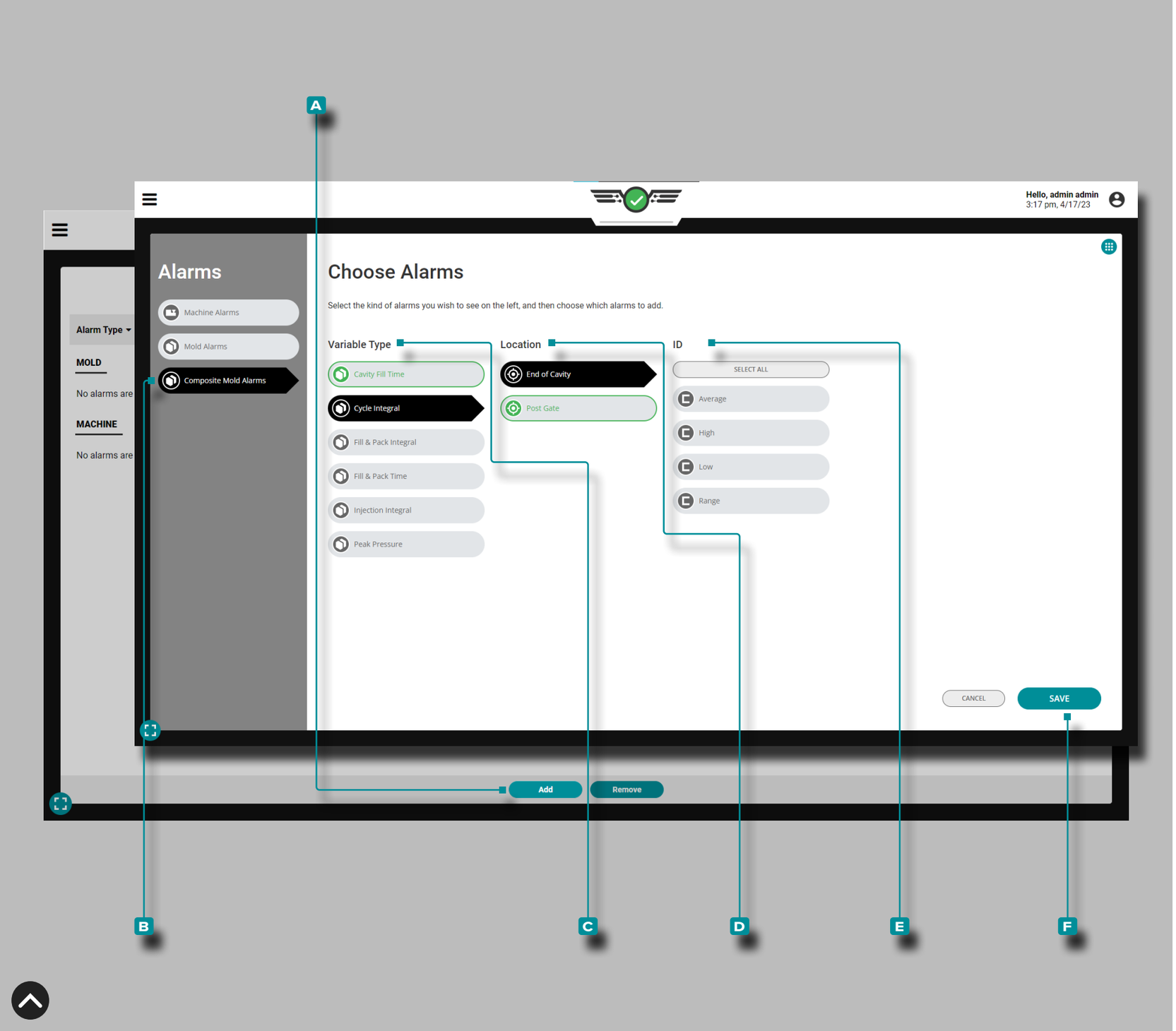
Mold alarms can be set up *only* if sensors are present. Mold alarms are calculated from cavity pressure, temperature, and mold deflection sensor data based on integrals, peaks, or times (refer to the"Glossary" on page 194 for more information on integrals, peaks, and times); temperature sensor data, and TCU data.

Mold alarms can be set for cavity pressure, temperature, and TCU sensors. If a sensor is connected but not set up, it will not appear in the mold alarms location list.

Tap the A ⓘ Add button on the Alarm Settings widget, then **tap** select B Mold Alarms; **tap** to select or deselect a mold C Variable Type, D Location, and E Cavity; if applicable, **tap** to select the Sensor ID. **Tap** the F SAVE button when finished.

ⓘ **NOTE** *If present, multiple cavities may be selected for each alarm; select a cavity, then select the Sensor ID for that cavity, and repeat until all desired cavities and related Sensor ID are selected, then select DONE.*

ⓘ **NOTE** *If a previously-assigned sensor with alarm configurations is disconnected, the alarm will not automatically be removed, but will also not function; either connect and assign the sensor or deselect the alarm to continue.*



Job Dashboard (*continued*)

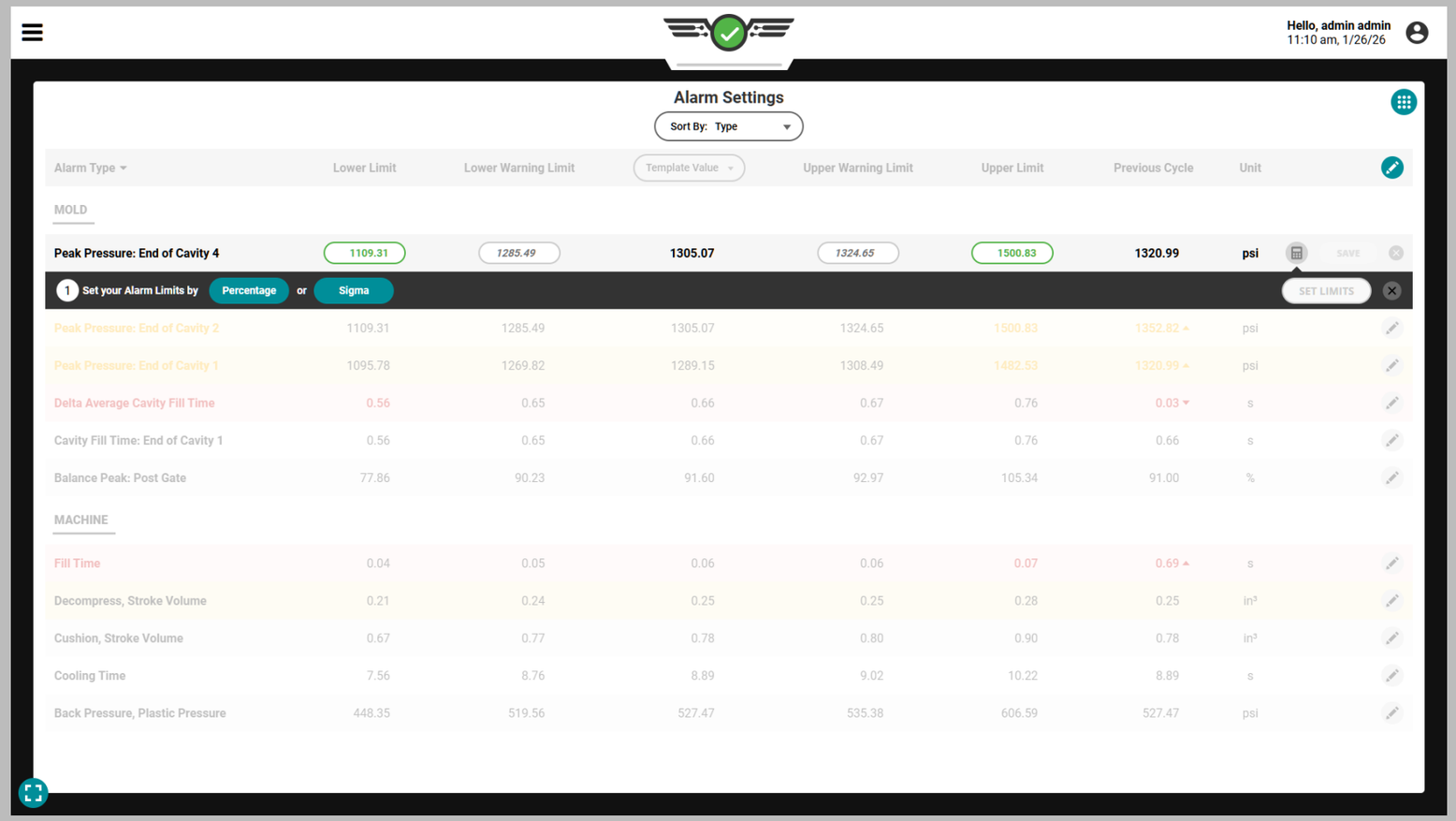
Alarm Selection (continued)

Add Composite Mold Alarms

Composite mold alarms are alarms that use summary variable high, low, average, or range composite sensor data. Composite mold alarms enable a single alarm to be set for a summary variable using composite sensor data instead of setting multiple alarms for multiple sensors. Composite mold alarms can be set up for Cavity Fill Time, Cycle Integral, Fill & Pack Integral, Fill & Pack Time, Injection Integral, and Peak Pressure summary variables.

Tap the **A** Add button on the Alarm Settings widget, then **tap** select **B** Composite Mold Alarms; **tap** to select or deselect a mold **C** Variable Type, **D** Location, and **E** ID (Average, High, Low, or Range). **Tap** the **F** SAVE button when finished.

Job Dashboard (*continued*)



Setting Alarms

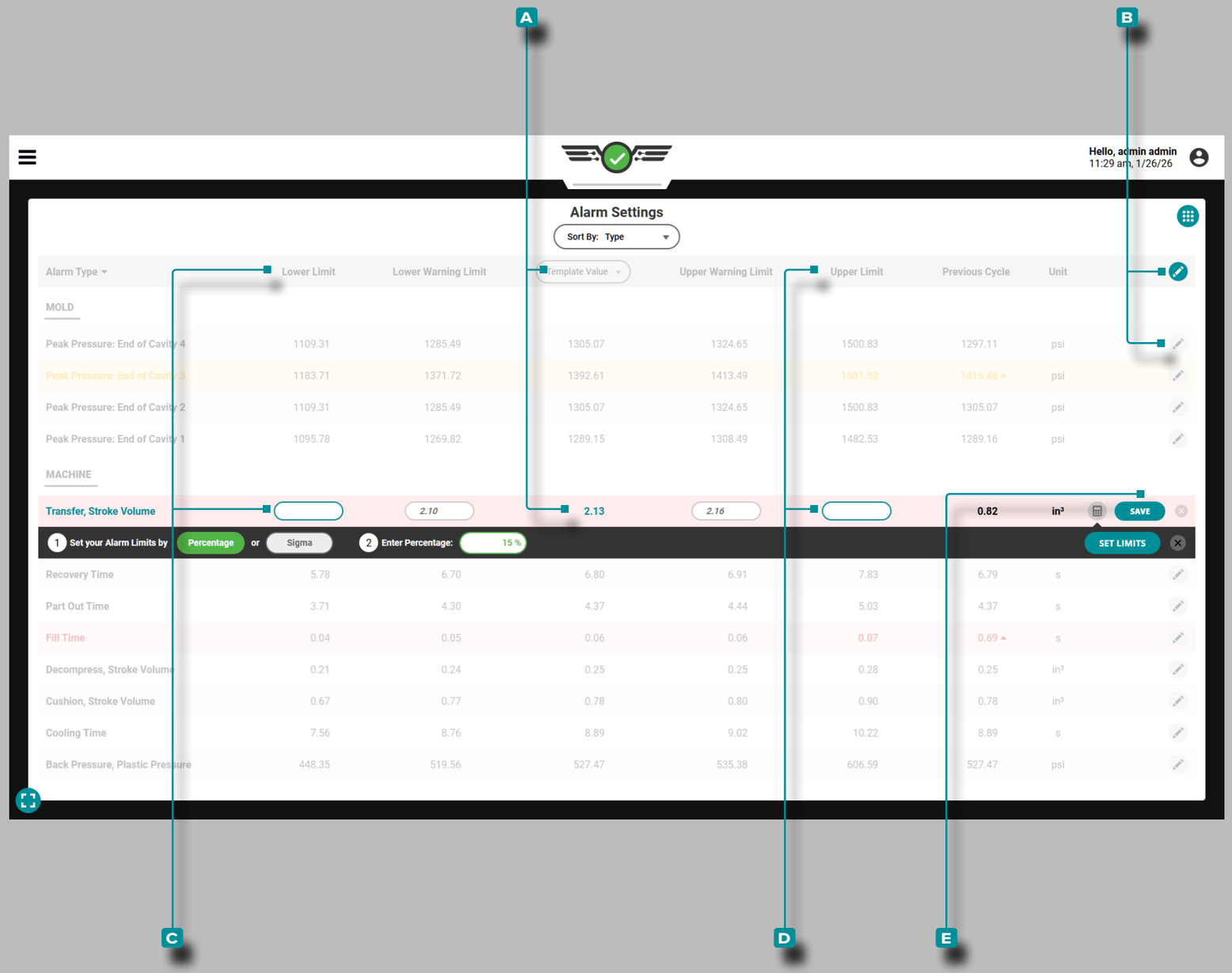
With injection molding machine in auto, run the process until it has stabilized to create a template of process values using real-time data; to learn more about creating templates, refer to ”Cycle Graph Process Templates” on page 84. Alarm limits can be set three ways: manually, by percentage, or by sigma.

Regardless of alarm limit setting method, most changes will apply to the CURRENT cycle. The following configuration changes will be applied to the NEXT cycle: alarm levels, summary values adjustments, cavity pressure fill threshold, transfer discovery detection threshold, standard cycle time, downtime, and timeout.

DEFINITION CAVITY PRESSURE FILL THRESHOLD *A set of process conditions which must be present during a cycle in order for the CoPilot system to calculate cavity fill; conditions include zero line crossing, stroke volume/injection pressure zero line crossing, and in-cavity fill time.*

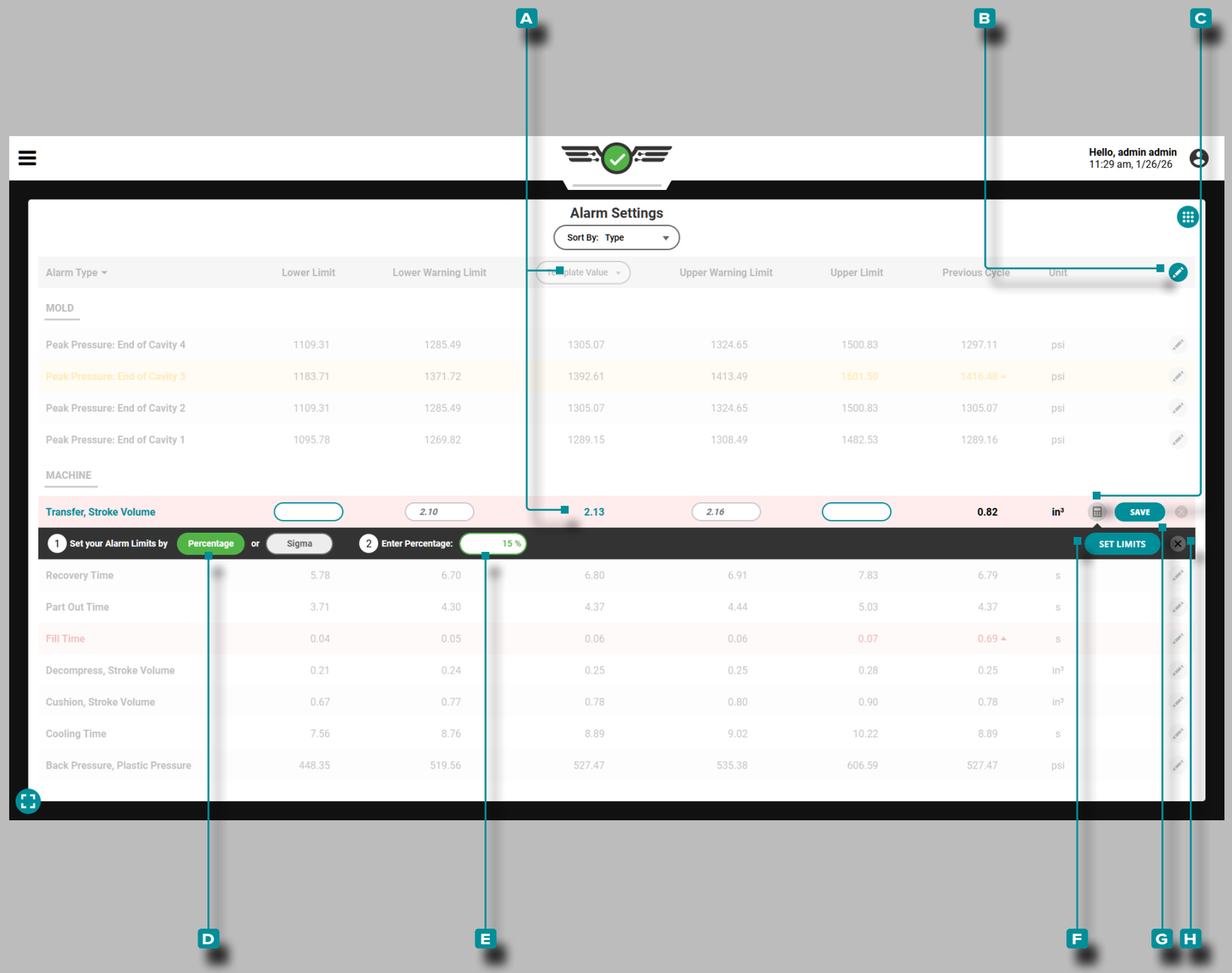
DEFINITION TRANSFER DISCOVERY DETECTION THRESHOLD *A set of process conditions which must be present during a cycle in order for the CoPilot system to calculate transfer; conditions include injection forward sequence signal, and screw run signal, stroke/velocity signal.*

Job Dashboard (*continued*)



Setting Alarm Limits Manually

Once a template is loaded and **A** template values are populated, **tap** the **B** edit icon on the table header to edit all alarms, **OR Tap** the **B** edit icon next to an individual process value to edit that value. **Tap** the desired fields to **enter** a **C** lower limit and **D** upper limit for each process value; tap the **E** SAVE button to set limits.



Job Dashboard (*continued*)

Setting Alarm Limits by Percentage

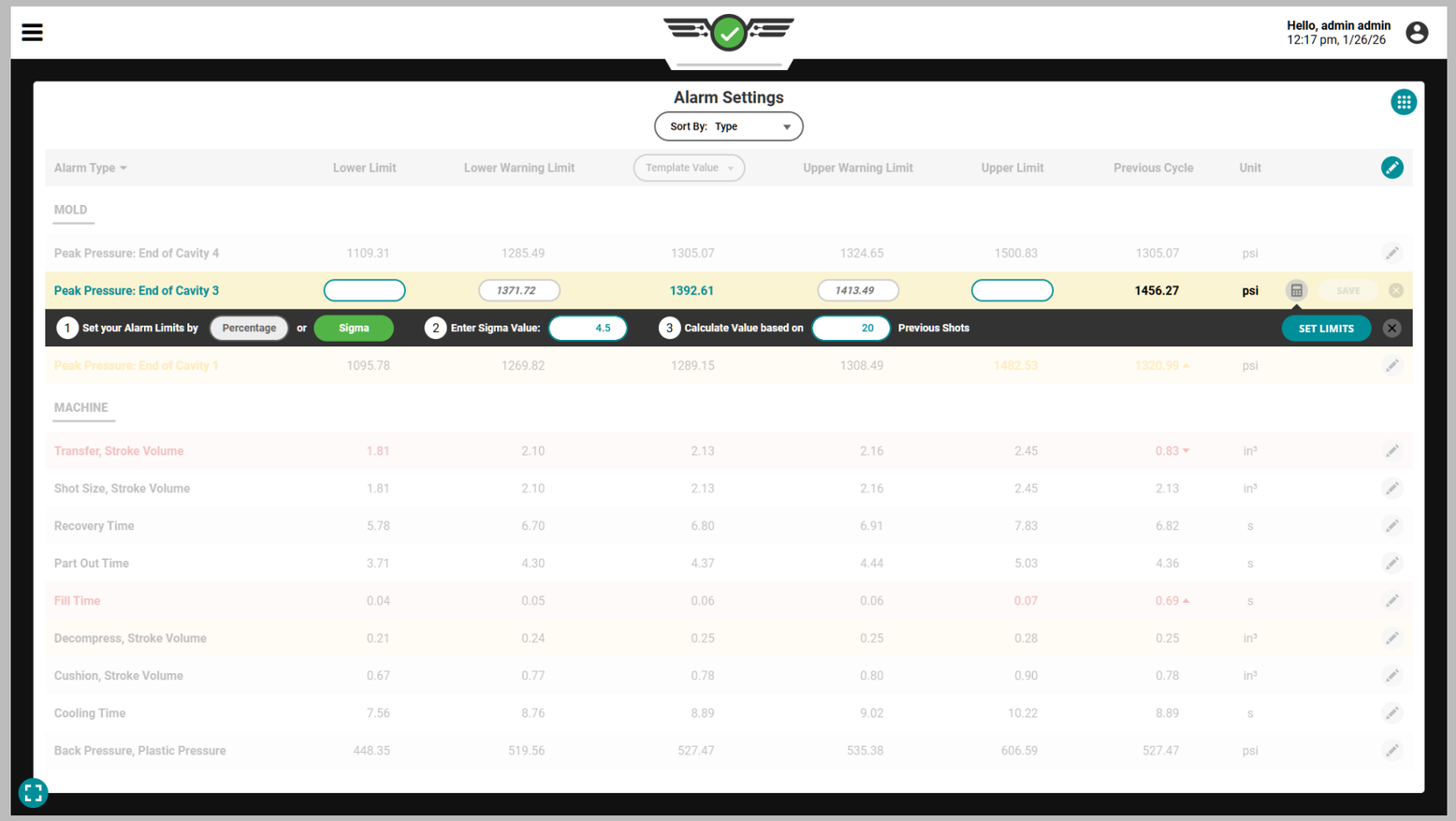
Alarm limits can be set by percentage collectively or individually.

1. Set One Alarm's Limits By Percentage

Once a template is loaded and **A** template values are populated, **tap** the **B** edit icon next to the desired alarm. **Tap** the **C** calculator, and then **tap** the **D** percentage button. If desired, **tap** the field to **enter** a different default **E** percentage. **Tap** the **F** set limits button to auto-fill the lower and upper limits using a percentage calculation of the target value—the default percentage is 15%. **Tap** the **G** SAVE button to save the values, or **tap** the **H** cancel button to discard any changes.

2. Set All Alarms Limits By Percentage

Once a template is loaded and **A** template values are populated, **tap** the **B** edit icon on the table header to edit all alarms. **Tap** the **C** calculator, and then **tap** the **D** percentage button. If desired, **tap** the field to **enter** a different default **E** percentage. **Tap** the **F** SET ALARM LIMITS button to auto-fill the lower and upper limits using a percentage calculation of the target value—the default percentage is 15%. **Tap** the **G** SAVE button to save the values, or **tap** the **H** cancel button to discard any changes.



Job Dashboard (*continued*)

Setting Alarms Using Sigma

Sigma, the Greek letter σ or lower case s, is the symbol used to represent standard deviation; a standard deviation—"sigma"—is a description of how far a sample or point of data is away from its mean (also known as "average"). A data point with a higher sigma value (higher standard deviation) is further away from the mean than a data point with a lower sigma value. Refer to X for the sigma calculation formula.

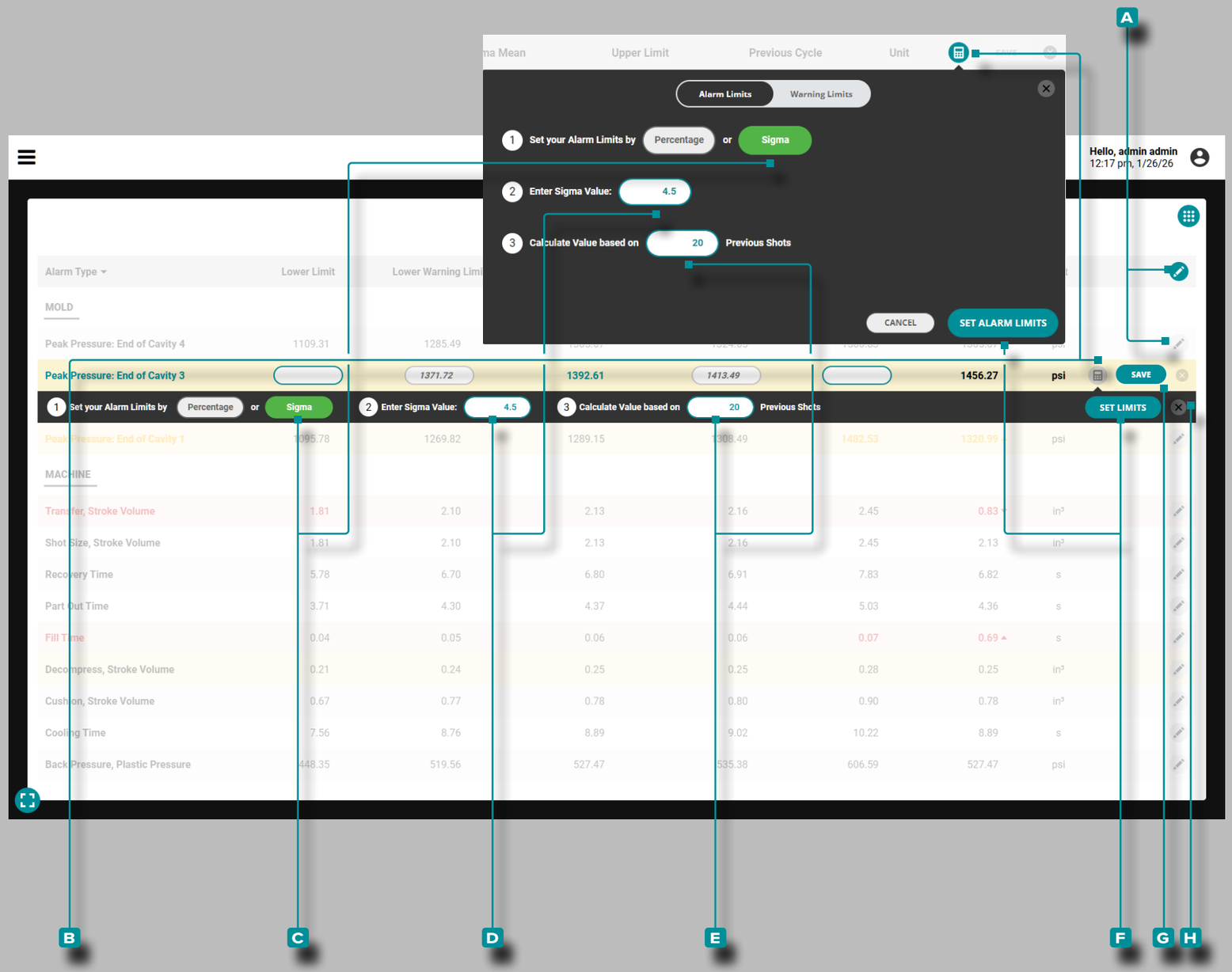
The CoPilot system calculates the standard deviation/sigma value from the entered number of previous shots. It then multiplies the standard deviation/sigma by the entered number, adds it to the mean, and sets the result as the high level alarm ("Upper Limit"). It subtracts standard deviation/sigma from the mean, and sets that as the low level alarm ("Lower Limit").

The CoPilot system default number of previous shots (cycles) used to calculate standard deviation/sigma is twenty, and the default number of standard deviations/sigmas added/subtracted to/from the mean to compute alarm limits is 4.5 σ. Reject and down cycles are not excluded from the calculations.

The process MUST be stable for a recommended minimum of twenty shots before adding alarms, though the lowest number of shots that can be entered is ten. If startup values were used to compute standard deviation, the variation would render the values wild and useless.

The alarm levels set on sigma do not represent any specific part characteristics. To determine whether a part is good or bad at a specific value, complete a part correlation study on The Hub software.

Job Dashboard (*continued*)



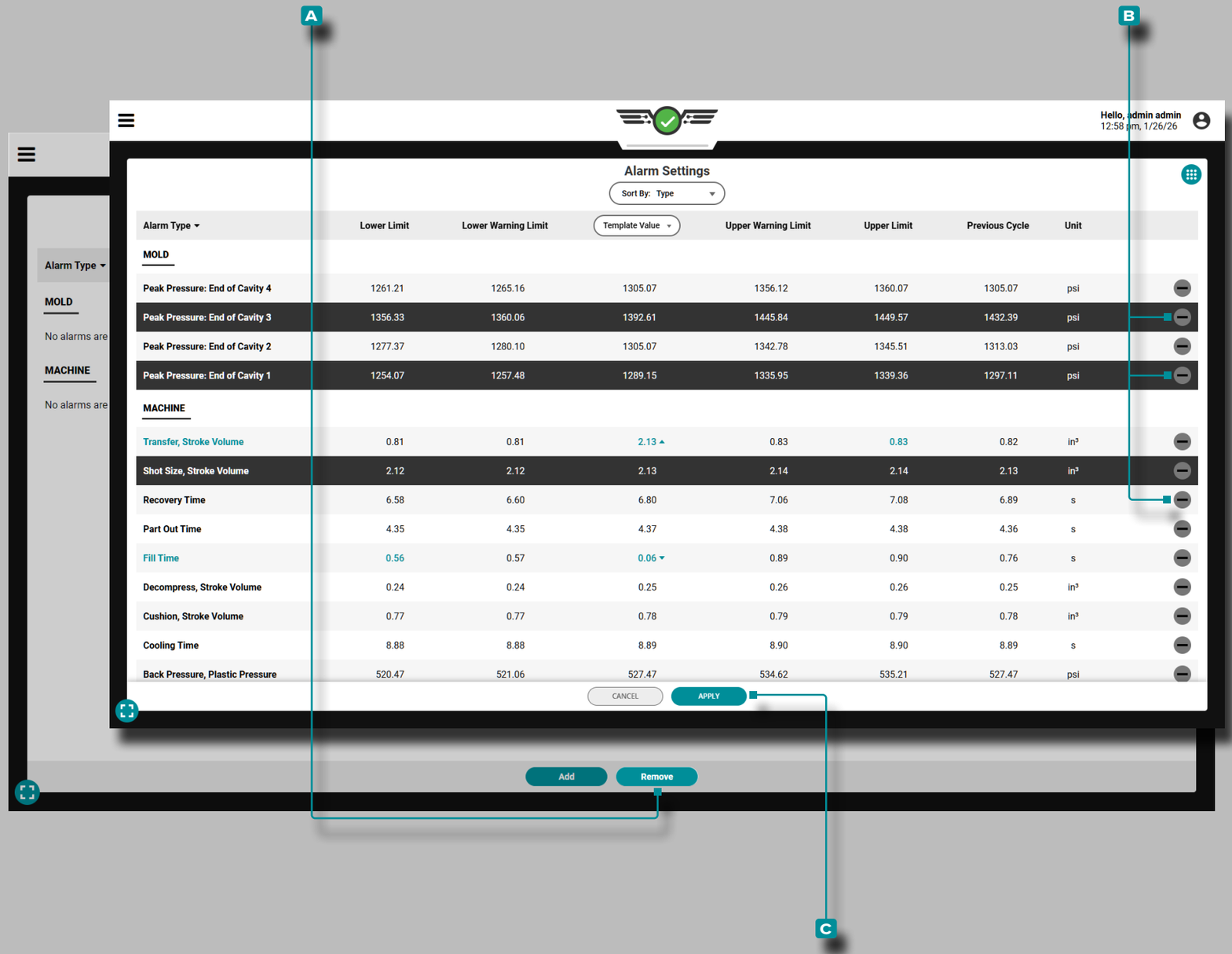
Setting Alarms Using Sigma (continued)

An active template is not required set alarms using sigma.

Tap the **A** edit icon on the table header to edit all alarms, or **tap** the **A** edit icon next to an individual process value to edit that value. **Tap** the **B** calculator, and then **tap** the **C** Sigma button. If desired, **tap** the field to **enter** a different **D** sigma value or **tap** the field to **enter** a different number of **E** previous shots from which to calculate the limits. **Tap** the **F** SET ALARM LIMITS/SET LIMITS button to auto-fill the lower and upper limits using a standard deviation calculation. **Tap** the **G** SAVE button to save the values, or **tap** the **H** cancel button to discard any changes.

When alarms are set using sigma, a “Sigma Mean” column will appear in the Alarm Settings. Sigma mean is the sum of a summary variable’s calculated sigma values divided by the number of sigma values calculated for the summary variable.

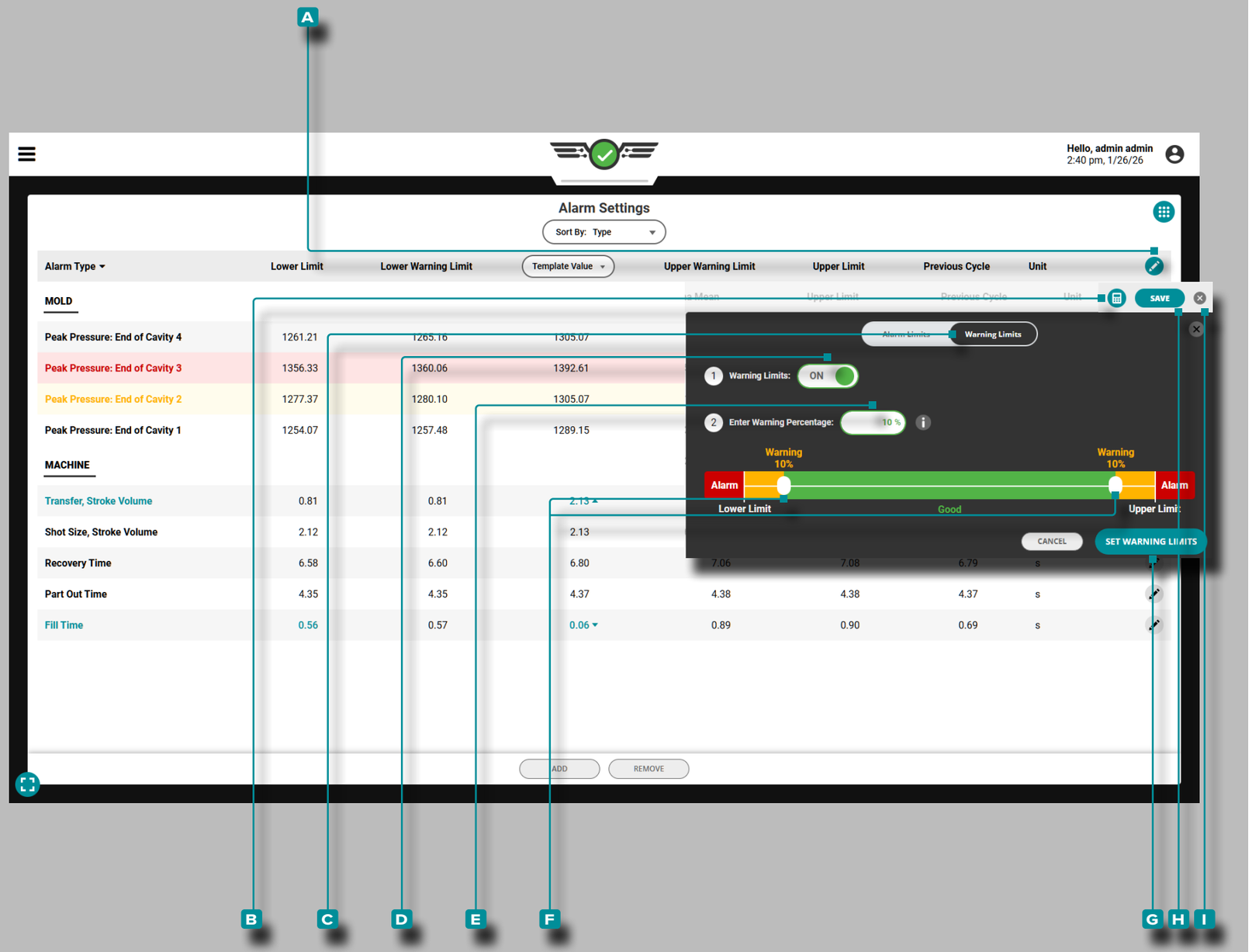
Job Dashboard (*continued*)



Remove Alarms

Tap the A REMOVE ALARMS button on the Alarm Settings widget, then **tap** on an alarm(s) to select the alarm(s) for B removal; **tap** to the C APPLY button to remove the selected alarm(s).

Job Dashboard (*continued*)



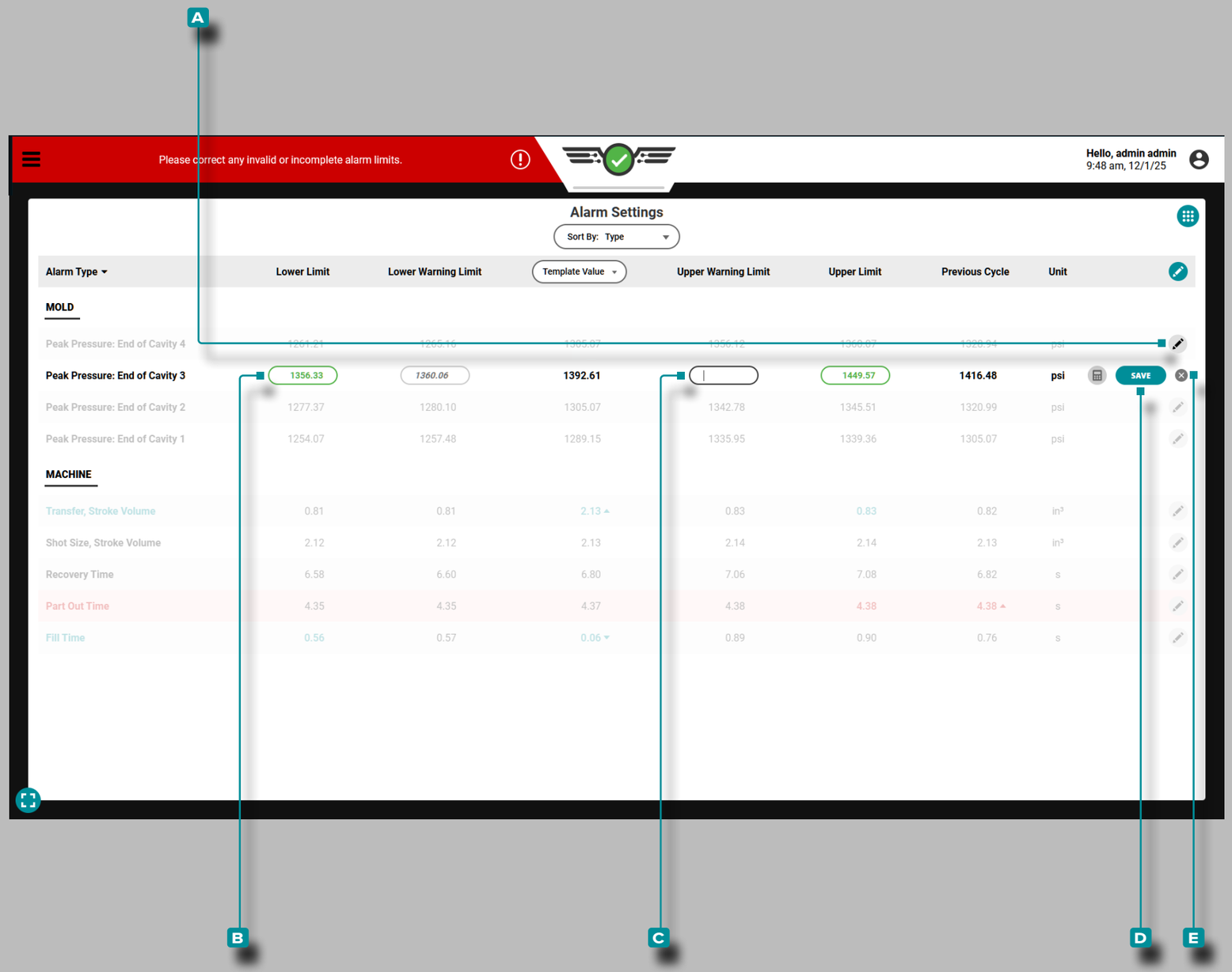
Warning Limits

Setting Warning Limits by Percentage

Tap the A edit icon on the table header, then **tap** the B calculator. **Tap** the C Warning Limits button. If warning limits is OFF, **tap** the D ON button. **Tap** the field to **enter** a E warning percentage, or **tap, hold, and drag** the F sliders to the desired E warning percentage. **Tap** the G SET WARNING LIMITS button to save the warning limits settings. **Tap** the I SAVE button on the table header to save and apply any settings, or **tap** the J exit button to cancel any settings changes.

Warning Limits are automatically adjusted based on adjustments to Alarm Limits when Alarm Limits and Warning Limtis are set by percentage; any changes to the Alarm Limit percentage will affect the Warning Limit percentage. *This applies ONLY to limits set by percentage, not individually-set warning limits*.

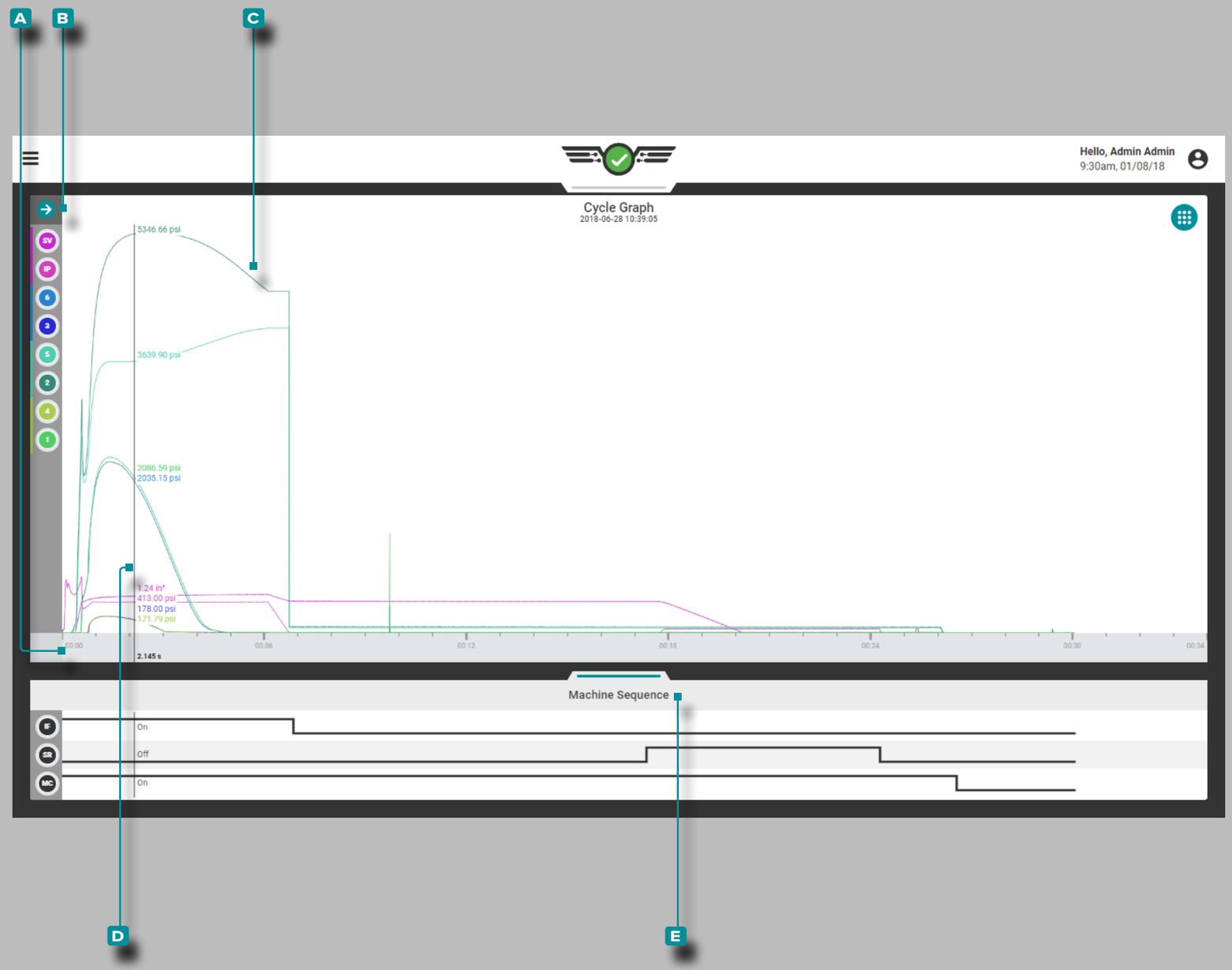
Job Dashboard (*continued*)



Setting Individual Warning Limits

Tap the **A** edit icon next to an individual process value to edit that value. **Tap** the **B** Lower Warning Limit field to **enter** a different value or **tap** the **C** Upper Warning Limit field to **enter** a different value. **Tap** the **D** SAVE button to save the values, or **tap** the **E** cancel button to discard any changes.

NOTE *Warning limits cannot be set outside of the entered alarm limits; e.g. if an upper alarm limit is set to 10, the waraning limit may not be set to ≥ 10.*



Job Dashboard (*continued*)

Cycle Graph

Cycle Data Curves

The Cycle Graph displays cycle data as real-time curves from connected machine and mold sensors such as cavity pressure, injection volume and velocity, and cavity pressures; the Cycle Graph additionally displays machine sequence signals states (signal on or off) in a separate area below the curves graph.

The **A** x axis denotes time; the **B** y axis denotes the process value (pressure, volume, velocity, etc.), therefore, the **C** cycle curves provide a visual representation of the process values over the length of a cycle. **Tap** ☝ and hold on the cycle graph to reveal the **D** cursor; the **D** cursor displays the cycle data curve values. Drag the **D** cursor ←left and right→ to view the values along the entire cycle data curve.

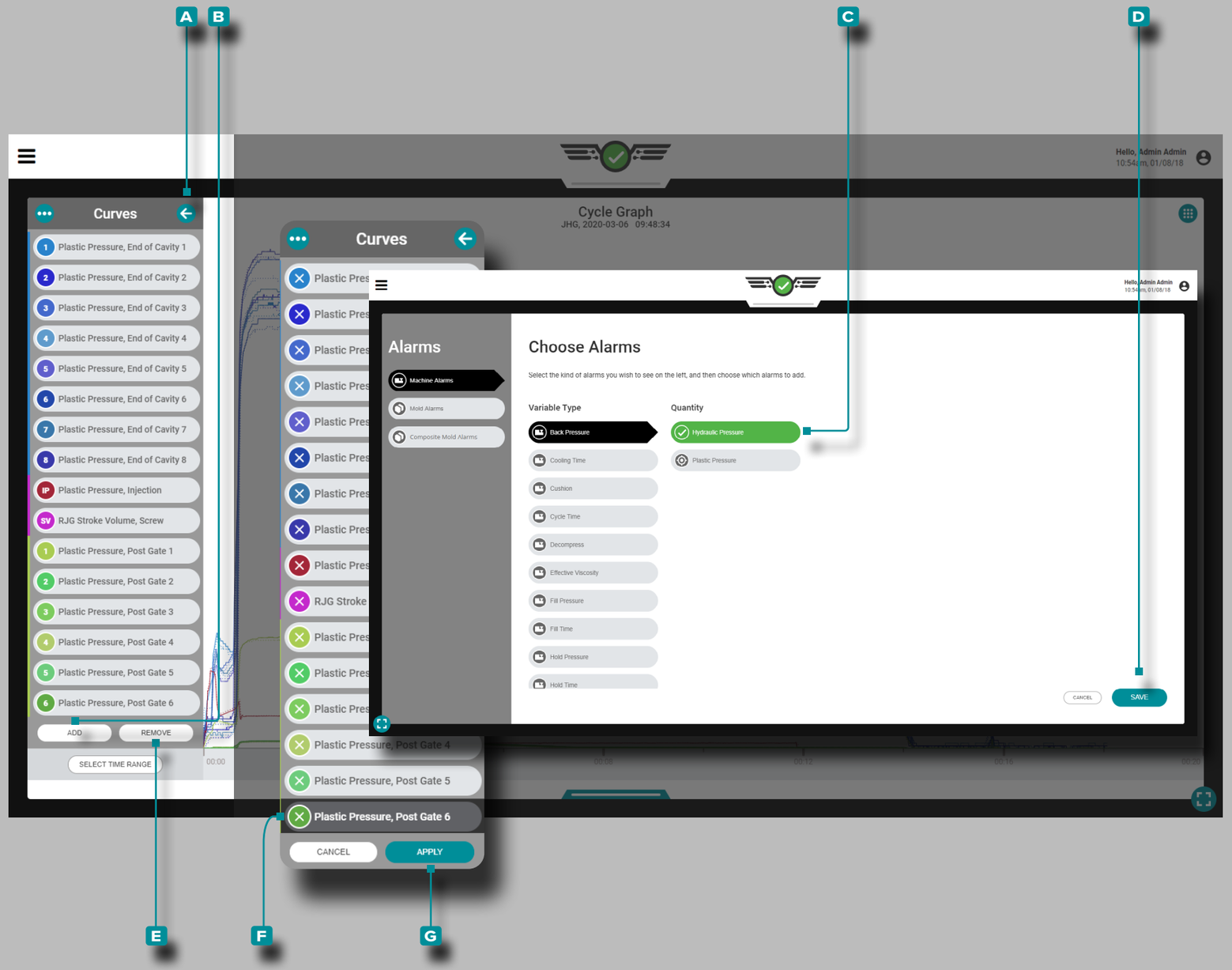
Machine Sequence States

The **E** Machine Sequence States graph displays the current state of each ***assigned*** machine sequence signal, inputs, and output.

Available machine inputs include: fill, first stage, hold, injection forward, second stage, mold closing, mold closed, mold opening, machine in manual, machine auto, machine in semi-auto, pack, and screw run. Available machine Outputs include: good control, reject control, excessive rejects, inject enable, V2P, mold heating, mold cooling, allow mold close, allow mold open, process good, process alarm, process warning, job started, and job running.

If a sequence signal/input/output is on, the corresponding line will appear in the top half of that sequence signal's area (high); if a sequence signal/input/output is off, the corresponding line will appear in the bottom half of that sequence signal's area (low).

Machine sequence states are particularly useful for analyzing cycle data curves. Cycle data curves should follow predictable paths during a cycle; reference the machine sequence states versus the cycle data curves to verify that the process is performing as expected throughout the cycles.



Job Dashboard (*continued*)

Cycle Graph Controls

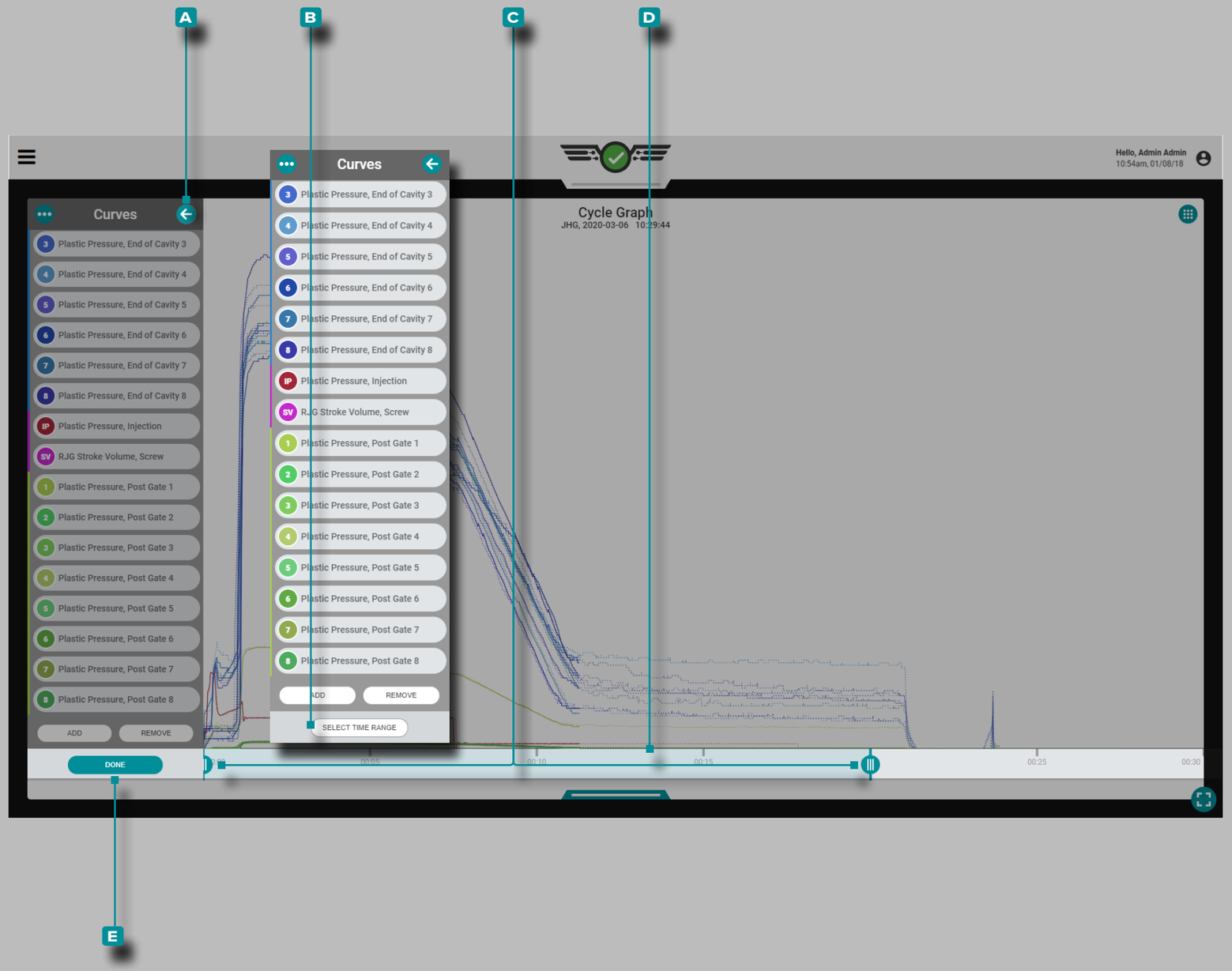
The cycle graph can display machine and mold cycle data curves; the actual number of cycle data curves available depends upon the equipment (machine and mold) installed.

Add Curves

Tap the **A** arrow button to expand and view the cycle data curve menu, then **tap** the **B** ADD button to view selectable machine, mold, or composite mold cycle data curves; **tap** the desired **C** cycle data curve type, then **tap** the **D** DONE button to return to the cycle graph.

Remove Curves

Tap the **A** arrow button to expand and view the cycle data curve menu, then **tap** the **E** REMOVE button to activate current cycle data curves for removal; **tap** the desired **F** cycle data curve, then **tap** the **G** APPLY button to remove it from the graph.



Job Dashboard (*continued*)

Cycle Graph Controls (continued)

Zoom In

Tap 👆 the **A** arrow button to expand and view the cycle data curve menu, then **tap** 👆 the **B** SELECT TIME RANGE button to zoom in to a time selection of the cycle graph. **Tap** 👆, hold, and drag one or both of the **C** sliders to the selected time.

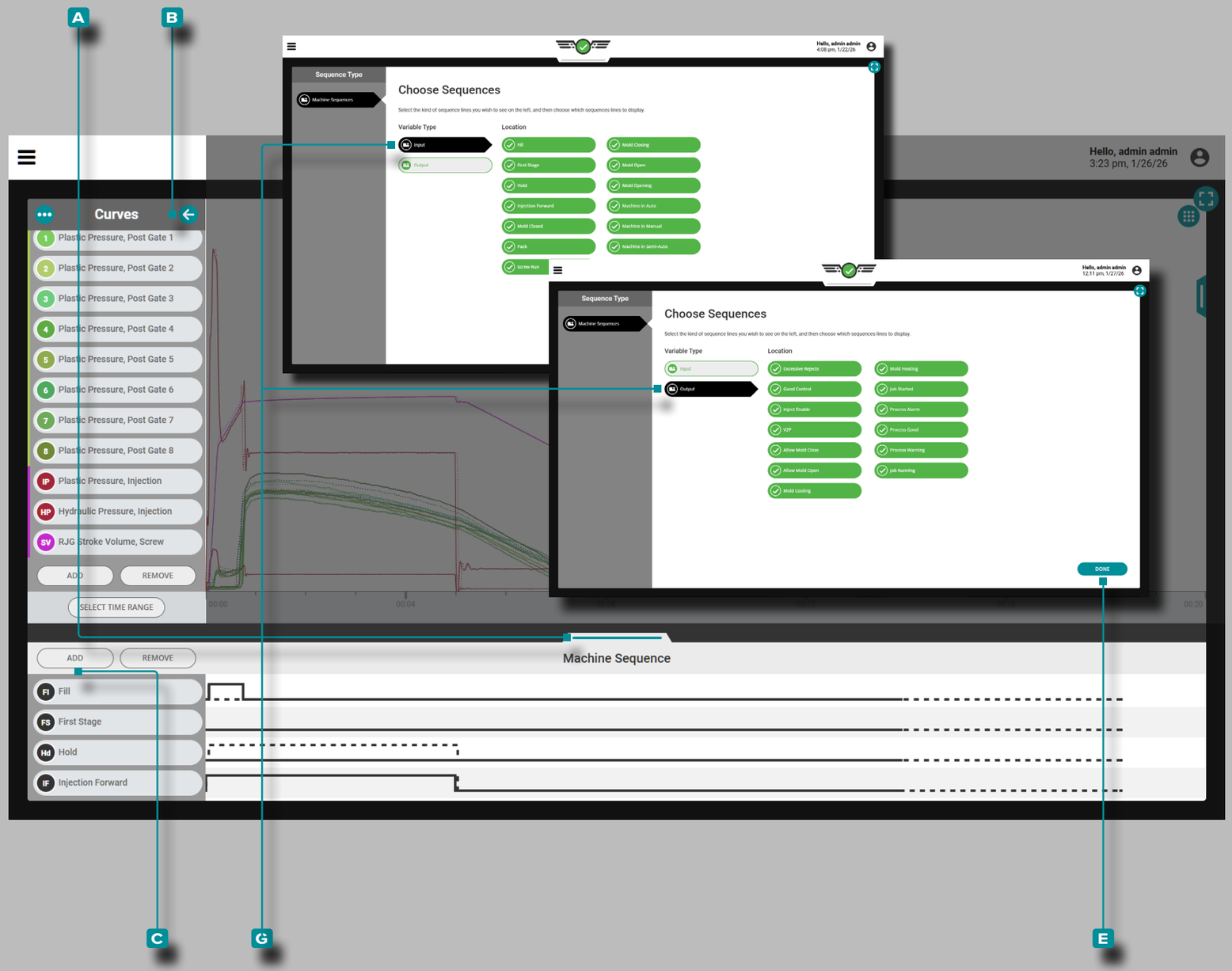
Tap 👆, hold, and drag the **D** time selection bar to pan left or right on the cycle graph. **Tap** 👆 the **E** DONE button to apply the changes.

Zoom Out

Tap 👆 the **B** SELECT TIME RANGE button to zoom in to a time selection of the cycle graph, then **tap** 👆, hold, and drag one or both of the **C** sliders to the selected time. **Tap** 👆 the **E** DONE button to apply the changes.

Pan

Tap 👆, hold, and drag on the cycle graph to pan left or right at any time.



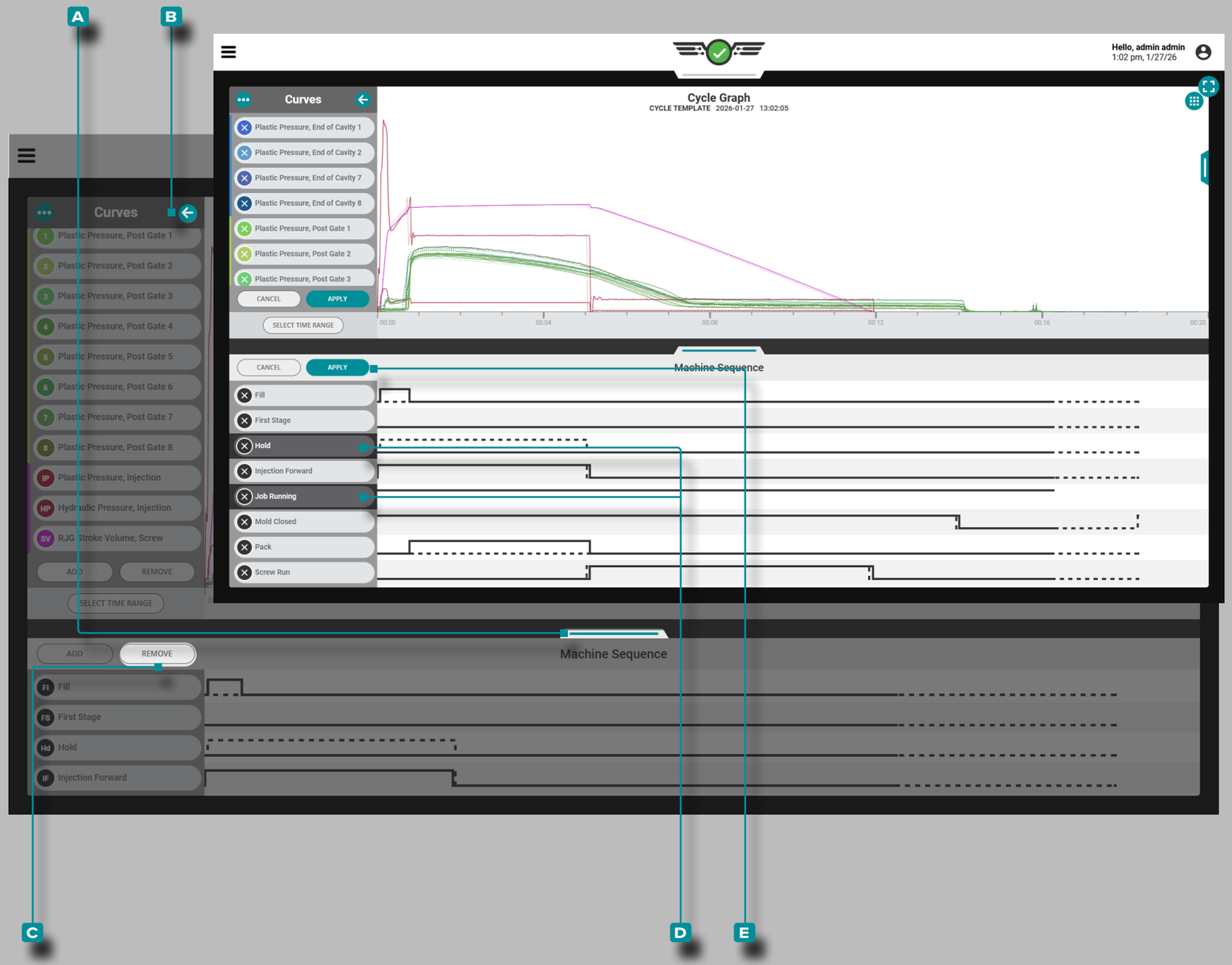
Job Dashboard (*continued*)

Cycle Graph Controls (continued)

Add Machine Sequence States

Expand the Cycle Graph widget, then **tap** 👆, **hold**, and **drag** the **A** Machine Sequence bar up to view Machine Sequences.

With the Cycle Graph widget expanded so that the Machine Sequence states are visibile, tap 👆 the **B** arrow button to expand and view the cycle data curve menu, then **tap** 👆 the **C** ADD button to view selectable input or output machine sequence variables. **Tap** 👆 the desired **D** machine sequence variable type, then **tap** 👆 the **E** DONE button to return to the cycle graph.



Job Dashboard (*continued*)

Remove Machine Sequence States

Expand the Cycle Graph widget, then **tap** 👆, **hold**, and **drag** the **A** Machine Sequence bar up to view Machine Sequences.

With the Cycle Graph widget expanded so that the Machine Sequence states are visibile, tap 👆 the **B** arrow button to expand and view the cycle data curve menu, then **tap** 👆 the **C** REMOVE button, then **tap** 👆 the desired **D** machine sequence variable type to remove, then **tap** 👆 the **E** APPLY button to remove it from the graph.

Job Dashboard (*continued*)

Set Fill Volume at Cursor

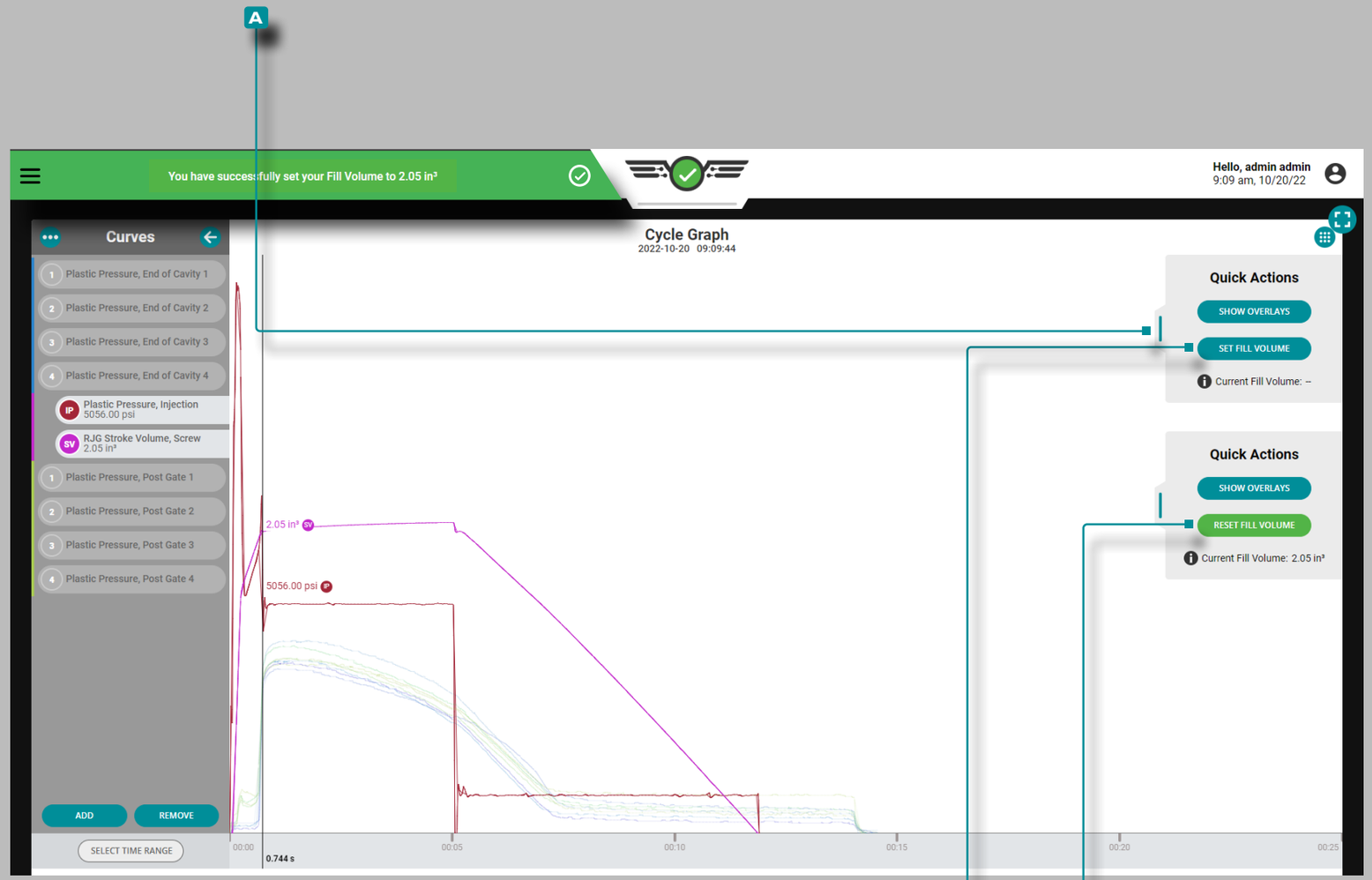
In Decoupled processes the filling (velocity) phase is separated from the packing (pressure) phase, therefore, DECOUPLED II and DECOUPLED III processes require the machine sequence signal “fill”. Most machines do not produce the fill signal, so the signal may be generated using the zero position of the screw and a set fill volume position.

In order to use the Set Fill Volume at Cursor function, there must be the following:

- a configured machine stroke input—either from an LE-R-50 or an IA1-M-V configured for stroke (refer to “Stroke Position/Velocity (Electric Machines)” on page 14 OR “Stroke Position/Velocity (Hydraulic Machines)” on page 15)

AND

- a configured machine injection pressure input—either from an injection pressure sensor or an IA1-M-V configured for injection pressure (refer to “Injection Pressure (Electric Machines)” on page 16 OR “Injection Pressure (Hydraulic Machines)” on page 17).



Job Dashboard (*continued*)

Set Fill Volume at Cursor (continued)

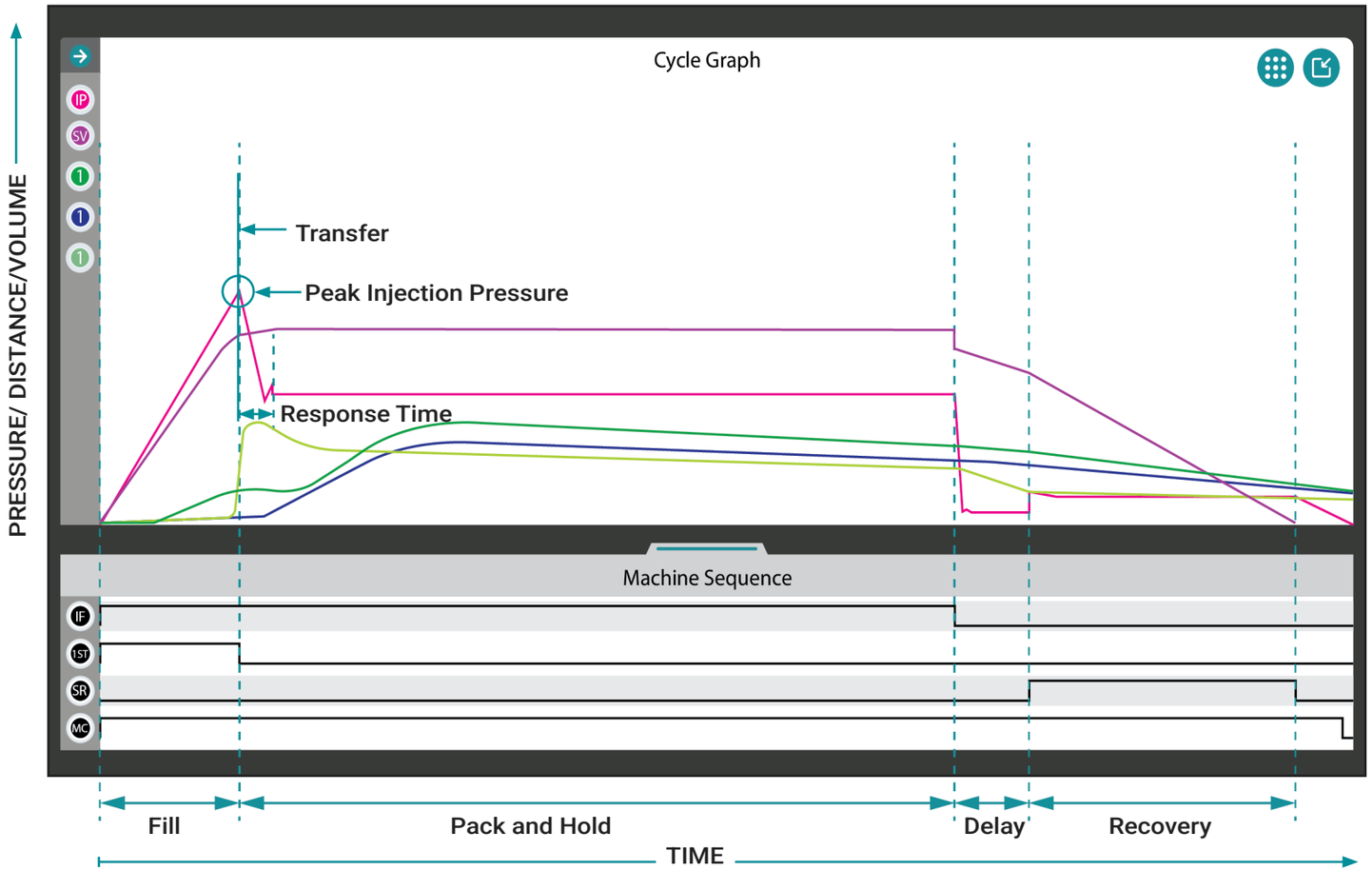
To set fill volume using the cursor, perform the following:

1. Start the job in the CoPilot software with the molding machine running in auto.
2. Navigate to the Job Dashboard, and then expand the Cycle Graph to full screen. The curves “injection pressure” and “injection volume” must be visible. Once several “normal” cycles are observed, examine the injection pressure and injection volume curves for “the end of fast fill”—usually depicted as a local peak in the injection pressure curve or a sudden change in the volume curve slope, where it moves from steep to shallow. Regularly these happen at the same point.
3. **Tap** and hold on the graph; the cursor will appear. Drag the cursor to just before the end of the fast fill. **Tap**, **hold**, and **drag** the Cycle Graph **A** Quick Actions menu slider to the left. **Tap** the **B** SET FILL VOLUME button to set the fill volume position at the selected location on the Cycle Graph. A **C** notification will appear to confirm the assigned fill volume position. The selected fill volume position will be saved with the process and will override all other machine signals that may be assigned; the fill volume position will also persist until it is reset, or a new fill volume position is set.

To reset the fill volume position, **tap** the **D** RESET FILL VOLUME button on the **A** Quick Actions menu.

To override a selected fill volume position, select a new position, then **tap** the **B** SET FILL VOLUME button on the **A** Quick Actions menu.

Fill Time is calculated based on the fill volume selected using the Set Fill Volume at Cursor function.



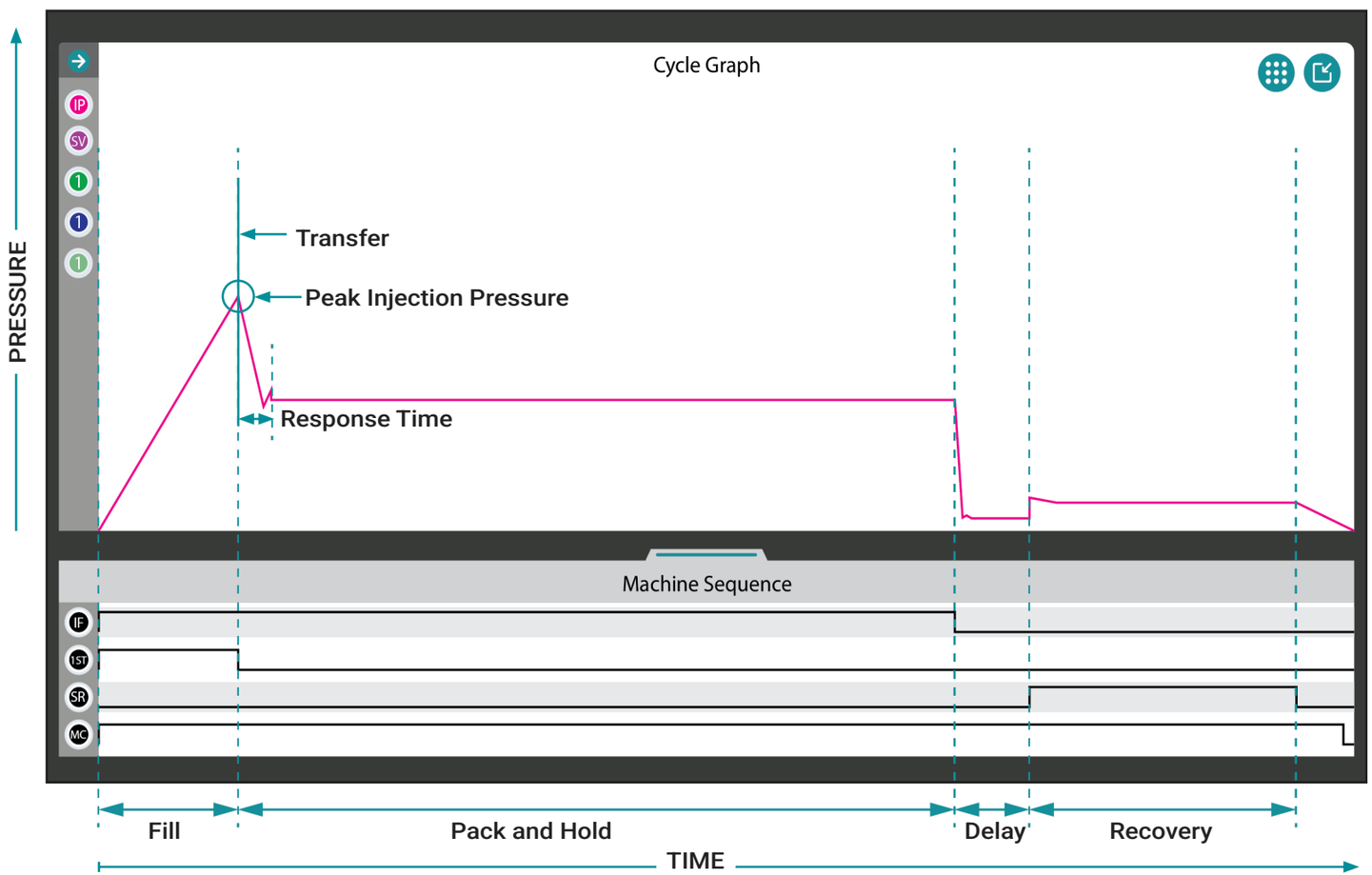
Monitoring Cycle Graph Curves

Cycle graph curves ⓘ are a visual indication of what is occurring inside the mold, and therefore, should be monitored to identify changes in the process.

ⓘ **NOTE** *The curves shown and described in the following are for informational purposes only. Each process is unique and curve shapes are mold-specific and often deviate dramatically from the ideal curves shown.*

The injection pressure curve shows the pressure levels during the molding cycle. The injection volume (or stroke) curve shows the volume of material moved by the screw into the mold. The cavity pressure curves show the material pressure detected by cavity pressure sensors during the molding cycle.

Changes in the process—injection pressure, injection volume, and cavity pressure—are easily detected by monitoring the corresponding cycle graph curves. Additionally, changes in machine performance can be detected; for example, a spike in the injection volume curve after the pack phase often indicates a potential problem with the non-return valve.



Injection Pressure Curve

The injection pressure curve is depicted on the cycle graph in pink. Injection pressure can be monitored to detect changes in fill speed and time, first stage pressure, pack and hold pressure, and back pressure (refer to the "Glossary" on page 194 for more information on these variables).

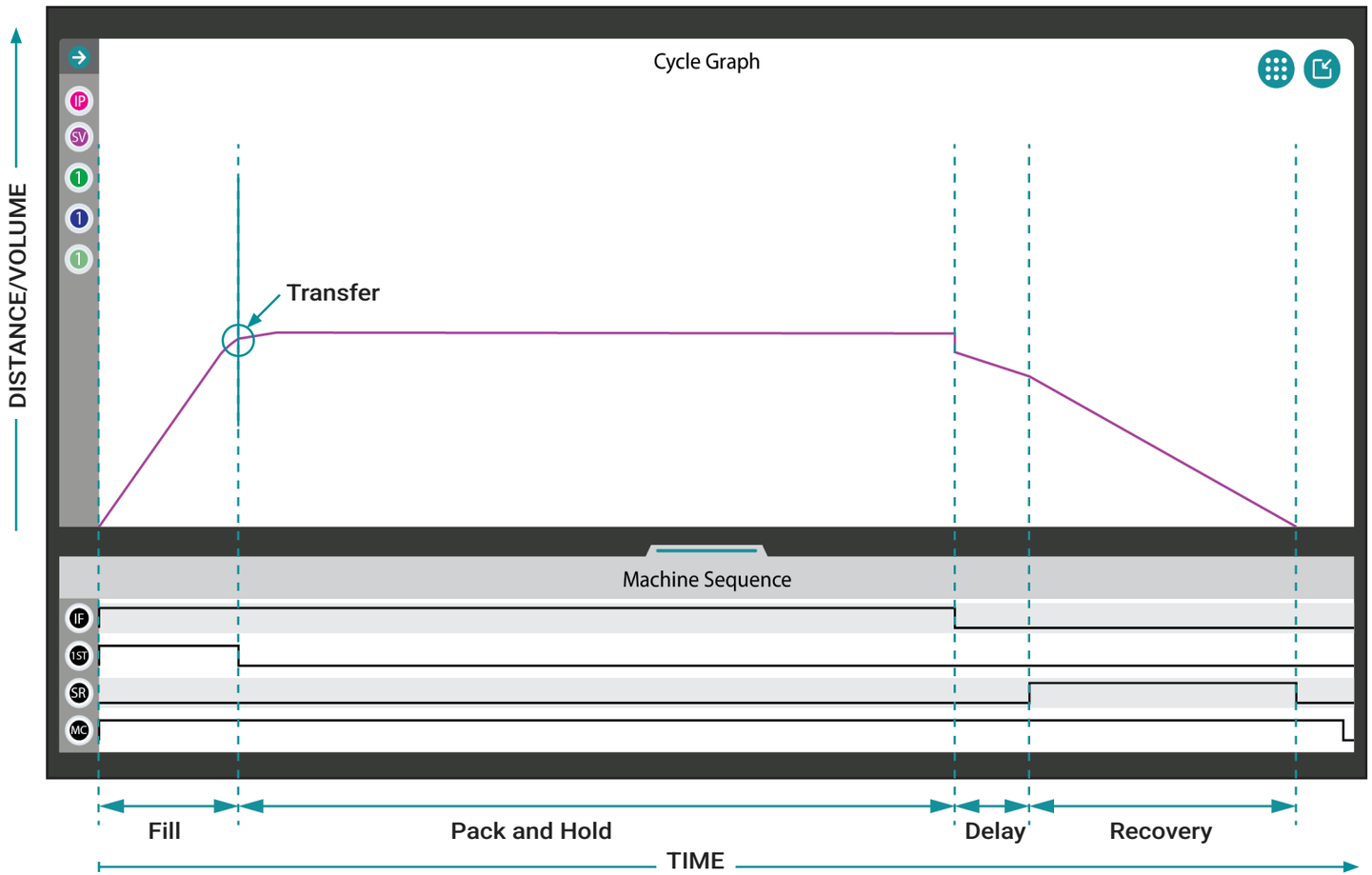
The injection pressure curve should have a steep incline from the start of the cycle, which shows the building of pressure from cycle start time to the end of fill time. When peak injection pressure is reached, the curve is at its highest point on the cycle graph and the following are also applicable:

- The point at which in Decoupled Molding II and III applications the mold cavities are 95–98%/85–90% full.
- The point at which fill time ends and is calculated, and pack and hold time begins.
- The point known as the transfer position (X-fer, V→P) in which control is transitioned from velocity to pressure (hold).

The curve will decline as transfer from velocity to pressure occurs. Though the curve may spike slightly again, it will level out as pressure is equalized throughout the cavities to the hold pressure.

The curve will decline sharply to indicate the end of hold; pack and hold time ends and is calculated, and the delay time begins.

Pressure will then spike slightly as delay time ends and is calculated, and screw recovery begins (and recovery time begins), until it drops to the x axis, signaling the end of recovery and recovery time is calculated. Back pressure is calculated during recovery time.



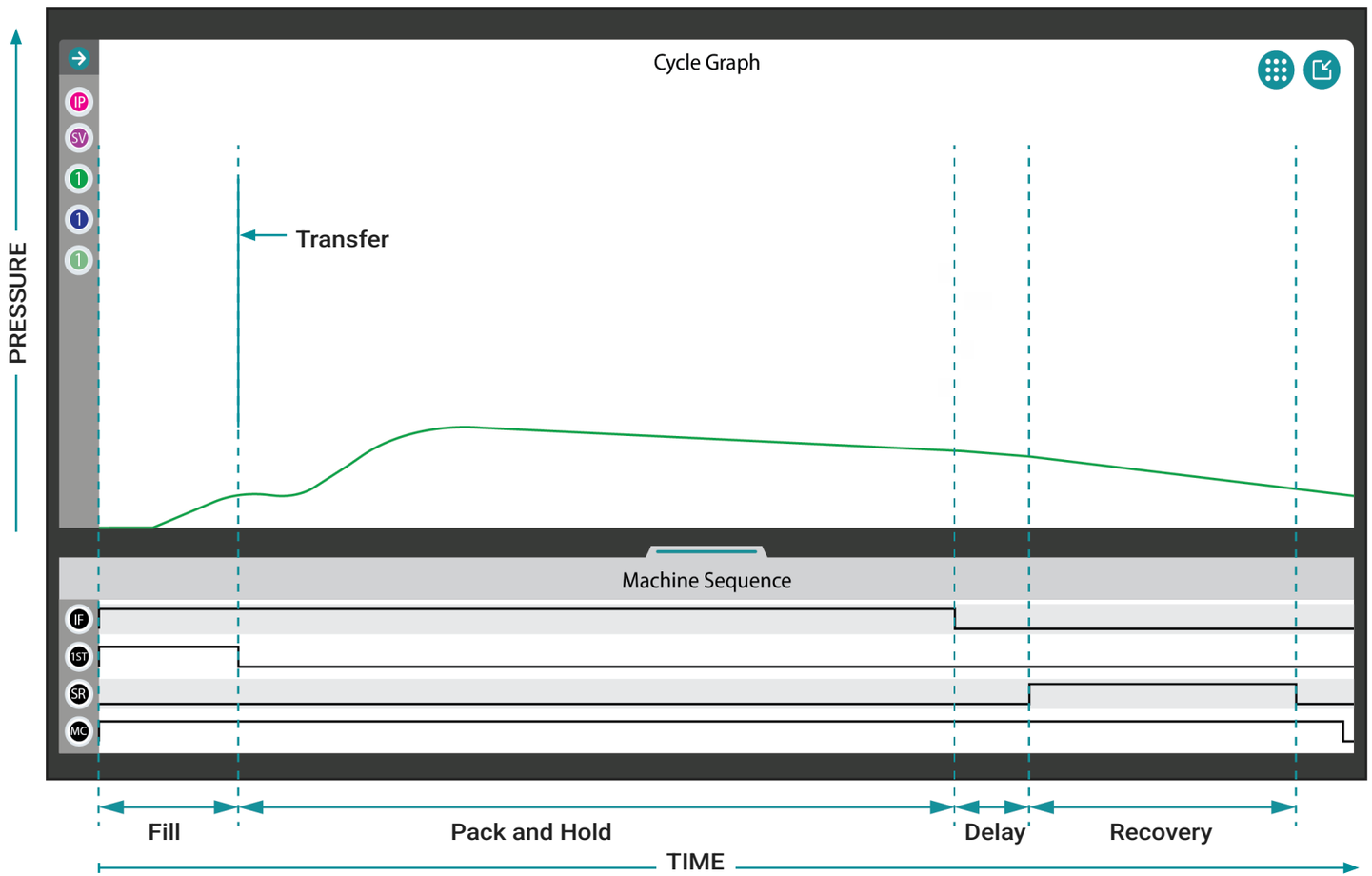
Injection Stroke/ Volume Curve

The injection stroke/volume curve is depicted on the cycle graph in magenta. Injection can be monitored as stroke (distance) or volume, and can be used to detect changes in fill volume (refer to the "Glossary" on page 194 for more information on injection volume).

The injection stroke/volume curve should have a steep incline at the start of the cycle, which shows the increase in material into the mold from cycle start time to the end of fill time. When the mold cavities are 95–98%/85–90% full (Decoupled Molding II and III processes) the transfer position is reached and control is transitioned from velocity to pressure (hold)—also known as X-fer, V→P. Also at this time, fill time ends and is calculated, and pack and hold time begins.

The curve will continue to climb, though much more gradually, as transfer from velocity to pressure occurs and the part is packed out. The curve will then decline to indicate the end of hold; pack and hold time ends and is calculated, and the delay time begins.

The curve will then decline slightly as the part cools and shrinks, delay time ends and is calculated, and screw recovery begins (and recovery time begins). When recovery ends and the part is ejected, recovery time is calculated. Back pressure is calculated during recovery time.



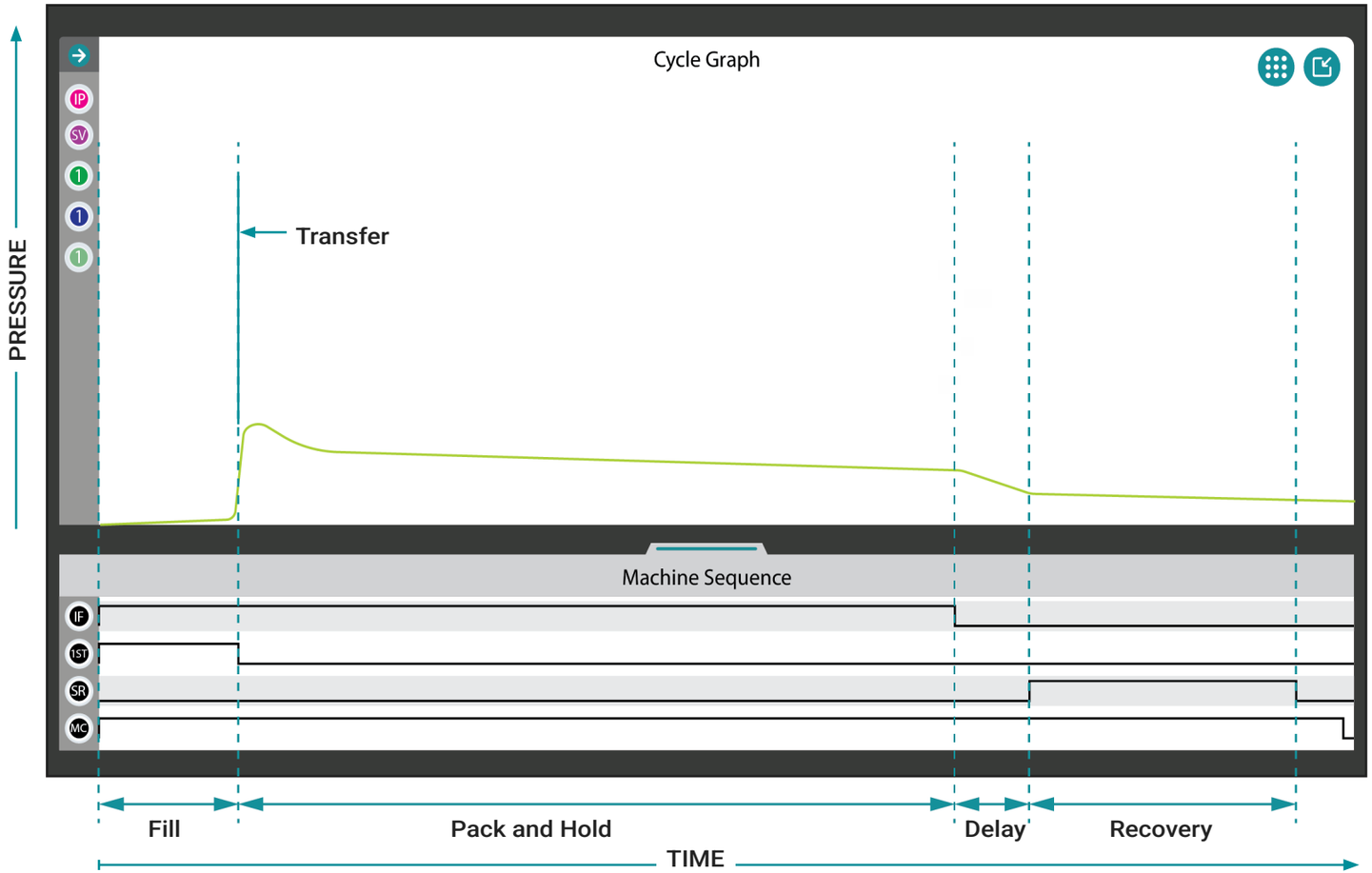
Post-Gate Cavity Pressure Curves

The PG cavity pressure curve is depicted on the cycle graph in green. Post-gate cavity pressure can be monitored to detect changes in pack rate, cooling rate, peak pressure, and cycle integral (refer to the “Glossary” on page 194 for more information on these variables).

The PG cavity pressure curve should be flat at the start of the cycle, then climb slowly from cycle start time to the end of fill time, showing the increase in material into the mold past the sensor from cycle start time to the end of fill time. When the mold cavities are 95–98%/85–90% full (Decoupled Molding II and III processes) the transfer position is reached and control is transitioned from velocity to pressure (hold)—also known as X-fer, V→P. Also at this time, fill time ends and is calculated, and pack and hold time begins.

The curve will level and then continue to climb as transfer from velocity to pressure occurs. The curve will decline slowly after the second climb to indicate gate seal until the end of hold; pack and hold time ends and is calculated, and the delay time begins.

The curve will then decline slightly more than during pack and hold as the part cools and shrinks, delay time ends and is calculated, and screw recovery begins (and recovery time begins). When recovery ends and the part is ejected, recovery time is calculated. Back pressure is calculated during recovery time.



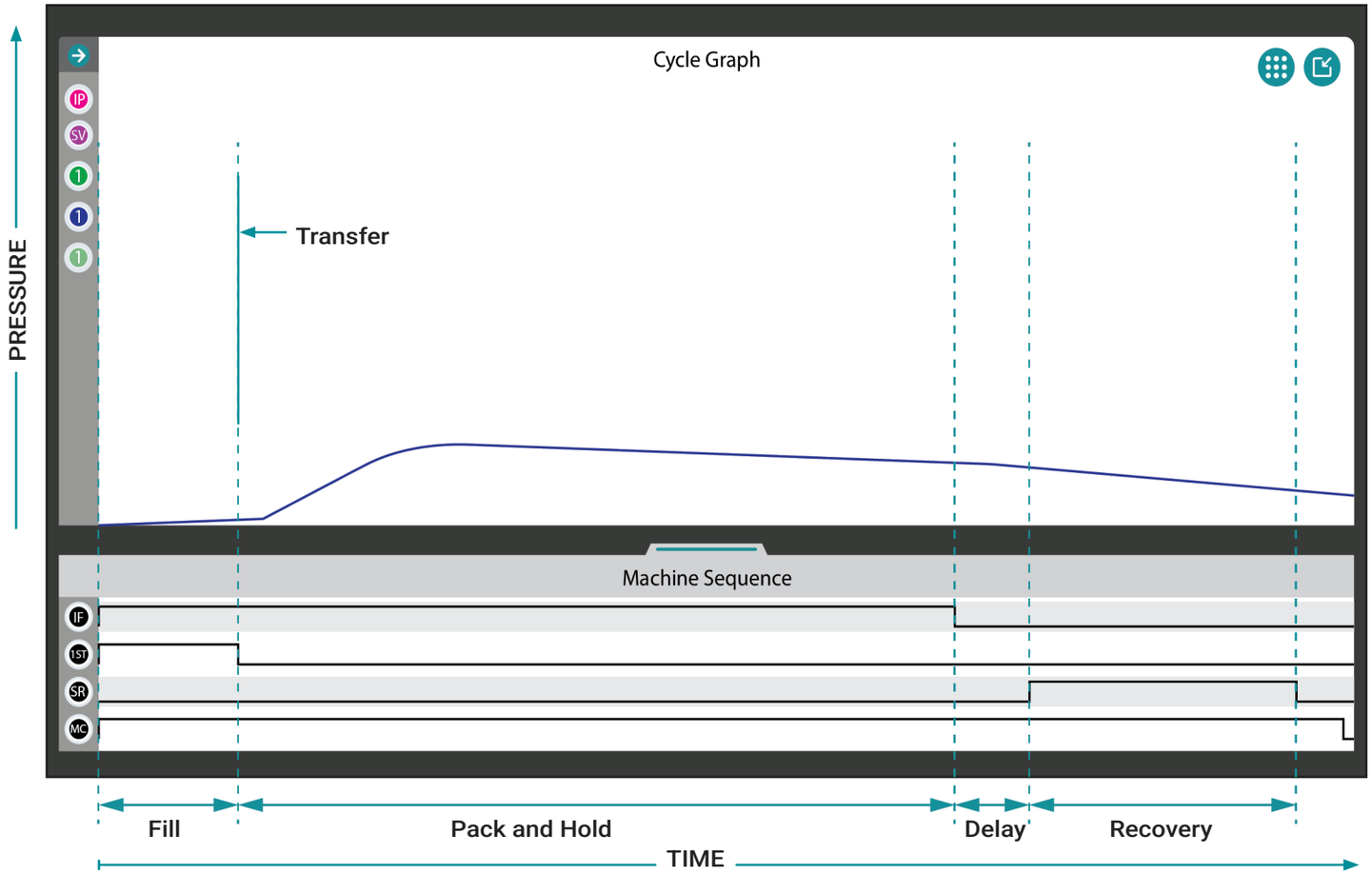
Mid-Cavity Pressure Curves

The MID pressure curve is depicted on the cycle graph in lime green. Mid-cavity pressure can be monitored to detect changes in pack rate, cooling rate, peak pressure, and cycle integral (refer to the "Glossary" on page 194 for more information on these variables).

The MID pressure curve should be relatively flat at the start of the cycle from cycle start time and rise quickly through the end of fill time. When the mold cavities are 95–98%/85–90% full (Decoupled Molding II and III processes) the transfer position is reached and control is transitioned from velocity to pressure (hold)—also known as X-fer, V→P. Also at this time, fill time ends and is calculated, and pack and hold time begins.

The curve will then decline slightly and then level as transfer from velocity to pressure occurs as material reaches and compresses against the end of the cavities. The curve will then decline slowly to indicate gate seal until the end of hold; pack and hold time ends and is calculated, and the delay time begins.

The curve will continue to decline slightly more than during pack and hold as the part cools and shrinks, delay time ends and is calculated, and screw recovery begins (and recovery time begins). When recovery ends and the part is ejected, recovery time is calculated. Back pressure is calculated during recovery time.



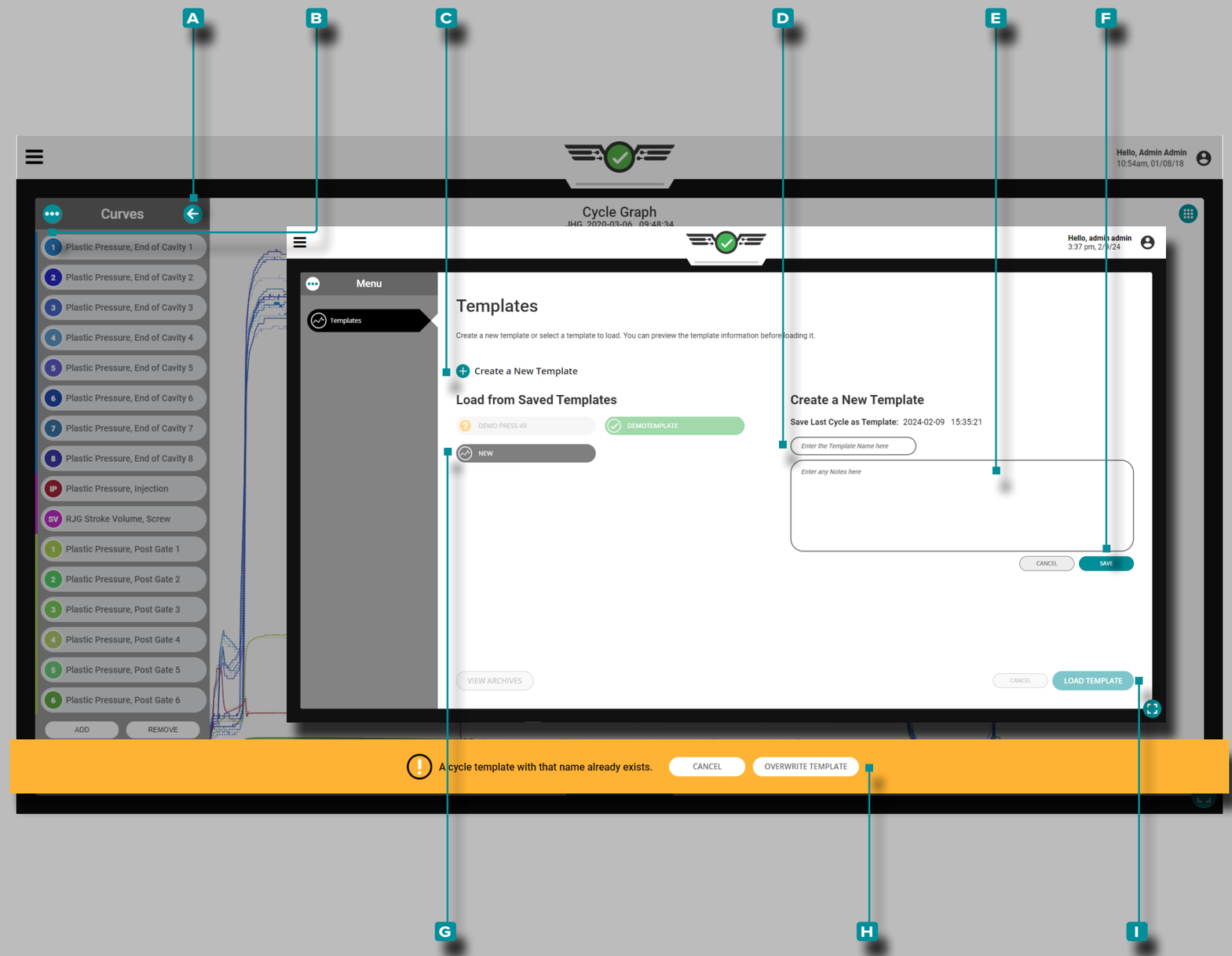
End-of-Cavity Pressure Curves

The EOC pressure curve is depicted on the cycle graph in blue. End-of-cavity pressure can be monitored to detect changes in pack rate, cooling rate, peak pressure, and cycle integral (refer to the "Glossary" on page 194 for more information on these variables).

The EOC pressure curve should be relatively flat at the start of the cycle from cycle start time to the end of fill time. When the mold cavities are 95–98%/85–90% full (Decoupled Molding II and III processes) the transfer position is reached and control is transitioned from velocity to pressure (hold)—also known as X-fer, V→P. Also at this time, fill time ends and is calculated, and pack and hold time begins.

The curve will then climb as transfer from velocity to pressure occurs as material reaches and compresses against the end of the cavities. The curve will then decline slowly to indicate gate seal until the end of hold; pack and hold time ends and is calculated, and the delay time begins.

The curve will continue to decline slightly more than during pack and hold as the part cools and shrinks, delay time ends and is calculated, and screw recovery begins (and recovery time begins). When recovery ends and the part is ejected, recovery time is calculated. Back pressure is calculated during recovery time.



Job Dashboard (*continued*)

Cycle Graph Process Templates

Cycle graph process templates are user-created templates that, if matched, produce parts closest to those created by the process from which the template was made. If used, the template is displayed on the cycle graph with the current cycle graph curves; the template is displayed as dotted lines. Template values are also applied to the Alarm Settings widget when a template is selected.

Create a Template

Tap the **A** arrow button to expand and view the cycle data curve menu, then **tap** the **B** menu button to view existing templates; **tap** the **C** Create a New Template button, then **tap** **enter** a **D** new template name. Optionally, **enter** **E** notes in the provided field, then **tap** the **F** SAVE button.

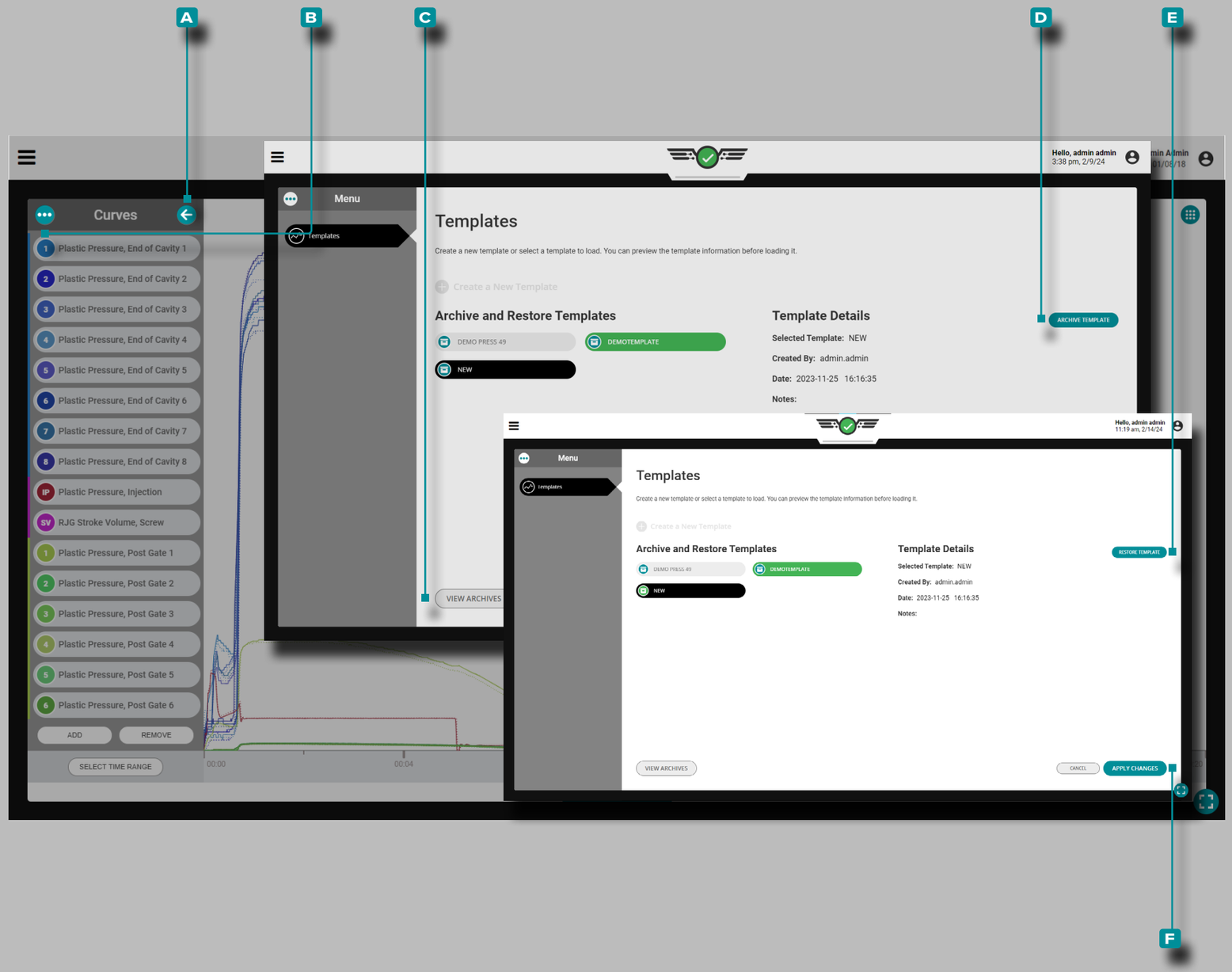
If the template uses the name of an existing template name, tap the **H** OVERWRITE TEMPLATE button to confirm that the new template will overwrite the existing template.

NOTE *A new template may be saved using an existing template name; the new template will override the existing template. If a template is saved to overwrite an archived template, the template will become un-archived and updated to the new template values.*

Load a Template

Tap the **A** arrow button to expand and view the cycle data curve menu, then **tap** the **B** menu button to view existing templates. **Tap** an existing **G** template to select it for use, then **tap** the **I** LOAD TEMPLATE button to load the selected template.

Job Dashboard (*continued*)

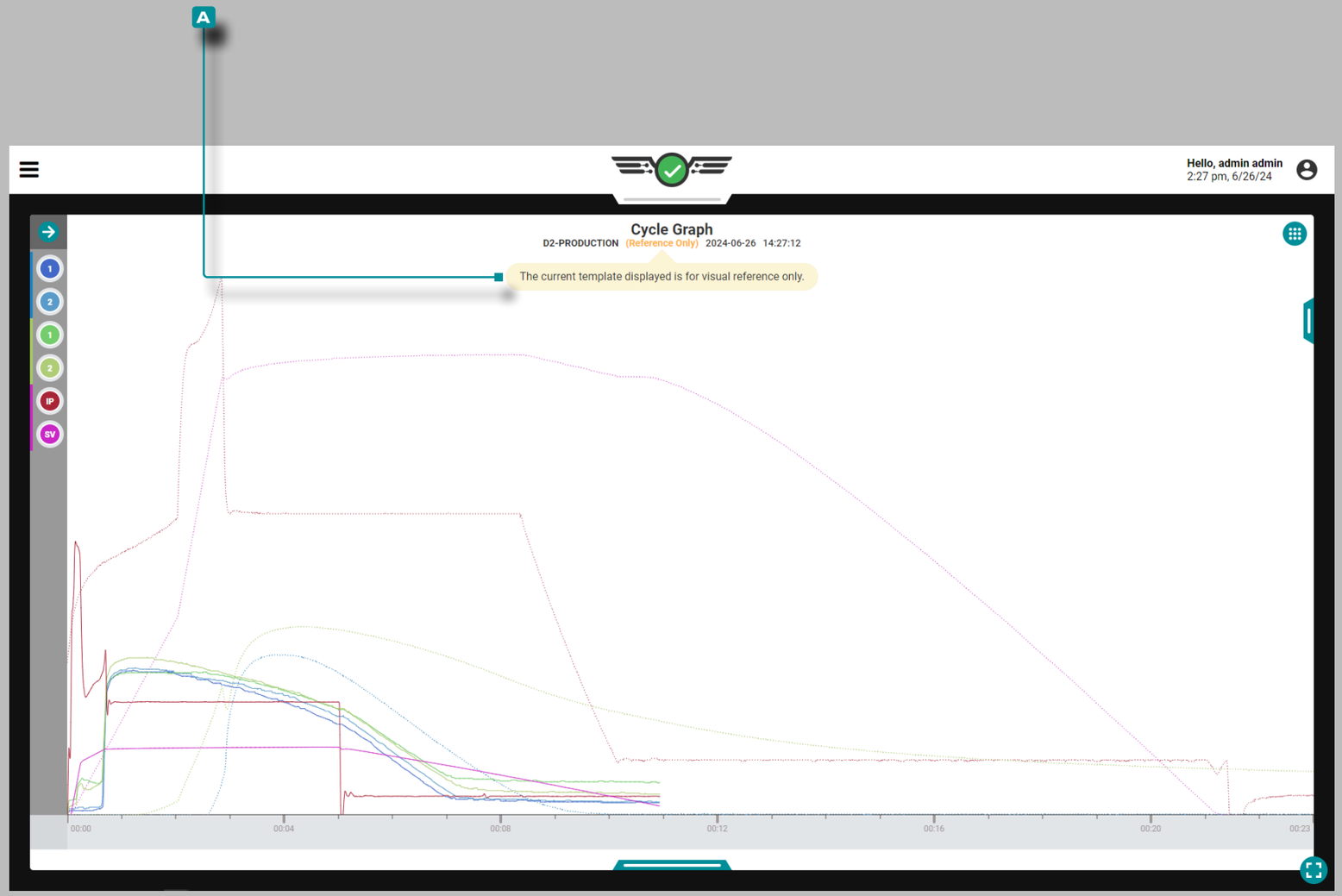


Archive a Template

Tap 👆 the **A** arrow button to expand and view the cycle data curve menu, then **tap** 👆 the **B** menu button to view existing templates. **Tap** 👆 the **C** VIEW ARCHIVES button, then **tap** 👆 to select the template(s) to archive. **Tap** 👆 the **D** ARCHIVE TEMPLATE button, then **tap** 👆 the **F** APPLY CHANGES button to archive or the selected template(s).

Restore a Template

Tap 👆 the **A** arrow button to expand and view the cycle data curve menu, then **tap** 👆 the **B** menu button to view existing templates; **tap** 👆 the **C** VIEW ARCHIVES button, then **tap** 👆 the template(s) to restore, **tap** 👆 the **E** RESTORE ARCHIVE button, then **tap** 👆 the **F** APPLY CHANGES button to restore the selected template(s).



Job Dashboard (*continued*)

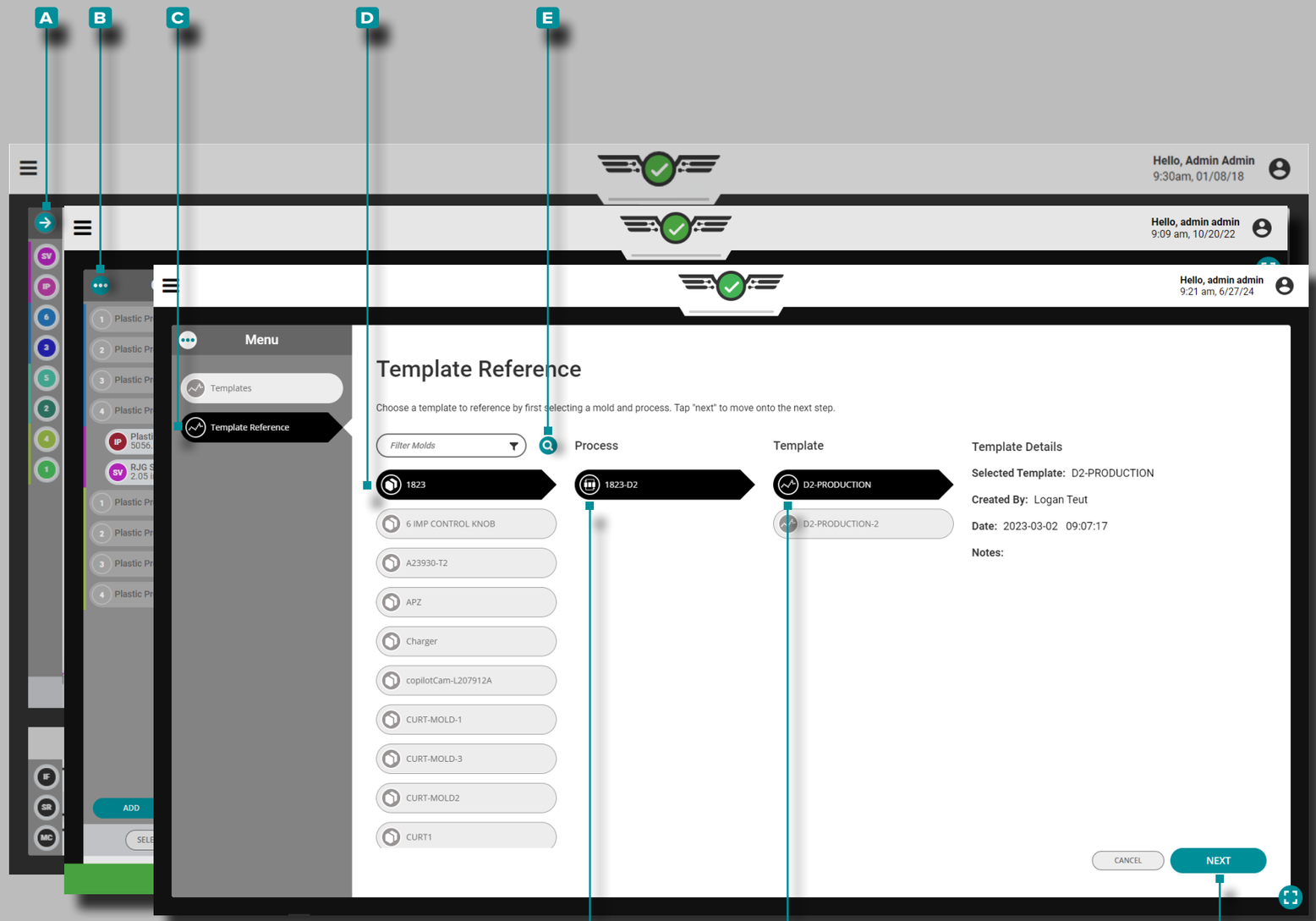
Cycle Graph Reference Templates

Reference template cycle from a different mold and process can be displayed on the Cycle Graph using the Template Reference function. Cavity pressure sensors can be assigned to the location/cavity of the reference template mold. Valve gate assignments on the mold can be matched/assigned to valve gate assignments on the loaded mold.

CAUTION *Template Match cannot be utilized while a reference template is loaded.*

When a reference template is loaded on the Cycle Graph, the template name on the Cycle Graph and the Previous Cycle Values widgets are replaced with a yellow combination A notification/tool tip, '("Reference Only").' **Tap** and hold on the A notification/tool tip to display the following message: "*The current template displayed is for visual reference only*."

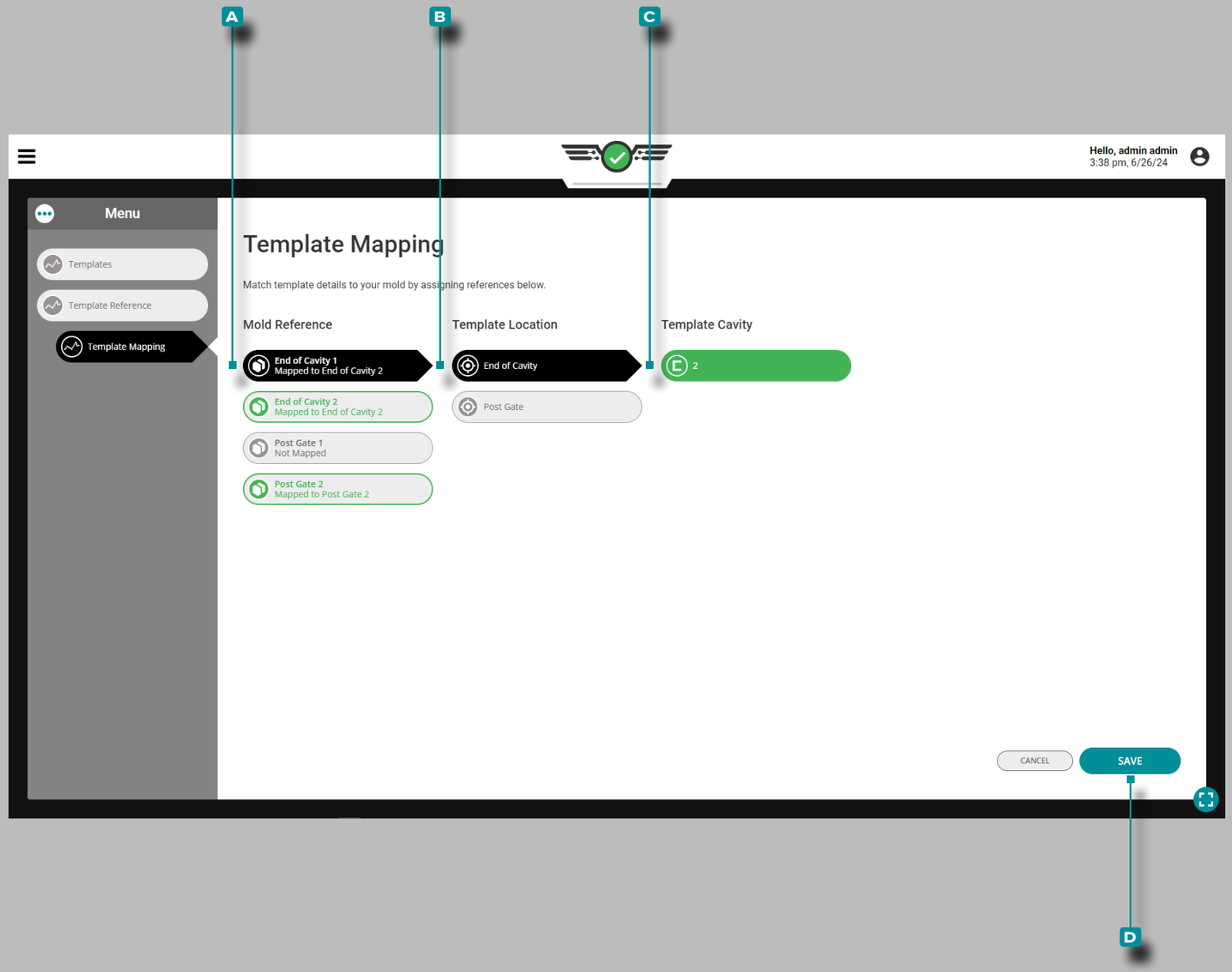
Job Dashboard (*continued*)



Load a Reference Template

Tap the **A** arrow button to expand and view the cycle data curve menu, then **tap** the **B** menu button to view the template menu. **Tap** the **C** Template Reference tab to view available reference templates. **Tap** to select a **D** Mold. Optionally, **tap** the **E** search icon , then **enter** a mold name to search for a mold by name. **Tap** to select a **F** Process, then **tap** to select a **G** Template. **Tap** the **H** NEXT button to continue to template mapping.

ⓘ **NOTE** *If the process has a template selected, the template will be automatically unloaded when a reference template is loaded.*



Job Dashboard (*continued*)

Template Mapping

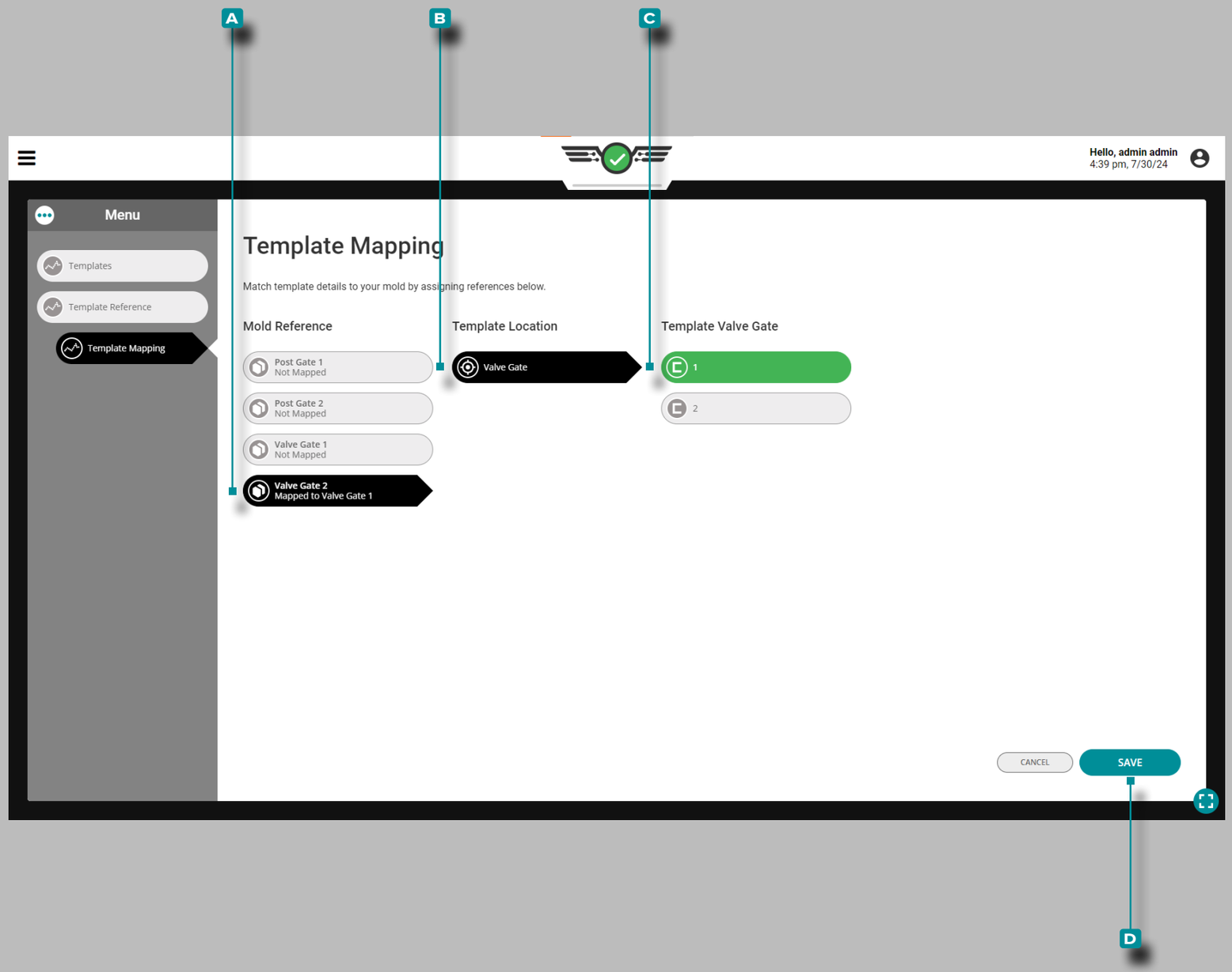
The template mapping function enables:

- cavity pressure sensors currently assigned in the mold to be matched to the sensors in the reference template.
- valve gate assignments in the mold to be matched to valve gate assignments in the reference template.

Mapping Cavity Pressure Sensors

Any cavity pressure sensors with matching location/cavity/ID assignments are automatically mapped between the current mold and reference template mold.

Tap a **A** mold reference cavity pressure sensor to select it, then tap the appropriate **B** location and **C** template cavity to map (match) the template reference sensors to the mold sensors. **Tap** the **D** SAVE button when all sensors have been mapped.

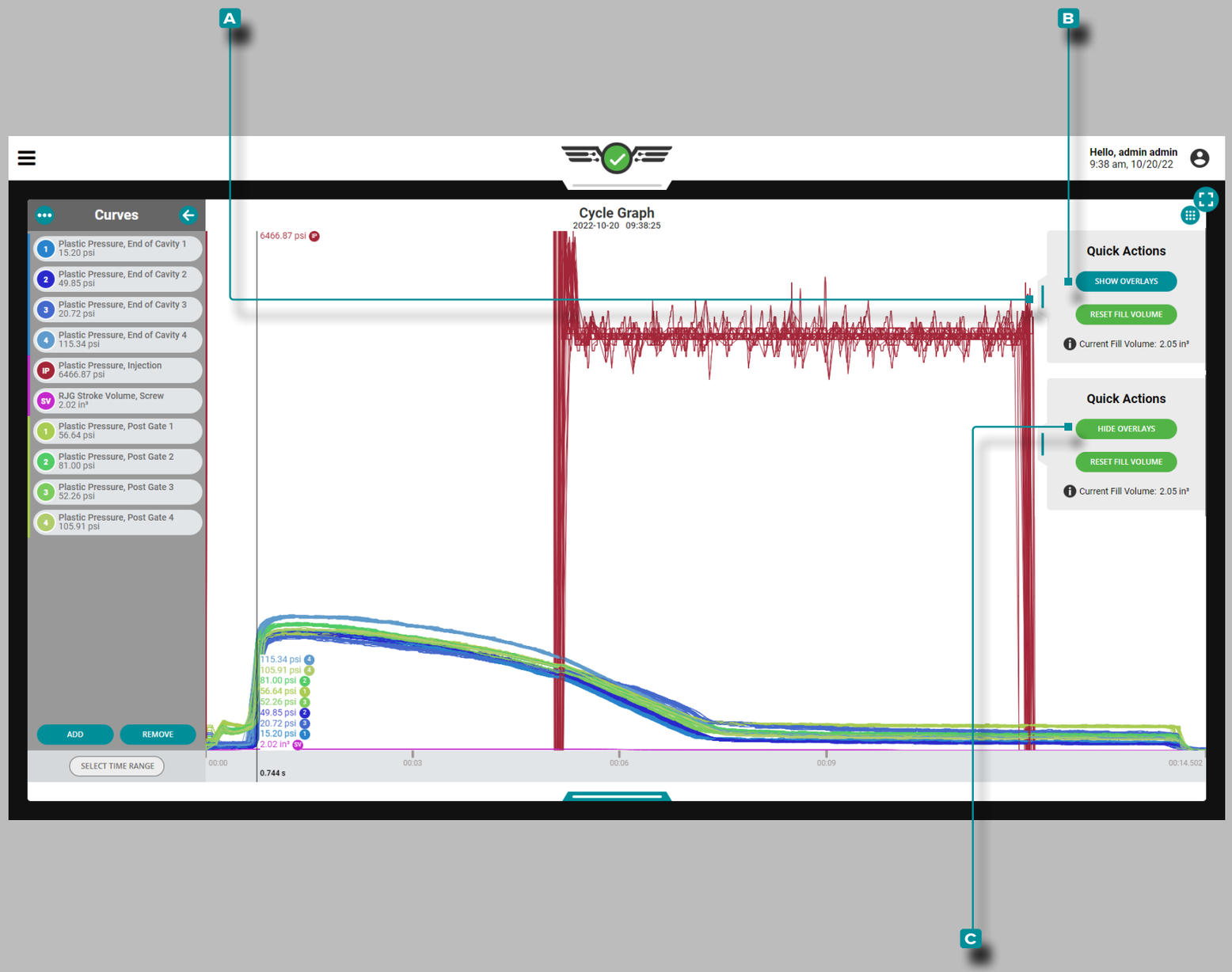


Job Dashboard (*continued*)

Mapping Valve Gate Assignments

Any valve gate assignments with matching assignments are automatically mapped between the current process and reference template process.

Tap a **A** reference valve gate to select it, then tap the process **B** valve gate to map (match) the template reference valve gates to the process valve gates. **Tap** the **C** SAVE button.



Job Dashboard (*continued*)

Cycle Graph Overlay Cycles

On the Cycle Graph, subsequent cycles can be overlaid on top of one another using the overlay function.

Show Overlay Cycles

On the Cycle Graph, **tap** 👆, **hold**, and **drag** the **A** Quick Actions menu slider to the left, then **tap** 👆 the **B** SHOW OVERLAYS button; this will overlay each subsequent cycle on top of the cycle that was current when the overlay function was activated.

Clear Overlay Cycles

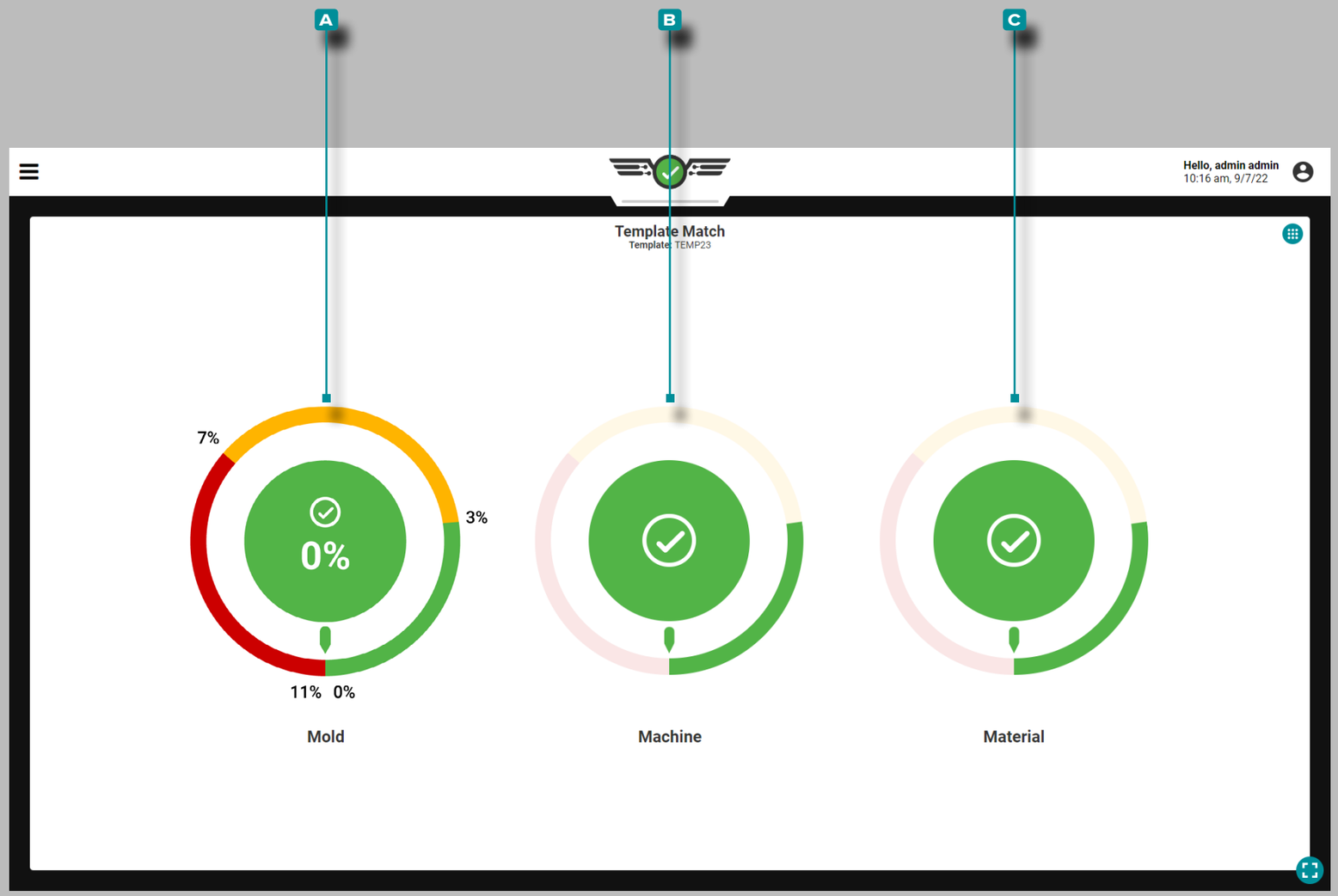
To remove overlay cycles, **tap** 👆 the **C** HIDE OVERLAYS button on the Cycle Graph **A** Quick Actions menu.

ⓘ **NOTE** *Whenever the scaling of the Summary or Cycle Graph is changed, the applied overlay will be reset; the CoPilot system does not store cycle data, it renders the data. To view stored cycle data, view the job on The Hub software.*

Job Dashboard (*continued*)

Cycle Graph Sensor Errors and Missing Data

On the Cycle Graph, sensor errors that cause missing data are displayed as dots. Sensor errors are also displayed on the Summary Graph; refer to “Summary Graph Sensor Errors and Missing Data” on page 118.



Job Dashboard (*continued*)

Template Match

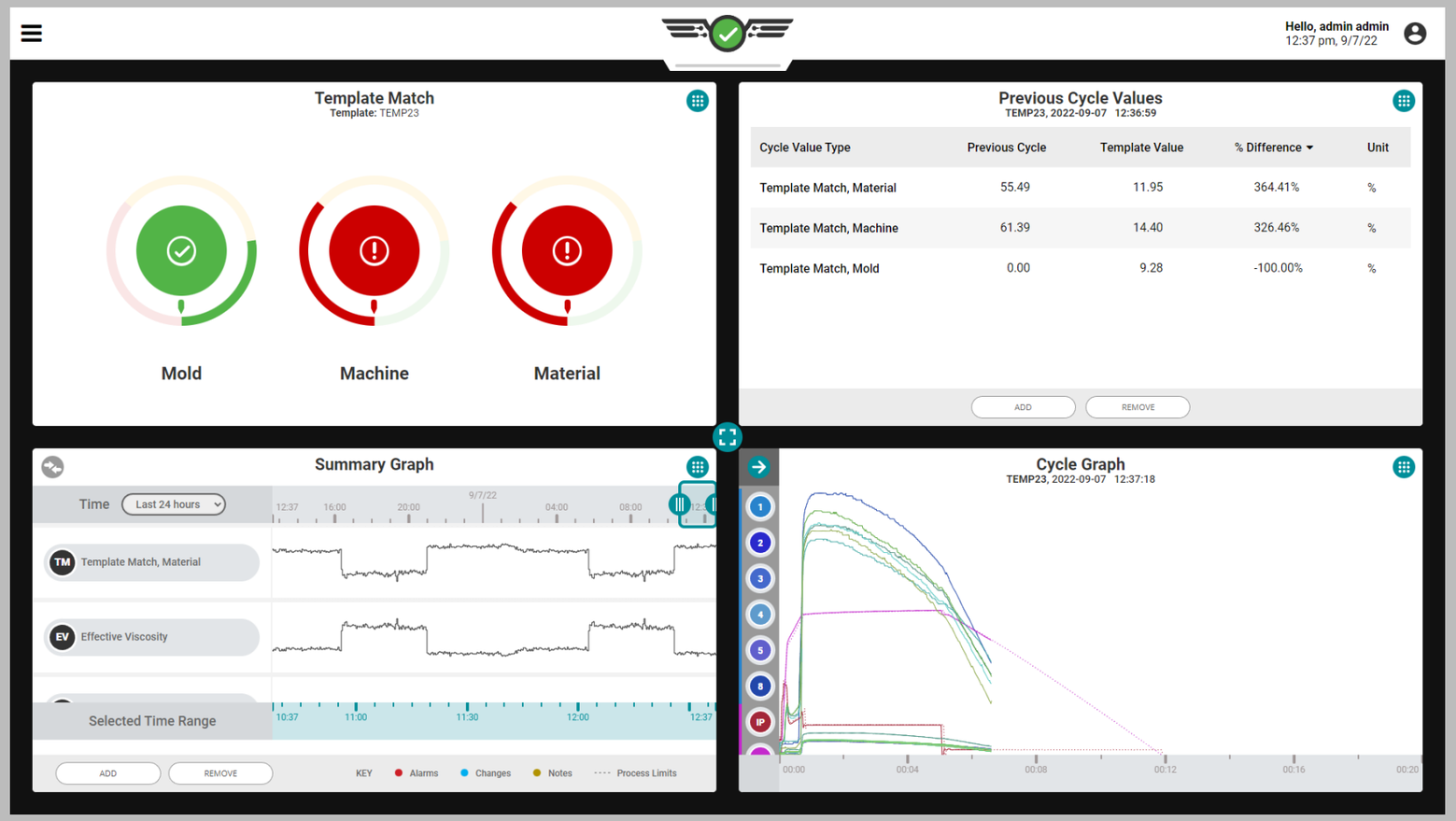
The Template Match widget provides process template match status based on the entered good and warning percentages and the selected process template on the Cycle Graph for mold, machine, and material process values. The Template Match widget compares the previous cycle's summary values to the template values and displays the difference and percent difference of each value.

The Template Match widget displays three "dials": A Mold, B Machine, and C Material. **Tap** and hold on a template match dial to view the previous cycle's match percentage for the selected dial; release the dial to return to the default view.

Match percentages displayed on each dial correspond to the percent match the previous cycle was to the template value being referenced. A zero percent indicates a zero percent difference from the template value; the greater the percent difference of a value from the template value, the closer the value is to being out of match. When the system is unable to calculate a summary variable, an error state will be displayed.

If no percentages are entered for a dial during process setup, the template match dial will be inactive.

Job Dashboard (*continued*)

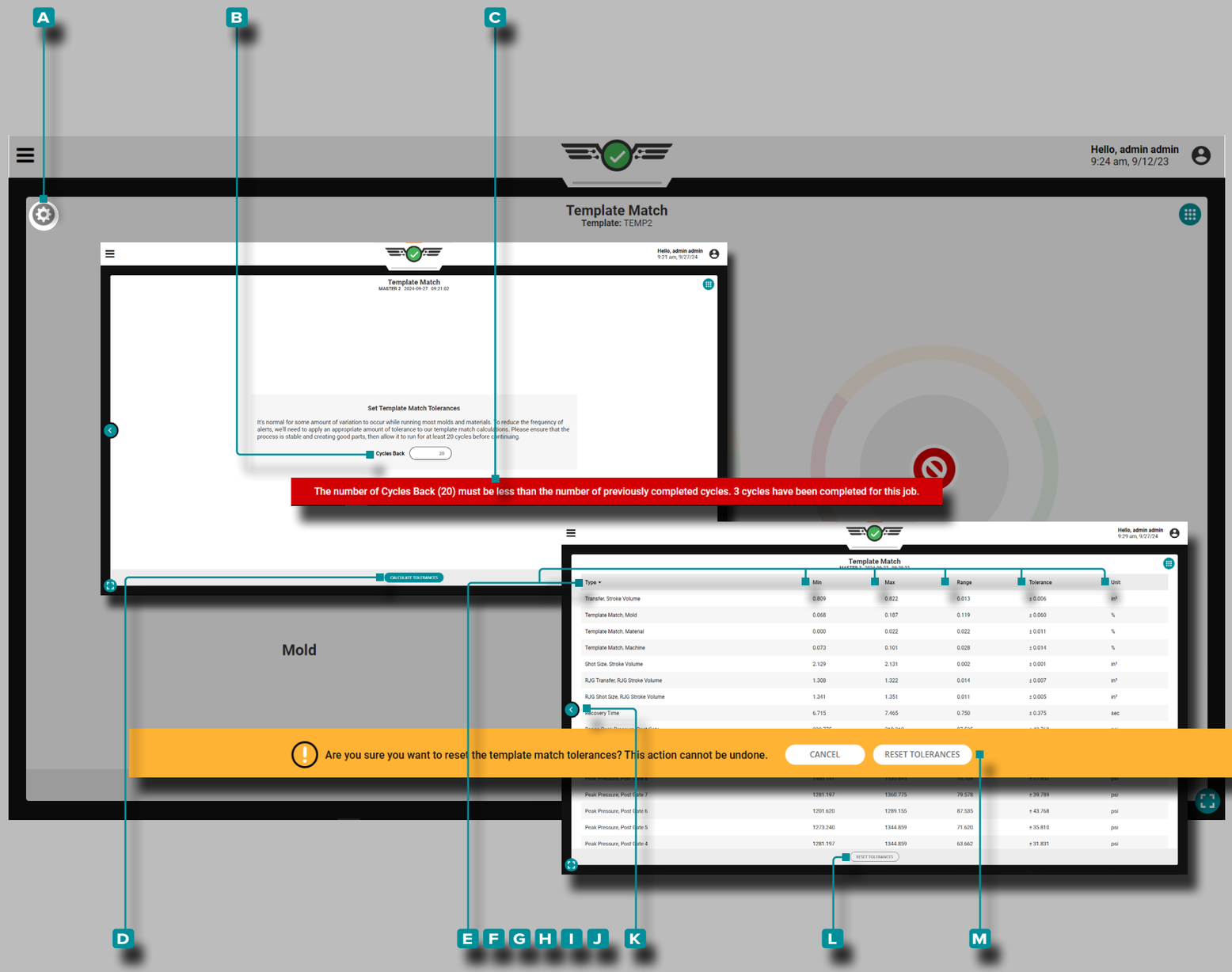


Template Match (continued)

A template must be created and loaded on the Cycle Graph in order for the Template Match widget to operate. Refer to “Create a Template” on page 84 for creating and loading cycle graph templates. The process must be stable before creating a template for use with the Template Match widget.

The loaded template name is displayed on the template match widget. If a remote user changes the loaded template, the system will utilize that template. If new sensors are connected/assigned, a new template must be saved to include the new sensors.

Users can add and view template match mold, machine, and/or material trends to the summary graph; refer to “Summary Graph” on page 107. The overall percent difference template match for mold, machine, and material can be added and viewed on the Previous Cycle Values widget; refer to “Previous Cycle Values Table” on page 119.



Job Dashboard (*continued*)

Set Tolerance (Normal Process Variation)

When running most molds and materials, there is some amount of normal variation that occurs: this is referred to as “tolerance”.

To reduce the occurrence of template match alerts from variations, a tolerance will be calculated and added to the template match values; ensure that the process is stable and creating good parts, then allow it to run for at least 20 cycles before continuing.

To set ranges for the process (if no ranges currently exist on the process), **tap** the **A** gear icon on the upper-left corner of the Template Match widget.

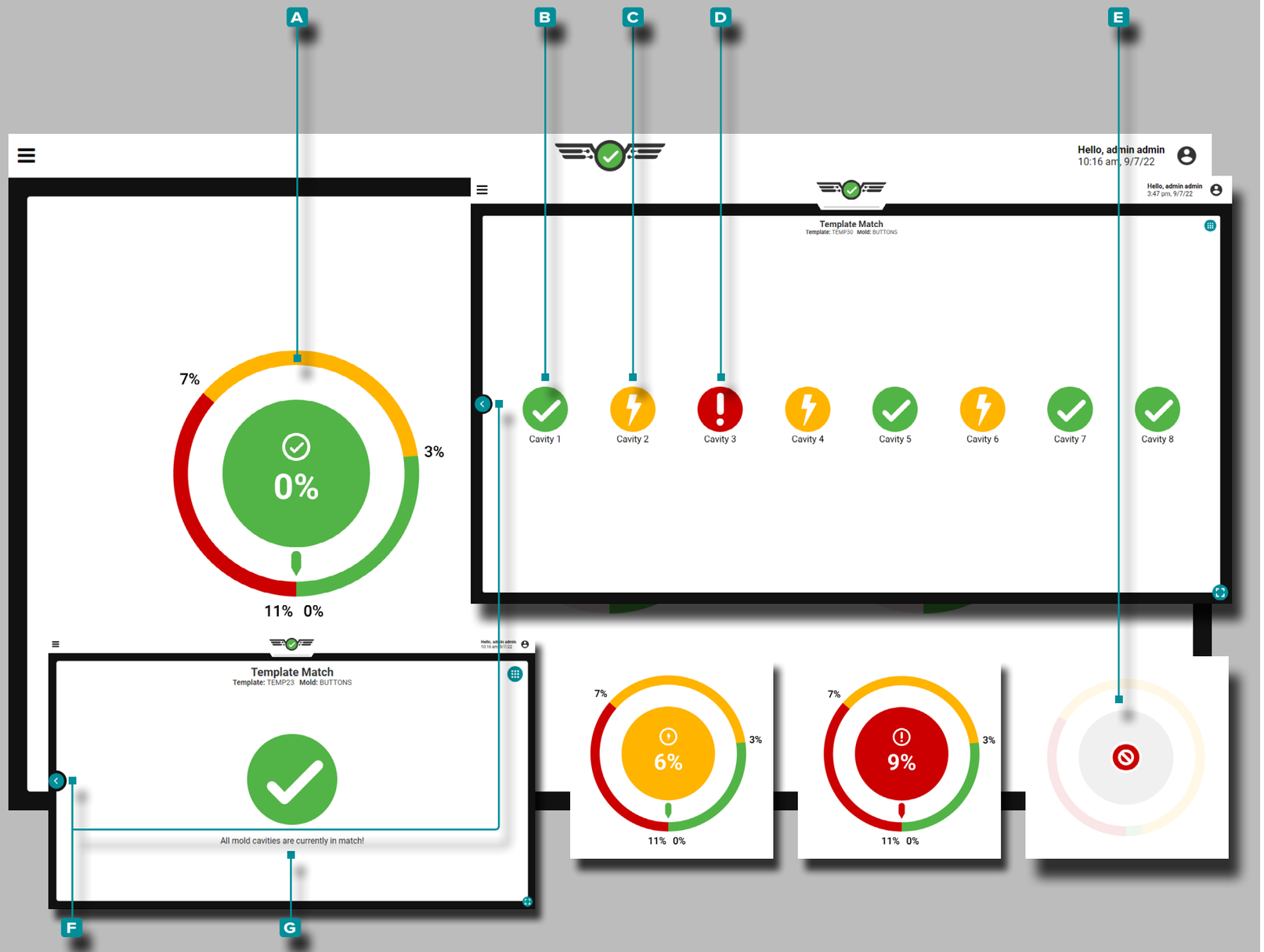
Enter the **B** number of cycles back (minimum of 20); if no value is entered, the system defaults to the minimum of 20. If the input has more cycles than have ran, a **C** user notification is generated to inform the user.

Tap the **D** CALCULATE TOLERANCE button to begin.

A table showing the **E** Type, **F** Minimum, **G** Maximum, **H** Range, **I** Tolerance, and **J** Unit is displayed for every available summary variable, including variables that aren’t currently used for template match. **Tap** the **K** back icon to return to the template match gauge view.

To reset the tolerances, **tap** the **L** RESET TOLERANCES button on the template match widget, then **tap** the **M** RESET TOLERANCES button on the user notification to confirm the reset. The user must set a new number of cycles back, and calculate tolerances again to set normal process variation after a tolerances reset occurs.

Job Dashboard (*continued*)



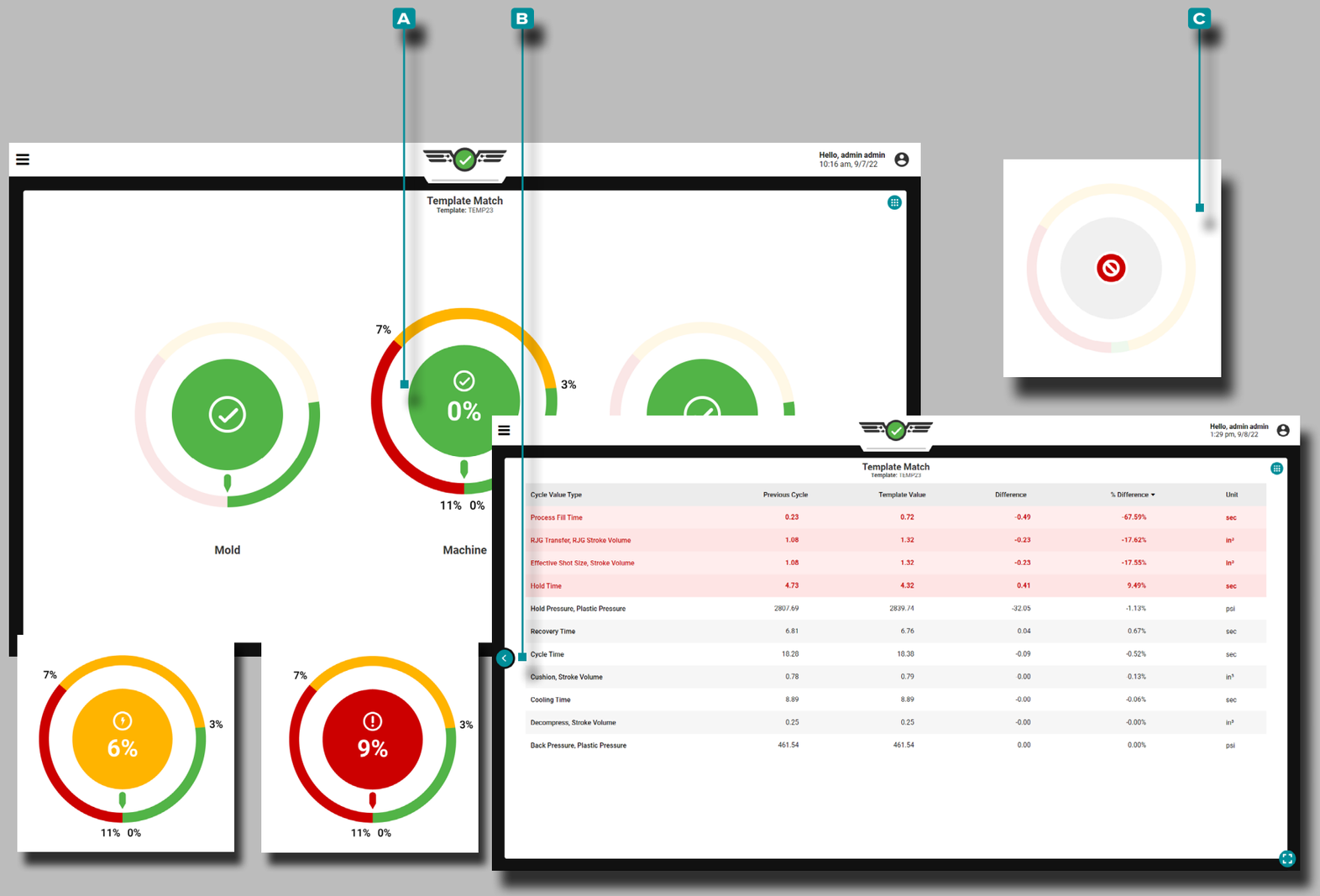
Mold Match

The Mold Match dial monitors and displays connected and assigned cavity pressure sensor match percent. Mold Match percent is based on the previous cycle's EOC cooling rate, peak pressure, cavity fill time, and cavity fill & pack time summary values compared to the selected template values. If the center of the dial is green, all cavities are in the "good" match range; if the center of the dial is yellow, at least one cavity is in the "warning" range; and if the center of the dial is red, at least one cavity is "out of match".

During Process Setup, Mold Match settings are defaulted to 3% for good match percentage and 7% for warning match percentage.

Tap on the **A** Mold Match dial to view **B** good cavities, **C** warning cavities, **D** out of match cavities, and **E** error state cavities. **Tap** the **F** back button to return to the Template Match widget overview. If all sensors are in match, the mold match dial will display an overall **G** all sensors in match screen. The mold name is displayed on the Mold Match details view.

When a sensor(s) become invalid, an **E** error state will be displayed. If no mold sensors are connected/assigned, the mold match template dial will be inactive.



Cycle Value Type	Previous Cycle	Template Value	Difference	% Difference	Unit
Process Fill Time	0.23	0.72	-0.49	-67.59%	sec
RJG Transfer, RJG Stroke Volume	1.08	1.32	-0.23	-17.62%	in³
Effective Shot Size, Stroke Volume	1.08	1.32	-0.23	-17.55%	in³
Hold Time	4.73	4.32	0.41	9.49%	sec
Hold Pressure, Plastic Pressure	2807.69	2839.74	-32.05	-1.13%	psi
Recovery Time	6.81	6.76	0.04	0.67%	sec
Cycle Time	18.28	18.38	-0.09	-0.52%	sec
Cushion, Stroke Volume	0.78	0.79	0.00	0.13%	in³
Cooling Time	8.89	8.89	-0.00	-0.06%	sec
Decompress, Stroke Volume	0.25	0.25	-0.00	-0.00%	in³
Back Pressure, Plastic Pressure	461.54	461.54	0.00	0.00%	psi

Job Dashboard (*continued*)

Machine Match

The Machine Match dials monitors and displays 11 machine-related values' match percent, including:

- process fill time,
- Transfer (volume),
- shot size,
- hold time, recovery time,
- decompress/stroke volume,
- cushion/stroke volume,
- cooling time,
- cycle time,
- hold pressure/plastic pressure, and
- back pressure/plastic pressure.

There are no default settings for good or warning match percentages; always set good and warning match percentages based on proven, stable process values. If the center of the dial is green, all values are in the "good" match range; if the center of the dial is yellow, at least one value is in the "warning" range; and if the center of the dial is red, at least one value is "out of match".

Tap on the **A** Machine Match dial to view the machine values. **Tap** the **B** back button to return to the Template Match widget overview.

Ensure the sorting output timing is set to End of Mold Clamped during process setup to allow cooling time to be calculated; refer to "Sorting Output Timing" on page 42.

When a machine sensor(s) become invalid, an **C** error state will be displayed. If no machine good or warning limits are assigned, the Machine Match template dial will be inactive.

In order for the Machine Match to function, fill volume must be set using the cursor on the Cycle Graph. Refer to "Set Fill Volume at Cursor" on page 76 for information and instructions on setting fill volume at cursor.

Job Dashboard (*continued*)

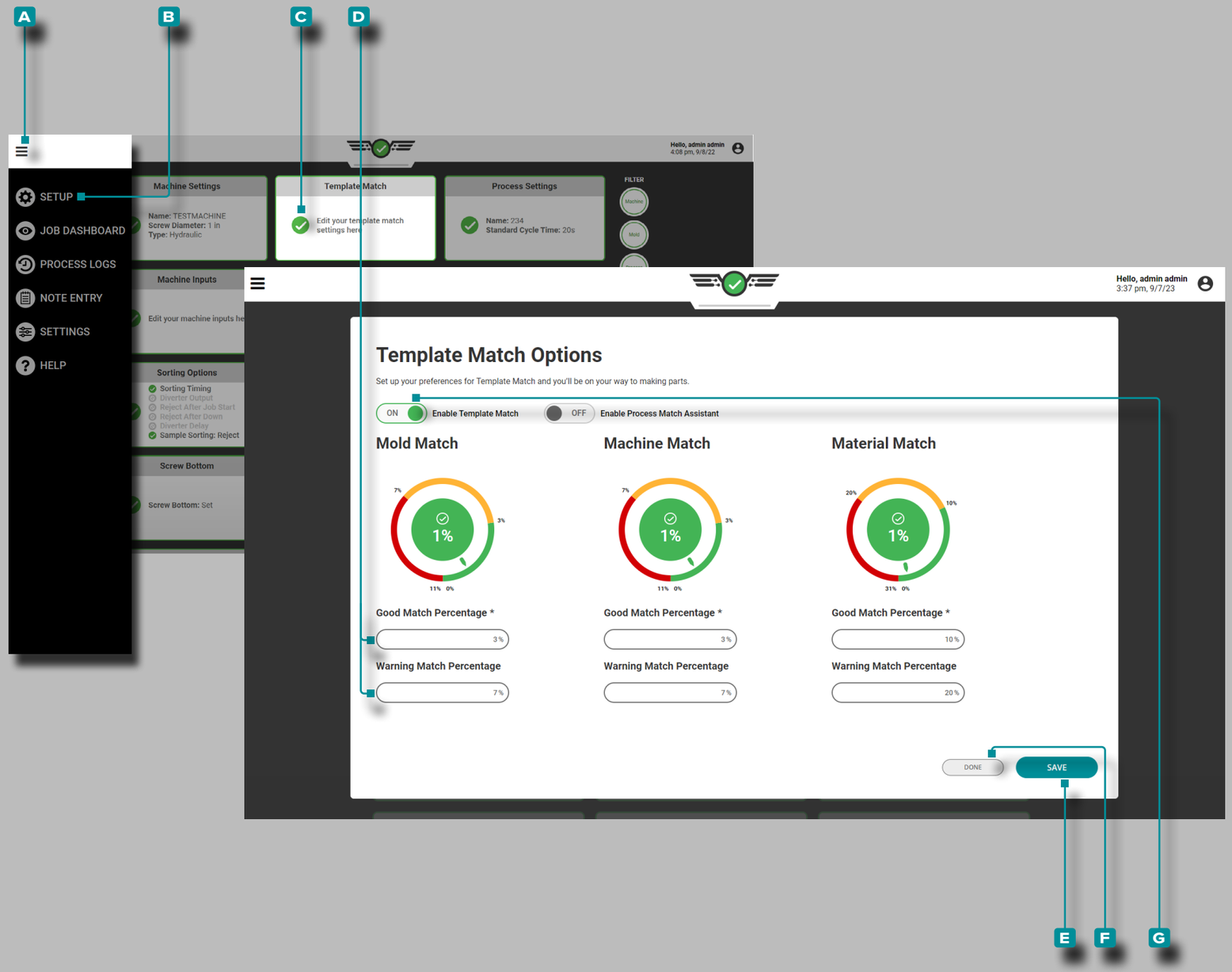
Material Match

The Material Match dial monitors and displays effective viscosity match percent. Material Match is based on the previous cycle's effective viscosity compared to the selected template effective viscosity value. There are no default settings for good or warning match percentages; always set good and warning match percentages based on proven, stable process values. If the center of the dial is green, effective viscosity is in the "good" match range; if the center of the dial is yellow, effective viscosity is in the "warning" range; and if the center of the dial is red, effective viscosity is "out of match".

Tap on the **A** Material Match dial to view the previous cycle, template, difference, and percent difference effective viscosity values. **Tap** the **B** back button to return to the Template Match widget overview. When a machine sensor becomes invalid, an **C** error state will be displayed. If no material good or warning limits are assigned, the Material Match template dial will be inactive.

If material match changes while no machine settings/ machine match values *and* no temperatures have changed, the incoming material has changed.

In order for the Material Match to function, fill volume must be set using the cursor on the Cycle Graph. Refer to "Set Fill Volume at Cursor" on page 76 for information and instructions on setting fill volume at cursor.



Job Dashboard (*continued*)

Edit Template Match Percentages

The Template Match mold, machine, and material good and warning match percentages can be edited through the setup dashboard.

Tap the A menu button, **tap** B Setup Dashboard, then **tap** the C Template Match setup dashboard card; **Tap** a D good or warning match percentage field to edit that field. **Enter** the desired match percentage, then **tap** the E SAVE button to save changes, or **tap** the F DONE button to exit and cancel any changes.

Turn Template Match On/Off

The Template Match feature can be turned on/off after setup through the setup dashboard card.

Tap the A menu button, **tap** B Setup Dashboard, then **tap** the C Template Match setup dashboard card; **tap** the G Enable Template Match ON/OFF slider to turn the Template Match feature on or off, then **tap** the E SAVE button to save changes, or **tap** the F DONE button to exit and cancel any changes.

Job Dashboard (*continued*)

Advice with MAX

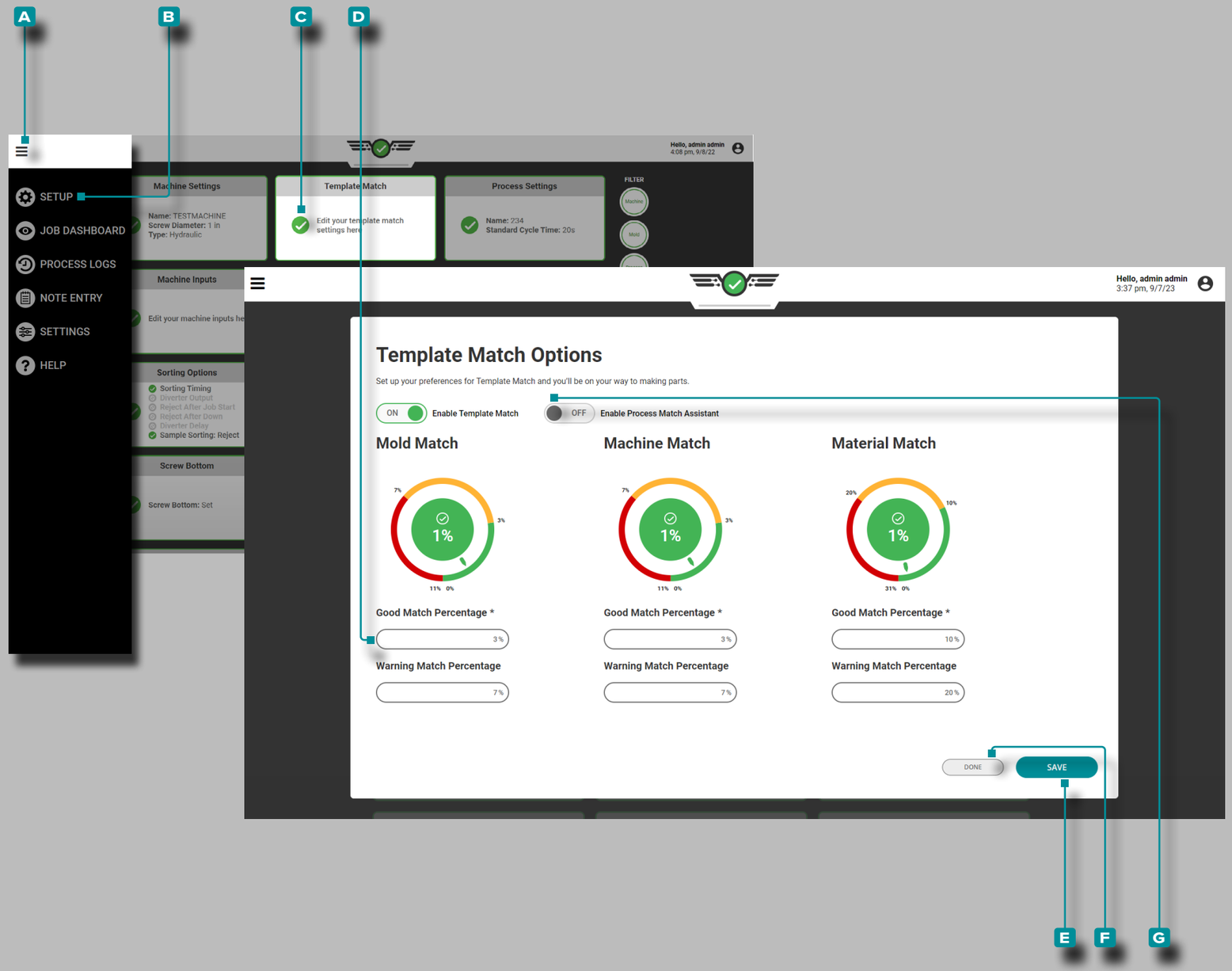
The Advice feature (previously known as “Process Match Assistance”), located on the Template Match Widget, provides advice using Molding Automation Xperience (MAX, the Process Advisor®) powered by smart AI and proven Master Molder® techniques for Process Technicians to correct mold pressures and material viscosity that do not match the template through systematic correction of process variables related to cavity filling, cavity packing, and cooling.

Requirements

To use Advice the following is required:

1. Must have connected, assigned cavity pressure sensors
2. Must have a process template loaded. Advice will work with existing CoPilot templates; these templates will have retroactively-calculated summary data that could affect job performance or could cause template match and advice to become unreliable.
3. Must have Advice enabled on the Process Setup>Process Settings card during the setup OR during the process from the Setup Dashboard>Template Match dashboard card.
4. Must have at least 10 completed cycles on the current job before starting the advice.
5. A user with either Process Engineer or Process Technician role must be logged in to the CoPilot system.

CAUTION *Advice is not for use with DECOUPLED III processes at this time.*



Job Dashboard (*continued*)

Advice with MAX Activation

The Advice feature can be turned on/off during Process Setup (refer to page 47), or after setup through the setup dashboard card.

Tap 👆 the A menu button, **tap** 👆 B Setup Dashboard, then **tap** 👆 the C Template Match setup dashboard card; **tap** 👆 the G Enable Advice with MAX ON/OFF slider to turn the Advice feature on or off, then **tap** 👆 the E SAVE button to save changes, or **tap** 👆 the F DONE button to exit and cancel any changes.

The Advice controls bar is hidden while the Mold is in an In-Match state. The controls bar with Start Advice button is visible only while the Mold is in either a Warning or out of match state.

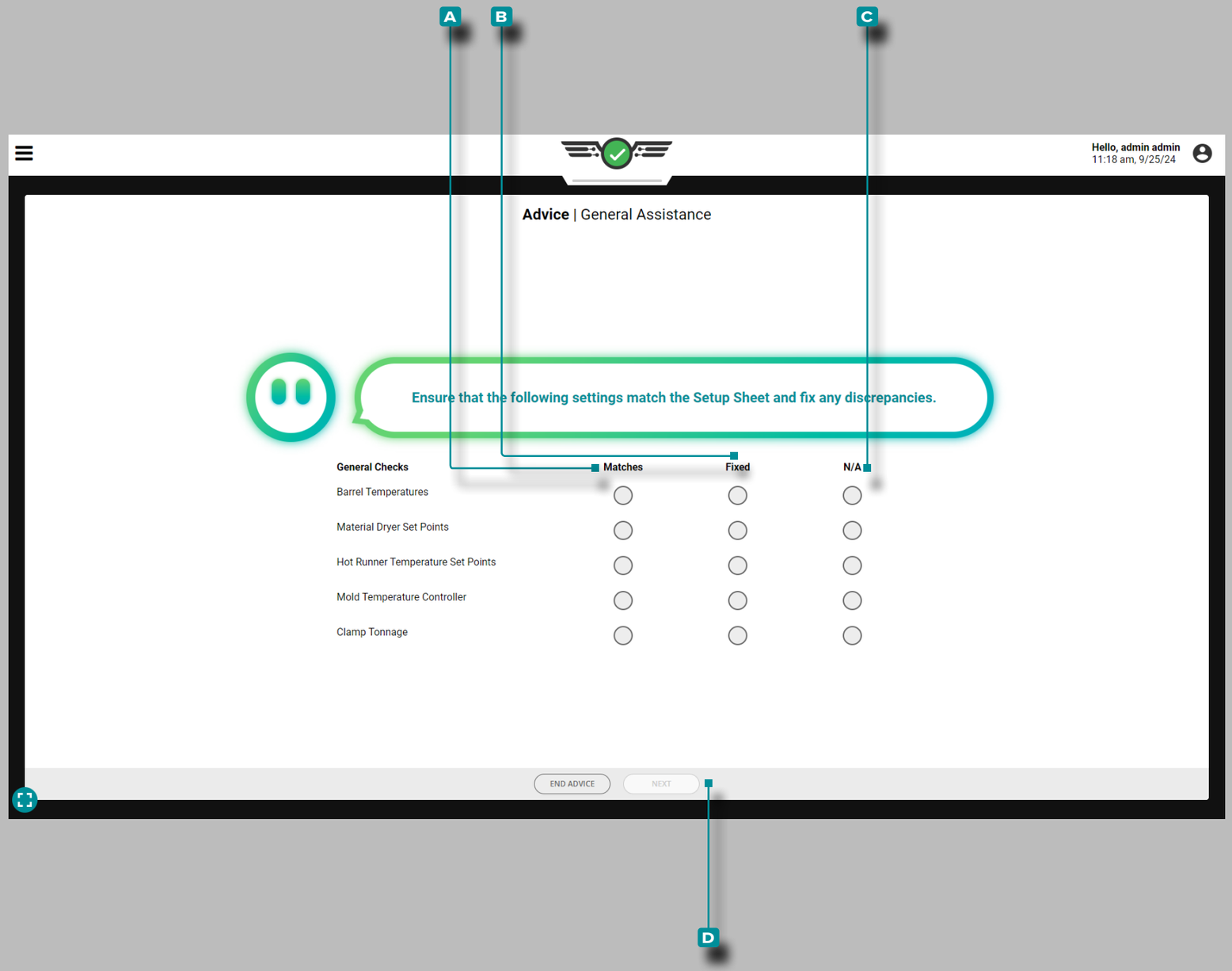
If the Mold is out of match *and* the template match widget isn't selected, then each widget selection icon switches to an out-of-match state with a pulse animation. While the Mold is Out-of-Match, if the Template Match widget is not already selected, then the widget selection menu should display a message and highlight the Template Match widget.

CAUTION *Composite variables are not referenced during the advice process.*

Out of match does not mean that there are active alarm cycles or bad parts—only that the current process is out of match from the selected process template.

CAUTION ***The user must be logged in start the advice.***

NOTE *Advice can be disabled by a Process Engineer for any mold.*



Job Dashboard (*continued*)

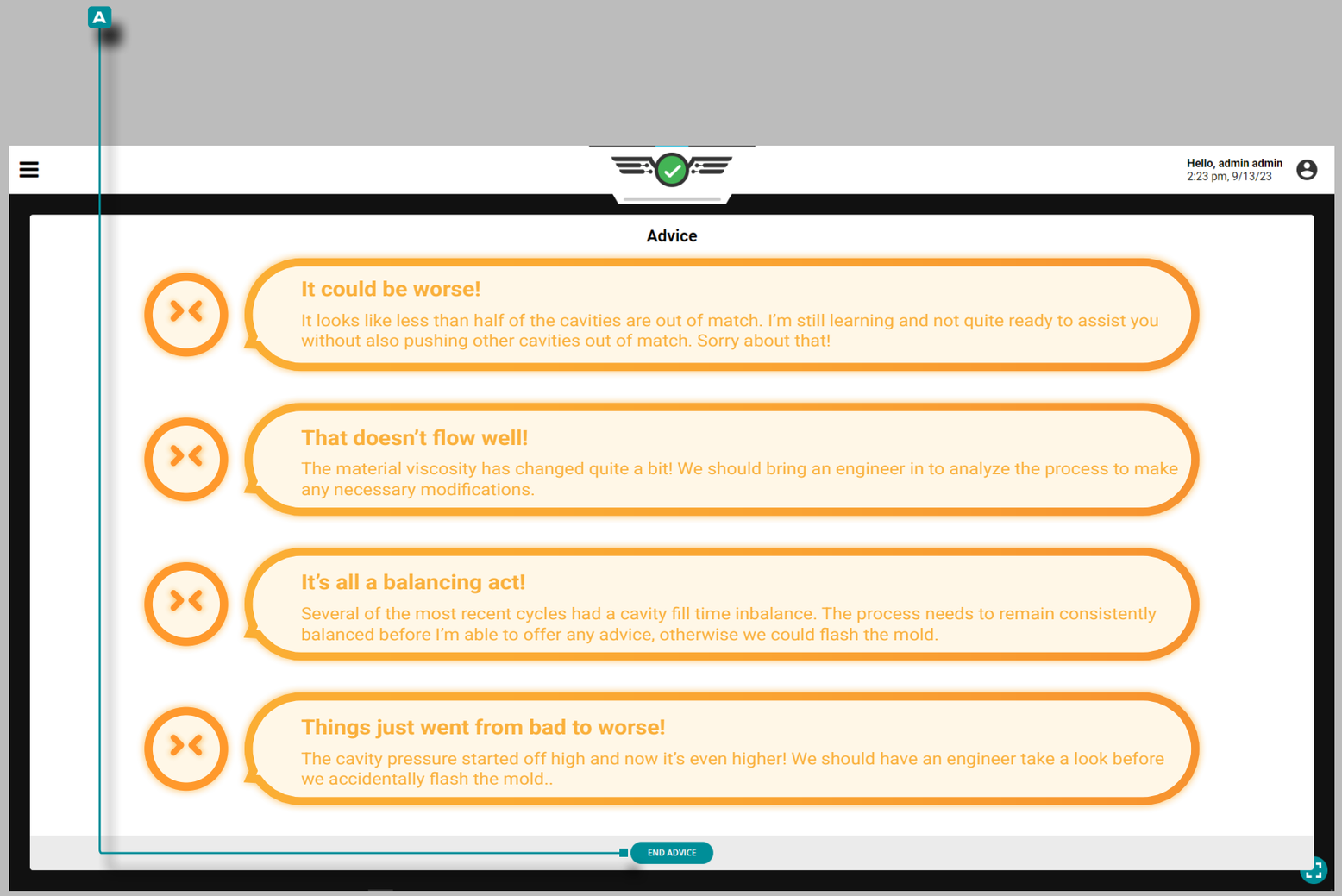
General Checks

General Checks are checks for settings on the setup sheet that include any extraneous settings that cannot be easily detected using the RJG, Inc. CoPilot system hardware, including:

- barrel temperature
- material dryer set points
- hot runner temperature set points
- mold temperature controller

Tap 👆 to select either **A** Matches, **B** Fixed, or **C** N/A for each General Check, then **tap** 👆 the **D** NEXT button to continue with process match assistance. The system will enter a thirty-minute wait after general checks are completed before process match assistance will provide the next step.

General checks must be completed each time advice is started.



Job Dashboard (*continued*)

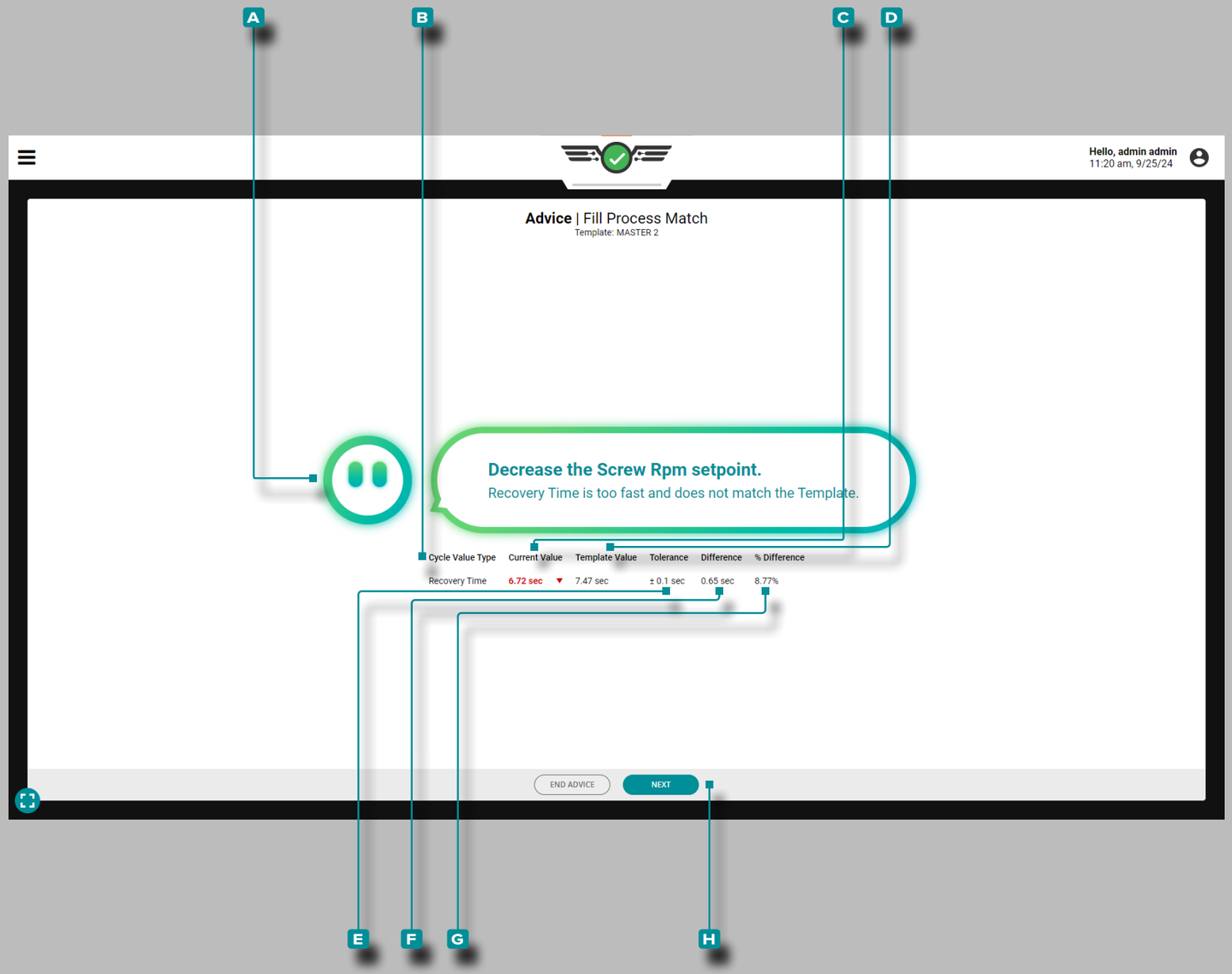
Starting Advice with MAX

After General Checks are completed, all of the following must be true, otherwise the software will direct the user to "Get an Engineer" and not provide advice/assistance:

- at least 50% of the cavities must be in either a warning or out-of-match state;
- the Material Viscosity must be within or equal to ±20% of the Cycle Template;
- the Cavity Fill Time Balance must be greater than or equal to the lower limit for at least 8 of the last 10 cycles;
- all Cavity Peak Pressures must be no more than 10% over the Cycle Template; and/or
- a summary variable needed for advice is missing from the cycle template.

If the software displays the Get an Engineer page, **tap** the A END ADVICE button, then complete the Notes required (refer to "Advice Notes" on page 105).

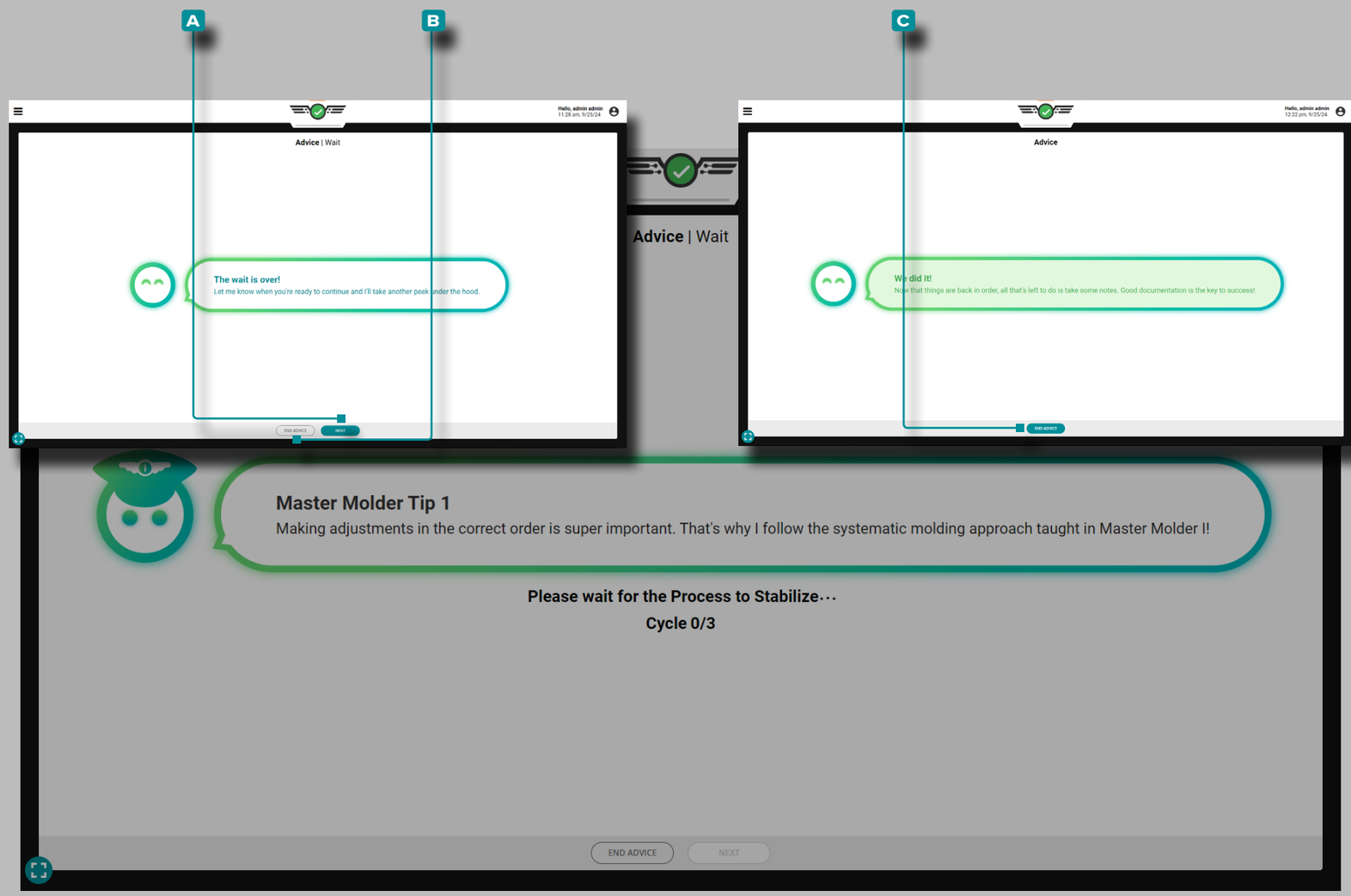
Job Dashboard (*continued*)



Advice with MAX

After completing General Checks, and if the advice start requirements are met, the CoPilot system will display **A** Advice with MAX for correcting the process to match the template. The **C** current value for the **B** variable that is being corrected will be displayed, along with the **D** template value, **E** tolerance, the **F** difference, and the **G** percent difference.

Make the recommended change, then **tap** the **H** NEXT button to continue.



Job Dashboard (*continued*)

Advice with MAX (continued)

Advice with MAX will allow for the process to stabilize for three cycles after a change is made to affect process variables. Wait for the three cycles to elapse. For the duration of the the three stabilization cycles, MAX will feature Master Molder® molding tips.

When the three-cycle wait has elapsed, the view will change to either:

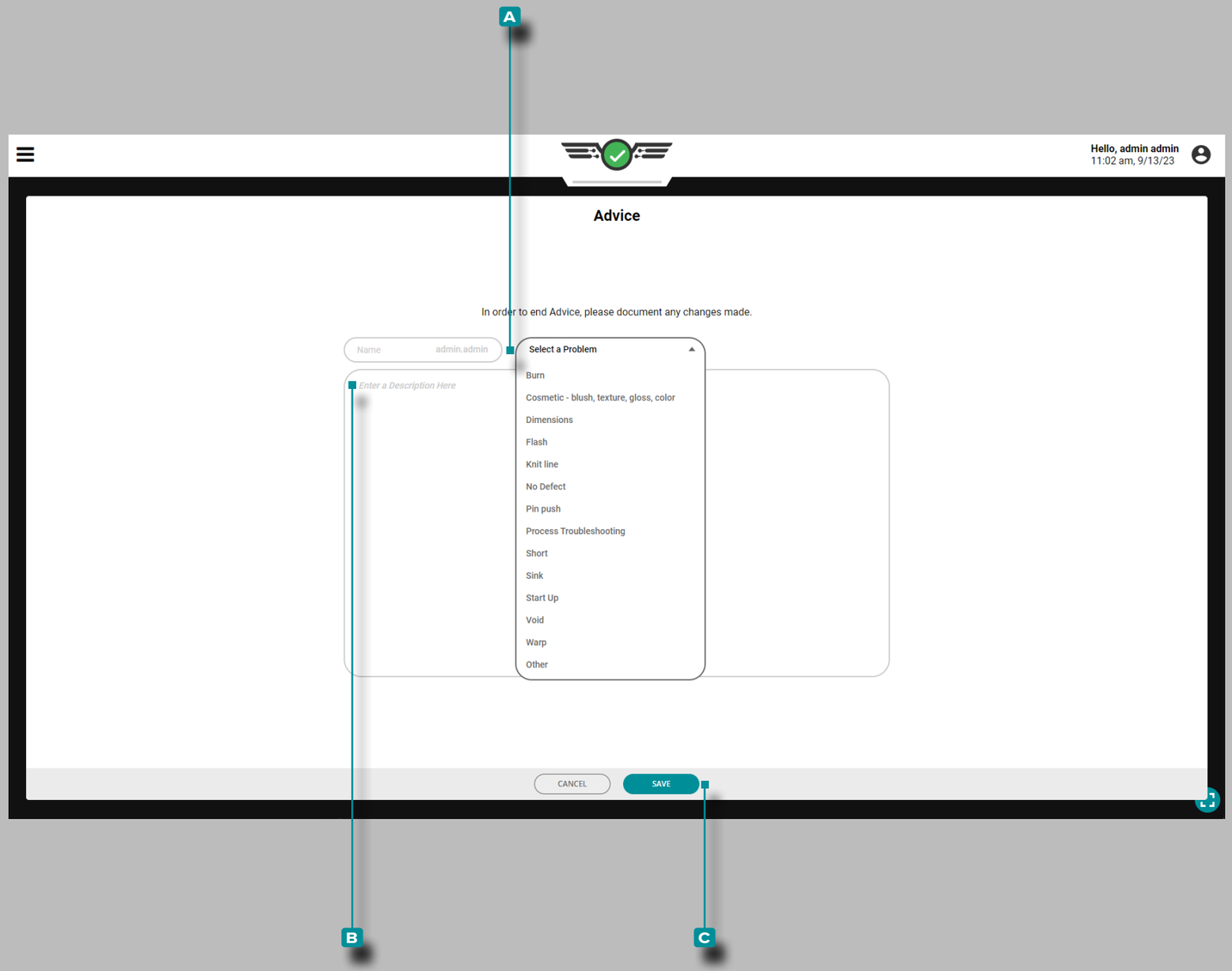
- guide the user to the next step of advice; **tap** the **A** NEXT button to continue with advice, or **tap** **B** END ADVICE to escape the advice, OR
- confirm that the template has been matched/the advice session was successful; **tap** the **C** END ADVICE button to escape the advice screen, then complete the Notes required (refer to “Advice Notes” on page 105).

Advice will stop if:

- three advice attempts have been exceeded
- if cavity peak pressure goes 10% above the upper template match limit to prevent flash and damage to the mold
- material viscosity has shifted more than 20% after performing the general checks and after verifying back pressure and screw run time

An Advice Document is generated and versioned in the software that will log which set of advice rules were followed and the number of times that advice was provided to correct a process variable value for ease of use when investigating an issue.

Job Dashboard (*continued*)



Advice Notes

When the advice session is completed or abandoned before completion, a note must be entered. The system will auto-populate the Note name field with the logged-in username; the name field is not editable. **Tap** to select a mold process **A** problem type (short, flash, sinks, etc.) from the drop-down list, then **tap** the field to enter a **B** description; **tap** the **C** SAVE button to save the note. The notes created during the advice workflow are available on the Notes widget, or under the Notes tab; refer to pages “Notes” on page 152 and “Note Entry” on page 166.

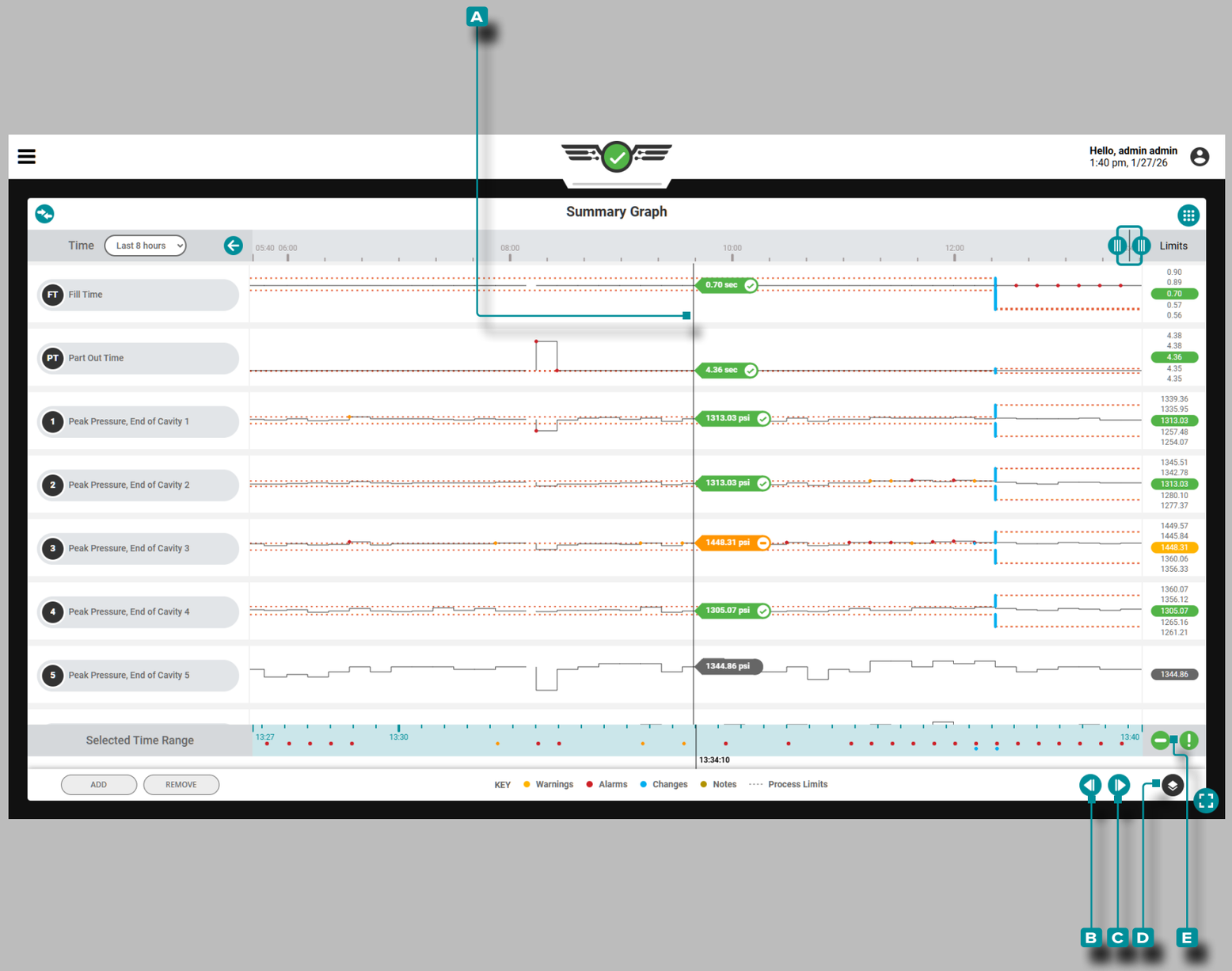
Job Dashboard (*continued*)

Advice with MAX Interruptions

If any of the following actions occur during use of the advice with MAX feature, the software will record the advice session as “Interrupted”:

- the job is stopped
- the machine enters a down state
- the cycle template is changed
- the template match thresholds on the process are changed

The user must enter a note after the advice session has been interrupted, unless the job was stopped; refer to “Advice Notes” on page 105.



Job Dashboard (*continued*)

Summary Graph

Cycle Data Trends

The Summary Graph provides the selection and graphical display of job cycle summary data that form trends and highlight alarm conditions.

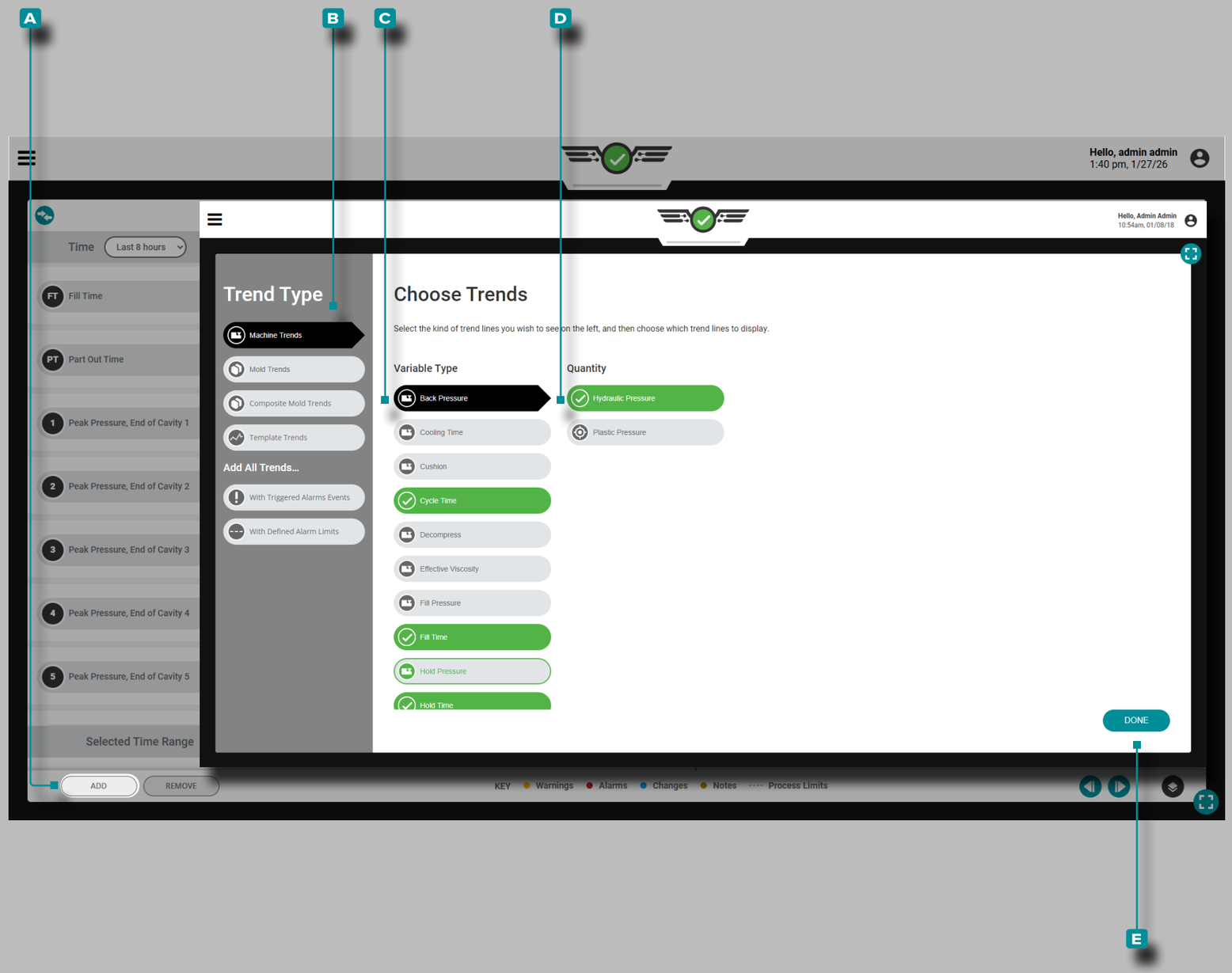
The cycle summary data are summary values of a complete cycle; *a single data point represents a cycle*. The data points are displayed in chronological order, creating a curve and allowing the viewing of trends. The type and number of cycle data trends available depends upon equipment (machine and mold) installed.

The upper and lower process limits set for each cycle data trend type is displayed as dashed lines (- - - -) with the trend; warnings (●), alarms (●), changes (●), and notes (●) are also displayed on each trend.

Tap ☝ **and hold** on the summary graph to reveal the A cursor; the A cursor displays the cycle data curve values. Drag the A cursor ←left and right→ to view the values along the entire cycle data curve.

Tap ☝ the B PREVIOUS or C NEXT buttons to move the cursor to the previous or next cycle. **Tap** ☝ the D Limits Layers button to display the E Limits Layers menu and warning and/or alarm limits; refer to “Warning and Alarm Limits” on page 115.

Job Dashboard (*continued*)

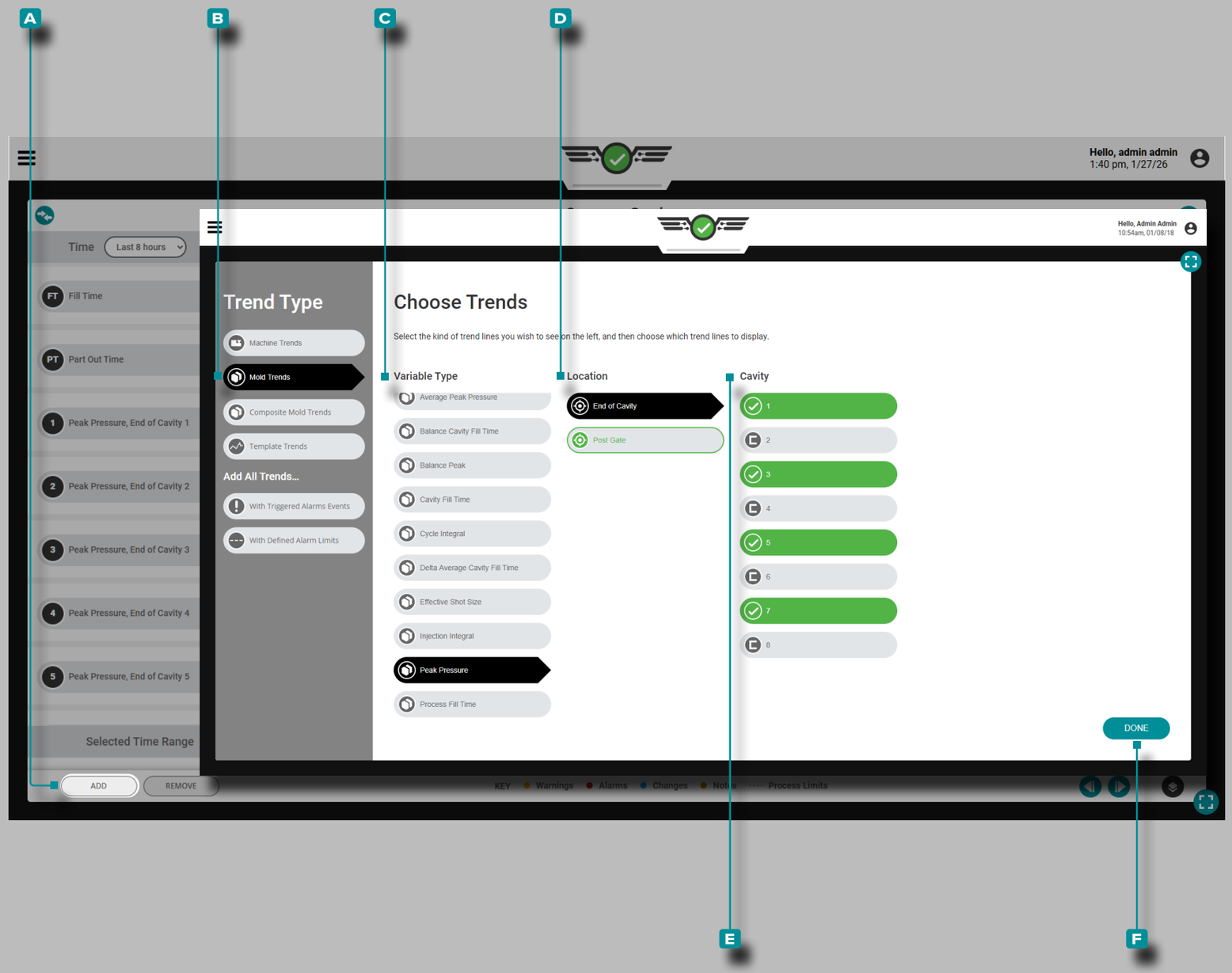


Summary Graph Controls

Add Machine Trends

Tap the **A** ADD button to view selectable machine cycle data trends; **tap** the desired **B** cycle data trend type and **C** variable type, and—if applicable—**tap** the desired **D** Quantity, then **tap** the **E** DONE button to return to the summary graph.

Job Dashboard (*continued*)

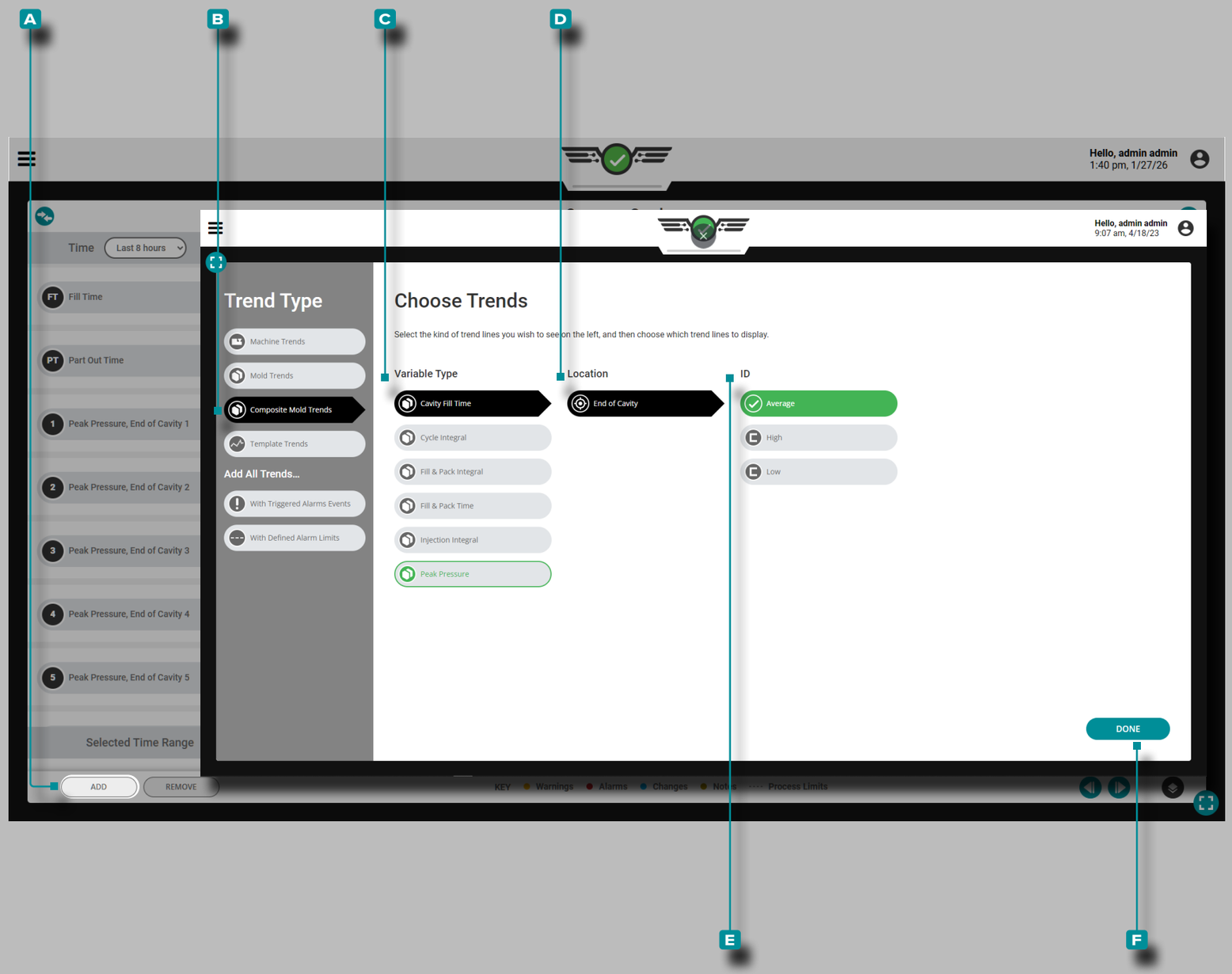


Summary Graph Controls (continued)

Add Mold Trends

Tap the **A** ADD button to view selectable mold cycle data trends; **tap** the desired **B** cycle data trend type, **C** variable type, **D** location, and—if applicable—**tap** the desired **E** Cavity, then **tap** the **F** DONE button to return to the summary graph.

Job Dashboard (*continued*)

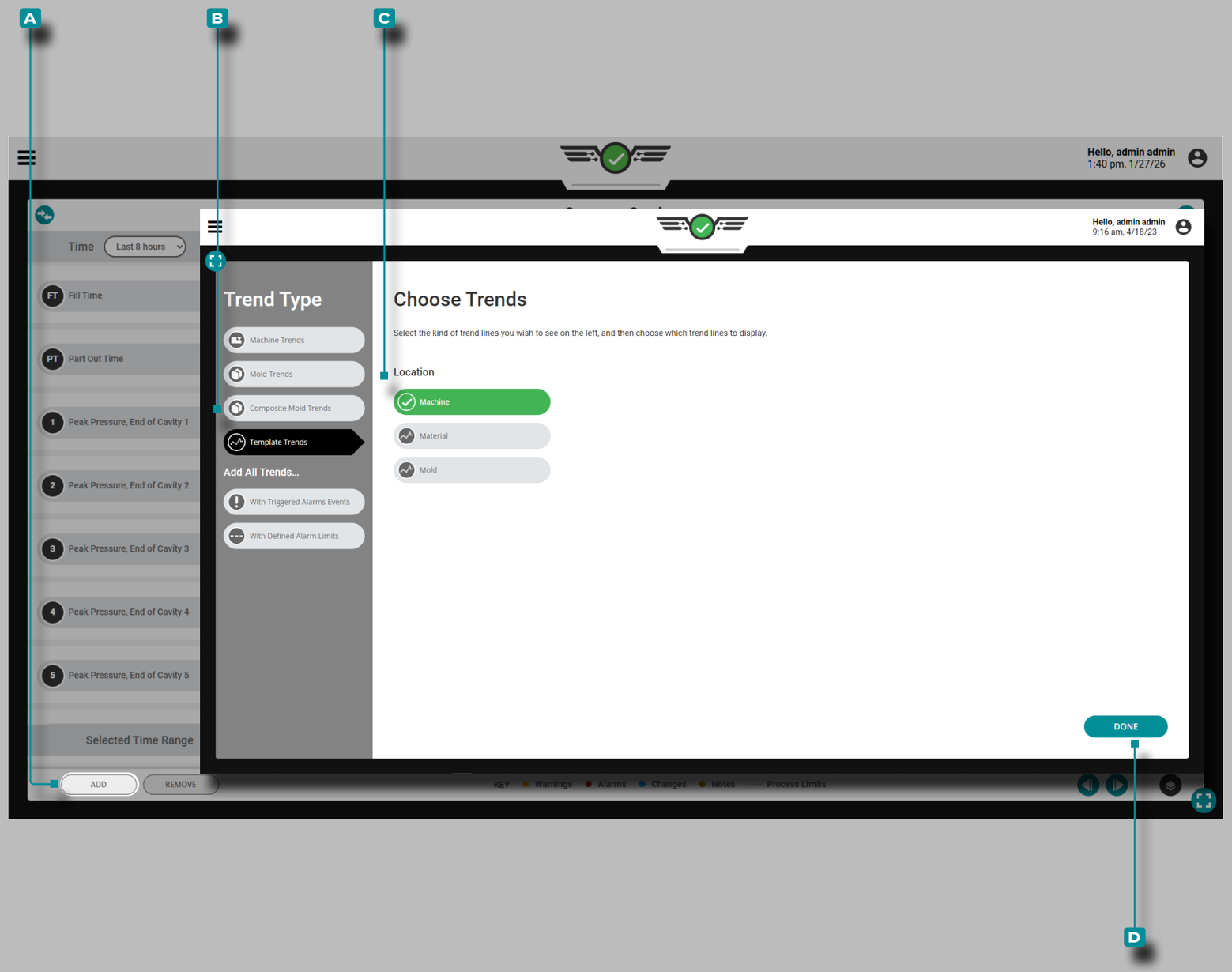


Summary Graph Controls (continued)

Add Composite Mold Trends

Tap the A ADD button to view selectable cycle data trends; **tap** B composite mold trends, C variable type, D location, and **tap** the desired E ID (average, high, low, or range), then **tap** the F DONE button to return to the summary graph.

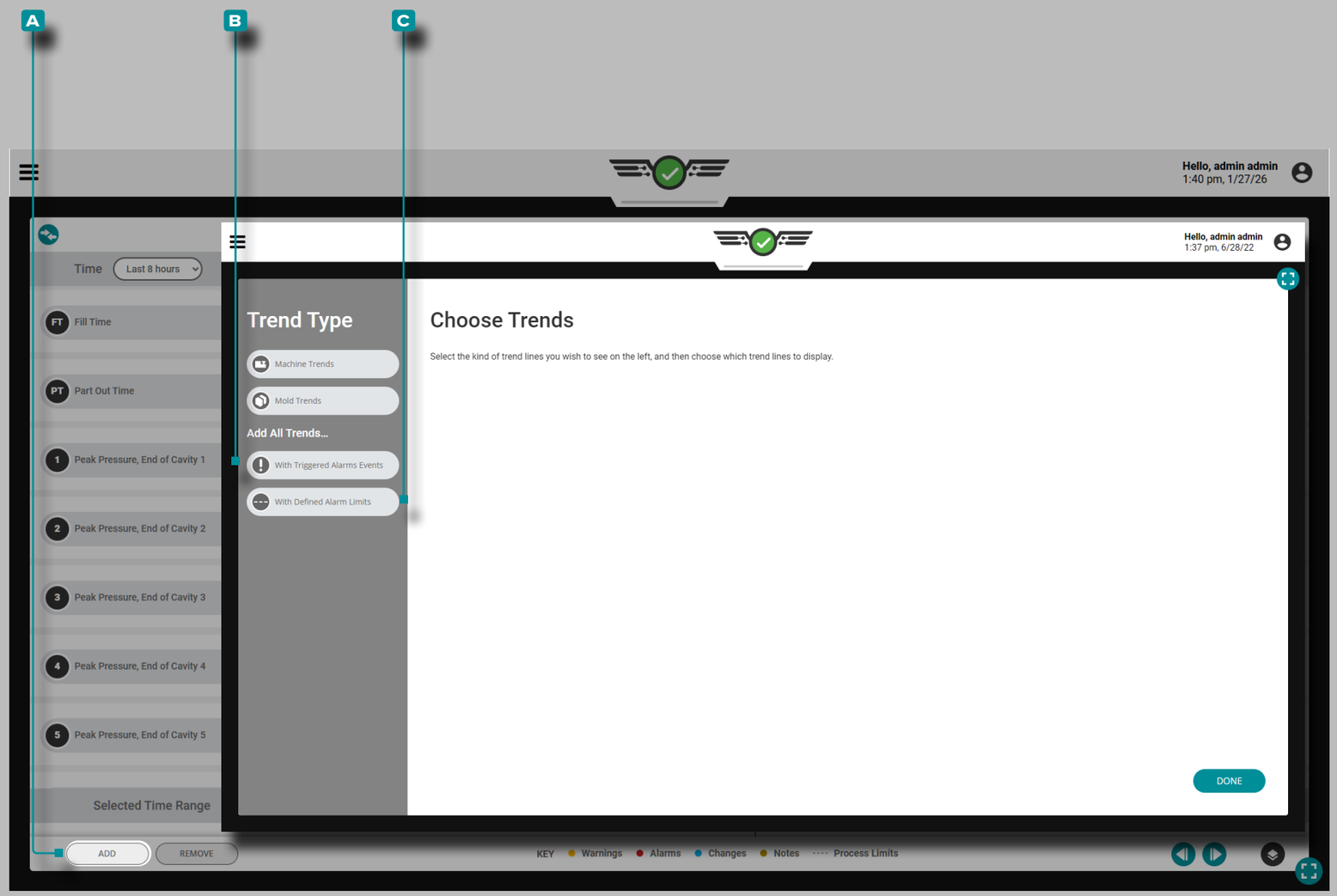
Job Dashboard (*continued*)



Summary Graph Controls (continued)

Add Template Trends

Tap 👆 the **A** ADD button to view selectable template cycle data trends; **tap** 👆 **B** template trends, **C** location (machine, material, or mold), then **tap** 👆 the **D** DONE button to return to the summary graph.



Job Dashboard (*continued*)

Summary Graph Controls (continued)

Add All Trends with Alarms or Limits

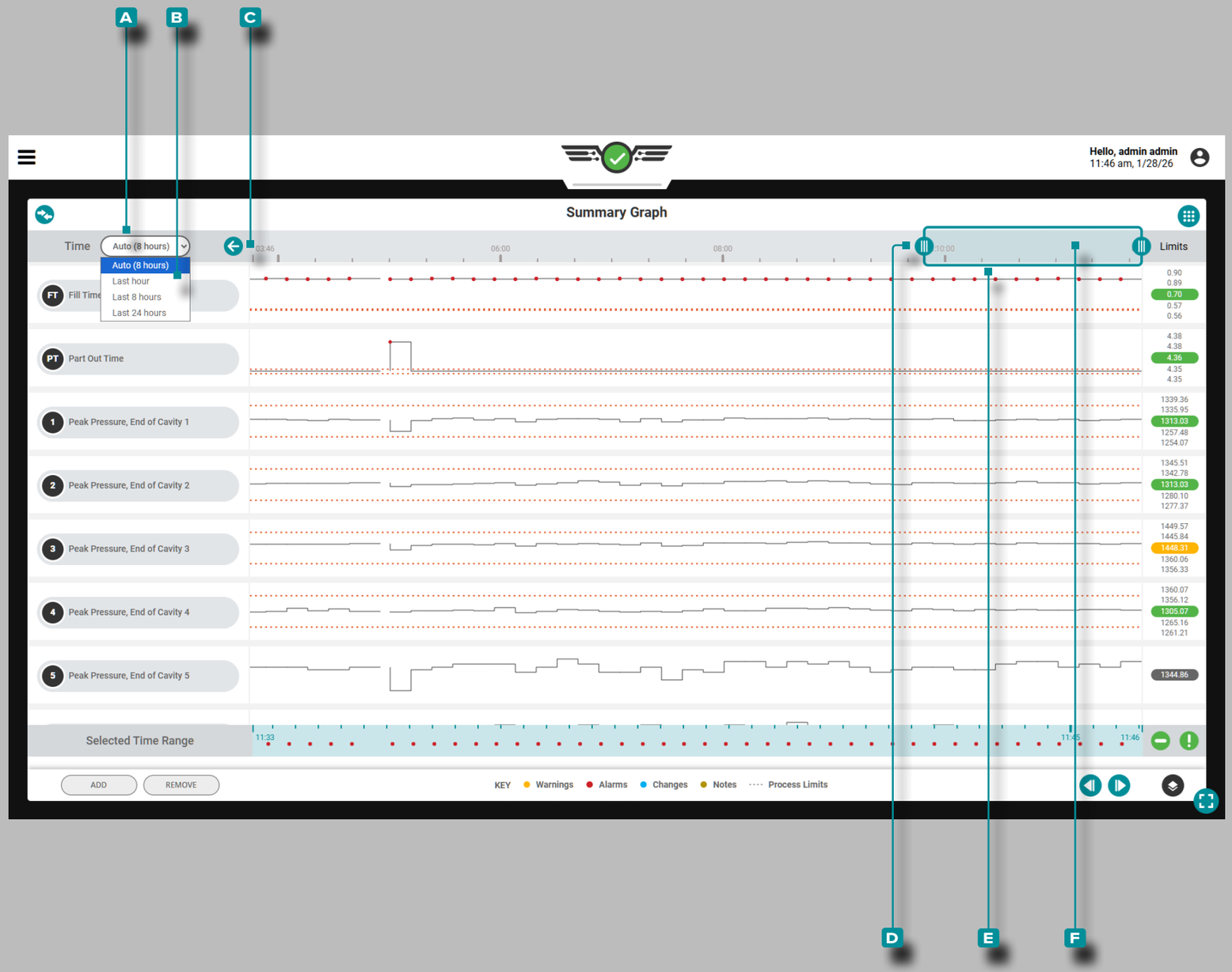
Tap the A ADD button to view selectable machine or mold cycle data trends; **tap** the B Add All Trends with Triggered Alarm Events and/or C Add All Trends with Defined Alarm Limits button to display all trends with alarm events and/or set limits and return to the summary graph.

Job Dashboard (*continued*)

Summary Graph Controls (continued)

Remove Trends

Tap the A REMOVE button, **tap** the desired B cycle data trend, then **tap** the C APPLY button to remove a trend.



Job Dashboard (*continued*)

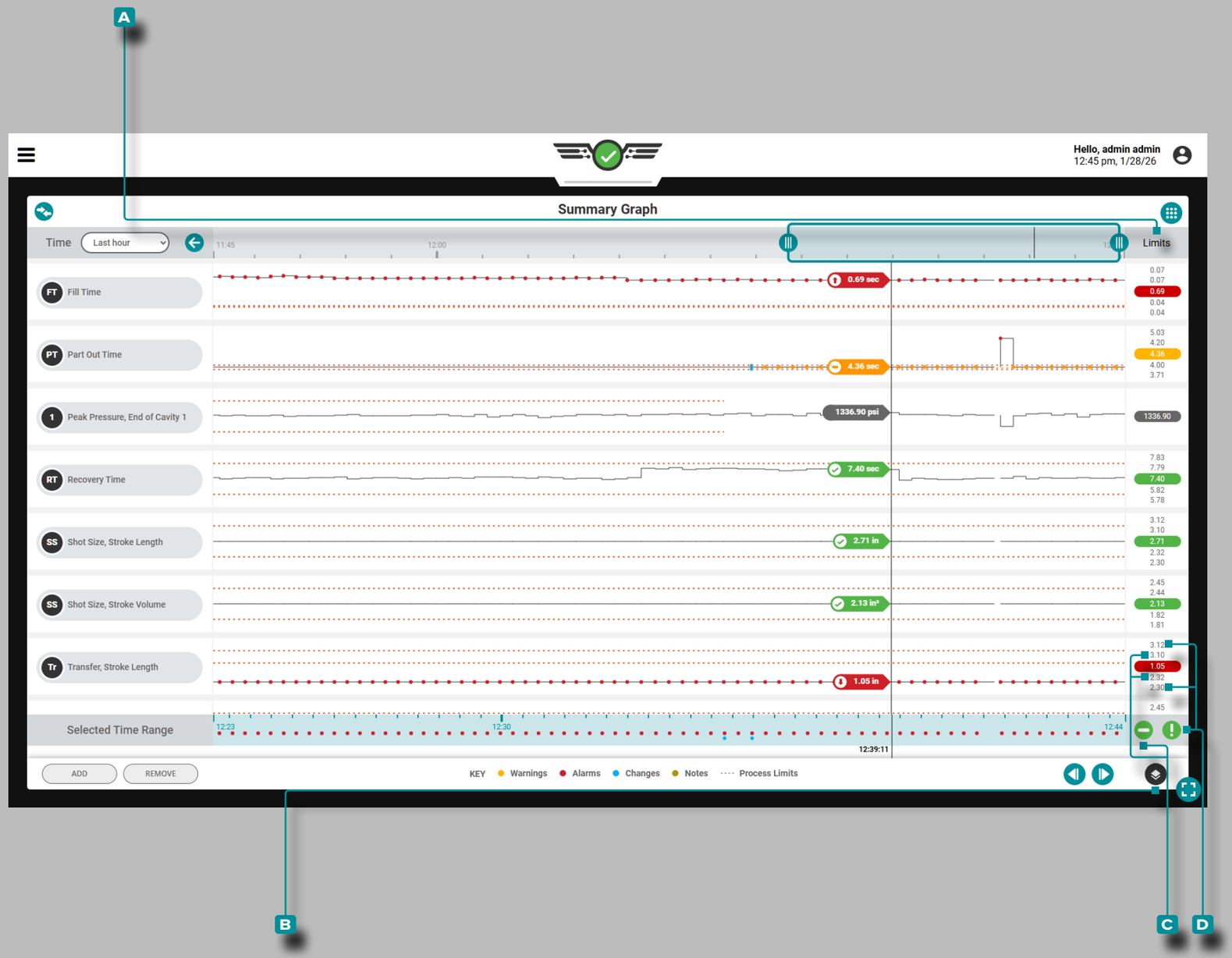
Summary Graph Controls (continued)

Select Data Time Range

Summary trend graphs display data from an automatically-selected range, the last hour, the last 8 hours, or the last 24 hours; **Tap** the **A** Time drop-down menu and then **tap** the desired **B** data time range for the displayed summary trend graphs. The **C** time range will auto-update on the screen, and will be displayed along the top of the summary graph.

Zoom In or Out

Tap, hold, and drag one or both of the **D** sliders to the desired time. A auto-scaled indication of the **F** selected time range will update below the summary trends. **Tap**, hold, and drag the **E** time selection bar to pan left or right on the cycle graph.



Job Dashboard (*continued*)

Summary Graph Controls (continued)

Warning and Alarm Limits

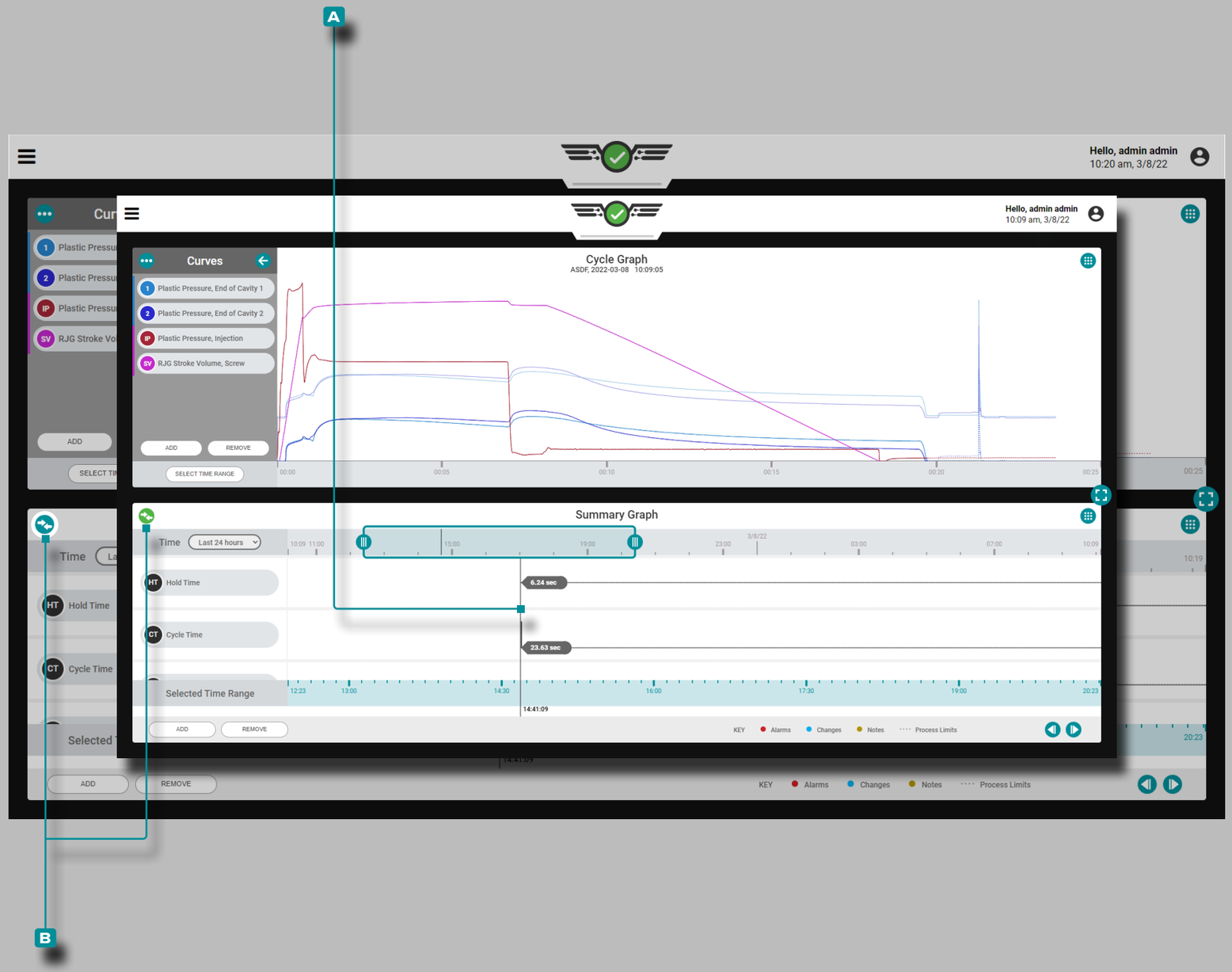
With the cursor selected and the **A** Limits Layers menu visible, the currently-assigned warning and/or alarm limits are displayed in the **A** Limits Layers menu.

Add Warning Limits

If not visible, tap 👆 the **B** Limits Layers button to display the **A** Limits Layers menu, then **tap** 👆 the **C** warning limits button to display warning limit lines for trends that have warning limits assigned.

Add Alarm Limits

If not visible, tap 👆 the **B** Limits Layers button to display the **A** Limits Layers menu, then **tap** 👆 the **D** alarm limits button to display alarm limit lines for trends that have alarm limits assigned.



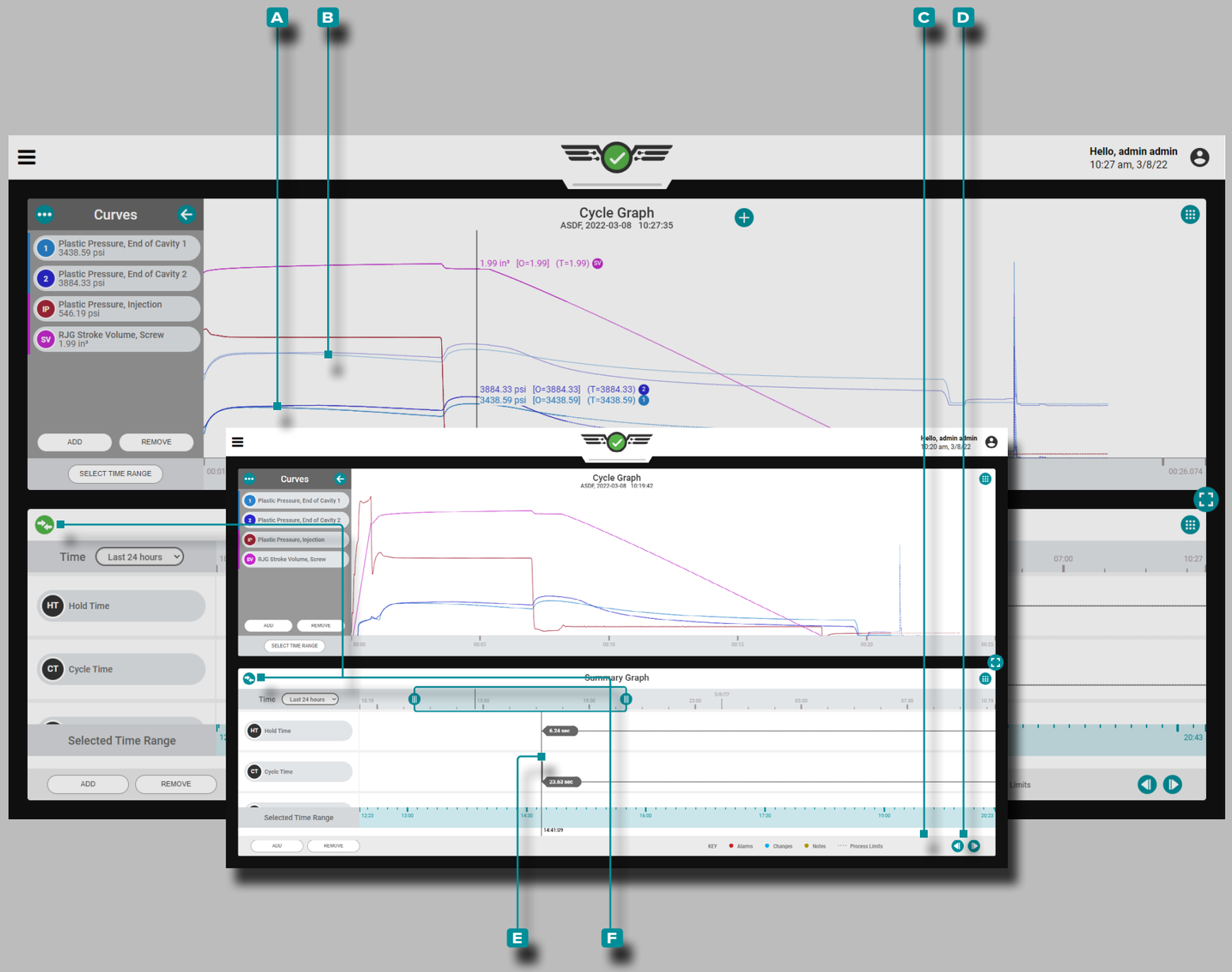
Job Dashboard (*continued*)

Comparing Summary Graph Cycles to Current Cycles

Cycles from the Summary Graph can be selected for comparison and displayed on the current Cycle Graph. This feature works best when the Summary Graph and Cycle Graph are displayed on the Job Dashboard together (refer to page 53 for instructions on choosing and resizing the Job Dashboard widgets).

Selecting a Cycle for Comparison

Tap 👆, hold, and drag the **A** cursor on the Summary Graph to the desired cycle; the **B** compare icon will be teal. **If no cycle is selected for overlay on the Summary Graph, the compare icon will be grey. Tap** 👆 the **B** compare icon to display the selected Summary Graph cycle on the Cycle Graph; the icon will be green.



Job Dashboard (*continued*)

Comparing Summary Graph Cycles to Current Cycles (continued)

Cycle Graph Comparison Cycle Display and Behavior

The Cycle Graph will display the curves for the **A** currently-running job and the **B** selected cycle from the Summary Graph. The comparison cycle appears on the cycle graph as lighter-tinted curves than the currently-running job's cycle curves.

If a template is active on the cycle graph, the template will continue to be displayed. The cycle graph cursor will display values for the current cycle, the template (if selected), and the overlay cycle selected from the summary graph.

The comparison cycle will remain displayed on the cycle graph until the comparison cycle is cleared, or until the job is stopped.

Selecting a Different Cycle for Comparison

To select a different cycle to compare on the cycle graph, use the **C** PREVIOUS or **D** NEXT buttons to navigate to the desired cycle, OR **tap** 👆, hold, and drag the **E** cursor to the desired cycle. The Cycle Graph will automatically update.

Clearing a Comparison Cycle

To remove a comparison cycle, **tap** 👆 the **F** compare icon; the icon will be teal OR stop the job.

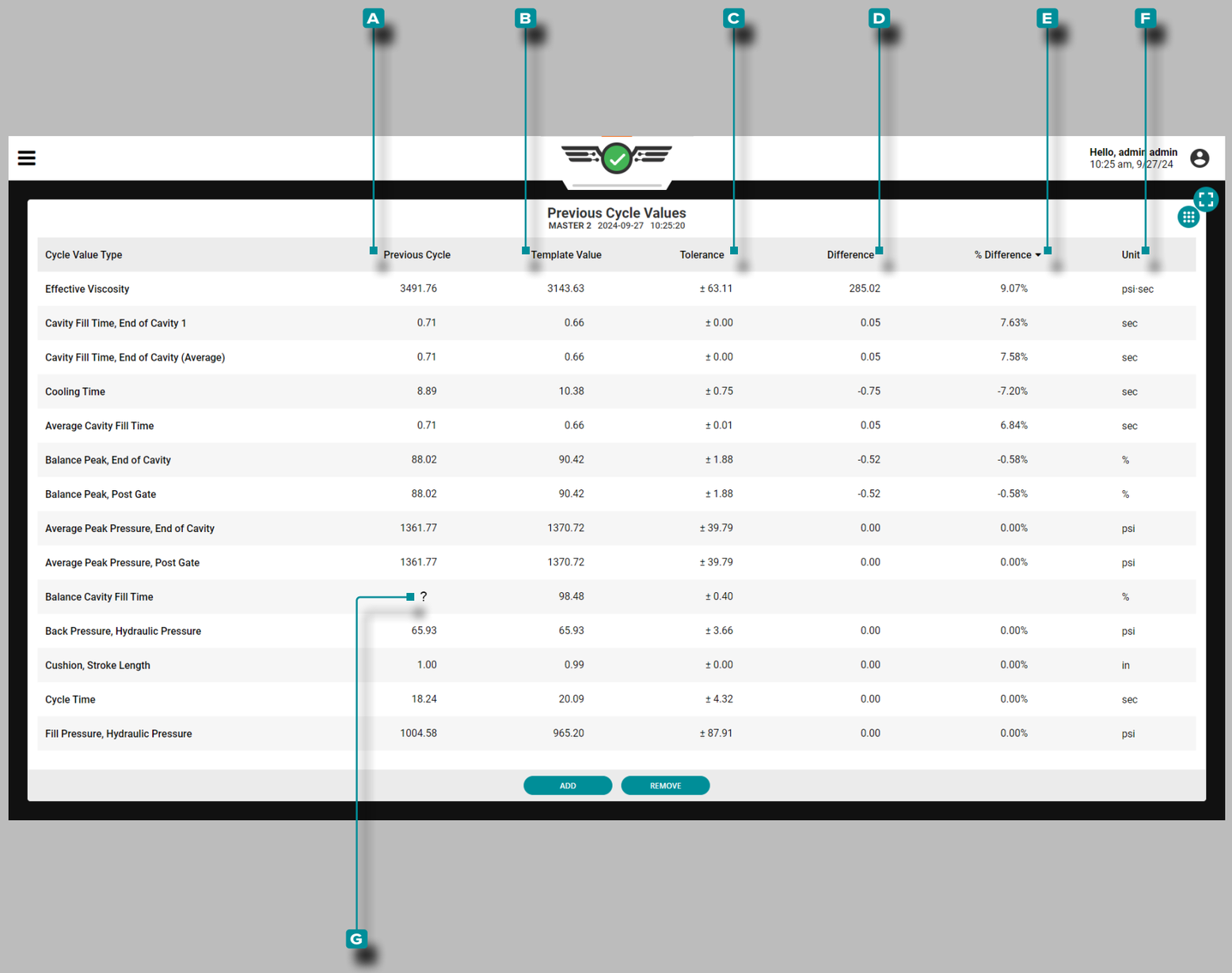
Refer to page 71–page 84 for Cycle Graph widget information and instructions.

Job Dashboard (*continued*)

Summary Graph Sensor Errors and Missing Data

On the Summary Graph, sensor errors that cause missing data are displayed as dots. Sensor errorrs are also displayed on the Cycle Graph; refer to “Cycle Graph Sensor Errors and Missing Data” on page 91.

Job Dashboard (*continued*)



Cycle Value Type	Previous Cycle	Template Value	Tolerance	Difference	% Difference	Unit
Effective Viscosity	3491.76	3143.63	± 63.11	285.02	9.07%	psi·sec
Cavity Fill Time, End of Cavity 1	0.71	0.66	± 0.00	0.05	7.63%	sec
Cavity Fill Time, End of Cavity (Average)	0.71	0.66	± 0.00	0.05	7.58%	sec
Cooling Time	8.89	10.38	± 0.75	-0.75	-7.20%	sec
Average Cavity Fill Time	0.71	0.66	± 0.01	0.05	6.84%	sec
Balance Peak, End of Cavity	88.02	90.42	± 1.88	-0.52	-0.58%	%
Balance Peak, Post Gate	88.02	90.42	± 1.88	-0.52	-0.58%	%
Average Peak Pressure, End of Cavity	1361.77	1370.72	± 39.79	0.00	0.00%	psi
Average Peak Pressure, Post Gate	1361.77	1370.72	± 39.79	0.00	0.00%	psi
Balance Cavity Fill Time	?	98.48	± 0.40			%
Back Pressure, Hydraulic Pressure	65.93	65.93	± 3.66	0.00	0.00%	psi
Cushion, Stroke Length	1.00	0.99	± 0.00	0.00	0.00%	in
Cycle Time	18.24	20.09	± 4.32	0.00	0.00%	sec
Fill Pressure, Hydraulic Pressure	1004.58	965.20	± 87.91	0.00	0.00%	psi

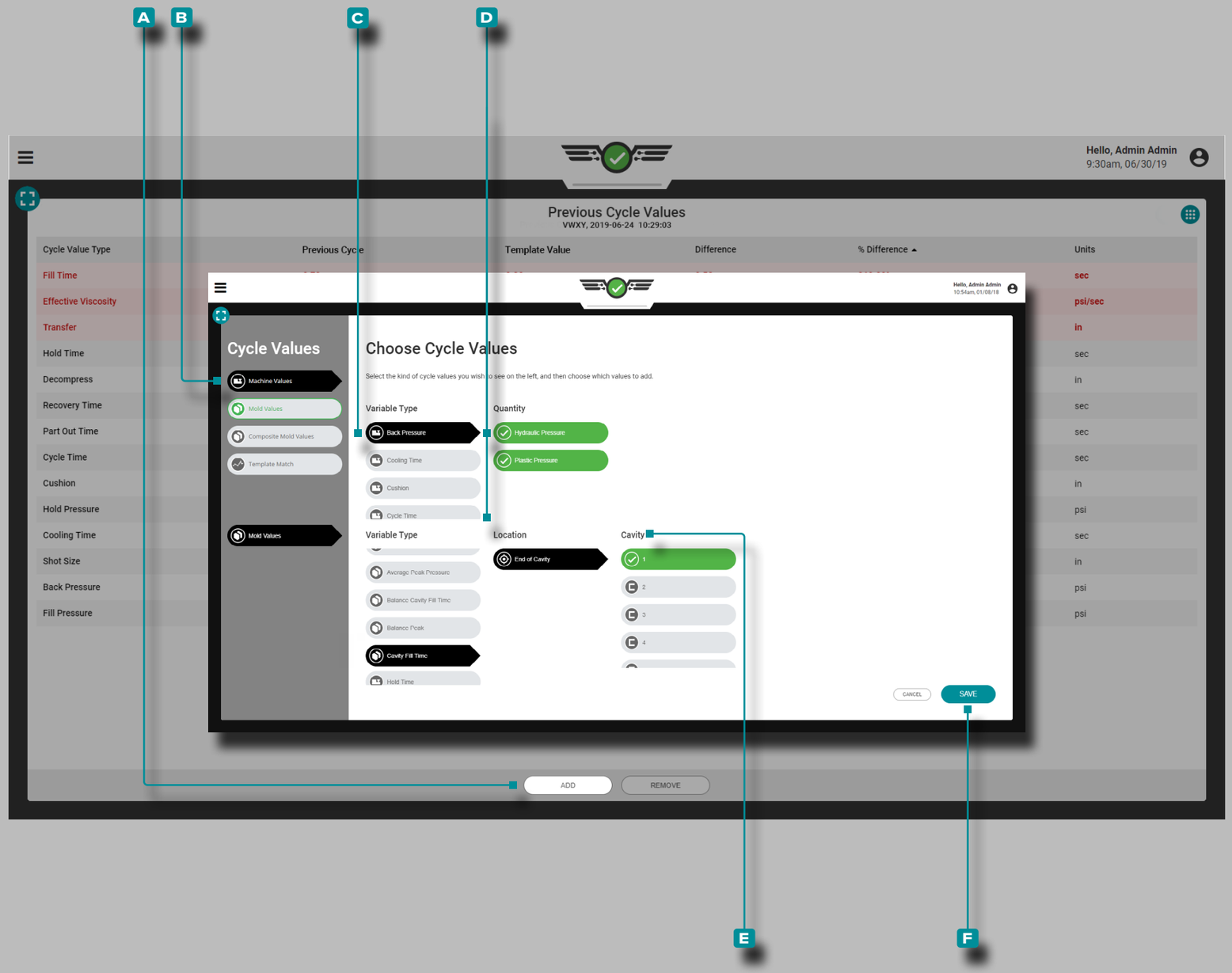
Previous Cycle Values Table

Process values for each cycle are accessible on the Job Dashboard's Previous Cycle Values view—including temperatures, timers, pressures, positions, and material viscosity. In addition to the process values, cycle values for pressures from cavity pressure sensors are displayed.

The table can display each process cycle value including the **A** Previous Cycle value, **B** Template (target) Value, **C** Tolerance (will display a value only if Template Match or Advice with MAX is enabled; refer to "Set Tolerance (Normal Process Variation)" on page 94), **D** Difference (of the target/current values), **E** % (percent) Difference (of the target/current values), and **F** Units (of measurement).

Cycle values that are out-of-match are highlighted red, with red text, while warning values are highlighted in yellow, with yellow text for easy identification. If the CoPilot system cannot calculate a previous cycle value(s) a **G** quesiton mark (?) will be displayed in the previous cycle value column for that value; the **D** Difference and **E** % (percent) Difference will be also not be calculated and be empty.

Job Dashboard (*continued*)



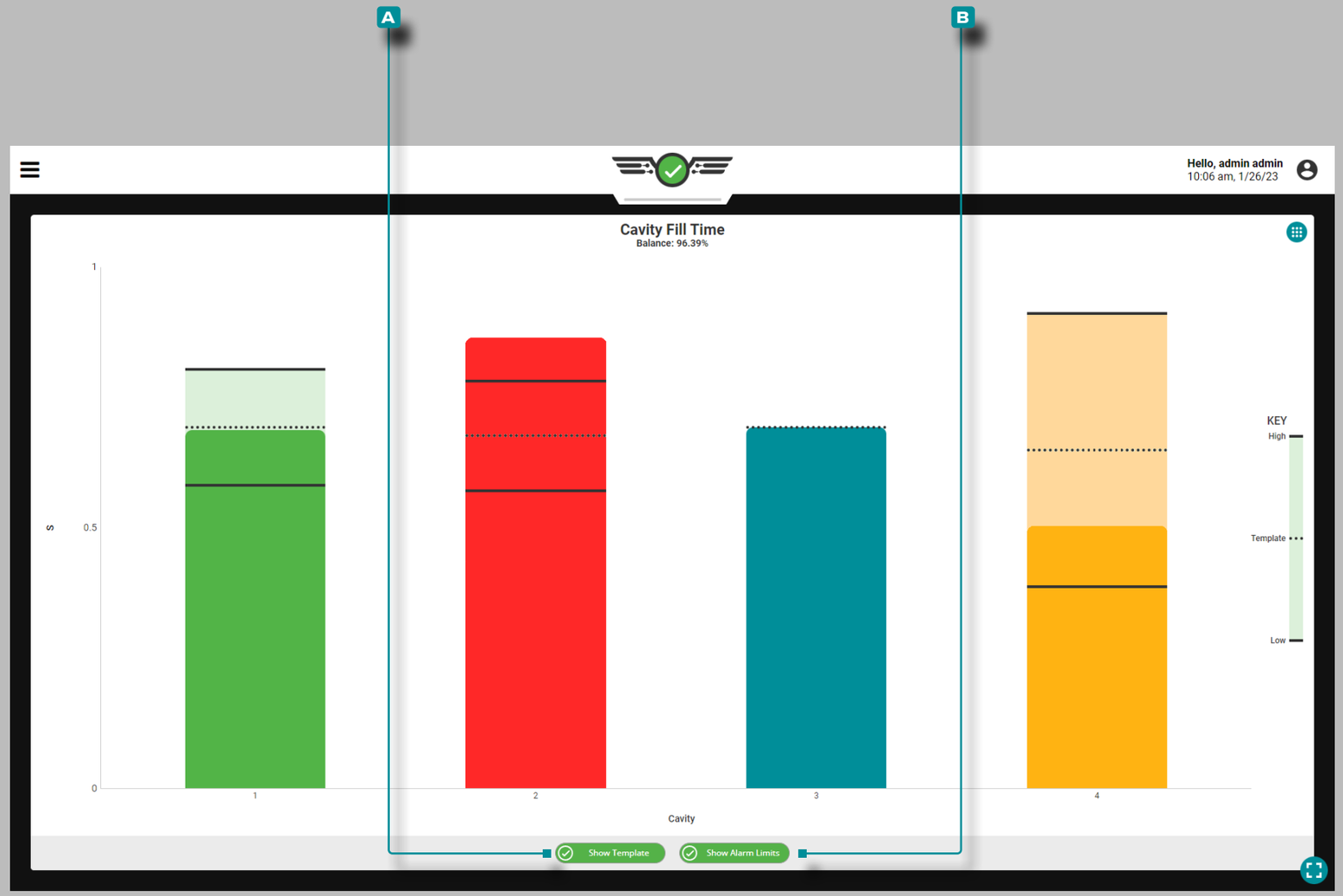
Add Previous Cycle Values

Tap 👆 the **A** ADD button to view selectable cycle values; **tap** 👆 the desired **B** cycle value type, **C** variable type, and—if applicable—**tap** 👆 the desired **D** Quantity or Location and **E** Cavity then **tap** 👆 the **F** SAVE button to return to the summary graph.

Job Dashboard (*continued*)

Remove Previous Cycle Values

Tap the **A** REMOVE button, **tap** the desired **B** cycle value(s), then **tap** the **C** APPLY button to remove the selected cycle value(s).



Job Dashboard (*continued*)

Cavity Fill Time

The Cavity Fill Time widget ⓘ displays each cavity fill time for cavities which have an assigned EOC cavity pressure sensor *and cavity fill time alarm settings* on a bar graph, and displays the cavity fill time balance—a comparison of cavity fill times across the mold represented in a percentage. The live-updating graph also features indicator marks on each cavity's bar denoting the lower alarm limit, template value, and high (upper) alarm limit.

ⓘ **NOTE** *A cavity fill time alarm must be set for each EOC cavity pressure sensor in order for the cavity fill time widget to display data for each cavity/sensor.*

As material enters the mold cavities and is detected by the EOC sensors, the chart's bars will "fill"; when the cavities are detected as full, the bars will rest at their detected fill position until the end of the cycle. If the fill time is within the designated alarm limits, the bar will be green; if the fill time is in warning state, the bar will be yellow; if the fill time is above or below the designated alarm limits, the bar will be red; and if there is no alarm set for the cavity, the bar will be blue.

ⓘ **NOTE** *If a cavity does not have an alarm set, the bar representing the cavity will be blue, and will not display green or red indications that are present when alarms are assigned.*

Tap 👆 the **A** Show Template button to view/hide the template value line on the chart; **tap** 👆 the **B** Show Alarm Limits button to view/hide the high (upper) and low (lower) alarm limit lines on the chart. **Tap** 👆 and hold on a bar to view the upper and lower alarm limit values, the template value, and the actual cavity fill time value.

Job Dashboard (*continued*)

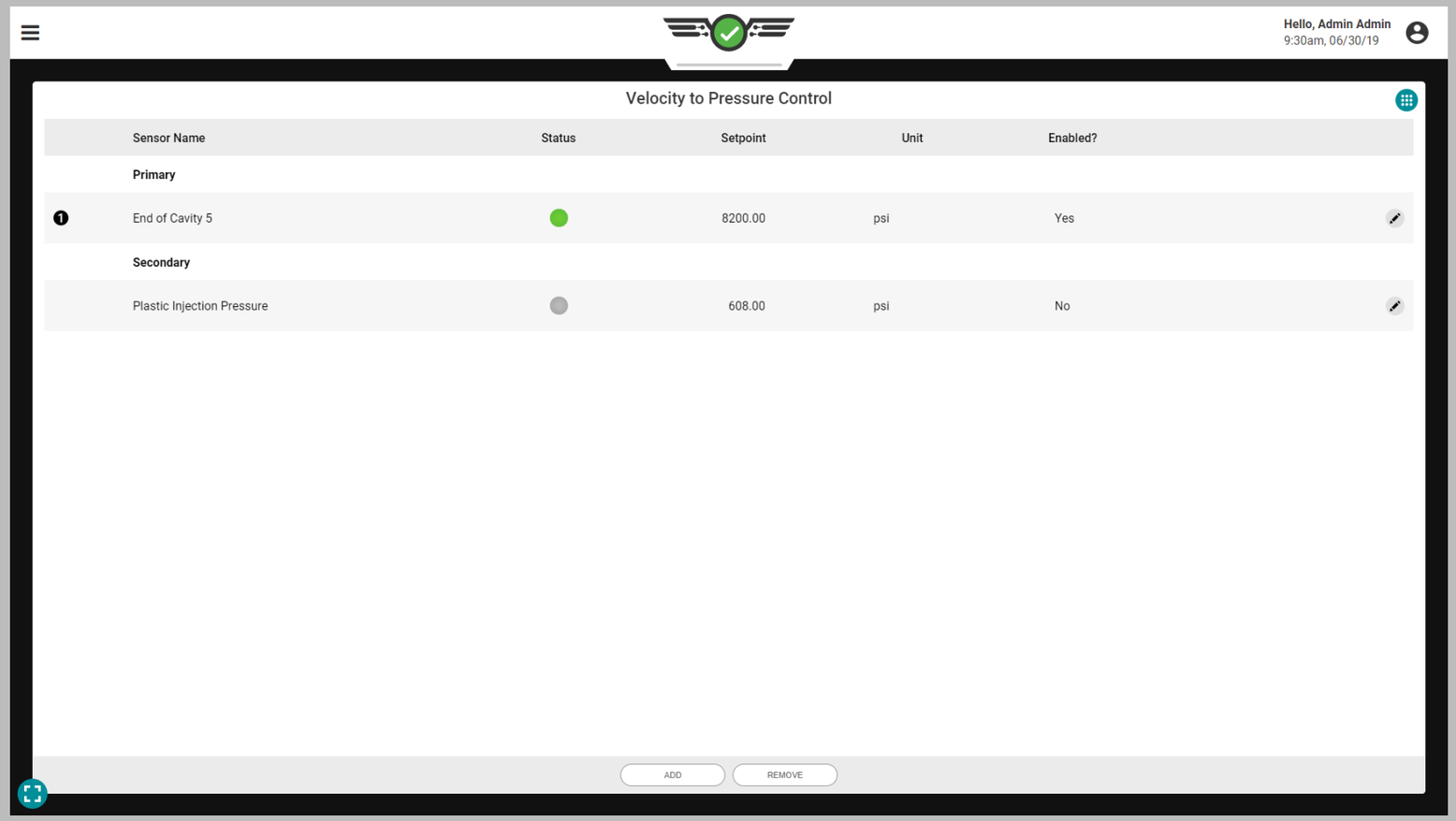
Peak Pressure: End-of-Cavity

The Peak Pressure: End-of-Cavity ⓘ widget displays each peak pressure at the EOC location for cavities which have an assigned EOC cavity pressure sensor with peak pressure alarm limit settings on a single bar graph, and displays the EOC peak pressure balance—a comparison of EOC peak pressures across the mold represented in a percentage. The live-updating graph also features indicator marks on each cavity's bar denoting the lower alarm limit, template value, and high (upper) alarm limit.

ⓘ **NOTE** *A peak pressure alarm must be set for each EOC cavity pressure sensor in order for the peak pressure: EOC widget to display data for each cavity/sensor.*

As material enters the mold cavities and is detected by the EOC sensors, the chart's bars will "fill" until the cavities are determined to be at the peak pressure, when the bars will fall to zero again at the end of the cycle. If the peak pressure is within the designated alarm limits, the bar will be green; if the peak pressure is in warning, the bar will be yellow; if the peak pressure is above or below the designated alarm limits, the bar will be red; and if there is no alarm set for the cavity, the bar will be blue.

Tap 👆 the **A** Show Template button to view/hide the template value line on the chart; **tap** 👆 the **B** Show Alarm Limits button to view/hide the high (upper) and low (lower) alarm limit lines on the chart. **Tap** 👆 and hold on a bar to view the upper and lower alarm limit values, the template value, and the actual peak pressure at EOC value.



Job Dashboard (*continued*)

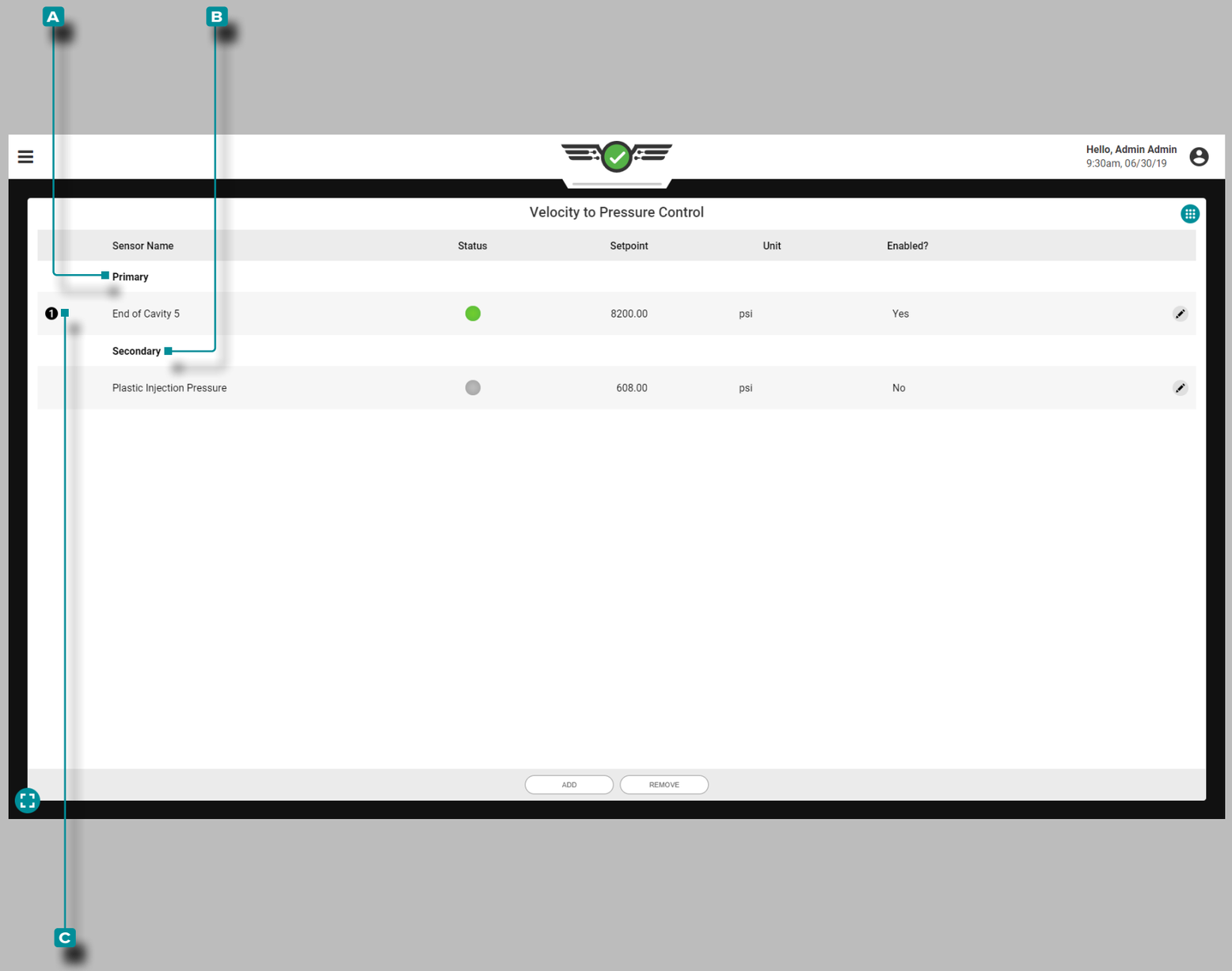
Velocity to Pressure Control (V→P)

Velocity to pressure transfer is used to control when the machine transfers from the velocity (fill and pack) to pressure (hold) stage using a cavity pressure with a designated setpoint or a designated time after the fill sequence begins. This removes the machine-controlled transfer which is based on screw position outside of the mold, and instead moves the control to the process values inside the mold—providing control which limits variation caused by inherent material variation.

In order to use the V→P control, an output from a physical OR2-M or OA1-M-V module must be installed, connected, and have been assigned to V→P control in the Machine Settings (refer to the CoPilot™ Hardware Installation and Setup Guide for installation instructions, and "Assigning Outputs" on page 21 for instructions on assigning control outputs in setup).

NOTE *V→P control will not operate if CoPilot Go is active; is utilized; refer to "CoPilot Go" on page 12 for more information on CoPilot Go.*

CAUTION *Always set up backup setpoints on the machine when using the V→P Control tool; failure to comply will result in damage or destruction of equipment and injury to personnel.*



Job Dashboard (*continued*)

Controls

RJG, Inc. recommends that both a primary and secondary control be assigned for controlling machine V→P transfer.

Primary Control

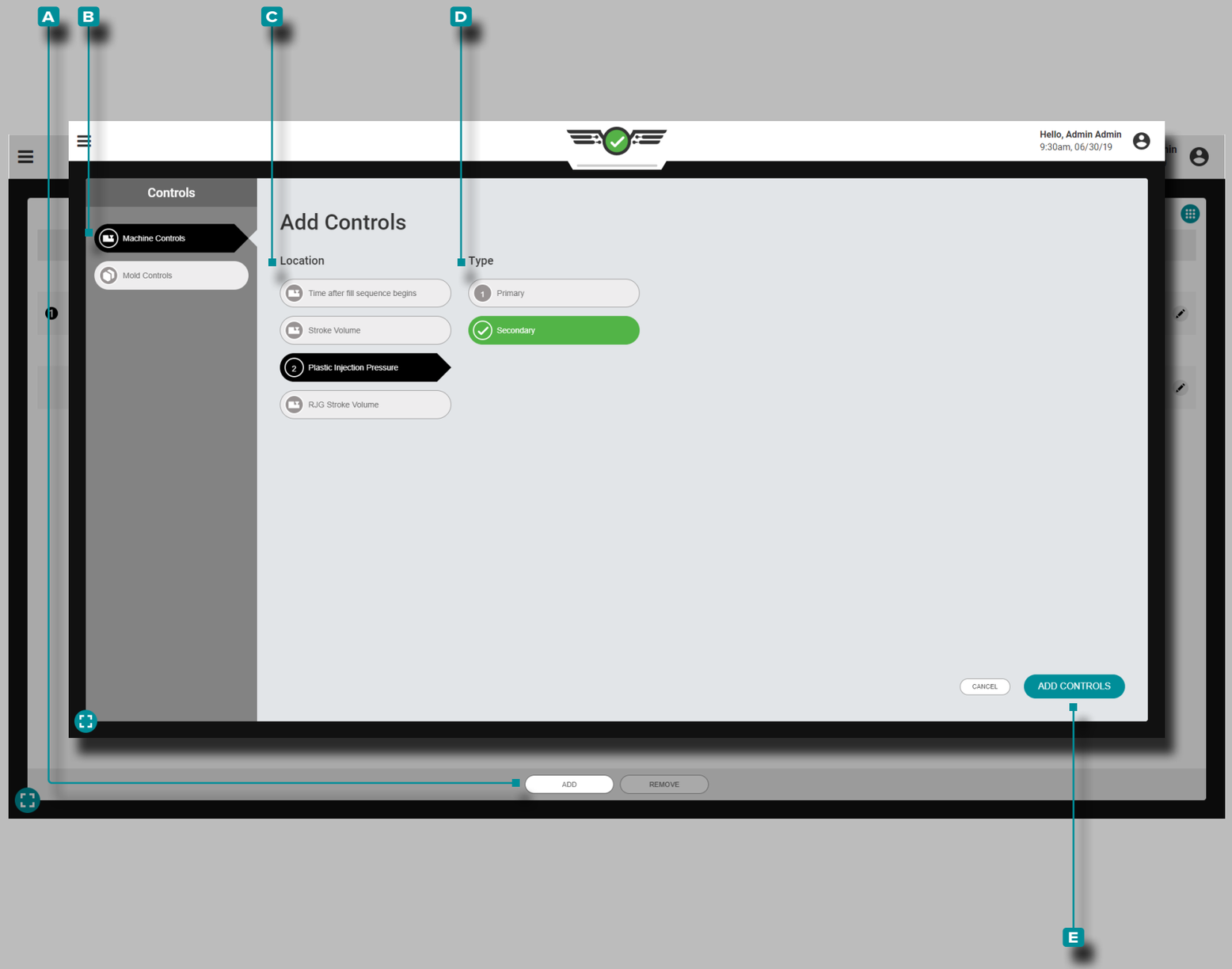
A **A** primary control is the control which is set with the intention that it will be the main transfer control setpoint.

Secondary Controls

A **B** secondary control is the control which is set with the intention that if the primary control is not reached, the secondary control will provide the transfer signal as a backup.

The V→P control will transfer the machine based on which primary setpoint is reached first; any control that is enabled but did not reach its set point first will become the back-up control. If none of the primary controls are reached, the controls move to the secondary controls which will operate as the primary controls in order of reached setpoints.

The control/setpoint which triggered the machine transfer on the last cycle is denoted on the VP Control widget by a **C** circled number next to the control on the left-hand side of the widget.



Job Dashboard (*continued*)

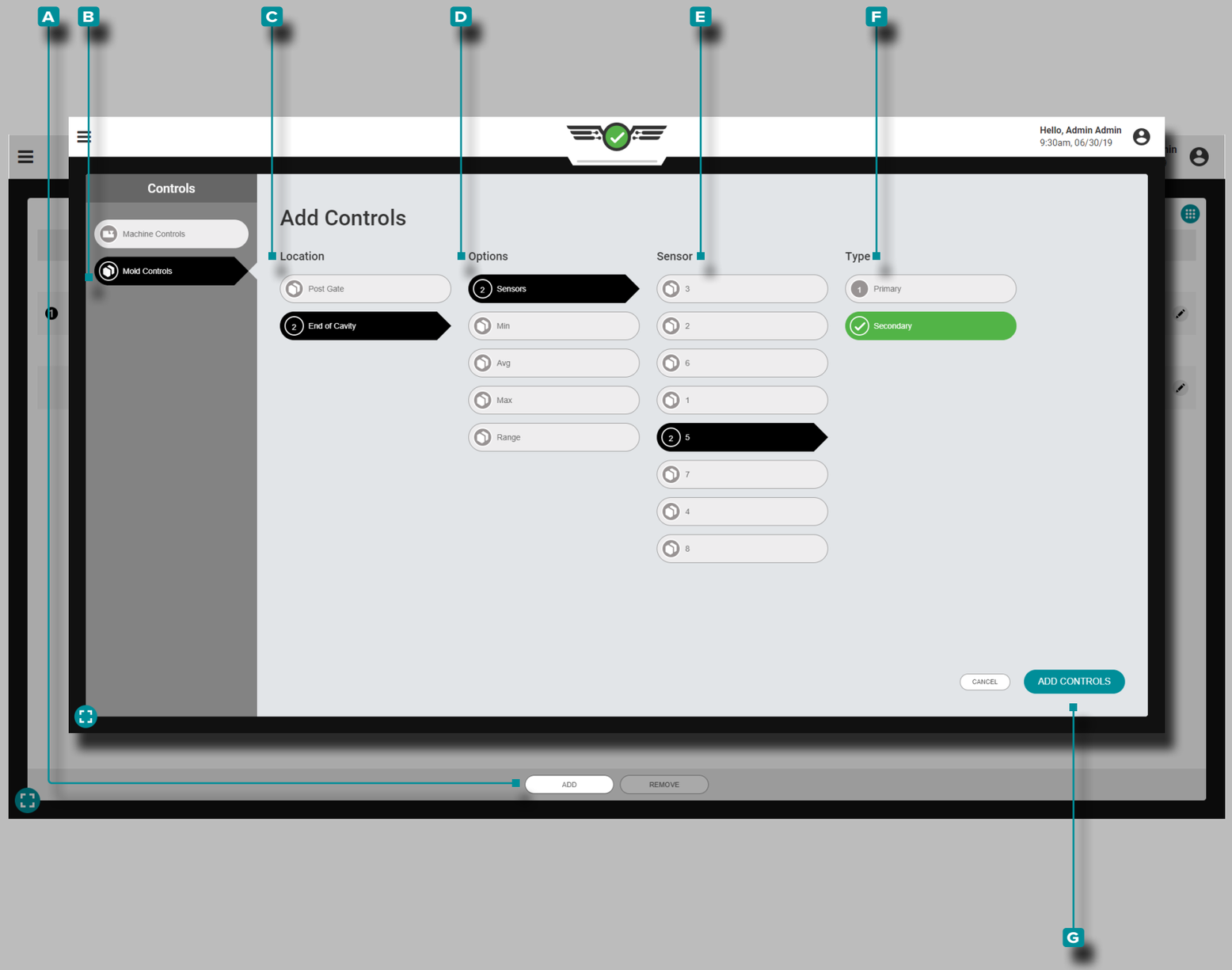
Add V→P Controls

Add controls from the V→P widget while a job is running.

Machine Controls

Tap the **A** ADD button, then **B** Machine Controls to view selectable machine controls; **tap** the desired **C** Location and **D** Type, then **tap** the **E** ADD CONTROLS button to return to the V→P widget.

The added control will appear on the V→P widget but is not active until a setpoint is assigned; refer to "Edit or Remove V→P Controls" on page 128.



Job Dashboard (*continued*)

Add V→P Controls (continued)

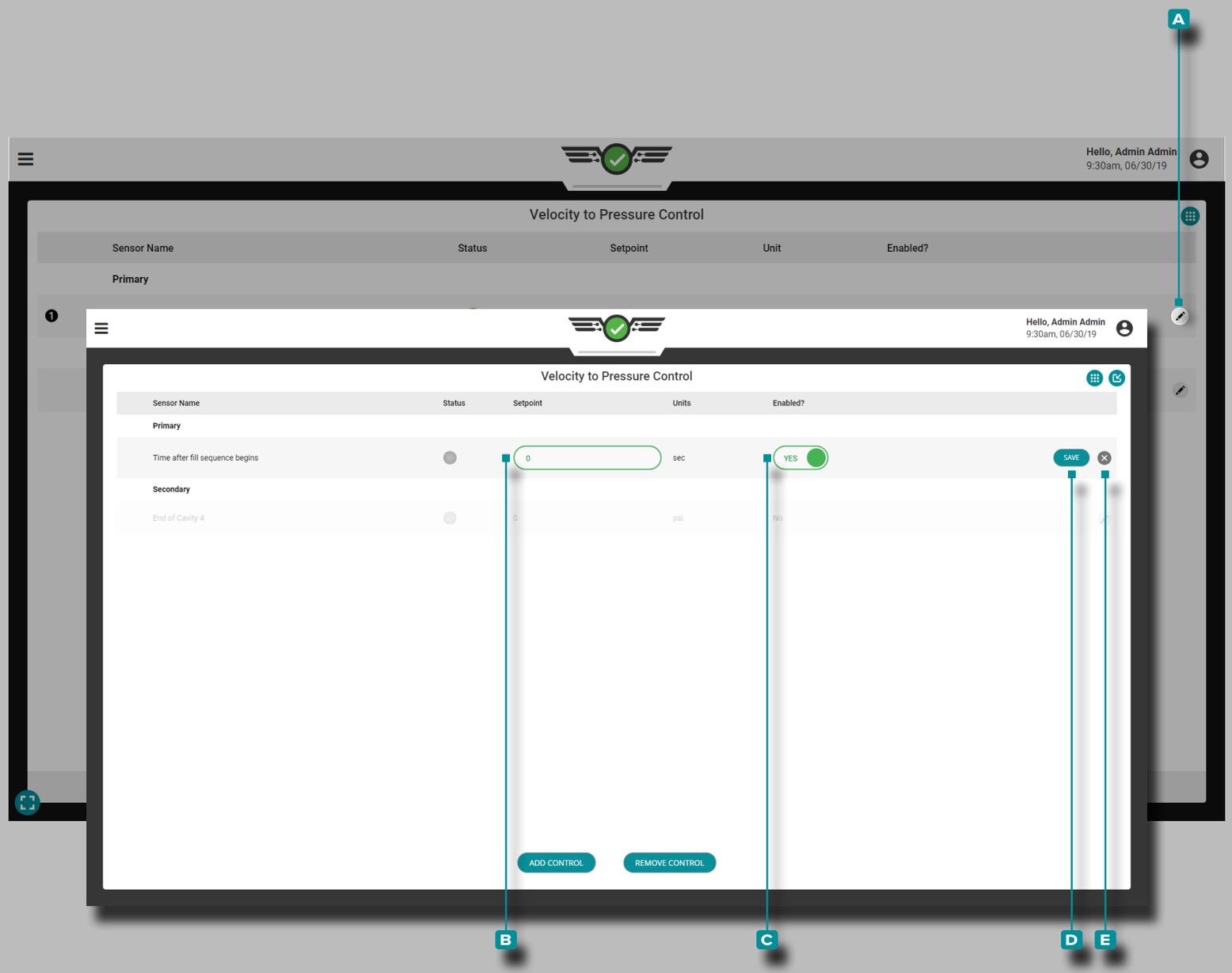
Mold Controls

Mold controls are based on cavity pressures provided by cavity pressure senors in the mold. Mold controls for V→P can be based on the following:

1. Individual **Sensors** with a cavity pressure setpoint at which transfer will occur, set as a primary or a secondary control;
2. **Min**, or a minimum cavity pressure threshold setpoint which must be reached by *all of the selected sensor types*, set as a primary or a secondary control;
3. **Range**, a setpoint at which transfer will occur based on a range calculation of all of the selected cavity pressure sensors, set as a primary or secondary control;
4. **Max**, or a maximum cavity pressure threshold setpoint which must be reached by *all of the selected sensor types*, set as a primary or a secondary control
5. **Avg**, or a setpoint at which transfer will occur based on the average of all selected cavity pressure sensor types, set as a primary or a secondary control.

Tap the A ADD button, then B Mold Controls to view selectable mold controls; **tap** the desired C Location and D Options, then either the E Sensor and/or F Type depending upon the options chosen. When finished, **tap** the G ADD CONTROLS button to return to the V→P widget.

The added control will appear on the V→P widget but is not active until a setpoint is assigned; refer to “Edit or Remove V→P Controls” on page 128.



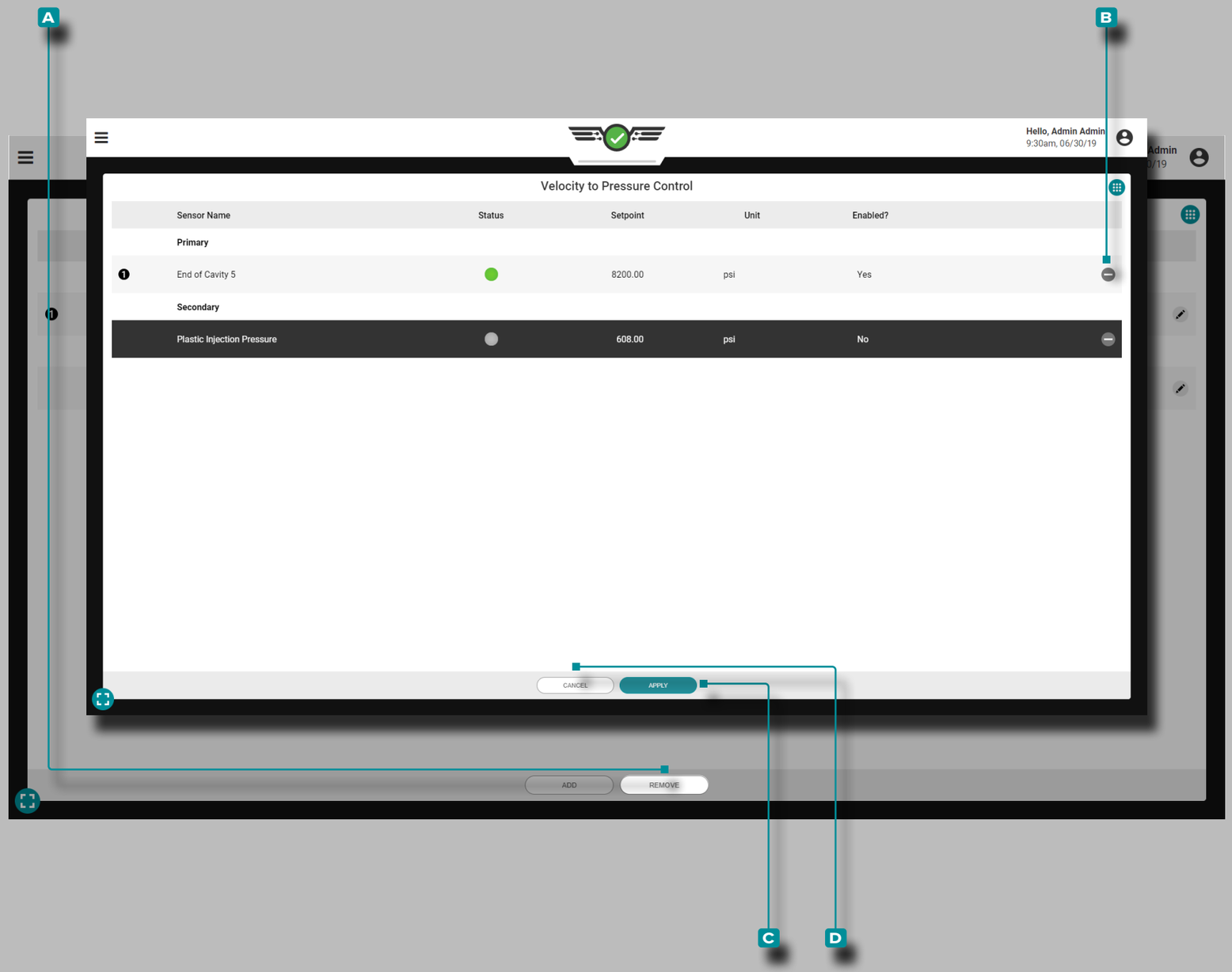
Job Dashboard (*continued*)

Edit or Remove V→P Controls

Once a control is added it can be enabled, edited, or removed on the V→P widget.

Enable or Edit V→P Controls

Tap the **A** edit button adjacent to the control which to enable or edit, then **tap** the **B** setpoint field to enter a new setpoint; **tap** the **C** Enabled? slider to either enable or disable the control. When finished, **tap** the **D** SAVE button to save the changes and return to the V→P widget; alternatively, tap the **tap** the **E** exit button to cancel any changes.



Job Dashboard (*continued*)

Edit or Remove V→P Controls (continued)

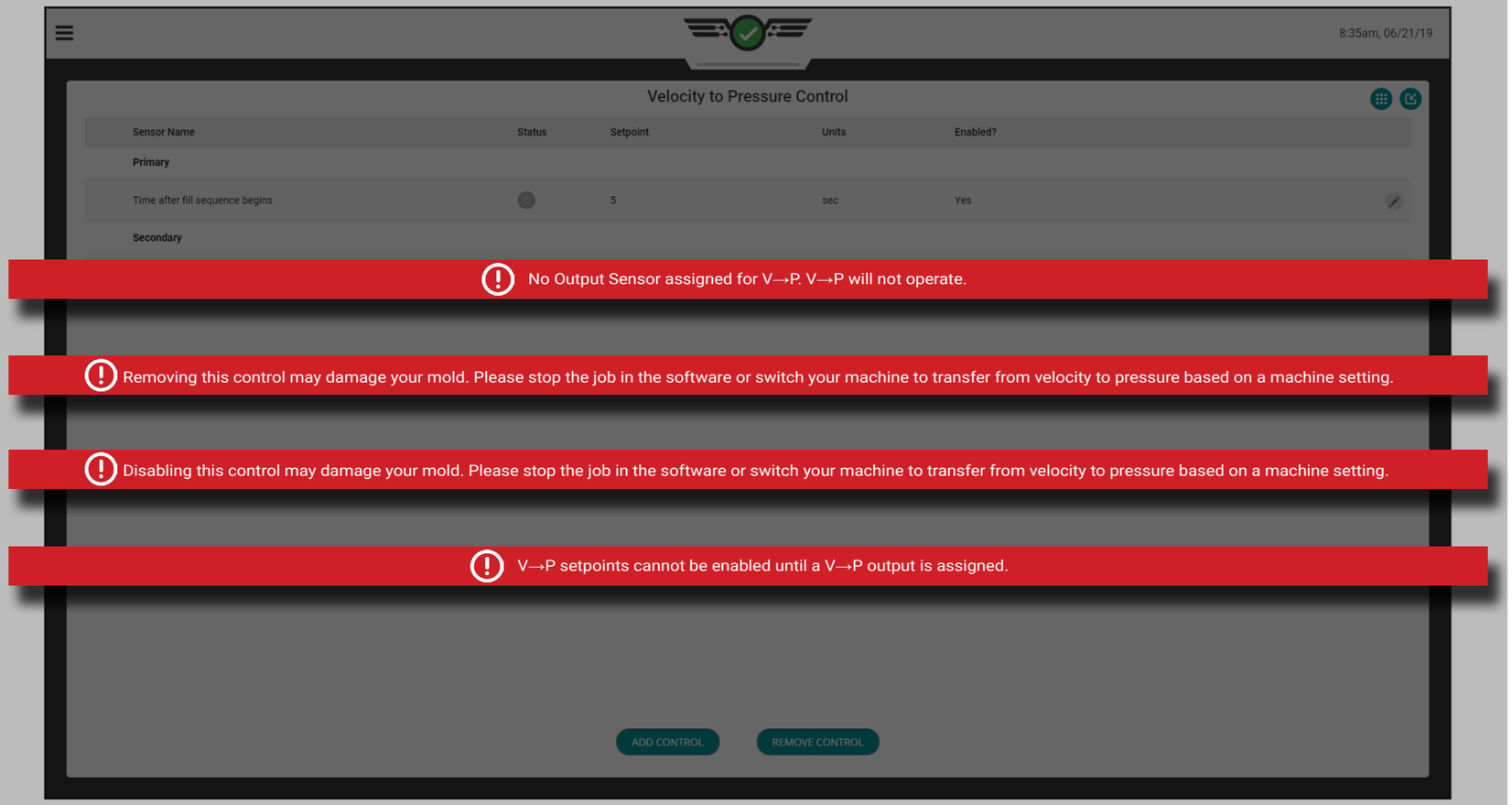
Remove V→P Controls

Tap the A REMOVE button, then **tap** the B delete button(s) next to the control(s) which to remove. When finished, **tap** the C APPLY button to save the changes and return to the V→P widget; alternatively, **tap** the D CANCEL button to cancel any changes.

If a control is removed, a warning notification will display requiring the user to confirm the removal of the control.

If only one V→P control exists, it cannot be removed without stopping the job.

CAUTION *DO NOT remove the only V→P control unless changes are made to ensure the machine will transfer from velocity to pressure based a machine setting. Failure to comply will result in damage or destruction of equipment and injury to personnel.*



Job Dashboard (*continued*)

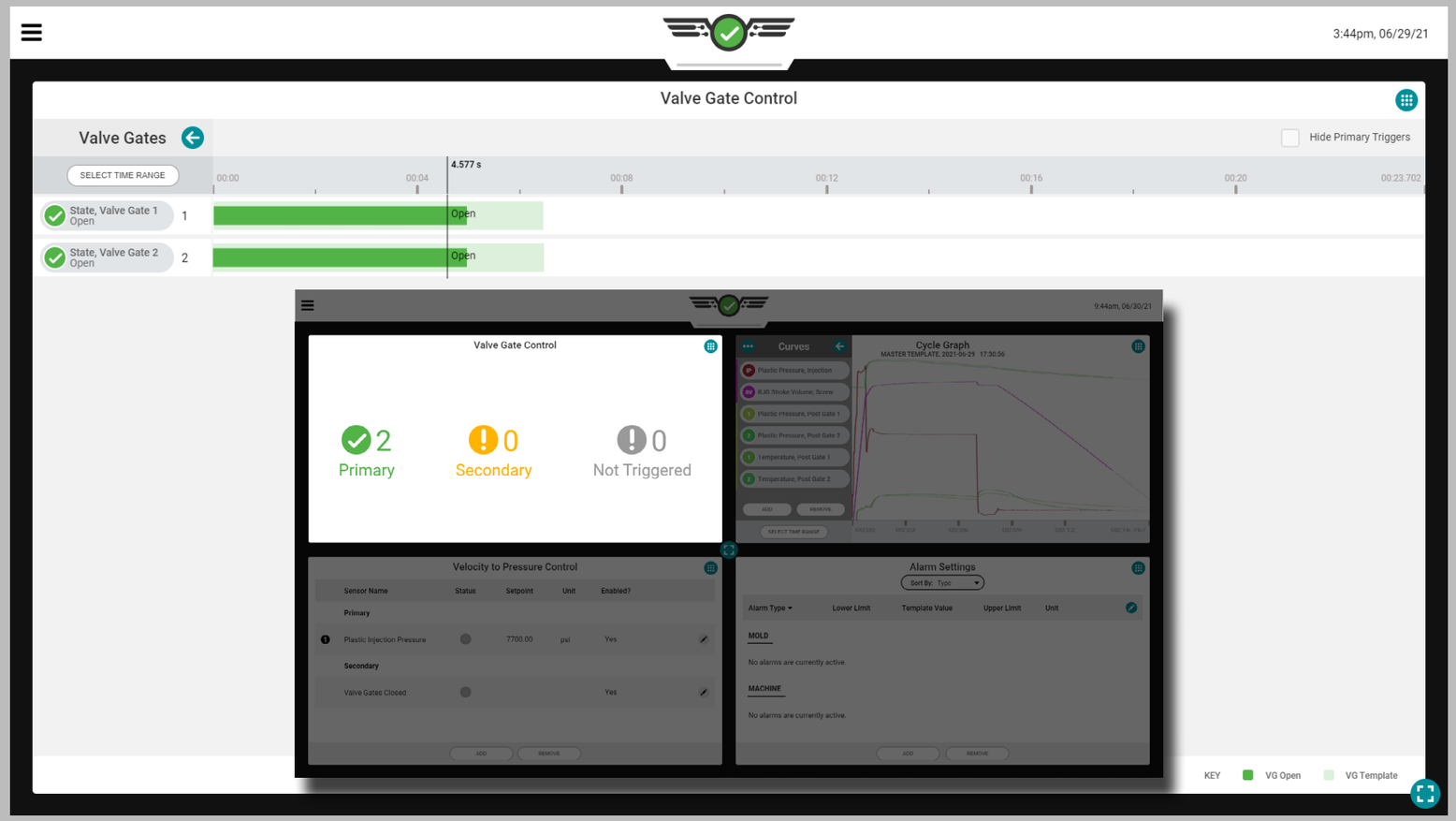
V→P Errors

If a cavity pressure control is set for cavity fill time and EOC locations and the threshold of 1,000 psi is not detected at EOC, an error notification will display to alert the user to the issue.

When an assigned V→P output loses communication with the physical hardware to which it is attached, an error message will display to notify the user that the output has been disrupted and the control will not operate properly.

When an assigned output's physical hardware is disconnected at job start, an error message will display to notify the user that the output is no longer available and the control will be disabled.

When a job is running and a setpoint whose sensor goes into an error state or disconnects, an error message will display to notify that the output has been disrupted and the control will not operate.



Job Dashboard (*continued*)

Valve Gate Control

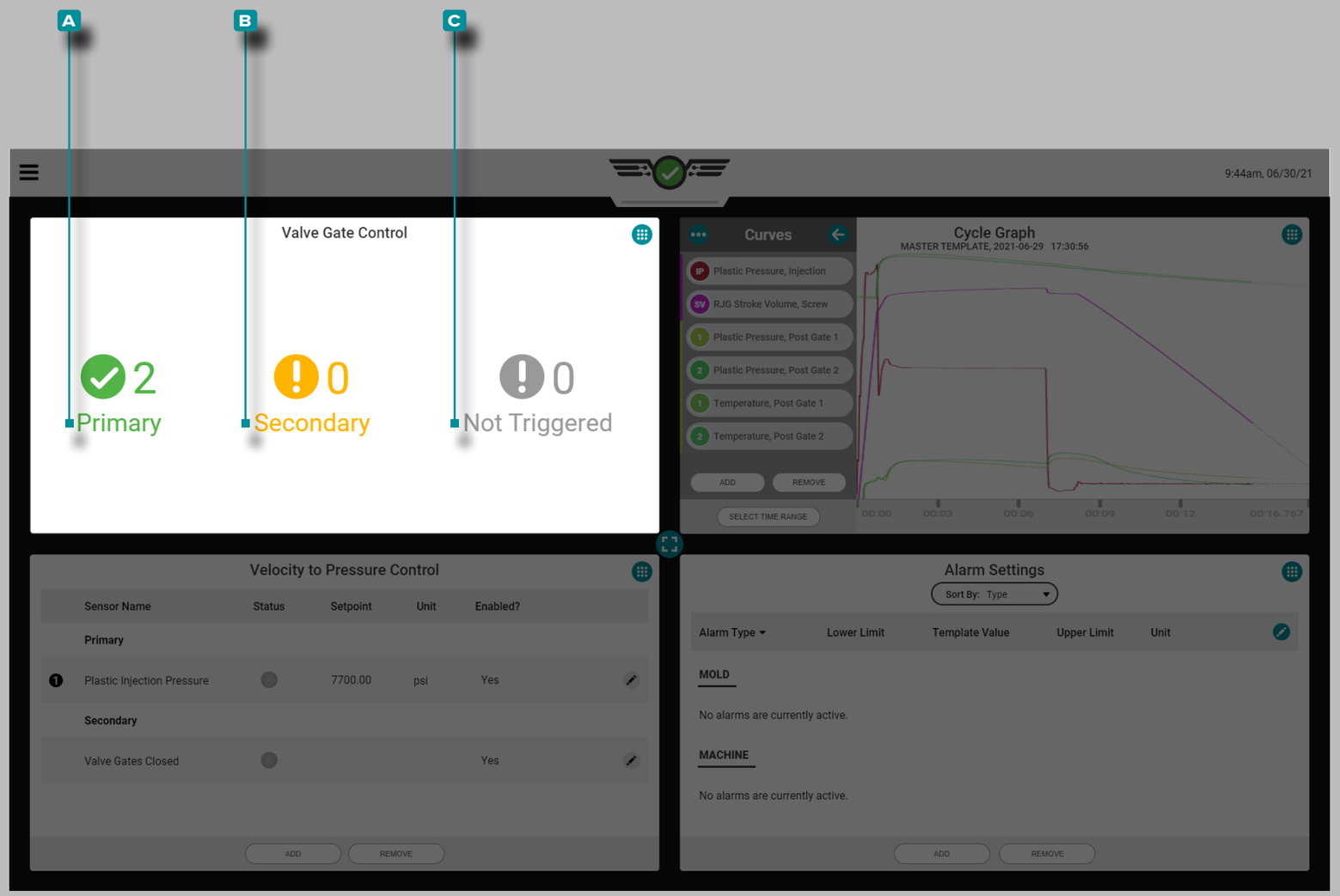
The Valve Gate control tool (optional—if licensed) is designed to open valve gates at specific events during the cycle, then close the valve gates again at other events. Use the valve gate control tool set open and close events using injection start plus a time delay, start of mold clamped, cavity pressure, temperature, or RJG stroke volume. Using valve gate control can dramatically reduce the effects of material changes.

This tool also allows the transfer of 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).

In order to use the valve gate control, an output from a physical OR2-M or OA1-M-V module must be installed, connected, and have been assigned in the Mold Settings (refer to the CoPilot™ Hardware Installation and Setup Guide for installation instructions, and “Mold Outputs” on page 37 for instructions on assigning outputs in setup).

NOTE *Valve Gate control will not operate if CoPilot Go is active; is utilized; refer to “CoPilot Go” on page 12 for more information on CoPilot Go.*

CAUTION *Always set up backup setpoints on the machine when using the valve gate control tool; failure to comply will result in damage or destruction of equipment and injury to personnel.*



Job Dashboard (*continued*)

Job Dashboard Valve Gate Control Quarter-View Screen

When viewed on the Job Dashboard along with three other screens, the valve gate control quarter-view screen will display a simple information view of current valve gates including a count of primary, secondary, and not triggered valve gates.

Primary

A gate that opened AND closed on a primary rule will display as one (1) **A** primary count.

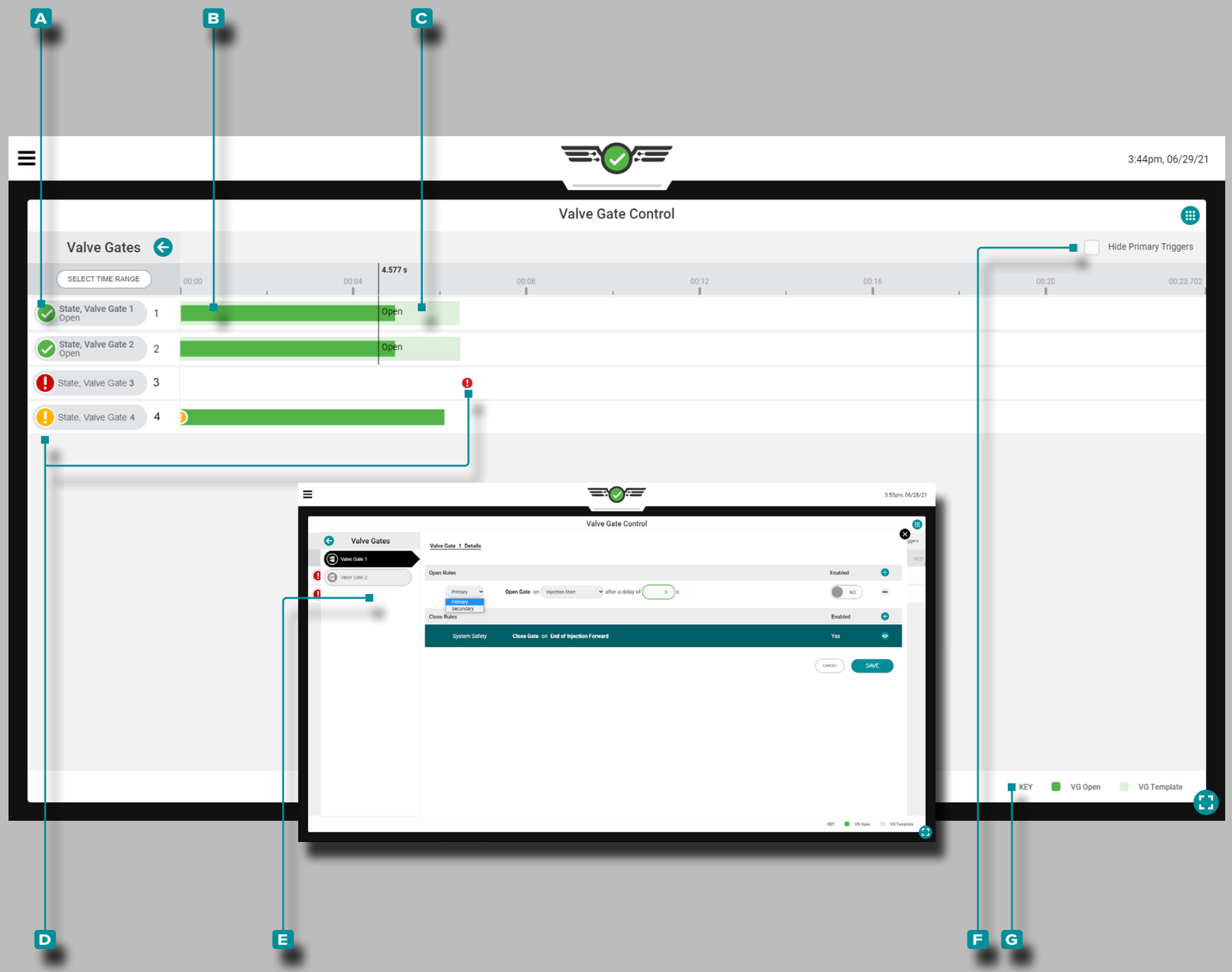
Secondary

A gate that opens OR closes on a secondary rule will display as one (1) **B** secondary count.

Not Triggered

A gate that does not open AND/OR does not close will display as one (1) **C** not triggered count.

Job Dashboard (*continued*)



Job Dashboard Valve Gate Control Full-View Screen

When viewed on the Job Dashboard in full-screen, the valve gate control widget will display current valve gate(s) in a gantt-chart-type view including the following:

A: gate and cavity name label,

B: open and close actual,

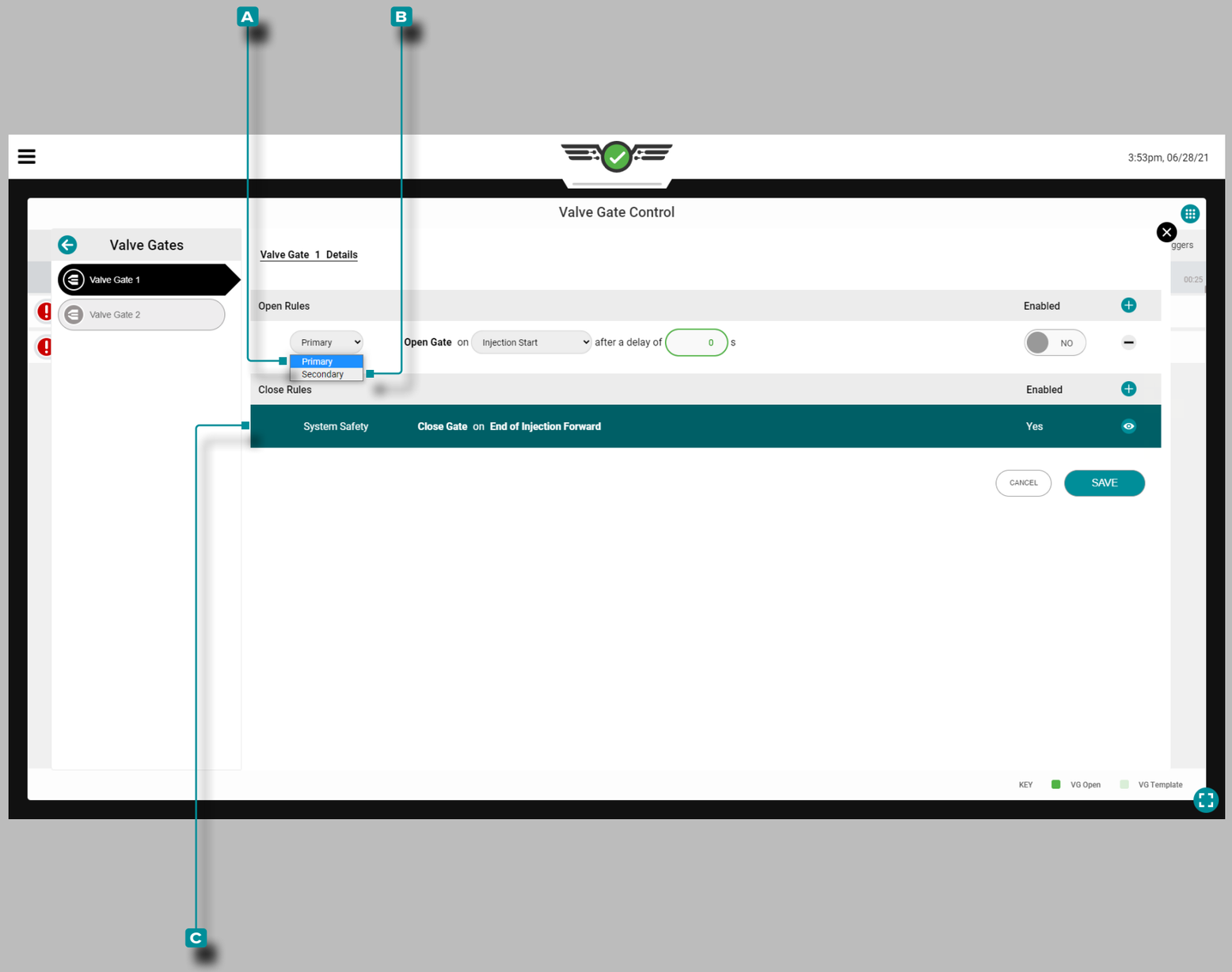
C: open and close process template,

D: secondary and not triggered event icons,

E: view or edit valve gate rule settings,

F: hide valve gate that trigged on the primary control rule button, and

G: color key.



Job Dashboard (*continued*)

Valve Gate Control Setup

Once a job with valve gate outputs assigned is started, the Valve Gate Control widget will appear on the Job Dashboard. **Tap** the widget to view and add controls.

RJG, Inc. recommends that both a primary and secondary control be assigned for valve gate control.

Primary Control

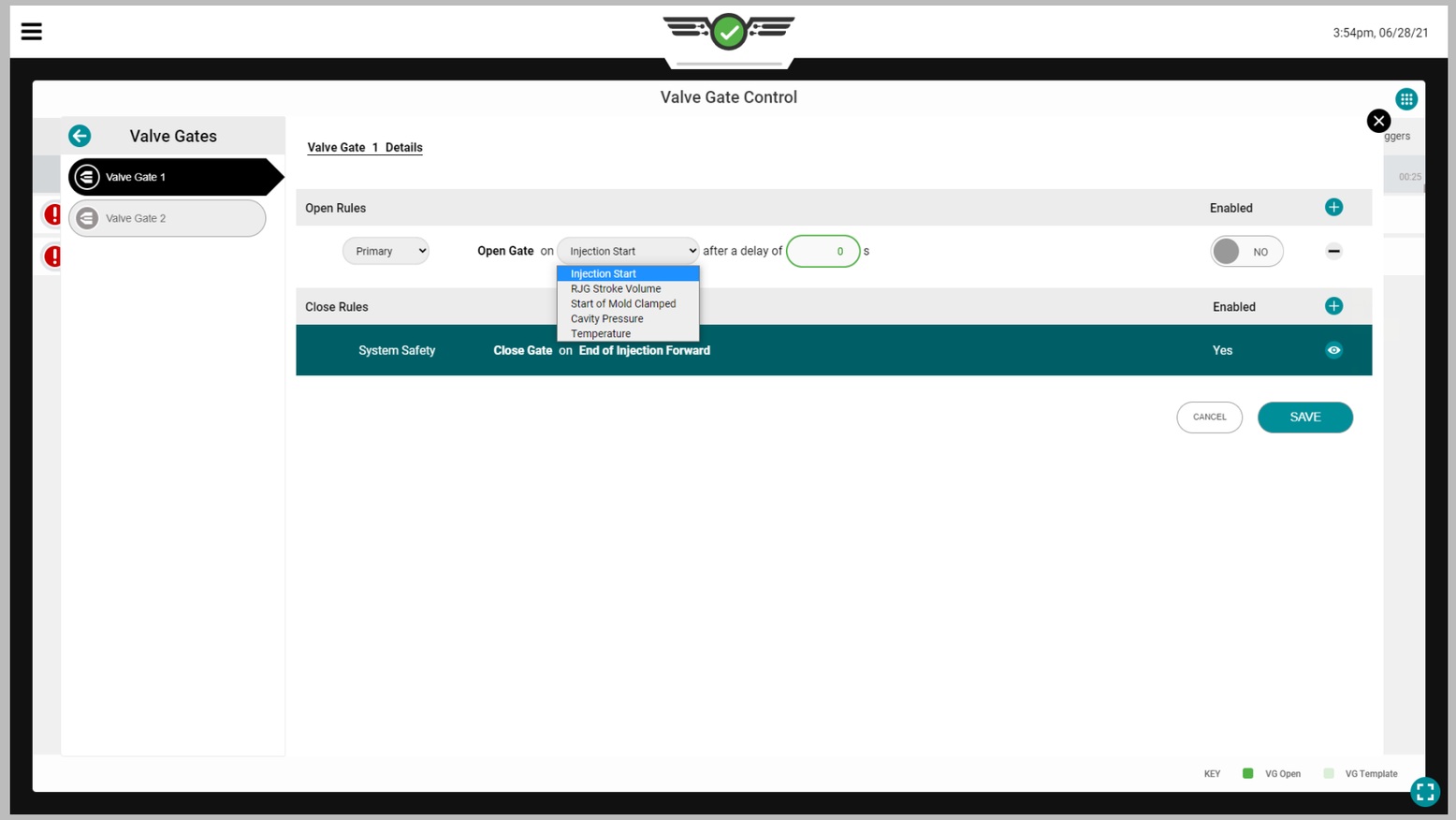
A **A** primary control is the control which is set with the intention that it will be the main control setpoint.

Secondary Controls

A **B** secondary control is the control which is set with the intention that if the primary control is not reached, the secondary control will provide the signal as a backup.

The valve gate control will open or close the gate(s) based on which primary setpoint is reached first; any control that is enabled but did not reach its set point first will become the back-up control. If none of the primary controls are reached, the controls move to the secondary controls which will operate as the primary controls in order of reached setpoints.

A built-in C system safety control will close the valve gate(s) on the end of injection forward to prevent damage to the mold or machine. This control cannot be edited or removed.



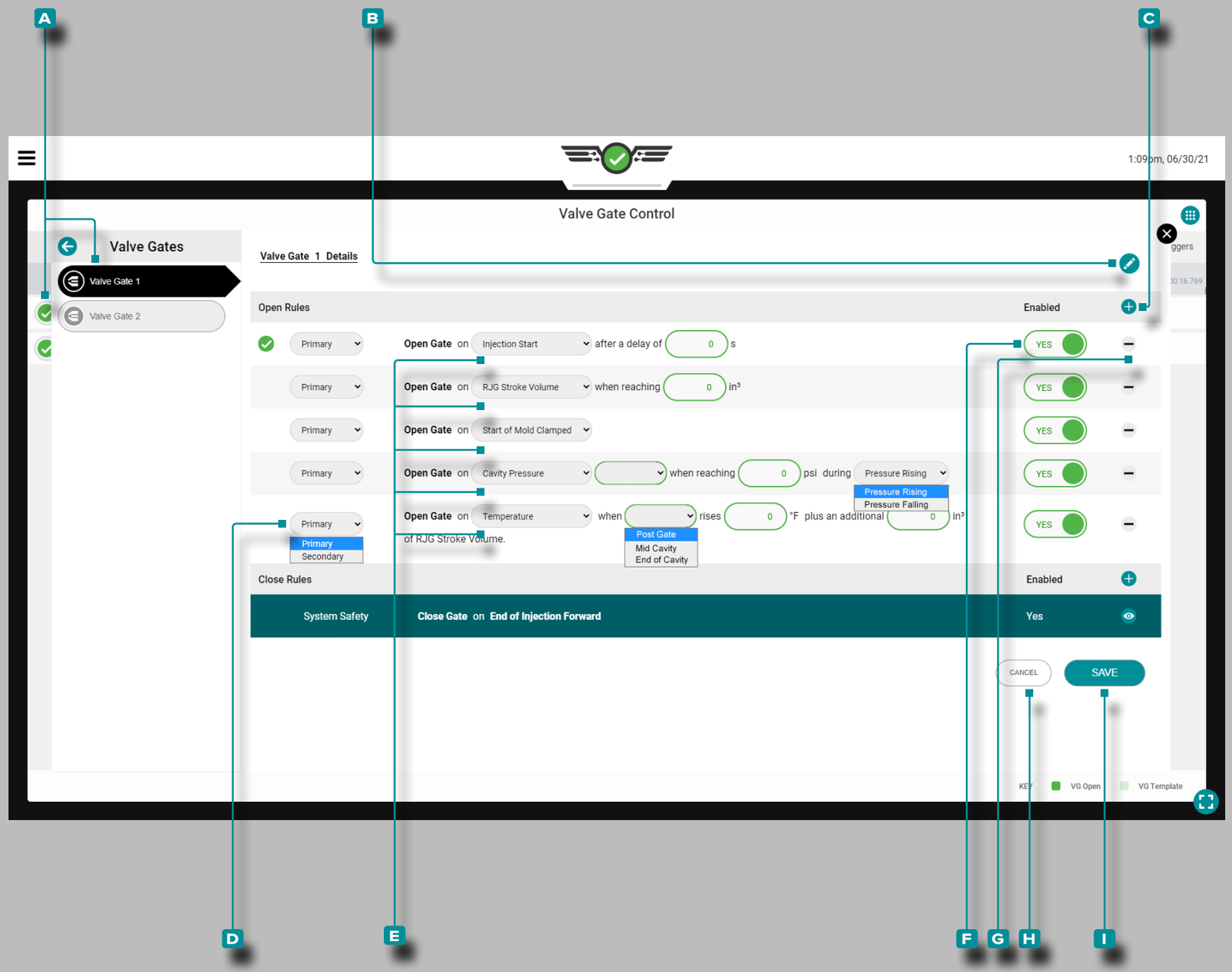
Job Dashboard (*continued*)

Valve Gate Control Setup (continued)

Open Valve Gate Controls

There are five (5) events at which a gate can be designated to open:

- Open on Injection Start after a Delay of X seconds
  If selected, the valve gate will open at start of injection after a delay of 0–X seconds, as indicated by the user-entered number of seconds. This function can be used as a backup in case the mold clamped signal does not come on. This can also 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.
- Open on RJG Stroke Volume
  If selected, the valve gate will open at 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, for balance or sequential knitline control.
- Open on Start of Mold Clamped
  If selected, the valve gate will open when the mold clamps. Use this feature for pre-heating valve pins in polycarbonate applications.
- Open on Cavity Pressure
  If selected, the valve gate will open at the user-entered cavity pressure of the selected sensor during either pressure rising or pressure falling, as selected by the user. Use this feature for sequential knitline control.
- Open on Temperature Rise
  If selected, the valve gate will open at the user-entered temperature rise of the selected sensor plus an additional volume. The additional volume value entered is a volume of screw travel AFTER the flow front reaches the sensor—the volume number is the increase in volume from what it was when the flow front reached the sensor. With the sensor installed in a position slightly upstream of when the gate should open, the additional volume allows the screw to advance by a certain volume before opening the valve gate. Use this feature for processes such as structural foam or coining in which there is no pressure in the material as it flows past the sensor.



Job Dashboard (*continued*)

Valve Gate Control Setup (continued)

Add, Edit, or Remove an Open Valve Gate Control

A job with mold outputs assigned must be running.

To add an open valve gate control, open the valve gate control widget to full-screen, then **tap** a **A** valve gate from the list; **tap** the **B** edit icon, then **tap** the **C** add icon.

Tap the **D** drop-down menu to select primary or secondary control type.

Tap the **E** drop-down menu to select an event on which to open the valve gate; depending upon the selection, tap to select a cavity pressure or temperature sensor, tap a field and enter the required information (delay of X seconds, in³ setpoint, °F/°C, and/or ⓘ pressure rising/pressure falling).

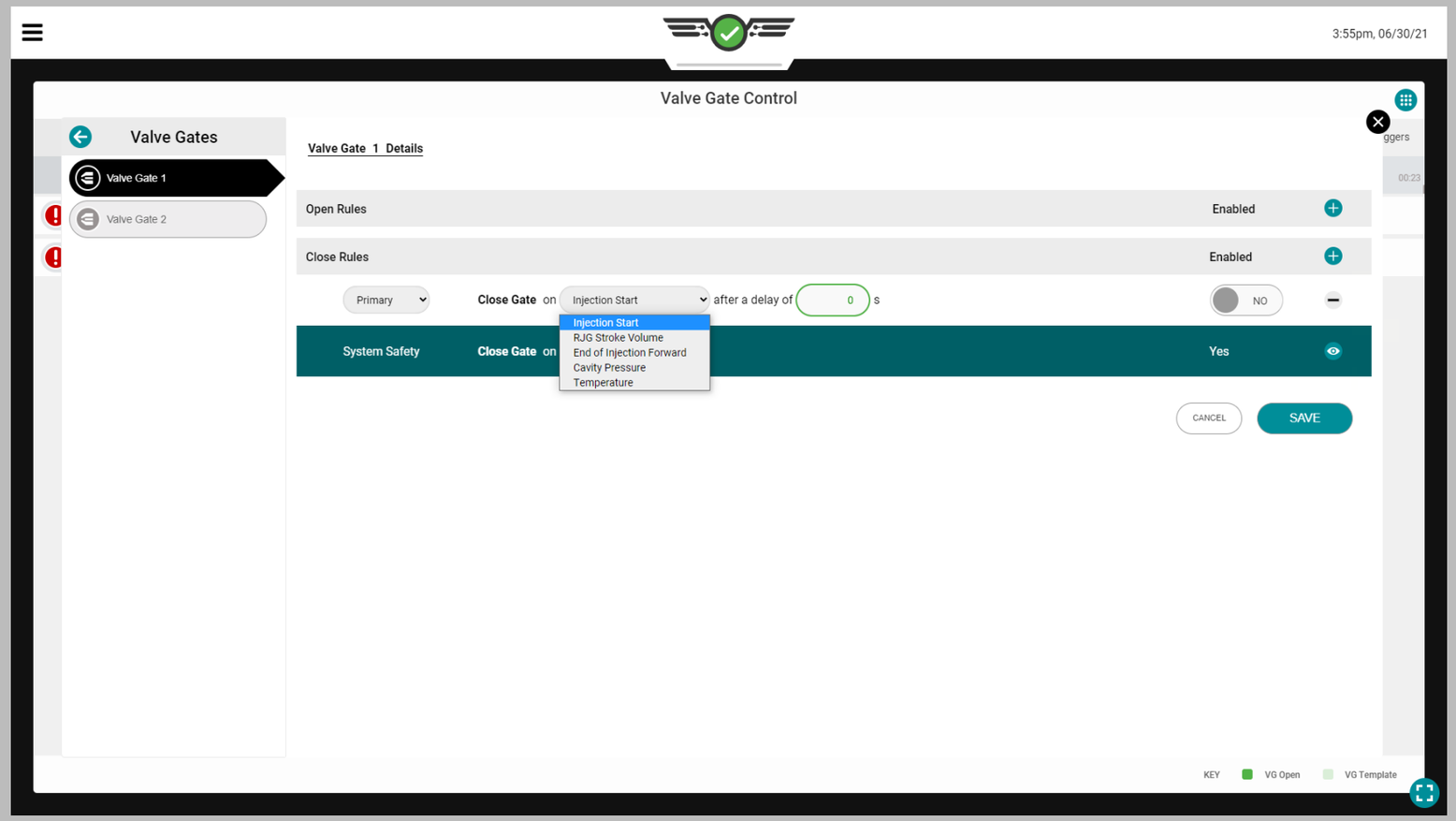
Tap the **F** slider to YES enable or NO disable the control.

Tap the **G** delete icon to delete the control.

Tap the **H** CANCEL button to cancel any changes or **tap** the **I** SAVE button to save any changes.

Any changes made will take effect on the following full cycle.

ⓘ **NOTE** *If selected, "Pressure Rising" will open the gate when pressure at the sensor reaches the entered setpoint while the pressure is increasing (before the peak). If selected, "Pressure Falling" will open the gate after the peak when the pressure falls below the entered setpoint. If you use this method and the pressure never gets as high as the setpoint, the valve gate will NOT open on pressure.*



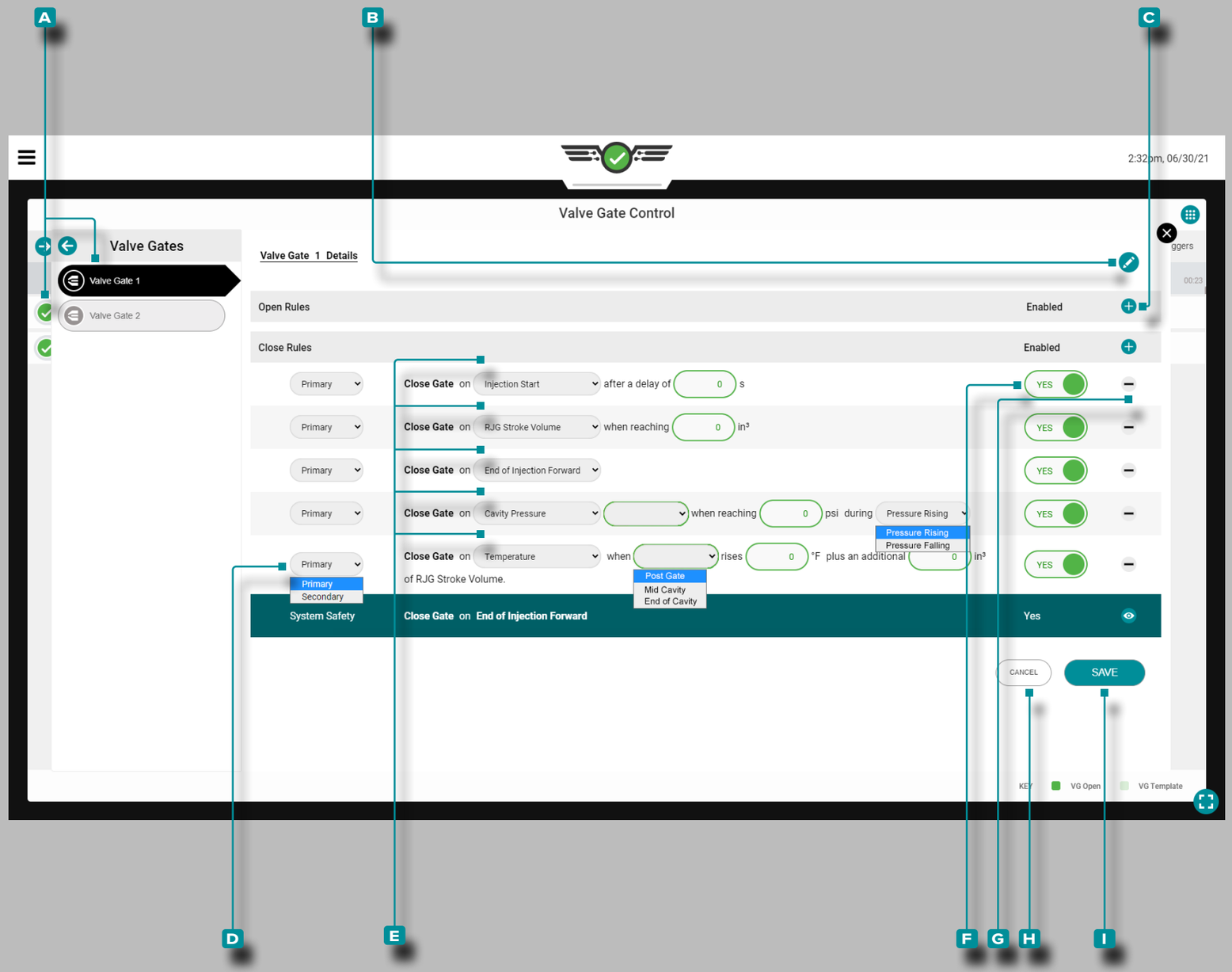
Job Dashboard (*continued*)

Valve Gate Control Setup (continued)

Close Valve Gate Controls

There are five (5) events at which a gate can be designated to close:

- Close on Injection Start after a Delay of X seconds
  If selected, the valve gate will close at start of injection after a delay of 0–X seconds, as indicated by the user-entered number of seconds. This function can be used as a backup in case the mold clamped signal does not come on.
- Close on RJG Stroke Volume
  If selected, the valve gate will close at the volume above zero at which the valve gate is set to close. 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 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.**
- Close on End of Injection Forward
  If selected, the valve gate will close at the end of injection forward.
- Close on Cavity Pressure
  If selected, the valve gate will close at the user-entered cavity pressure of the selected sensor during either pressure rising or pressure falling, as selected by the user. Use this feature for sequential knitline control. If using “Injection”, the pressure shown is NOT hydraulic pressure, but plastic pressure (hydraulic x intensification ratio [ri]). Use falling pressure to close a gate for controlled discharge after packing. “Pressure Falling” is useful for controlled discharge after packing to reduce pressure and dimensional gradients.
- Close on Temperature Rise
  If selected, the valve gate will close at the user-entered temperature rise of the selected sensor plus an additional volume. The additional volume value entered is a volume of screw travel AFTER the flow front reaches the sensor—the volume number is the increase in volume from what it was when the flow front reached the sensor. With the sensor installed in a position slightly upstream of when the gate should close, the additional volume allows the screw to advance by a certain volume before opening the valve gate.



Job Dashboard (*continued*)

Valve Gate Control Setup (continued)

Add, Edit, or Remove a Close Valve Gate Control

A job with mold outputs assigned must be running.

To add a close valve gate control, open the valve gate control widget to full-screen, then **tap** a A valve gate from the list; **tap** the B edit icon, then **tap** the C add icon.

Tap the D drop-down menu to select primary or secondary control type.

Tap the E drop-down menu to select an event on which to close the valve gate; depending upon the selection, tap to select a cavity pressure or temperature sensor, tap a field and enter the required information (delay of X seconds, in³ setpoint, °F/°C, and/or ⓘ pressure rising/pressure falling).

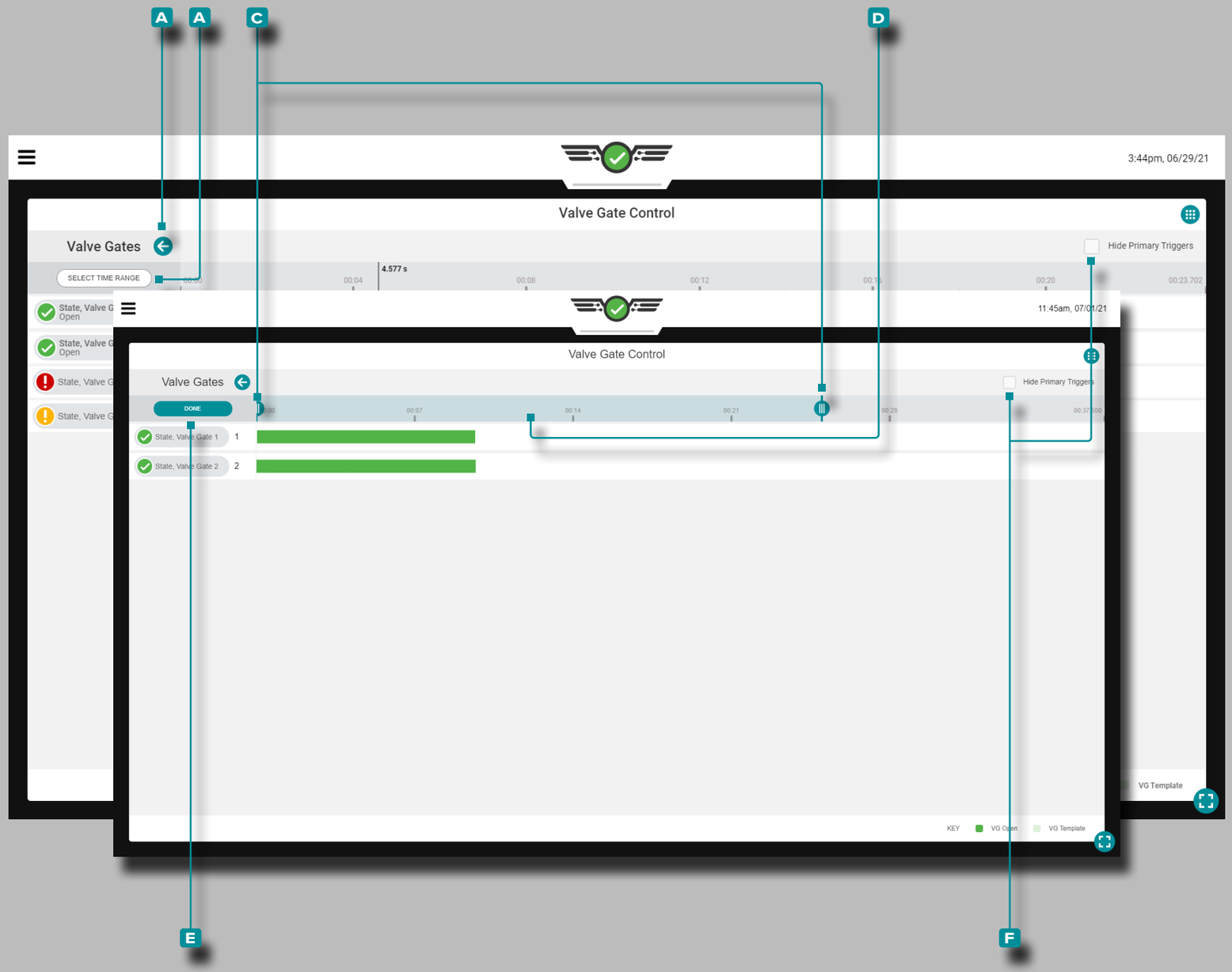
Tap the F slider to YES enable or NO disable the control.

Tap the G delete icon to delete the control.

Tap the H CANCEL button to cancel any changes or **tap** the I SAVE button to save any changes.

Any changes made will take effect on the following full cycle.

ⓘ **NOTE** *If selected, "Pressure Rising" will close the gate when pressure at the sensor reaches the entered setpoint while the pressure is increasing (before the peak). If selected, "Pressure Falling" will close the gate after the peak when the pressure falls below the entered setpoint. If you use this method and the pressure never gets as high as the setpoint, the valve gate will NOT close on pressure. This is useful for controlled discharge after packing to reduce pressure and dimensional gradients.*



Job Dashboard (*continued*)

Valve Gate Control Tools

Process Templates

The valve gate control tool displays process templates with the running process if selected in the cycle graph widget. Refer to “Cycle Graph Process Templates” on page 84 for process template creation and viewing instructions.

Zoom In

Tap the A arrow button to expand and view the valve gate control menu, then **tap** the B SELECT TIME RANGE button to zoom in to a time selection of the cycle graph. Tap , hold, and drag one or both of the C sliders to the selected time.

Tap, **hold**, and **drag** the D time selection bar to pan left or right on the cycle graph. **Tap** the E DONE button to apply the changes.

Zoom Out

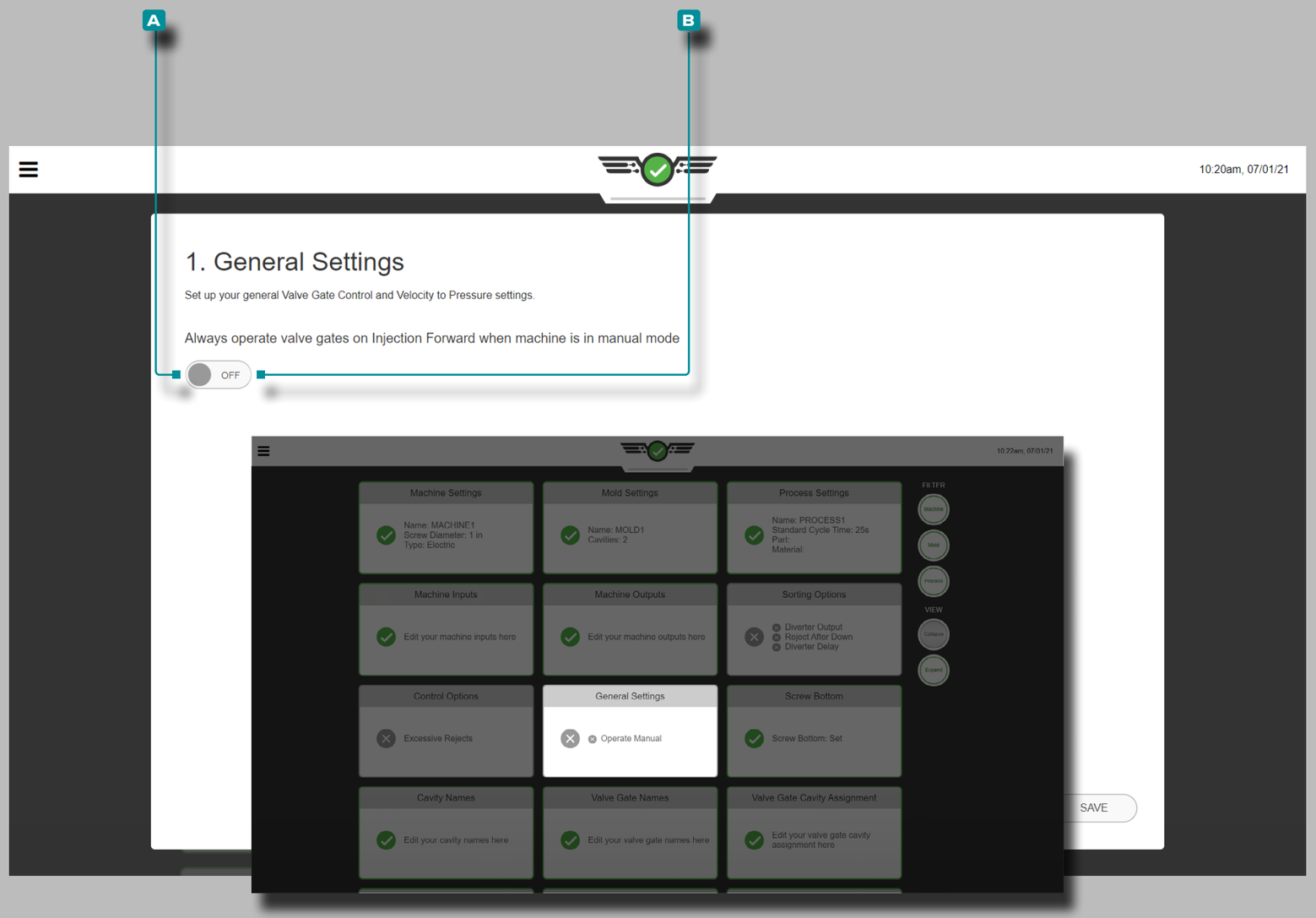
Tap the B SELECT TIME RANGE button to zoom in to a time selection of the cycle graph, then **tap**, **hold**, and **drag** one or both of the C sliders to the selected time. **Tap** the E DONE button to apply the changes.

Pan

Tap, **hold**, and **drag** on the valve gate open/close chart to pan left or right at any time.

Hide Primary Triggers

Tap the F HIDE PRIMARY TRIGGERS check box to hide or unhide the primary valve gate open and close triggers.



Job Dashboard (*continued*)

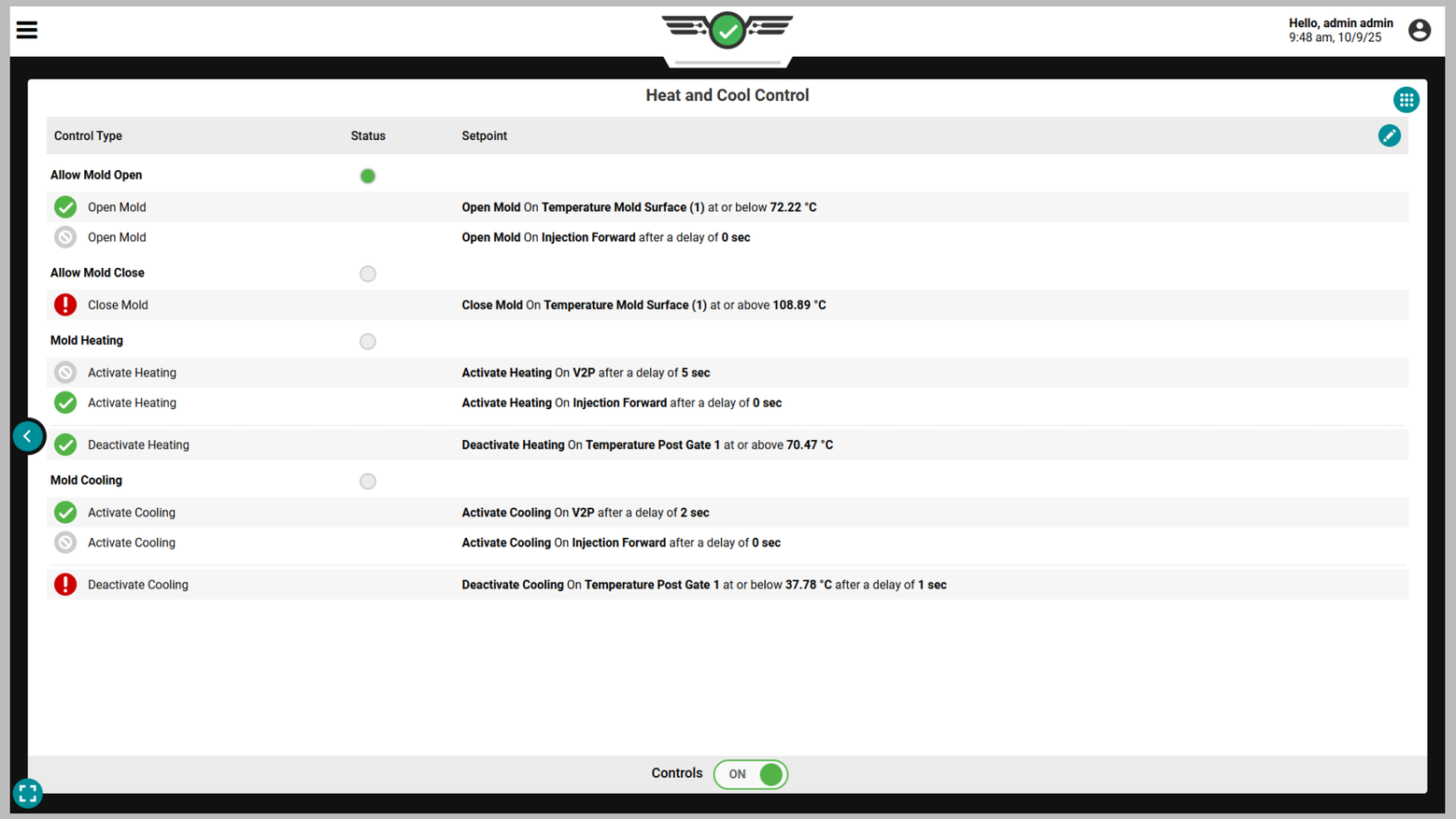
Valve Gate Control General Settings

This option is for valve gate control users only.

To be able to purge through the mold and the valve gates, navigate to the dashboard, locate the general settings card, and **tap** to select it; **tap** to select **A** ON so that the gates open even in manual mode and allow the material through; **tap** to select **B** OFF if this is not desired.

A machine-in-manual sequence signal must be connected and assigned in the machine setup in order to operate valve gate controls in manual mode.

This option can also be setup during process settings; refer to “General Settings” on page 45.



Job Dashboard (*continued*)

Heat and Cool

A license is required to utilize the Heat and Cool feature.

Overview

The Heat and Cool feature is used control and maintain specific mold temperatures, and control part heating and cooling to achieve the desired part finish and reducing overall cycle time.

Three (3) dual output relay modules (OR2-M) are required to send control output signals from the CoPilot system to the IMM; refer to page 22 to set up the required control outputs for mold open, mold close, mold heating on, mold cooling on, and V→P.

Mold heating and mold cooling can be activated using velocity to pressure transfer plus a specified time or injection forward plus a specified time; mold heating additionally be activated using a cavity temperature sensor set point plus a specified time. Both can be deactivated using a cavity temperature set point. Mold open and mold close are controlled using a temperature sensor set point, and mold open can additionally be activated using injection forward plus a specified time.

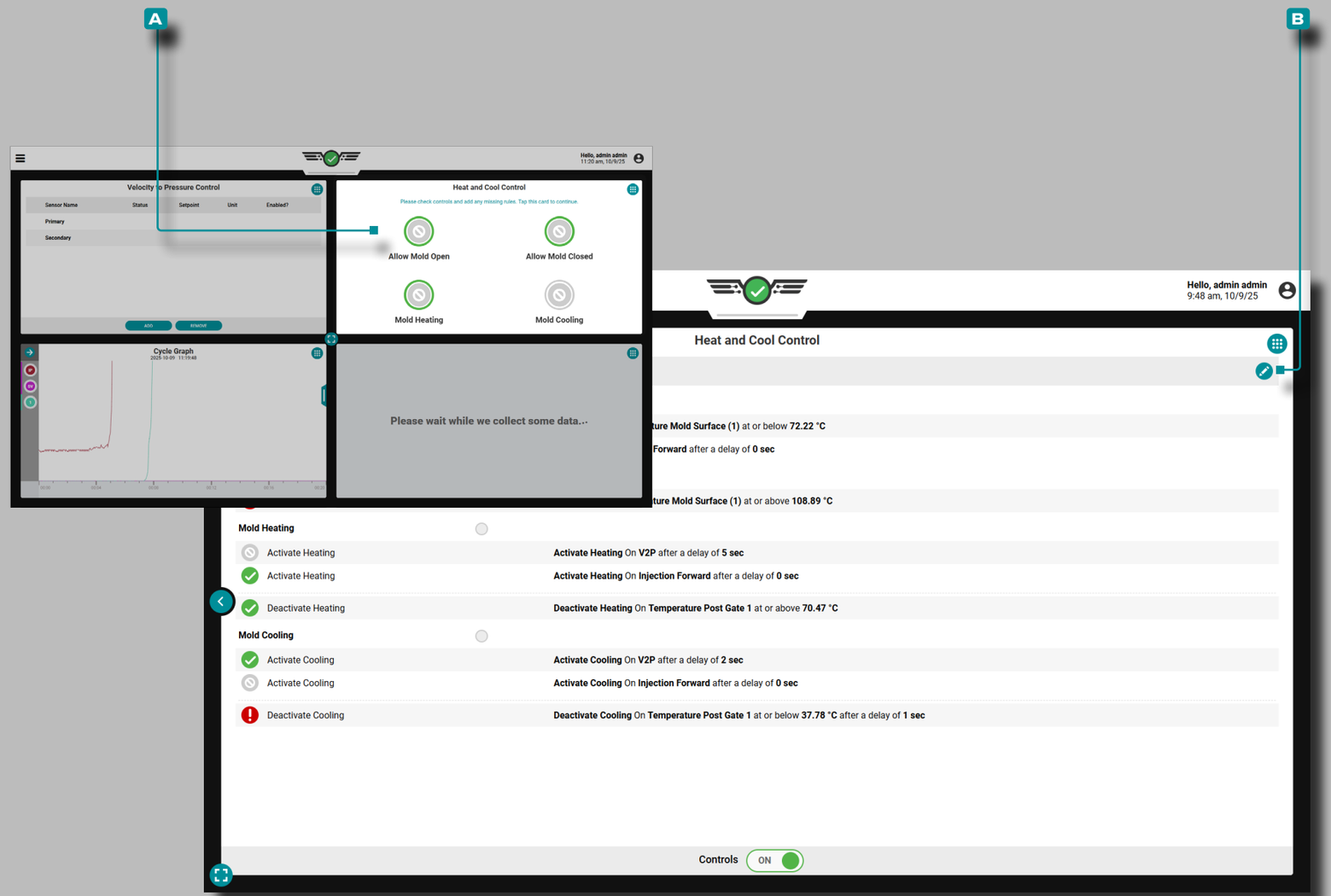
The controls are configured while the machine is not cycling to prevent material waste and/or damage to the mold. The machine can then be cycled without Heat and Cool being active in order to debug and test the process.

Mold Stabilization Time

Process engineers can view the machine value “mold temperature stabilization” time (the time delta between the falling edge of mold clamped and the time at the minimum value of the control temperature sensor) on the Previous Cycle Values and Summary Graph widgets so that the Mold Heating activation setting can be optimized. Mold temperature stabilization time can be saved to a template, but **alarms limits may not be set for the variable on the Alarms widget**.

Process engineer users can set alarm limits on composite temperature alarms to ensure that the parts are good, and can view output triggers compared with cycle curves on the Cycle Graph Machine Sequence States graph to verify correct timing.

Heat and Cool cannot be utilized while CoPilot GO is active; refer to “CoPilot Go” on page 12.



Job Dashboard (*continued*)

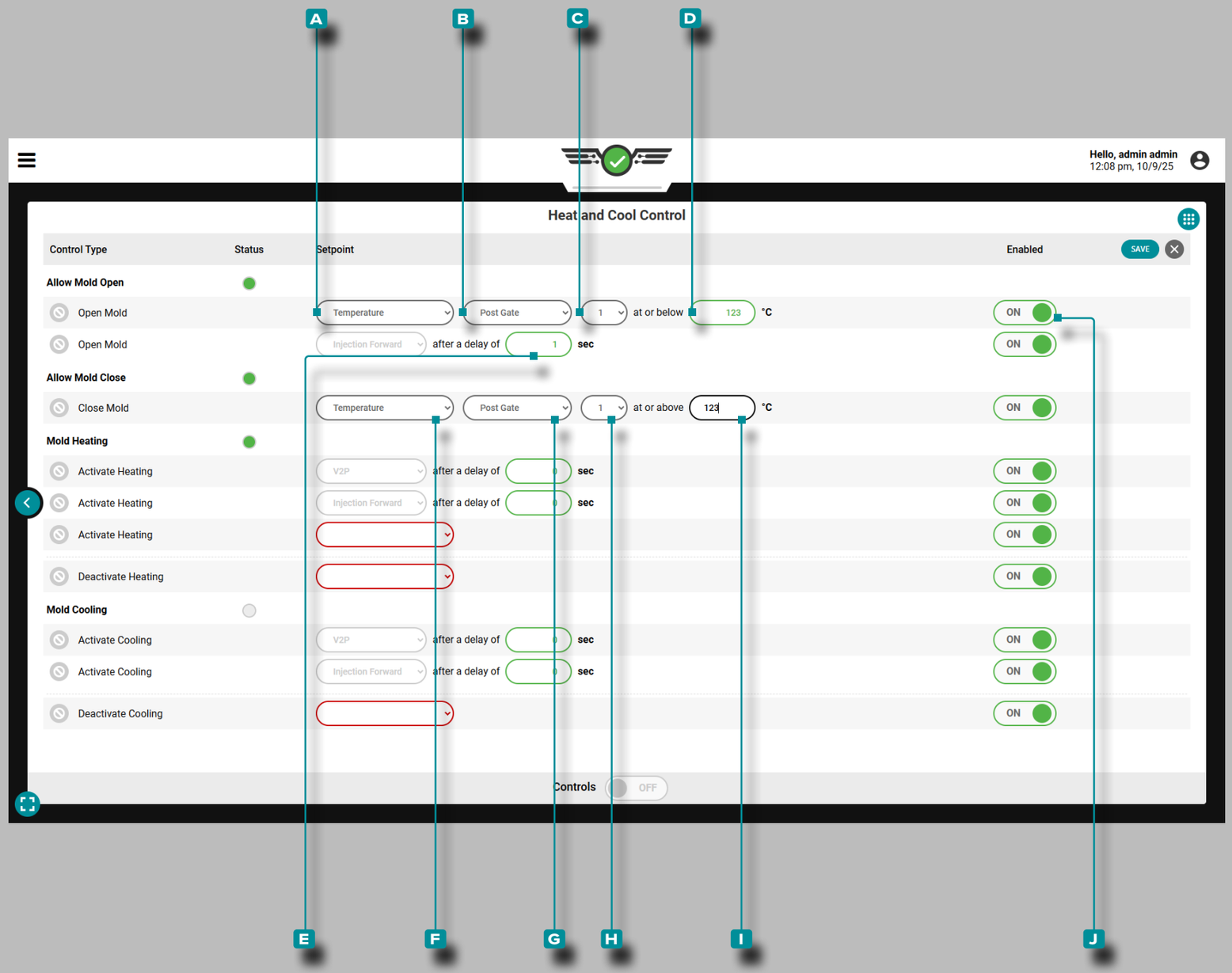
Heat and Cool Setup

Select the Heat and Cool widget for display on the Job Dashboard (refer to “Job Dashboard” on page 53 for Job Dashboard customization); **tap** the **A** heat and cool control quarter-view widget to expand to full size.

The open, close, heating, and cooling rules will be added by default to the Heat and Cool Control Widget; ***a user with the assigned role “process engineer” can enable/disable the rules.***

Tap the **B** edit button to edit the Allow Mold Open, Allow Mold Closed, Mold Heating, and Mold Cooling controls; the control settings can be adjusted before the controls are enabled.

CAUTION *Inject enable is not required, but is encouraged to disable injection in the event that one of the control sensors for Mold Open, Mold Closed, Heating On or Cooling On sensors fails or is in error state.*



Job Dashboard (*continued*)

Allow Mold Open: Cavity Temperature Setpoint

The output "allow mold open" is set to activate after a cavity temperature sensor or composite cavity temperature reaches the defined temperature.

A cavity temperature sensor may be located at end of cavity, mid-cavity, post gate, or mold surface. Composite temperatures may be located at end of cavity, mid-cavity, post gate, or mold surface; a composite setting may be average, high, low, or range.

Tap a field or drop-down menu to adjust the **A** temperature sensor or composite temperature, **B** sensor location, **C** sensor ID or composite (if necessary), or **D** degrees Fahrenheit or Celsius for the control.

Allow Mold Open: Time After Injection Forward

The output "allow mold open" is set to activate after injection forward plus a set time.

Tap the field to adjust the **E** seconds after the start of injection for the control.

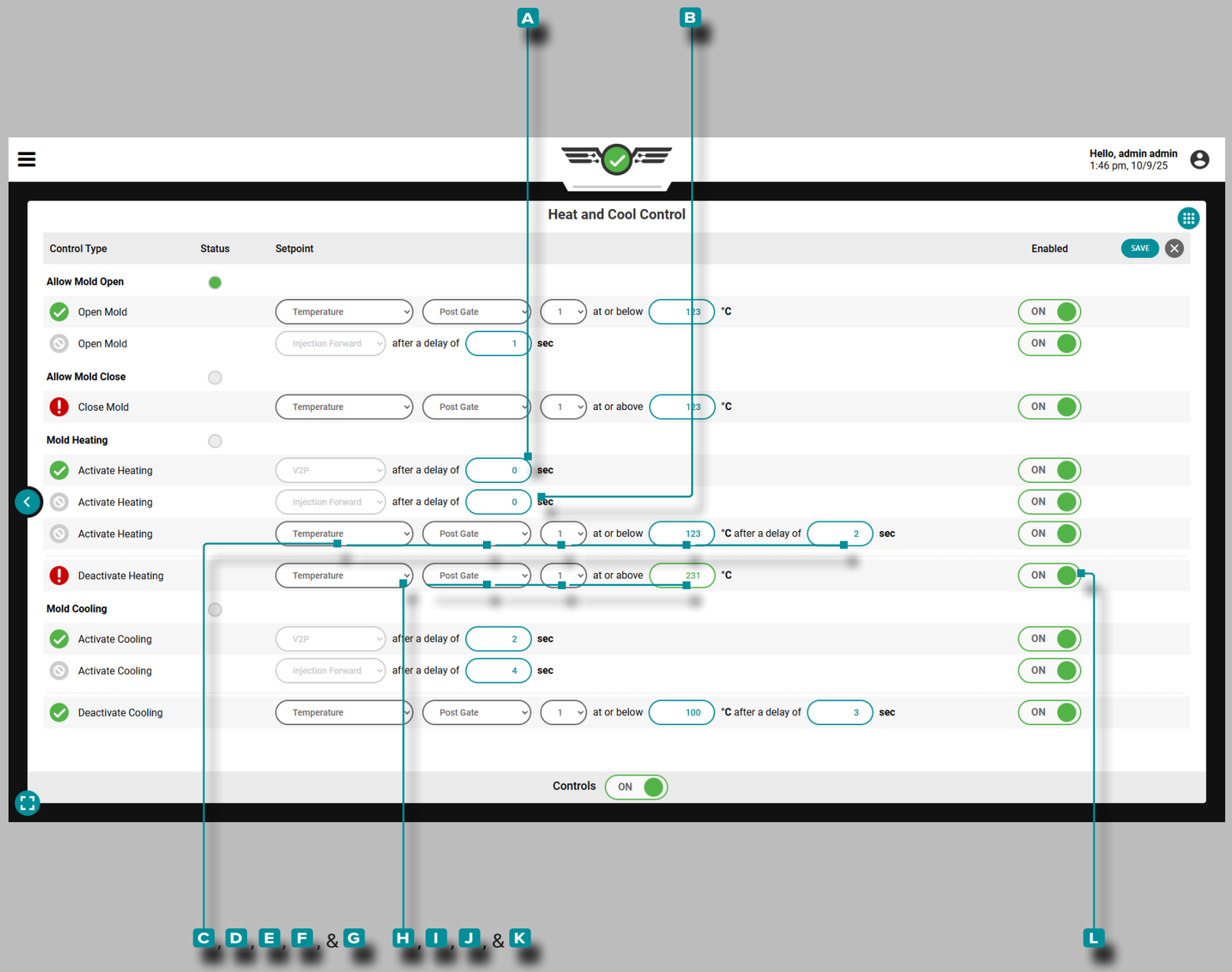
Allow Mold Closed: Cavity Temperature Setpoint

The output "allow mold closed" is set to activate after a cavity temperature sensor or composite cavity temperature reaches the defined temperature.

A cavity temperature sensor may be located at end of cavity, mid-cavity, post gate, or mold surface. Composite temperatures may be located at end of cavity, mid-cavity, post gate, or mold surface; a composite setting may be average, high, low, or range.

Tap a field or drop-down menu to adjust the **F** temperature sensor or composite temperature, **G** sensor location, **H** sensor ID or composite, or **I** degrees Fahrenheit or Celsius for the control.

Tap the **J** slider next to a control to turn that control ON or OFF.



Job Dashboard (*continued*)

Heat and Cool Setup (continued)

Mold Heating

The mold heating control assigned during machine setup sends a signal to the mold temperature controller to activate mold heating when a control rule is fulfilled. Mold heating can only occur once per cycle. **Mold Heating On control is defaulted to enabled, even when the Heat and Cool feature is disabled.**

Mold Heating Activation: Time After V→P Setpoint

The output "mold heating" is set to activate after the V→P set point is reached plus a set time (x seconds). **Tap** the field to adjust the **A** seconds after the V→P set point is reached for the control.

Mold Heating Activation: Time After Start of Injection

The output "mold heating" is set to activate a set time after the start of injection. **Tap** the field to adjust the **B** seconds after the start of injection for the control.

Mold Heating Activation: Cavity Temperature Setpoint

The output "mold heating" is set to activate after a cavity temperature sensor or composite cavity temperature reaches the defined temperature.

A cavity temperature sensor may be located at end of cavity, mid-cavity, post gate, or mold surface. Composite temperatures may be located at end of cavity, mid-cavity, post gate, or mold surface; a composite setting may be average, high, low, or range.

Tap a field or drop-down menu to adjust the **C** temperature sensor or composite temperature, **D** sensor location, **E** sensor ID or composite, **F** degrees Fahrenheit or Celsius, and **G** delay in seconds for the control.

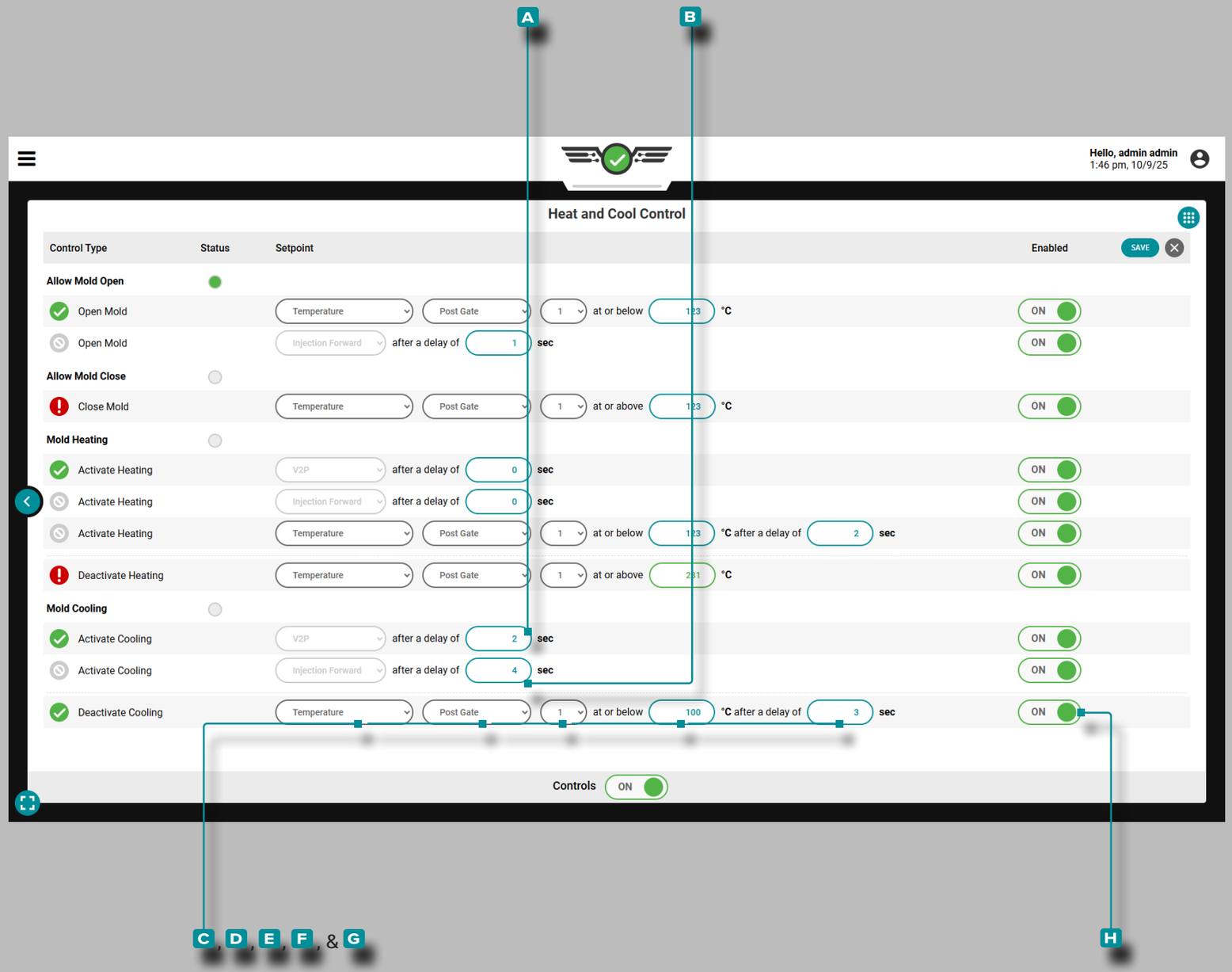
Mold Heating Deactivation: Cavity Temperature Setpoint

The output "mold heating" is set to deactivate after a cavity temperature sensor or composite cavity temperature reaches the defined temperature.

A cavity temperature sensor may be located at end of cavity, mid-cavity, post gate, or mold surface. Composite temperatures may be located at end of cavity, mid-cavity, post gate, or mold surface; a composite setting may be average, high, low, or range.

Tap a field or drop-down menu to adjust the **H** temperature sensor or composite temperature, **I** sensor location, **J** sensor ID or composite, and **K** degrees Fahrenheit or Celsius for the control.

Tap the **L** slider next to a control to turn that control ON or OFF.



Job Dashboard (*continued*)

Heat and Cool Setup (continued)

Mold Cooling

The mold cooling control assigned during machine setup sends a signal to the mold temperature controller to activate or deactivate mold cooling when the rules are fulfilled. **Mold cooling can only occur once per cycle.**

Mold Cooling Activation: Time After V→P Setpoint

The output "mold cooling" is set to activate after the V→P set point is reached plus a set time (x seconds).

Tap the field to adjust the **A** seconds after the V→P set point is reached for the control.

Mold Cooling Activation: Time After Start of Injection

The output "mold cooling" is set to activate a set time after the start of injection.

Tap the field to adjust the **B** seconds after the start of injection for the control.

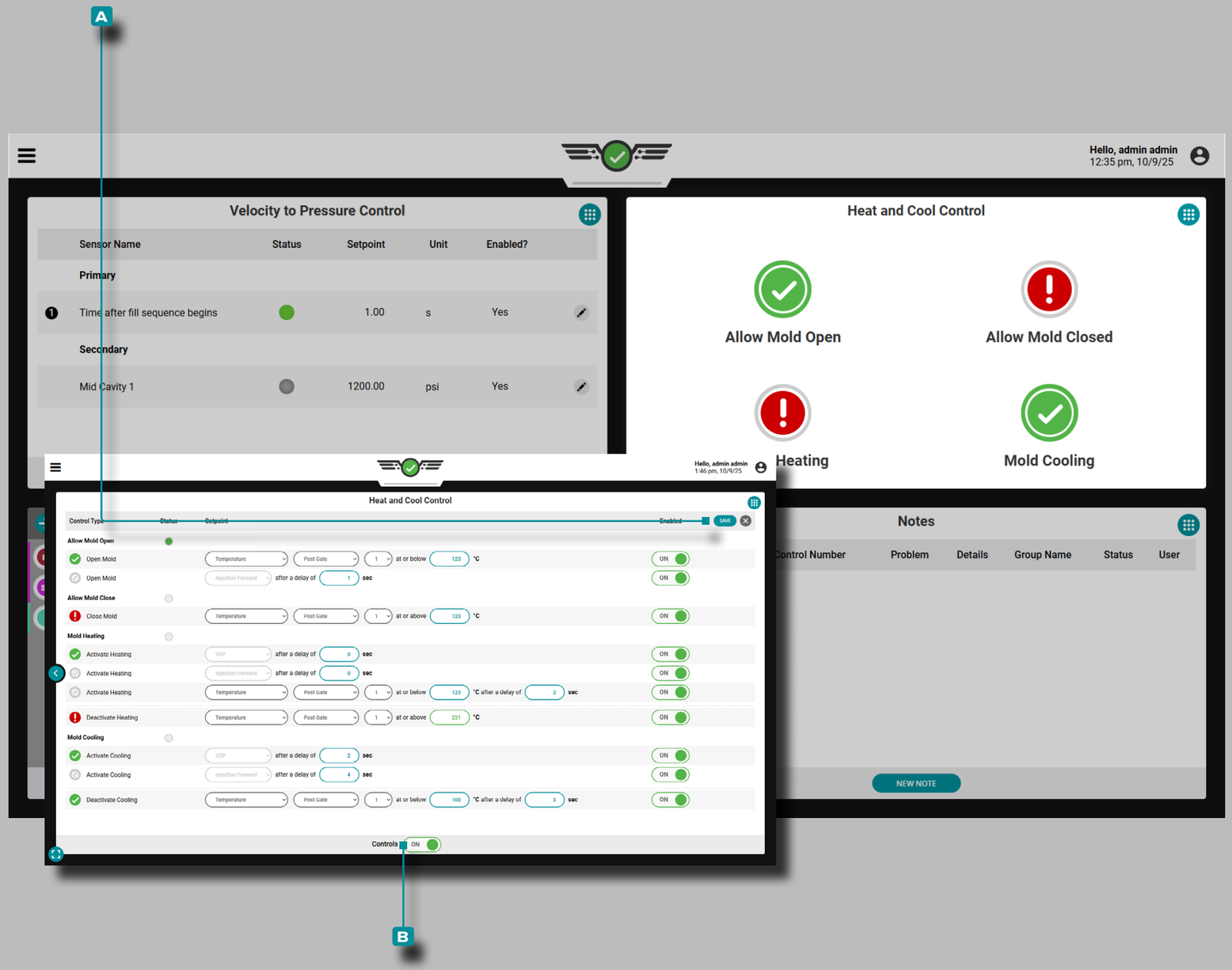
Mold Cooling Deactivation: Cavity Temperature Setpoint

The output "mold cooling" is set to deactivate after a cavity temperature sensor or composite cavity temperature reaches the defined temperature plus a set time.

A cavity temperature sensor may be located at end of cavity, mid-cavity, post gate, or mold surface. Composite temperatures may be located at end of cavity, mid-cavity, post gate, or mold surface; a composite setting may be average, high, low, or range.

Tap a field or drop-down menu to adjust the **C** temperature sensor or composite temperature, **D** sensor location, **E** sensor ID or composite, **F** degrees Fahrenheit or Celsius, and **G** delay in seconds for the control.

Tap the **H** slider to turn a control ON or OFF.



Job Dashboard (*continued*)

Enabling Heat and Cool Controls

Mold Heating On control is defaulted to enabled, even when the Heat and Cool feature is disabled.

At least one control for each setting must be enabled to turn on Heat and Cool control.

Any changes to the heat and cool controls will take effect on the current cycle.

When all controls are setup, **Tap** the A SAVE button to save all controls. **Tap** the B slider to turn on Heat and Cool controls.

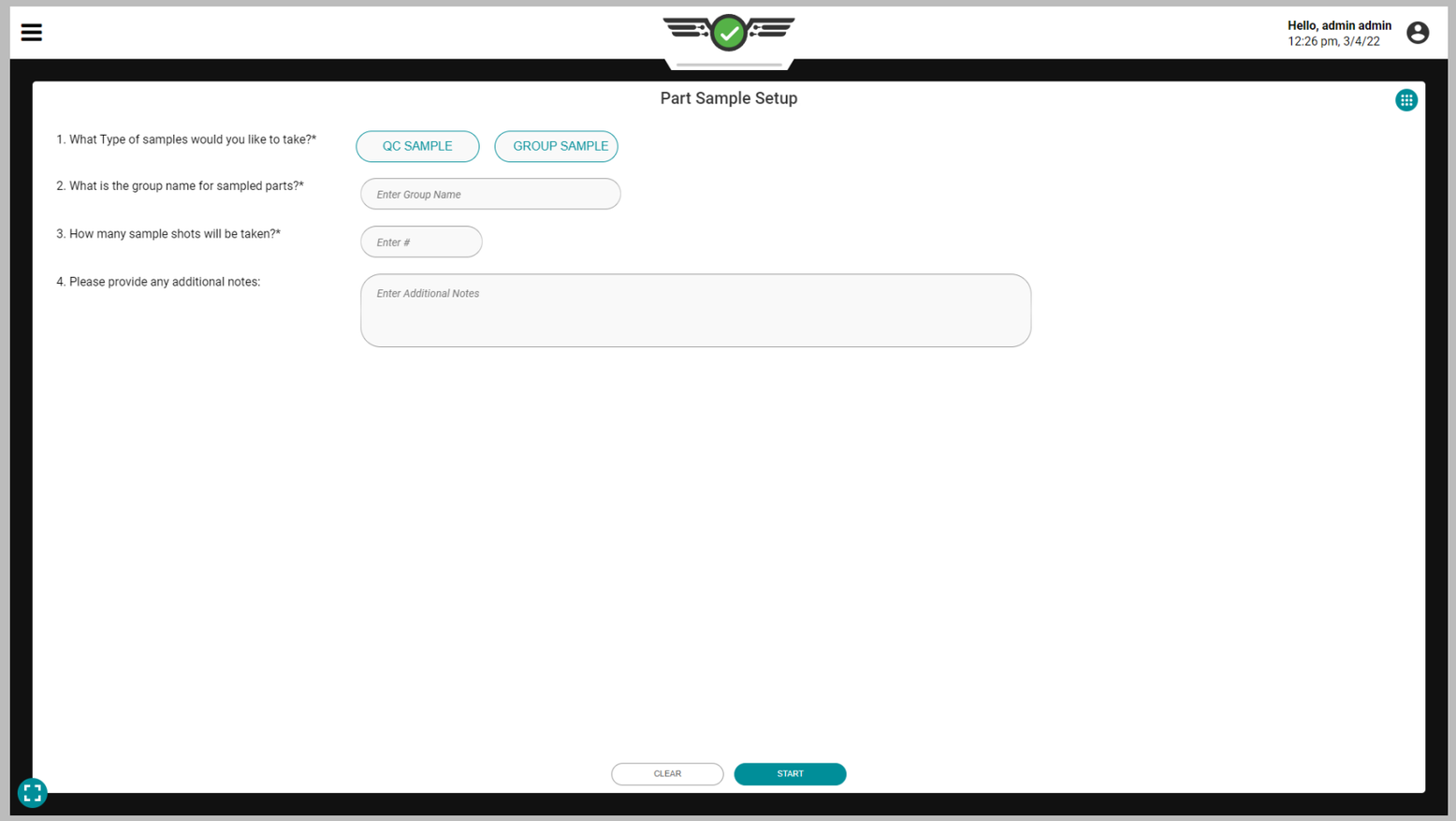
Monitoring Heat and Cool

Heat and Cool Quarter-View Screen

After the Heat and Cool controls are setup and activated, the status of the mold open, mold closed, mold heating, and mold cooling controls can be observed on the quarter-view screen.

Output States

Output States will show a green check mark when a control rule activates on the cycle, or a red exclamation mark when the control rule does not activate on the cycle. Additionally, the output states “halo” will be green when the output is “on”.



Job Dashboard (*continued*)

Part Sampler

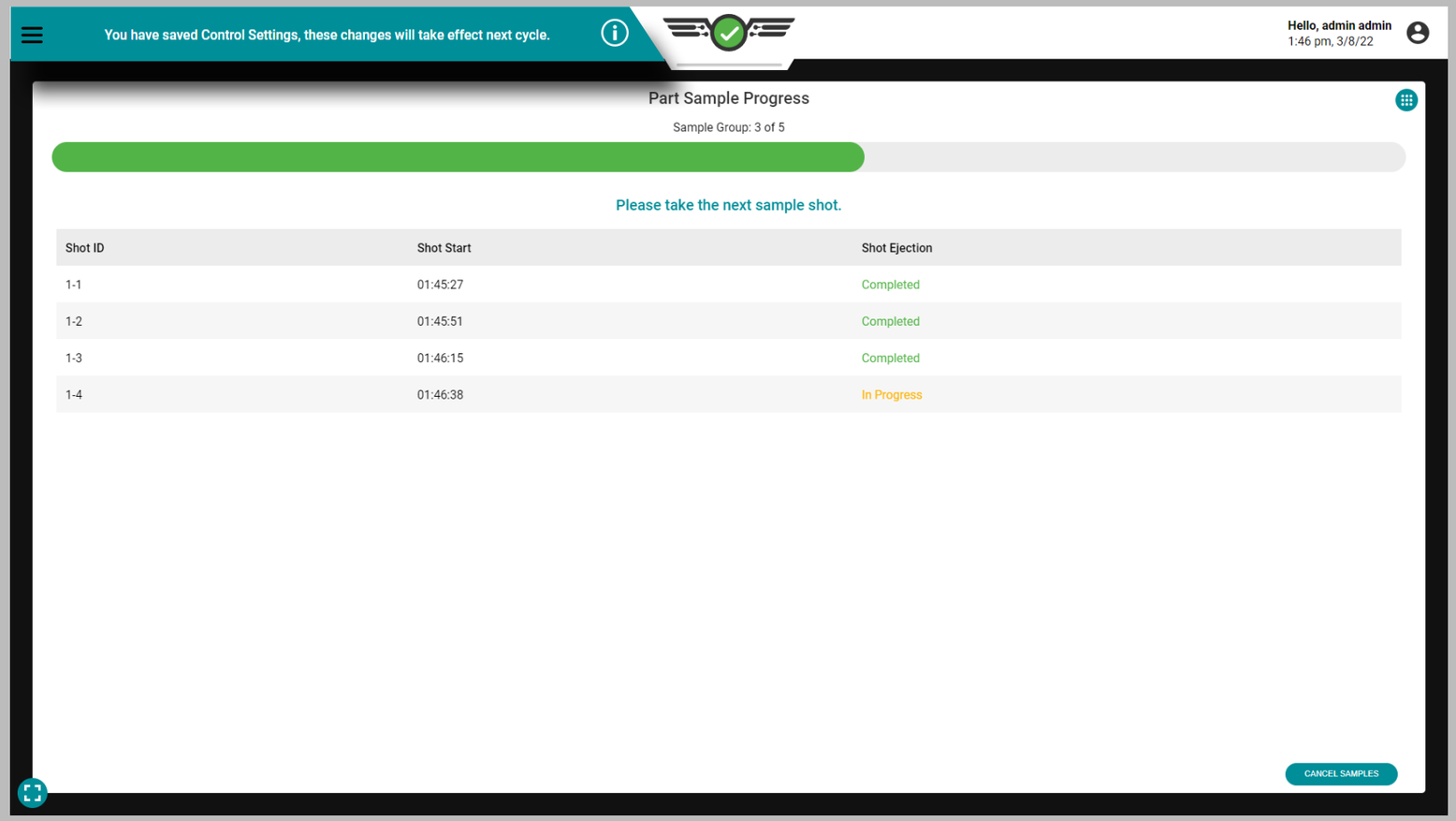
The Part Sampler widget enables Process Engineer and QC Engineer users to create part samples in order to enter and view associated part measurements in The Hub software.

Part Variants

In order to take part samples, a part variant must be selected on the job pull down menu (refer to “CoPilot Dashboard” on page x). Part variants are used to associate parts made from the same mold but with different materials/customers/ processes, and to associate part measurements with any samples taken of the part variant. **If a part variant is not selected on the job notch, no measurements will be able to be entered into The Hub software for those part samples; a notification will be displayed on the screen to notify the user.**

Sample Types

There are two sample types—QC Samples and Group Samples. QC Samples are typically taken after process development, when a part is in production; group Samples are typically used during process development with a new Mold.



Job Dashboard (*continued*)

Part Sample Sorting

If changes are made to sorting outputs during a sample, the changes will take effect on the next sample (the in-progress sample will use the previous settings); a notification will be displayed on the screen for the user.

Good Control or Reject Control

When using the part sampler widget, part samples will be sorted according to the sorting settings present on the Sorting Options dashboard card (Good Part or Reject Part).

Excessive Rejects

When sorting is started, excessive rejects sorting is disabled until the sample is completed. Sample cycles will not count toward excessive rejects cycle counts, and cycle counts will resume once the samples are completed.

Hold Diverter and Diverter Delay Output

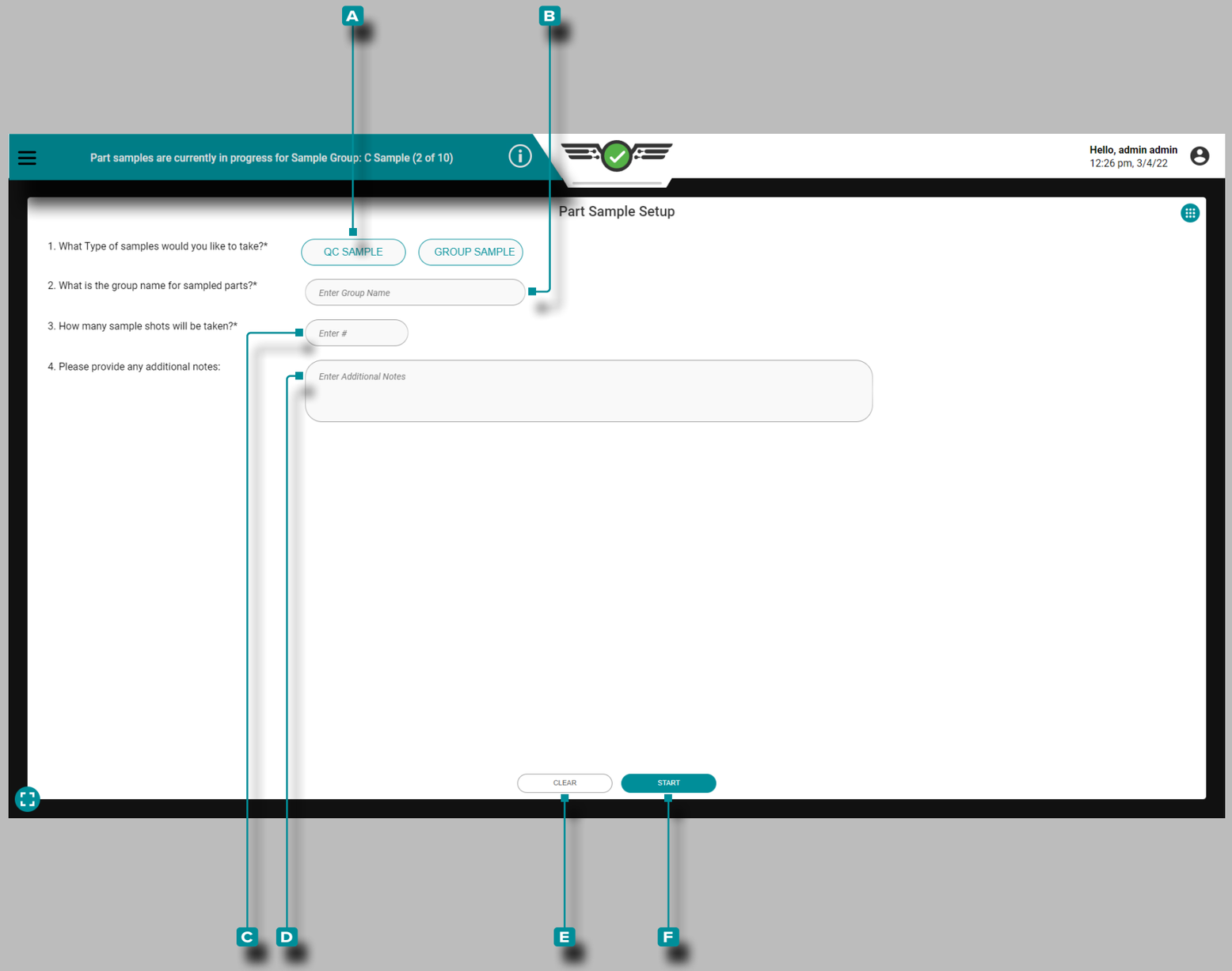
Hold diverter output and diverter delay output sorting settings are not affected during part samples.

Reject After Down

When sorting is started, reject after down sorting is disabled until the sample is completed. Sample cycles will not count toward reject after down cycle counts, and cycle counts will resume once the samples are completed.

Sorting Output Timing

When using the part sampler widget, part samples will be sorted according to the sorting settings present on the Set Up Sorting Settings dashboard card for sorting output timing—refer to “Sorting Options” on page 42 and page 44.



Job Dashboard (*continued*)

Taking Part Samples

QC Samples

To take a part sample, **tap** the **A** QC SAMPLE button to select the sample type.

Optionally, **tap** the field to **enter** a **B** group name for the sampled parts; if no group name is entered, the part sampler will default to the group name “QC Sample”.

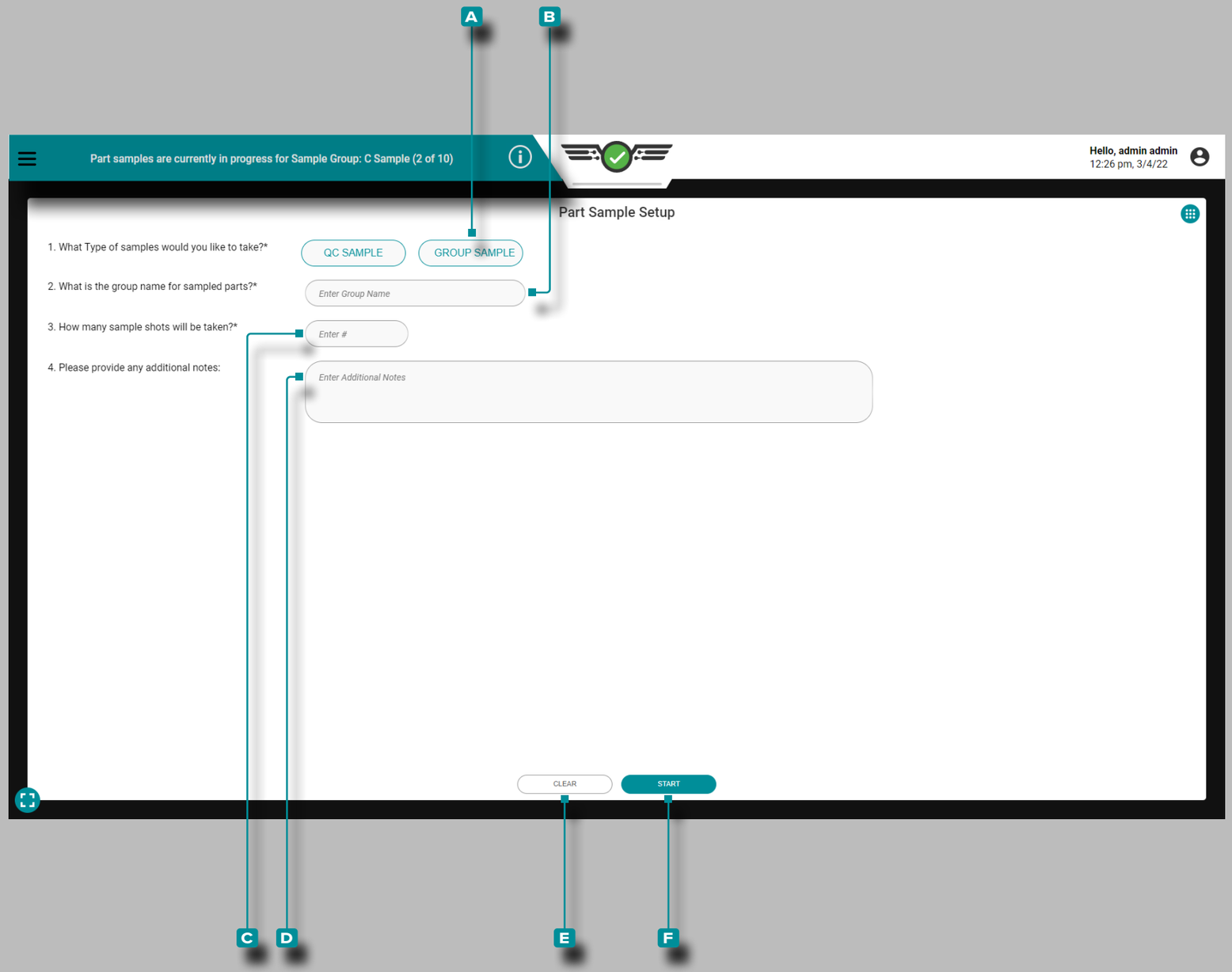
Optionally, **tap** the field to **enter** the **C** number of sample shots that will be taken; if no number is entered, the part sampler will default to take one QC sample shot.

Optionally, **tap** the field to **enter** any **D** notes for the sample(s).

Tap the **E** CLEAR button to clear any entered information, or **tap** the **F** START button to begin taking part samples.

When a part sample is being taken, a noticiation will appear on the screen indicating that a sample is in progress. The part sample notification will display the sample group name and count (x of y) to allow the user to view other widgets and settings while a part sample is running.

Job Dashboard (*continued*)



Taking Part Samples (continued)

Group Samples

To take a group sample, **tap** the **A** GROUP SAMPLE button to select the sample type.

Tap the field to **enter** a **B** group name for the sampled parts.

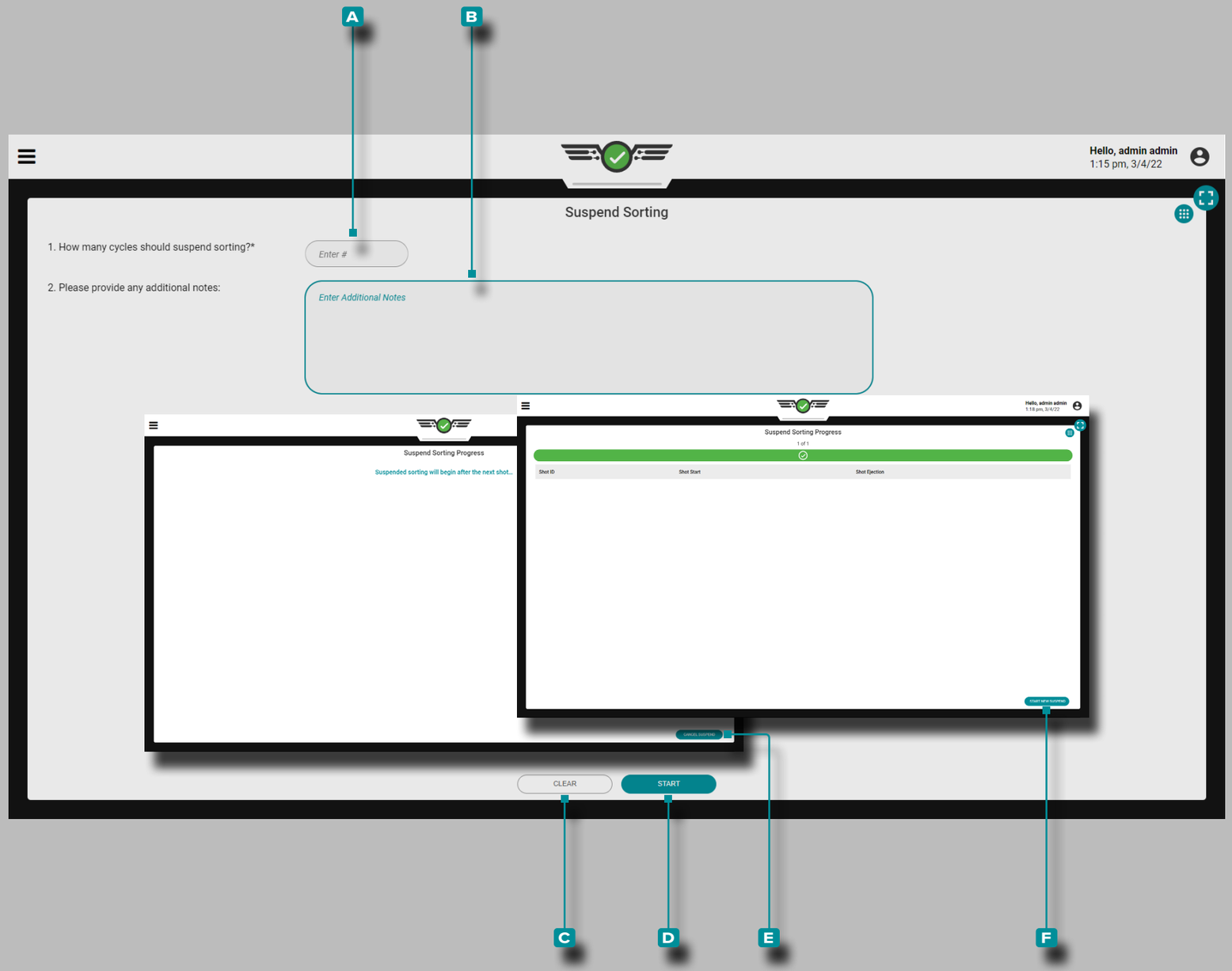
Tap the field to **enter** the **C** number of sample shots that will be taken.

Optionally, **tap** the field to **enter** any **D** notes for the sample(s).

Tap the **E** CLEAR button to clear any entered information, or **tap** the **F** START button to begin taking part samples.

When a part sample is being taken, a notification will appear on the screen indicating that a sample is in progress. The part sample notification will display the sample group name and count (x of y) to allow the user to view other widgets and settings while a part sample is running.

Job Dashboard (*continued*)



Suspend Sorting

The Suspend Sorting widget facilitates the suspension of all sorting settings for a specified number of cycles in order to perform troubleshooting and maintenance activities.

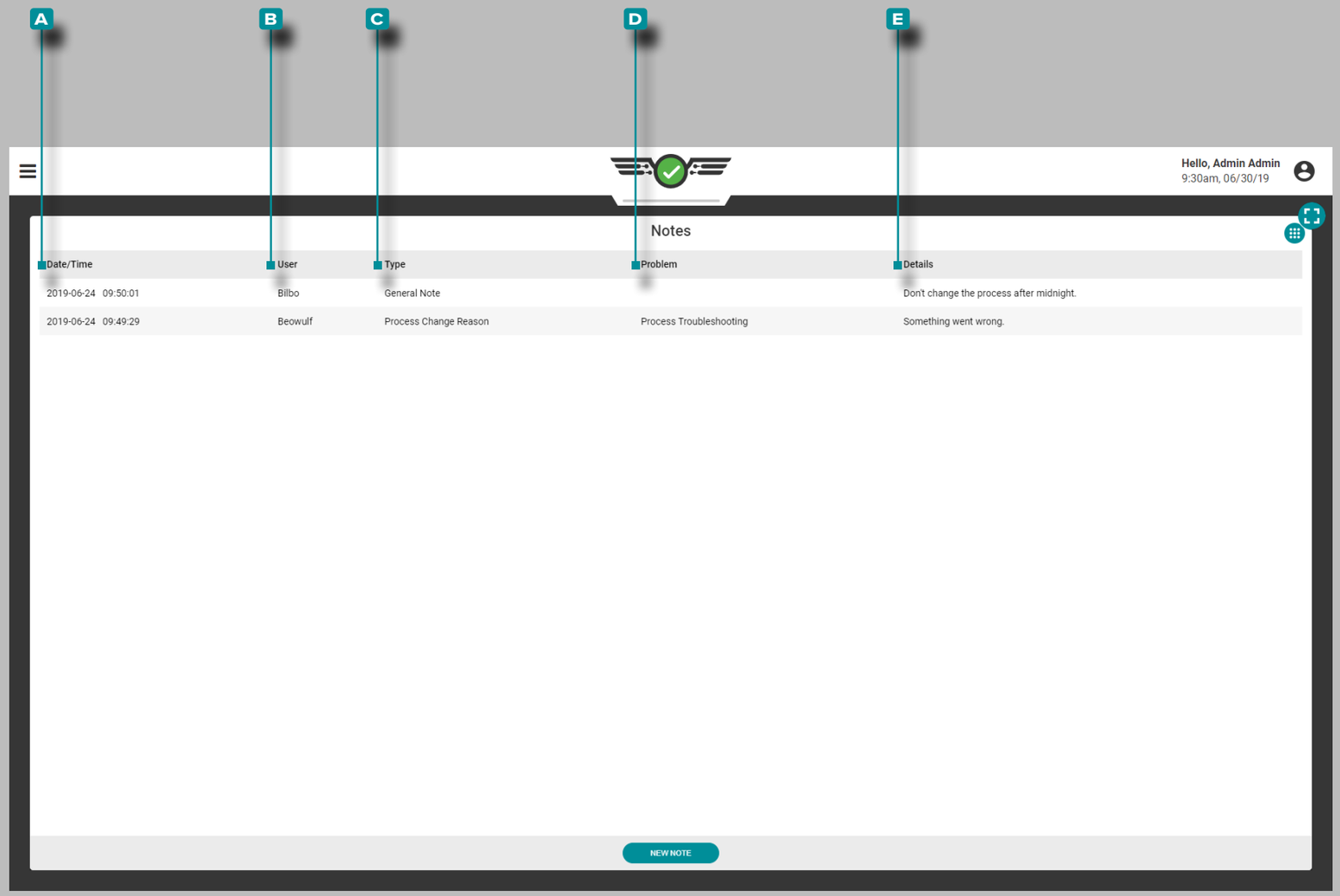
Tap 👆 to **enter** ⌶ the **A** number of cycles to suspend cycles. Optionally, **Tap** 👆 to **enter** ⌶ any **B** additional notes.

Tap 👆 the **C** CLEAR button to clear any entered information, or **tap** 👆 the **D** START button to begin suspending sorting.

Once the start button is selected, the sorting suspension will begin on the next shot; a screen will be displayed notifying the user of the status. To cancel the sorting suspension while it is running, **tap** 👆 the **E** CANCEL SUSPEND button .

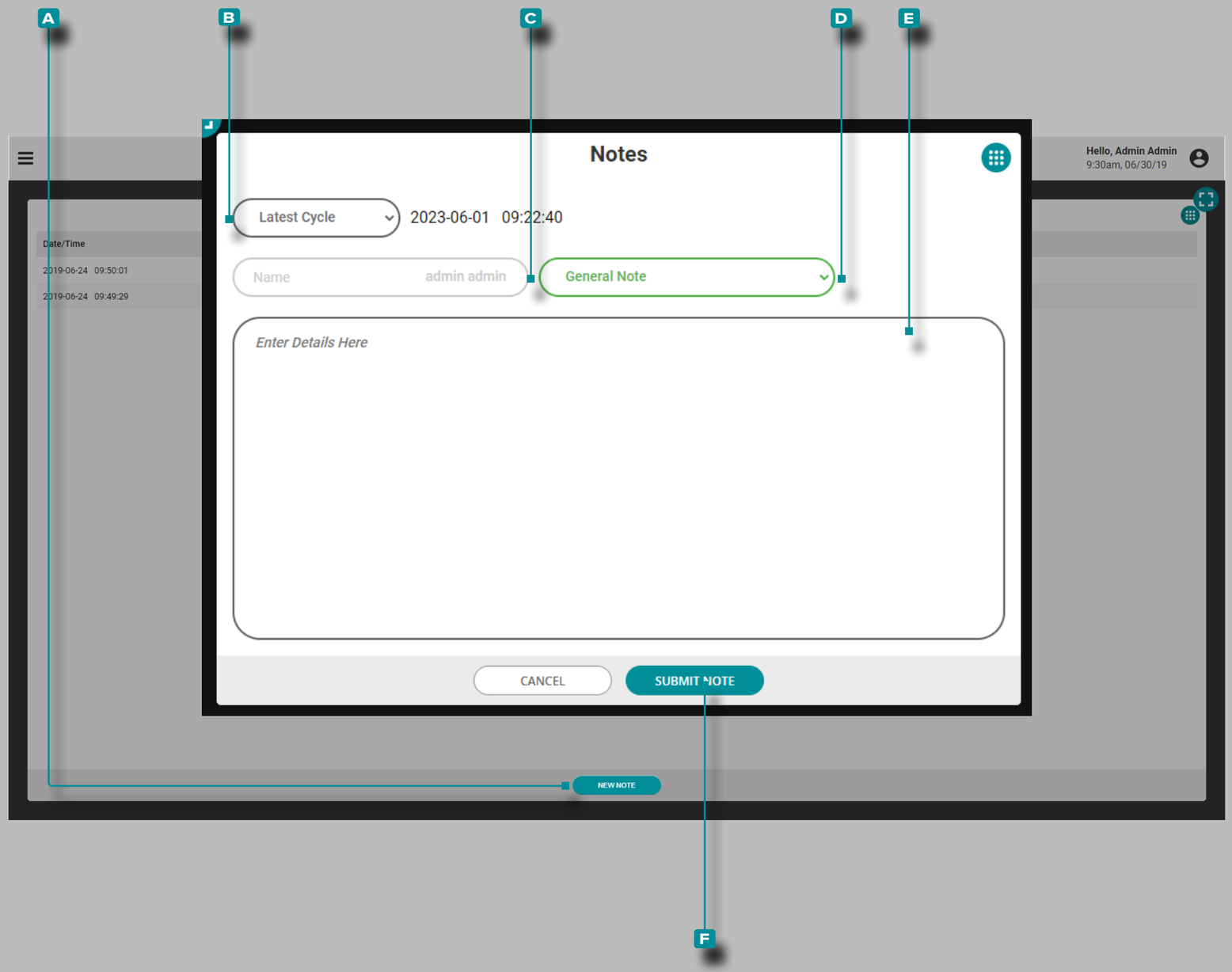
Once the number of specified shots with sorting suspended have elapsed, a screen will be displayed notifying the user that the sorting suspension is complete. To suspend sorting again, **tap** 👆 the **F** START NEW SUSPEND button to return to the suspend sorting widget main page.

Job Dashboard (*continued*)



Notes

View any notes entered on the Notes widget; note details include **A** date/time the note was entered, the **B** user who entered the note, the note **C** type, the **D** problem (if the note type was a process change reason), and any **E** details entered by the user.

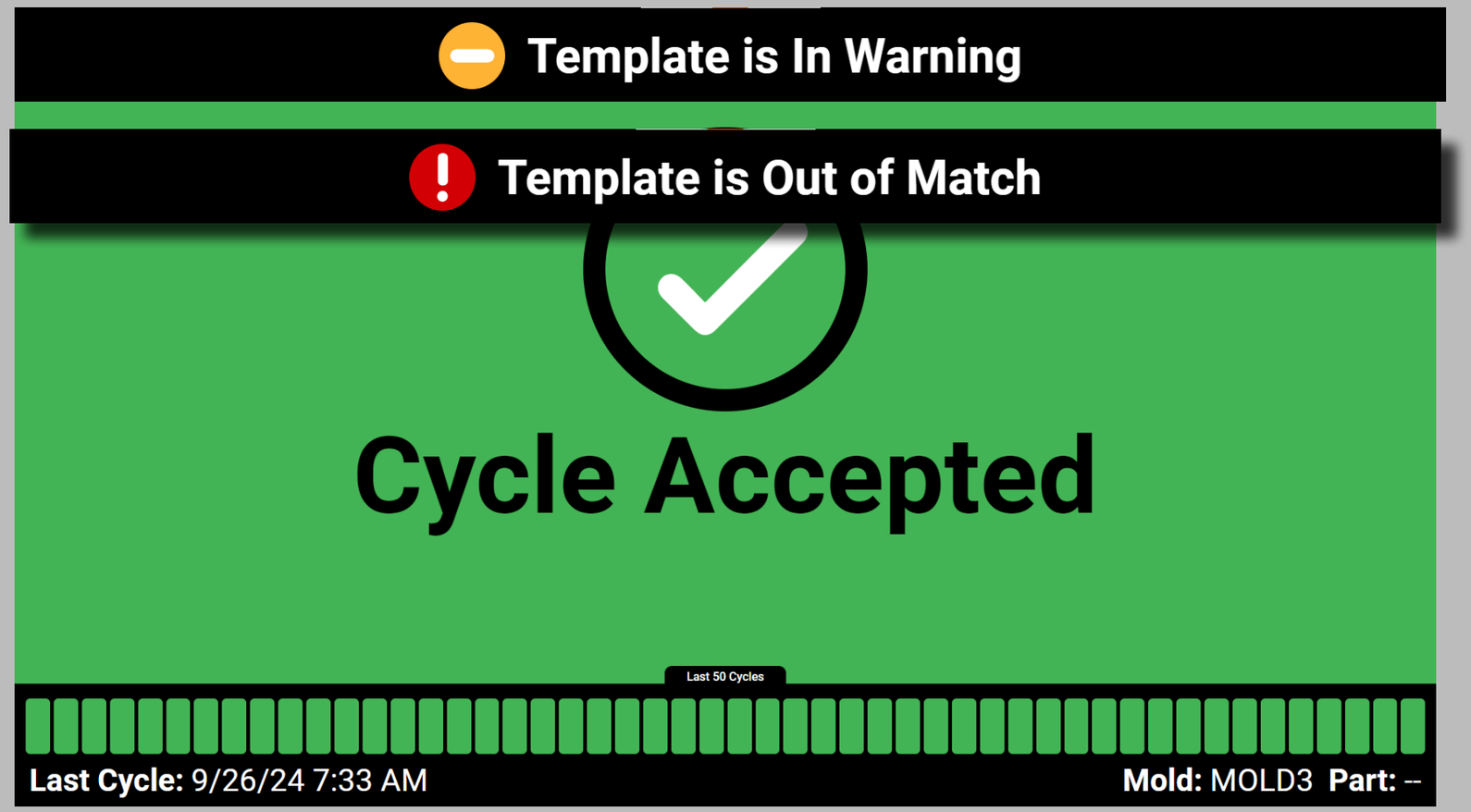


Job Dashboard (*continued*)

Add a New Note

Tap 👆 the **A** NEW NOTE button. **Tap** 👆 the **B** drop-down menu to select the cycle to attach the note—Latestest Cycle or Selected Cycle (on the Summary Graph). **Tap** 👆 the **C** field to enter a username, then **tap** 👆 the **D** drop-down menu to select a note type; **tap** 👆 the **E** field to enter the note, then **tap** 👆 the **F** SUBMIT NOTE button to save and close the note entry.

Notes can also be entered using the Note Entry function; refer to “Note Entry” on page 166 for the Note Entry function and note type descriptions.

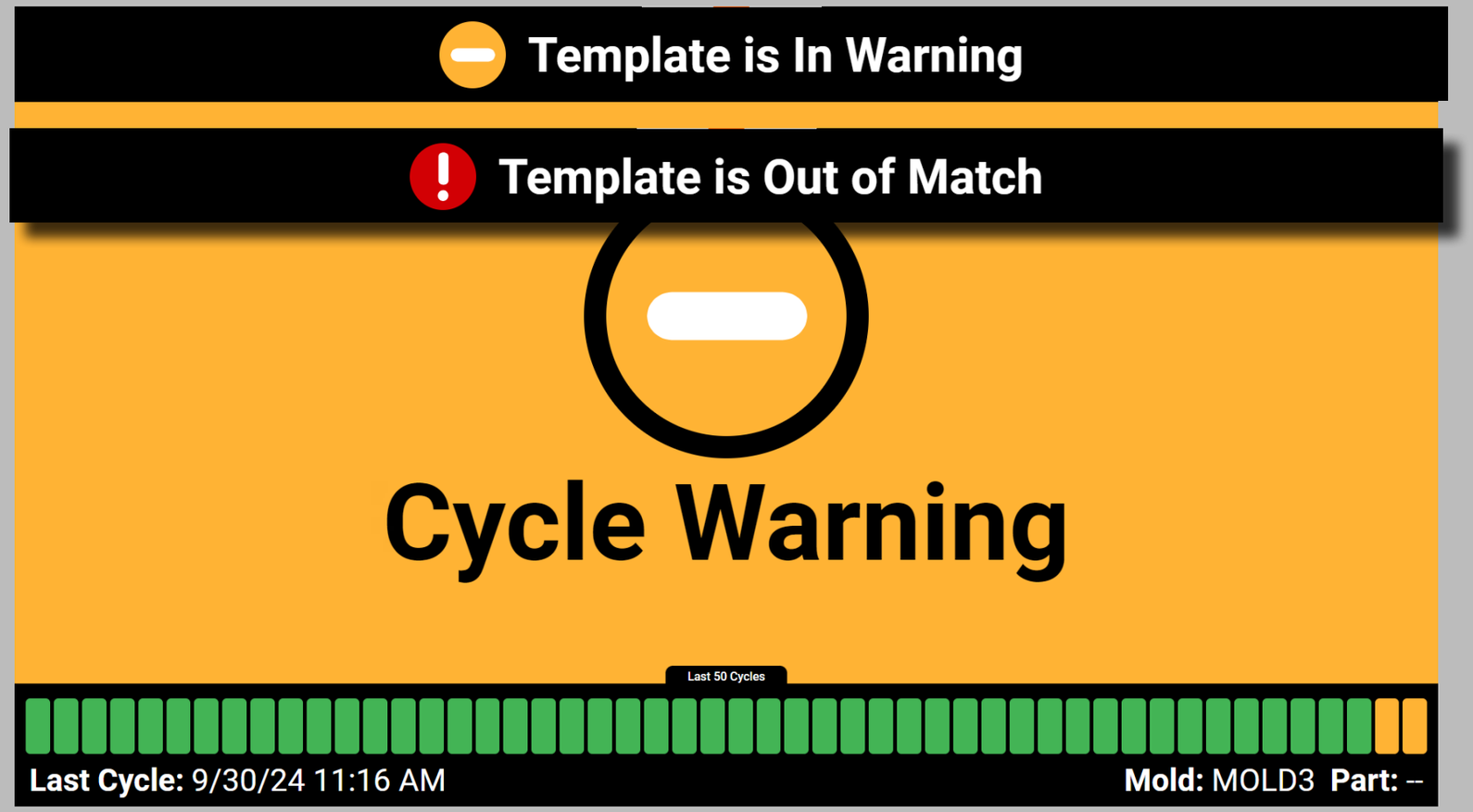


Idle Status Screens

The CoPilot software continues to monitor running jobs while users are inactive on the software. If a job is running on a CoPilot system and no user is active for 10 minutes or longer, the idle status screens Cycle Accepted, Cycle Warning, Cycle Rejected, or Machine Down will display for a quick-reference view of the current process. If Template Match is in use, the template match status will be displayed at the top of the idles status screen. The current idle status screen will remain until a user interacts with the CoPilot system.

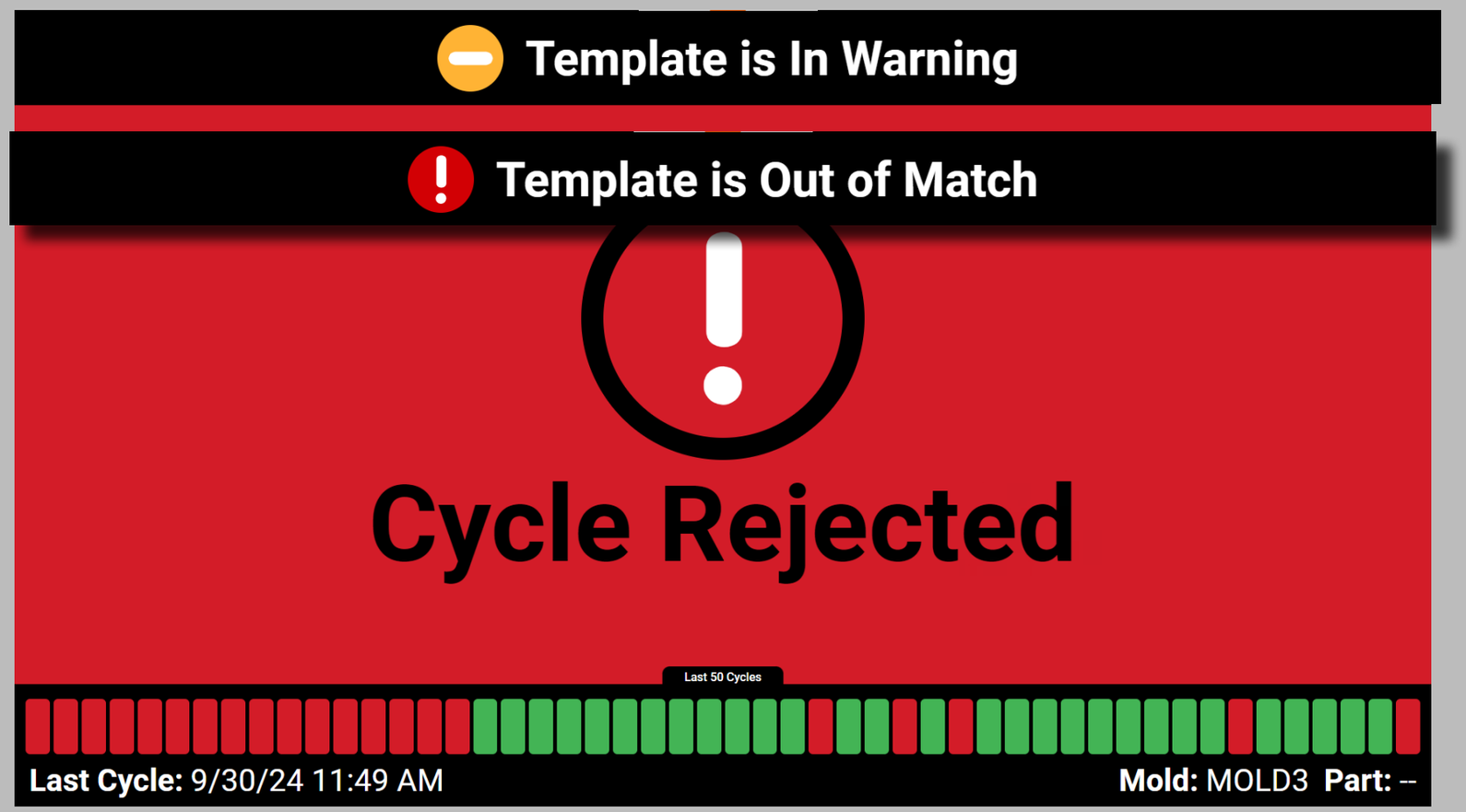
Cycle Accepted

The Cycle Accepted idle status screen includes the current date and time, the number of cycles in match during the last 50 cycles, and the mold and part names.



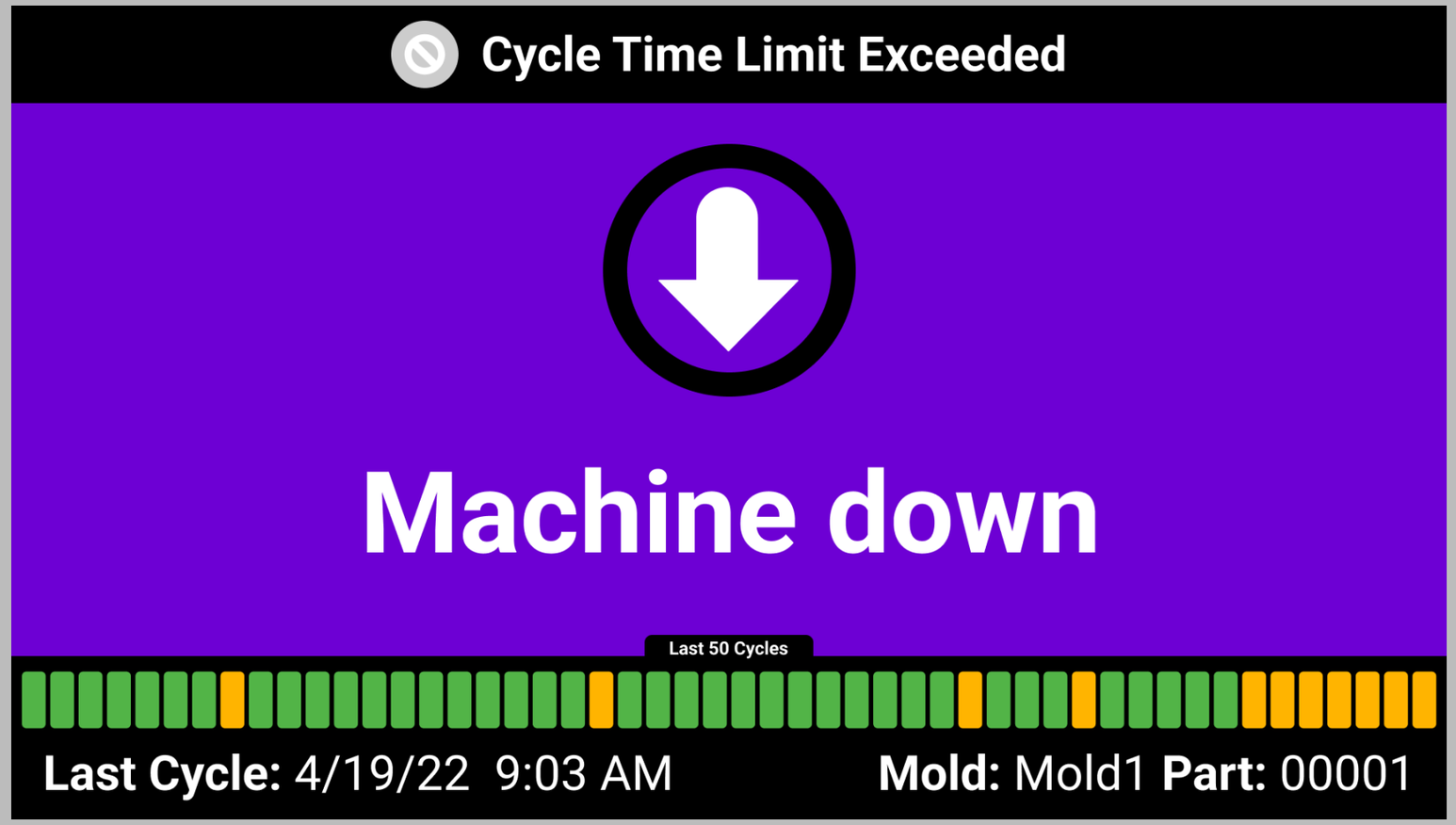
Cycle Warning

The Cycle Warning idle status screen includes the current date and time, the number of cycles with alarms in warning during the last 50 cycles, and the mold and part names.



Cycle Rejected

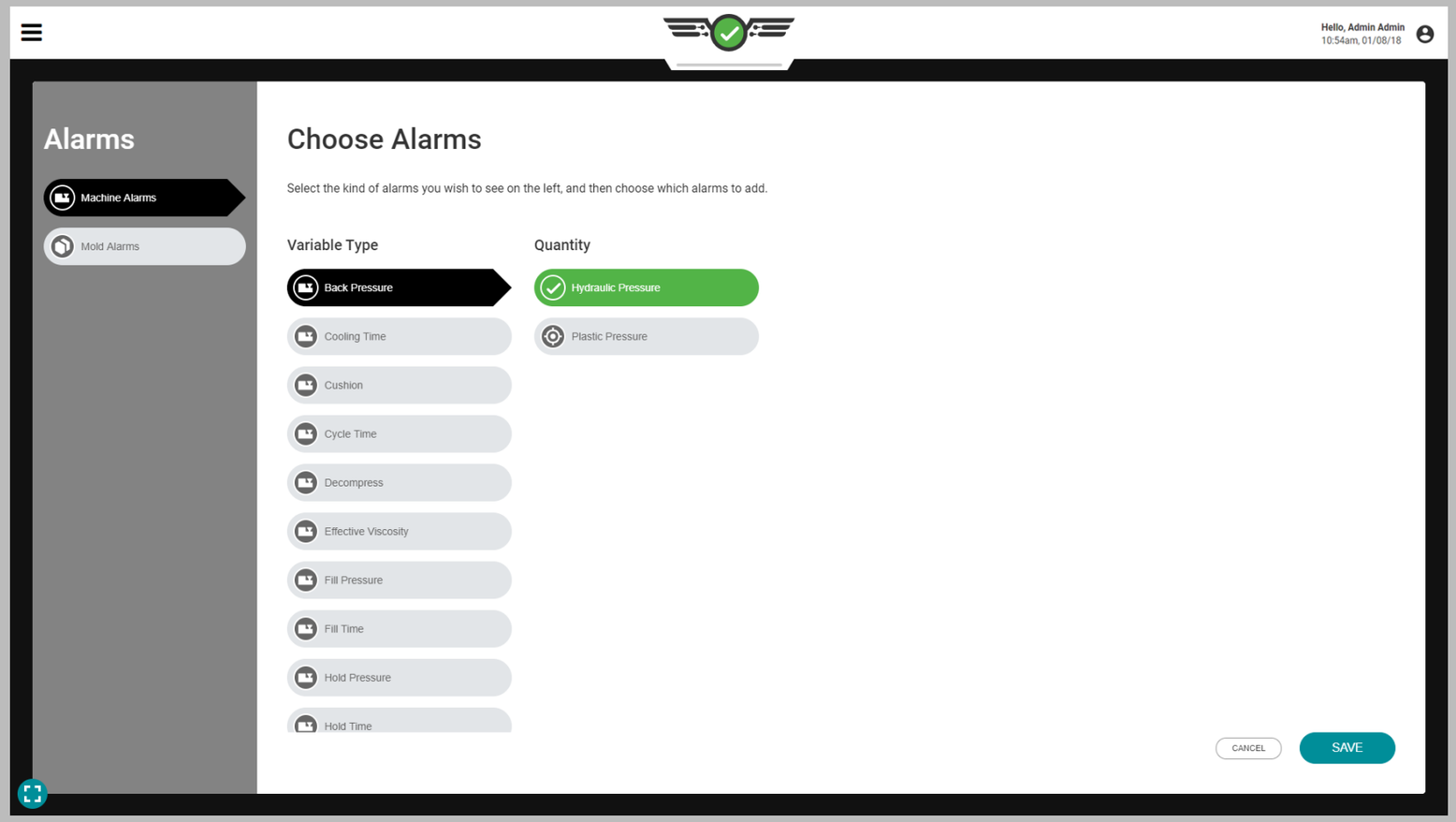
The Cycle Rejected idle status screen includes the current date and time, the number of cycles out of match during the last 50 cycles, and the mold and part names.



Machine Down

The Machine Down idle status screen includes the current date and time, and the mold and part names.

CAUTION *When the CoPilot system goes into a down state, job data is NOT SAVED.*



Job Dashboard (*continued*)

Normalizing Process Values

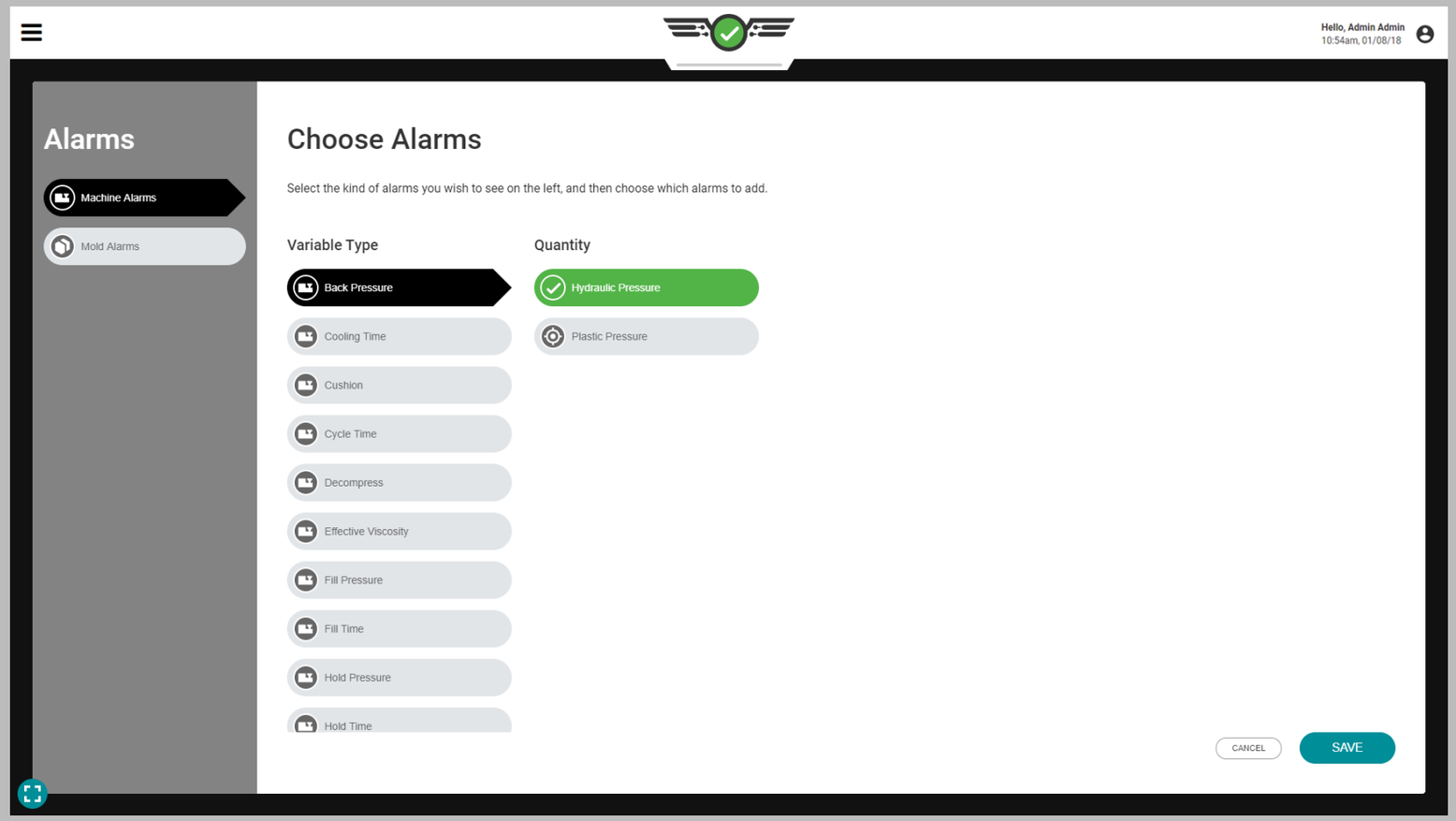
The CoPilot software is able to display some machine process values are monitored as positions (in.) or volumes (in.^{3}); speeds (in./sec) or volumetric flows (in.^{3}/sec); and hydraulic pressure (psi) or plastic pressure (ppsi). Each of these sets of measurements display, first, the machine's process measurements and, second, the process measurements from a "normalized" view.

The values are "normal" because they relate to the process inside the mold—the plastic's point of view—instead of outside. Displaying the normalized process measurements allows a setup to make the same parts in a mold on any machine.

Positions or Volumes

The amount of material (volume) required to fill a cavity within a mold remains constant (not counting inserts). To adjust the volume of material going into the mold, the machine's shot size and transfer must be adjusted (positions).

If the screw diameter is different on one machine than another, then it will take different screw position values on each machine to put the same volume in the mold. By defining the fill quantity in terms of volume (in.^{3}) instead of machine positions (in.) the process inside the mold can be set up the same on different machines.



Job Dashboard (*continued*)

Speeds or Volumetric Flows

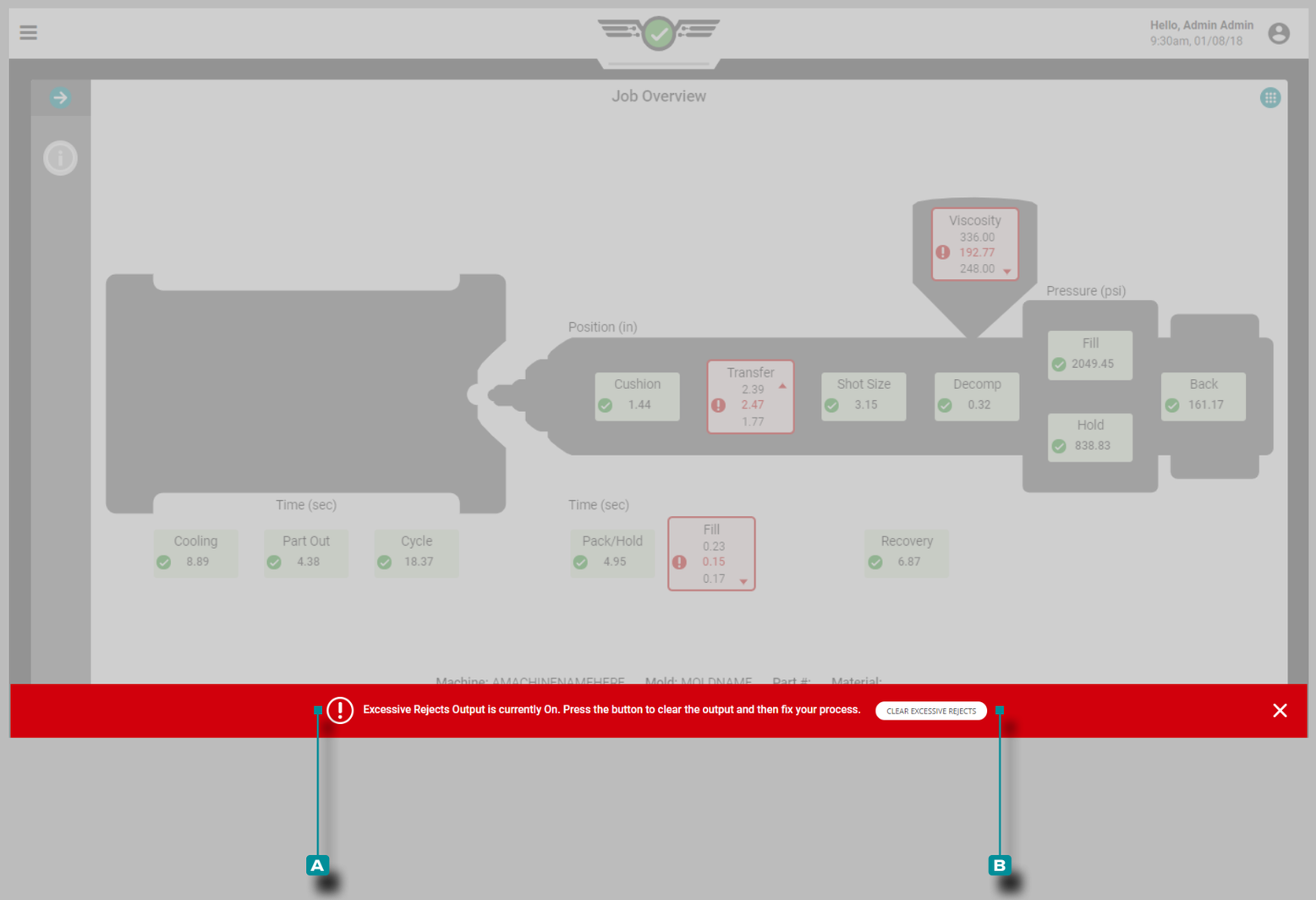
The fill time required to move the correct amount of material into a cavity within a mold remains constant (not counting inserts). To adjust the time it takes to move material into the mold, the machine's speed must be adjusted (in./sec). However, if a process is set up with the same fill time (in./sec) on a different machine with a different screw, the volume (in.^{3}/sec) of material moved during the fill time will not be the same. Using a volumetric flow rate (in.^{3}/sec) instead of speed (in./sec) normalizes the filling rate in the same way that volume normalizes position; unlike hydraulic pressure, the plastic pressure normalizes processes between machines.

Hydraulic Pressure or Plastic Pressure

Hydraulic pressure is the amount of pressure (psi) required from the hydraulic unit to fill a cavity within a mold. To adjust the pressure of material going into the mold, the machine's hold and back pressures must be adjusted.

The pressure of the plastic inside the barrel or cavity (ppsi) is not equivalent to the hydraulic pressure inside the hydraulic unit (psi). The intensification ratio is used to multiply hydraulic pressure to determine the plastic pressure. By defining the pressure in terms of plastic pressure (ppsi) instead of hydraulic pressure (psi) the process inside the mold can be set up the same on different machines.

Job Dashboard (*continued*)



Processing Errors

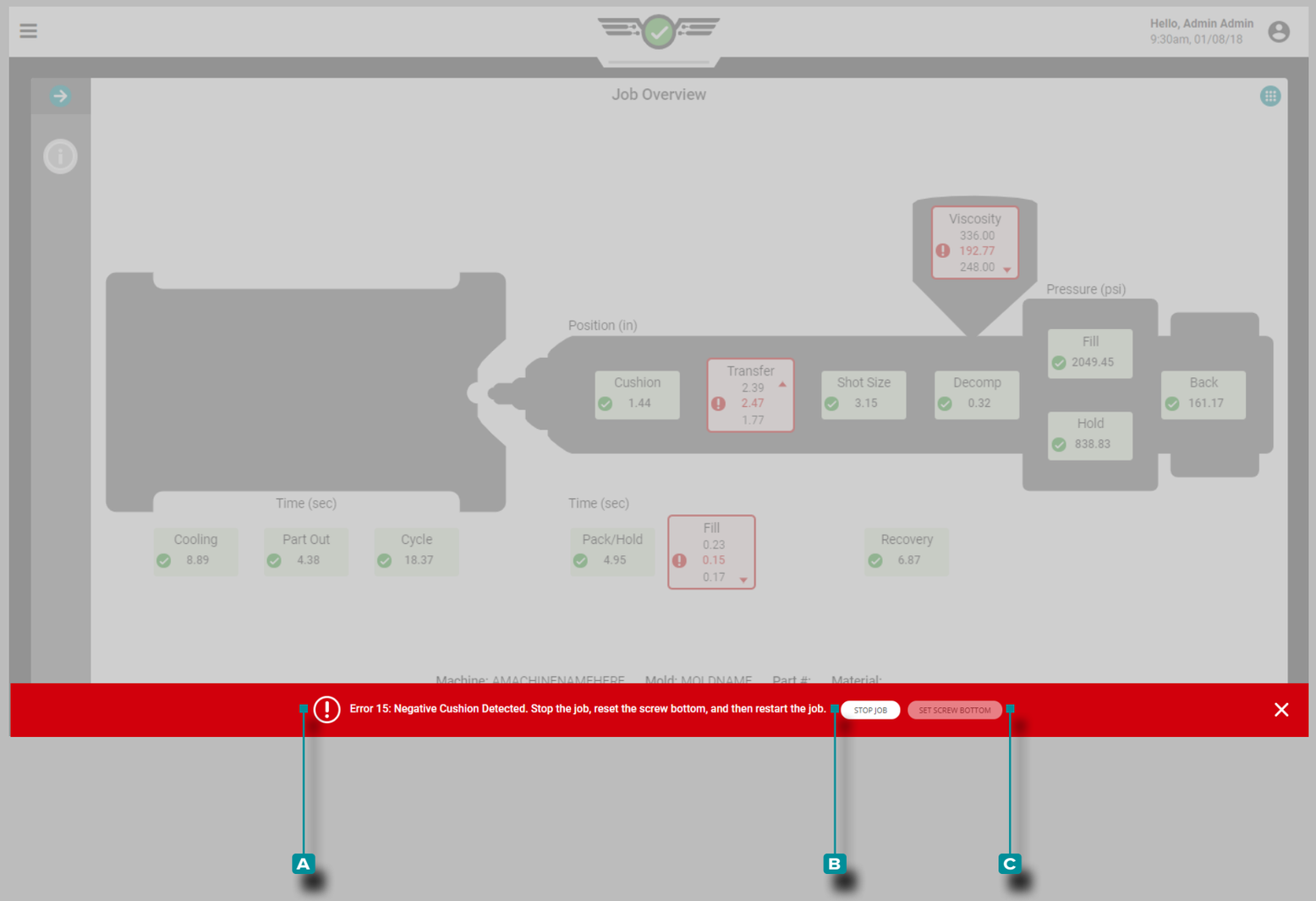
Excessive Rejects

If the control output option for excessive rejects is assigned during machine setup and configured during process setup, then the connected robot or machine will be activated after the designated number of rejects occur within the specified consecutive cycles (refer to “Assigning Outputs” on page 21 and “Control Options” on page 46 for more information).

If the excessive rejects output is activated, an **A** error message will appear to indicate that the output is on and must be cleared to continue the job. **Tap** the **B** CLEAR EXCESSIVE REJECTS button to clear the condition.

Once the activated output is cleared, it is reset and ready to activate in the event that conditions are met for excessive rejects as defined during machine and process setup.

Job Dashboard (*continued*)



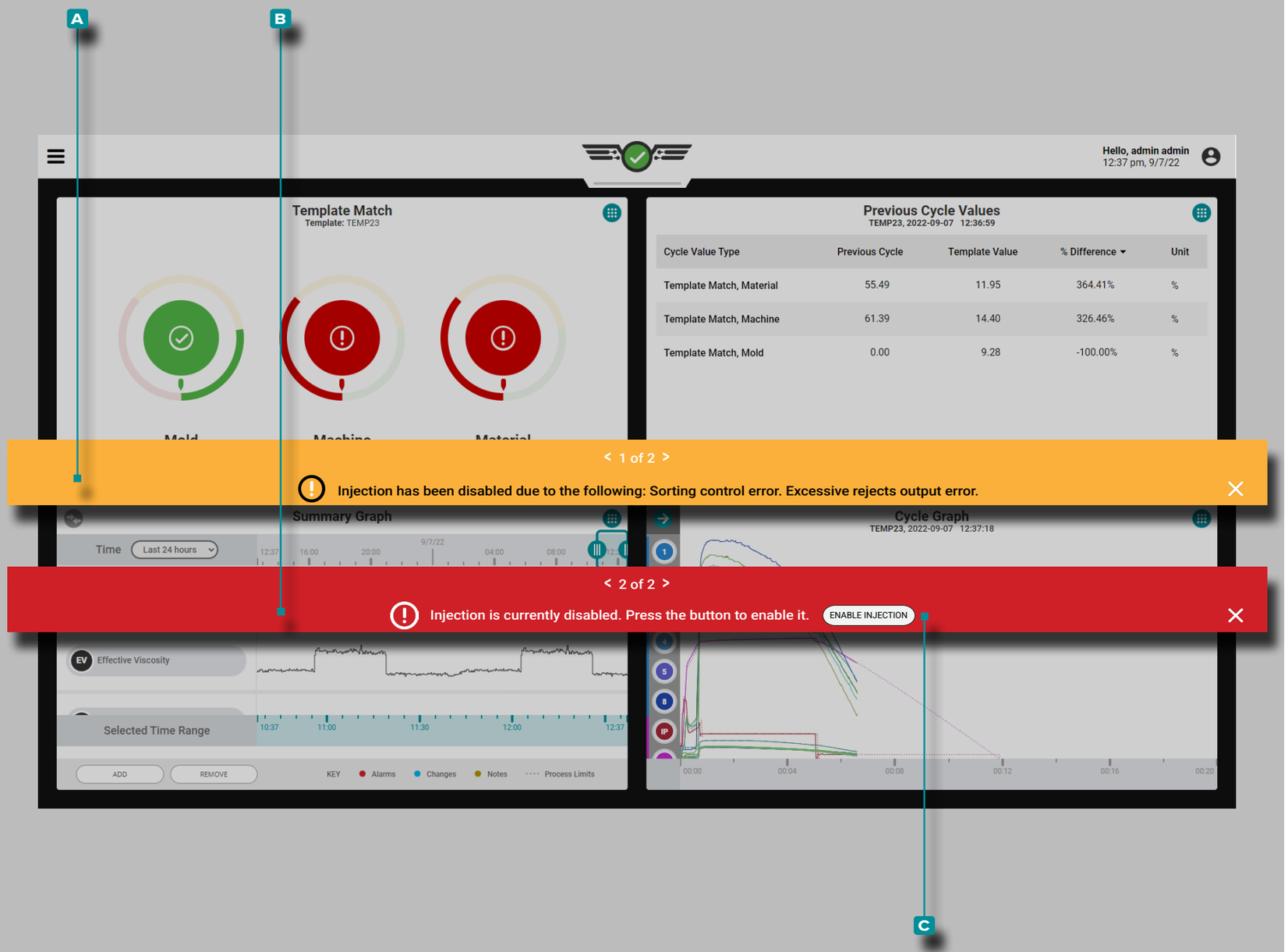
Negative Cushion Detected

If screw bottom is not set correctly during process setup, an **A** error message may appear on to indicate that negative cushion is detected and it must be verified that screw bottom is set properly.

Tap the **B** STOP JOB button to stop the job; physically bottom out the screw on the machine, then **tap** to select the **C** SET SCREW BOTTOM button. The job must be re-started after screw bottom is set.

NOTE *Screw bottom must be set each time a setup is created. The CoPilot does not store this position, and cushion will not be correctly calculated if screw bottom is not set.*

If the error is not resolved by setting the screw bottom, check the physical stroke sensor for communication drop-outs.



Job Dashboard (*continued*)

Inject Enable Disabled

Inject Enable allows the machine to run until one of the following occurs: a control sensor fails or stops communication with the CoPilot system; any module used for control or sequencing fails to communicate with the CoPilot system; the output relay module associated with the Inject Enable control is disconnected; or the power to the CoPilot system is disconnected.

If any of the conditions occur to disable injection, an **A** error message will appear to indicate which condition occured, then another **B** error message will appear to allow the user to re-enable injection.

Tap the **C** ENABLE INJECTION button to re-enable injection without stopping and restarting the job on the CoPilot system.

Job Dashboard (*continued*)

Cycle Time Exceeded

If the set cycle time is exceeded by more than 50 percent, the system will go into a down state, THE SYSTEM WILL STOP SAVING DATA, and the following message will appear:

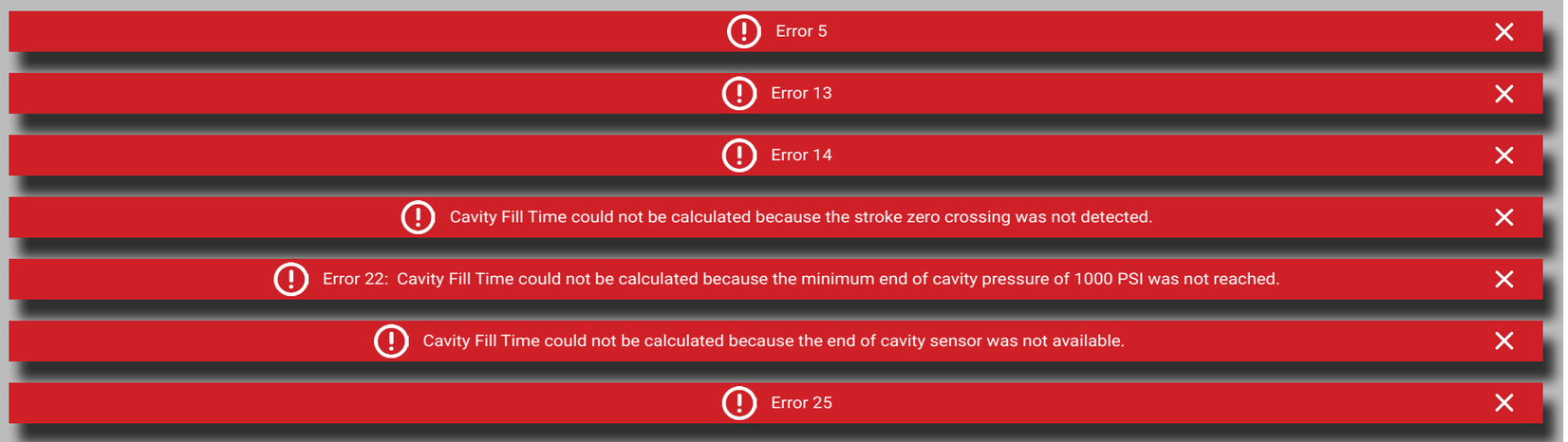
“The job is down because the standard cycle time (x seconds) was exceeded by more than 50% (y seconds); verify that the standard cycle time is correct in the process settings. Data is not saved for the down cycles.”

Job Dashboard (*continued*)

Sequence Errors

There are 15 errors which may occur attributed to sequence errors, found below:

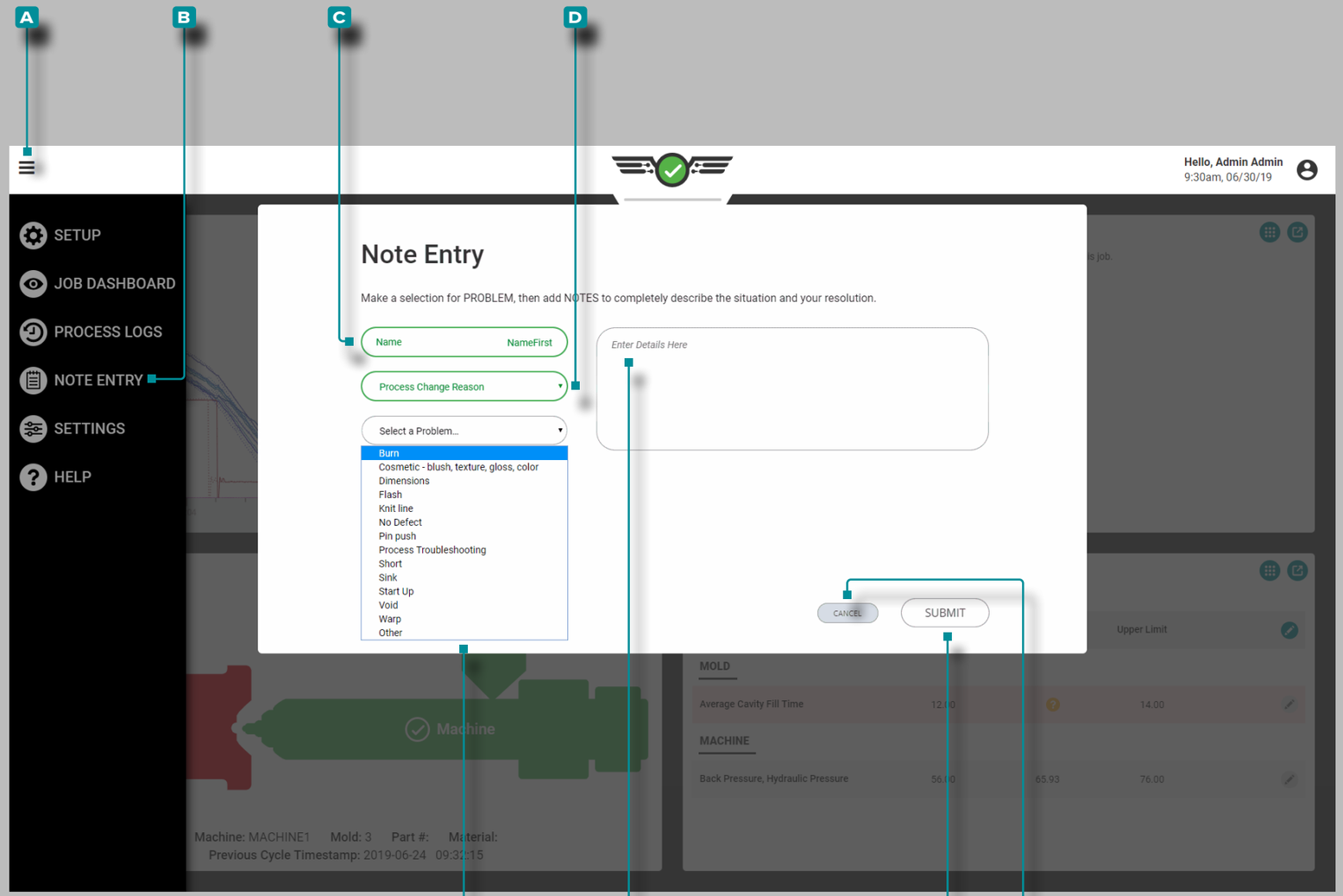
- Screw Run detected before Injection Forward.
- Error 8—The CoPilot system detected an incorrect cycle start, typically due to incorrect or missing mold clamped or injection forward sequence signals.
- Error 9—The CoPilot system detected an incorrect cycle end, typically due to incorrect or missing mold clamped or injection forward sequence signals.
- Error 11—The CoPilot system sequencer failed to calculate a value, typically due to incorrect or missing sequence signals.
- Error 12—The CoPilot system is unable to detect fill time; this can be due to an incorrect first or second state sequence signal, or a disconnected first or second sequence signal.
- Error 16—The CoPilot system cannot detect the screw direction; this can be due to communication errors.
- Error 17—The CoPilot system cannot detect transfer position; this can be due to an incorrect or missing first or second stage sequence signal.
- Error 18—The CoPilot system could not compute some data from start of fill to the end of hold; this can be due to missing sequence signals or sensor communication errors.
- Error 20—The CoPilot system end of cavity threshold for cavity fill time was exceeded before fill actually started; this can be due to incorrect or missing sequence signals and sensor data.
- Negative Cushion Detected. Stop the job, reset the screw bottom, then restart the job. This is typically due to the incorrect screw bottom set, or communication interuptions from the stroke sensor.
- Cavity Fill Time does not appear to be correct because the minimum 1000 psi threshold was reached too early in the cycle. This can be due to missing or incorrect sequence signals or sensor communication errors.
- User set fill volume was not reached, system could not calculate “Process Fill Time” or “Process Fill and Pack Time”.
- First Stage is asigned, but did not trigger during injection.
- Second Stage is assigned but did not trigger during injection.
- Unable to calculate cooling time when a sort timing other than “End of Mold Clamped” is selected.



Sensor Communication Errors

There are seven errors which may occur attributed to sensor communication errors, found below:

- Error 5—The CoPilot system screw position sensor is not connected or assigned; this can be due to sensor communication errors.
- Error 13—The CoPilot system is unable to find the screw position; this can be due to sensor communication errors.
- Error 14—The CoPilot system detected a general sensor error; this can be due to sensor communication errors (sensor is invalid due to an under- or over-range condition).
- Cavity Fill Time could not be calculated because the stroke zero crossing was not detected. This can be due to negative stroke data, incorrect screw run zeroing, or can be caused by error 15 or 16 (refer to “Sequence Errors” on page 164).
- Error 22—Cavity Fill Time could not be calculated because the minimum end of cavity pressure of 1000 psi was not reached.
- Cavity Fill Time could not be calculated because the end of cavity sensor was not available.
- Error 25—The CoPilot system detected invalid sensor data; this can be due to invalid sensors or sensor communication errors.



Note Entry

Notes can be entered as a General Note, for a Process Change Reason, or with a Process Change Control Number for viewing in the Process Logs and/or the Notes widget on the Job Dashboard.

General Notes

Tap the A menu button, then **tap** B Note Entry; **enter** a C user name, then **tap** to select the D note type.

Enter any details in desired in the F details field. **Tap** the G SUBMIT button to save the note, or **tap** the H CANCEL button to discard any changes.

Process Change Reason Notes

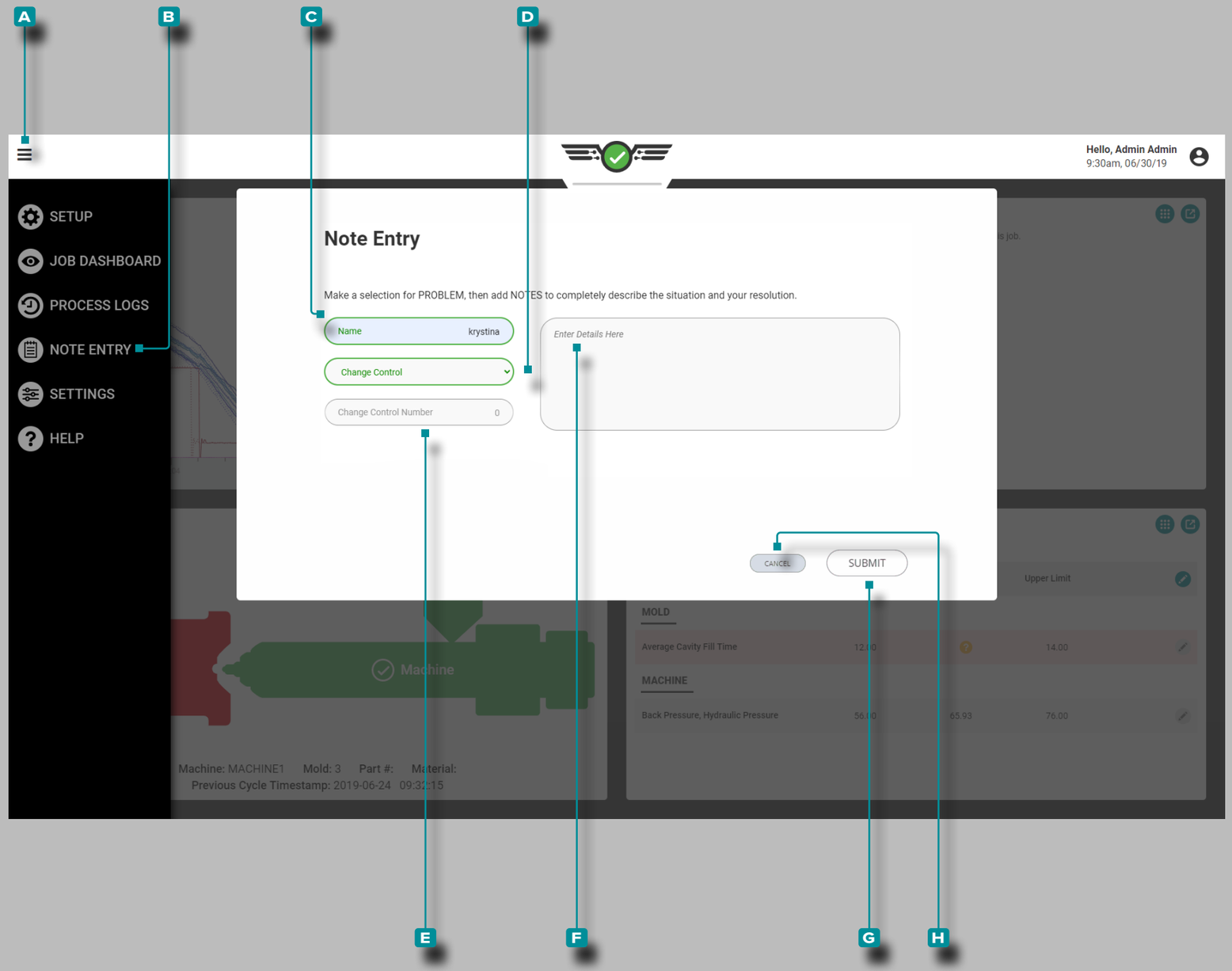
Tap the A menu button, then **tap** B Note Entry; **enter** a C user name, then **tap** to select the D note type. If the note type is a Process Change Reason, **tap** to select a E Problem from the drop-down menu.

Problems include the following selectable options (for Process Change Reason note types only):

- Burn
- Cosmetic—blush, texture, gloss, color
- Dimensions
- Flash
- Knit Line
- No Defect
- Pin Push
- Process Troubleshooting
- Short
- Sink
- Start Up
- Void
- Warp
- Other

Enter any details in desired in the F details field. **Tap** the G SUBMIT button to save the note, or **tap** the H CANCEL button to discard any changes.

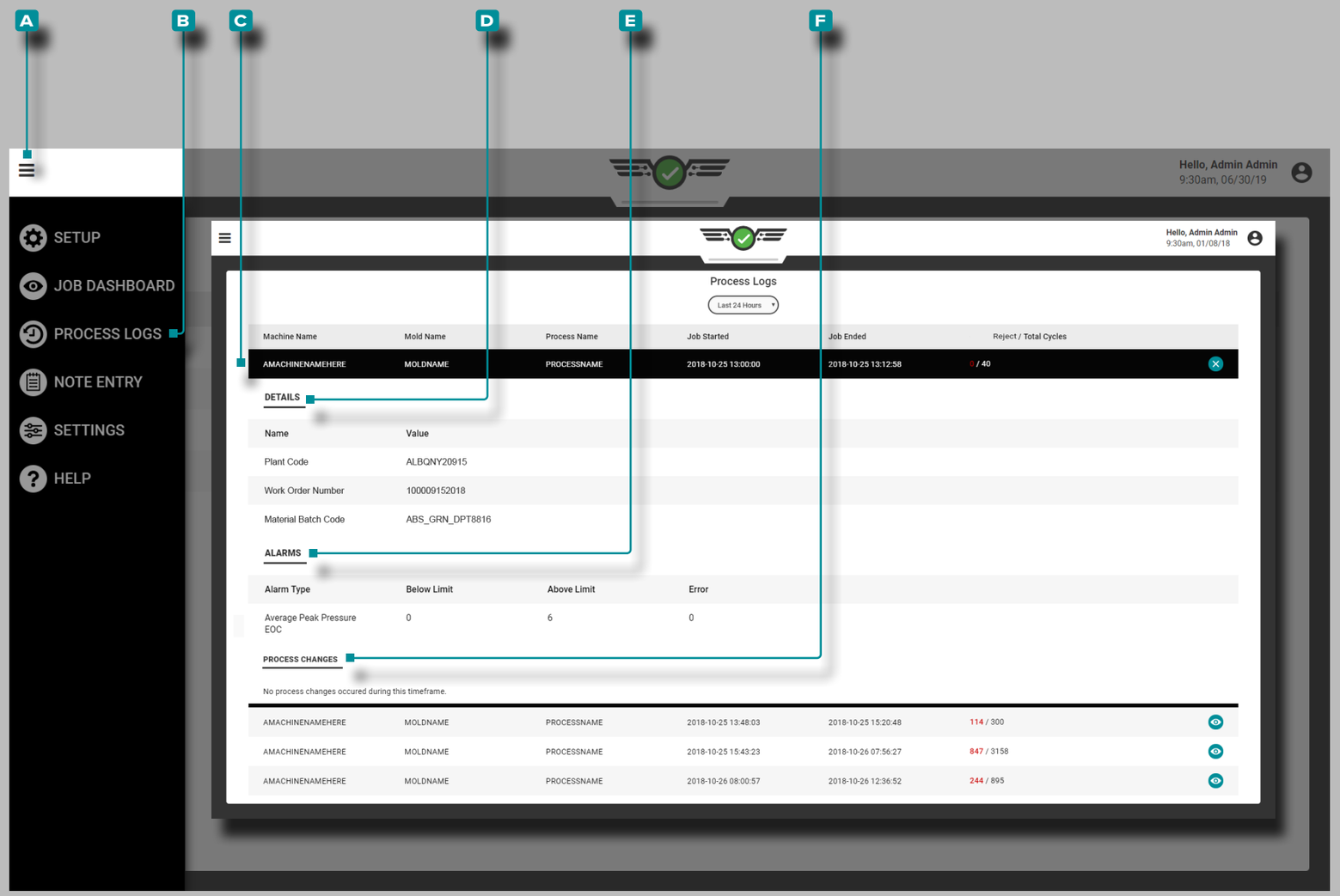
Note Entry (*continued*)



Process Change Control Number Notes

Tap the **A** menu button, then **tap** **B** Note Entry; **enter** a **C** user name, then **tap** to select the **D** change control note type.

Enter the **E** change control number in the field. **Enter** any details in desired in the **F** details field. **Tap** the **G** SUBMIT button to save the note, or **tap** the **H** CANCEL button to discard any changes.



Process Logs

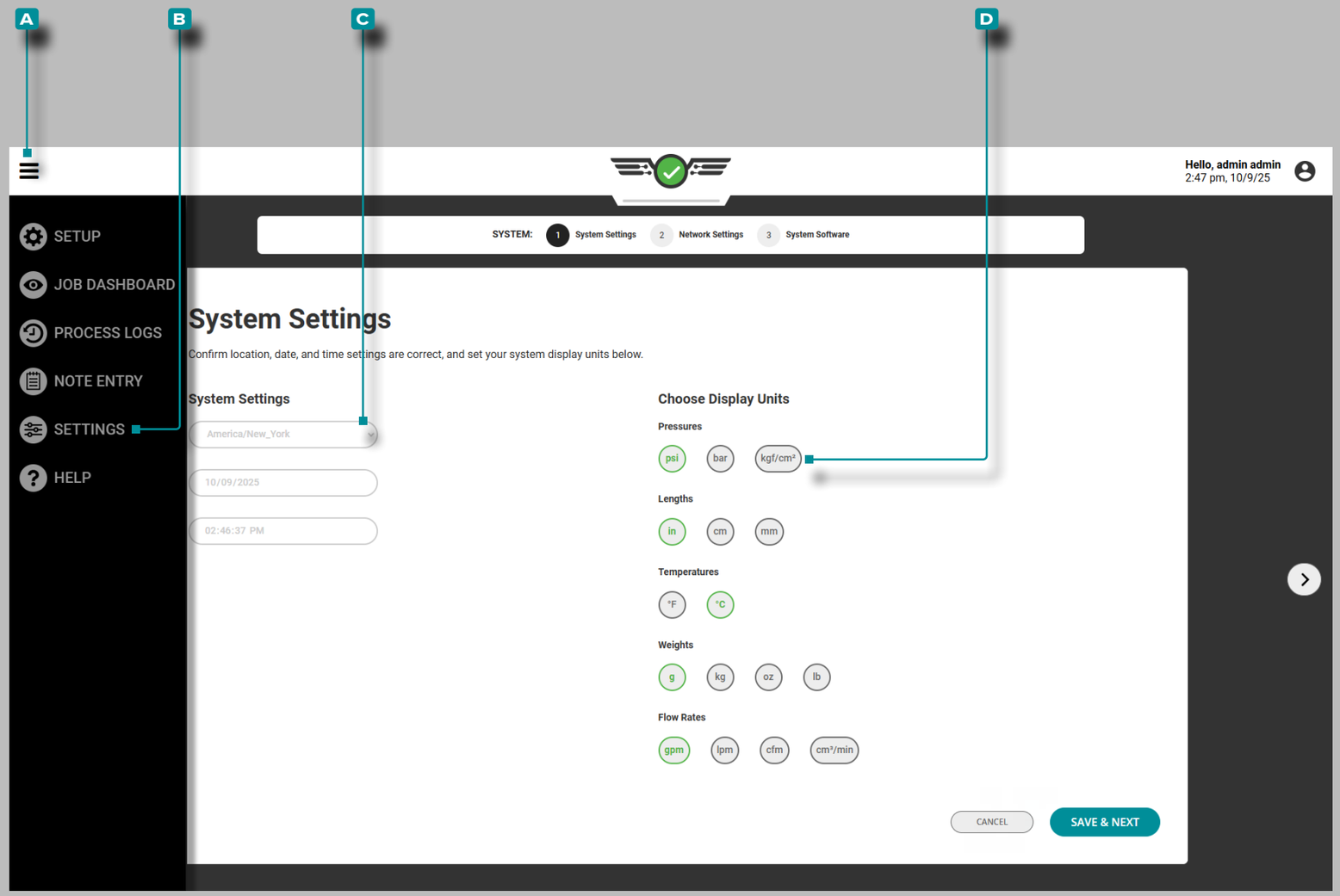
The CoPilot system enters logs for out-of-match instances that are not corrected by a user. System logs include the same information as user logs, with the exception of problem, solution, and notes.

View Log

The Process Log includes each entry of changes made to the process. To view the process log, **tap** the A menu button, then tap B Process Log.

Details in the B Process Log include the machine, mold, and process name, job start and end date and time, and the number of reject and total cycles.

To view additional details of a process log, **tap** an C entry; additional details include D custom fields details, E alarm events, F process changes, and any notes—if entered.



Settings

CoPilot Settings

The CoPilot System, Network, and Software settings and information utilities are available from Settings. Tap the **A** menu button, then **tap** **B** Settings to view CoPilot software settings and information.

System Settings

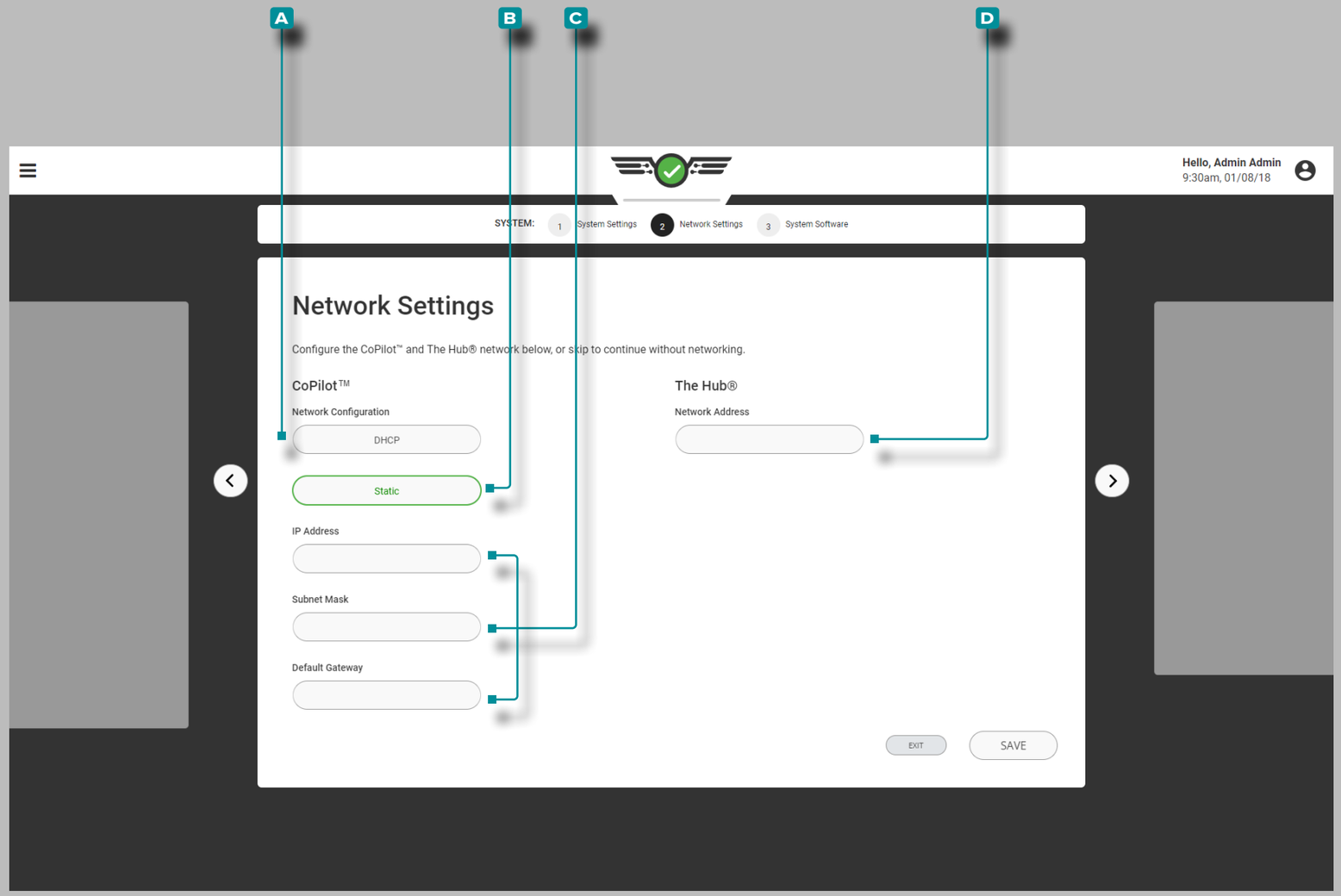
Complete System Settings the first time a setup is created. System settings include timezone, date, time, and display units.

Timezone, Date, Time

Tap to select the desired time zone, date, and time from the provided **C** drop-down boxes.

Display Units

Tap to select the desired software **D** display units for pressure, length, temperature, and weight.



Settings (*continued*)

Network Settings

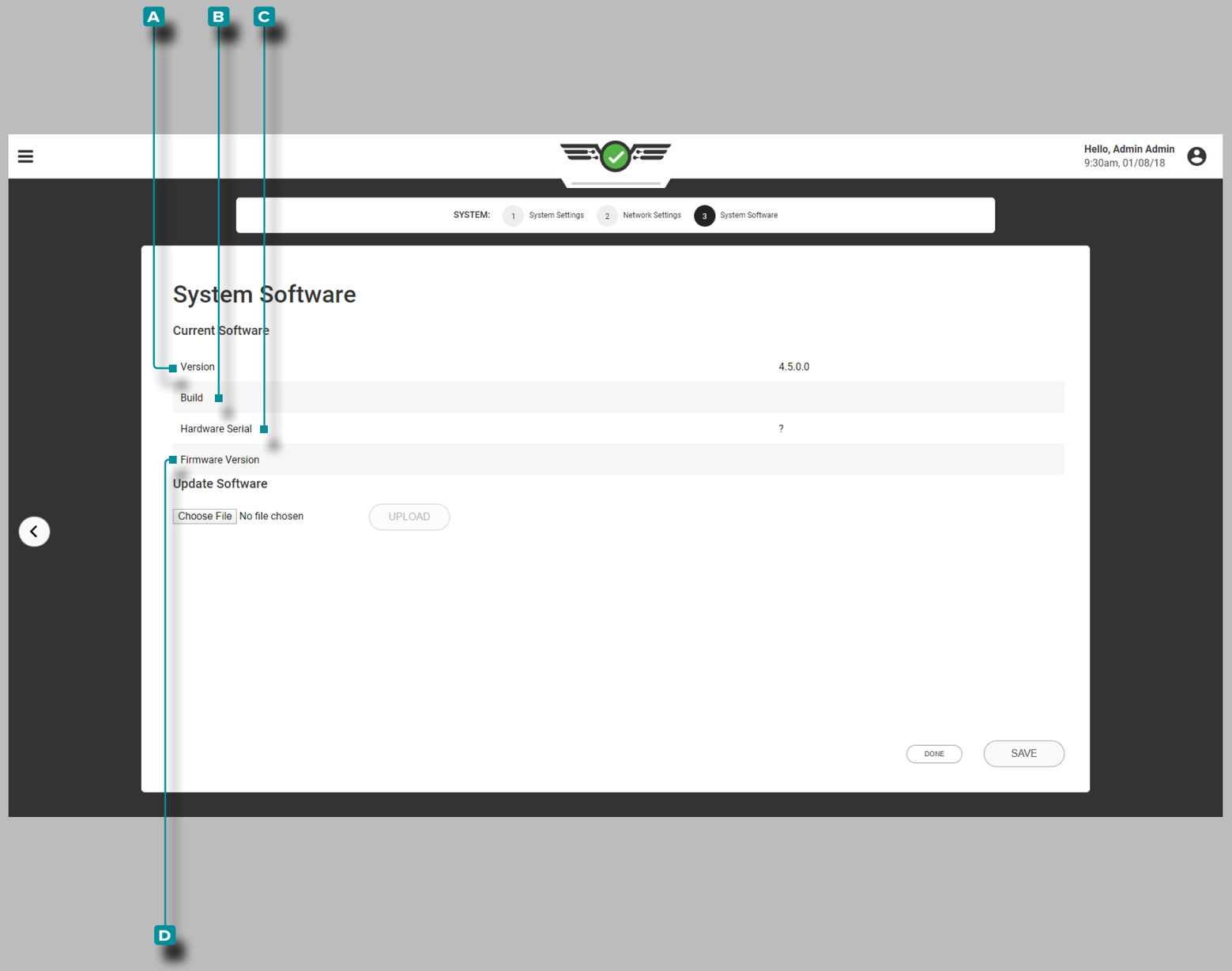
Complete Network Settings for CoPilot and The Hub® network configurations during the first time setup, or configure the CoPilot and The Hub systems later from the Settings utility.

CoPilot Network Configuration

Select the desired CoPilot Network configuration; **A** DHCP or **B** Static. If a **B** Static configuration is chosen, **enter** the **C** required network information in the provided fields.

The Hub Network Configuration

Enter The Hub **D** network address in the provided field.



Settings (*continued*)

System Software

Software Version

The software version is the installed software A version number.

Software Build

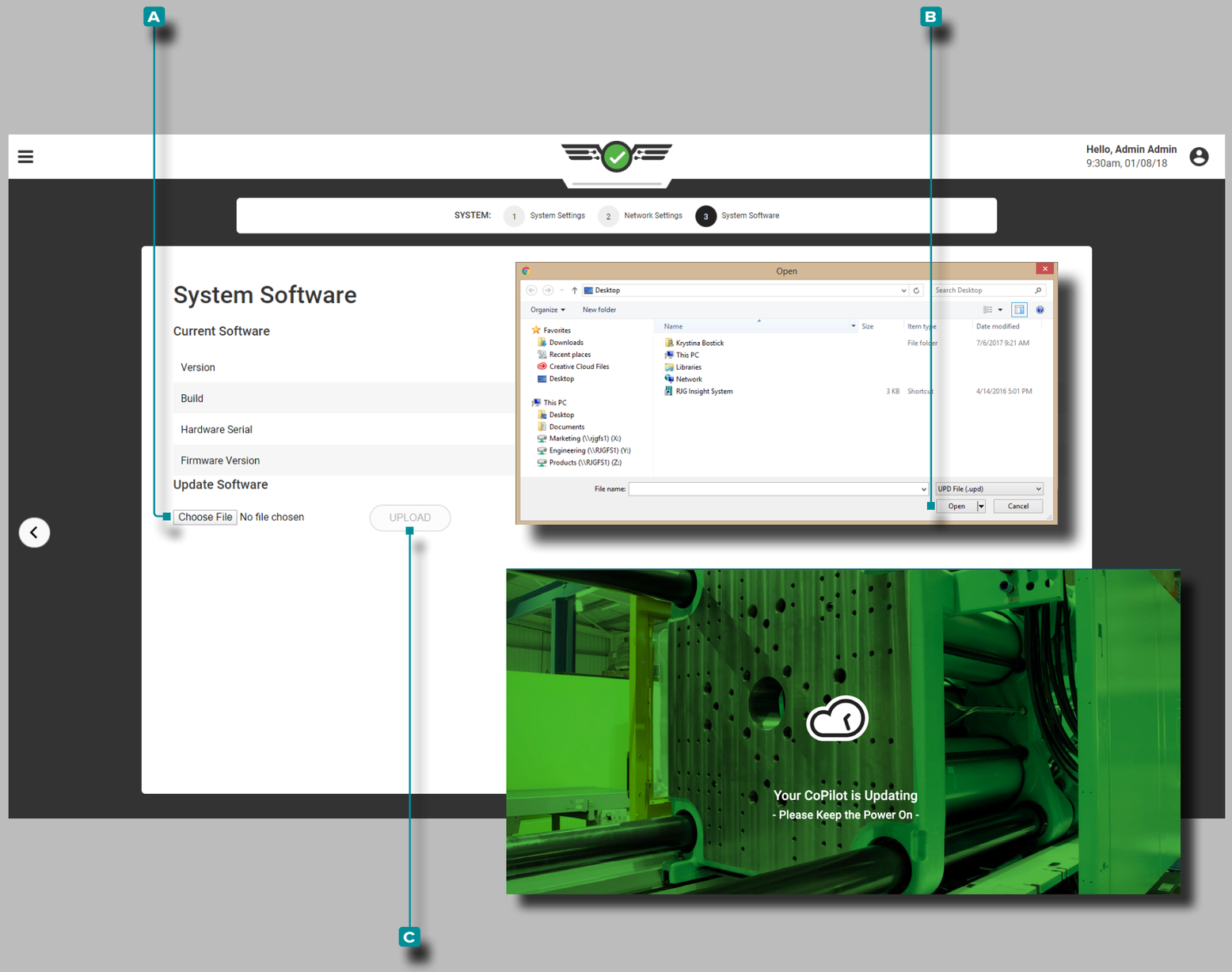
The software build is the installed software B build number.

Hardware Serial

The C hardware serial number associated with the installed equipment is displayed.

Firmware Version

The D firmware build number associated with the installed hardware is displayed.



Settings (*continued*)

Update Software

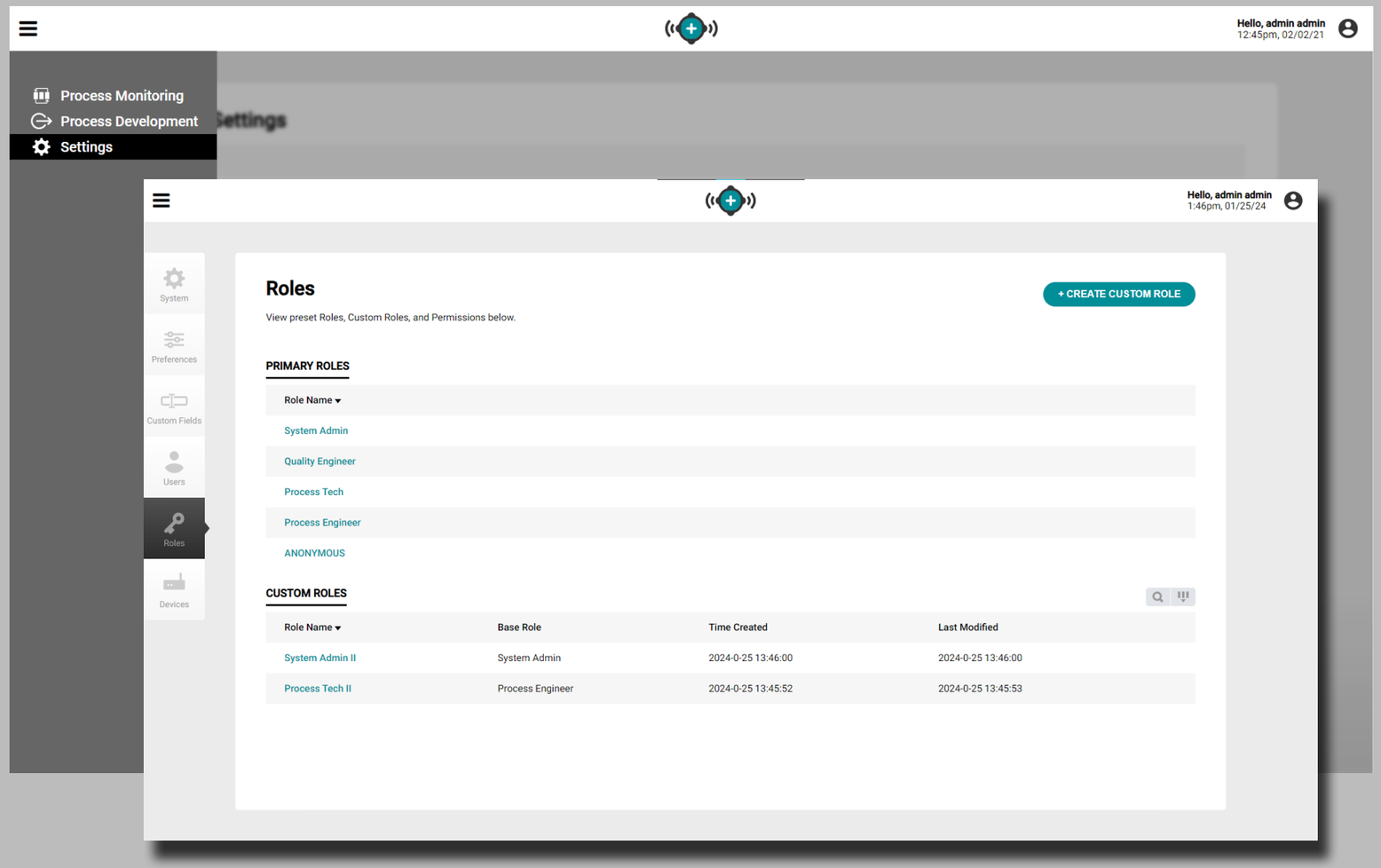
CAUTION *DO NOT SHUT DOWN OR RESTART THE COPILOT SYSTEM AP4.0 WHILE AN UPDATE IS BEING APPLIED; FAILURE TO COMPLY WILL RESULT IN DAMAGE OR DESTRUCTION OF THE AP4.0 BOARD.*

If the CoPilot system is networked to a The Hub system, refer to The Hub Software User Guide for software update instructions. If the CoPilot system is not networked to a The Hub system, perform the following when updates are available.

CAUTION *DO NOT skip update versions; DO NOT apply a newer update if an older update is available—i. e. applying v7.2 update to a v7.0 system versus applying v7.1 update to a v7.0 system, then applying the v7.2 update. Refer to the RJG website to ensure that the correct update is applied to the CoPilot system. Failure to comply may result in errors or issues in the CoPilot system.*

Download the appropriate update file from the rjginc.com website. **Tap** the A CHOOSE FILE button to select the update file; **tap** the update file (.UPD), **tap** the B Open button to install software updates, and then **tap** the C UPLOAD button.

Settings (*continued*)

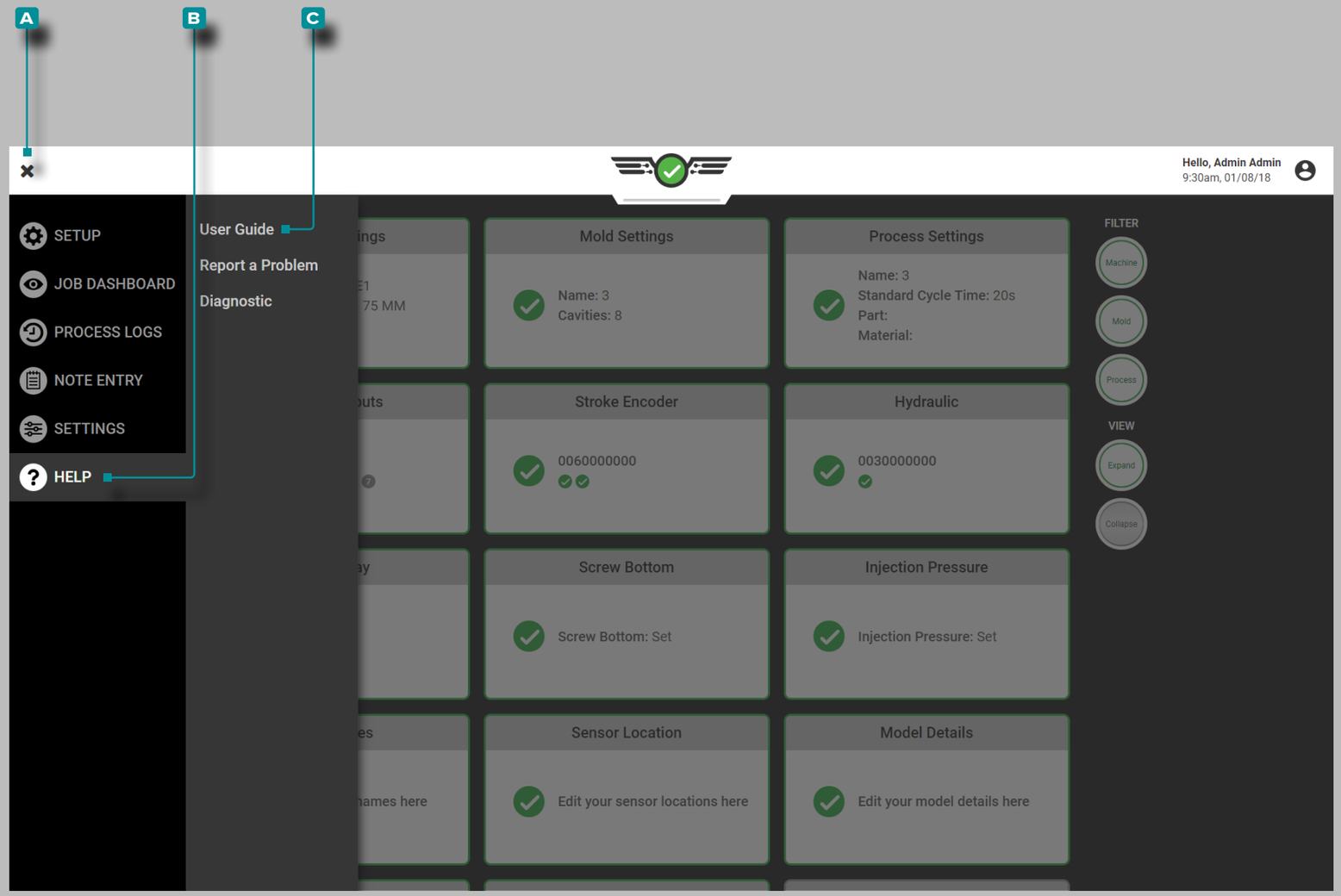


User Role Permissions & Security

Individual access to features and functions is determined by the user role assigned during setup of the CoPilot system and The Hub software. If a feature or function is not available, please check user role permissions before submitting an error report.

A notification may or may not appear to make the user aware that the required permissions are unavailable to perform the function or use a feature.

User role permissions for the CoPilot system are managed on The Hub software; refer to The Hub Software User Guide for full user role permissions.



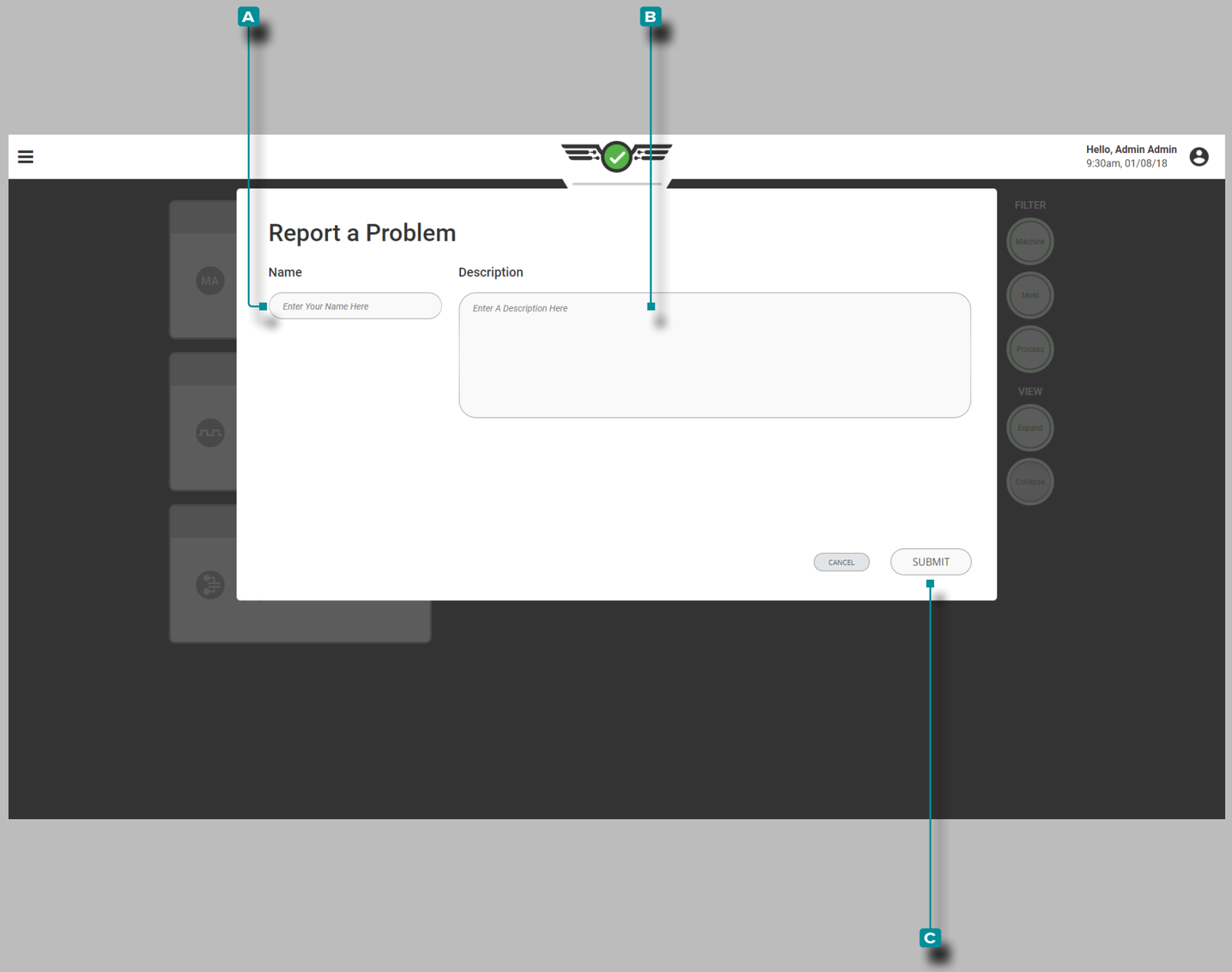
Help

CoPilot Help and Problem Reporting

The Help and Problem Reporting are available from the Help menu. Tap the **A** menu button, then **tap** **B** Help to report a software problem.

User Guide

Tap the **C** User Guide button to view a notification directing the user to the rjg website to view the CoPilot System User Guide.

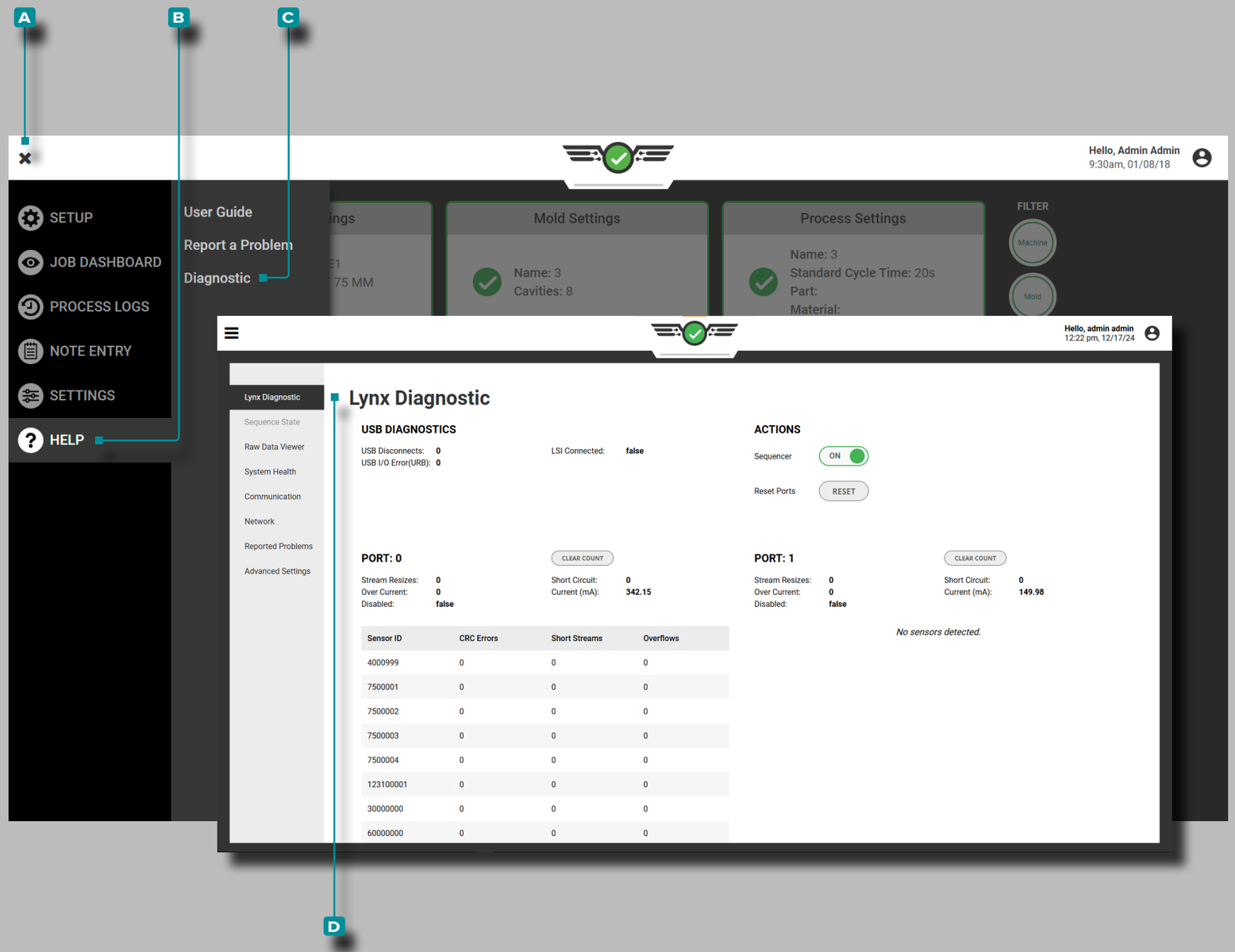


Help (*continued*)

Report a Problem

Enter a **A** name and **B** description in the provided fields, then tap the **C** SUBMIT button to report a problem with the software.

ⓘ **NOTE** *Individual access to features and functions is determined by the user role assigned during setup of the CoPilot system and The Hub software. If a feature or function is not available, please check user role permissions before submitting an error report. User role permissions for the CoPilot system are managed on The Hub software; refer to The Hub Software User Guide for full user role permissions.*



Help (*continued*)

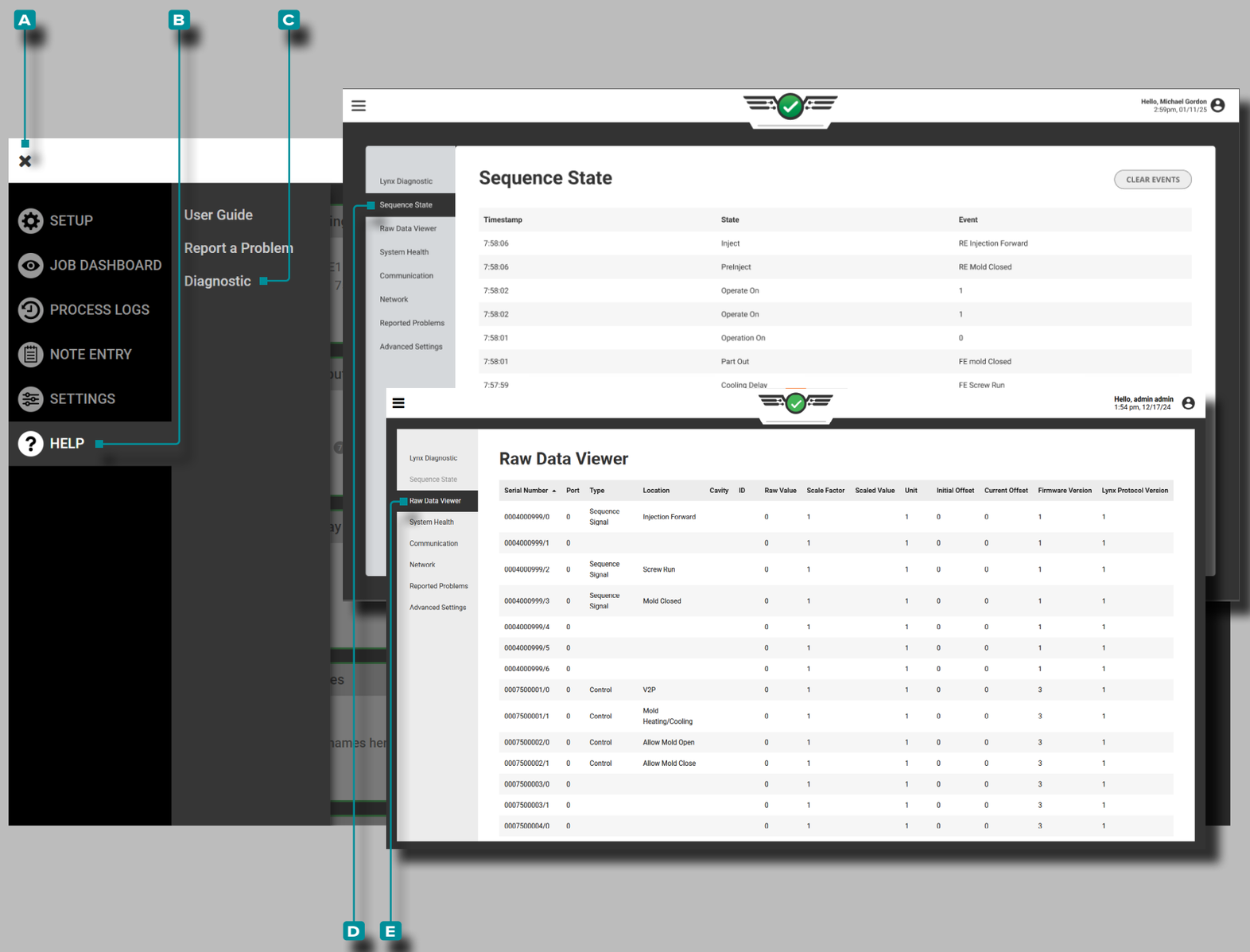
Diagnostic

The Diagnostic pages are used for troubleshooting potential Lynx™ sensor issues or system issues; in general, this page is for use by RJG, Inc. customer support personnel. To view the Diagnostic Page, **tap** the A menu button, then **tap** B Help, then **tap** C Diagnostic.

Lynx Diagnostic

The Lynx Diagnostic page displays USB Diagnostics, Actions, and Port information. Tap D Lynx Diagnostic from the C Diagnostic page to view D Lynx Diagnostic.

1. USB Diagnostics includes the number of USB disconnects, USB I/O Error(URB), and LSI Connection information.
2. Actions includes sequencer and reset ports options.
   - SEQUENCER: The sequencer On/Off switch facilitates the connection between the AP4.0/CoPilot and the Lynx Machine Sequence Module ID7-M-SEQ. If the Sequencer is turned off the AP4.0/CoPilot will not receive signals from the ID7-M-SEQ.
   - RESET PORTS: Selecting the Reset Ports RESET button beside the Reset Ports Heading will display a Confirm button. The Confirm button will default back to reset after five seconds if the user has not confirmed the action; if the Confirm button is selected, the ports will be reset, and a message for the user will be displayed while the Lynx Ports reconnect: "The ports are currently resetting. Please allow up to 30s for the Ports to fully reset." The user can resume the job once the ports have reconnected successfully. No data will be accessible after the RESET button is selected until the ports have reconnected successfully. ***Ports cannot be reset if a job is running.***
3. PORTS: Ports 0 and 1 relate to the physical Lynx ports on the CoPilot system application processor AP4.0. The Ports section display any connected sensor count information. To clear the values of the error counts, the user can tap the CLEAR COUNT button located near each port.



Help (*continued*)

Diagnostic (continued)

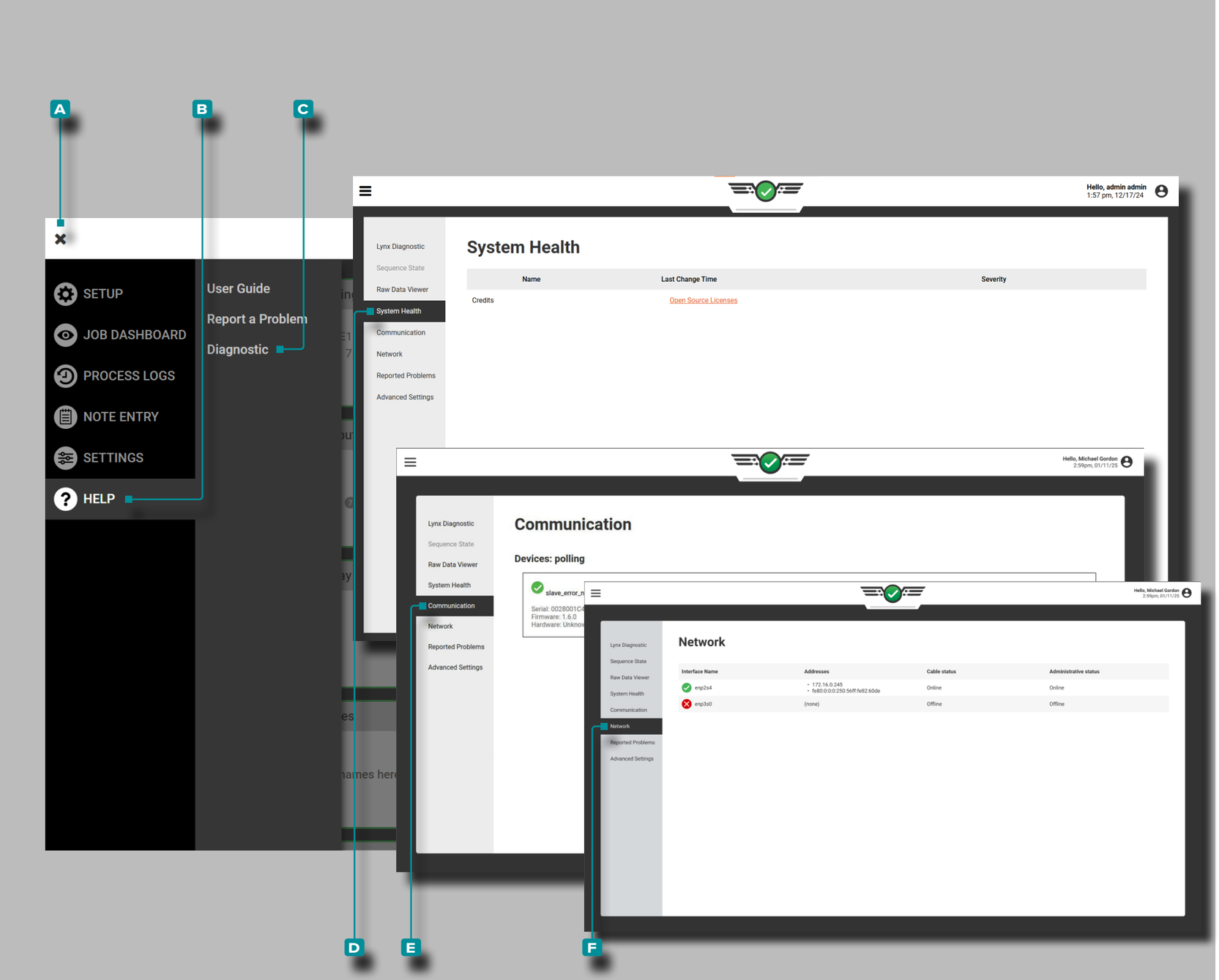
To view the Diagnostic Page, **tap** the **A** menu button, then **tap** **B** Help, then **tap** **C** Diagnostic.

Sequence State

The Sequence State page provides a table of sequence states including timestamp, state, event, and a clear events button. **Tap** **D** Sequence State from the **C** Diagnostic page to view **D** Sequence State.

Raw Data Viewer

The Raw Data Viewer page provides a table of all system data including Serial Number, Port, Type, Location, Cavity, ID, Raw Value, Scale Factor, Scaled Value, Unit, Initial Offset, Current Offset, Firmware Version, and Lynx Protocol Version. **Tap** **E** Raw Data Viewer from the **C** Diagnostic page to view **E** Raw Data Viewer.



Help (*continued*)

Diagnostic (continued)

To view the Diagnostic Page, **tap** the A menu button, then **tap** B Help, then **tap** C Diagnostic.

System Health

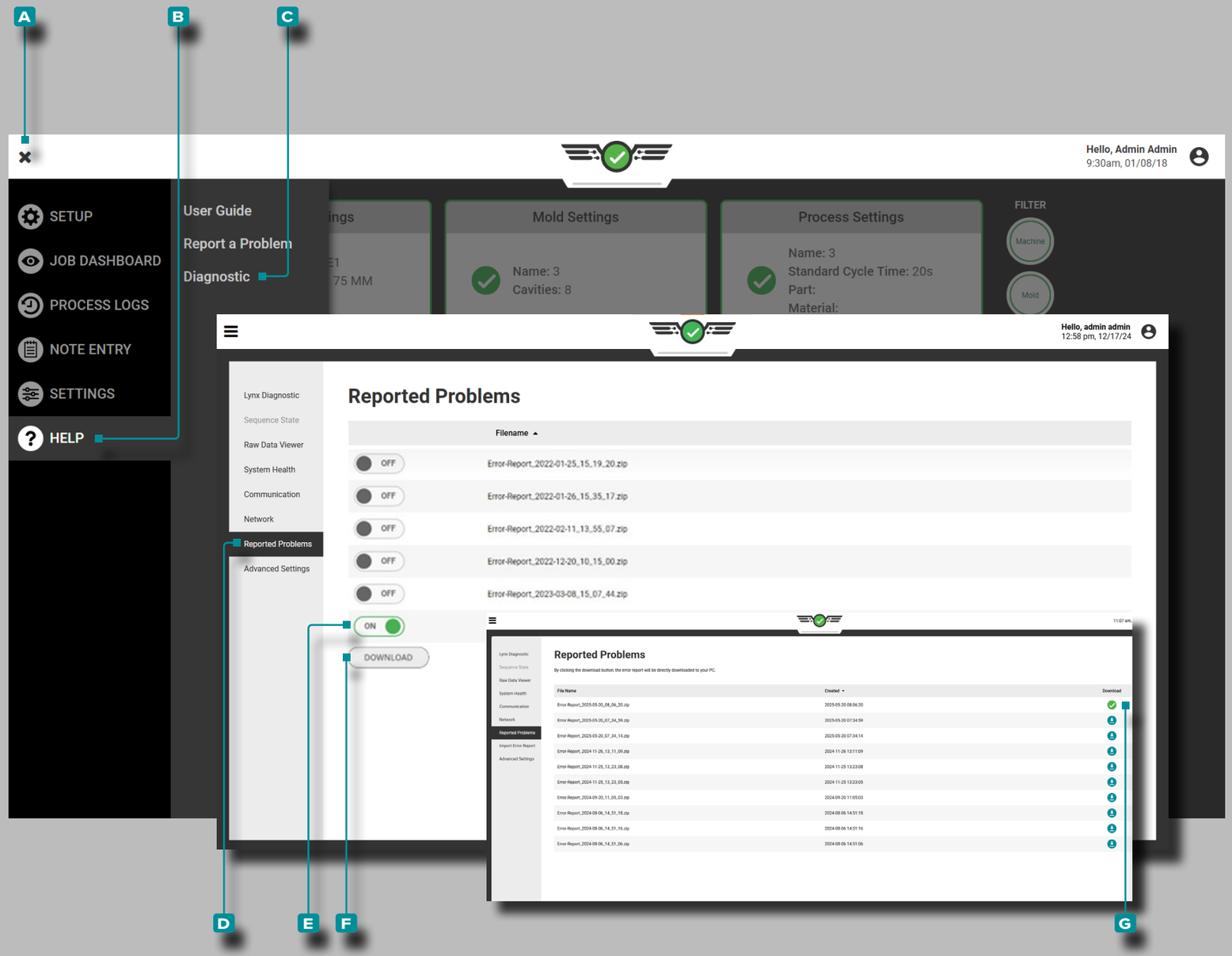
The System Health page provides the name, last change time (open source licenses), and severity of the system. **Tap** D System Health from the C Diagnostic page to view D System Health.

Communication

The E Communication page provides a list of connected EtherCAT devices. **Tap** E Communication from the C Diagnostic page to view E Communication.

Network

The Network page provides a table of interface names, addresses, cable status, and administrative staus. **Tap** F Network from the C Diagnostic page to view F Network.



Help (*continued*)

Diagnostic (continued)

To view the Diagnostic Page, **tap** the A menu button, then **tap** B Help, then **tap** C Diagnostic.

Reported Problems

Tap D Reported Problems on the C Diagnostic page to view D Reported Problems.

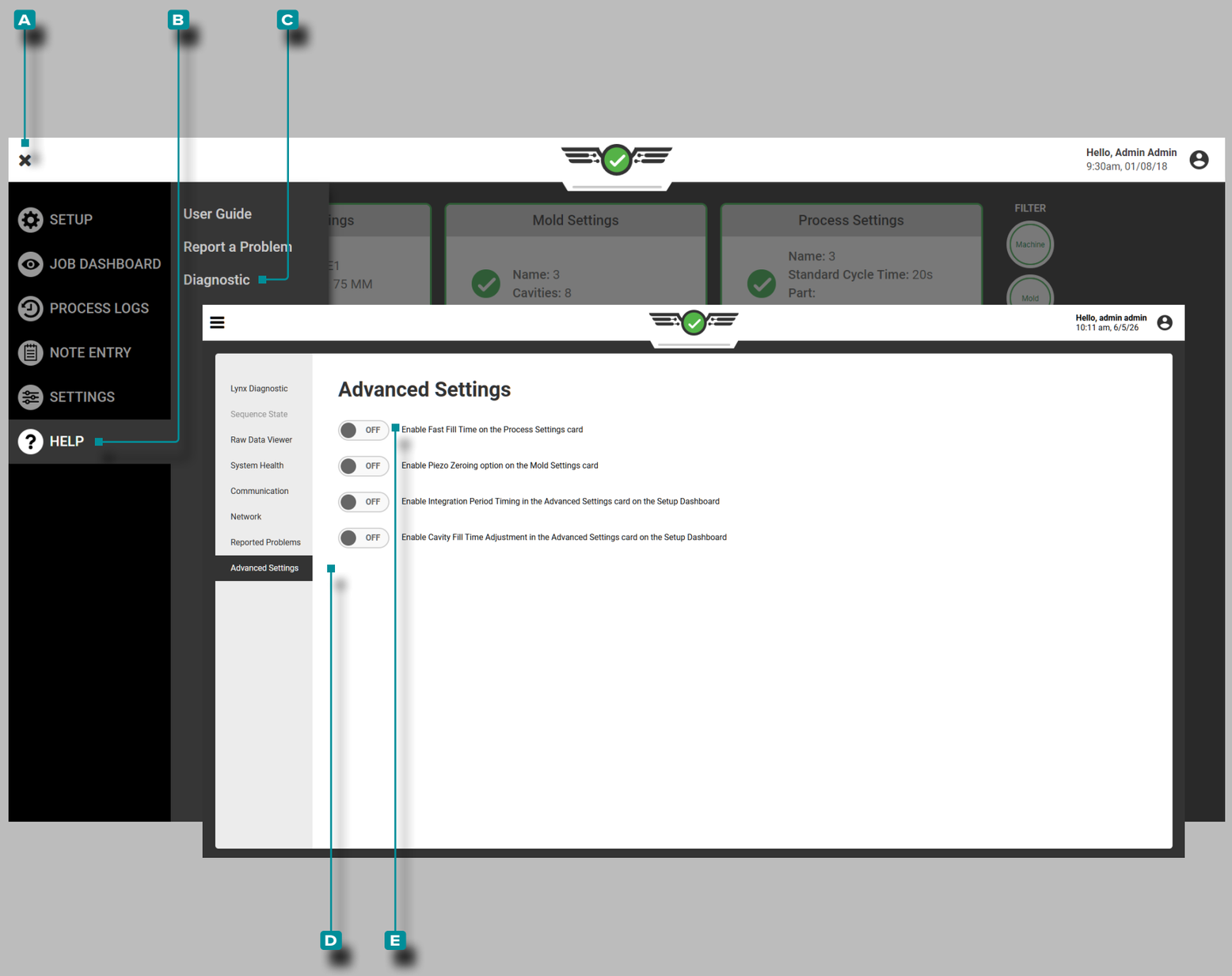
Downloading Error Report(s) to a USB Flash Drive

1. Plug a USB drive into the CoPilot system application processor's AP4.0 USB port.
2. In the CoPilot software C Diagnostic D Reported Problems page, **tap** the E ON button to select the problem report(s) for download (it is permissible to select multiple problem reports).
3. **Tap** the F download button to download the selected error reports.
4. The error report will now be available on the USB Drive.
5. Unplug the USB drive from the AP4.0, and then insert the USB Drive into a computer's USB Port.

ALTERNATIVELY

Users may remotely connect to a CoPilot system and download an error report to a PC. ***Use of this feature is secondary to the method outlined above and is not the recommended or preferred method; proceed at your risk.***

In the CoPilot software C Diagnostic D Reported Problems page, **tap** the G download button to download the problem report(s) to the PC (it is permissible to select multiple problem reports).



Help (*continued*)

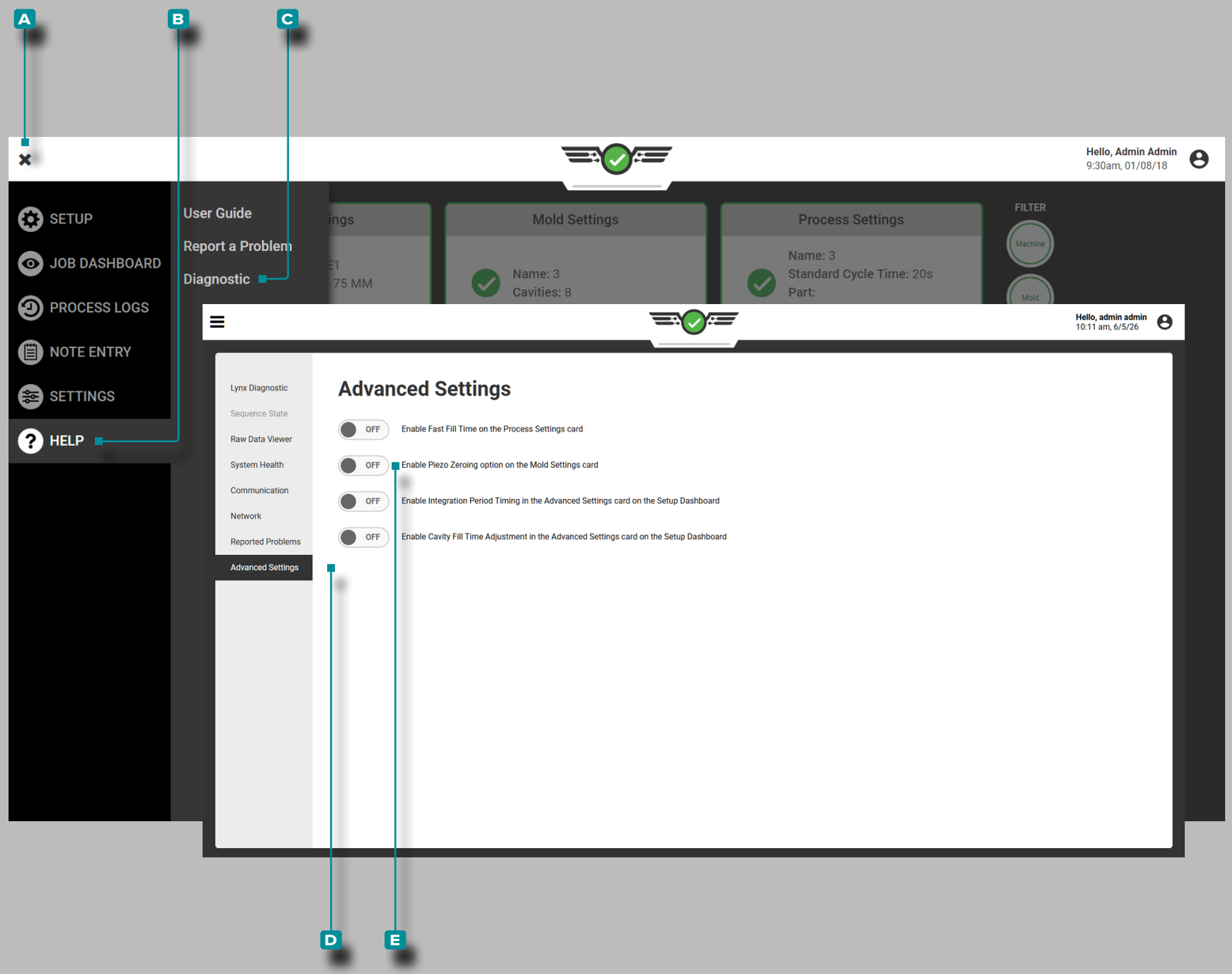
Advanced Setting: Enabling Fast Fill Time

However, if a fast fill time of less than 0.1 seconds is used, Advanced Settings must be activated within the Diagnostic/ Advanced Settings page in order for the related settings to display in setup.

Tap the **A** menu button, then **tap** **B** Help, then **tap** **C** Diagnostic, and then **tap** **D** Advanced Settings.

To enable or disable fast fill times, **tap** the slider to select **E** ON/OFF; ⓘON will enable fast fill times and related options during setup, while OFF will disable fast fill times and related options during setup.

ⓘ **NOTE** *Even when enabled on the Advanced Settings page, the fast fill time function* ***WILL NOT BE ACTIVE*** *until the user activates the option on the Process Settings page for a process. Each process must individually have this option activated if it is desired.*



Help (*continued*)

Advanced Setting: Piezoelectric Sensor Zeroing

Piezoelectric sensors are connected to the CoPilot system using adapters that contain components which require a reset or “zeroing” of the electronics each cycle. The piezoelectric sensor compononets are reset or “zeroed” each cycle using the mold closed sequence signal (on the falling edge of mold closed) in order to correctly calculate the previous and next cycle sensor data.

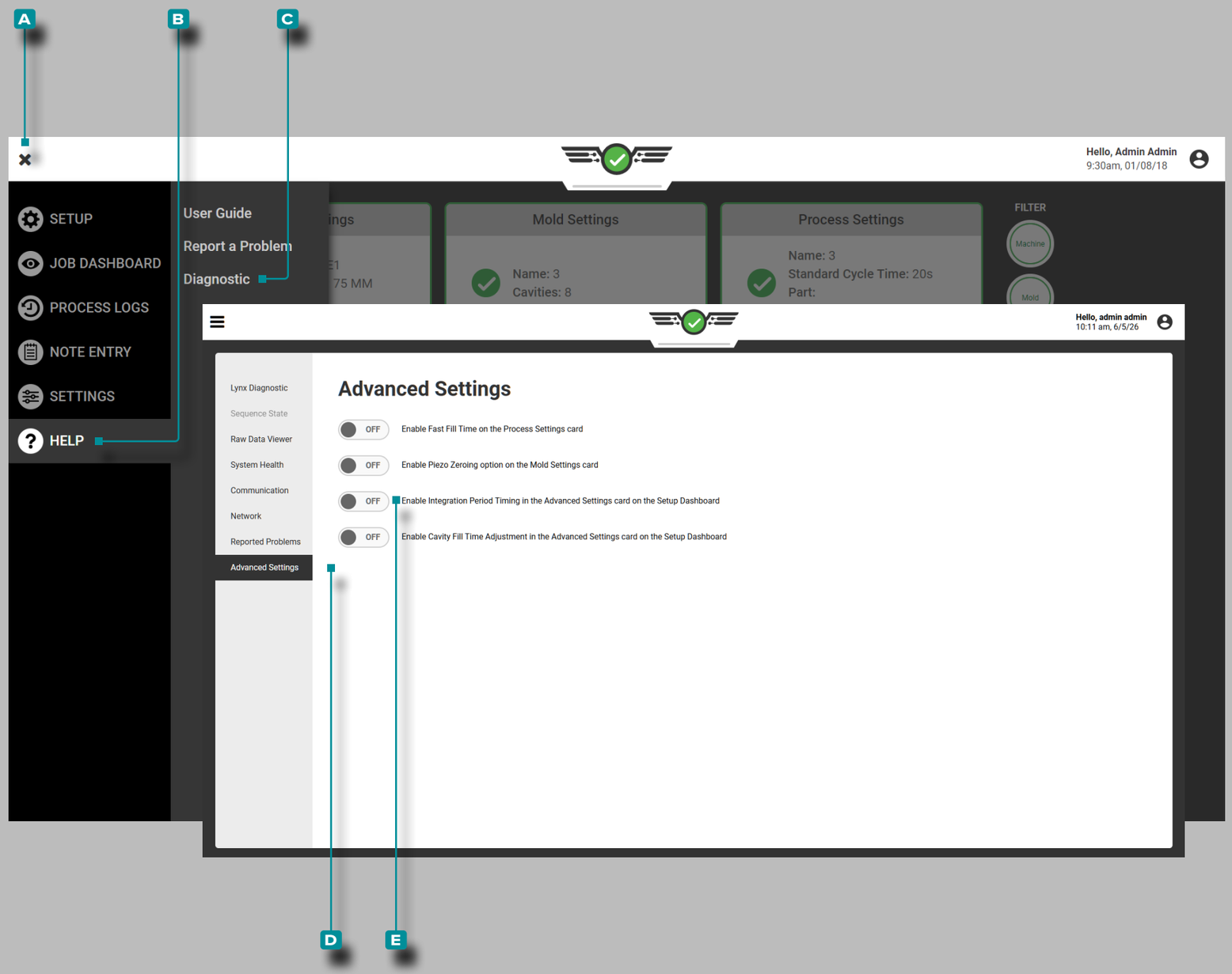
In some processes, a peizoelectric sensor(s) continues to have pressure applied after the mold closed signal ends. If pressure remains on the sensor(s) at 0.5 s after the falling edge of mold closed, the sensor data will become out of range, causing an underrange condition. When the underrange condition occurs, the CoPilot determines that the data is invalid and will no longer display the piezoelectric sensor data.

To prevent this underrange condition, the user may choose to change the default piezoelectric sensor component cycle “zero” from the falling edge of mold closed to the rising edge of mold clamped (delays the zeroing of the components). This option can be enabled on the Advanced Settings page, and activated on the Mold Setup page of the CoPilot system software.

Tap the **A** menu button, then **tap** **B** Help, then **tap** **C** Diagnostic, and then **tap** **D** Advanced Settings.

To enable or disable the delayed piezoelectric sensor zeroing, **tap** the slider to select **E** ON/OFF; ⓘON will enable the delayed piezoelectric sensor zeroing option during mold setup, while OFF will retain the default the piezoelectric sensor zeroing.

ⓘ **NOTE** *Even when enabled on the Advanced Settings page, the delayed piezoelectric sensor zeroing* ***WILL NOT BE ACTIVE*** *until the user activates the option on the Mold Settings page for a mold. Each mold must individually have this option activated if it is desired.*



Help (*continued*)

Advanced Setting: Integration Period Timing

The CoPilot system uses the end of injection for the integration limit, but with certain applications it may be neccesary to use a time before injection ends to compute data in order to negate a spike in cavity pressure later during injection that is not critical to part quality.

By default, the CoPilot system uses start of injection through end of injection for integration calculations.

Integration limits can be set to the start of injection through the start of injection plus a time (in seconds) OR end of injection plus a time (in seconds).

The integration time affects the following summary variable calculations; ***all other summary variable calculations are unaffected***:

- Peak End of Cavity, Post Gate, Mid Cavity
- Cycle Integral End of Cavity, Post Gate, Mid Cavity
- Fill and Pack Time for End of Cavity, Post Gate, Mid Cavity
- Fill and Pack Integral for End of Cavity, Post Gate, Mid Cavity

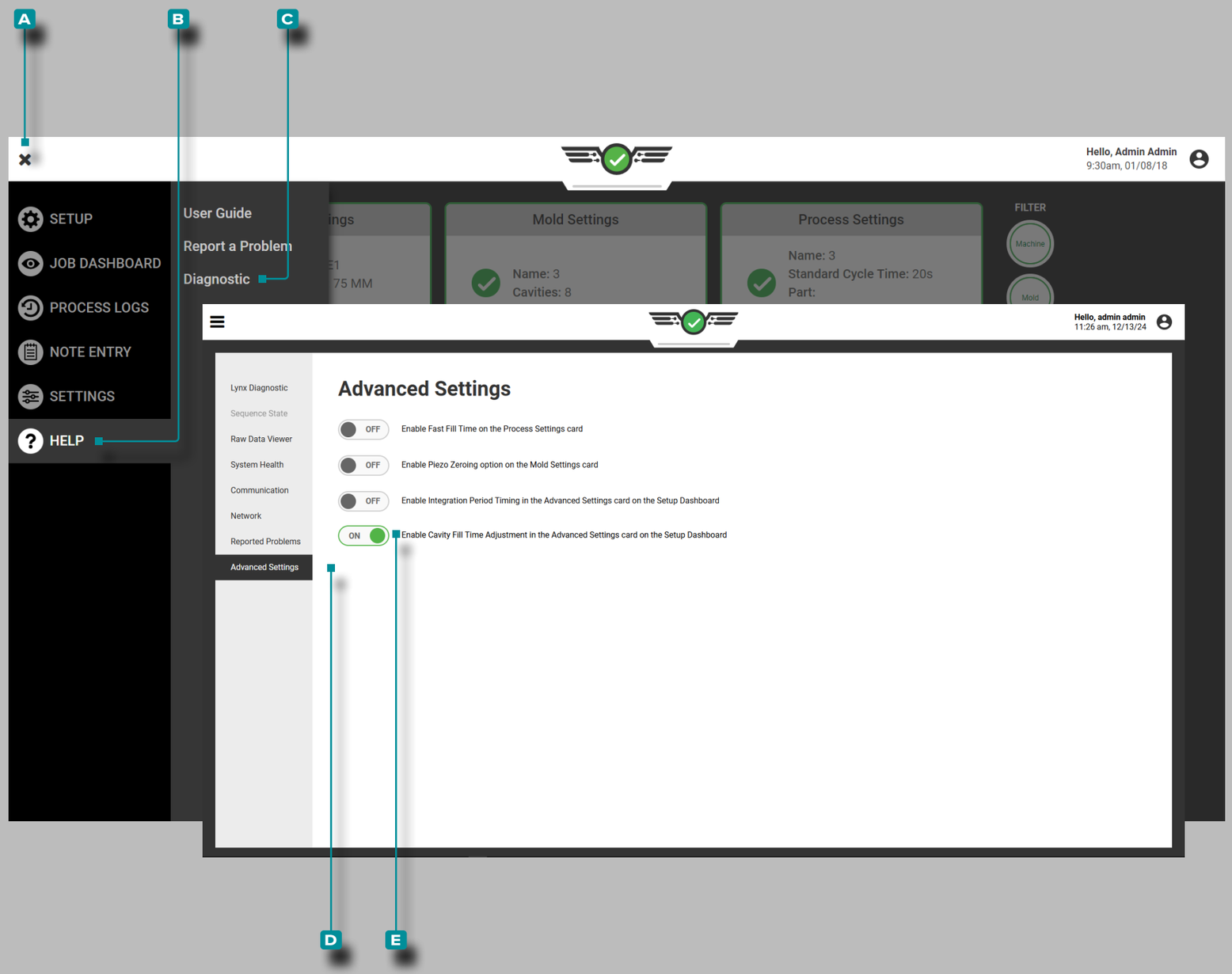
If the start of injection plus a time is longer than the injection time, summary variables will be computed at the start of injection plus a time.

If specified integration limit time does not occurr before sorting time, integration limit time is calculated until sorting time.

Tap the **A** menu button, then **tap** **B** Help, then **tap** **C** Diagnostic, and then **tap** **D** Advanced Settings.

To enable or disable custom Integration Period Timing, **tap** the slider to select **E** ON/OFF; ⓘON will enable the integration period timing option, while OFF will retain the default integration period timing.

ⓘ **NOTE** *Even when enabled on the Advanced Settings page, the integration period timing **WILL NOT BE ACTIVE** until the user completes the option setup on the Advanced Settings Dashboard card; refer to "Set Integration Period Timing from the Advanced Settings, Setup Dashboard Card" on page 51*



Help (*continued*)

Advanced Setting: Cavity Fill Time Adjustment

The CoPilot system calculates cavity fill time using the end of cavity sensor location when it reaches 1000 psi, but with certain applications it may be neccesary to use a lower pressure threshold. The cavity fill time adjustment allows users to enter a different cavity pressure threshold, and select a cavity location (EOC, MID, or PG) for the calculation.

If no EOC sensors are assigned, cavity fill time will not calculate unless a MID or PG sensor is assigned and selected.

The following widgets will display the selected sensor location, and cavity fill information:

Alarm Settings	Add/remove alarms and warning limits on the cavity fill time for the selected sensor location (EOC, MID, or PG). **Users with designated role Process Engineer can set alarms on cavity fill time for the selected location.**
Cavity Fill Time	Displays Cavity Fill Time for the selected sensor location (EOC, MID, or PG).
Previous Cycle Values	Add/remove the cavity fill time for the selected sensor location (EOC, MID, or PG).
Summary Graph	Displays the cavity fill time for the selected sensor location (EOC, MID, or PG).
Template Match	Mold Match uses the selected sensor location (EOC, MID, or PG)

Tap the **A** menu button, then **tap** **B** Help, then **tap** **C** Diagnostic, and then **tap** **D** Advanced Settings.

To enable or disable Cavity Fill Time Adjustment, **tap** the slider to select **E** ON/OFF; ⓘON will enable the cavity fill time option, while OFF will retain the default cavity fill timing (End of Cavity and 1000 PSI).

ⓘ **NOTE** *Even when enabled on the Advanced Settings page, the cavity fill time adjustment **WILL NOT BE ACTIVE** until the user completes the option setup on the Advanced Settings Dashboard card; refer to "Set Cavity Fill Timing from the Advanced Settings, Setup Dashboard Card" on page 52.*

Appendix

Valve Gate Control Applications

Sequential Valve Gate Application

There are three different schemes for controlling valve gates sequentially in a long flat part to prevent knit lines: shot volume control, cavity pressure pack control, and cavity pressure knitline control.

- Use shot volume control if no cavity pressure sensors are present in the mold.
- Use cavity pressure pack control with cavity pressure sensors to close the gates.
- Use cavity pressure knitline control with cavity pressure sensors to open and close the gates—this method is the most robust.

Note that “volume” is used instead of screw position whenever possible—this “normalizes” molds across all machines so that the control settings will be the same regardless of the screw diameter.

Shot Volume Control

If there are no cavity pressure sensors in a mold, perform the following shot volume control applicaiton:

1. Shoot a series of short shots, recording the volume at each shot (“Peak, Shot Volume”) that just passes the next gate.
2. Set open valve gate controls as follows:
   - Gate 1 opens at injection forward.
   - Gates 2 and 3 open at the volume where material has flowed past them (at the volume recorded plus a small amount).
   - Gates 4 and 5 open at almost-full volumes.

After the material has nearly reached the end of the cavity (at high speed), slow the machine to a pack speed—about 10% of fill speed for an initial value.

By experiment, find a volume for each valve that will properly pack that area of the mold, assuming the balance does not change from shot to shot, and set the vavles to close at those volumes.

Once all gates close, the valve gate control transfers the machine to hold pressure. Alternatively, use a holding stage to pack the part out; set the valve gates to close at the end of injection forward.

Once all of the gates are closed, remove hold pressure long enough to cool around any pulling cores and then end injection (by time) and start the screw.

Cavity Pressure Pack Control

If cavity pressure sensors are installed in the mold, setpoints can be entered to close each valve gate at a specific pack pressure. Volume settings could be used to open the valves in sequence, but this may still cause variation with check ring leakage. To prevent this, use the cavity pressure knit line control discussed as the third approach—refer to “Cavity Pressure Knit Line Control” on page 184.

In cavity pressure pack control, each gate is set to close when its associated sensor reaches a setpoint. In the valve gate close control, select the sensor location closest to the control point for that valve—it does not have to be post gate if the sensor were actually located at mid cavity or elsewhere. Enter a volume setpoint in the Valve Close Control widget as a backup in the event that the pressure at that sensor never reaches its setpoint.

Cavity pressure control can operate on either rising or falling signals, allowing a cavity to pack to a higher pressure than required, and then discharge some before closing the gate. If this scheme is used, lower pressure gradients across the part can occur, but the machine must be transfered once all of the valve gates have closed.

Cavity Pressure Knit Line Control

Cavity pressure for knitline control makes the most consistent parts possible, avoiding knit lines and packing all portions of the part to the same or specified pressure.

Cavity pressure knit line control uses cavity pressure to open and close the valve gates (except for valve gate 1, which will open on injection forward).

Set the open setpoint to “detect” the flow front and open the valve gate as it passes by setting the valve to open at a low pressure—for example, 100 psi—at the sensor near the gate. Enter a volume setpoint on the valve gate open control as a backup.

If desired, close the gates as in the previous method, “Cavity Pressure Pack Control” on page 184 for packing control.

Appendix (*continued*)

Independent Cavity Control

In this control method, all cavities are filled and packed simultaneously. The CoPilot system 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 Setup

1. Set each valve gate open to “Injection start”.
2. For each valve gate close control, select cavity pressure, a sensor to close the valve, and select during pressure rising. RJG recommends that post gate control sensors are used, and that the cavity number is matched to the valve gate number (post gate 1 closes valve gate 1).
3. Enter a very high pressure on the sensor to start the process setup—this prevents the valve gate control from closing any gates during process setup until a rheology study is completed and set the machine “fast-fill-to-slow-pack’ position.

Process Setup

A basic process will be set up using machine volume control, and then will be transitioned to valve gate cavity pressure control. This requires a few extra steps, but is the safest way to set up the process.

1. Initial Press Setup
   Set up at least two velocity profiles on the press—one for filling at a high speed (V1), and one transferring to a slower speed (V2) when nearing the end of the cavity. Set the transfer position from V1 to V2 at the same position where transfer out of 1st Stage (V→P transfer) occurs normally. This way, V2 will not be used until later when pack speed is set.
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, the 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 a fill speed has been chosen 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; V→P transfer will be increased, but the system controls should be tested first.
6. Test the Controls
   Note the “Peak, Shot Volume” value on the previous cycle values tool or the cursor value on the cycle graph where the volume curve reaches its peak. On the V→P control tool, use the “Stroke Volume” or “RJG Stroke 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 CoPilot system 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. To verify, reduce the V→P transfer position on the CoPilot system significantly; the fill-only part should become smaller.
7. Set the Press Transfer Position so that the CoPilot System Controls V→P Transfer
   Once confident that the press is transferring correctly using the V→P Transfer tool, set up the V→P transfer position on the press so the CoPilot system will always transfers first. Once the process is set up, reset it to a position where it will act as a backup in case the CoPilot system control fails for any reason.
8. Pack the Cavities using the V→P Transfer Tool
   Increase the volume setpoint on the V→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 previous cycle values tool. For example, if cavity #4 packs first, look up the “Peak, Post Gate #4” value; use this value in the next step.

Independent Cavity Control—Process Setup (continued)

9. Enter the Cavity Pressure Values on the Valve Gates Tool (Cavity 1)
   In the valve gates tool, locate 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 control, 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 (8 and 9) for each cavity. This is done by increasing the volume setpoint in the V→P Transfer tool, and as each cavity packs out, entering in the cavity pressure setpoint for that cavity in the valve gate control tool. Continue this process until all cavities are transferring using cavity pressure control. As cavities begin to close, the pack rate on the remaining ones will increase; 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.

Setting Backups

1. Stroke Volume or RJG Stroke Volume
   Set a backup stroke volume or RJG stroke volume setpoint in the V→P Transfer tool in case none of the valves fire (approximately 10% above the last setting on this tool for volume transfer). For example, during setup if the last valve gate to close had its pressure set to 6250 psi when the shot volume was 1.48 in^2, then enter 1.6 in^2 as the injection volume to transfer.
2. Cavity Pressure
   Now that the valve gates are closing on cavity pressure, it is important to 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 RJG stroke volume setpoint in the valve gate close control. 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, if gates #3 and #4 close when shot volume is 1.455 in^2. and gates #1 and #2 close near 1.48 in^2, set the injection volume backup for #3 and #4 to 1.6 in^2. and #1 and #2 to 1.63 in^2.

Preventing Inter-Cavity Variation

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. Always set appropriate backups in the CoPilot system and on the machine.

Appendix (*continued*)

Additional Valve Gate Control Techniques

"Running" Start

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, detailed in the following sections.

Open on RJG Stroke Volume

The Open on RJG Stroke Volume is likely the most consistent "running start" method. A good starting point is zero volume that will be crossed once the ram is up to speed. This requires that some decompress is used on the process.

CAUTION **f CAUTION** *If using high injection velocities with a significant delay in the opening of the valve gates, this approach may over-pressurize the manifold.*

Open on Pressure

Similar to the "open at RJG Stroke Volume" technique, the "open on pressure" method uses pressure to "pre-pressurize" the barrel and force an initial very fast injection due to the built-up pressure. The only difference is that "Pressure at Injection" would be selected as the open on target.

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, a fast fill and slow pack to pressure is set up, leaving the pressure at the gate considerably higher than the pressure at the end of the cavity after the gate closes.

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

To reduce the pressure gradient, use the CoPilot system V→P Transfer tool to allow the machine to transfer to hold. The tool is set to transfer the machine to hold at the maximum pack pressure desired.

Alternate Cavity Control

Alternate cavity control is a technique for reducing the clamp tonnage by filling, packing, and closing the gates on cavities in sequence. This means that each cavity is completely finished (fill, pack, and 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.

Alternate Cavity Control (continued)

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.

Process Setup (Method #1)

Setting up an alternate cavity process requires both press control settings and CoPilot system control settings. Here is a step-by-step method for setting up the process with two alternate cavities, with one gate in each cavity. This procedure assumes that the Valve Gate control tool and the V→P Transfer tool have been set up and tested on the CoPilot system.

1. Build the Shot Size
   Load enough material ahead of the screw to fill and pack both cavities. Initially, 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-to-mid fill speed. Gradually increase the shot size until both cavities are capable of filling; make sure there is enough material for packing and cushion.
   Open the valve gate control tool in the CoPilot software. For the valve gate that controls the first cavity to fill, create the valve gate open control “Injection Start”. Next, for the valve gate close control, create a “Pressure at” control, then choose which pressure sensor that will be used to control the valve gate. Initially, enter a low cavity pressure setpoint, such as 1000 psi. Also create a valve gate close control for “RJG Stroke Volume” and enter a high value which cannot be reached.
   Set up each remaining valve gate the same as the first cavity, except that the valve gate 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.

ⓘ **NOTE** *There is currently no “valve gate open on valve gate close” control in the Copilot system. The close setpoint used for the previous gate could be set for the open setpoint for the next gate.*

2. Set the Fill Speed on the Press
   With the valve gates control tool configured, set a low fill speed and low injection pressure on the press.

CAUTION *These should be set low enough that if the valve gates do not close, the mold will not be damaged.*

3. 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, 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 the injection pressure setting on the press. Otherwise, gradually increase the 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.
4. Pack Out the Parts
   One cavity at a time, increase the cavity pressure setpoint in the valve gate control until that cavity is fully packed out; 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.
5. Set Backups
   On the bottom of the cycle graph sequence graph, find the point where the first valve gate closes. Place the cursor at that point and read the RJG Stroke Volume value displayed. Add 5–10% and enter this value into the close at RJG Stroke Volume field in the valve gate open control 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.

Appendix (*continued*)

Alternate Cavity Control (continued)

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.

Process Setup (Method #2)

Setting up an alternate cavity process requires both press control settings and CoPilot system control settings. 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 the Valve Gates tool and the V→P Transfer tool have been set up and tested on the CoPilot system.

1. Build the Shot Size
   Load enough material ahead of the screw to fill and pack both cavities. Initially, start by filling all cavities simultaneously to determine shot size by setting 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 shot size until both cavities are capable of filling. Make sure there is enough material for packing and cushion.

2. Setup Cavity 1 Valve Gates

   Navigate to the valve gate control tool in the CoPilot software.

   - Select the valve gate that controls the first cavity to fill.
   - Add a valve gate open control, selecting the Injection Start option.
   - Next, add a valve gate close control and select the “Cavity Pressure” method for closing the gates, then choose which pressure sensor that will be used to control the valve gate. Initially, enter a cavity pressure setpoint high enough that it will never be reached, such as 20,000 psi.
   - Also add a valve gate close control for “RJG Stroke Volume” and enter a high value which cannot be reached.
   - Finally, add a valve gate close control for the “End of Injection Forward”.

3. Turn Off Other Cavities

   For each remaining cavity, do not set any control. This will prevent the valve from opening, allowing you to set up cavity 1 only at this time.

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, run fill-only parts (must be short, even at the highest fill speed). Once a fill speed is determined, select a transfer position that makes the part 90–95% full.

7. Test the External Transfer (Optional)
   Make a single cavity short shot and note the “Peak, Shot Volume” value on the previous cycle values tool. Enter a value approximately 30% lower than this in the close at RJG Stroke Volume column for gate 1. This should cause the CoPilot system to transfer the press before its transfer position is reached, resulting in a shorter part and a lower “Peak, Shot Volume” value on the previous cycle values tool. If the press doesn’t transfer earlier, check the setup of the hardware and software that control the valve gates.
   Set the close at RJG Stroke Volume value back to its original level.

Appendix (*continued*)

Alternate Cavity Control—Method #2: Multiple Velocity (continued)

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.

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, the CoPilot system should be controlling the transfer of the valve gates, which cannot be done 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. Pack Cavity 1
Steadily (over several shots) increase the close valve gate at RJG Stroke Volume value for gate 1 until cavity 1 is properly packed. Make a note of this volume for setting backups.

12. 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. Either make a note of this value or leave the cursor in that position, as the value will be used to set the cavity pressure setpoint for this valve gate. Now increase the close valve gate at RJG Stroke Volume value for gate 1 gradually by about 3% (or less to avoid over-packing the part). Continue shooting parts while adjusting the close valve gate at RJG Stroke Volume value until maximum pressure is reached in the cavity without damaging the mold. This position will become the backup position for closing the valve gate in case of unsuccessful transfer off of cavity pressure.

13. Close Valve Gate 1 Using Cavity Pressure
Enter the pressure at the cursor for post gate #1 in the close gate 1 control at pressure. The valve gate for this cavity should now begin closing off of cavity pressure instead of RJG Stroke Volume. If this is the case, the close valve gate at Pressure for this valve gate will be green when the valve gate closes.

ⓘ **NOTE** *RJG recommends saving a template at this time (named "Fill and Pack Cavity 1", for example). While the template will not be used here again, it maybe be useful later when the process needs to be set up again.*

14. Prepare to Setup Cavity 2
At this point, one cavity should be making a good part. Now it's time to set up the next cavity. Stop the press as the next steps are set up.

15. Set Up 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 RJG Stroke Volume, when Injection Forward goes Off, and pressure at post gate #2. The initial pressure setting can be quite high, or use it to prevent damage by setting above the pressure found for the first cavity.
Next, set the initial close valve gate at RJG Stroke 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 valve gate at RJG Stroke Volume value for cavity 1 and add the fill-only part volume. This should make a partially full part on which shot volume can be adjusted until the part is 90% full.

Alternate Cavity Control—Method #2: Multiple Velocity (continued)

16. 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 it can be set to the same speed as the fast fill speed for cavity 1. Choose the position where the previous speed (slow pack speed for cavity 1) ends—the V2-V3 transfer position—just after the point where valve gate 1 closes. This will be done by trial and error, but following these steps will help:

- On the previous 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 valve gate at RJG Stroke Volume setting on the valve gate control tool.
- On the cycle graph, place the cursor at the point where valve gate 1 closes, and inspect 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.

17. Adjust Fill-Only Shot Size

Steadily adjust the Close at Volume value for gate 2 until cavity 2 is 90% full.

Next, 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. To find the position to transfer from V3 to V4 (fast fill to slow pack for the second cavity), note the "Peak, Shot Stroke" value on the previous 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.

Open the valve gate control tool. Continue increasing the Close at RJG Stroke Volume value for gate 2 until the part in cavity 2 is fully packed as was done with cavity 1.

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 the volume backup is determined in the next step. This value will be used to set the Close at Pressure value for the second cavity.

Now increase the close valve gate at RJG Stroke Volume value for gate 2 gradually by about 3% (or less to avoid over-packing the part). Continue shooting parts while adjusting the close valve gate at RJG Stroke Volume value until you are getting the maximum pressure in the cavity while not damaging the mold. This position will become the backup position for closing the valve gate in case unsuccessful transfer off of cavity pressure.

Enter the pressure at the cursor for the second valve gate (which was noted earlier) in the close valve gate at pressure setting for gate 2. The valve gate for this cavity should now begin closing off of cavity pressure instead of close valve gate at RJG Stroke Volume . If this is the case, the close valve gate at pressure setting for this valve gate will be green when the valve gate closes.

At this point, good parts should be being made in two cavities.

ⓘ **NOTE** *RJG recommends saving a template at this time (named "Fill and Pack Cavity 2", for example). While the template will not be used here again, it maybe be useful later when the process needs to be set up again.*

If there are 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.

Appendix (*continued*)

Alternate Cavity Control (continued)

Making Process Adjustments

This process builds two parts in sequence, so making adjustments to the process must be well thought out; making changes to one part can have an effect on the other.

1. Large Pressure Increases on Cavity 1 Pack Pressure
   As the pack pressure on cavity 1 is increased, 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 the backup position, so 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 starting from the beginning.
2. Cushion is Too Small
   If the ram is hitting bottom before or very close to when cavity 2 is finished, add cushion. Add 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 CoPilot system 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 is 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 the shot size is reduced to 140 mm, there is still 5 extra mm in the barrel. In order not to overfill the cavities, purge and recharge the screw so that the CoPilot system knows the new zero (screw stop) and so that excess material is removed from the barrel.

Notes on Summary Values

Since the Fill Volume (set in the cycle graph) only provides 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). These values can still be used 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.

The cooling time for cavity 1 is much higher than cavity 2, so a much shorter cooling time on cavity 2 would be used as the "worst case". The "Sequence Time, Plastic Cooling" value only applies to cavity 1.

Pre-Open of Slow Gates

Valve gates do not operate instantaneously—there is always some solenoid delay time, even with hydraulics. With pneumatic valves, it is possible to have 0.25 second or longer delay between the time the Copilot system tells the valve to open or close and the time it actually does open or close.

In one 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, the second gate should open early. Another method of opening gate 2 was added, specifically open gate 2 when gate 1 reaches a cavity pressure.

The opening of gate 2 is set at 250 psi below the closing of gate 1 (3770 psi). If the closing setpoint pressure of gate 1 is adjusted, closing setpoint pressure of gate 2 should be adjusted as well to keep the "pre-open" timing correct.

Alternate Cavity Control—Making Adjustments (continued)

Blush Control

In addition to the "slow gate" situation described in "Pre-Open of Slow Gates" on page 192, 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: If the pack speed for cavity 1 is the same as the slow speed required to reduce blush in cavity 2, usually that little extra slow pack at the beginning of cavity 2's fill can be used. If not, a slow profile may need to be inserted there. If slower than cavity 1's pack, it will become a problem since the position of where in the machine's control profile is the location of the gate's switch over.

Multi-Gate & Multi-Cavity Issues

When four cavities are filled and packed in two pairs, set the valve gates for the second pair of cavities to open when the valve gates for the first two cavities have both closed, following the steps below:

1. Setup the open control for gate #3

On the valve gate open control screen for gate #3, choose the gates that must be closed in order for gate #3 to open.

2. Setup the open control for gate #4

On the valve gate open control screen for gate #4, choose the gates that must be closed in order for gate #4 to open.

ⓘ **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.

Glossary

Times

Cooling Time

The elapsed time required for the melt to reach its Vicat hardness. Cooling time begins immediately after hold time ends and continues until a part can be ejected from the mold safely while remaining dimensionally stable.

Too short of a cooling time can result in stuck parts and parts that are dimensionally-deficient; too long of cooling time can also create parts that are dimensionally-deficient, as well as unnecessarily extend cycle times.

The CoPilot computes this signal at the end of falling edge of mold closed and turns it off at one of the following (in order of priority):

- decompression begin
- cycle time end
- rising edge of mold closed

Cycle Time

The time required by an injection molding system to mold a part and return to its original position/state.

Fill Time

The time required to fill the cavity/cavities measured from screw decompression to screw transfer position. The fill signal is computed by the CoPilot as on at the rising edge of injection forward and off at the end of transfer.

Fill time is dependent upon screw travel distance and speed; if either—or both—screw distance or screw speed change, fill time will also change.

Fill time needs to remain constant because the machine automatically compensates by modifying other parameters as needed. If the automatic compensation is not operating correctly, process values such as fill time may be out of the acceptable range.

Pack/Hold Time

Pack

The filling of the mold cavity or cavities as full as possible without causing undue stress on the mold or causing flash to appear on finished parts.

Hold

The amount of time that hold pressure is being applied; hold time ends when the gate(s) seal all material that has been packed into the cavity/cavities. If hold time is set too short, sink marks may occur near the gate (gates may not seal), or undersized parts may result.

The CoPilot computes the hold signal at the falling edge of injection forward or at the falling edge of second stage.

Recovery Time

The length of time for the screw to rotate, create a shot, and return to original position.

Glossary (*continued*)

Positions

Cushion

The material remaining in front of the screw after forward movement ends; it is measured as the linear distance between the nozzle and the screw after the screw stops forward movement. The material remains between the screw and nozzle, transferring screw pressure to maintain pack and hold pressures inside the mold. Mold packing cannot occur without cushion.

Verify that shot size and transfer position are in specification with process settings. Increase shot size and transfer position to adjust cushion.

Decompression

The distance the screw retracts after the completion of screw rotation, used to relieve plastic pressure built in front of the screw during rotation. If decompression is too low, plastic may drool out of the nozzle into the sprue bushing causing a blockage in the nozzle or bushing, or causing cold plastic to be injected into the part(s). If decompression is too high, air may enter the melt stream causing bubbles or splay to form in the part(s).

Also referred to as “suck back”.

Shot Size

The amount of material from the start of injection to the transfer position. Shot size should be 20–80% of the barrel capacity.

Transfer Position

The position at which the screw transfers from velocity control to pressure control—usually where the part is 95–99% full.

The point where the machine changes from filling the mold with velocity control to packing the mold with pressure. This set point on the machine is determined during setup. If this value is increased, it will result in less plastic being injected into the mold and may result in parts that are short, have sinks, or are dimensionally incorrect. Decreasing this value will result in parts that are larger and potentially result in flash.

Also known as velocity to pressure, or V→P.

Changes in transfer pressure are indicative of viscosity changes.

Glossary (*continued*)

Pressures

Average Peak

The average of the highest pressure detected by a particular cavity pressure sensor group; can be a PG average peak, a MID average peak, or an EOC average peak.

Back Pressure

The pressure applied by the injection unit at the back of the injection cylinder as plastic pressure is built up in front of the screw. Plastic pressure must be greater than the back pressure or the screw will stall; increasing back pressure may decrease variation in screw recovery.

Back pressure increases the melt temperature and contributes to the homogeneous mixing of material. As back pressure increases, screw run time increases and may lengthen cycle time. Back pressure determines the next shot's volume.

Balance Peak

A mathematical calculation using range and average which accounts for peak pressure in each cavity in order to determine a spread in quality between cavities. Commonly, peak balance is used to set alarms or warnings in the software, often non-sorting.

At the end of each shot (integration limit or end of screw run) the software calculates all of the basic values that make up balance. The following example uses EOC sensors:

First, the software calculates the peak EOC values for each EOC sensor. The software then calculates the range for those sensors:

Range for EOC peak = highest EOC peak – lowest EOC peak

At the same time, the software creates an average of the peak values for each sensor:

$$\text{Average for EOC peak} = \frac{\text{all EOC peaks added}}{\text{number of EOC peaks}}$$

The software then calculates the balance peak percent using the range and averages already found:

$$\text{EOC peak Balance \%} = \frac{\left(\dfrac{1 - \text{EOC Peak Range}}{2}\right)}{\text{EOC Peak Average}} \times 100$$

Fill Pressure

The pressure required to fill the cavity/cavities from shot size to transfer position. Fill pressure will vary shot-to-shot due to material viscosity.

The first stage injection set point pressure must never be reached during filling; it should be set higher than the pressure required to fill the mold. If the first stage injection pressure is reached, the machine cannot compensate for changes in viscosity.

Hold Pressure

The pressure used to retain material in the cavity/cavities after the part is filled. If hold pressure is too low, the part could be undersized or have cosmetic defects such as sinks or shorts; if the hold pressure is too high, the part could be over-sized, become stuck in the mold, or have cosmetic defects such as pin push or drag marks.

Peak

The highest pressure detected by the particular cavity pressure sensor; can be a post-gate peak, a mid-cavity peak, and/or an end-of-cavity peak.

Plastic Pressure

The actual pressure of plastic in the injection molding machine during injection.

Glossary (*continued*)

Effective Viscosity

A relative measure of the resistance to fill a specific mold for a mold, machine, and nozzle combination, including changes in material viscosity, obstructions in the flow channels of the mold or machine, and changes in material, mold, or hot runner temperatures. Effective viscosity reflects problems from a wide array of causes and is a powerful tool to detect process problems.

Material Viscosity

A non-Newtonian polymer's resistance to flow due to inner friction. The higher the material's viscosity, the more resistance it will have to flow; the lower the material's viscosity, the less resistance it will have to flow.

When material viscosity changes, certain process values—such as fill pressure—will be affected. However, fill time needs to remain constant because the machine automatically compensates by modifying other parameters as needed. If the automatic compensation is not operating correctly, process values such as fill time may be out of the acceptable range.

Formulas

Intensification Ratio (Ri)

If the input where the pressure is applied (injection cylinder) has a greater square-inch area than the output square-inch area (screw) where the pressure is directed, the output pressure will be greater than the input pressure.

Ri = Injection Cylinder Area (in2) ÷ Screw Area (in2)

Example: The intensification ratio for an injection molding machine with an injection cylinder area of 50 in2 and a screw area of 5 in2 is 50 in2 ÷ 5 in2 = 10 or 10:1.

Plastic Pressure (ppsi)

Plastic Pressure is calculated by multiplying the system pressure in pounds per square inch (psi) by the injection molding machine's intensification ratio (Ri)—this applies only to hydraulic machines.

ppsi = System Pressure (psi) x Ri

Example: The plastic pressure of an injection molding machine with 1,000 psi and an intensification ratio of 10 (10:1) is 1,000 psi x 10 = 10,000 ppsi.

Effective Viscosity

Effective viscosity of a material is calculated by multiplying fill time in seconds (sec) by the transfer pressure in plastic pressure per square inch (ppsi).

Effective Viscosity (psi/sec) = Fill Time (sec) x Transfer Pressure (ppsi)

Example: With a fill time of 0.128 sec and a transfer pressure of 16,940 psi, the effective viscosity of a material is 0.128 sec x 16,940 ppsi = 2,168 psi/sec.

Sigma (Standard Deviation)

Sigma σ (standard deviation) is calculated by finding the mean of a group of data, then calculating the variance (the group of data's spread size compared to the mean) from that mean and group of data, and finally by finding the square root of the variance.

Mean = all data points / number of data points

Then, Variance = (sum of each (data point - mean)^2)/(number of data points - 1)

Then, sigma = √variance

$$\text{Sigma } (\sigma) = \sqrt{\frac{\left(\sum_{i=1}^{n} (x_i - \dot{x})^2\right)}{n - 1}}$$

where
x_i = value of the ith point in the data set
$\dot{x}$ = the mean value of the data set
n = the number of data points in the data set

Glossary (*continued*)

DECOUPLED MOLDING®

A process control method that addresses how the machine controls are used to fill and pack plastic into a mold. In a Decoupled process, an abundance of first stage pressure is used, and the filling (velocity) phase is separated from the packing (pressure) phase.

DECOUPLED MOLDING II

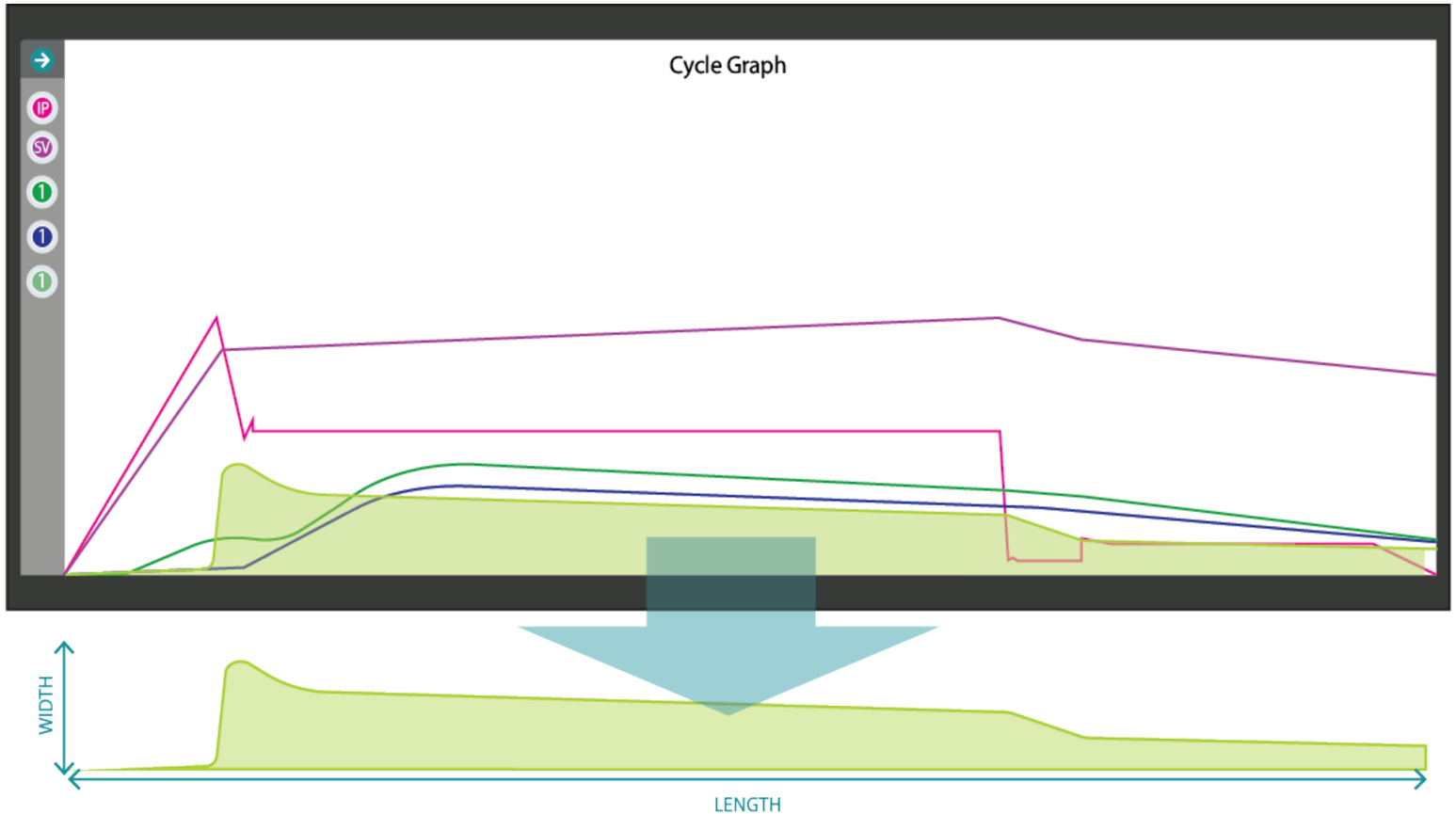
Uses Pressure and Time

Fill the mold as quickly as quality allows, and transfer by screw position when cavities are 95–98% full. The melt decompresses and the screw slows just before the cavities fill out; second stage (hold) pressure is used to complete the filling and packing out of the parts.

DECOUPLED MOLDING III

Uses Velocity and Cavity Pressure

Fill the mold fast and profile by screw position. When the cavities are 85–90% full, transfer to a slow, controlled velocity pack stage. Packing is complete when cavity pressure or screw position transfer completes packing the parts.

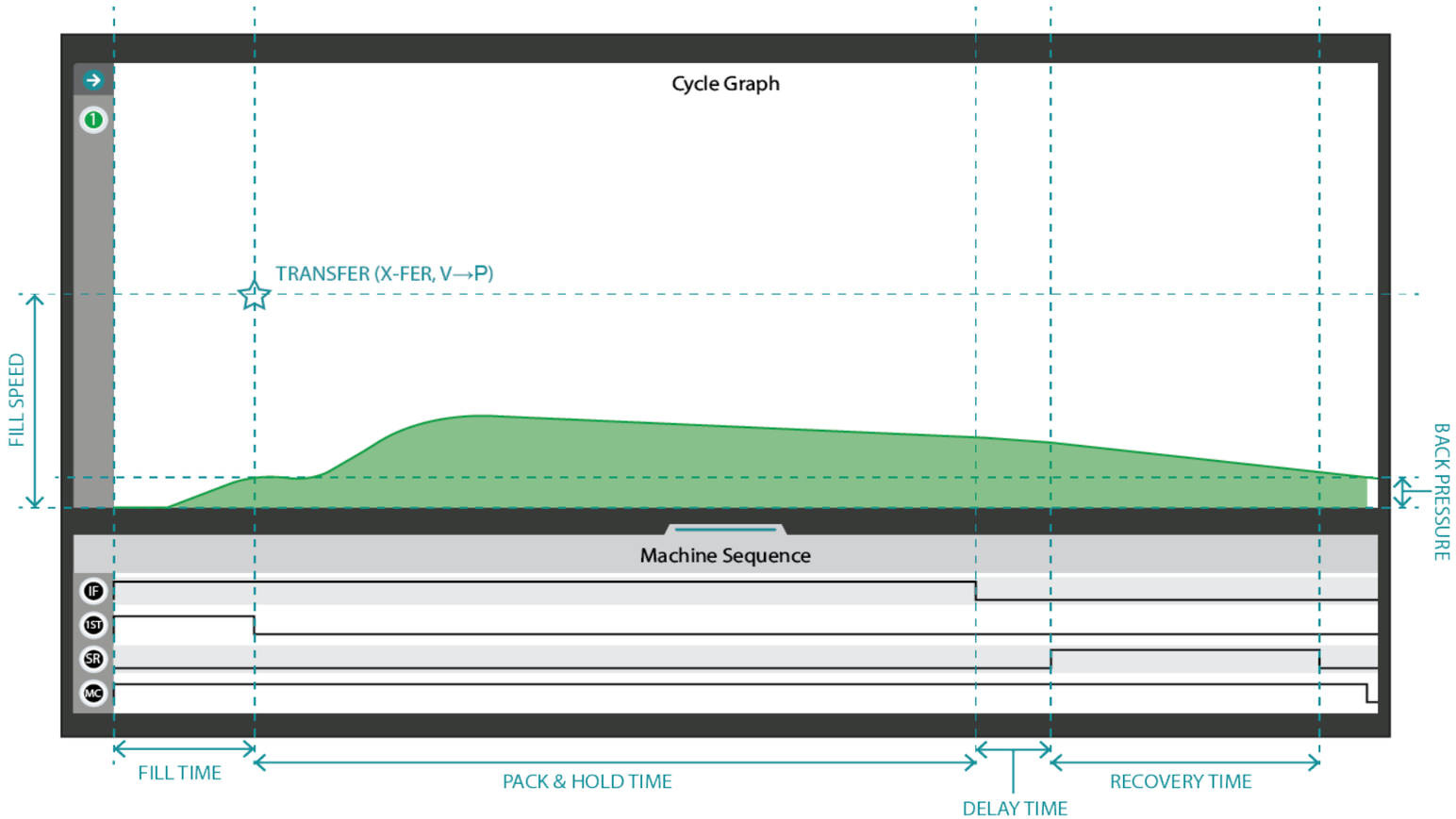


Integrals

The word “integral” is a calculus term that roughly translates to “area”; in simple geometry area is equal to width times length (area=width x length). Cavity pressure and volume integrals are calculated using the total area under the pressure or volume curves seen on the cycle graph during each cycle. Integral calculation begins at the start of the cycle; the defined end of the calculation of the integral is referred to as the *integration limit*.

Integrals are useful for detecting changes in part weight or dimensions. A cavity pressure sensor detects the injection, pack, and hold pressures from material flowing into the cavity, therefore, the entire range of pressures detected by the sensor throughout the cycle is a direct indication of the amount of material which was injected, packed, and held in the cavity.

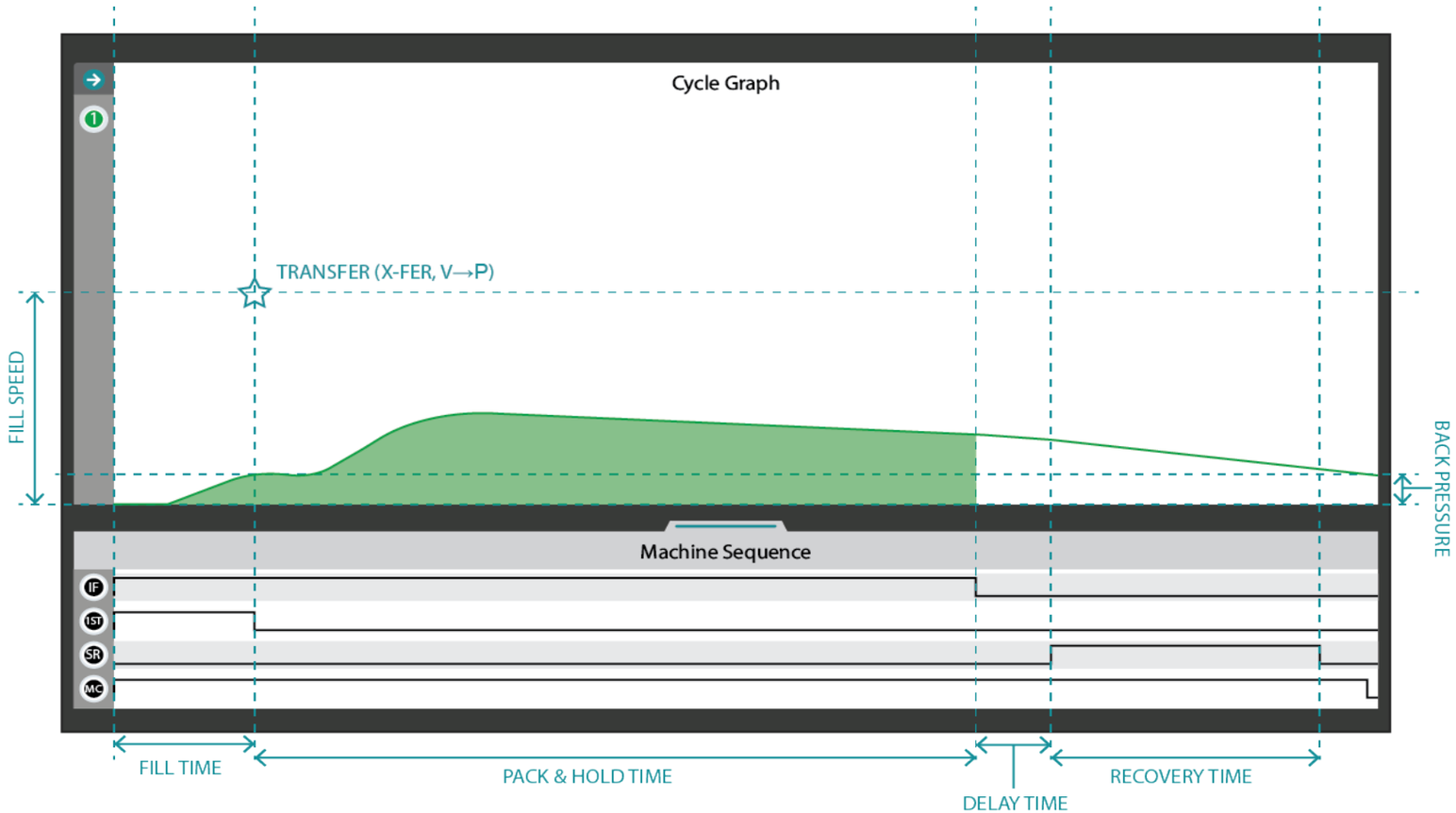
If there is a change in the pressure/amount of material injected, packed, and held in the cavity, there will be a change in the part weight and/or dimensions which will be reflected in the integral.



Cycle Integral

A cycle integral is calculated using the area under a cavity pressure cycle curve during a cycle; the cycle integral's integration limit is the end of the mold clamped machine sequence signal. Below, shaded in green, is a visual depiction of a post-gate cavity pressure curve cycle integral.

The cycle integral number includes all of the pressure detected by the cavity pressure sensor multiplied by the time the sensor detected pressure before the mold clamped signal turns off.



Injection Integral

An injection integral is calculated using the area under a cavity pressure sensor cycle curve during a cycle; the injection integral's integration limit is the end of the injection forward machine sequence signal. Below, shaded in green, is a visual depiction of a post-gate cavity pressure curve injection integral.

The injection integral number includes all of the pressure detected by the cavity pressure sensor multiplied by the time the sensor detected pressure before the injection forward signal turns off.

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