



Safety rules for automatic control system

EB03.76.020

/B

Standard

Status **Binding**

Importante Note : This document has been translated from the French. In the event of any dispute, only the French version is referred to as the reference text and is binding on the parties.

Purpose To define the rules specific to Renault applying to the use of control system components relating to the safety of the means of production.

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European	:	EN 954-1.
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Foreword

Decree 92.767 clause R233-84 sets out the essential requirements of the revised European directive 89/392 which the production installations must meet if the safety of people at work is to be guaranteed. These requirements are repeated in the harmonised European safety standards, the most important of which are referred to by the standard EB75.04.130. It must be acknowledged that, even if standards EN 954-1 and IEC 60204-1 along with the latter's complement CNOMO E03.15.600.N may appear somewhat directive, they do leave the designer considerable room for manoeuvre with regard to their application. It seems necessary to us to publish the rules for technical implementation, since there is a pronounced effect on the operating modes of the machines that could be a source of unacceptable diversity in the Renault group's workshops.

Our aim is to ensure the consistency of the interfaces between man and machine so as to make maintenance operations easier and meet the requirements of operators, but above all to limit the number of errors that might be harmful to safety.

1 Terminology

1.1 Safety perimeter

A protective device which demarcates part of an automated installation. Nobody can enter this perimeter unintentionally. Stationary and movable guards equipped with a closure control device usually mark out this perimeter.

For low-risk installations, handrails equipped with movable and uncontrolled guards may mark out the perimeter.

1.2 Safety zones

A safety zone is a monitored space of an automated installation. This space is demarcated by a safety perimeter. When the perimeter is crossed, automated components of the installation switch to a state that is harmless to human beings (components are powered down, operator safety devices are triggered).

1.3 Power devices

The power devices stop the installation and make it safe in the event of a failure occurring in any of the components of the safety system. This is achieved by cutting off and disabling power sources and cutting off actuator commons:

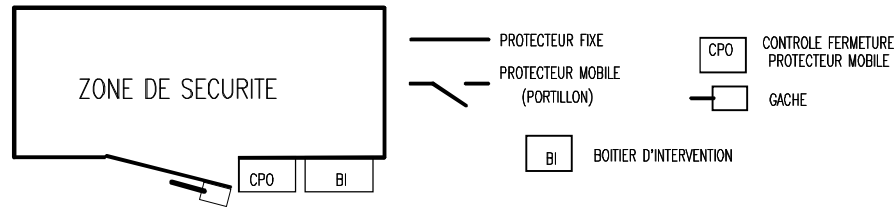
- Electric power KMS
- Hydraulic power RGH
- Pneumatic power EV_AIR

Powering up or powering up after an outage requires validation (resetting). Power outage is caused by:

- **the IAPC** (*industrial automatic programmable controller*) **programme** if a procedure is not followed, or by the failure of the IAPC or the DC (*digital control*), or a power supply defect in the IAPC input circuits,
- **the wiring** in the event of an emergency shutdown or if the movable guard opens.

1.4 Movable guard

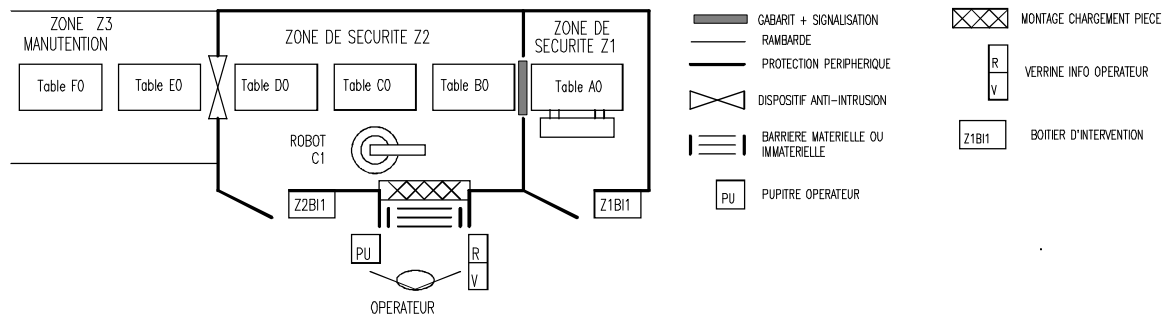
A locking or interlocking device using a padlock protects access to a closed safety zone. The guard can be a metal casing or curtain (risk of projections), or a screened gate (screened enclosure zone), etc.



In the example above, the movable guard is a screened gate. It is closed electrically by a safety bolt. The strike plate of this bolt enables the gate to be blocked in the open position by several padlocks in order to create a safe environment for repair and maintenance work.

This assembly, combined with a control unit, is used to protect high-risk installations (robotised islands, high-speed handling devices, elevators, etc.).

1.5 Positioning and protection of different zones



In the example shown, zones have controls that act locally and possibly also on neighbouring zones. They can be supplemented by local protective systems.

2 Emergency shutdown

The emergency shutdown control is preferably a red self-locking strike button, 40 mm in diameter, on a label with a yellow background.

It is located on the machine control consoles, in the operators work zones as well as in the automatic zones when required.

In some cases, it can be replaced by a resettable taught cable. This cable shall, as far as possible, be visible along its whole length from the reset point.

2.1 Perimeter of action

The emergency shutdown usually cuts off the power supply to the actuators in the zone concerned (KMS), and in upstream and downstream zones in a flow-type process whenever continued operation could prove to be dangerous.

This command generates a persistent state preventing any restart. The emergency stop must be deliberately unlocked and only authorises restart of the installation (or machine).

Emergency shutdown data is exchanged by wire between 2 adjacent zones of a single flow, when each zone belongs to different installation.

2.2 Application

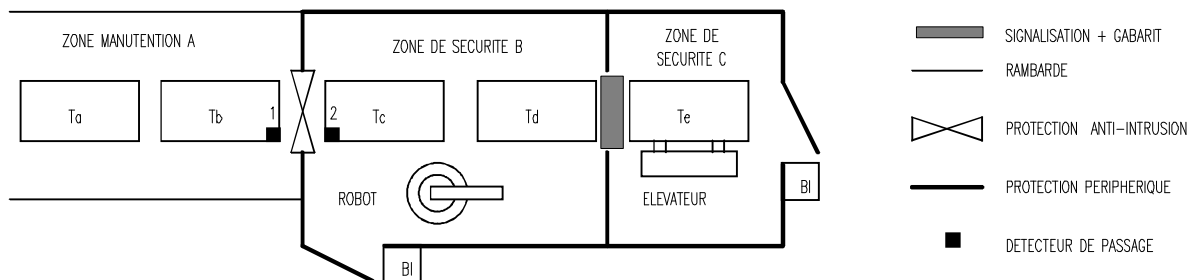
The consistency of the safety data issued by the emergency shutdown commands is monitored very carefully in compliance with the standard EN 954-1.

3 Anti-intrusion protection

Discharging loads from a safety zone to an open zone (or vice versa) involves passing through the peripheral guard. If the supply system forms a natural obstacle of a height of at least 1.10 m or if it transports parts of small overall dimensions, no additional devices are necessary. In all other cases in which it is possible to enter the zone, an additional device is required.

Intrusion causes the whole safety zone to be closed by shutting off the power supply (KMS) to the dangerous components and triggering an alarm.

It is only necessary to position an additional automated anti-intrusion protective device between 2 safety zones under special circumstances. An appropriate deterrent device (template, signalling, etc.) is recommended.



The following automated anti-intrusion protective devices can be used:

- photoelectric cells (position of the beams regulated at 400 and 900 mm relative to the level at which people move). These cells are not necessarily specific safety equipment,
- an immaterial safety barrier,
- a material barrier or automated panel (unusual),
- a touch-sensitive floor (exceptional).

In some applications, movement detectors are installed on the upstream and downstream tables to limit the inhibition time of the cell-controlled protective devices (see examples Tb and Tc).

3.1 Perimeter of action

Any intrusion through the opening, other than the load, will cause the whole safety zone to be closed by cutting off the power supply (KMS) and triggering an alarm. A deliberate resetting action is required to restart the installation.

Automatic introduction of loads inhibits the protective device so as not to shut down the safety zone. The size of the load obstructs the opening during transit through the different zones. Operation of the protective device shall be checked at each cycle.

When the load does not act upon the protective device monitoring the presence of an operator within a certain zone, the protective device must never be inhibited. The safety system is cyclically self-checked.

3.2 Application

The consistency of the safety data issued by the emergency shutdown commands is monitored very carefully in compliance with the standard EN 954-1.

4 Access to the safety zone

The safety zone is accessed by opening one or more controlled movable guards.

Opening the movable guard without complying with the access procedure, or any movements deemed to be dangerous in the upstream and downstream zones (KMS, Line EV, Variator Line Relay contact switches), cause the zone to be made safe by cutting off the power supplies to the dangerous components within the peripheral guard.

Power is shut down by wire and the API programme, which de-activates the movement commands and the automatic mode.

If the power supply cannot be disabled, dangerous movements are locked mechanically.

Closing the mobile guard should not allow the dangerous components in the safety zone to return to operation. A control component provided to this effect (cycle ON / resetting push button) must be deliberately pressed to start the installation operating once again.

When there is a risk of somebody being trapped inside a danger zone, an additional device must be combined with the guard which, depending on the risk, may be either a safety selector, an anti-confinement handle, or an emergency stop mechanism that enables the operator to prevent the machine, etc. from restarting.

4.1 Control unit

The control unit is used on automated and robotised sites equipped with a peripheral guard.

It is used to make operations easier and safer. It enables manoeuvres to be performed without risk, and reduces the time for repair and maintenance.

It is placed outside the guards and outside the danger zone, preferably near each movable guard it is associated with, and in full view of the components to be controlled. It is controlled by the movable guard locking device.

N.B. It is not necessary to install a control unit on small items of equipment, which are clearly visible from the start-up console.

The control unit features controls acting on the whole safety zone. It generally comprises four components:

- a "Marche / Arrêt" (*ON / OFF*) switch,
- a "Portillon Hors Service / En Service" (*Gate out of order / in order*) key-operated switch,
- a "Réarmement / Marche Cycle" (*Resetting / cycle ON*) luminous push button,
- "Arrêt Cycle" (*Halt cycle*) luminous push button.

4.1.1 "MARCHE / ARRET" (*ON / OFF*) switch

This safety selector cuts off the power supplies to the moving pieces of equipment in the safety zone (KMS) from the moment it is activated. It can be locked in its "ARRET DE SECURITE" (*safety stop*) position. It enables the gate opening information to be made more reliable through replication and the zone to be placed off-limits. It is red on a yellow background.

4.1.2 "PORTILLON HORS SERVICE / EN SERVICE" (*Gate out of order/in order*) key-operated switch

When this switch, which can be locked using key No. 455, is positioned on "HS" (*out of order*), the automatic mode of operation is neutralised and some manual equipment movements are possible in open-gate mode.

4.1.3 "REARMEMENT / MARCHÉ CYCLE" (*Resetting / cycle ON*) luminous push button

Pressing the button causes the safety zone to begin operating again:

- in automatic mode insofar as all the restarting conditions are met (movable guards closed, key-operated switch on "ES", etc.),
- in manual mode once an access has been opened (movable guard open, key-operated switch on "HS", etc.) in order to authorise power-up.

The indicator light comes and remains on in automatic mode of operation and a normal production cycle, whereas it flashes in the other cases. It goes off the moment the automatic mode of operation is lost.

4.1.4 "ARRET CYCLE / DEMANDE D'INTERVENTION" (*Halt cycle / Corrective action request*) luminous push button

Pressing this button causes the cycle operation to be lost and the moving pieces of equipment to be stopped in a known position. The stoppage can be delayed relative to the moment the button is activated. During this delay, the button indicator light flashes. It comes and remains on when the zone is shut down and safe (power supply off). The indicator light is off when the machine is in automatic cycle mode.

4.2 Carrying out repair and maintenance work in a danger zone

The inspection, adjustment, cleaning or maintenance operations are carried out when the machine is at a standstill. Making the zone safe consists in:

- **Activating the "arrêt cycle" (*halt cycle*) button**
Optional. This enables the machine to be correctly brought to a complete stop.
 - **Position the safety selector switch on "Arrêt" (*stop*)**
Cuts off the power supply, is key-lockable.
 - **Open the movable guard**
Controls the guard opening information.
- ⇒ **THE OPERATOR CAN WORK IN SAFETY**

To bring about a return to normal functioning, the restart operation consists in:

- **Closing the movable guard**
Visual check that there are no operators in the zone.
- **Position the safety selector switch on "Marche" (*ON*)**
- **Activate the "Marche cycle" (*start cycle*) button**

N.B. When a failure to the closure control mechanism appears, or when the movable guard is open but the safety selector switch is not in the "stop" position, the power supplies are cut off (KMS), as are all movements of pieces of equipment deemed to be dangerous in either upstream or downstream zones. Notification is given of a procedure defect, and resetting is performed either on the island console or on the main cabinet.

4.3 Carrying out work in a danger zone with neutralised guard

When maintenance operations to the machine require certain movements of equipment with the guard open, the protective device must be neutralised (open-gate operation). These operations can only be performed by authorised personnel:

- **Activate the "arrêt cycle" (*cycle OFF*) button**
Optional, enables the machine to be correctly brought to a complete stop.
 - **Position the gate switch on "Hors service" (*out of order*)**
Disables automatic operation.
 - **Open the movable guard**
Control of the guard opening data.
- ⇒ **THE OPERATOR CAN WORK**

Automatic mode is impossible, movement controls are permanent, dangerous components operate under conditions of increased safety (reduced speed, reduced stress, etc.), and any movement acting deliberately or otherwise on sensors inside the machine shall be prohibited.

To return to normal operation, restart by:

- **Closing the movable guard**
Visual check that there are no operators in the zone.
- **Position the gate switch on "En service" (*in order*)**
- **Activate the "Marche cycle" (*cycle ON*) button**

N.B. When a failure in the closure control mechanism appears, or when the movable guard is open but the gate switch is not in the "out of order" position, the power supplies are cut off (KMS) as are all movements of pieces of equipment deemed to be dangerous in either upstream or downstream zones. Notification is given of a procedure defect, and resetting is performed either on the island console or on the main cabinet.

4.4 Application

Opening a guard without applying the procedure or the safety selector switch being in the OFF position causes the KMS relay to deactivate and the power supplies powering the movement of equipment in the zone to be cut off. The power supply is always restored only following actuation of a validation component:

- Cycle resetting on the control unit to choose the repair and maintenance work modes,
- Resetting of the installation at the midpoint when the information concerns an open guard without there having been a repair or maintenance work selection beforehand.

The consistency of the safety information carried by the shutdown control components, the switches and the guard closing control device is monitored very carefully in compliance with the standard EN 954-1

5 Protection of the operators at the workstation

There can, in some cases, be a joint activity between an operator and a machine at a single workstation. In this case, simultaneous presence at this station must be prohibited using a device that guarantees the operator's safety:

- the operator is not exposed (example: use of a mechanical drawer)
 - no additional safety measure
- the operator can be exposed
 - installation of material, immaterial, sensor-based or distance-based protective devices.

The workstation's protective device only acts on those components that are dangerous for the operator and not necessarily on all the components in the safety zone.

The machine shall be designed in such a way as to guarantee the operator's safety even in the event of an ill-timed start-up. To this end it is necessary, in some applications where the operator runs the risk of being exposed, to implement the most suitable device or measure, such as: cutting off the power supply, mechanical blocking of dangerous movements of pieces of equipment, monitoring of dangerous movements of pieces of equipment, etc.

5.1 Material protection

When manual and automated operations are scheduled to be carried out simultaneously at the same workstation, a device must be in place to protect the operator from dangerous movements of pieces of equipment.

The material protection can be either a fixed or movable casing, or the part worked at this workstation.

In the case of a movable housing, an inspection is carried out carefully by the automatic control unit to make sure that the device is operating correctly (e.g. closed housing position information redundancy).

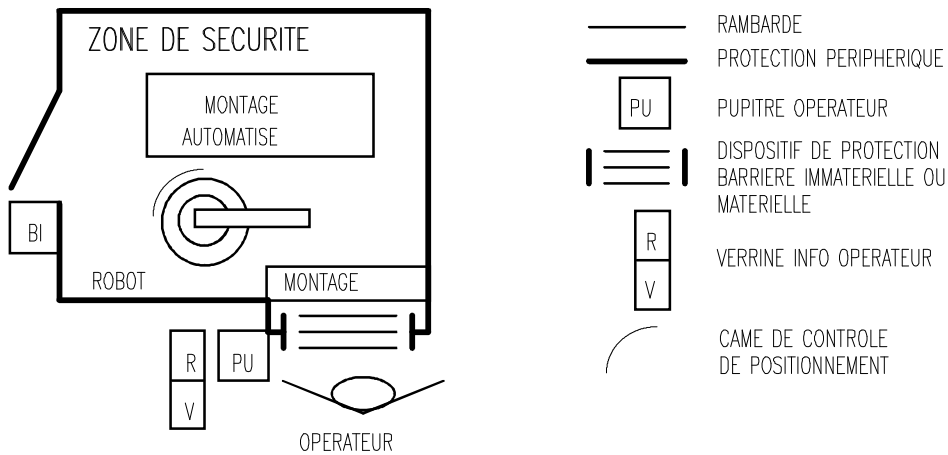
In the event of the part acting as the housing (e.g. small welding fixtures), its presence shall be monitored and the correct operation of this presence detector shall be tested cyclically.

An open housing shall deactivate the dangerous moving equipment control.

Any defect recognised by the automatic control unit cuts off the electricity to the pre-actuators (RSOP).

5.2 Immaterial protection

5.2.1 General



If the workstation cannot be designed in such a way as to materially prohibit any possibility of interaction between the operator and the dangerous moving equipment, immaterial protective measures are used (e.g. loading/unloading of parts/units, joint operator/machine activity, etc.).

The protective device includes:

- An operator presence detector (light beam/curtain, scanning cell, etc.) covering the shared man/machine work zone.
- A console with a "validation fin de travail/réarmement machine" (*end-of-work validation /machine resetting*) impulse function installed outside the safety zone.
- Operator access signalling, usually a light glass cap with 2 lights:
 - green = "AUTORISATION" (*authorisation*) and red = "INTERDICTION" (*prohibition*)
- A machine positioning control device (camplate, position detector, software stops, etc.). When the operator is in the danger zone, this device warns against the dangerous subassembly (the robot in our example) encroaching into the operator's work zone. In the event of a malfunction, the power supply to the subassembly is cut off.

Perimeter of action

The immaterial device permanently monitors the presence of the operator in the work zone. While the machine is operating, the "Interdiction de pénétrer" (*Entry prohibited*) indicator light is on. Any intrusion into the zone brings the machine's motions to a halt by causing the electricity supply to the pre-actuators to be cut off (RSOP).

The operator is given permission to work when there are no more dangerous movements at the workstation and the machine's control device is active.

The immaterial protection device is tested to make sure it is operating correctly:

- when the operator enters the work zone in the case of a fixed station,
- by carrying out a cyclical test in the case of a workstation used only occasionally (e.g. one used only when one of the usual stations is out of action).

Signalling available to the operator:

- Red "Interdiction" (*prohibition*) indicator light on; any intrusion into the zone under surveillance causes:
 - the immediate stoppage of the components concerned by cutting off the electricity supply to the pre-actuators (RSOP),
 - the "Autorisation" (*authorisation*) indicator light comes on flashing (reset request)
- Green "Autorisation" (*authorisation*) indicator light comes on flashing following an intrusion; the operator must activate the end-of-work validation device in order to restore the power supply.

N.B. In the event of the installation being required, for maintenance operations, to operate when the power supply to the immaterial protection device has been cut, the operating mode selector switch placed in the "MANUEL" (*manual*) position can serve to neutralise the immaterial protection device.

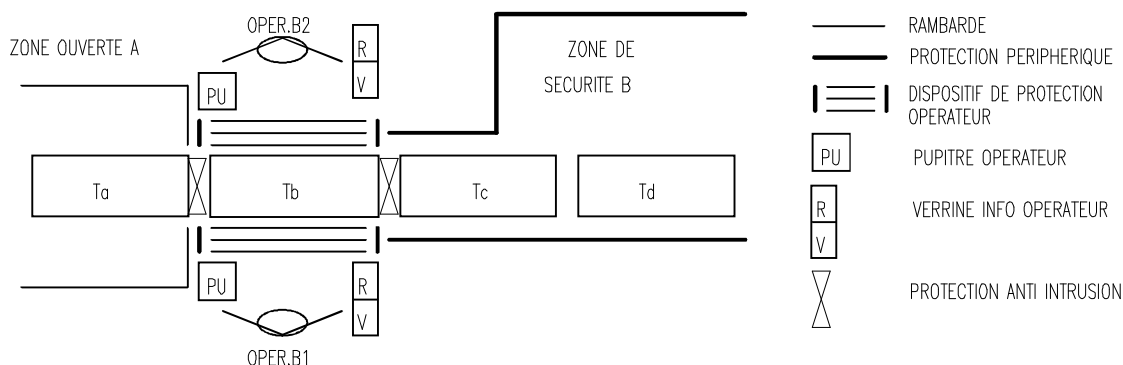
The consistency of the information carried by the operating mode selector switch must be monitored.

The validation buttons are used as input. Resets are programme-controlled.

Application

The consistency of the safety information carried by the immaterial protection device is monitored carefully in compliance with the standard EN 954-1.

5.2.2 Several operators at a single workstation



In the case of a station controlled by several operators, a console is required for each operator. The immaterial protection devices must cover the whole work zone of the operators.

The machine is powered up, and can operate when all the operators have validated the end of their work session and keep away from the zones that are under surveillance.

Application

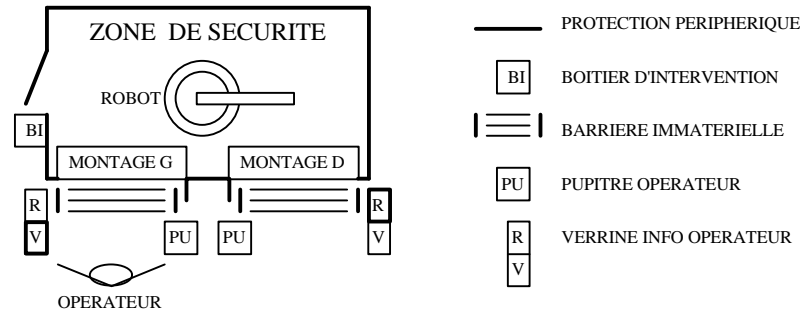
A safety information processing setup is necessary for each immaterial protection device.

The end-of-operator-work-session validation information is stored.

When all the validations have been activated and none of the immaterial protection devices detect any presence in the danger zone, movement of parts and equipment is authorised.

The consistency of the safety information carried by the immaterial protection device is monitored carefully in compliance with the standard EN 954-1.

5.2.3 Operator at a dual workstation



In the case of a dual workstation controlled by a single operator, an independent protective device is necessary for each opening of the safety zone.

In this example, the robot can only work on the right-hand assembly (red indicator light activated), not on the left-hand assembly. The left-hand assembly is used by the operator (green indicator light activated).

Application

The application of each immaterial protection device is the same as for a single workstation. Complete-type position control devices are installed for each workstation (see paragraph 5.2).

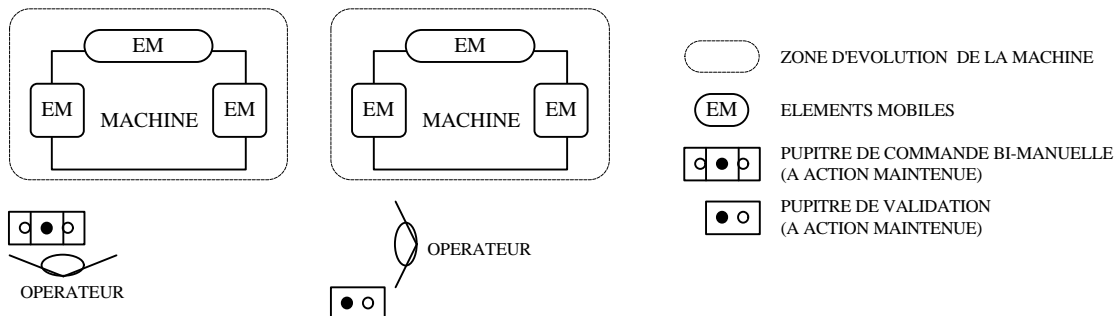
5.3 Remote protection

These devices are, for example:

- a console with two-handed control kept pressed down,
- a console with a single control kept pressed down.

They are installed in such a way that the operator can clearly see the equipment used to monitor equipment operations.

5.3.1 Workstation with isolated operator



Perimeter of action

Keeping the control pressed down permits control of the movement of parts on the machine (supplying power to the control commons).

Releasing the control causes the machine to come to a stop due to the electricity supply to the pre-actuators being cut off (RSOP).

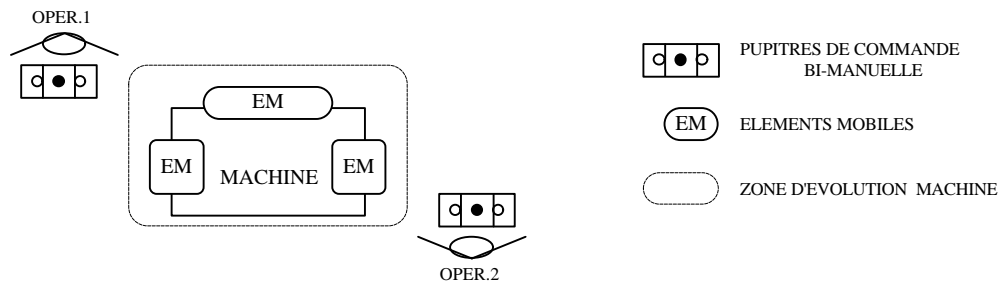
The device is inspected to make sure that it is functioning correctly each time the control is prompted (press-down and release).

Application

The control components' function is monitored carefully in compliance with the standard EN 954-1. The safety module is currently the most rational means of ensuring the consistency of the two-handed control console safety information (see article: Safety function characteristics).

- N.B. In manual operation, the movements of parts must be authorised whatever the status of the two-handed controls. The module is shunted by the "MANUEL" (*manual*) position of the zone's operating mode selector switch. The consistency of the information carried by the operating mode selector switch is monitored per programme.

5.3.2 Several operators at a single workstation



In the case of a workstation controlled by several operators, a remote protective device is necessary for each operator. Each one must have a sufficiently clear view of the machine.

Application

The control components' function is monitored carefully in compliance with the standard EN 954-1. The safety module is currently the most rational means of ensuring the consistency of the two-handed control console safety information.

Safety information processing must be processed for each two-handed control.

When the validations are activated **simultaneously**, movements of parts on the machines are authorised (see article: Safety device Application).

5.4 Operator validation consoles

There are at least as many validation consoles in order as there are operators planned in the manufacturing process.

It is possible to have more consoles than operators when the operations to be carried out are on both sides of the workstation and there is only one operator.

Any system for selecting the number of consoles in order, must not be able to be easily controlled by the operators. The selection systems fastened to the validation console are prohibited except in the event of an immaterial presence detection device being associated with it.

This selection system must be validated by the operator during design and can either:

- be shut away in a housing subassembly that can be accessed by those senior in rank (supervisors, managers, etc.),
- be installed in an electrical cabinet,
- be locked by a stroke on a switch on the operating console (e.g., access code to the PC).

In the event of the selection system neutralising a validation console linked to the functioning of a safety device, material or immaterial, this safety device will always remain active.

6 Safety device use

In compliance with EN 954-1, safety-related information must be checked carefully.

The automatic control unit will check that there is always operating conformity between the state of the components and the result of the processing of this safety-related information. In the event of inconsistency, all the movement controls are deactivated and power supply to the zone is cut off.

The solutions for application are numerous (safety boxes, safety-dedicated modules or automaton, etc.), but the most rational is the double channel method.

6.1 Double channel method

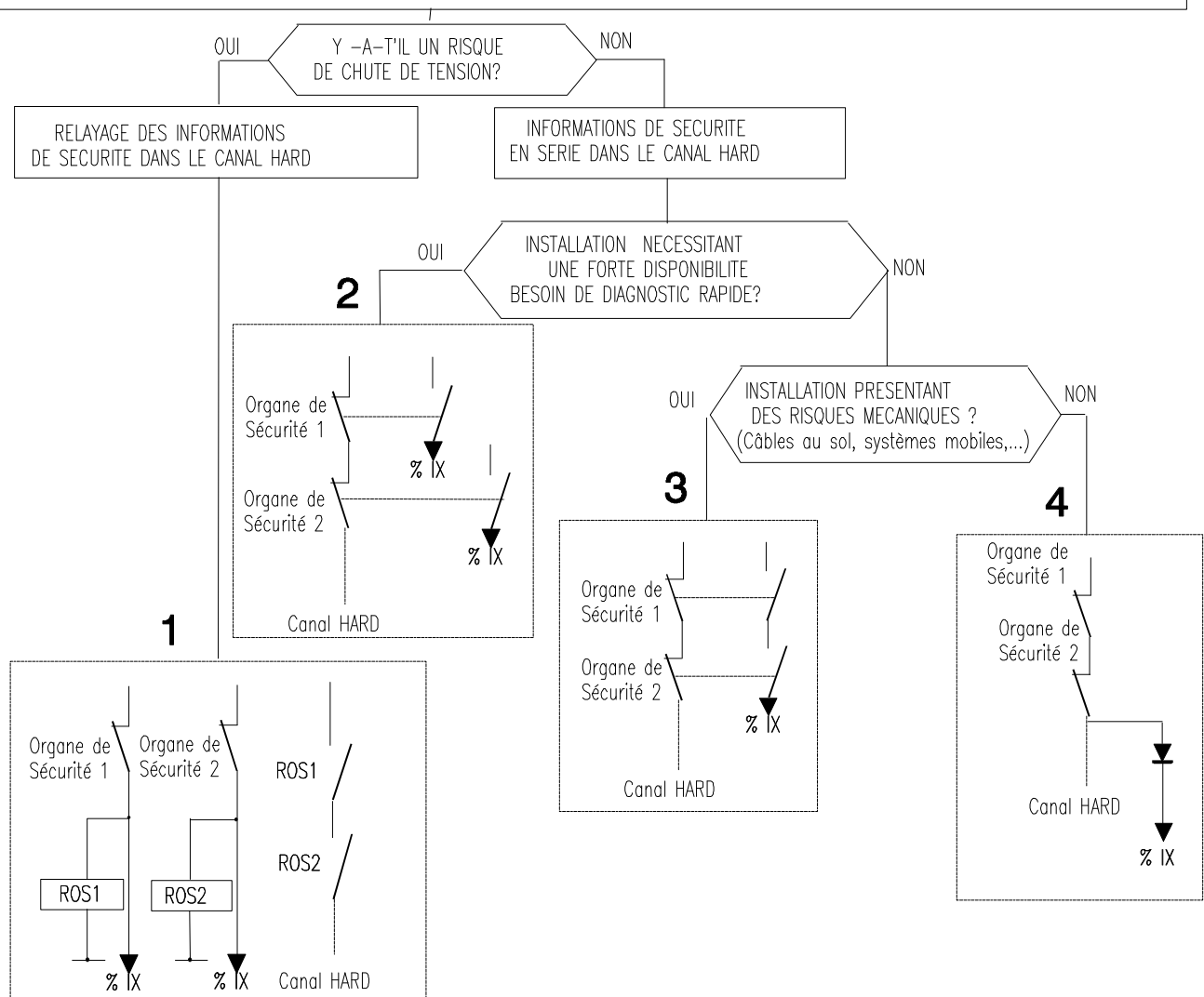
The double channel method consists in permanently checking the equivalence of the components in a system of wired contacts and of the same system programmed in an API.

In the event of there being an inconsistency between the two systems, the system is made safe by cutting off the power supply to the actuators. Deliberately performing a reset will deactivate the defect. The reset is processed in a programme in the form of a pulse.

Several technical solutions are possible; depending on the requirement and configuration of the installation. The logical diagram below enables the choice to be oriented towards a solution for monitoring the safety shut-off devices. This process does not stop at the safety shut-off devices; it concerns the whole safety system.

6.2 Double channel method application

APPLICATION DE LA METHODE DU DOUBLE CANAL POUR LE CONTROLE DES ORGANES DE SECURITE
AU, Contrôle ouverture porte, Sélecteur de sécurité, ...



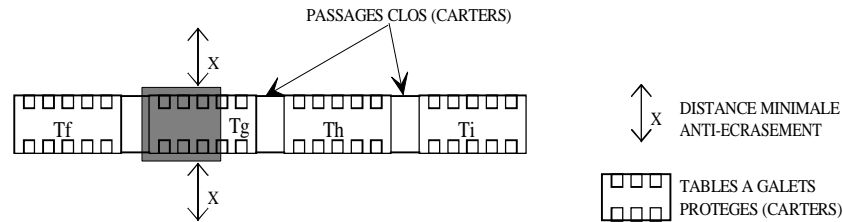
1	Relay actuation avoids the number of safety shut-down device contacts and solves the problem of voltage drops. Diagnosis is quick and accurate.
2	Greater degree of operational safety than solution 1 thanks to the redundancy of the primary information. Voltage drops are to be expected if the installation is too spread out or if the number of pieces of safety-related information to be serialised is too considerable. Diagnosis is quick and accurate.
3	Less inputs used compared to solution 2 but diagnosis becomes more difficult.
4	Same remark as 3, but the defects caused by short circuits to the contacts are not taken into account.

7 Protective devices adapted to continuous handling

In floor stock handling systems, with no workstations, three families are defined:

- systems with acceptable risks \Rightarrow no protective device,
- low-risk systems \Rightarrow use of protective devices for special cases,
- high-risk systems \Rightarrow systematic use of protective devices.

7.1 Systems with acceptable risks



These are systems made up exclusively of roller tables meeting the following conditions:

- no item enabling the direction or level to be changed,
- possibilities of seizure and shearing eliminated (extension of the housing or flooring plates between tables),
- transportation of loads at a speed of less than 60 metres per minute,
- the minimum anti-crushing safety distance of 500 mm between the load and the fixed parts (protection of a person's body) is always respected.

Protection

It is not necessary for a protective device to be implemented. The organisational measures must be formalised before any personnel are put in place on these systems.

7.2 Low-risk systems

These are systems comprising:

- roller tables for which there are risks of seizure or shearing between tables,
- movable components whose function is to change direction (conveyor table, contact slide, swivel table, etc.).

They are considered "low-risk" if:

- their being installed enables the minimum anti-crushing safety distance of 500 mm to be respected,
- the speed of the loads transported or of the movable components does not exceed 60 metres per minute.

Special case

If, exceptionally, the minimum anti-crushing distance cannot be complied with locally inside a low-risk installation, a failsafe shutdown control component (of the emergency shutdown type) must be put in place in the vicinity of the critical zone.

Protection

The periphery of these zones, except when they are located on a platform, is marked out and given material form by means of handrails.

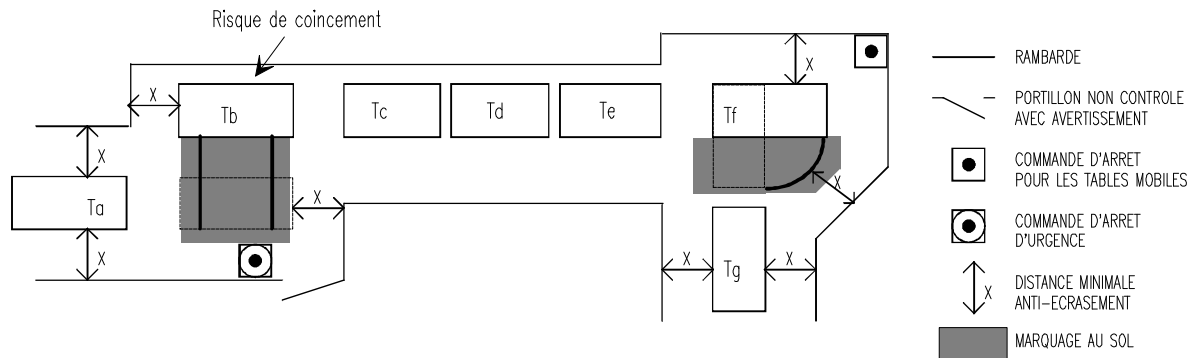
Shutdown devices (push button type, \varnothing 40, yellow in colour, "arrêt mouvement" (*stop movement*) managed by a programme) are installed in the vicinity of the movable components.

This zone is accessed via a small gravity-operated gate.

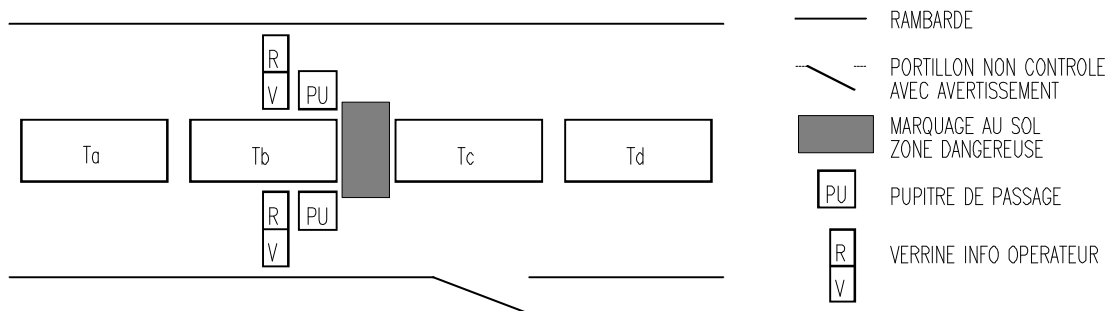
The accesses are not monitored but are fitted with the following warning panel:

"ACCES INTERDIT AU PERSONNEL NON AUTORISE" (*Authorised access only*)

7.2.1 Local shutdown devices for low-risk installations



7.2.2 Course taken by repair and maintenance personnel crossing the flow of low-risk installations



If the most favoured course for repair and maintenance personnel cuts through a flow and does not present any risk (step-by-step operation of the tables), the crossing is marked out on the ground (alternating yellow and black stripes).

If the most favoured course for repair and maintenance personnel cuts through a flow and presents a risk (simultaneous operation, conveyor table, etc.), a control device is installed on either side of the crossing in order to stop the dangerous movement of parts and equipment.

This protected crossing requires two consoles, each one comprising:

- one request button,
- one end-of-crossing validation button,
- one white indicator light with the indication "Attente de validation fin de passage" (*Awaiting end-of-crossing validation*).

One luminous signalling unit comprising 2 indicator lights:

- Green = "AUTORISATION de passage" (*Crossing AUTHORISATION*),
- Red = "INTERDICTION de passage" (*Crossing PROHIBITED*).

Perimeter of action

The effects of pressing the "Demande de passage" (*Crossing request*) button are to:

- prevent the authorisation to start those movements of parts and equipment which are dangerous for the crossing of the repair and maintenance personnel as soon as the way is free,
- switch off the "Interdiction" (*Prohibition*) indicator light and switch on the "Autorisation" (*Authorisation*) as soon as the shutdown has been obtained,
- Signal "Attente validation fin de passage" (*Awaiting end-of-crossing validation*) on each console.

The effects of pressing the "Validation fin de passage" (*End-of-crossing validation*) are to:

- switch off the "Autorisation" (*Authorisation*) indicator light and the "Attente validation fin de passage" (*Awaiting end-of-validation*) indicator light, and switch on the "Interdiction" (*Prohibition*) indicator light,
- restore the authorisation to start up the movements in the zone concerned.

The "Validation fin de passage" (*End-of-crossing validation*) request is only validated on the opposite console to the "Demande de passage" (*Crossing request*) so as to avoid the possibility of a reset being carried out behind the back of the repair or maintenance technician. The latter must always be able to see the reset point all the time he is moving about.

7.3 High-risk installations

These are installations made up of:

- elevators / pallet conveyor buffer replacement station chutes, chutes belonging to stations at which parts are loaded into swing trays, pallet conveyor buffer stackers / unstacker station chutes, storage towers, shuttle conveyors, and automatic pallet conveyor buffer geometry inspection stations.
- handling components which are able to move loads at speeds greater than 60 metres per minute (except for zones with special operations: curing time, polymerisation, removal of chemicals, etc. using a mechanical protection).
- movable components making possible changes in direction (conveyor tables, contact slides, swivel tables, etc.) which do not comply with the minimum anti-crushing safety distance of 500 mm (except for zones of special operations: curing time, polymerisation, removal of chemicals, etc. using a mechanical type of protection).

Protection

These devices are necessarily closed off in a safety perimeter.

This is the case with the safety zones.

7.4 Elevator / chute

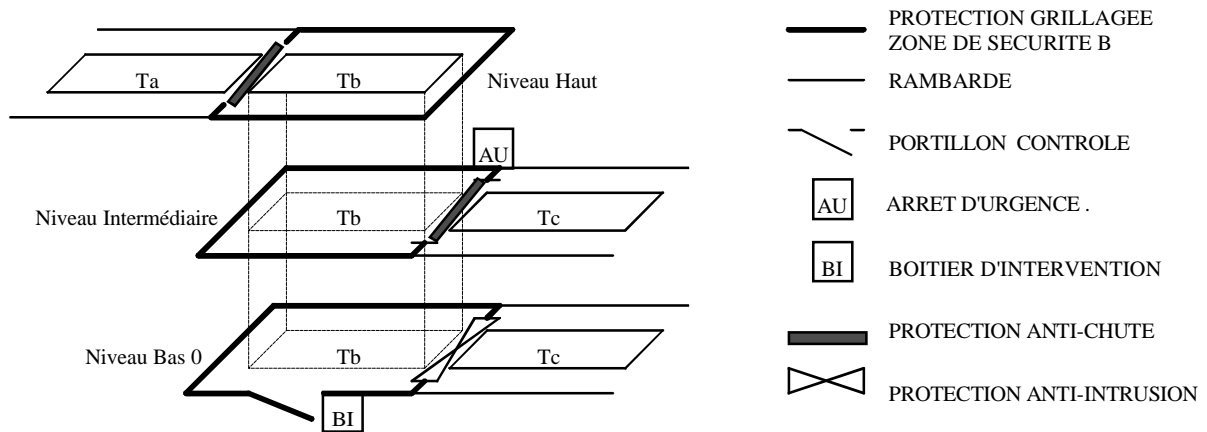
7.4.1 Elevator with lifting travel not exceeding 1,000mm

Eliminating the risks of shearing / crushing must require close protection (casing, mesh apron, etc.) rather than peripheral protection.

If mechanical protection is not possible, an immaterial form of protection or peripheral protection needs to be installed (see paragraph 7.4.2).

When the silhouette effect exercised in the guard does not prove sufficiently dissuasive, an anti-intrusion device must be installed in order to prevent intrusion by the flow into the danger zone (see article 4).

7.4.2 Elevator with lifting travel greater than 1,000mm



Protection is provided by a single safety zone for all levels. The control console is installed on the outside of the guards outside a danger zone.

Low-level protection (level 0)

A peripheral protective device equipped with an electrically controlled movable guard (repair and maintenance work access gate and box) is systematically installed at this level (repair or maintenance or adjustment work to the motor or the container).

Opening one of the accesses causes all the movable parts located inside the guards to come to a stop. Any component adjacent to the elevator, which does not enable the anti-crushing distance of 500 mm to be respected, must be included inside the peripheral protection.

These measures also apply to those elevators whose height between level 0 and the top level is less than 2 m and that offer no other access at the top level.

When the silhouette effect exercised in the guard does not prove sufficiently dissuasive, an anti-intrusion device must be installed in order to prevent intrusion by the flow into the danger zone (see article 4).

Protection of the upper levels

If the level under consideration requires frequent repair or maintenance work, a controlled movable fall protection system is installed.

If the setpoints are not accessible from the gangways or platforms, another access device must be provided (ladder, pod, etc.). In this case, the repair and maintenance procedure must be clearly specified.

7.5 Stock handling systems crossing the traffic passageways

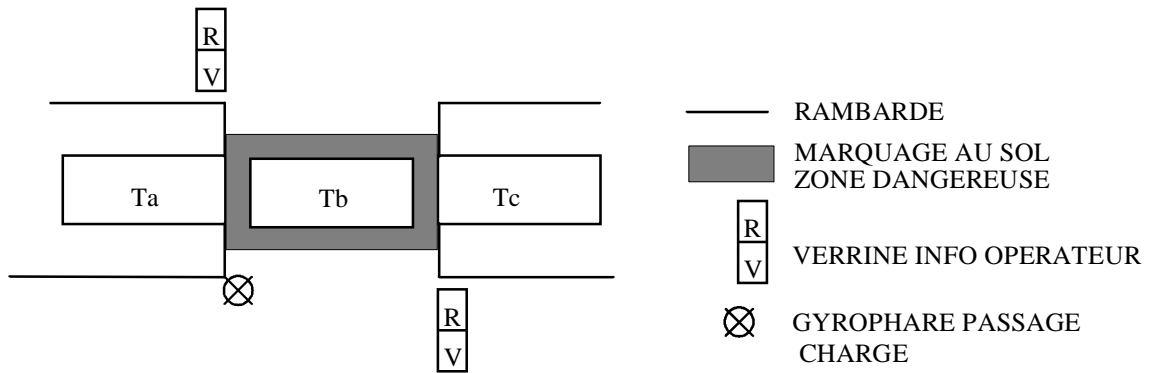
This article deals with the stock handling systems which cross the passageways used either by pedestrians, handling equipment (e.g. forklift trucks) or both at the same time.

7.5.1 Buried roller tables

7.5.1.1 If the speed is between 10 and 40 metres per minute

The passageway is equipped with:

- a light or sound system which functions during the movements,
- ground marking (alternating yellow and black stripes) of the load transit zone,
- a two-colour light signal on either side of the manoeuvring zone, of the traffic signal type and visible to every pedestrian and vehicle driver/operator:
 - Red = "INTERDICTION de passage" (*passage prohibited*),
 - Green = "AUTORISATION de passage" (*passage authorised*).

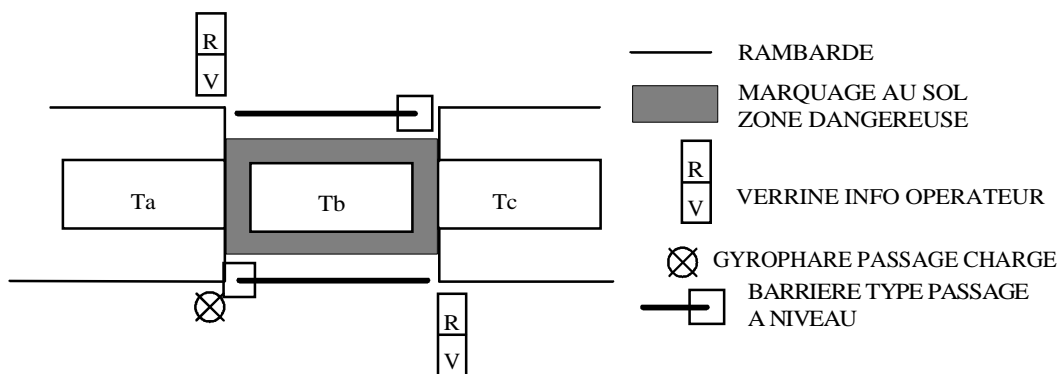


If the direction of the loads might lead or push a person into a risk-prone zone, the installation of a sensitive control device for bringing the moving parts to a standstill (e.g. floor, servo-gauge, etc.) is required.

Should it be impossible to install such a device, the parts are conveyed in compliance with the specifications described when the speed is between 40 and 60 metres per minute.

7.5.1.2 7.5.1.2 If the speed is between 40 and 60 metres per minute

The passageway is equipped as in the previous paragraph, to which is added on either side an access prohibiting device (e.g. "level crossing"-type barrier, cells, etc.).



When the device uses cells, they must be of category 4 type and program-driven along with the load transit cycle.

In the event of the device being violated, the load is immediately brought to a halt and reset is authorised only following a visual inspection to make sure that the load transit zone is free of danger.

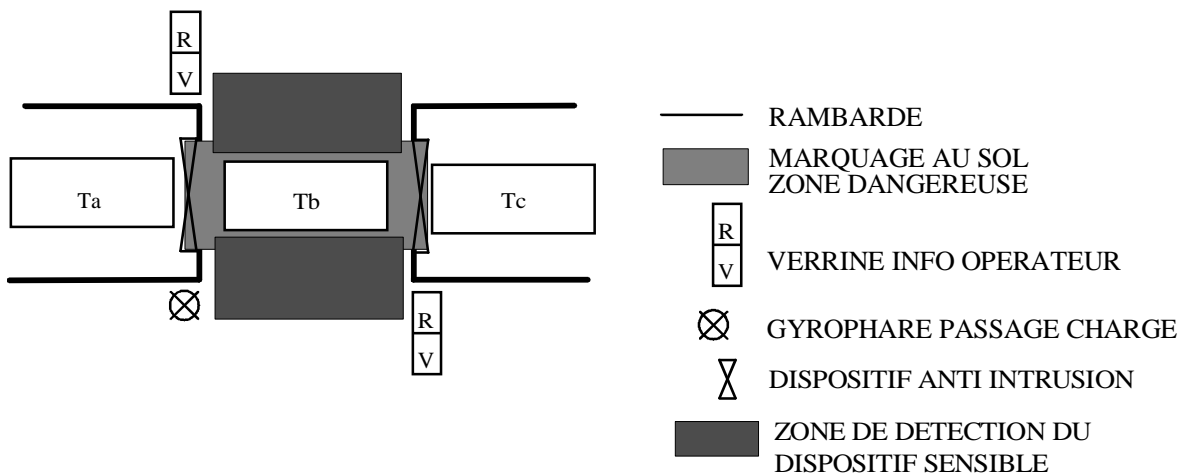
If the load run might lead a person into a danger zone, the installation of a sensitive control device for bringing the moving parts to a standstill (e.g. floor, servo-gauge, etc.) is required.

Should it be impossible to install such a device, the parts are conveyed in compliance with the specifications described when the speed is between 40 and 60 metres per minute.

7.5.1.3 If the speed is greater than 60 metres per minute

The passageway is equipped with:

- ground marking (alternating yellow and black stripes) demarcating the load manoeuvring zone,
- sensitive or immaterial devices for detecting the presence of a person in the passageway. These devices check for the absence of any persons in the danger zone prior to start-up. When the check is carried out, some devices can be neutralised, except for those devices that detect a person entering the danger zone while parts are moving. In this case, the on-board light or sound signal and the signalling in the free-play zone can be removed.
- "Demande de validation fin de passage" (*End-of-crossing validation request*) control components on either side of the walkway,
- a light and/or sound system which operates during load movements,
- a two-colour light signal on either side of the manoeuvring zone, of the traffic signal type and visible to every pedestrian and vehicle driver/operator:
 - Red = "INTERDICTION de passage" (*passage prohibited*),
 - Green = "AUTORISATION de passage" (*passage authorised*).



When the silhouette effect exercised in the guard does not prove sufficiently dissuasive, an anti-intrusion device must be installed in order to prevent intrusion by the flow into the danger zone (see article 4).

Perimeter of action

Red "Interdiction de passage" (*crossing prohibited*) indicator light on, any attempt to force crossing will cause:

- the tables concerned to come to an immediate halt due to power supply being cut,
- the "Demande de réarmement" (*reset request*) green indicator light to come on flashing.

Fixed green "Autorisation de passage" (*crossing authorised*) indicator light on, the pedestrian can use the passageway, the load cannot move to the place where it is scheduled to cross.

Green "Demande de réarmement" (*reset request*) indicator light on flashing, the pedestrian must activate the reset device in order to restore the power supply and enable the tables to begin operating again:

- following non-compliance with the crossing prohibition (red indicator light on),
- presence in the passageway when the installation goes from the "Autorisation de passage" (*crossing authorised*) status to the "Interdiction de passage" (*crossing prohibited*) status.

In some cases a 'Demande de passage' (*crossing request*) is added which enables the installation to be brought to a standstill in a particular configuration (avoiding instances of decycling, keeping the passageway free, etc.).

A check must be carried out prior to each "Autorisation de passage" (*crossing authorised*) signal to make sure that the protective device is in correct working order.

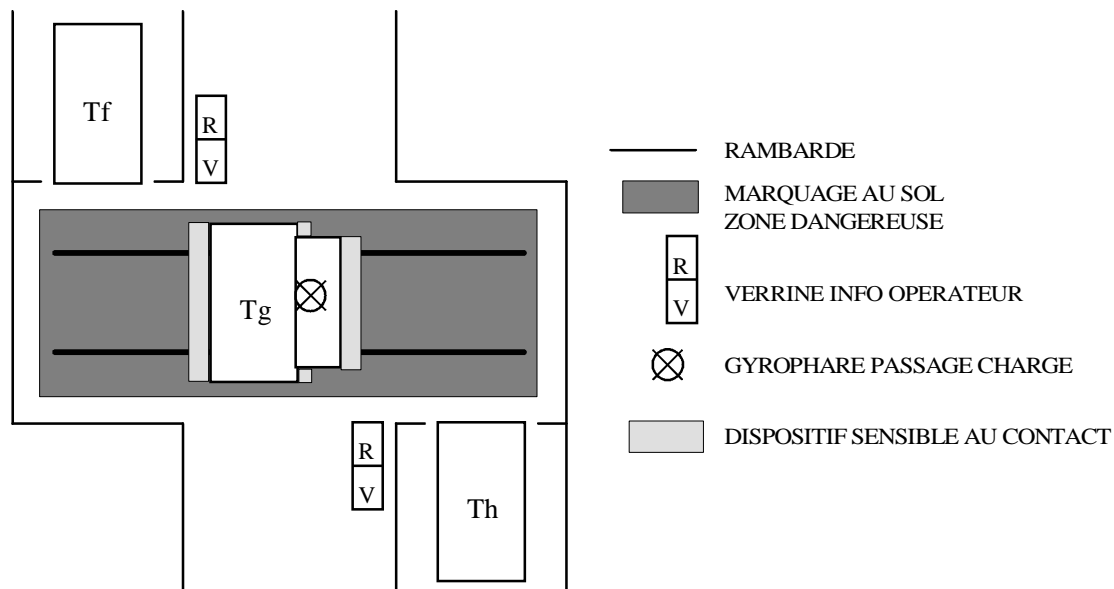
The manoeuvring zone is inspected prior to and during the movement of parts. In this case, the light and/or sound system in the free-play zone are of no use.

7.5.2 Simple conveyor table (with no rotation movement)

7.5.2.1 If the displacement speed is between 10 and 40 metres per minute

The passageway is equipped with:

- ground marking (alternating yellow and black stripes) demarcating the load manoeuvring zone,
- a light and/or sound system which operates during load movements,
- a two-colour light signal on either side of the manoeuvring zone, of the traffic signal type and visible to every pedestrian and vehicle driver/operator:
 - Red = "INTERDICTION de passage" (*passage prohibited*),
 - Green = "AUTORISATION de passage" (*passage authorised*).
- sensitive buffers placed on the movable part in the direction of movement, enabling movement to be brought to a stop in the event of a collision.



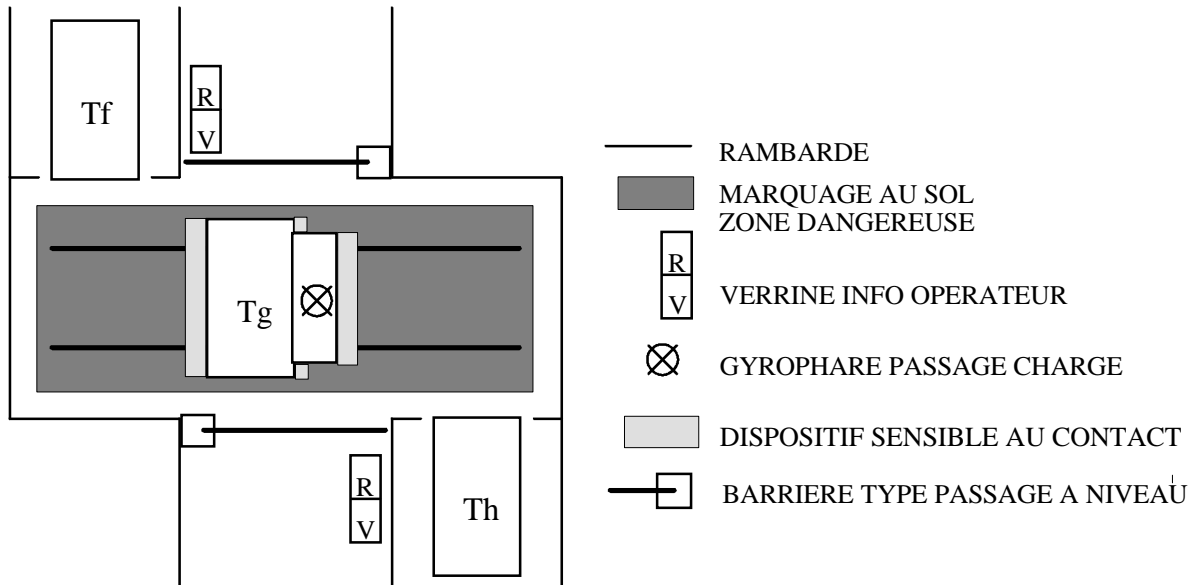
If the load run might lead a person into a risk-prone zone, the installation of a sensitive control device for bringing the moving parts to a standstill (e.g. carpet, servo-gauge, etc.) is required.

If this device cannot be installed, the rules described for when the speed is greater than 40 metres per minute are to be applied.

The detection of the presence of an obstacle by the sensitive buffers stops movement by cutting off the power supply to the conveyor table. Restoring the power supply requires a reset device to be placed in the vicinity of the passageway.

7.5.2.2 If the displacement speed is between 40 and 60 metres per minute

The passageway is fitted out in the same way as in the previous paragraph, to which is added on either side an access device (e.g. "level crossing"-type barrier, cells, etc.).



If the load run might lead a person into a risk-prone zone, the installation of a sensitive control device for bringing the moving parts to a standstill (e.g. carpet, servo-gauge, etc.) is required.

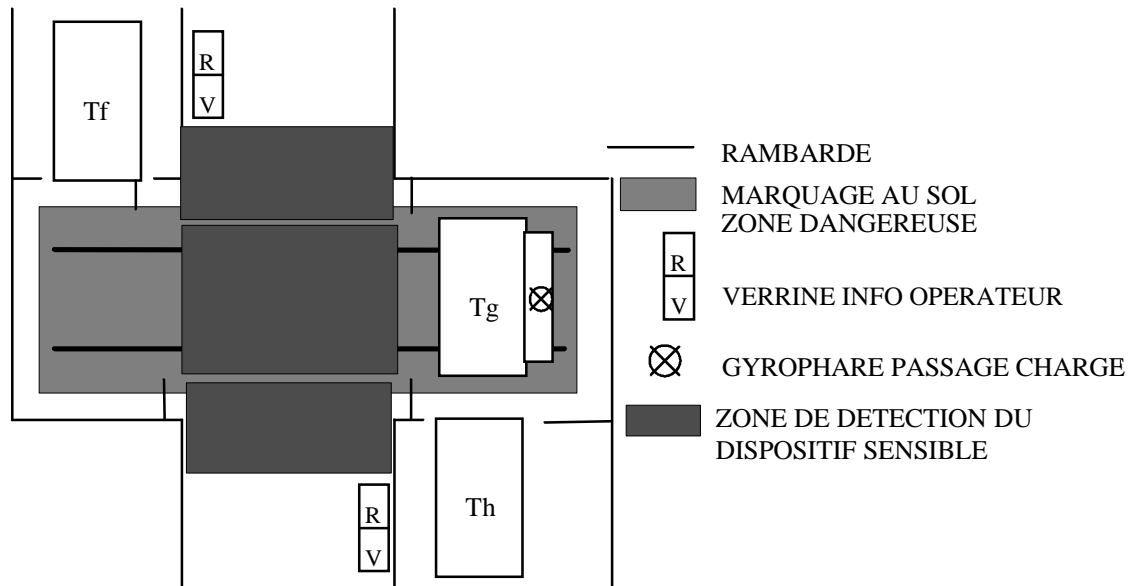
If this device cannot be installed, the rules described for when the speed is greater than 60 metres per minute are to be applied.

The detection of the presence of an obstacle by the sensitive buffers stops movement by cutting off the power supply to the conveyor table. Restoring the power supply requires a reset device to be placed in the vicinity of the passageway.

7.5.2.3 If the displacement speed is greater than 60 metres per minute

The passageway is equipped with:

- ground marking (alternating yellow and black stripes) demarcating the load manoeuvring zone,
- sensitive or immaterial devices for detecting the presence of a person in the passageway. These devices check for the absence of any persons in the danger zone prior to start-up. When the check is carried out, some devices can be neutralised, except for those devices that detect a person entering the danger zone while parts are moving.. In this case, the on-board light or sound signal and the signalling in the free-play zone can be removed.
- "Demande de validation fin de passage" (*End-of-crossing validation request*) control components on either side of the walkway,
- a light and/or sound system which operates during load movements,
- a two-colour light signal on either side of the manoeuvring zone, of the traffic signal type and visible to every pedestrian and vehicle driver/operator:
 - Red = "INTERDICTION de passage" (*passage prohibited*),
 - Green = "AUTORISATION de passage" (*passage authorised*).



When the silhouette effect exercised in the guard does not prove sufficiently dissuasive, an anti-intrusion device must be installed in order to prevent intrusion by the flow into the zone (see article 4).

Perimeter of action

Red "Interdiction de passage" (*crossing prohibited*) indicator light on, any attempt to force crossing will cause:

- the tables concerned to come to an immediate halt due to power supply being cut,
- the "Demande de réarmement" (*reset request*) green indicator light to come on flashing.

Fixed green "Autorisation de passage" (*crossing authorised*) indicator light on, the pedestrian can use the passageway, the load cannot move to the place where it is scheduled to cross.

Green "Demande de réarmement" (*reset request*) indicator light on flashing, the pedestrian must activate the reset device in order to restore the power supply and enable the tables to begin operating again:

- following non-compliance with the crossing prohibition (red indicator light on),
- presence in the passageway when the installation goes from the "Autorisation de passage" (*crossing authorised*) status to the "Interdiction de passage" (*crossing prohibited*) status.

In some cases, a "Demande de passage" (*crossing request*) is added which enables the installation to be brought to a standstill in a particular configuration (avoiding instances of decycling, keeping the passageway free, etc.).

A check must be carried out prior to each "Autorisation de passage" (*crossing authorised*) signal to make sure that the protective device is in correct working order.

The manoeuvring zone is inspected prior to and during the movement of parts. In this case, the light and/or sound system in the free-play zone are of no use.

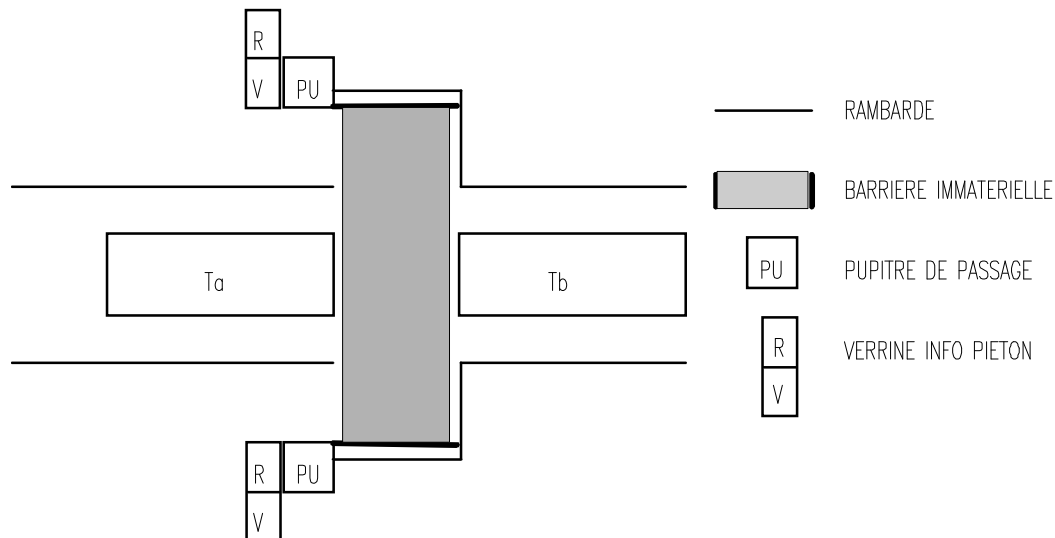
7.5.3 Conveyor with rotation movement

The provisions are the same as in subclause 7.5.2, to which is added a guard on board the conveyor table eliminating any risk due to rotation (except in the case of a presence detection or access prohibition device being already installed).

7.5.4 Pedestrian access crossing a handling path

A pedestrian passage system is installed each time a flow of pedestrians is foreseeable through a dangerous handling path. The passage is fitted out with:

- an immaterial detection device for detecting the presence of a person in the passage,
- "Demande de réarmement" (*reset request*) control components on either side of the walkway,
- a two-colour light signal on either side of the passage, generally speaking 2 indicator lights:
 - Red = "INTERDICTION de passage" (*passage prohibited*),
 - Green = "AUTORISATION de passage" (*passage authorised*).



Perimeter of action

If the red "Interdiction de passage" (*passage prohibited*) indicator light on, any attempt to force the passage will cause:

- the tables concerned to come to an immediate standstill due to power supply being cut,
- the "Demande de réarmement" (*reset request*) green indicator light to come on flashing,
- prohibiting loading of the upstream table unless a mechanical stop makes it possible to physically prevent the load from overstepping the passage.

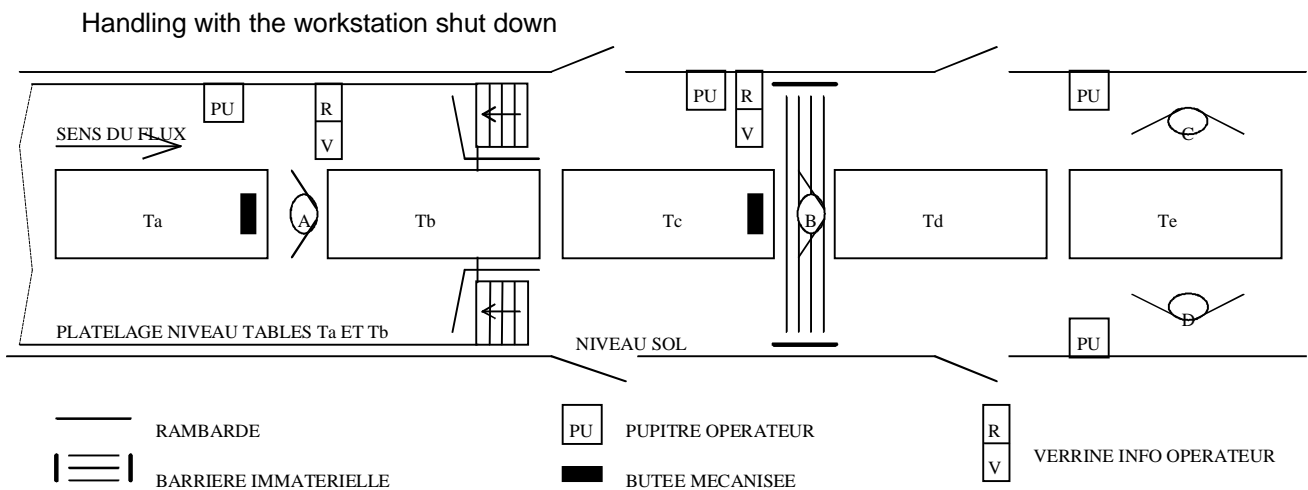
Fixed green "Autorisation de passage" (*passage authorised*) indicator light on, the pedestrian can use the passageway, the load cannot move to the place where it is meant to cross.

Green "Demande de réarmement" (*reset request*) indicator light on flashing, the pedestrian must activate the reset device in order to restore the power supply and enable the tables to begin operating again:

- following non-compliance with the passage prohibition (red lights on),
- presence in the passageway when the installation switches from "Autorisation de passage" (*passage authorised*) to "Interdiction de passage" (*passage prohibited*).

In some cases, a "Demande de passage" (*passage request*) is added which enables the installation to be brought to a standstill in a particular configuration (avoiding instances of decycling, keeping the passageway free, etc.).

A check must be carried out prior to each "Autorisation de passage" (*passage authorised*) signal to make sure that the protective device is in correct working order



N.B. see operator validation consoles clause

7.5.5 Workstation on roller tables

OPERATOR A

When the operator performs his operation at the front or rear of a table (Ta or Tb) and the operators' manoeuvring zone is at the same level as the rolling level of the loads, an automated removable mechanical stop must be installed on the table upstream of the workstation (Ta).

The protective device includes:

- one validation component (button, pedal, etc.) per operator, installed outside the danger zone (with the operator having to move away to validate),
- an operator access signalling mechanism, usually an indicator light with 2 lamps:
 - green = "AUTORISATION" (*authorisation*) and red = "INTERDICTION" (*prohibition*).

N.B. A re jogging device cannot act as a substitute for a removable stop.

Perimeter of action

This protection must guarantee that the load will come to a stop should a mechanical breakage occur (drive chain) and prevent any untimely start-up.

In the event of a loss of power, the stop must keep its position and it must be inspected at each cycle to ascertain that it is operating correctly.

Signalling available to the operator:

- fixed red "Interdiction" (*prohibition*) indicator light on, the protective stop is not active,
- fixed green "Autorisation" (*authorisation*) indicator light on, the stop is active. The operator must validate the end of his job in order to authorise the stop to be deactivated.

7.5.6 Workstation between 2 roller tables

OPERATOR B

When the operator has to carry out a job between 2 tables (Tc and Td) and the operators' manoeuvring zone is below the rolling level of the loads (risks of seizure / shearing), a removable mechanical stop is installed on the upstream table (Tc). An immaterial or sensitive protective device (usually a light beam) is installed in the danger zone in which the operator moves about. The protective device is combined with:

- one validation component (button, pedal, etc.) per operator, installed outside the danger zone (with the operator having to move away to validate),
- an operator access signalling mechanism, usually an indicator light with 2 lamps:
 - green = "AUTORISATION" (*authorisation*) and red = "INTERDICTION" (*prohibition*).

N.B. A re jogging device cannot act as a substitute for the removable stops.

Perimeter of action

By cutting off the power supply, this protective device shall prohibit movement of the load while a person is present in the danger zone.

The device is inspected at each cycle by the operator being authorised access.

An automated removable mechanical stop is installed on the upstream table (Tc) :

- if the load does not come to a standstill quickly when a mechanical breakage occurs,
- or if the protective device is neutralised when the upstream table is loaded (Tc).

In the event of a loss of power, the stop must keep its position and it must be inspected at each cycle to ascertain that it is operating correctly.

Signalling for the operator:

- Fixed green "Autorisation" (*authorisation*) indicator light on, the stop is active. The operator can enter the monitored zone, movement of the load is prohibited by the power supply being cut off.
The operator must validate the end of his job in order to authorise the stop to be deactivated.
- Green "Autorisation" (*authorisation*) indicator light on flashing, reset request, the operator must activate the reset device to restore the power supply.
- Fixed red "Interdiction" (*prohibition*) indicator light on, the protective stop, is not active, an intrusion into the monitored zone causes:
 - the tables concerned to come to an immediate standstill due to the power supply being cut off locally,
 - the green indicator light to come on flashing (reset request).

The operator must activate the reset device in order to restore the power supply, validate the end of his job and, should there be one, authorise the removable stop to be deactivated.

It is prohibited to load the upstream table unless a mechanical stop makes it possible to physically prevent the load from overstepping the passage.

7.5.7 Workstation on either side of the roller table

OPERATORS C AND D

No special safety device is necessary if:

- the operators are not required to work between the tables,
- the roller tables are on the same plane as the one on which the operators move about, or the fairing of the tables is done in such a way that there is no risk of shearing,
- the movement speed of the loads does not exceed 60 metres per minute.

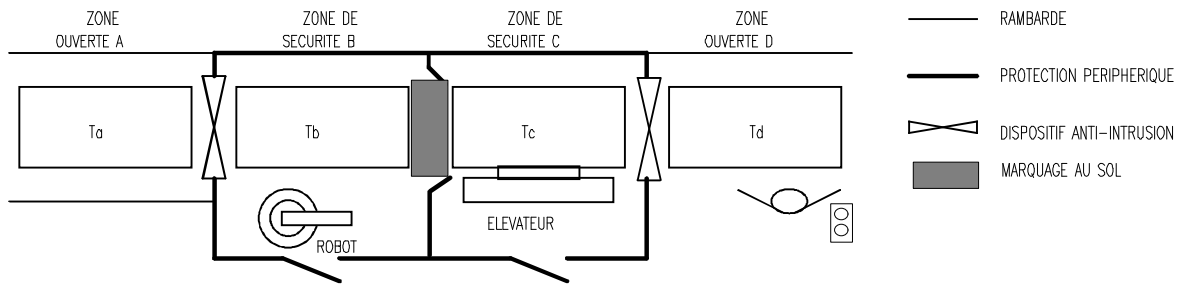
The protective device comprises:

- one validation component (button, pedal, etc.) per operator installed outside the danger zone (with the operator having to move away to validate),
- an operator access signalling mechanism, usually an indicator light with 2 lamps:
 - green = "AUTORISATION" (*authorisation*) and red = "INTERDICTION" (*prohibition*).

Should there be a risk of shearing with the table, or should the loads carried constitute a particular risk, additional devices (light beams, sensitive floors, etc) prohibiting access to the danger zone during movement of the load must be installed.

7.6 Access of flow to protected zones

7.6.1 No risk of falling



7.6.1.1 Access of flow to the safety zone from an open zone

When the silhouette effect is not sufficiently dissuasive, an anti-intrusion device must be installed (see article 4).

7.6.1.2 Access of flow between 2 safety zones

Floor signalling combined with a gauge in the fixed guard marks the device.

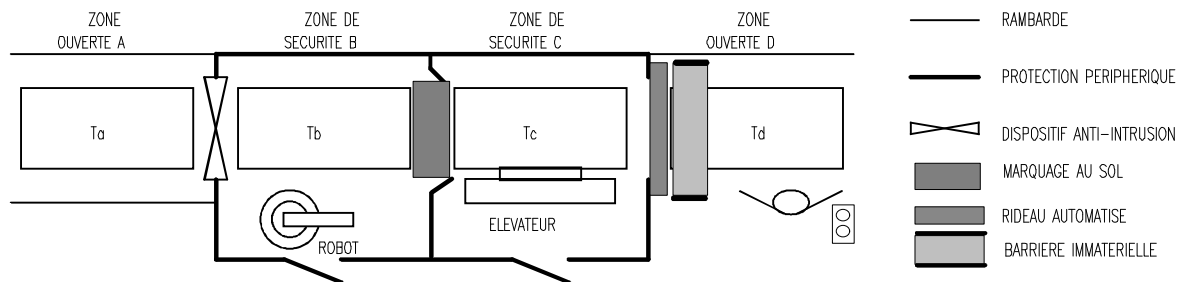
7.6.2 Risk of falling

7.6.2.1 Access of flow to a safety zone from an open zone

ADJACENT OPERATOR WORKSTATION

In the example of zone D to zone C

A movable guard (e.g. curtain) shall be installed to protect from the risk of falling. It is only opened for the crossing of loads.



Should the height of the tables not be sufficient (400mm minimum) to deter an operator from finding himself caught between the load and the curtain, or should the curtain introduce an additional risk (seizure, shearing), a presence detecting device (light beam, sensitive floor, etc.) must be used to check that the operator is absent before authorising opening of the curtain. The device must be inspected at each cycle to make sure that it is in correct working order.

ADJACENT OPERATOR WORKSTATION: REPAIR OR MAINTENANCE PERSONNEL ACCESS

In the example of zone D to zone C

The device is marked by floor signalling combined with a gauge in the fixed guard.

7.6.2.2 Access between 2 safety zones: repair or maintenance personnel access

In the example between zone B and zone C

A movable guard (curtain) preventing falling shall be installed to separate safety zones only during repair or maintenance work.

The protective curtain is:

- either automated with an interlocking device (access gate open if the protective curtain designed to prevent falling is in place),
- or installed manually, complying with repair and maintenance work procedures.

8 List of documents quoted

N.B. For undated documents, the last version in force applies.

Directive 89/392 - Machines directive.

Decree 92-767 art.233-84 – Technical rules of the European directive 89/392.

CEI 60204-1 Sécurité des machines. Equipement électrique des machines. Partie 1 : Règles générales.

EN 954-1 Sécurité des machines. Parties des systèmes de commande relatives à la sécurité. Partie 1 : principes généraux de conception.

E03.15.600.N Sécurité des machines. Equipement électrique des machines.

EB75.04.130 Sécurité condition de travail. Spécification technique. Machines et installations industrielles.