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**Federal Railroad  
Administration**

# Research Results

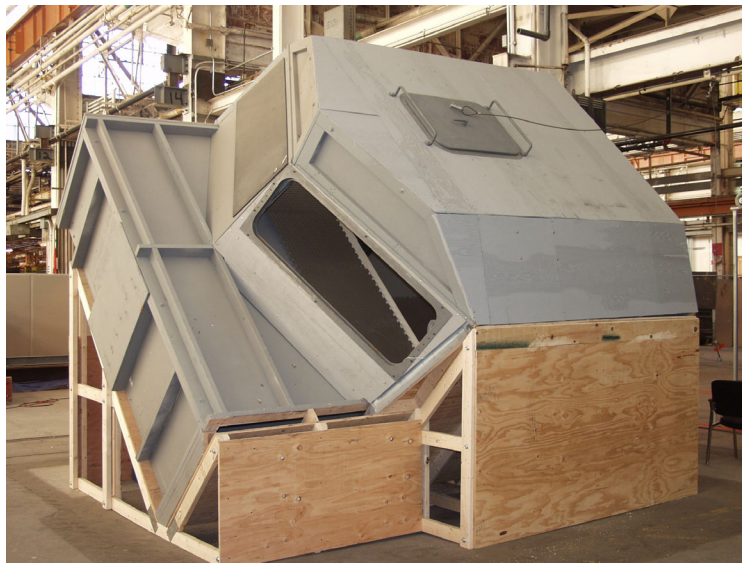
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## **Locomotive Crew Egress**

### **SUMMARY**

The Federal Railroad Administration (FRA) Office of Research and Development initiated a research project to develop and evaluate innovative concepts for locomotive crew egress in the event of a crash that makes the normal means of egress unusable. Locomotive operating crews and rescue workers need improved means of cab egress and access in the event of an accident. Although present regulations and practices address this need in a limited way, further measures could provide substantial improvements in the survivability of crews. This program has focused on three innovative egress concepts that would be of particular use following a crash that toppled the locomotive or prevented use of the front and rear doors. These concepts are 1) roof-mounted escape hatch with hand/foot holds to facilitate reaching the hatch 2) easily removable door hinges and 3) windshield that is removable from the cab interior. A fourth concept, automated collision notification (ACN), determines that a crash has occurred and places a phone call to report the crash. The roof-mounted hatch system was fabricated as a working prototype and installed in a full-scale mockup of a toppled locomotive. Usability testing with experienced train crewmembers and emergency responders demonstrated the usability of the system under 90° and 45° toppled scenarios. The removable door hinges have been fabricated and installed in a crash test locomotive. A prototype hatch egress system is being installed in a demonstration locomotive. A prototype windshield system is ready for installation in a demonstration locomotive.



***Figure 1. Prototype roof-mounted hatch egress system installed in partially toppled cab mockup***



## BACKGROUND

Current federal regulations as well as industry standards and practices address various aspects of locomotive cab design with respect to crew egress. Elements of FRA's safety standards in 49 CFR deal with overall locomotive crashworthiness and glazing. The American Public Transportation Association (APTA) has developed standards and recommended practices that pertain to emergency evaluation and crashworthiness of passenger equipment. While there is a substantial body of existing rail industry and equipment standards that relate to some cab egress issues, the FRA felt there was a need to specifically address the issues of crew egress, crew survivability, and access to the crew in the event of an accident.

### Current Egress Options

Current freight locomotive designs offer three options for emergency egress: side windows, front and rear doors, and the windshield. None of these provides adequate access in the event of a toppled locomotive. Table 1 summarizes the sizes and limitations of each of these options.

**Table 1. Existing Locomotive Egress Options**

| Option           | Size                   | Limitation(s)  |
|------------------|------------------------|--|
| Side windows     | 33 x 26 in (max)       | Difficult to access in rollover                              |
| Rear door        | 18 x 73 in             | Accessible in roll-over if locomotive rolls to opposite side |
| Front inner door | 22 x 69 in             | Limited access with body board                               |
| Front outer door | 23 x 64/59 in          | Limited access with body board                               |
| Windshield       | 51 x 18 in (each pane) | Impact-resistant glazing, difficult to remove                |

Locomotive cabs can generally be accessed via two doors. A contemporary wide nose freight locomotive has an entry door at the right rear-facing corner, plus a front door in the nose. Doors in the cab open outward. However, the door opening widths may be insufficient to accommodate emergency responders. Both doors and windows may become deformed in crashes, thus hindering operation.

Windows are either single or double slider units, except some older models that may have a double-hung design. A few new locomotives,

such as the F59PHI passenger model, have a push out emergency window. Side-opening windows appear to have adequate dimensions to enable their use for emergency egress, but since the window may be blocked in a rollover or be inaccessible following a crash, there is need for another option.

### Innovative Egress Concepts

Current egress options, as described above, are inadequate in the event that the locomotive is toppled in an accident. Three concepts that offer improved egress under this and other situations are the following:

1. Roof-mounted hatch system with hand/fooholds to aid climbing inside a toppled locomotive.
2. Easily removable door hinges.
3. Internally removable windshield.

In addition, the automatic collision notification system can alert railroad officials once a crash has occurred.

### Review of Concepts

Focus groups with locomotive engineers and conductors provided a forum to gather information about train crew perceptions of the candidate designs. Overall, participants viewed the hatch concept with hand/fooholds to aid access as a significant improvement in cab egress. Participants unanimously agreed that the hatch would provide the quickest escape for the crew and that it would provide the quickest access for rescue workers. They also favored a windshield that could be released from the cab interior since it would provide the crew with an additional egress route.

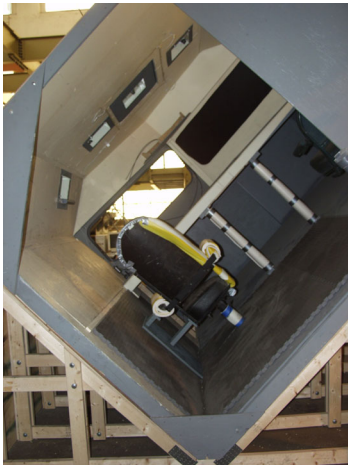
Interviews with rescue personnel indicated that the major issues of concern to rescue personnel are ease of access and personnel safety. Compared to current procedures, the hatch would make it much easier to get into the locomotive cab and rescue an injured person.

### Hatch System Design

Construction of a system mockup facilitated evaluation of the hatch system concept (see Figure 1). A full-sized locomotive cab, with an integrated hatch and hand/foohold system was constructed. The mockup is a wood-framed, plywood-sheathed structure representing a "generic" freight locomotive cab.



Figure 2 shows an interior view the cab mockup with the hatch system. Figure 3 shows an interior view of the hatch cover. Figure 4 shows the hand/foothold in the stowed position. The rungs are hinged so they can be folded flush to the ceiling when not in use, and folded down to allow access to the roof hatch. The hatch system includes two hand/footholds below the hatch and two above the hatch in the rolled-over orientation.



**Figure 2. Interior view of rotated cab mockup with hatch system**



**Figure 3. Interior view of hatch cover**



**Figure 4. Hand/foothold in stowed position**

To provide insight into the utility and effectiveness of the hatch and hand/foothold concepts, two sets of usability tests were

conducted, one with the cab toppled at 90° and a second at 45°. An uninjured crewmember was able to exit via the hatch in under 20 sec in both scenarios. Emergency responders removed an “injured crewmember” in under 10 min. Vibration and moisture tests of the prototype hatch did not find any deficiencies.

### Removable Door Hinges

This innovative door hinge attachment is designed to facilitate removal of the cab rear door when deformation of the cab and the doorframe prevent normal operation of the door. Under emergency conditions, the crew inside the cab can activate the door hinge release mechanism by pushing down on the release handle located on the inner side of the door. The actuation of this handle will move the sliding bar upward. When the fastener nut positions coincide with the large diameter key hole slots, the tension on the bolts will be released and the hinge leaves on the outer side of the door will swing outward, thus disengaging the fastener bolts (see Figure 5.).



**Figure 5. Exterior view of fastener bolts and hinge leaf released from the hinge support block**

The crew can then push the hinge side of the door out of their way and escape. A set of these door hinges is on the rear door of a crash test locomotive at the Transportation Technology Center in Pueblo, CO. To date the hinges have been in one crash test. The easily removable hinge pins provide a means for exterior removal of the door by emergency response personnel.

### Removable Windshield

The current windshield design does not permit easy removal from the cab interior. A means to sever the window gasket from the cab interior will allow crewmembers to use the windshield opening as a means of egress if other options are blocked as a result of a crash.



By imbedding a double twin loop cutting wire in the window gasket, removal of the windshield is possible. With this method each loop cuts half of the gasket on the top of the window, the top outer corner and the entire length of the small vertical side of the windshield. Prototype testing showed that with this amount of the gasket cut, the bottom length of gasket acts as a hinge and the glazing is easily pushed from the windshield. One actuator, a winch, collects both wires, which are inserted through black rubber sleeves as they approach the winch.

Tests with a prototype windshield installed in the mockup indicate that the maximum force required to activate this emergency egress system is 10 ft-lb. The time required to cut the gasket, push out the glazing and exit the cab is approximately 50 s.

### Automatic Collision Notification

By sensing the rapid deceleration following a crash the ACN system determines that a crash has occurred. ACN places a call phone call to a pre-specified phone number to notify the railroad of the crash.

### Ongoing and Future Work

Current work includes the following:

- Installation of hatch system, removable door hinges and removable windshield in FRA's demonstration GP40 locomotive.
- Refinement of installation procedures.
- Development and test of motor actuator for removable windshield
- Crash test of ACN at TTCI.
- Evaluate performance of innovative egress equipment on FRA's GP40.
- Field test of innovative egress equipment in revenue service locomotives.

### Training Video

The training video, "Locomotive Emergency Response Operations," was prepared for emergency response personnel. This video provides rescue professionals with the specifics of locomotive construction and features.

It also describes potential locomotive accident scenarios and suggests appropriate methods for responding to such incidents.

### WANT MORE INFORMATION?

Carter, J., Gertler, J., Kokkins, S., & Acton, S. (2003) *Evaluation of Concepts for Locomotive Crew Egress*. (Report No. DOT/FRA/ORD-03/07) Washington, DC: Federal Railroad Administration.

Kokkins, S. (2002). *Locomotive Crashworthiness Research: Locomotive Crew Egress Evaluation*. (Report No. DOT/FRA/ORD-02/03). Washington, DC: Federal Railroad Administration.

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