

## **FULL DOOR AND COMBINATION DETAILED TEST PROCEDURES**

### **A. Hinged side door latches (other than cargo-type doors) in primary latched position**

#### **1. Longitudinal Full Door Test**

##### Test Equipment

The test equipment consists of:

1. Two 3-inch linear hydraulic actuators (hydraulic rams) each with a 2 foot overall power stroke.
2. Two 25,000 lb load cells (This load capacity to withstand shear loading that may be occurring)
3. Two linear string potentiometers
4. An Allen Bradley servo controller

##### Test Setup

The door is mounted to a section of 3/8-inch thick angle iron (approximately 5 foot long) mounted vertically to a support fixture. The support fixture has horizontal slots milled into the mounting plate while the angle iron has vertical slots milled into one face of the section. These slots allow for the adjustment of the vertical and horizontal positions as well as the roll angle of the door.

The door is mounted to the post using the door hinges. Holes are drilled as needed into the flange of the angle iron to accommodate the door hinges. The pitch angle of the door is determined by where the hinges are mounted on this "door post". The pitch angle is adjusted so that the latch is oriented vertically (within  $\pm 5$  degrees).

This procedure will typically require that a unique set of boltholes be drilled in the angle iron "door post" for each model of door to be tested. The goal is to attach the door to a rigid mount so that, as far as feasible, the loading conditions on the various doors to be kept constant and to ensure that displacement and failure would occur at the door latch. By using specifically drilled holes matched to an appropriate bolt size and using a 3/8" thick piece of metal in which a shear load is applied to hold the door, there should be minimal movement or distortion of the door due to potential slippage of the mounting points or deformation of the mounting structure.

The longitudinal actuator consists of a 3-inch diameter hydraulic ram with a 25,000-pound load cell mounted along the load axis. A steel shaft with the striker is threaded into the end of the load cell. A string potentiometer is used to measure displacement of the actuator.

The longitudinal actuator is adjusted so that the striker is aligned with the door latch and normal operation of the door latch is possible (the door opens and latches normally). For the test, the door is closed so that the door latch engages the striker as designed. The door is left unlocked and the "security" lock is not engaged.

The lateral actuator consists of a 3-inch diameter hydraulic ram with a 25,000-pound load cell mounted along the load axis. A steel shaft with a 3x5 inch loading plate is threaded into the end of this load cell. The loading plate is aligned with the inner edge of the latch opening. During testing, the door tends to exhibit some lateral distortion due to deformation in the hinges or in the body of the door. As a result the loading point of the lateral actuator tends to move or “slip” forward in relation to the latch. If precautions are not taken, then in some extreme cases, this movement can allow the loading plate to slip off of the structural components of the inner door and push directly against the linkage rods connecting the door latch to the latch handles causing premature latch activation. The 225-pound lateral load is applied to help identify a definite failure of the door latch, as the door will tend to spring open when the latch fails.

#### Pre-test Conditions

1. The door is mounted to the angle iron such that the door is positioned vertically in the roll axis and the door around the latch is positioned vertically along the pitch axis. The internal padding/insulations/ decorative panels are removed from the door before testing.
2. The longitudinal actuator, with the striker mounted in line with the load cell, is positioned at the correct height and placement to fully engage the door latch.
3. The door is “shut”, in such a manner as to fully engage the door latch with the striker.
4. The door is not locked and the security lock is not engaged.
5. The lateral ram with the 3"x5" loading plate is run up to the door at the latch point. The outer edge of the loading plate is placed as close to the latch as possible without jeopardy of accidentally interfering with the movement of the striker or the fork bolt of the latch during the test. Typically this means aligning the outer edge of the loading plate with the inner edge of the latch opening.

#### Test Procedure

1. The lateral ram loads the door/latch assembly to 1,000 N and maintains this load throughout the course of the test.
2. After reaching the lateral load of 1,000 N, the longitudinal ram moves the striker away from the latch, causing tension at the interface, at a rate of 2 cm per minute until a force of 17,000 N
3. After reaching the longitudinal load of 17,000N, compliance is achieved by maintaining the loads and not separating for at least 10 seconds

## **2. Lateral Full Door Test**

### Test Equipment

The test equipment consists of:

1. One 3 inch linear hydraulic actuator (hydraulic ram) with a 2 foot overall power stroke.
2. One 25,000-pound load cell.
3. One linear string potentiometer
4. An Allen Bradley servo controller

### Test Setup

The door is held rigidly in place while the striker, attached to a linear actuator (hydraulic ram), loads the latch assembly in tension (in the direction of door opening).

The door is mounted to the angle iron of the door pillar in the same manner as outlined for the longitudinal full door test. The motion of the door is restrained by a 12" x 24" loading plate rigidly mounted to prevent rotational movement of the door about its hinges or lateral movement due to loading from the actuator. The striker is securely attached to a metal fixture that is installed in line with the load cell to the hydraulic actuator.

The fore and aft (longitudinal) placement of the loading pad has a potentially significant effect on the interactive door/door latch response. The closer the loading plate is positioned to the latch, the less effect deformation, mounting points, etc. of the door has on the test results, thus eliminating the need for a full door test. Place the loading plate approximately 1 inch from the forward edge of the latch opening.

### Pre-Test Conditions

1. The door is mounted to the angle iron such that the door is positioned vertically in the roll axis and the door around the latch is positioned vertically in the pitch axis. The internal decorative panels are removed from the door before testing.
2. The "lateral" actuator, with the striker, is adjusted to the correct height and position in relation to the door.
3. The door is "shut", in such a manner as to fully engage the door latch with the striker.
4. The loading plate is positioned approximately one inch forward of the latch opening. This loading point is marked on the door and documented for future reference.
5. The door is unlocked (the security lock is not engaged).

### Test Procedure

1. The ram is retracted at a constant displacement rate of 2.0 cm/min applying a lateral tensile force of 14,000 N to the door near the door latch.
2. After reaching the lateral load of 14,000N, compliance is achieved by maintaining the load and not separating for at least 10 seconds

### **3. Combination Full Door Test**

#### Test Equipment

The test equipment consists of:

1. A simulated test device. A ½ inch thick aluminum plate is prepared for mounting the latch mechanism. This involves cutting a notch in the plate so that the striker and longitudinal shaft can apply load to the latch mechanism with interfering with the aluminum plate. Holes must be drilled and tapped into the plate to allow mounting of the latch mechanism, and
2. One latching system, which includes latch and striker

#### Pre-test Conditions

1. The trolley with the latch is positioned and the longitudinal ram is run down to engage the striker with the latch in the primary latched position.
2. Movement of the latch is constrained in a direction along the vehicle's transverse axis

#### Test Procedure

1. The lateral ram loads the latch to 6,650 N and maintains this load throughout the course of the test.
2. When the lateral load of 6,650 N is reached, the longitudinal ram applies a 16,000 N compressive load on the latch at a displacement rate of 1.0 cm/min.
3. After reaching the longitudinal load of 16,000N, compliance is achieved by maintaining the load and not separating for at least 10 seconds

## **B. Sliding Door Test**

### Test Equipment

The test equipment consists of:

1. A vehicle structure, complete with sliding doors assembly and all door-retention and load-bearing components.
2. Two loading devices, or rams, capable of applying the outward transverse load requirements
3. Two load cells of sufficient capacity to measure the applied load
4. Two linear displacement measurement devices required for measuring ram displacement during the test. [Note: Deflection measurements are necessary if the load is to be applied at a constant displacement rate, or if maximum displacement is a criterion.]
5. Equipment for measuring and recording the applied load and the ram displacement rate.

### Pre-test Setup

1. Remove all interior trim and decorative components from the sliding door assembly.
2. Remove seats and any interior components, which may interfere with the mounting and operation of test equipment.
3. The rams and associated support structure are mounted rigidly to the floor of the test vehicle. [Note: We are specifying that the loading rams are mounted inside of the vehicle. This is the way the equipment was set up at VRTC and DTL. Transport Canada mounted the rams exterior to the vehicle, which requires a method to rigidly restrain the vehicle. This should be discussed in the preamble - and comments sought.]
4. The load application structure shall consist of two loading plates joined by a longitudinal member (spacer) attached to the centers of the loading members.
5. Determine the forward and aft edge of the sliding door (or its adjoining vehicle structure), which contains a compliant latch/striker. The door edge containing such a latch/striker, and the opposite door edge, are to be tested. If adjacent door edges contain a compliant latch/striker, either side, and its opposite, may be tested.
6. For forward and aft door edge to be tested that contains exactly one compliant latch/striker, the following set-up procedures are to be used:
  - a. The loading plate shall be 152 millimeters (6 inches) in length and 51 millimeters (2 inches) in width.
  - b. Locate the loading device and loading plate such that the applied load will be horizontal, normal to the vehicle's longitudinal centerline, and centered on the door-mounted portion of the compliant latch/striker. Any non-compliant door retention components on this door edge are to be ignored in this set-up.
  - c. The loading plate should be positioned as close to the edge of the door as possible. It is not necessary for the loading plate to be vertical.
7. For any door edge to be tested that contains more than one compliant latch/striker, the following set-up procedures are to be used:
  - a. The loading plate shall be 304 millimeters (12 inches) in length and 51 millimeters (2 inches) in width.

- b. Locate the loading device and loading plate such that the applied load will be horizontal, normal to the vehicle's longitudinal centerline, and centered on a point mid-way between the outermost compliant latch/strikers. Any non-compliant door retention components on this door edge are to be ignored in this set-up.
  - c. The loading plate should be positioned as close to the edge of the door as possible. It is not necessary for the loading plate to be vertical.
8. For any door edge to be tested that does not contain at least compliant latch/striker, or that contains only non-compliant door retention components, the following set-up procedures are to be used:
  - a. The loading plate shall be 304 millimeters (12 inches) in length and 51 millimeters (2 inches) in width.

#### Test Procedure

1. After the sliding door is closed, and the load application structure is placed so that the force application plates are in contact with the interior of the sliding door, both force application devices are moved at a rate of 5 mm per minute until a force of 8,900 N is achieved on each ram or until the rams displace 460 mm from their initial position.
2. If one of the force application devices reaches the target force of 8,900 N prior to the other, 8,900 N force is maintained with that force application device until the second force application device reaches the 8,900 N force or 460 mm of displacement.
3. After reaching the combined target force of 17,800 N, compliance is achieved by maintaining the load and not separating for at least 10 seconds