Interlocking Basics

by Randy Mathis

Having a flexible door system enables project engineers to outfit cleanrooms with vision panels on doors, pushplates or other activation devices, magnetic locks, and interlocking systems. The most important feature a door system can have to prevent contamination is an interlocking system.

An interlock, sometimes referred to as an “airlock,” can take many forms. In its simplest form, an interlock comprises two doors, each opening into a separate space, with an airspace between them. The airspace will be referred to as airlock where appropriate in this article. The functional concept of an interlock is to prevent two doors from being open at the same time, therefore preventing air from passing from one space directly into the other. Interlocks are typically used in cleanroom environments and manufacturing areas to preserve air quality and prevent outside airborne particulates from entering process areas. Common areas in cleanroom and production environments using interlocks are personnel entrances and exits, gowning and degowning areas, and material transfer airlocks.

Soft Interlocks

The simplest, albeit least effective, type of interlock is based purely on protocol. This “soft” interlock can be overridden by a person who accidentally or intentionally breaches the air space.

In the most basic soft interlock, each door leading into the airlock has a vision panel (window). A person wishing to enter from either side looks through the window to see whether the opposite door is open or closed. If the opposite door is closed, the protocol allows that person to enter the airlock. If the opposite door is open, the person waits until it is closed before entering.

Adding a position switch to each door that is connected to a controller with outputs to a visual and/or audible indicator is an alternative arrangement. When one door is open, a lighted sign will activate above the opposite door stating, “Do not enter,” or announcing a similar warning. Another method is to use red and green lights instead of a lighted sign. With both doors in the closed position, a green light would indicate that either door can be opened. Once one door is opened, the light on the opposite door turns red, indicating that the airlock cannot be entered from that side. If an audible alarm is added, any personnel violating the protocol by ignoring the lighted indicator and opening a door in breach of protocol will cause the buzzer or siren to sound until one door is closed.

Another simple type of interlock adds automation into the equation. In this case, if an automated door is opened, a position switch will activate, causing the controller to interrupt the activation signal to the opposite door, thus preventing automatic operation. The same go/no-go indicators mentioned previously would also apply to this situation.

Hard Interlocks

Hard interlocks add a locking mechanism into the system to create another level of insurance to prevent violation of protocol. The system requires that each door be equipped with a position switch and an electrically controlled locking device. In the clean environments, these devices are generally electromagnetic devices commonly referred to as “mag-locks.” In this system, both doors are normally unlocked at all times. When one door is opened, the position switch triggers an input signal to the interlock controller, which sends a signal to activate the

Interlocks are used in cleanrooms to provide security, and to preserve air quality and pressure. ASI TECHNOLOGIES, INC. (WWW.ASIDOORS.COM)
Because every airlock that has the most basic airlock electromagnetically necessary functionality.

In addition to the above, an airlock space or on the interlock locking device of the opposite door. The second door remains locked until the first door is closed. Once the first door is closed, the locking signal to the second door is dropped, and both doors return to normally unlocked status until the next input is received at the controller.

The same go/no-go indicators previously described for soft interlocking can be added to a hard interlock system for added communication capability. This is often valuable for employees to understand why a door is locked and they can’t enter the space.

With any hard interlock system, life safety and emergency ingress and egress issues must be considered. At a minimum, the airlock should include an emergency release device to prevent anyone from being trapped inside. It is also common to provide a means of interfacing the facility's building management system with the interlock controller. That would ensure that all doors are unlocked in the event of a fire alarm, sprinkler flow, or other user-defined event.

Hard interlocks are also available for integration in systems with automatic door operators. The functionality remains, but an interrupt signal output is added to the automatic door operator, preventing it from opening a locked door. In addition to simple two-door interlocks, security interlocks, multiple door interlocks, and equipment or process interlocks are solutions to consider.

INTERLOCK APPLICATIONS
Customized Solutions: Because every pharmaceutical manufacturing facility is different, application requirements and needs vary. For example, one company wanted to isolate the operation of a V-blender: a machine for mixing and lubrication of dry powders. To accommodate the requirement for interlocking with a V-blender and the possible future requirement for card reader access at one operation, several pieces of hardware needed to be supplied on the front-end of the project, along with a control system to provide necessary functionality.

Using a pair of Securitron (Sparks, NV; www.securitron.com) electromagnetic locks to prevent the doors from opening when the blender was operating, a position switch was integrated into the frame and door panels. Wall construction can alter the kind of device used for position sensing. It is not always possible to run wires through existing masonry walls for a completely hidden installation. The position sensor and magnetic lock each require a minimum of two wires. If surface mounting of those wires (either in conduit or wire races) is the chosen method, an electronic lock and position sensor can be integrated into the door frame, but wires will need to exit the frame at some point and be routed to the controller location.

Using a request-to-enter or -exit device inside and outside the interlock space was suggested as a starting point for this particular company, because a card reader was a future possibility. Incorporating such devices at the outset allows simulation of controlled access to the room for the short term with a fully operational control logic system and gives the facility the option to migrate to a card reader later. Standard wall-mounted pushplates are typically used, and any switch a customer prefers can be incorporated. A control enclosure with the necessary contacts and logic to achieve the desired access control and personnel safety is also installed. In this example, additional wiring to and from the V-blender interface was required, with assistance for the interface from the blender manufacturer or a knowledgable technician.

The logic for such a system would be as follows: Whenever the door(s) are closed, they automatically lock in place by the electromagnetic locking device(s). When a “request-to-exit” or “request-to-enter” device is initiated, the locks release for a specified amount of time to allow the door(s) to be manually opened. After release, they will close and automatically lock in place again. The exception to this operation would be when the blender is operating. In that case, the “request-to-exit” or “request-to-enter” buttons would be disabled, preventing entry. Similarly, the blender could be prevented from starting when the doors are not fully closed and locked.

It is assumed that the blender is started and stopped from outside the room and that disabling the “request to exit” device is not an issue. If necessary, the “request-to-exit” device could always be active, regardless of the blender’s status. That setup would allow the company to switch out its “request-to-enter” device for a card reader in the future and preserve the intended function of the control system.

In addition to the above, an emergency release device was installed both inside and outside the space. Assuming this is the only means of ingress and egress, either an “e-stop” release or a “break-glass” release can be wired in series with the electronic lock so that the lock(s) will drop out any time a release is initiated. As an alternative to the wall-mounted request to exit device and emergency release station, a crash bar on the door panel(s) can be integrated into the locking devices to release them.
A Necessary Upgrade: One company, which discovers, develops, manufactures and markets vaccines and medicines, required an interlock system that offered increased security and insurance.

Initially in the aseptic vaccine production areas of this facility, soft interlocks were installed on all of the rooms classified as airlocks. When a door to an airlock was opened, a “Do not enter” sign lit up on both sides of the opposite door to warn personnel not to enter. This was not very effective. With the opening of both doors, some areas had audible alarms, and some did not. The effectiveness of the audible alarm eventually wore off as well. Hard interlocks were not used because of foreseeable safety issues regarding egress during a building evacuation.

This pharmaceutical manufacturer had specific criteria for aseptic vaccine production areas. Upon opening any airlock door, the remaining doors needed to be physically locked to prevent loss of room pressurization. Production personnel also needed a means to evacuate in an emergency.

Once production personnel accepted the interlock changes (from soft to hard), the doors have been an added benefit to the production area with regard to cleanliness, cleanability, and reliability in operation.

The range of interlocking possibilities is enormous. Facility managers can consult with door contractors to develop customized solutions for their cleanroom and manufacturing spaces.

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**INTERLOCK VENDORS**

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