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Horinzontal plastic injection molding machine: Safety checklist

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HORIZONTAL PLASTIC INJECTION MOLDING MACHINE

SAFETY CHECKLISTS

RG-687



SAFETY CHECKLISTS

This document has been developed to support companies in the plastics processing industry in their efforts to prevent accidents involving horizontal plastic injection molding machines. It can also serve as a basic document in the training offered to the personnel in these companies and to students in plastics processing. However, it does not allow a risk analysis to be done to determine the limits, to identify hazards, and to estimate the risk; in these cases, appropriate standards must be consulted. Users of this document must have knowledge about horizontal plastic injection molding machines in general, and the ones that they use in particular.

Practical safety checklists make up the core of this document, namely a general checklist on the safeguarding of machines, and a specific checklist for those individuals who perform various tasks on these machines, such as production, tuning, maintenance. These checklists essentially refer to sections of ANSI/SPI B151.1 – 2007 standard (see reference 1), which are indicated for consultation purposes.

The components of a horizontal plastic injection molding machine and the safeguards against its inherent risks are also presented to facilitate the use of the checklists.

These risks can lead to serious, and even fatal, injuries. The following tables present the main harm that can be associated with the hazard zones of the **mold closing unit** and **injection unit** of these machines.

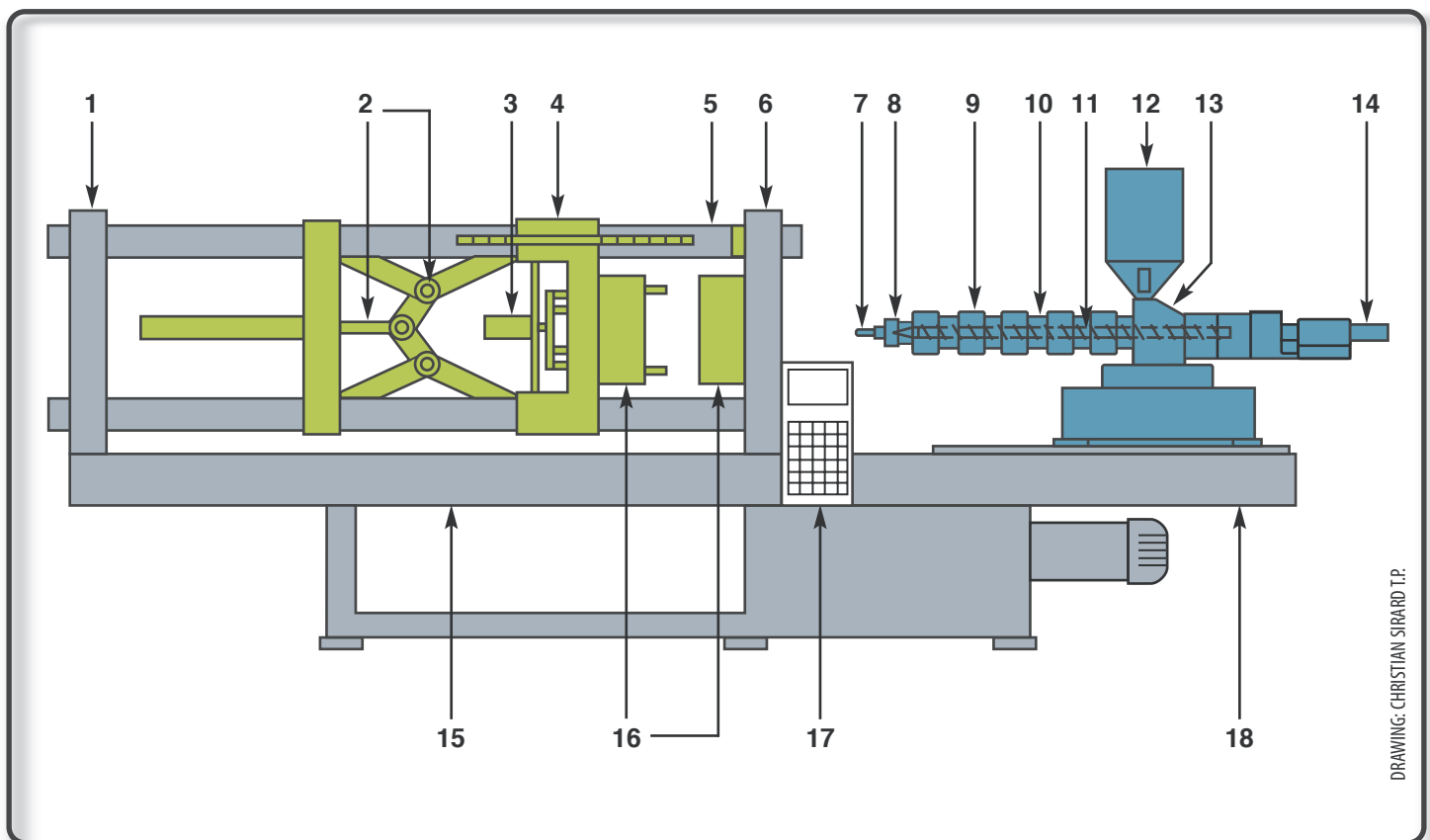


MOLD CLOSING UNIT	
HAZARD ZONES	POSSIBLE HARM
MOLD AREA (mold opening and closing movements, movement of ejectors)	<ul style="list-style-type: none"> • Burns • Injury due to expelled material (e.g., fragments from an improperly installed mold) • Shearing • Impact • Crushing • Death
CLOSING MECHANISM (shearing and pinch points on the sides and behind the movable platen)	<ul style="list-style-type: none"> • Shearing • Impact • Crushing

INJECTION UNIT	
HAZARD ZONES	POSSIBLE HARM
NOZZLE AREA	<ul style="list-style-type: none"> • Burns • Injury due to expelled material • Intoxication by the vapours emitted from the hot plastic • Crushing • Shearing
SCREW AREA (screw, feed throat leading to an access to the screw, vent on the plasticizing unit, injection barrel)	<ul style="list-style-type: none"> • Burns • Intoxication by the vapours emitted from the hot plastic • Winding around the screw • Shearing • Crushing • Death

FIGURE 1

1. Backing platen
2. Closing mechanism - Toggle lever and cylinder
3. Ejector
4. Movable platen (Floating platen)
5. Tie bar
6. Fixed platen
7. Nozzle
8. Barrel head
9. Heater band
10. Injection barrel (Transfer chamber)
11. Screw
12. Feed hopper
13. Feed throat
14. Screw motor
15. Parts discharge opening
16. Mold
17. Digital control panel
18. Frame

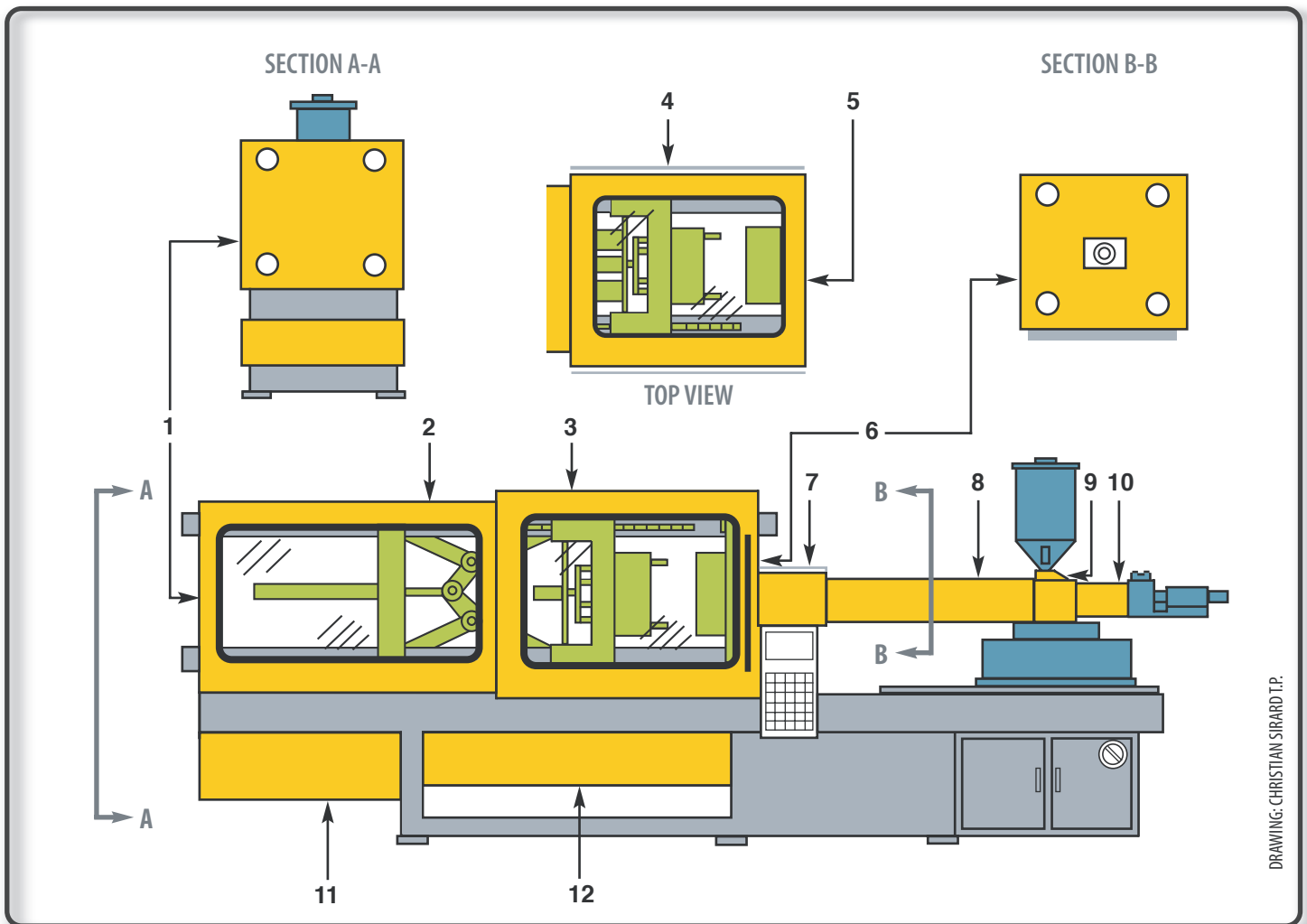


DRAWING: CHRISTIAN SIRARD T.P.

FIGURE 2

1. Guard at the end of the closing mechanism (section A-A)
2. Guard for the closing mechanism
3. Mold area guard (operator side)
4. Guard opposite the operator side
5. Top guard
6. Guard at the end of mold area (section B-B)
7. Purge splash guard
8. Injection barrel guard
9. Feed throat casing
10. Screw coupling guard
11. Guard under the closing mechanism
12. Guard (or conveyor or chute) for the parts discharge opening

NOTE: Guard 4 is installed on the machine, opposite guard 3, and may resemble it.



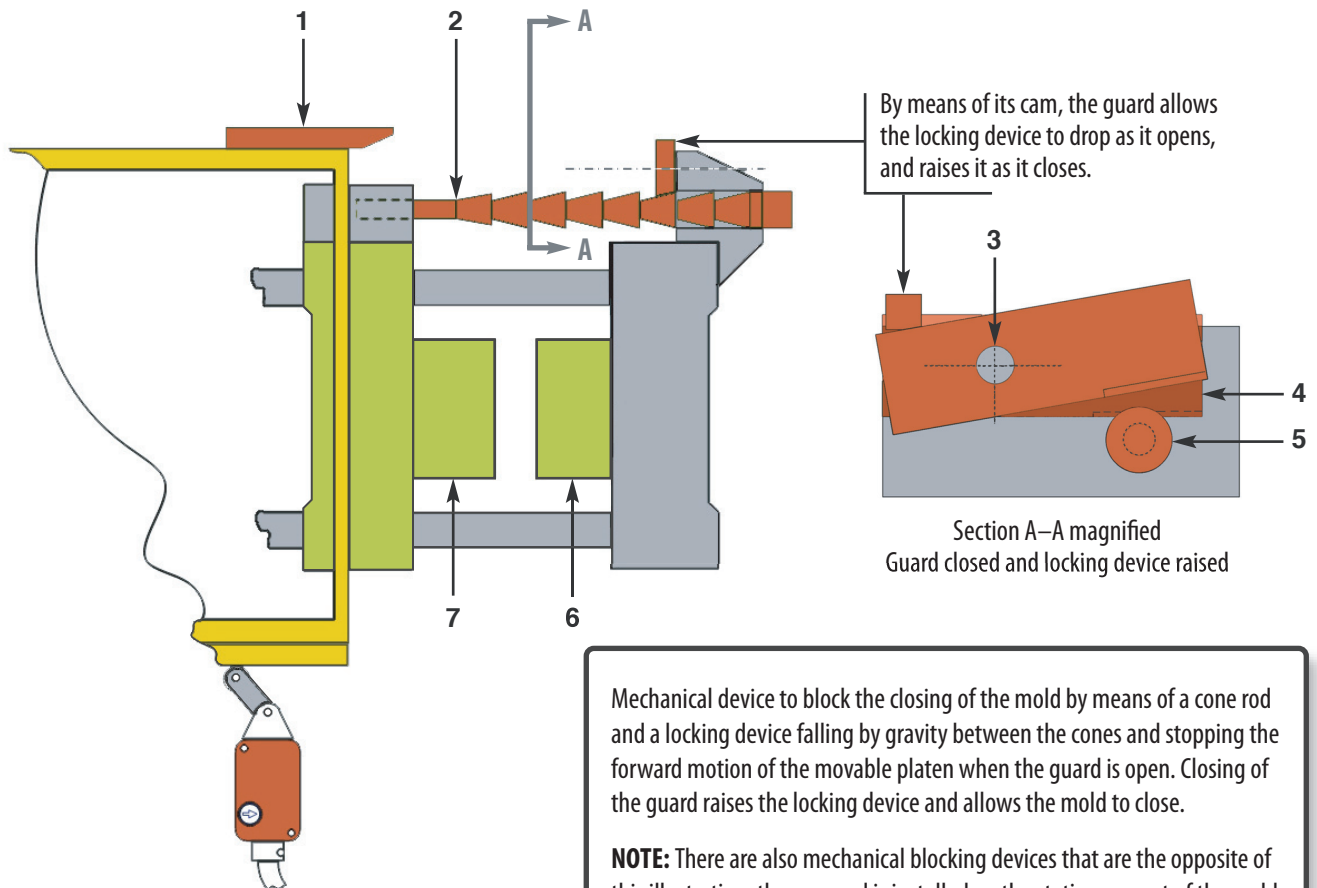
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FIGURE 3

EXAMPLE OF BLOCKING MECHANISM FOR THE MOVABLE PLATEN WHEN THE MOLD AREA GUARD (OPERATOR SIDE) IS OPEN

Different protective devices are installed on guards such as the mold area guard. Their state allows the relevant parts of the machine to operate or not. Position switches and hydraulic or pneumatic valves are examples of protective devices (see reference 2 to learn about their safe installation). In the mold area, the blocking mechanism for the movable platen is also a protective device, as illustrated below.

1. Cam connected to the guard
2. Cone rod attached to the mobile mold
3. Locking device pivot
4. Lowered locking device (open guard)
5. Cone rod
6. Stationary part of mold
7. Mobile part of mold



Mechanical device to block the closing of the mold by means of a cone rod and a locking device falling by gravity between the cones and stopping the forward motion of the movable platen when the guard is open. Closing of the guard raises the locking device and allows the mold to close.

NOTE: There are also mechanical blocking devices that are the opposite of this illustration: the cone rod is installed on the stationary part of the mold, with the locking device falling on the mobile part.

SAFEGUARD CHECKLIST

CHECKLISTS

Each machine must be subjected to verifications using the following checklists.
“Yes” answers to the statements on the checklists are synonymous with compliance with the standard. “No” answers imply that the machine must be repaired or stopped.

The general checklist for verifying the safeguarding of the horizontal injection molding machine is intended primarily for the person in charge of start-up of the machine.

Checklist completed by: _____

Signature: _____

Date (MM/DD/YYYY): _____

Horizontal plastic injection molding machine: _____
 (identification number or make, model and year of manufacture)

Submitted to: _____




SAFEGUARDING OF THE MOLD CLOSING UNIT

ACCESS TO
THE MOLD
FROM THE
OPERATOR
SIDE

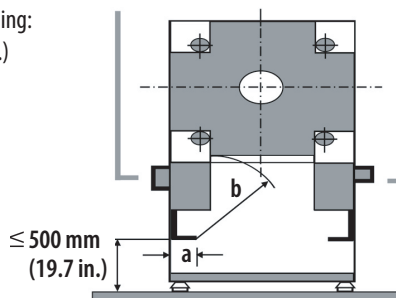
N°		YES	NO
MOLD AREA GUARD (FIGURE 2) WITH INTERLOCKING OR BLOCKING DEVICE (FIGURE 3)			
1.	This guard protects the operator from ejector movements. (For more information on the installation of interlocks, see reference 2.) (sec. 9.2.1)	<input type="checkbox"/>	<input type="checkbox"/>
2.	This guard protects the operator from mold closing and opening. (sec. 9.2.1)	<input type="checkbox"/>	<input type="checkbox"/>
3.	This guard protects the operator from hot plastic expelled during production. (sec. 9.2.1)	<input type="checkbox"/>	<input type="checkbox"/>
4.	This guard must be closed for the machine to operate. (sec. 9.2.1)	<input type="checkbox"/>	<input type="checkbox"/>
CASE WHERE THE MOLD AREA GUARD IS A POWER-OPERATED GATE			
5.	The guard operates in such a way as not to injure the operator when it closes (e.g.: presence of a pressure sensitive switch). (sec. 9.2.1.1)	<input type="checkbox"/>	<input type="checkbox"/>
6.	Closure of the guard does not initiate an operation cycle (unless it is synchronized with a robot). (sec. 9.2.1.1)	<input type="checkbox"/>	<input type="checkbox"/>
CASE OF A MECHANICAL BLOCKING DEVICE (FIGURE 3)			
7.	This device prevents the platens from closing when the mold area guard is sufficiently open to allow access. (sec. 9.2.3)	<input type="checkbox"/>	<input type="checkbox"/>



**ACCESS TO
THE MOLD
FROM THE
OPERATOR
SIDE**

N°		YES	NO
CASE OF AN INDEPENDENT HYDRAULIC OR PNEUMATIC INTERLOCK (PLATEN MOVED BY HYDRAULIC OR PNEUMATIC ENERGY)			
8.	This device prevents the platens from closing when the mold area guard is sufficiently open to allow access. (sec. 9.2.4)	<input type="checkbox"/>	<input type="checkbox"/>
CASE OF AN ELECTRICAL INTERLOCK			
9.	This device prevents the machine mechanism from moving when the mold area guard is sufficiently open to allow access. (sec. 9.2.2)	<input type="checkbox"/>	<input type="checkbox"/>
10.	This device is protected against accidental actuation, such as involuntary bypassing of the device (see reference 2). (sec. 9.2.2)	<input type="checkbox"/>	<input type="checkbox"/>
11.	If the machine is powered by an energy other than hydraulic or pneumatic, an additional independent interlock device is present. (sec. 9.2.2)	<input type="checkbox"/>	<input type="checkbox"/>
12.	When the blocking mechanism is a bar that fulfills its function only at the maximum opening point according to the current production (set point), the electrical interlock allows the platen opening movement to continue up to the set point so that the blocking mechanism engages. (sec. 9.2.2)	<input type="checkbox"/>	<input type="checkbox"/>
CASE OF SOME HORIZONTAL PLASTIC INJECTION MOLDING MACHINES			
13.	<p>In semi-automatic operating mode, the choice of the "no motion" or "motion" operating mode of the machine is authorized only by a key selector. (sec. 9.2.5)</p>  <p>Figure 4: "no motion" or "motion" key selector</p>	<input type="checkbox"/>	<input type="checkbox"/>
14.	When the "no motion" mode is chosen, motions of the platens, cores and ejectors are prevented as long as the mold area guard remains open. (sec. 9.2.5)	<input type="checkbox"/>	<input type="checkbox"/>
15.	When the "motion" mode is chosen, the mold area guard can only be opened during the platen opening, ejector forward motion, and core-out phase. (sec. 9.2.5)	<input type="checkbox"/>	<input type="checkbox"/>
16.	When the movable platen opens while the mold area guard is open, any shearing and pinch zone behind the mounting surface of the mobile part of the mold remains inaccessible. (sec. 9.2.1 and 9.2.5)	<input type="checkbox"/>	<input type="checkbox"/>
17.	In automatic or manual operating mode, when the mold area guard is open, it is impossible to move the platen, cores and ejectors. (sec. 9.2.5)	<input type="checkbox"/>	<input type="checkbox"/>

	N°		YES	NO
ACCESS TO THE MOLD FROM THE SIDE OPPOSITE THE OPERATOR	GUARD OPPOSITE THE OPERATOR SIDE (FIGURE 2)			
	18.	This guard is present. (sec. 9.2.6)	<input type="checkbox"/>	<input type="checkbox"/>
	19.	This guard has at least one interlock device that prevents all movement of the machine if it is open or removed. (sec. 9.2.6)	<input type="checkbox"/>	<input type="checkbox"/>
ACCESS TO THE MOLD FROM ABOVE	GUARD ABOVE THE MOLD AREA (FIGURE 2)			
	20.	This guard (fixed or movable) exists. (sec. 9.2.7)	<input type="checkbox"/>	<input type="checkbox"/>
	21.	If it is movable, it is equipped with an interlock device. (sec. 9.2.7)	<input type="checkbox"/>	<input type="checkbox"/>
ACCESS TO THE MOLD FROM BELOW	PARTS DISCHARGE OPENING			
	22.	<p>A fixed or movable guard, or a conveyor, or a chute of dimensions complying with the following figure exists. (figures 2 and 5) (sec. 7.3.6 and 9.2.8)</p> <p>Dimensions to be met for the parts discharge opening: If $a < 100 \text{ mm}$ (3.9 in.), then $b > 550 \text{ mm}$ (21.6 in.) OR If $a > 100 \text{ mm}$ (3.9 in.), then $b > 550 \text{ mm} - a$</p> <p>Figure 5: Dimensions of the parts discharge opening</p> <p>© Copyright 2007 The Society of the Plastics Industry, Inc. All rights reserved. Reproduced with the permission of SPI.</p>	<input type="checkbox"/>	<input type="checkbox"/>

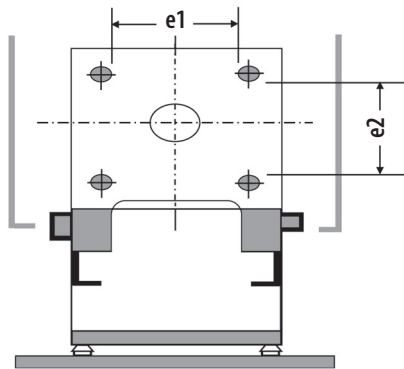

Remarks:

N°		YES	NO
23.	Fingers or hands cannot reach the screw through the feed throat (e.g.: due to the presence of the feed hopper). (sec. 9.3.2)	<input type="checkbox"/>	<input type="checkbox"/>
24.	The room where the machine is located is sufficiently ventilated to protect against hazardous vapours. (sec. 10.6)	<input type="checkbox"/>	<input type="checkbox"/>
PROTECTION AGAINST EXPELLED MATERIAL AND AGAINST BURNS			
25.	The injection barrel is equipped with a guard (figure 2) or an insulative fabric to prevent all contact with very hot surfaces. (sec. 9.3.6)	<input type="checkbox"/>	<input type="checkbox"/>
26.	The vent is equipped with a cover to protect the worker from expelled plastic or from vapour emissions. (sec. 9.3.3)	<input type="checkbox"/>	<input type="checkbox"/>
27.	The workers wear personal protective equipment (PPE) to prevent or limit harm (e.g.: burns, expelled material). (Examples of PPE to use: goggles, gloves and protective hood) (sec. 9.3.3)	<input type="checkbox"/>	<input type="checkbox"/>
28.	A purge splash guard (figure 2) protects the front, rear and top of the purge area (back of the fixed platen). (sec. 9.3.5)	<input type="checkbox"/>	<input type="checkbox"/>
29.	This guard is equipped with an interlock that prevents rotation of the screw as well as forward motion of the plunger, screw and injection carriage. (sec. 9.3.5)	<input type="checkbox"/>	<input type="checkbox"/>
30.	When the mold area guard (figure 2) is open, rotation of the screw is permitted only when the nozzle closing device prevents discharge of material (hot plastic). (sec. 9.2.9)	<input type="checkbox"/>	<input type="checkbox"/>
IN THE CASE OF A SWIVEL INJECTION UNIT (OUTSIDE ITS OPERATING POSITION) WITH AN INTERLOCK			
31.	Forward motion of the plunger or screw is possible only in manual mode. (sec. 9.3.7)	<input type="checkbox"/>	<input type="checkbox"/>
32.	The maximum forward speed is 13 mm/s (0.5 in./s). (sec. 9.3.7)	<input type="checkbox"/>	<input type="checkbox"/>

Remarks:

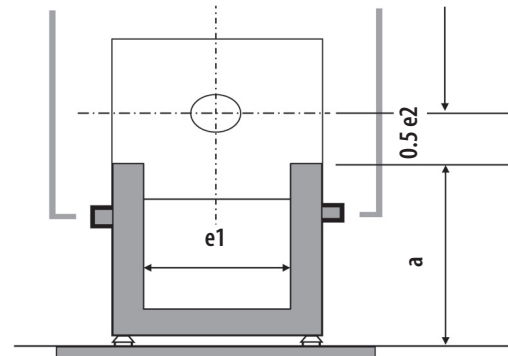
	N°		YES	NO
SPACE BETWEEN THE MOLD AREA GUARD AND THE MOLD AREA (FIGURES 6 AND 7)		WHEN A PERSON COULD BE IN THIS SPACE		
	33.	<ul style="list-style-type: none"> An emergency stop button* is easily accessible from this space AND This space is equipped with a mechanical device to block the mold area guard from closing. OR a double acknowledgement system for checking that no one is in the mold area** OR a presence-sensing device. (sec. 9.4.1) 	<input type="checkbox"/>	<input type="checkbox"/>
SPACE BETWEEN THE GUARD OPPOSITE THE OPERATOR SIDE AND THE MOLD AREA (FIGURES 6 AND 7)		WHEN A PERSON COULD BE IN THIS SPACE		
	34.	An emergency stop button* is easily accessible from this space. (sec. 9.4.2)	<input type="checkbox"/>	<input type="checkbox"/>
<p>According to section 3.22 of ANSI/SPI B151.1 – 2007 standard, a “large molding machine” means any horizontal plastic injection molding machine with the following characteristics:</p>				

FIGURE 6: Horizontal molding machine with tiebars



- $e1$ or $e2 > 1200$ mm (47 in.)

FIGURE 7: Horizontal molding machine without tiebar



- $a < 850$ mm (33.5 in.) and $e1 > 400$ mm (15.7 in.) OR and $e2 > 400$ mm (15.7 in.) OR
- $e1 > 1200$ mm (47 in.) OR
- $e2 > 1200$ mm (47 in.)

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MOLD AND MOVABLE PLATEN WITH WORKING PLATFORM		WHEN A PLATFORM IS USED TO ACCESS THE WORKING AREA DURING NORMAL OPERATION OF THE MACHINE		
	35.	One or more presence-sensing devices (e.g.: pressure-sensitive mat) are installed and positioned in such a way as to detect the presence of a person on the platform. (sec. 9.4.3.1)	<input type="checkbox"/>	<input type="checkbox"/>
		ACTUATION OF THE PRESENCE-SENSING DEVICE (SEC. 9.4.3.1)		
	36.	Prevents the closing motion of the power-operated gate used as the mold area guard;	<input type="checkbox"/>	<input type="checkbox"/>
	37.	Prevents motion of the movable platen;	<input type="checkbox"/>	<input type="checkbox"/>

	N°		YES	NO
MOLD AND MOVABLE PLATEN WITH WORKING PLATFORM	ACTUATION OF THE PRESENCE-SENSING DEVICE (SEC. 9.4.3.1) (CONT.)			
	38.	Prevents movement of the cores or ejectors;	<input type="checkbox"/>	<input type="checkbox"/>
	39.	Prevents movement of the injection mechanism;	<input type="checkbox"/>	<input type="checkbox"/>
	40.	Stops all movement during closing of the mold;	<input type="checkbox"/>	<input type="checkbox"/>
	41.	Requires that the large molding machine be manually restarted before a new cycle is begun.	<input type="checkbox"/>	<input type="checkbox"/>
MOLD AND MOVABLE PLATEN WITHOUT WORKING PLATFORM	WHEN THE LARGE MOLDING MACHINE IS NOT EQUIPPED WITH A PLATFORM (IN THE MOLD AREA) ALLOWING ACCESS TO THE WORKING ZONE DURING NORMAL OPERATION			
	42.	<ul style="list-style-type: none"> • There is a mechanical blocking device for the mold area guard OR • There is a double acknowledgement system for checking that no one is in the mold area**. (sec. 9.4.3.2) 	<input type="checkbox"/>	<input type="checkbox"/>
MOLD AND MOVABLE PLATEN	CYCLE INITIALIZATION			
	43.	Automatic start-up of movement of the large molding machine is impossible when the mold area guard is closing. (sec. 9.4.4)	<input type="checkbox"/>	<input type="checkbox"/>
	44.	Closing of the mold area guard requires direct and continuous action by the worker. (sec. 9.4.4)	<input type="checkbox"/>	<input type="checkbox"/>

* ANSI/SPI B151.1 - 2007 standard offers the possibility of using an emergency reverse button. This measure must be adopted with care and after a risk evaluation has been performed; this is necessary because actuating the button can be dangerous when more than one operator is working on the machine. For example, if a worker caught in the mold area reverses the movement of the movable platen to free himself while a co-worker is in the toggle lever area, this reverse movement represents a major risk for the latter.

** According to ANSI/SPI B151.1 – 2007 standard, the “double acknowledgement system” for checking that no one is in the mold area is a system that authorizes the start of a machine cycle only after the following sequence has been completed:

- 1- Pressing on a first button located **inside** the mold area guard (operator side); this area must be completely visible from the button location;
- 2- Closing the mold area guard (operator side);
- 3- Pressing on a second button located **outside** the mold area guard (production operator side), to authorize initiation of a cycle.
This area must be completely visible from the location of this button, which must be inaccessible from the area of the mold whose guard is closed.

Remarks:

SAFEGUARDING CHECKLIST FOR PEOPLE WORKING ON THE MACHINE

CHECKLISTS

Before working in the machine hazard zones, each worker (e.g.: production operator, maintenance technician, mold set-up technician) should check that the existing safeguards are functioning correctly. The following checklist facilitates this verification.

Checklist completed by: _____

Signature: _____

Date (MM/DD/YYYY): _____

Horizontal plastic injection molding machine: _____
(identification number or make, model and year of manufacture)

Submitted to: _____



POINTS TO BE CHECKED

ATTENTION:

The fact that a safety device associated with a guard is operating does not guarantee that the machine is safe. This device must be installed in such a way as not to jeopardize the safety of the people working on the machine (see reference 2).

N°		YES	NO
1.	It is impossible to start the machine when the mold area guard on the operator side is open (figure 2).	<input type="checkbox"/>	<input type="checkbox"/>
2.	It is impossible to start the machine when the guard opposite the operator is open (figure 2).	<input type="checkbox"/>	<input type="checkbox"/>
3.	It is impossible to start the machine with the purge splash guard open (figure 2).	<input type="checkbox"/>	<input type="checkbox"/>
4.	It is impossible to start the machine with the injection barrel guard open (figure 2).	<input type="checkbox"/>	<input type="checkbox"/>
5.	Actuation of the mechanical blocking system (e.g.: bar) of the movable platen prevents the mold from closing (figure 3).	<input type="checkbox"/>	<input type="checkbox"/>
6.	Actuation of the emergency stop button stops all motion of the machine.	<input type="checkbox"/>	<input type="checkbox"/>
7.	The working area is clean (e.g.: no granules or finished parts).	<input type="checkbox"/>	<input type="checkbox"/>
8.	The machine has no hydraulic oil, air or water leaks.	<input type="checkbox"/>	<input type="checkbox"/>

Remarks:



SAFETY CHECKLISTS

REFERENCES

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