

Automated Guided Vehicles (AGVs) and Fire Alarms

Understanding fire control system interfaces and egress requirements for hospital robots.



Overview

TransCar® Automated Guided Vehicles (AGVs) travel through hospital corridors, onto elevators and through fire doors as they execute orders to transport materials in carts. Proper planning of space and interfaces can assure safe operation when a fire alarm occurs. This document discusses how AGV Systems interface with hospital / building fire alarm systems, specifically the fire doors and elevators; as well as a discussion on egress requirements. Additional interfaces and system requirements that do not impact fire control or egress requirements are discussed in the white paper, "[Twelve Important Considerations for Planning a Robot-Friendly Hospital.](#)" What is presented here is the most common method of interfacing the AGV System with the hospital fire control system.

Definitions:

AGV System: One or more TransCar Automated Guided Vehicles (robots) that are coordinated by a central PC. Refer to TransCar System Diagram for an illustration of the various connectivity and interface points.

TransCar AGV: A computer- controlled, battery powered Automated Guided Vehicle (AGV) that uses laser scanners with electronic maps to navigate its way through a facility by matching architectural contours or triangulating off of reflectors. AGVs transport carts with various materials through a facility.

TransCar Manager: Windows-based server that efficiently manages movement and traffic for one or more AGVs and interfaces with external devices and systems. The complimentary TransCar Manager Client provides the user interface for configuration and monitoring of the system.

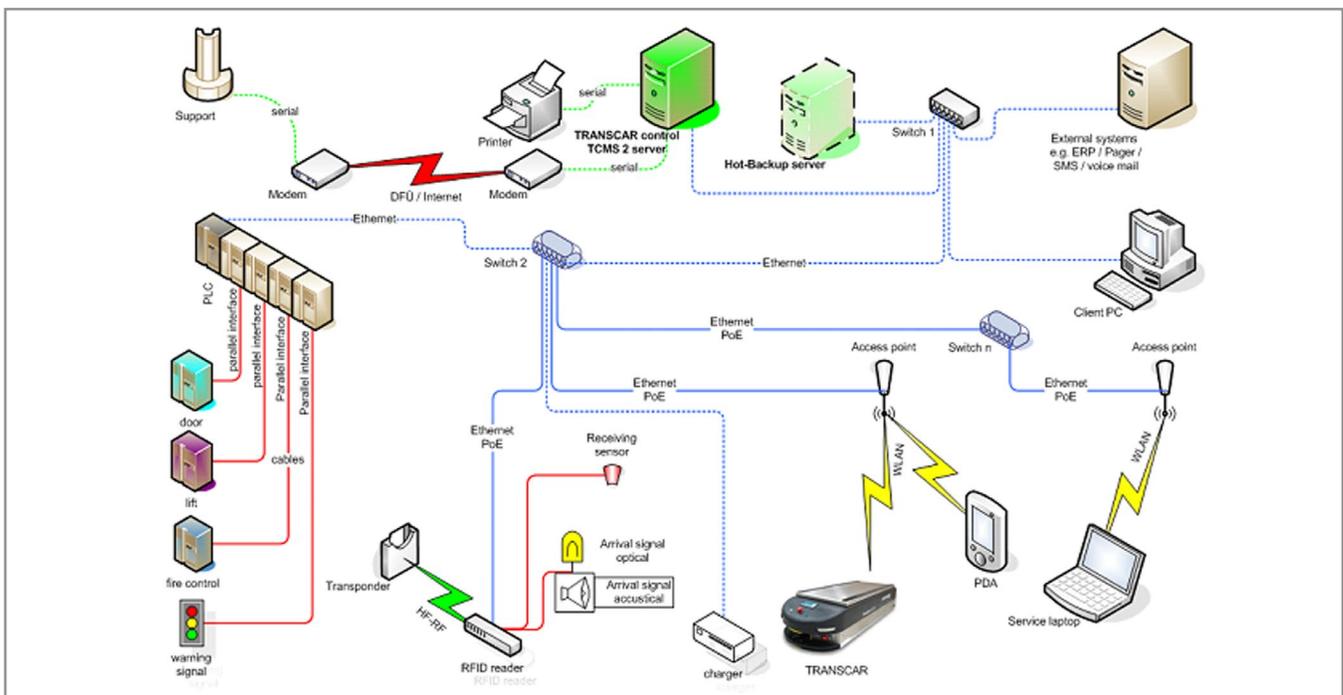
I/O Controller: A Programmable Logic Controller (PLC) that communicates over Ethernet to the TransCar Manager with hard-wired inputs and outputs to door controllers, FCS, Elevators as well as other lights, switches and indicators and peripheral equipment that may exist in the system.

FCS: Facility's Fire Control System.

Authority Having Jurisdiction (AHJ): The local fire authority (usually the City or County Fire Marshal) having jurisdiction over the facility. In government facilities this may be someone inside the organization.

1. Requirements

There are no references in the [NFPA 72 2007 National Fire Alarm Code](#) that recognize robots or AGV Systems or outline specific requirements for interfacing these vehicles with fire doors or providing adequate egress. There are, however, many systems installed across the US and around the world that interface successfully with fire doors and elevators and provide acceptable egress space. These systems were approved for operation by the AHJ and have set a precedent for future reference. The final answer as to what is acceptable rests with the local AHJ. Swisslog representatives are available to consult with users and fire authorities to discuss details of these interfaces as required for project approval. Three categories of interfaces are addressed: elevators, fire doors and egress space.



TransCar AGV System Communications

2. Fire Doors

Normally, fire doors can be closed (and motorized for automatic passage), or held open by a motor operator or electromagnet. Fire doors may be in collections on a fire zone or controlled independently. In any case, fire doors close when there is a fire alarm in the area. This is controlled by the building's FCS.

TransCar AGVs frequently travel through fire doors while en route to their destinations. In order to do so safely, an interface is required to notify the FCS that a vehicle is passing through a doorway. This signal causes a delay in the closing of the fire door so that the closing door does not get blocked open by a passing TransCar AGV. TransCar AGVs have safety switches, sensors and scanners that would be activated by a closing door and thus gridlock could occur if the door closing is not delayed until the AGV has fully passed through the doorway.

Most often fire wall openings in main corridors will include two fire doors. For purpose of this discussion, we assume that both doors operate together in conjunction with one controller. A recent California project, governed and approved by OSHPD, required that the fire door (with a passing vehicle) begin to close within 10 seconds from the initiation of the fire alarm. This closing time is controlled by the FCS. Uninterruptible power supply (UPS) circuits should be used to power the operating mechanism and ensure it has power to hold the door open during vehicle passage, even in the event of a normal building power loss.

As the TransCar AGV approaches a fire door, it will request a door to open (or pass through an already open door). The vehicle's request is communicated via WiFi and hospital network to the TransCar Manager. The TransCar Manager will first verify that there is no fire alarm active for that door. If there is a fire alarm, the TransCar AGVs will travel to their designated locations as described in the section on egress space.

If there is no fire alarm at the time a TransCar requests passage through a fire door, the TransCar Manager sends a request to the I/O Controller to send a signal to the door controller to "Open the Door." The motor operator opens the door (unless the door is already open) and a switch on the door (or two switches, one on each door) signal back to the I/O Controller (and the TransCar Manager) that the "Door(s) is/are completely open".

Once the "Open the Door" and "Doors are Open" signals have been exchanged, the TransCar Manager signals the FCS (via the I/O Controller) that a vehicle is passing through the doorway. The FCS then instates a delayed closing for that door if there is a fire alarm condition. When TransCar is clear of the fire door swing path, the "Open the Door" signal is released, indicating to the FCS that it can now safely close the fire door. If there is a fire alarm condition, or the "doors are open" signal is not received by the requesting TransCar robot, it will stop outside the door swing envelope and the desired egress space.

3. Elevators

Vertical transport can be via material cart lift ([ASME B20.1 Safety Standard](#)) or elevator ([A17 Safety Code](#)). The vertical lift may not have to be a full-fledged elevator, depending on state codes and other uses, especially if the elevation change is only a few feet. In either case, the TransCar lifts are best dedicated to TransCar operation when transport volumes demand full-time or even majority use. Some applications require multiple dedicated lifts. If elevators are recalled to the primary or secondary fire service level upon fire alarm for use by firefighters, a TransCar in the cabin during the alarm will be directed to temporarily abort its current job and leave the cabin (on whichever of the two recall floors the cabin is at) so it can park out of egress lanes on those landings.

If elevators are dedicated to AGV operation and not for patients, staff or visitors, then the AHJ should be consulted as to whether or not the elevators need to have operator buttons in the cabin, or on the landings and whether they can be right

sized for the AGV itself (saving space). See "[Twelve Important Considerations for Planning a Robot-Friendly Hospital](#)" for minimum elevator dimensions and capacities for AGV operation.

A detailed control interface specification is available upon special request from Swisslog at healthcare@swisslog.com. It outlines all signal timing and interchanges between the TransCar Manager (via the I/O Controller) and the elevator controller. The most important elevator signal with respect to operation during fire alarms is the Fire Alarm Signal (FAS). This signal is fail safe, meaning that lack of power indicates the fire alarm is active.

The FAS is checked by the TransCar Manager every time a transport on the elevator is required and before requesting transfer to any floor landings. When a fire alarm is active, a request for elevator service will not be placed. A fireman's fire service key overrides any automatic commands and the vehicle will exit the cabin upon arrival at the fire service floor.

4. Egress

Egress space is the amount of clear and unobstructed space available in a corridor used by people to safely exit a building. Egress space requirements vary somewhat based on building type and occupancy, but in most cases for hospitals it is a minimum of 5 feet and sometimes as much as 8 feet. The most common question with respect to TransCar AGVs operating in an egress corridor is – "Are they considered an obstruction even though they travel, and have a manual controller on board so they can be driven manually out of egress lanes?" More often than not, the answer is "Yes." The follow-on question is, "How does the system gain acceptance by the AHJ?"

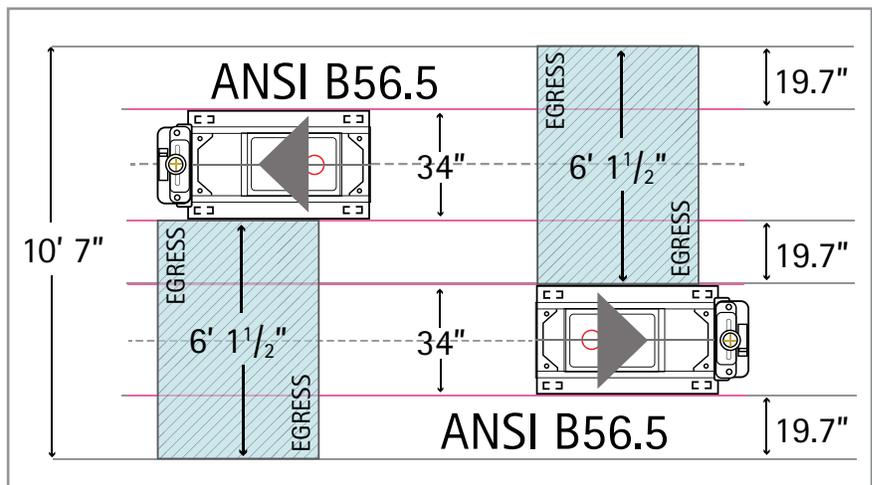
The answer lies in one of a series of possibilities, first of which is a facility with wider corridors where the system operates. This may be achievable only if a hospital is in its early design phase. The need for an AGVs is best identified in the programming phase, so proper corridor widths can be planned. There are also space considerations with respect to elevator and elevator lobbies with cart send and receive positions that are addressed during the early design phases.

5. New Building Corridors

Large systems usually have two lanes to accommodate traffic flow in both directions at the same time. Two lanes often neck down to a single lane at fire doors and sometimes at corners. The TransCar Manager controls AGV traffic so that only one robot is in the single bi-directional travel section in a fire doorway at a time. An exception to two lanes of traffic is a single vehicle system or systems designed with a circular traffic flow in separate corridors.

Following is an example of a corridor with a two 34" (.86 m) lanes of robot traffic. The 19.7" (0.5 m) between the wall and the side of a passing vehicle (or its load) is recommended by the [ANSI/ITSDF B56.5-2012 Safety Standard for driverless, Automatic Guided Industrial Vehicles and Automated Functions of Manned Industrial Vehicles](#).

In the layout (right), the 10'-7" aisle provides 6' 1½" of egress space. In a previous hospital installation in California, where the Office of Statewide Health Planning and Development (OSHPD) is the AHJ, a 5'-0" egress space is required. Six-foot egress is also achievable with a 10'-0" wide corridor by reducing the 19.7" dimension between the passing vehicles to 12" (.3m). It is recommended that floor colors be used to denote the vehicle's travel envelope so that people can see its intended travel path.



During a fire alarm condition, the locations at which the vehicles stop can be controlled so they do not stop in fire doorways, directly across from each other or in other locations where there is less than desirable egress space. It is also possible to create alcoves that vehicles will drive into (freeing the corridor completely) during a fire alarm, but this takes additional space for the alcoves, which are subject to being filled up with other materials – preventing vehicle entry. Vehicles en route will stop between fire doors, so AGV stopping locations should be defined for each corridor stretch between fire doors.

6. Existing Buildings

Existing facilities or ones in the latter stages of design development are more challenging for AGVs because there is little flexibility for changing a corridor's width. Many hospitals are built with 8-foot wide corridors, so a single 34" wide travel lane (with 1'-7 11/16" between the vehicle and adjacent wall on one side for ANSI space) will leave only 3'-6 5/16" egress space on the opposite side. With proper markings, warnings, etc. the 3 feet could be increased to 4' by reducing the ANSI space to 6" less than recommended. Alternatively, alcoves (or non-egress corridor space) designated in between each set of fire doors for TransCar to travel into during a fire alarm might be possible.

Egress space should be discussed with the AHJ early in the process to gain a mutual understating of the requirements and provide guidance for the design team to properly plan a robotic delivery system. It may be possible to review designated egress corridors and avoid travel in them or use / create non-egress spaces for vehicles to travel into during an alarm condition. Alternatively, or in addition, the emergency evacuation plan might include designated personnel to locate and manually drive vehicles (with manual control pendant) to safe locations, similar to what would be done with manually pushed carts.

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About the Author:

Jeff Barber has been involved in designing, estimating, sales, project management and installation of automated material handling systems for 35 years, including pneumatic tube systems, track vehicles and AGVs, primarily in hospitals. He holds a BS in business administration from Mt. Scenario College in Ladysmith, Wisconsin. Additionally, Jeff completed a management training program with emphasis on electrical and mechanical engineering.

About Swisslog Healthcare Solutions

Swisslog Healthcare Solutions (HCS) is the leading supplier of automation and software solutions for [materials transport](#) and [medication management](#) in healthcare facilities. Swisslog has installed facility-wide and pharmacy automation systems in more than 3,000 hospitals worldwide, including more than 2,000 in North America. Denver-based Swisslog Healthcare Solutions offers total system design, manufacturing, installation and customer support—providing an integrated solution for lean workflow and operations that enhances information access, patient safety and cost efficiency.

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