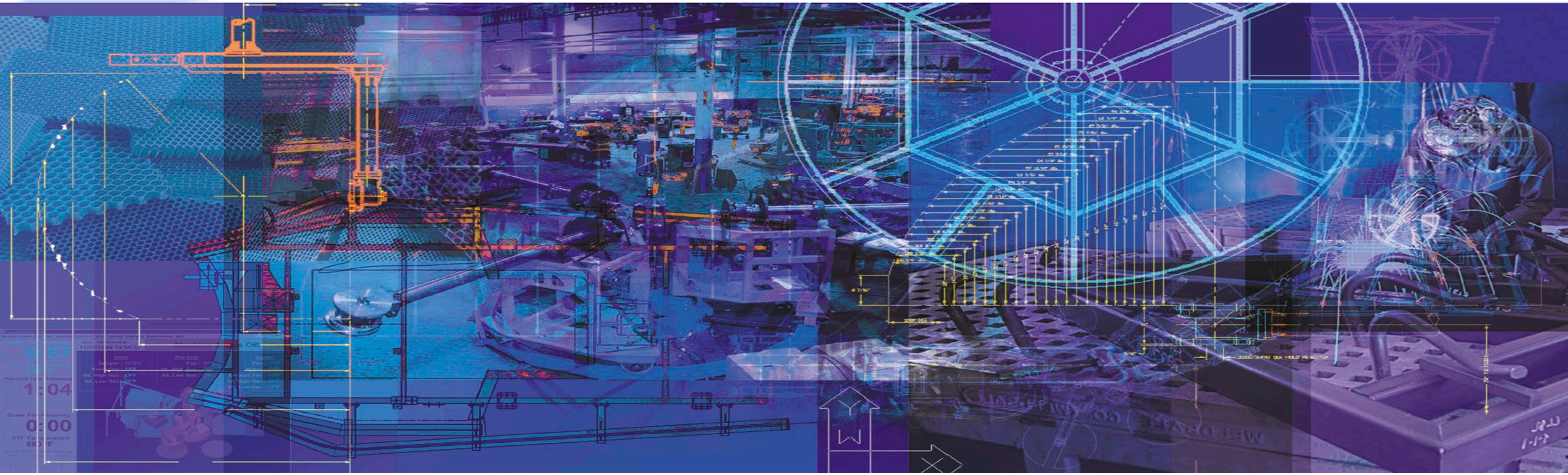

Rotomolding Safety Systems

2025 Executive Forum – March 24-26/Scottsdale AZ

Adam Covington - Ferry Industries, Inc.

Engineered for Safety

Rotational molding machines and work cell safety must focus on continuous improvement and elimination of personnel injury and property damage risk through:

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Engineered For Safety

- Risk Assessment & Safety SOP
- Lock-Out / Tag-Out Procedures
- Visual & Audible Warnings
- Operator / Machine Enunciation
- Oven & Machine System Interlocks
- Restricted Access, i.e. Fencing & Guarding
- Safety-Rated Zone Sensors
- Work Platforms
- Reduced Operator Fatigue

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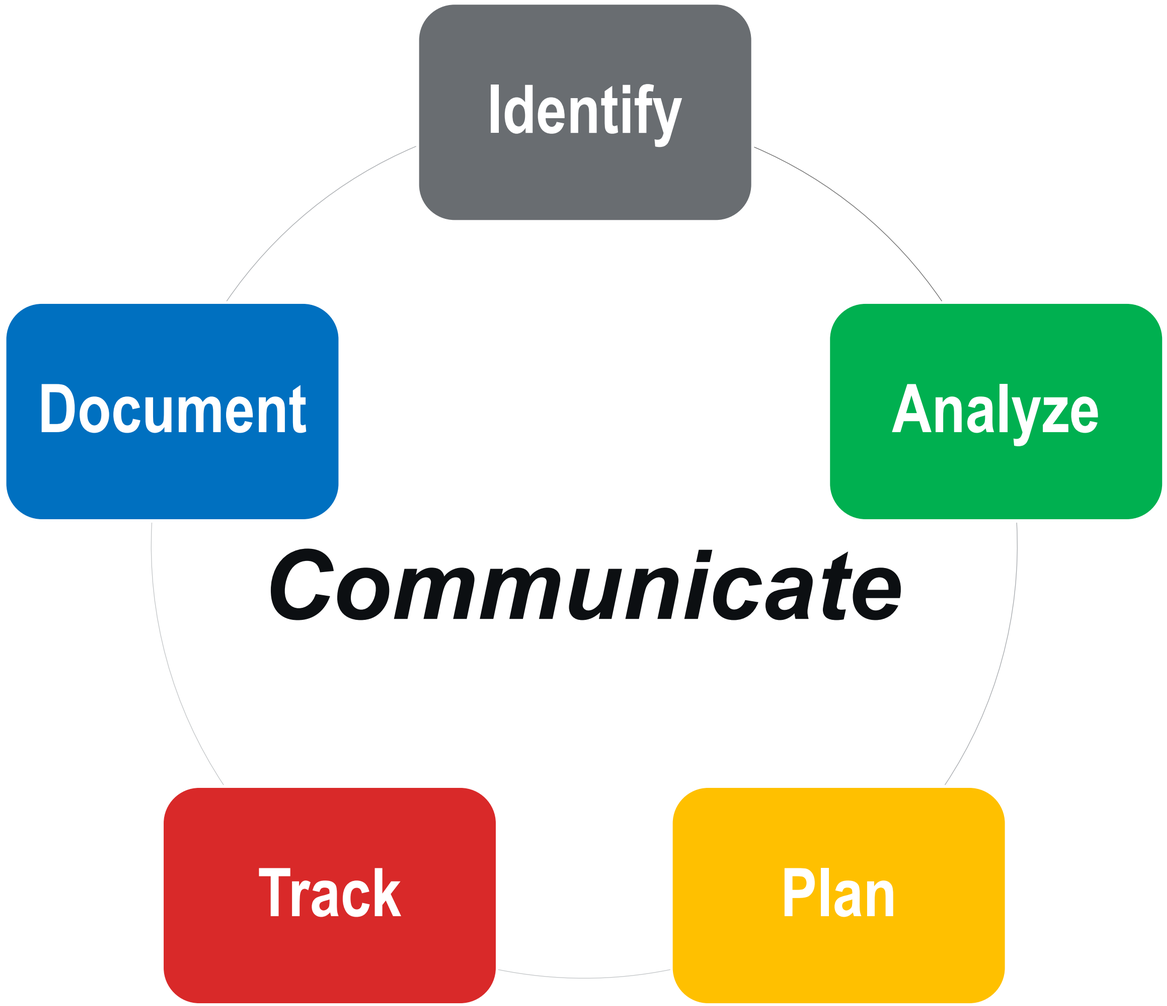
Company specific safety SOP

Develop a Risk Assessment



- Identify the hazards
- Decide who might be harmed & how
- Evaluate risks & decide on precautions
- Record significant findings
- Review assessment & update

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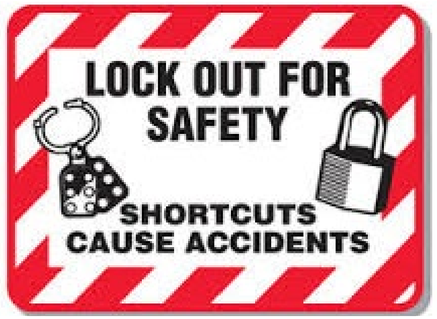
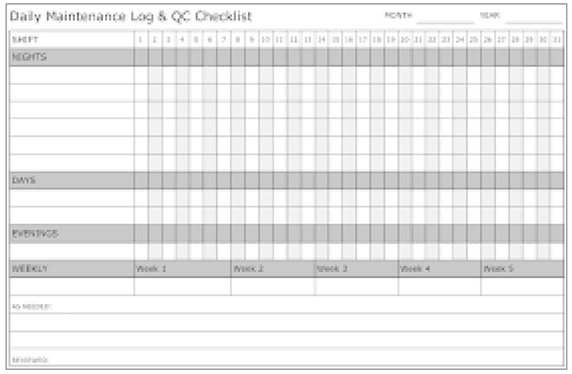
Company specific safety SOP



- Signage
- Manuals
- Personnel Training
- PPE
- Logs



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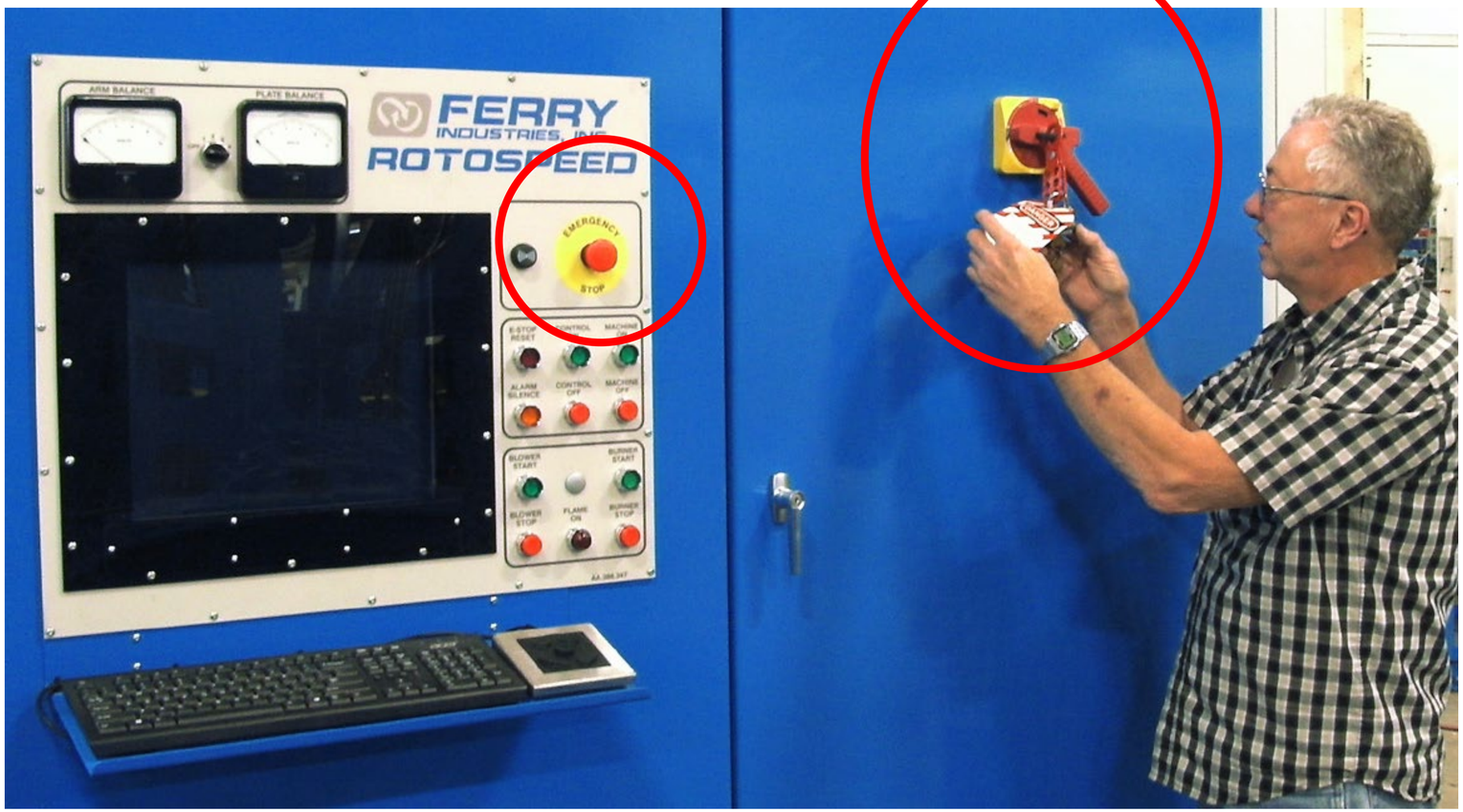
Lock-Out/Tag-Out Procedures

- State & Federal OSHA requirements
- Workers comp advisors
- Insurance company recommendations



- Daily/Weekly E-Stop system checks
- Posted LOTO procedures/training

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Visual Warnings

- Visual queue – caution & danger
- Painted floor areas
- Warning signage installed

Operator / Machine Interface

- Flashing light beacons and indicator towers
  - Indicate door open/close on oven or cooler
  - Carriage in motion
  - Cycle status
- Simultaneous audible alarm for door open/close on oven & cooler
- Doors stagger open /closing
- Load / Unload Stations - Operator push-hold button on podium to index carriages from station to station

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Restrict Access with Safety Fence

- OSHA & CE Rated – requiring tools for fence removal
- Safety rated electrical interlock on doors & gates
- Daily/Weekly verification of fence systems and door interlocks

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Restricted Access with Safety Fence

- Correct fence heights to inhibit access to pinch and crush points
- Relative low-cost solutions to inhibit unauthorized access

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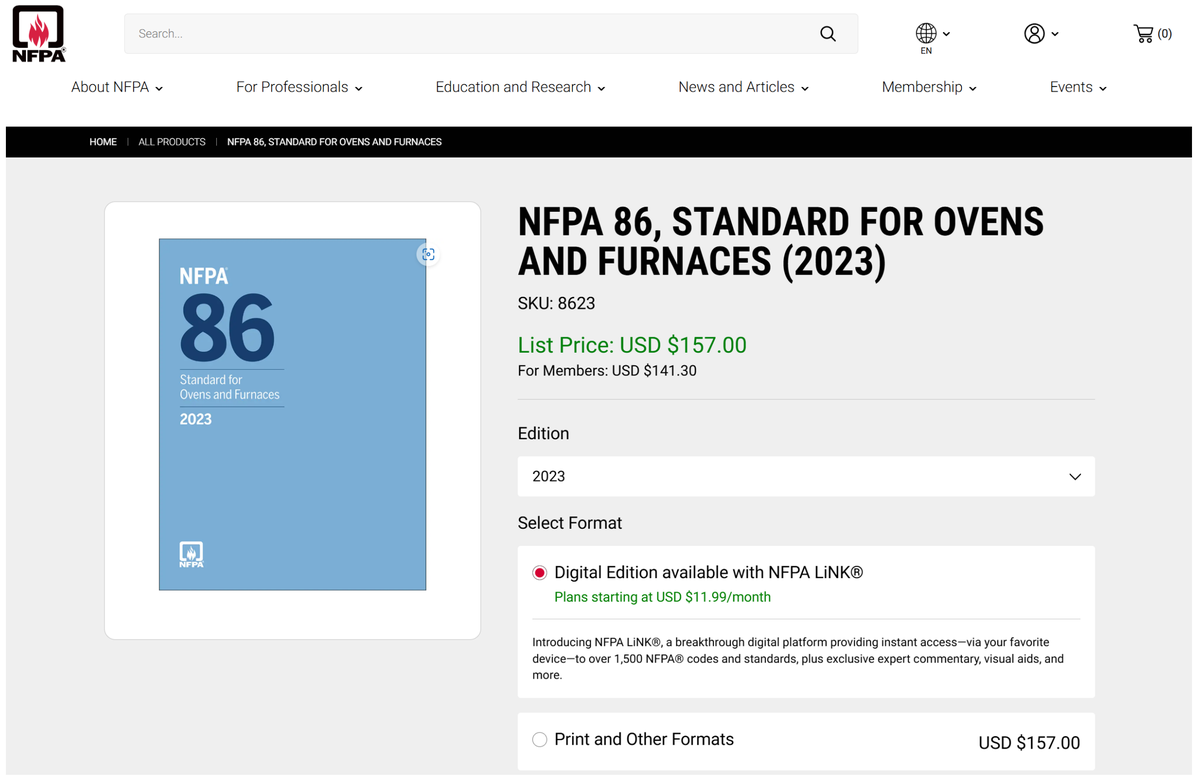
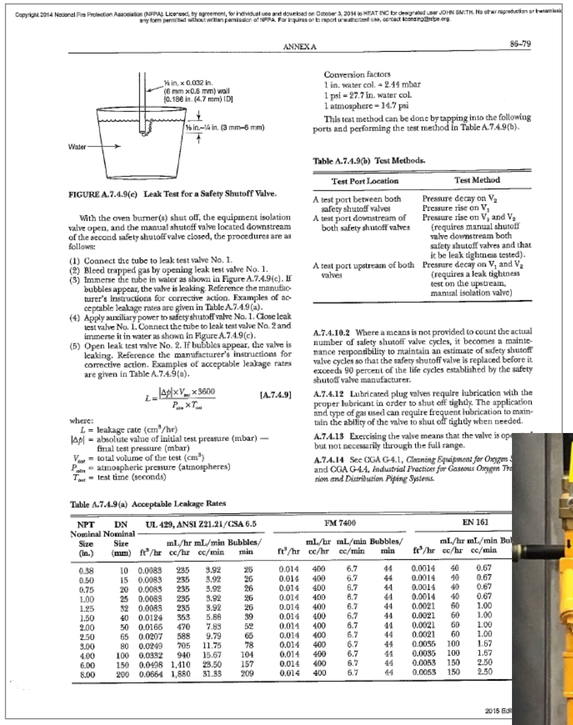
Oven & Burner Maintenance

- SAFETY – Employees & Property
- Improves and maintains machine up-time – higher productivity and profits
- Planned Maintenance vs. Forced Maintenance – Avoid “If it isn't broke, don’t fix it”
- Reference OEM and commercial part documentation
- Utilize PM schedule and practices based on findings & issues
- Create a maintenance log to record each PM event

Oven Safety – Burner gas train





ANNEX A 86–79

FIGURE A.7.4.9(c) Leak Test for a Safety Shutoff Valve.

With the oven burner(s) shut off, the equipment isolation valve open, and the manual shutoff valve located downstream of the second safety shutoff valve closed, the procedures are as follows:

(1) Connect the tube to leak test valve No. 1.
(2) Bleed trapped gas by opening leak test valve No. 1.
(3) Immerse the tube in water as shown in Figure A.7.4.9(c). If bubbles appear, the valve is leaking. Reference the manufacturer's instructions for corrective action. Examples of acceptable leakage rates are given in Table A.7.4.9(a).
(4) Apply auxiliary power to safety shutoff valve No. 1. Close leak test valve No. 1. Connect the tube to leak test valve No. 2 and immerse it in water as shown in Figure A.7.4.9(c).
(5) Open leak test valve No. 2. If bubbles appear, the valve is leaking. Reference the manufacturer's instructions for corrective action. Examples of acceptable leakage rates are given in Table A.7.4.9(a).

$$L = \frac{|\Delta p| \times V_{tot} \times 3600}{P_{atm} \times T_{tot}} \quad [A.7.4.9]$$

where:
L = leakage rate (cm^3/hr)
$|\Delta p|$ = absolute value of initial test pressure (mbar) — final test pressure (mbar)
V_{tot} = total volume of the test (cm^3)
P_{atm} = atmospheric pressure (atmospheres)
T_{tot} = test time (seconds)

Table A.7.4.9(a) Acceptable Leakage Rates

NPT Nominal Size (in.)	DN Nominal Size (mm)	UL 429, ANSI Z21.21/CSA 6.5 ft³/hr	mL/hr cc/hr	mL/min cc/min	Bubbles/ min	FM 7400 ft³/hr	mL/hr cc/hr	mL/min cc/min	Bubbles/ min	EN 161 ft³/hr	mL/hr cc/hr	mL/min cc/min	Bu
0.38	10	0.0083	235	3.92	26	0.014	400	6.7	44	0.0014	40	0.67	
0.50	15	0.0083	235	3.92	26	0.014	400	6.7	44	0.0014	40	0.67	
0.75	20	0.0083	235	3.92	26	0.014	400	6.7	44	0.0014	40	0.67	
1.00	25	0.0083	235	3.92	26	0.014	400	6.7	44	0.0014	40	0.67	
1.25	32	0.0083	235	3.92	26	0.014	400	6.7	44	0.0021	60	1.00	
1.50	40	0.0124	353	5.88	39	0.014	400	6.7	44	0.0021	60	1.00	
2.00	50	0.0165	470	7.83	52	0.014	400	6.7	44	0.0021	60	1.00	
2.50	65	0.0207	588	9.79	65	0.014	400	6.7	44	0.0021	60	1.00	
3.00	80	0.0249	705	11.75	78	0.014	400	6.7	44	0.0035	100	1.67	
4.00	100	0.0332	940	15.67	104	0.014	400	6.7	44	0.0035	100	1.67	
6.00	150	0.0498	1,410	23.50	157	0.014	400	6.7	44	0.0053	150	2.50	
8.00	200	0.0664	1,880	31.33	209	0.014	400	6.7	44	0.0053	150	2.50	

Conversion factors
1 in. water col. = 2.44 mbar
1 psi = 27.7 in. water col.
1 atmosphere = 14.7 psi

This test method can be done by tapping into the following ports and performing the test method in Table A.7.4.9(b).

Table A.7.4.9(b) Test Methods.

Test Port Location	Test Method
A test port between both safety shutoff valves	Pressure decay on V_2
A test port downstream of both safety shutoff valves	Pressure rise on V_1 Pressure rise on V_2 Pressure rise on V_1 and V_2 (requires manual shutoff valve downstream both safety shutoff valves and that it be leak tightness tested).
A test port upstream of both valves	Pressure decay on V_1 and V_2 (requires a leak tightness test on the upstream, manual isolation valve)

A.7.4.10.2 Where a means is not provided to count the actual number of safety shutoff valve cycles, it becomes a maintenance responsibility to maintain an estimate of safety shutoff valve cycles so that the safety shutoff valve is replaced before it exceeds 90 percent of the life cycles established by the safety shutoff valve manufacturers.

A.7.4.12 Lubricated plug valves require lubrication with the proper lubricant in order to shut off tightly. The application and type of gas used can require frequent lubrication to maintain the ability of the valve to shut off tightly when needed.

A.7.4.13 Exercising the valve means that the valve is op... but not necessarily through the full range.

A.7.4.14 See CGA G-4.1, *Cleaning Equipment for Oxygen S...* and CGA G-4.4, *Industrial Practices for Gaseous Oxygen Tra... tion and Distribution Piping Systems.*

2015 Edi...

NFPA 86 offers information about best practices and tests - e.g. the safety shut-off block valve seal bubble test

NFPA Audits can be performed to check recommended systems per the NFPA guidelines

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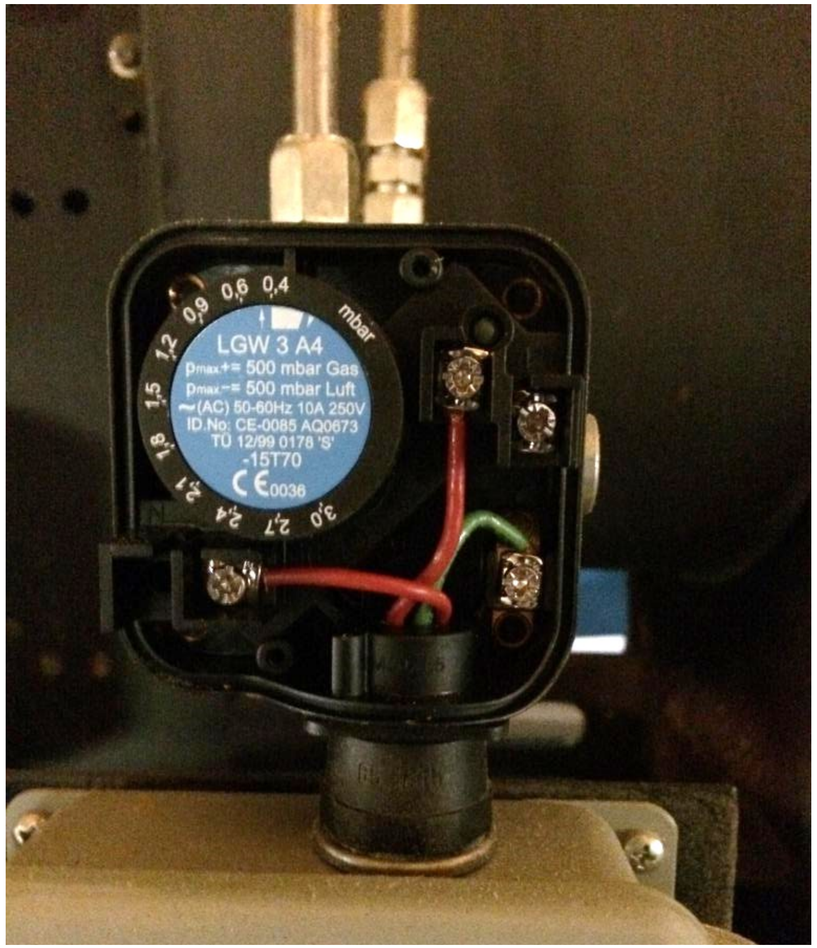
Oven Safety

Fan pressure and High/Low gas pressure switches



- ~6 locations: Oven exhaust fan, Oven Circulation Fan, Burner Combustion Fan, Gas piping manifold
- No jumper wires - <u>NEVER</u>
- Test switch performance and settings for flame relay safety circuit
- Record pressure switch settings in a maintenance log for reference at next service interval

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Oven Temperature Controllers

Test/Calibrate:

- **Oven thermocouples**
- **Oven over-temp protection circuit**
- **Temperature controllers for proper operations**

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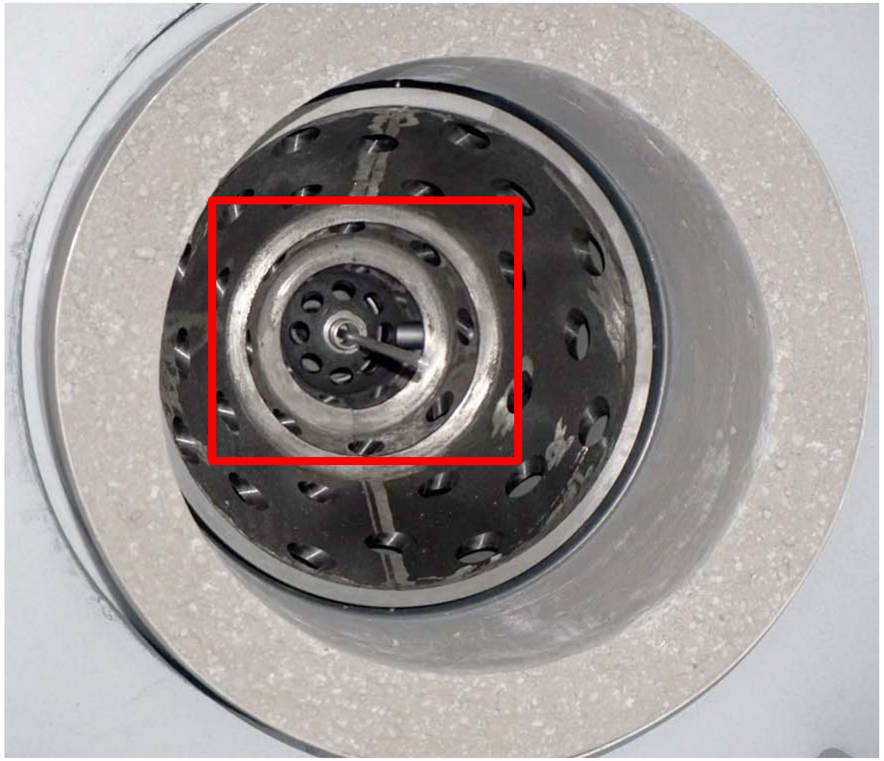
Burner Maintenance

- UV sensor – spare on-hand & clean lens and sight tube
- Test that burner shuts off if sensor removed

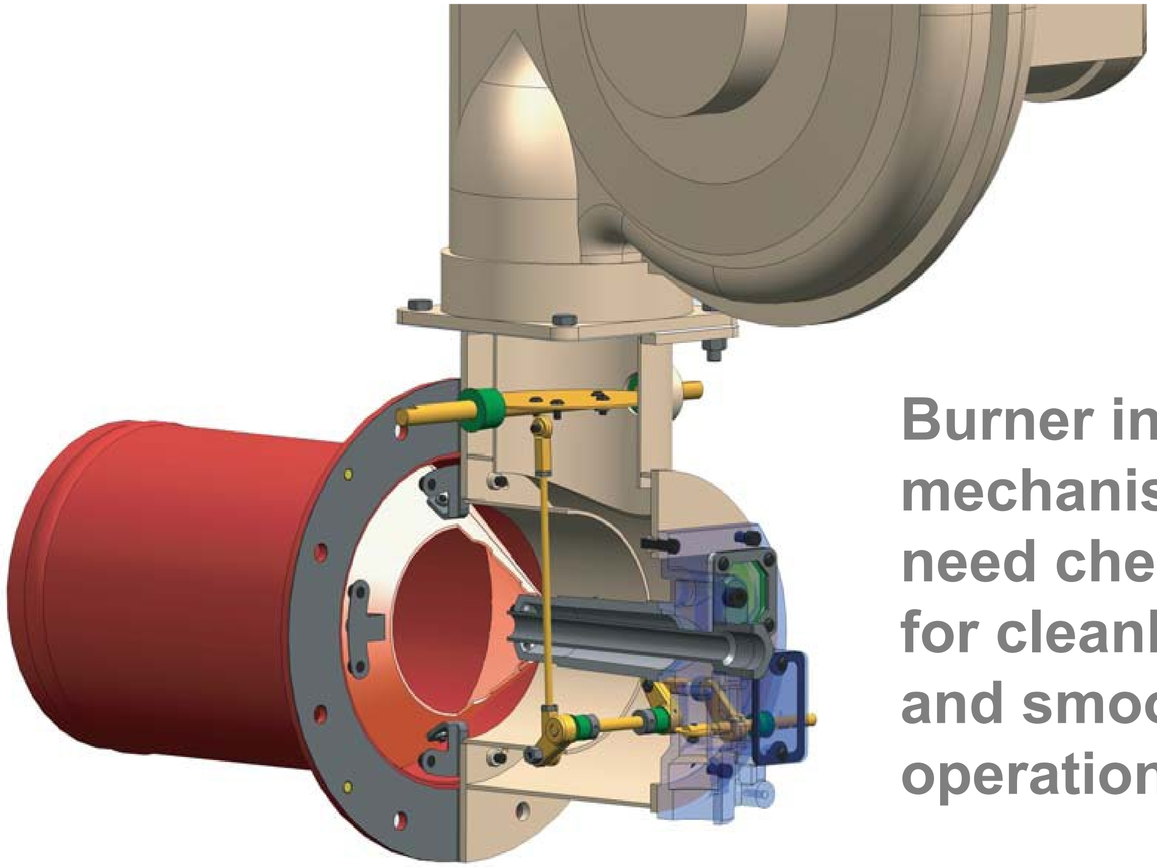


Flame rods

- fail-safe flame proving
- clean and set proper depth

Burner Maintenance

Oven Burner Fan Air Inlet



Burner internal mechanisms need checked for cleanliness and smooth operation

Clean burner combustion air fan intakes & impellers to ensure proper air flow – affects burner performance and output

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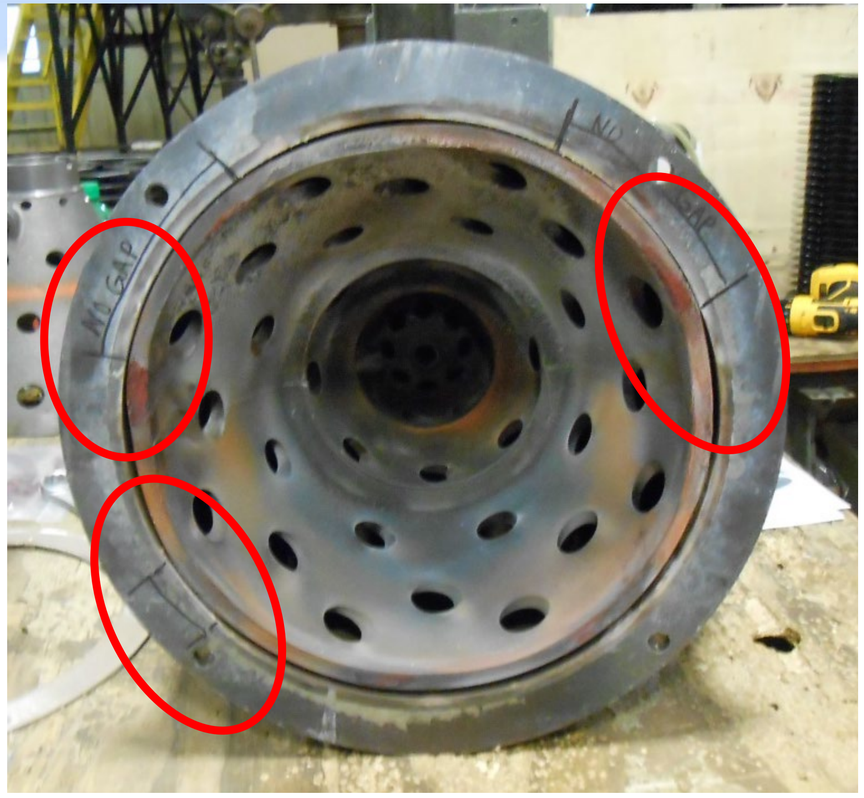
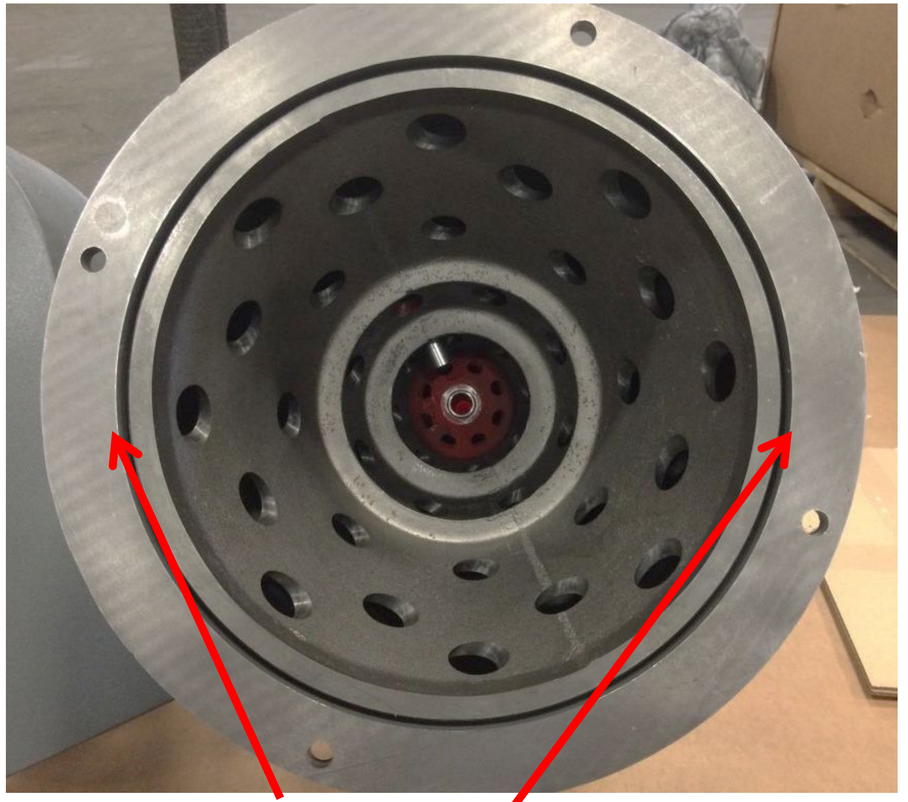
Burner Maintenance

Burner Mixing Cone



Watch for a warped or cracked mixing cone; can cause burner output and performance issues



Even gap between mixing cone OD and burner housing ID

Adjustment screws (4) – see Maxon documentation for your burner model for procedures

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Burner Maintenance – Discharge Sleeve

Check condition of gaskets, two different types depending on location/function.

Check condition of stainless-steel housing and ceramic core; replace if worn, melted and heavily cracked

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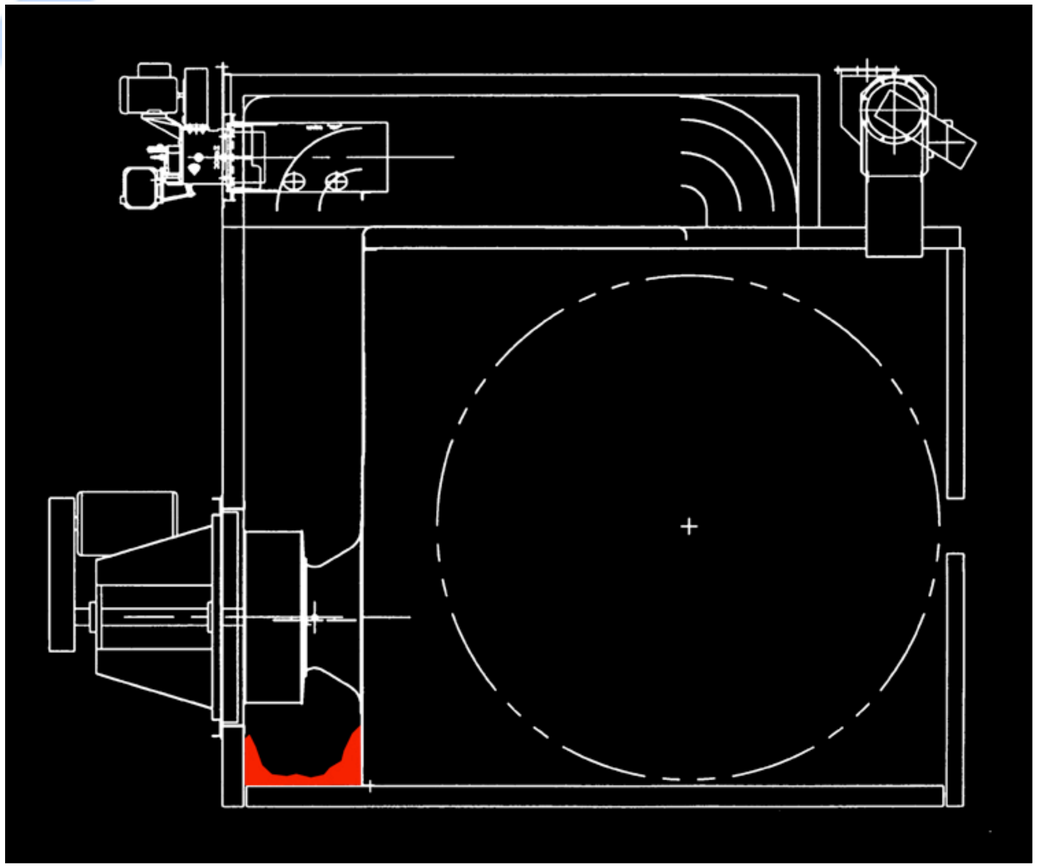
Oven Maintenance



Schedule periodic inspections for powder build-up & clean-outs
Inspect turning vanes, flame tube and burner box interior surfaces
Fan housing, impeller, shaft bearings and impeller shaft

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Oven Safety - Access Platform

Operator Stair Access to Burner & Oven Systems

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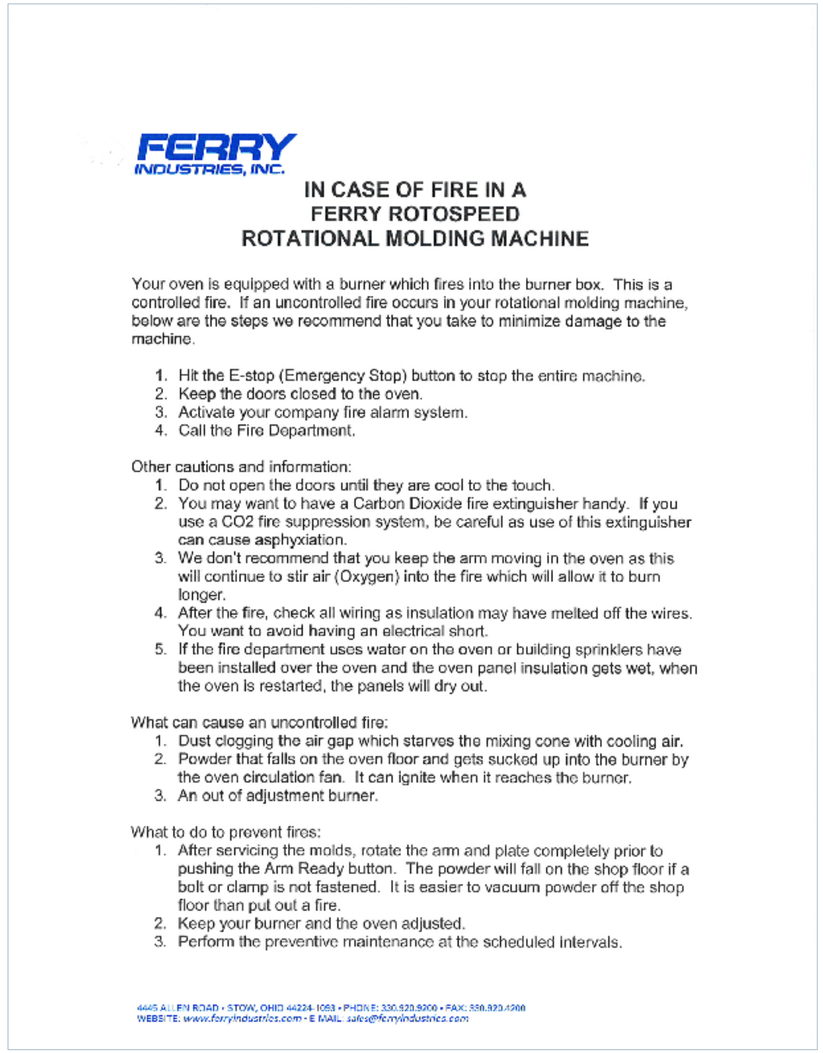
Oven Safety – Oven Fire

Procedures & Training

- Top-grade your oven cleanliness and housekeeping
- Proper mold maintenance – reduce/eliminate spillage of powder
- SOP & workforce training - Missing vents and vent filters
- Require arm turn-over prior to oven entry – manually or automatic
- SOP and workforce training
  - Actions to take when oven fire occurs
  - Verify mold clamping – manual or automatic clamps
  - Verify vents and vent filters
  - Required arm
  - Oven fire

- ARM Health & Safety Webinar Series – free to members



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IN CASE OF FIRE IN A FERRY ROTOSPEED ROTATIONAL MOLDING MACHINE

Your oven is equipped with a burner which fires into the burner box. This is a controlled fire. If an uncontrolled fire occurs in your rotational molding machine, below are the steps we recommend that you take to minimize damage to the machine.

1. Hit the E-stop (Emergency Stop) button to stop the entire machine.
2. Keep the doors closed to the oven.
3. Activate your company fire alarm system.
4. Call the Fire Department.

Other cautions and information:

1. Do not open the doors until they are cool to the touch.
2. You may want to have a Carbon Dioxide fire extinguisher handy. If you use a CO2 fire suppression system, be careful as use of this extinguisher can cause asphyxiation.
3. We don't recommend that you keep the arm moving in the oven as this will continue to stir air (Oxygen) into the fire which will allow it to burn longer.
4. After the fire, check all wiring as insulation may have melted off the wires. You want to avoid having an electrical short.
5. If the fire department uses water on the oven or building sprinklers have been installed over the oven and the oven panel insulation gets wet, when the oven is restarted, the panels will dry out.

What can cause an uncontrolled fire:

1. Dust clogging the air gap which starves the mixing cone with cooling air.
2. Powder that falls on the oven floor and gets sucked up into the burner by the oven circulation fan. It can ignite when it reaches the burner.
3. An out of adjustment burner.

What to do to prevent fires:

1. After servicing the molds, rotate the arm and plate completely prior to pushing the Arm Ready button. The powder will fall on the shop floor if a bolt or clamp is not fastened. It is easier to vacuum powder off the shop floor than put out a fire.
2. Keep your burner and the oven adjusted.
3. Perform the preventive maintenance at the scheduled intervals.

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Oven Safety – Fire Suppression

- Manual & Automatic Systems
- Stand-alone systems for oven interior fire suppression
- Third-party manufacturers + local authority/regulation codes and permitting will dictate requirements by application
- Some systems use water sprinklers, water spray/mist, carbon dioxide, foam extinguishers, or dry chemicals
- Recommend working directly with an SME/Licensed industrial oven fire suppression system supplier

PROTECTION SYSTEMS FROM firefly

ANSUL

MARIOFF

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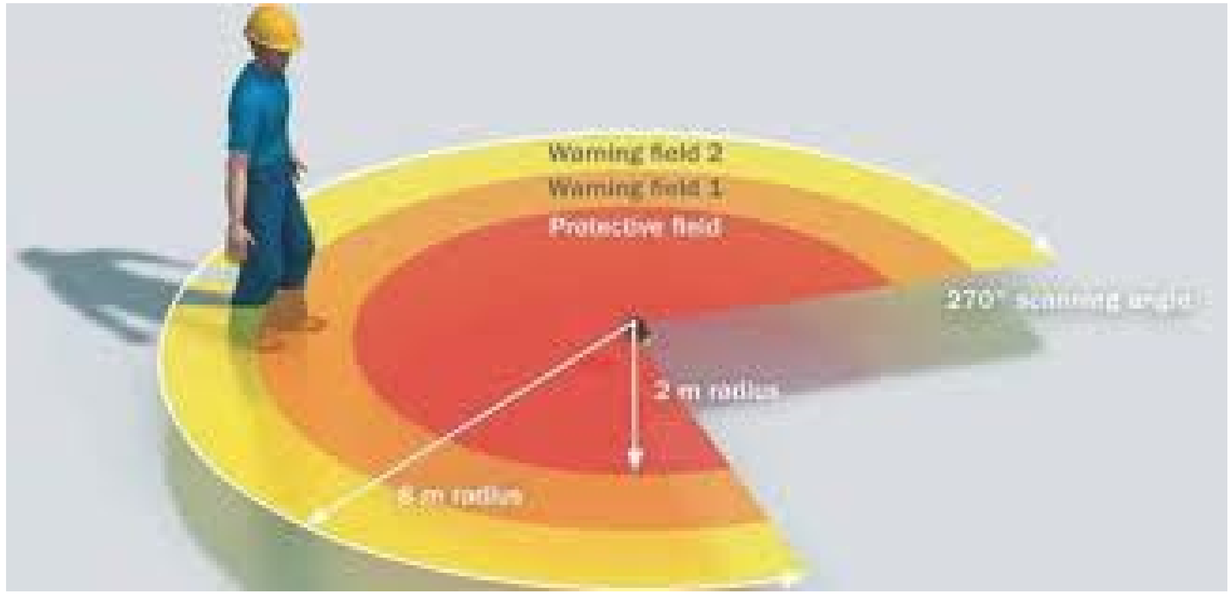
Safety-Rated Zone Sensors



Programmable Safety Rated Laser Scanners

Safety controller, Safe-Torque-Off Drives and Dual-contact switch systems

Irregular-shaped working zones

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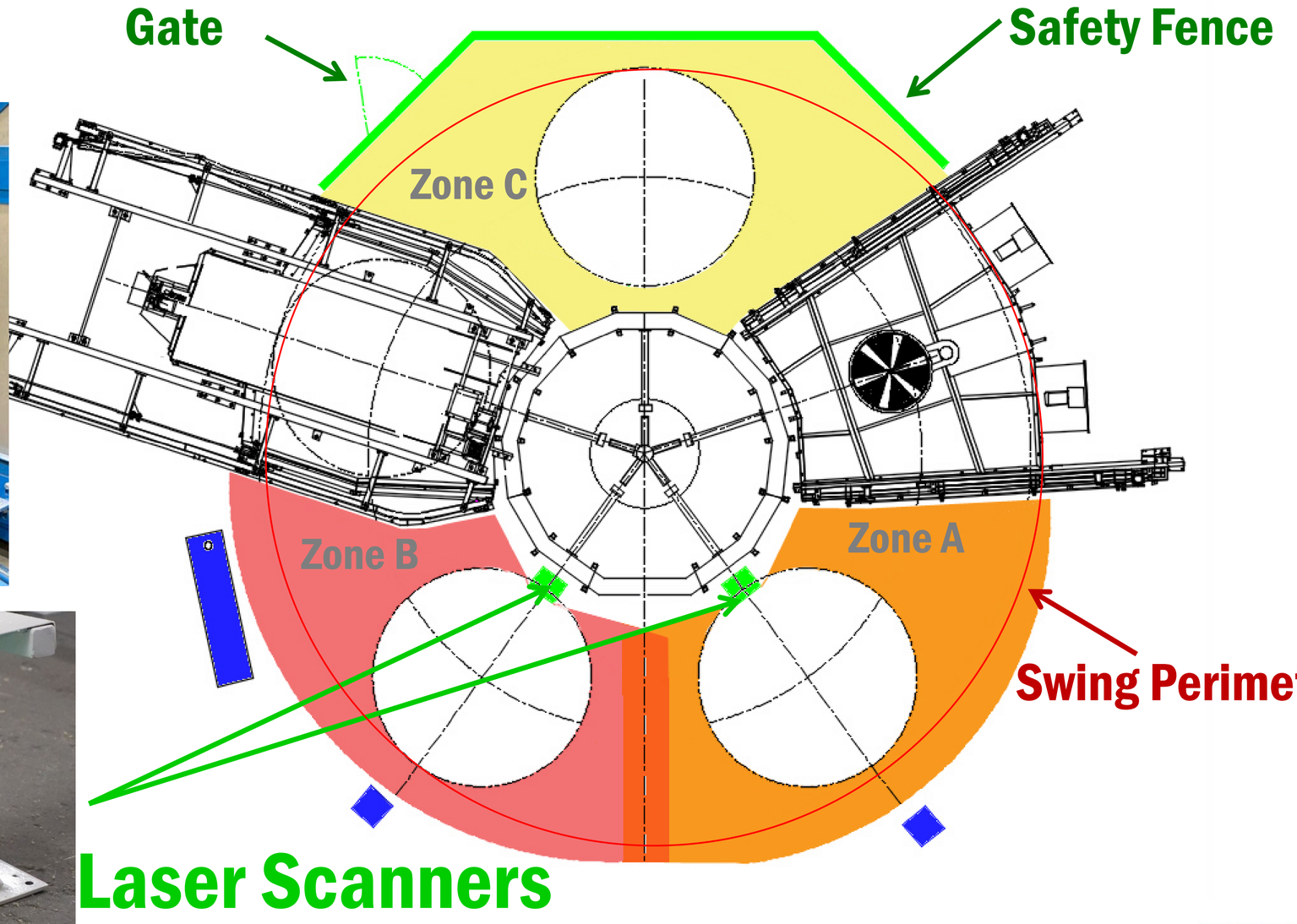
Safety-Rated Zone Sensors



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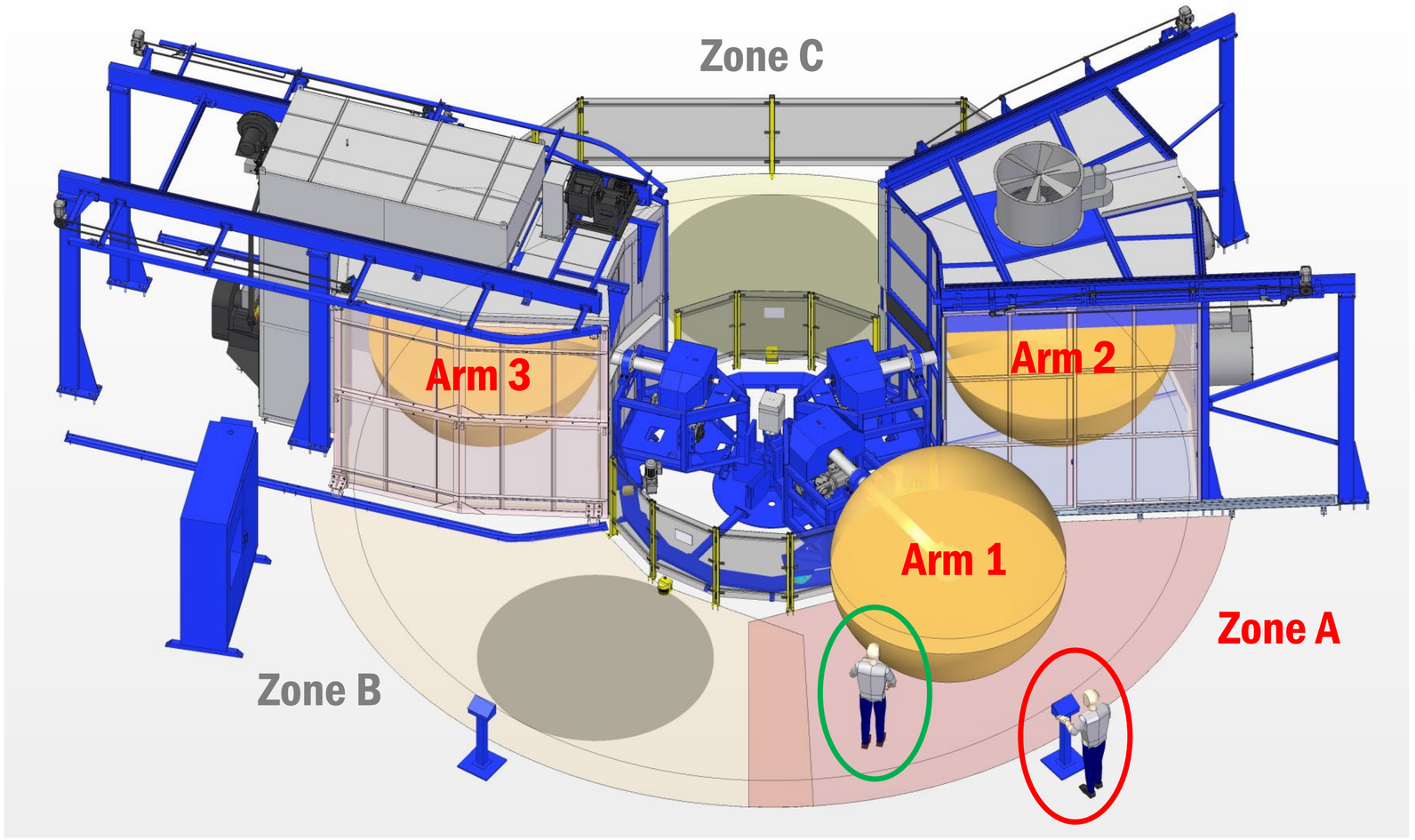
Safety-Rated Zone Sensors



Unload Station - Zone A Operation

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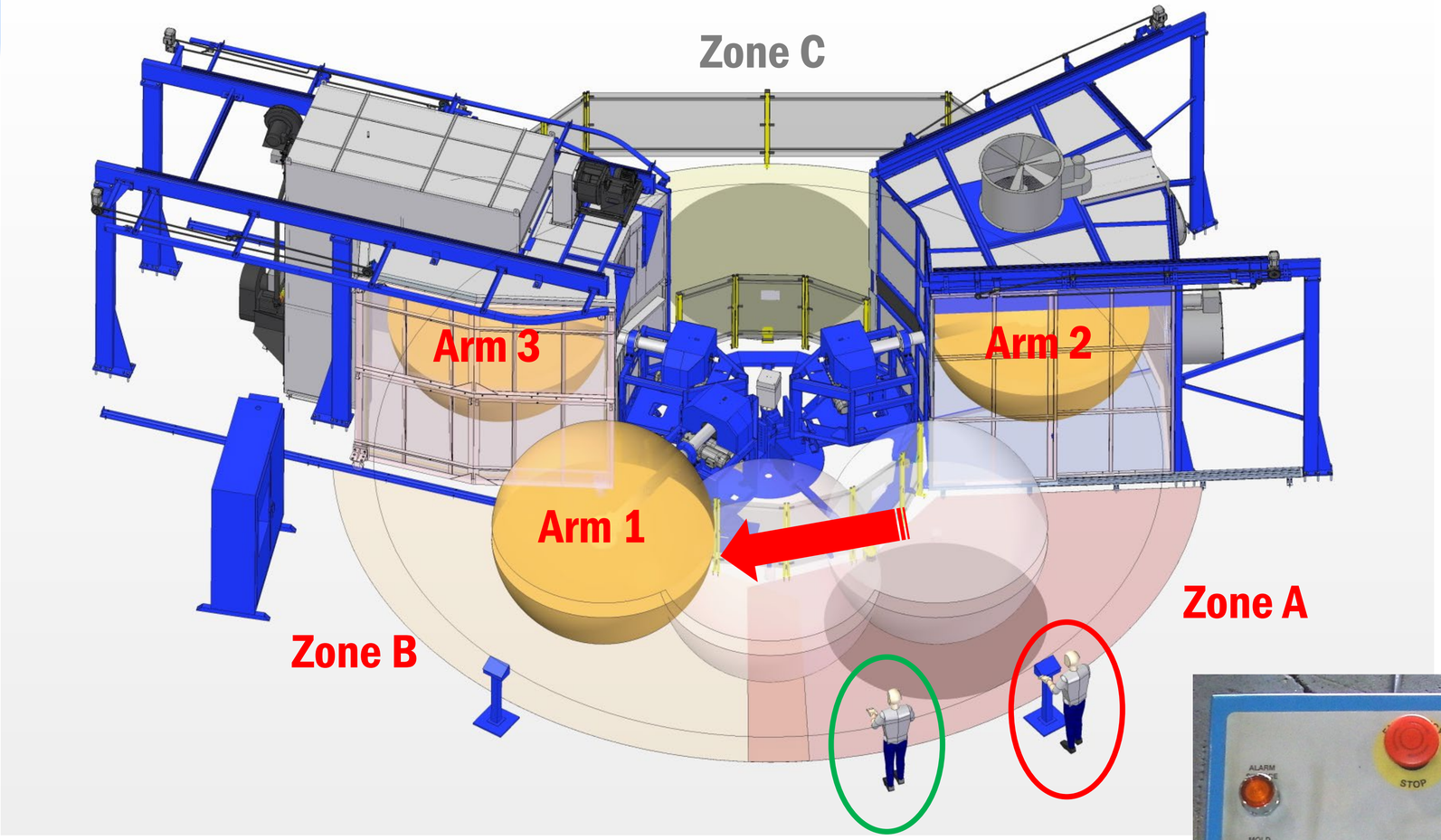
Safety-Rated Zone Sensors



Indexing Zone A to Zone B

1) Scanner Reset

2) Arm Ready Button, push/hold

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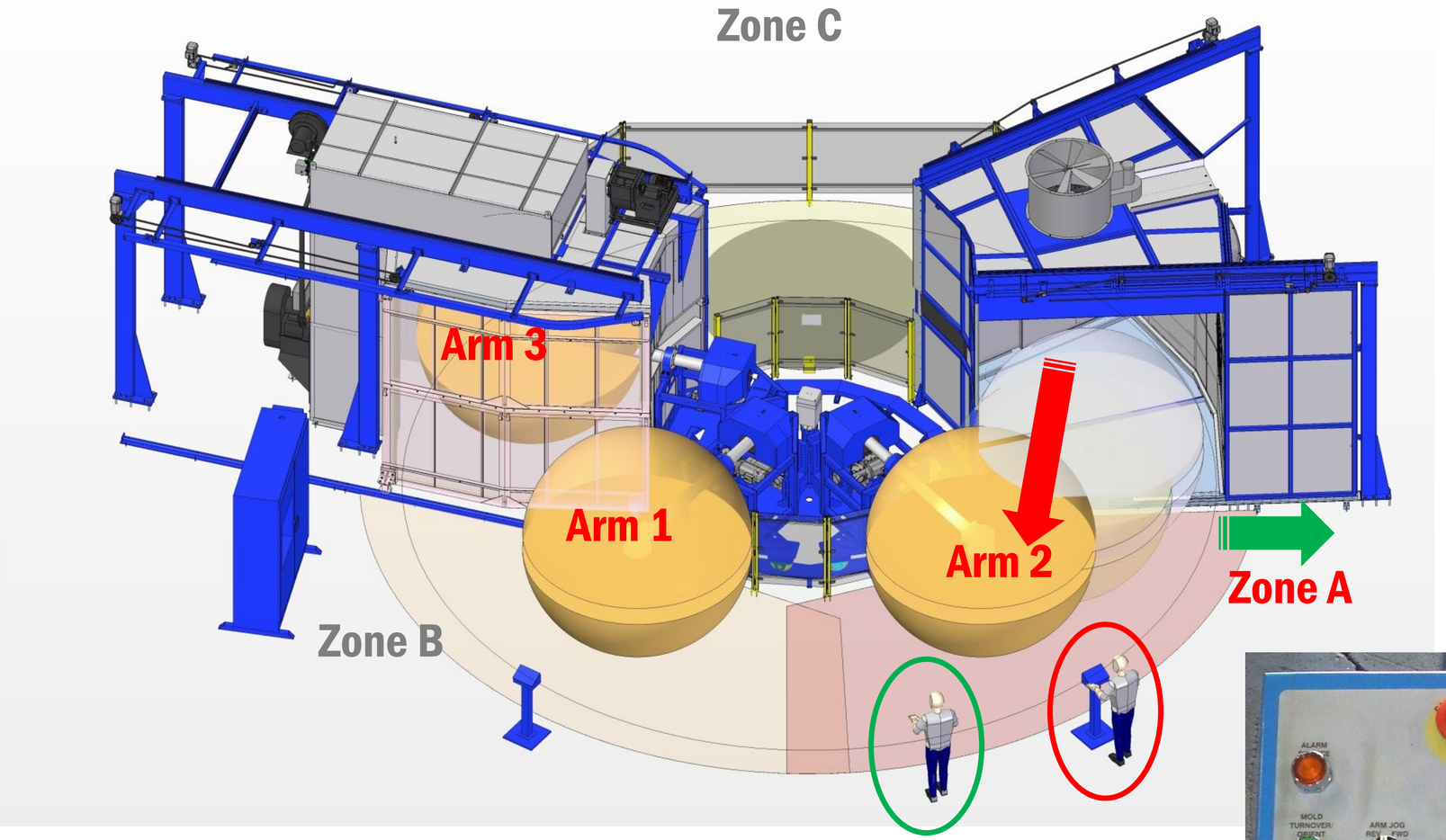
Safety-Rated Zone Sensors



Indexing Cooler to Zone A

Arm Ready Button, push/hold

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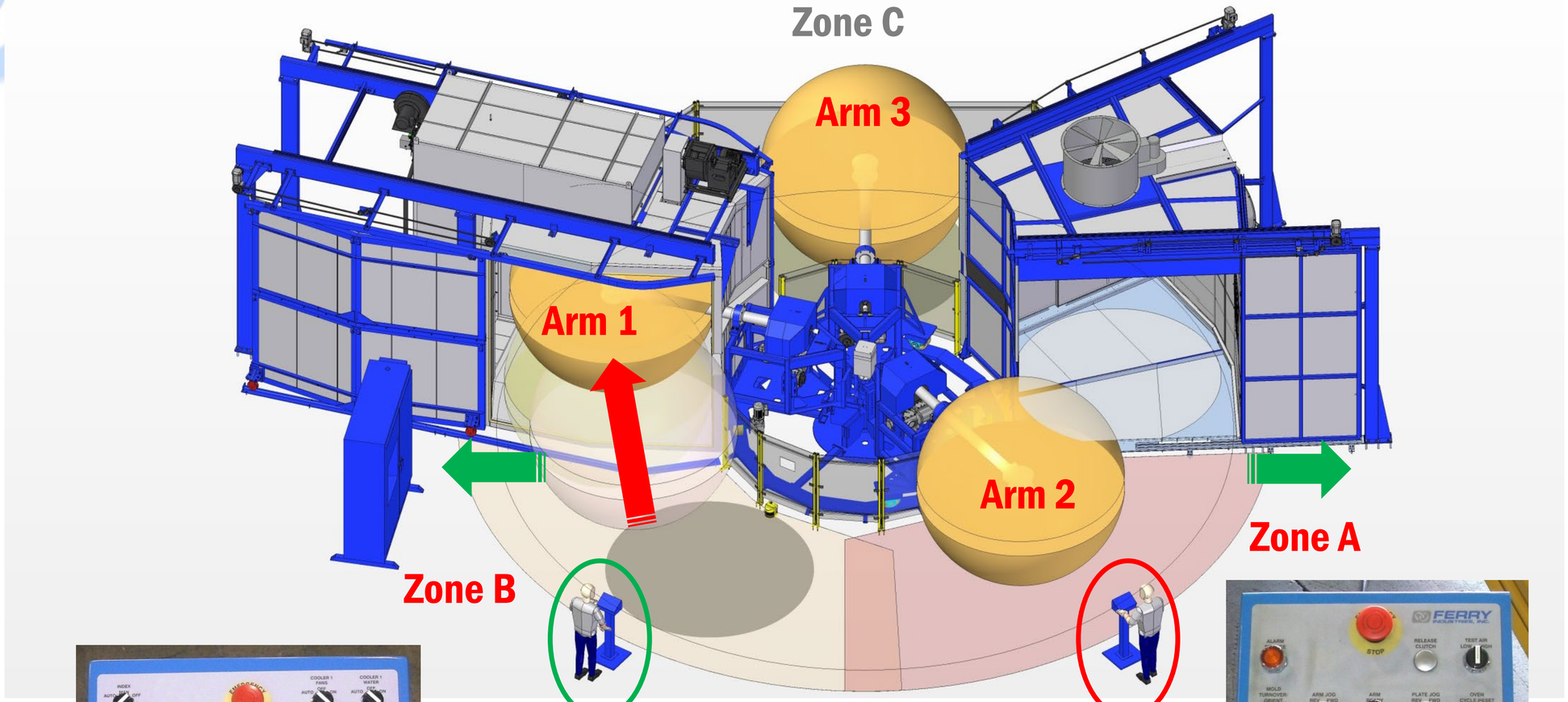
Safety-Rated Zone Sensors



Indexing Zone B to Oven

Indexing Cooler to Zone A

Arm Ready Button, push/hold

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Platform with Roll-over Safety Gate

- Operator ergonomics & productivity for mold servicing
- May reduce or eliminate operator fall protection requirements
- Safety interlocked to the machine function
- 360˚ Railings reduce risk of operators from stepping off platform

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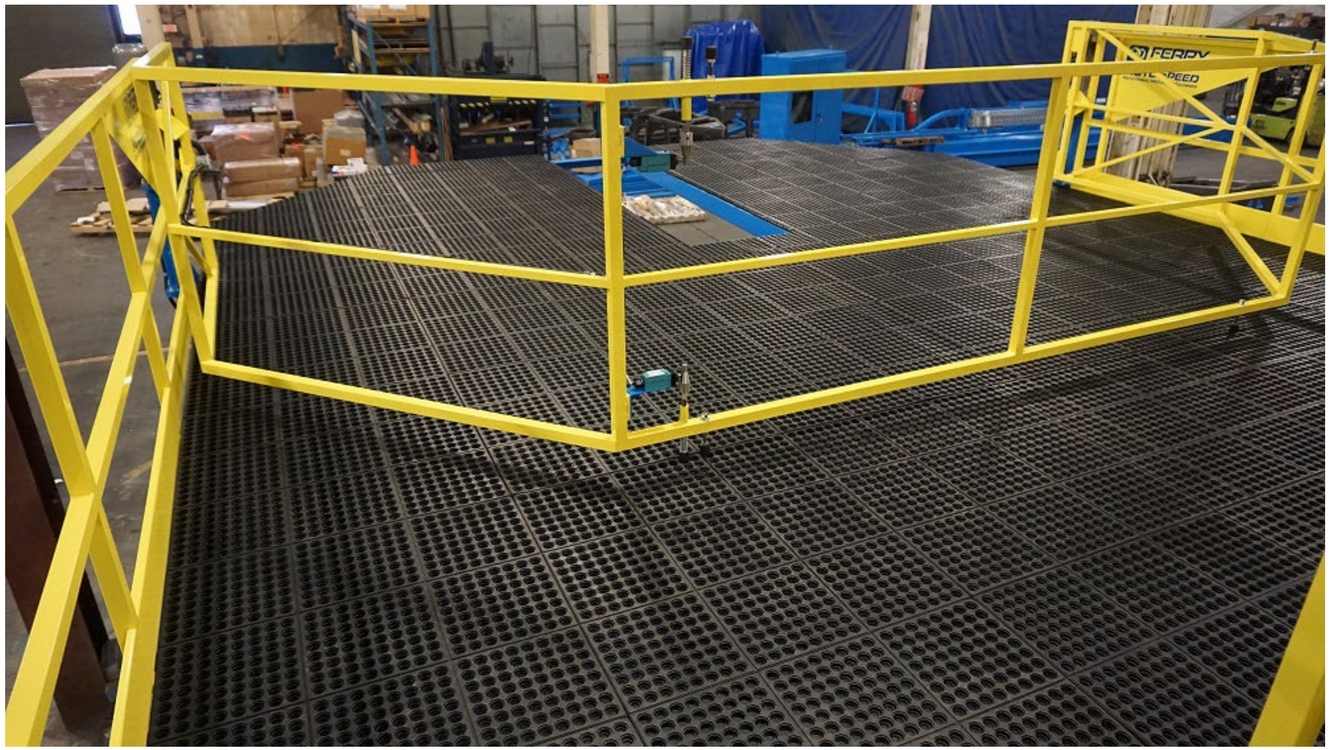
Operator Work Platform

Perforated anti-skid, anti-fatigue mats



Non-Slip Coating & Safety Zone Graphic

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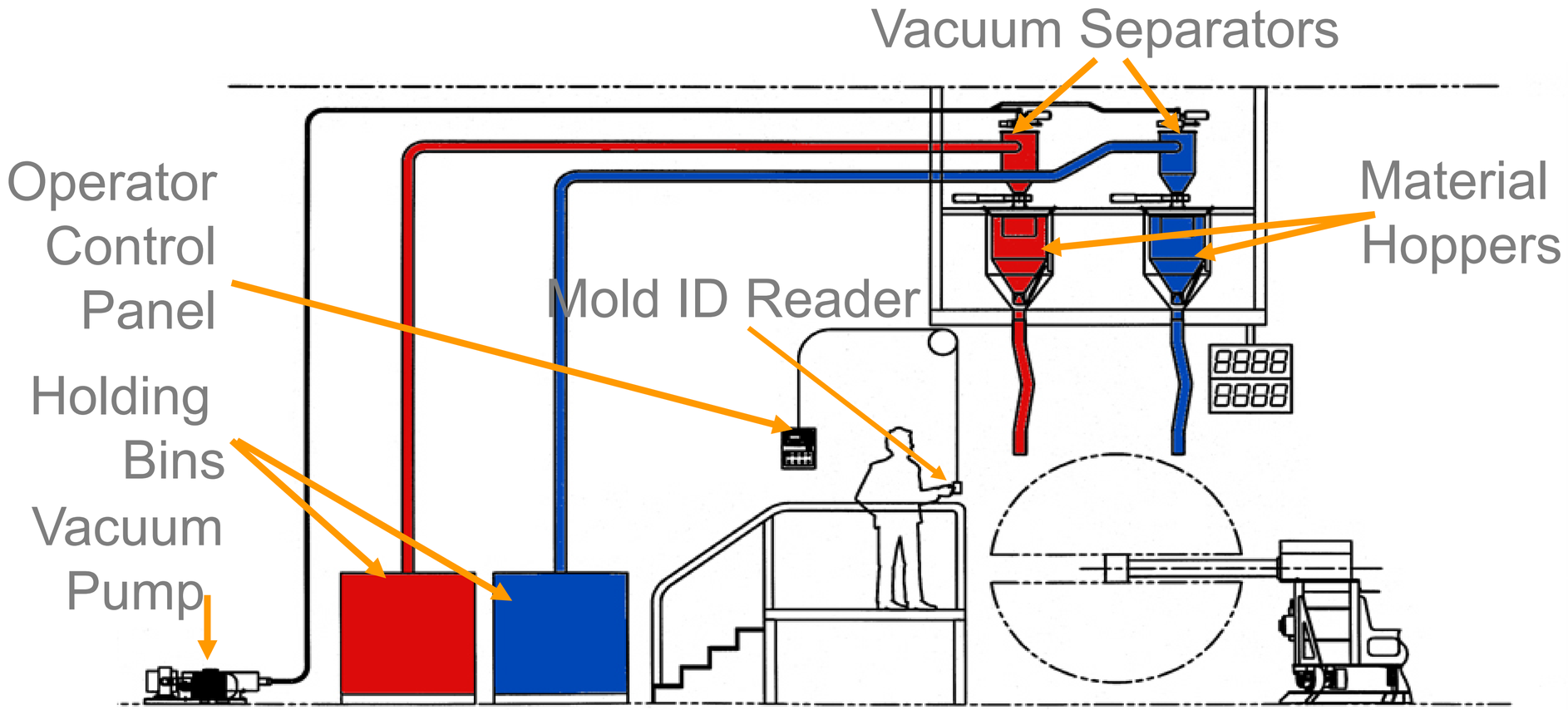
Powder Conveyance & Dispensing Systems

Use Dispensing systems to:

- Reduce operators slips/falls from powder spills
- Mitigate employee injuries from strains – hauling powder buckets, bending and twisting



ROTO LOAD

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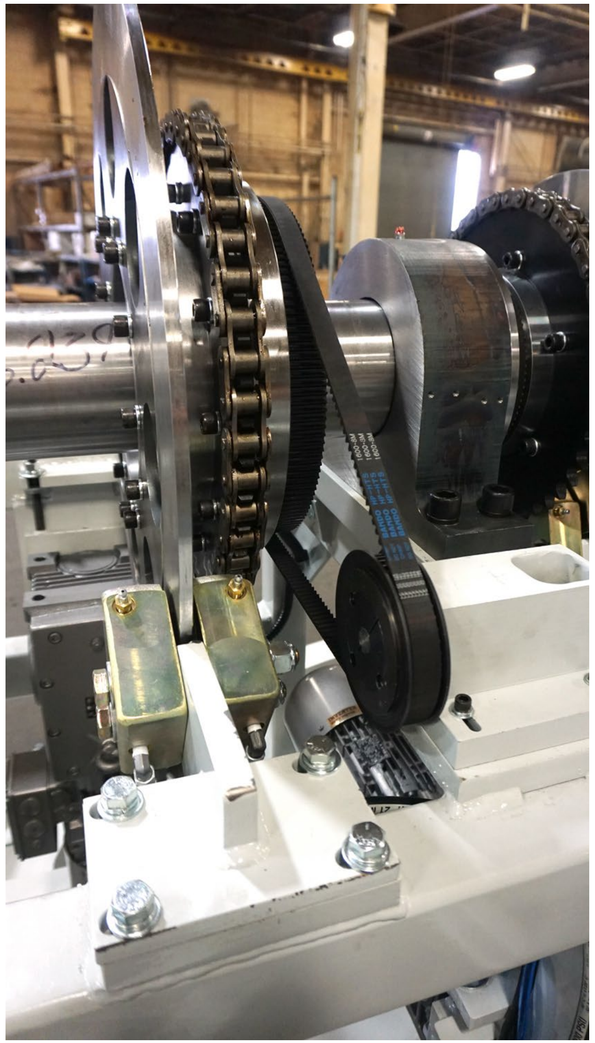
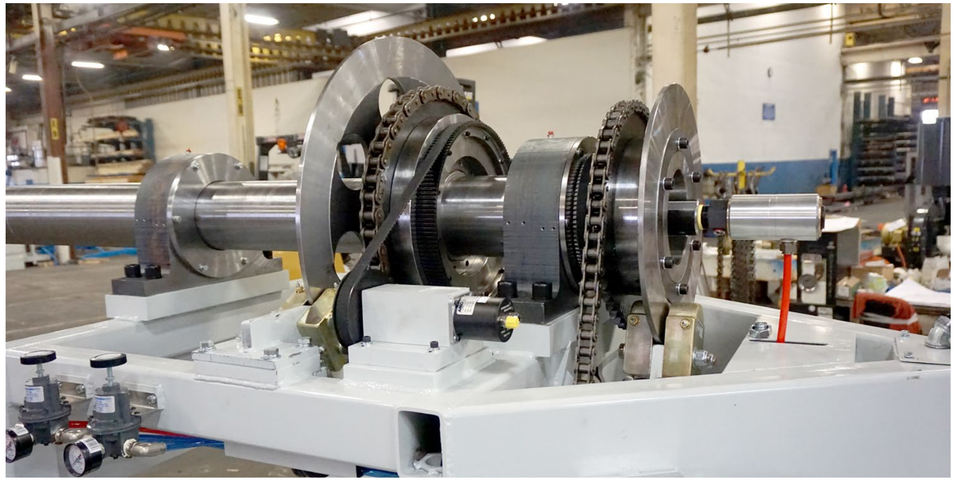
Brake & Position Systems

Arm/Plate/Cart Brake Hold & Positioning

- Hold arm/plate axis independent of gearmotor & chain mechanicals
- Redundant brake system
- Aids service station automation integration – accurate positioning
- Enhances safety for personnel/equipment in service





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Engineered For Safety

- Safety is a continuous improvement process
- Preventative maintenance may avert risk to personnel and property - an ounce of prevention is worth a pound of cure
- Routine assessments of work cell risks and actions taken builds trust and positive results with stakeholders

Thank You

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www.ferryindustries.com

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