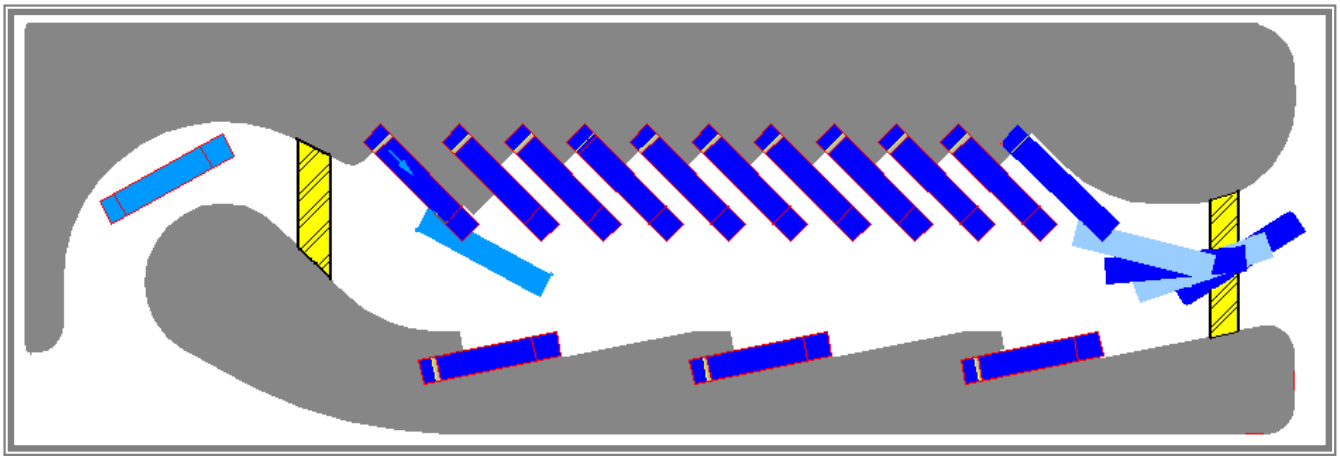
US Department of
Transportation
**Research and
Special Programs
Administration**



ITC Field Test Memorandum
For
Independence National Historic Park

December 21, 2000

Prepared for
**National Park Service
Northeast Region
200 Chestnut Street
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Memorandum

To: Distribution

CC:

From: David Spiller/49, Barry Mickela/36

Date: 12/21/2000

Re: ITC Field Test Evaluation Report

This memorandum documents a field test conducted on October 26, 2000 in Philadelphia, PA for the proposed Independence Transportation Center (ITC). The ITC is a bus depot to support visitation to the National Constitution Center (NCC) and the National Park Service's Independence Mall Historic Park (IMHP). The subject of the field test is a proposed final design for the ITC that evolved from an independent design review of alternative options. The US Department of Transportation's Volpe National Transportation Systems Center conducted the design review[1] at the request of the US Department of Interior's National Park Service (NPS). The design review was conducted in collaboration with all of the public and private stakeholders[2].

ITC Field Test: Narrative, Objectives, and Test Limitations

The ITC Field Test was conducted on 10/26/00 at the Philadelphia Naval Business Center (formerly the Philadelphia Naval Yard). Layout of the ITC facility was initiated and completed on 10/25/00 by a professional surveying firm using a 'final' design architectural drawing provided by the architects to the NCC, Pei Cobb Fried and Partners (PCF). A north-south and east-west control line with station markings was added at US DOT/Volpe request to provide reference markings as a basis for all position measurements. On the morning of 10/26/00, US DOT/Volpe and US DOI/NPS staff completed the layout by the placement of cones. The test setup and the need to simulate the vertical elements (bollards) at the terminus of each bus berth[3] dictated this placement. Figure 1 illustrates the schematic (drawing SKA-

[1] US DOT/Volpe also suggested new options as well as design modifications to improve the safety and efficiency of other options.

[2] Agencies of the City of Philadelphia, National Constitution Center, National Park Service, and architectural and traffic engineering consultants to the City of Philadelphia and the National Constitution Center.

[3] Simulation of the vertical elements (i.e., the bollards) at the terminus of each bus berth was essential to insure that buses docking at each berth were properly placed with respect to the bus berth and the central aisle. In the absence of wheel stops, which will be in place when the ITC is built, the cones provided visual guidance. The cones allowed the bus drivers to maneuver their buses into the bus berths with the proper overhang of the bus. Consequently, the tail of the bus was positioned as intended with respect to the central aisle, permitting maximum maneuvering space, given the design, for entering or exiting each bus berth.

319, 16 October 00) used for the layout. Susan Lowance, architect at PCF, verified the layout. US DOT/Volpe, US DOI/NPS and Orth Rodgers & Associates staff made secondary checks of the proper translation of dimensions, distances, angles and critical elements of the design to the ground. All parties agreed that the test layout accurately represented the intended design, except for the limitations mutually agreed to and detailed below. Five (5) design vehicles (i.e., a 45' 55 passenger motor coach) were made available as test vehicles. Test drivers were experienced in commercial, over-the-road long-haul operations. Additionally, two (2) bluebird full-size school buses were also made available for several test maneuvers. All test drivers walked the test facility before initiation of the set of tests to acquire a quick familiarization of the design.

Objectives of Field Tests

1. Verify that all physical maneuvers within the ITC[4] are feasible irrespective of the occupancy configuration of the bus berths.
2. Assess the safety of operations with respect to bus-to-bus separation, bus-to-control personnel separation, and bus-to-pedestrian/passenger separation using qualitative observations and quantitative measurements.
3. Assess efficiency of safe, control sequence operations during severe and worst-case test scenarios.

As previously noted, several limitations in the test facility and setup constrained full fidelity of the simulated bus operations within the ITC. Interpretation and qualification of the test results necessarily must be made in the context of these limitations to the extent that the test protocol design can not compensate for these constraints. The limitations included the following:

- Inability to duplicate actual vertical grades within the ITC facility, and therefore the effect this would have on vehicle performance, sight-lines, and throughput;
- Inability to duplicate building structures that also affect actual sight-lines between drivers of pairs of buses, or between drivers of buses and potential pedestrian movements on walkways;
- Lack of presence of vertical barriers[5] that are elements of the design and that affect bus stationary positions and circulation, and pedestrian stationary positions within designated waiting areas, and pedestrian circulation;
- Inability to adequately duplicate pedestrian flows either along planned walkways and crosswalks or in unintended and somewhat unpredictable pathways.
- Inability to adequately simulate peak hour bus and pedestrian flows and their mutual interaction within the ITC, or the interaction of buses with vehicles on the adjacent roadways[6].

ITC Field Test Protocol Design

[4] Physical maneuvers include entering the ITC Facility, docking at any bus berth, backing from any bus berth, and exiting the ITC Facility.

[5] These vertical barriers include pedestrian fences at the edge of the shallow bus berths and the central aisle, bollards at the terminus of each bus berth and curbs at the facing of each bus berth, wheel stops within each bus berth, curbs at the facing of the turnout pedestrian apron and terminus of the eastern island, a vertical fence blocking pedestrian flows on the 5th street crosswalk, and a vertical fence on the eastern edge of the eastern island to prevent inadvertent falls onto 5th street.

[6] This would include the NCC garage driveway entrance and the interaction of arriving buses with entering and exiting vehicles to the garage. It also includes the effect of vehicular queues on the adjacent roadways on the propagation of queues within the ITC and the blocking of bus berths therein.

All parties agreed that US DOT/RSPA/Volpe would develop the test protocol. It would build on the initial document prepared by US DOT/RSPA/Volpe, "ITC Verification Test". That document provided a brief on the nature and rationale of the tests to be conducted, the criteria for evaluating test outcomes, and the requisite materials for the test setup. Specifically, the test protocol would:

- Delineate each of the tests to be undertaken
- Identify the sequence of events and the actions to be taken by drivers and controllers respectively
- Develop quantitative criteria and methods of recordation of each test[7]
- Develop qualitative criteria and methods of recordation of each test[8]

The ITC Field Test Protocol, Driver Instruction Sheets, and Driver Survey are incorporated herein by reference and as Attachments A, B, And C respectively.

ITC Field Tests: Observations and Measurements

Session 1 Quantitative Measurements with Observations

Set up: All buses waiting in bus holding area (in consecutive order A to E).
Barrels placed along right side of exit-turnout and on both sides of entrance crosswalk.

Session 1 designated reference points: Lateral measurements are referenced from the perpendicular off the centerline (CL). Longitudinal measurements are referenced from the perpendicular off the entrance crosswalk (CW). See Figure 1. All bus berth numbers are identified on Figure 1.

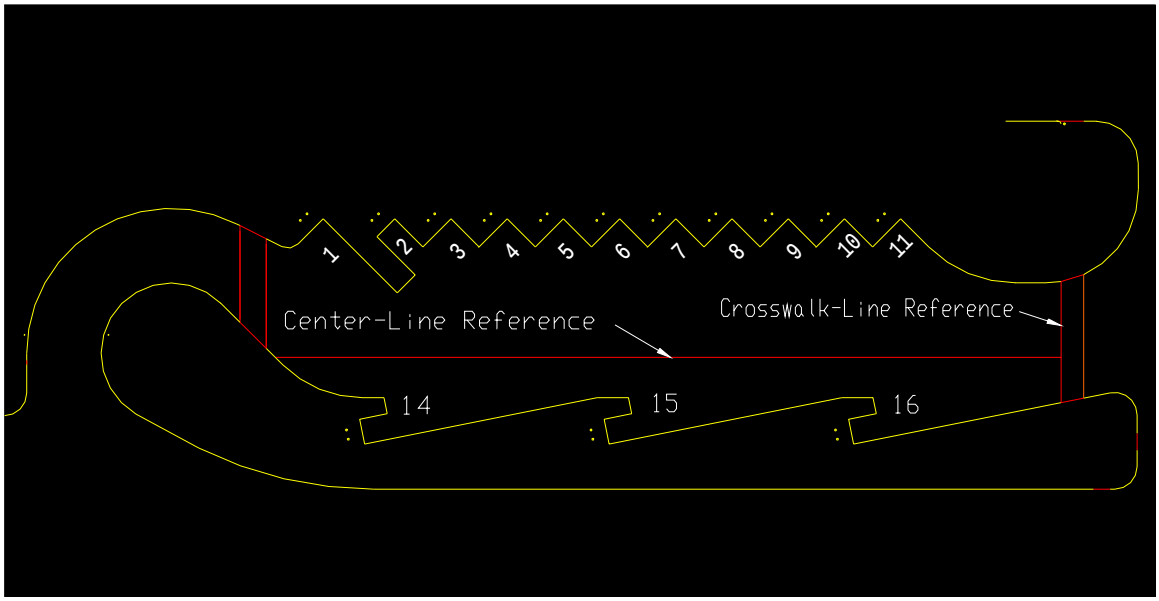

Figure 1, Center and Crosswalk Reference Lines

Maneuver: Bus A given the signal to enter ITC area and proceed to berth #9.

[7] E.g., time, bus positions, verification of physical maneuvers, etc.
[8] E.g., drivers survey, participant observations, etc.

Action: Bus A enters berth #9 and parks.
Observation and Measurement: Check radius of turn during the turning and entering.
Results: No problems were noted. Entrance radius appeared adequate for safe entry.

Maneuver: Bus B given the signal to enter ITC area and proceed to berth #10.
Action: Bus B enters berth #10 and parks.
Observation and Measurement: Check orientation of buses WRT each other and the facility. Measure separation distance.
Results: Bus separation distance (perpendicular between the pair of buses): 4 ft. 8 inches at closest point of approach; 5 ft. 10 inches at rear of buses. Orientation of Bus A WRT Bus B was slightly crooked, i.e., not strictly parallel. Two still photographs (S. Lowance) that document the relative positions of the two buses are incorporated by reference.

Maneuver: Bus C given the signal to enter ITC area and proceed to berth #16.
Action: Bus C enters berth #16 and parks.
Observation and Measurement: Check ease of maneuver.
Results: No problem observed in entering berth #16. Distance of right rear bumper of Bus C to centerline (3CR/CL): 13 ft. 2 inches.

Maneuver: Bus D given the signal to enter ITC area while stopping and pausing at 15-ft intervals proceeding to enter berth #11.
Action: Bus D while entering the ITC area and berth #11, stops and pauses at each marker that is incrementally spaced at 15-ft. intervals (approx. 7 cones).
Observation and Measurement: During the pauses at which Bus D stops at each marker, measure the distance of the driver's front bumper and rear bumper diagonal to driver's position of Bus D WRT Session 1 designated reference points (CL & CW).

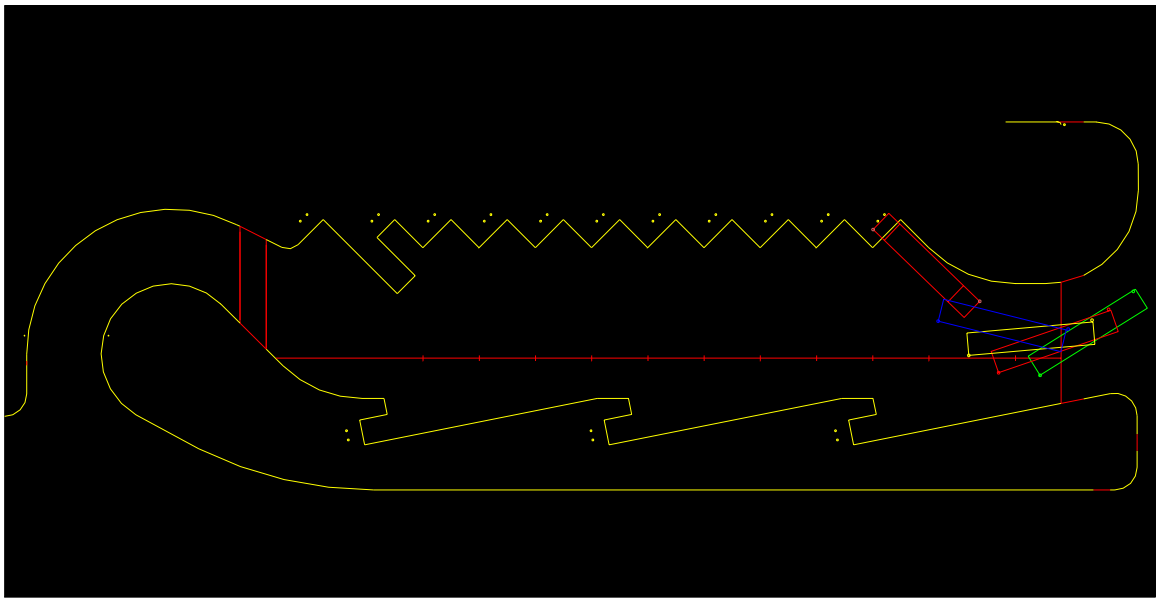

Figure 2, Positions While Entering Berth 11

Results: Figures 2 and 3 present schematics of the ITC facility design with the measured data points plotted. A time-phased snapshot of the position of the bus is illustrated in Figure 2. Also shown (Figure 3) are the interpolated track lines of the two reference points of Bus D (front and rear bumper

corners) . The two interpolated track lines jointly define the swept path of the vehicle during its entrance and turn into berth # 11.

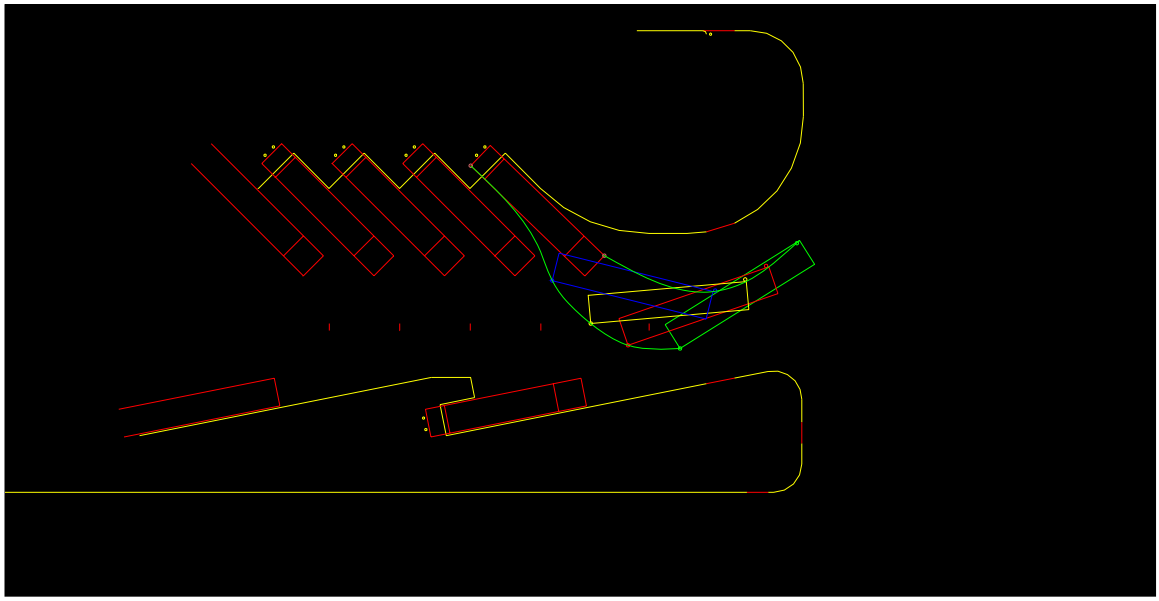

Figure 3, Splines Derived from Bus Corners

Notice that the design vehicle during this specific maneuver from its initial starting position in the vehicular lane on 'Race Street' had a wide "swing", with encroachment over the centerline of the ITC central aisle. Direct observation verified that entrance by Bus D into berth #11 was problem-free. The actual measured data points are given below in Table 1. Practical considerations limited the actual number of measured data points to four approximately equally spaced intervals.

Table 1.

	Cone 1	*Cone 2*	*Cone 3*	*Cone 4*
4DF/CL	6' 1''	5' 2''	1' 0''	13' 2''
4DF/CW	7' 6"	22' 3''	32' 10"	43' 9"
4DR/CL	23' 9"	17' 4"	13' 6"	10' 4"
4DR/CW	25' 8"	16' 11"	11' 0"	2' 6"

Maneuver: Bus E given the signal to enter ITC area and proceed to berth #8 after stopping and pausing when passing by Bus C in berth #16.
Action: Bus E enters berth #8 and parks.
Observation and Measurement: Measure distance of left side of Bus E WRT the closest point of approach to Bus C in berth #16. Measure distance of right side of Bus E WRT line formed by connecting left rear bumper corners of Buses A, B and D. Check clearances with Bus A to the right as Bus E enters berth #8.
Results: Left side distance was measured at 7 ft. 6 inches. Corresponding right side distance was measured at 9 ft 6 inches. There was no problem observed with entering berth # 8. Clearance to Bus A in berth #9 was observed to be safe but close, with no contact.

Maneuver: Bus A given the signal to exit berth #9 and ITC area.

Action: Bus A reverses out of berth #9 stops and pauses when ready to shift into drive. When signaled, returns to bus holding area. Bus A driver may be asked to stop and pause numerous times during maneuver for recording position measurements.
Observation and Measurement: Check ease of maneuver and encroachment on Bus C in berth #16. Record position of Bus A when fully backed and ready for forward movement. Check clearances during exit-turnout, record measurements if necessary.
Results: No problem was observed with backing maneuver. Verified that exit of Bus A involved only a two-point maneuver (i.e., single, fluid backing motion, followed by a single, fluid forward motion). The two-point maneuver is the minimal number of movements for a bus to exit the ITC given the current design (saw-tooth bus berths, with buses parked nose-forward therein). Adequate clearance was observed between Bus A and Bus C in berth #16. No problem of clearance or encroachment on the pedestrian walkway or apron was observed during Bus A's exit from the ITC. A tripod and video camera was set up for wide-angle shots at the exit-turnout. The videotape is incorporated by reference as documentation of this and all other exits by the test vehicles. For this maneuver, and for several other Bus exits, direct observation by US DOT/Volpe staff confirmed that the swept path of the vehicle (including front and rear bus overhangs) was fully contained within the roadway width at the turnout. Figure 4 provides a schematic of Bus A at its fully backed position as measured during this test maneuver. Table 2 below provides the actual data points.

Table 2.

6AF/CL	7 ft. 8 inches
6AF/CW	70 ft. 0 inches
6AR/CL	0 ft. 10 inches
6AR/CW	25 ft. 9 inches

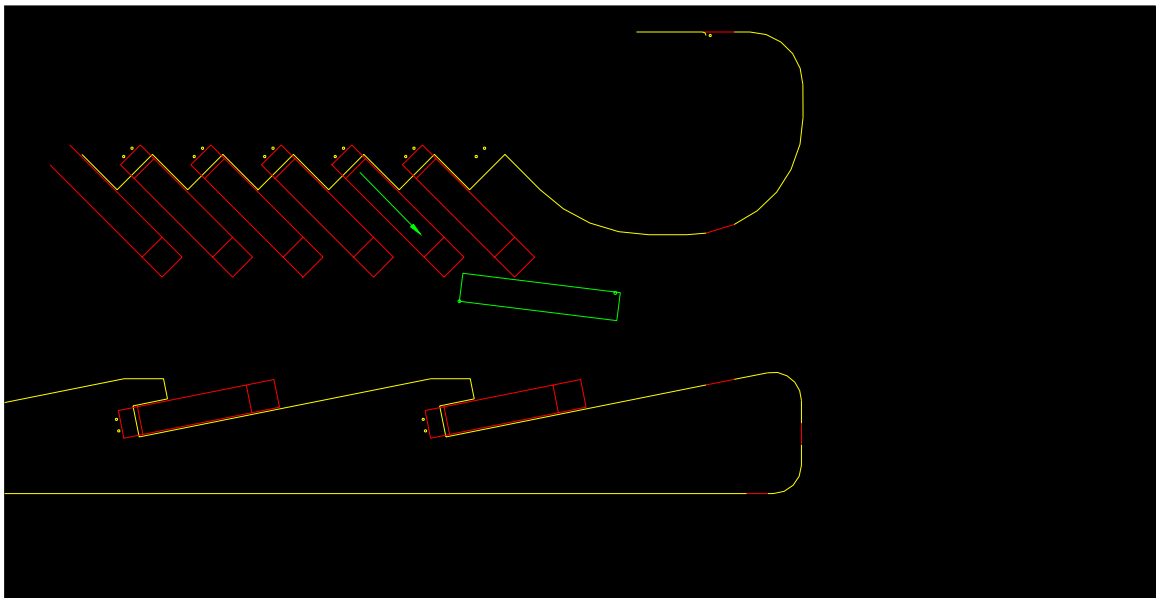

Figure 4, Bus A Fully Backed from Berth 9

Maneuver: Bus D given the signal to exit berth #11 and ITC area.
Action: Bus D reverses out of berth #11, stops and pauses when ready to initiate forward movement. When signaled, returns to bus holding area.

Observation and Measurement: Check ease of maneuver and encroachment on Race Street entrance crosswalk. Record position of Bus D relative to ITC facility when fully backed and ready to initiate forward movement.

Results: Direct observation and measurement indicated that Bus D encroached on the full width of the Race Street entrance crosswalk as illustrated on the final design schematic (See Figure 1). Figure 5 provides a schematic of Bus D at its fully backed position as measured during this test maneuver. Table 3 below provides the actual data points. Figure 5 also shows, however, that Bus D did not encroach on the vehicular way. Its furthest backing position was approximately 17 ft. short of the curb-line. Direct observation verified that Bus D was able to execute a two-point maneuver to exit the ITC.

Table 3.

7DF/CL	5 ft. 11 inches
7DF/CW	34 ft. 8 inches
7DR/CL	4 ft. 0 inches
7DR/CW	10 ft. 11 inches

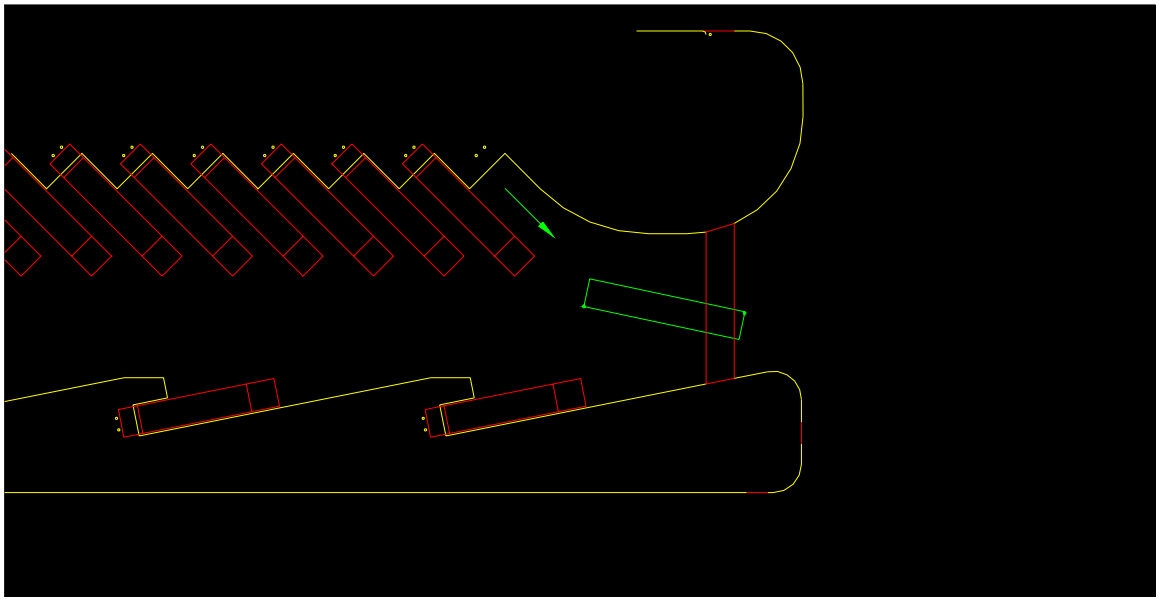

Figure 5, Bus D Fully Backed From Berth 11

Maneuver: Bus C given the signal to exit berth #16 and ITC area.

Action: Bus C reverses out of berth #16, stops and pauses when ready to initiate forward movement. When signaled, returns to bus holding area.

Observation and Measurement: Check ease of maneuver and encroachment on Race Street entrance crosswalk. Record position of Bus C relative to ITC facility when fully backed and ready to initiate forward movement.

Results: Direct observation and measurement indicated no encroachment on the crosswalk or the eastern curb cut at the Race Street crosswalk. Figure 6 provides a schematic of Bus C at its fully backed position as measured during this test maneuver. Table 4 below provides the actual data points. Direct observation verified that Bus C was able to execute a two-point maneuver to exit the ITC.

Figure 6, Bus C Fully Backed From Berth 16

Table 4.

8CF/CL	23 ft. 10 inches
8CF/CW	53 ft. 0 inches
8CR/CL	8 ft. 10 inches
8CR/CW	10 ft. 5 inches

Maneuver: Bus B given the signal to exit berth #10 and ITC area.
Action: Bus B exits berth #10 and ITC area, and proceeds to bus holding area.
Observation and Measurement: none.
Results: No encroachment on Race Street entrance crosswalk. No problem noted.

Maneuver: Bus E given the signal to exit berth #8 and ITC area.
Action: Bus E exits berth #8 and ITC area, and proceeds to bus holding area.
Observation and Measurement: none.
Results: No problem noted.

As was mentioned, two unplanned maneuvers were also executed using two full-size school buses that were laying over at the test facility during the Field Tests. For the first unplanned maneuver, one of the school buses was asked to enter berth #9, with berth #8 and berth #10 occupied by the test vehicles Bus E and Bus B respectively. Direct observation, confirmed by the school bus driver response, indicated that there were no problems with the entry and docking at berth #9.

For the second unplanned maneuver, a school bus was requested to enter and dock at berth #15. The door of the school bus was 4 ft. beyond the passenger-loading zone at the bus berth (see Figure 1). Because of a planned pedestrian fence or railing at the perimeter of the passenger-loading zone, passengers would be off-loaded from the bus within the central aisle of the ITC. Loading passengers would not be able to access the school-bus door because of the pedestrian railing or perimeter fence. Consequently, all parties agree on a recommended design modification to extend the passenger-loading zone for the three shallow saw-toothed bus berths (see *Recommended Design Modifications*, particularly the schematic illustrated in Figure 9).

Formal Test #1 Sequence

The test setup and sequence of events are delineated in the test protocol (see Attachment A), incorporated by reference here. As discussed in the test protocol, maintenance of fidelity of the simulation required that only the information that a driver has during actual operations be provided to each test driver.

Results: Clocked time for the complete test sequence was 7 minutes and 35 seconds. No problems were noted with the test setup. Verification was made that all physical maneuvers[9] were accomplished problem-free. No problems were noted with bus-to-controller communications. Use of flasher signal by the test buses was effective in communicating bus intent to initiate a backing maneuver and exit the ITC.

Formal Test #2 Sequence

The test setup and sequence of events are delineated in the test protocol (see Attachment A), incorporated by reference here. As discussed in the test protocol, maintenance of fidelity of the simulation required that only the information that a driver has during actual operations be provided to each test driver.

Results: Clocked time for the complete test sequence was 7 minutes and 46 seconds. No problems were noted with the test setup. Verification was made that all physical maneuvers[10] were accomplished problem-free. No problems were noted with bus-to-controller communications. Use of flasher signal by the test buses was effective in communicating bus intent to initiate a backing maneuver and exit the ITC.

Session 2 Quantitative Measurements with Observations

Set up: All buses waiting in bus holding area (in consecutive order A to E).
Barrels modeling pedestrians are placed along right side of exit-turnout and on both sides of exit crosswalk.

Session 1 designated reference points: Lateral measurements are referenced from the perpendicular off the centerline (CL). Longitudinal measurements are referenced from the perpendicular off the exit crosswalk (CW). See Figure 1. All bus berth numbers are identified on Figure 1.

Maneuver: Bus A given the signal to enter ITC area and proceed to berth #2.
Action: Bus A enters berth #2 and parks.
Observation and Measurement: Check ease of berth entrance.
Results: No problem noted.

Maneuver: Bus B given the signal to enter ITC area and proceed to berth #14.
Action: Bus B enters berth #14 and parks.
Observation and Measurement: Check ease of berth entrance.
Results: No problem noted.

Maneuver: Bus C given the signal to enter ITC area and proceed to berth #1.
Action: Bus C enters berth #1 and parks.

[9] Specific note was made of successful completion of two-point exits from the ITC, involving a single smooth, fluid backing maneuver into the central aisle to a position which permits the bus to move forward and exit the facility without any collision with the other test vehicles (including simulated stationary buses) in their respective berths.

[10] Specific note was made of successful completion of two-point exits from the ITC, involving a single smooth, fluid backing maneuver into the central aisle to a position which permits the bus to move forward and exit the facility without any collision with the other test vehicles (including simulated stationary buses) in their respective berths.

Observation and Measurement: Check ease of berth entrance and orientation WRT berth #1.
Results: No problem noted.

Maneuver: Bus D given the signal to enter ITC area and proceed to berth #15.
Action: Bus D enters berth #15 and parks.
Observation and Measurement: Check ease of berth entrance and orientation.
Results: No problem noted.

Maneuver: Bus E given the signal to enter ITC area and directed to perform a go-around. When signaled, Bus E returns to holding area.
Action: Bus E enters ITC area and while performing go-around immediately stops when the driver spots the barrels placed in the west end of the exit crosswalk. Driver may be asked to repeat this operation a number of times.
Observation and Measurement: Measure and record distance between stopped bus and crosswalk. Check clearances during exit-turnout.
Results: Distance of front left corner of stopped Bus E to closest (northern) edge-line of exit crosswalk measured at 46 ft. 4 inches. Side clearance between Bus E at stopped location and Bus B in berth #14 measured at 6 ft. 4 inches. No problem with exit noted. Confirmation by videotape, incorporated herein by reference. Figure 7 presents the corresponding schematic WRT driver's sight line to pedestrians at the crosswalk and his 'emergency' stop.

Figure 7, Stopped Bus After Driver Spots Pedestrians Entering Crosswalk

Maneuver: Bus C given the signal to exit berth #1 and ITC area.
Action: Bus C reverses out of berth #1, stops and pauses when ready to initiate forward movement.
Observation and Measurement: Check ease of maneuver. Record closest approach distance to Bus B in berth #14 and Bus A in berth #2. Record position of Bus C when fully backed into position ready for forward movement. Check clearances during exit-turnout, record measurements if necessary.
Results: No problem with exit noted. Confirmation by videotape, incorporated herein by reference. Figure 8 shows the position of Bus C when fully backed. Corresponding data points are given below in Table 5. Distance to Bus A at the closest point of approach was measured at 6 ft. 10 inches. The distance to Bus B at the closest point of approach was measured at 11 ft. 5 inches.

Figure 8, Bus C Fully Backed From Berth 1

Table 5.

6CF/CL	18 ft. 9 inches
6CF/CW	28 ft. 4 inches
6CR/CL	4 ft. 0 inches
6CR/CW	71 ft. 6 inches

Maneuver: Bus D given the signal to exit berth #15 and ITC area.
Action: Bus D exits the ITC area.
Observation and Measurement: Check ease of maneuver. Check clearances during exit-turnout.
Results: No problem with exit noted. Confirmation by videotape, incorporated herein by reference.

Maneuver: Bus A given the signal to exit berth# 2 and ITC area.
Action: Bus A exits the ITC area and returns to bus holding area.
Observation and Measurement: Check ease of maneuver. Check clearances during exit-turnout.
Results: No problem with exit noted. Confirmation by videotape, incorporated herein by reference.

Maneuver: Bus B given the signal to exit berth #14 and ITC area.
Action: Bus B exits the ITC area and returns to bus holding area.
Observation and Measurement: Check clearances during exit-turnout.
Results: No problem with exit noted. Confirmation by videotape, incorporated herein by reference.

Formal Test #3 Sequence

The test setup and sequence of events are delineated in the test protocol (see Attachment A), incorporated by reference here. As discussed in the test protocol, maintenance of fidelity of the simulation required that only the information that a driver has during actual operations be provided to each test driver.

Results: Clocked time for the complete test sequence was 3 minutes and 20 seconds. No problems were noted with the test setup. Verification was made that all physical maneuvers[11] were accomplished problem-free. No problems were noted with bus-to-controller communications. Use of flasher signal by the test buses was effective in communicating bus intent to initiate a backing maneuver and exit the ITC.

Formal Test #4 Sequence

The test setup and sequence of events are delineated in the test protocol (see Attachment A), incorporated by reference here. This test sequence differed from the other formal test sequences. Bus controllers were not resolving conflicts in bus maneuvers and sequencing the operations. The objective of the test was to determine bus occupancy conditions that would permit autonomous control of safe separation by the bus drivers. No use of the shallow, bus berths was assumed (i.e., less than peak bus flow condition).

Results: The test confirmed that provided there was sufficient space separation between the buses in the deep, saw-tooth berths, more than one bus could initiate a backing maneuver and exit the ITC area concurrently. Sufficient space separation was determined to be the width of at least one bus berth. Under these conditions, a positive control scheme enforced by the bus controllers was unnecessary.

Summary of Driver Survey

Comments were obtained from the five test drivers using a driver survey form (see Attachment C). The results are reported below in Table 6.

Table 6. Tabulation of Driver Responses (5)

Overall Handling	Satisfactory 4	Neutral 1	Unsatisfactory 0
Controller Interaction	Satisfactory 4	Neutral 1	Unsatisfactory 0
Cornering	Satisfactory 3	Neutral 2	Unsatisfactory 0
Turning/Steering	Satisfactory 4	Neutral 1	Unsatisfactory 0
Braking	Satisfactory 4	Neutral 1	Unsatisfactory 0
Accelerating	Satisfactory 3	Neutral 2	Unsatisfactory 0
Ease of Use	Satisfactory 4	Neutral 1	Unsatisfactory 0
Speed of 5-mph	Satisfactory 3	Neutral 1	Unsatisfactory 1
Do you have any safety Concerns?	No 5	Yes, explain: N/A	

[11] Specific note was made of successful completion of two-point exits from the ITC, involving a single smooth, fluid backing maneuver into the central aisle to a position which permits the bus to move forward and exit the facility without any collision with the other test vehicles (including simulated stationary buses) in their respective berths.

Do you have any concerns Regarding pedestrian safety?	No 4	Yes, explain: 1; adequate, but tight turnout; t turnout becomes tighter with compensation tracking of bus to avoid pedestrians apron/crosswalk
Do you have any operating Concerns?	No 5	Yes, explain: N/A
Do you have concerns with The controllers during maneuvering?	No 5	Yes, explain: N/A

Discussion and Interpretation of ITC Field Test

All parties agreed that the ITC Field Test did demonstrate and verify that all physical maneuvers within the ITC are feasible irrespective of the occupancy configuration of the bus berths. In this regard, the first objective of the Field Test was met. There are no inherent fatal flaws in the design that preclude the intended operational use of the facility. On the initial walkthrough before the tests, drivers did express concerns with respect to the entry width of the ITC (38 ft. 11 ½ inches), particularly with respect to docking at berth #10 and berth #11. These concerns were allayed, however, once the tests were initiated (see Figure 2 and Figure 3). Drivers also expressed concern with respect to the tight radii (outer and inner radii) at the exit-turnout, and were cautious in maneuvering through the turnout. All parties agree that it would be desirable to modify the radii by providing extra clearance for the buses. PCF have indicated that this design modification is feasible[12] (see Figure 9). US DOT/Volpe staff recommend implementation of this design modification (see **Recommendations for Design Modifications**).

Concerning the assessment of the safety of operations with respect to bus-to-bus separation, bus-to-control personnel separation, and bus-to-pedestrian/passenger separation, the most compelling data from the Field Test are the driver responses. None of the five drivers expressed safety or operational concerns for pedestrians or control personnel during maneuvering within the ITC. Driver response, direct observation, and measurement jointly confirmed adequate and safe bus-to-bus separation during maneuvers under a positive control regime (see **ITC Field Tests: Observations and Measurements**). Only one driver expressed a safety concern with respect to the position and flow of pedestrians at the turnout crosswalk. Design modification to expand the roadway width at the turnout (providing adequate clearance to preclude encroachment on pedestrian spaces) will address this point. Successful completion of *Formal Test #4 Sequence* confirms that a positive control regime that directs the movement of buses within the ITC facility may only be necessary under peak bus-flow conditions. These conditions hold when all 14 berths are utilized (the 11 deep saw-tooth berths on the western edge, and the 3 shallow, saw-tooth berths on the eastern edge of the ITC). During off peak conditions[13], autonomous control by the bus drivers is often possible, although controller supervision and vigilance is advisable. During imposition of a positive control regime, controller intervention to resolve conflicting movements is necessary.

Notwithstanding the above assessment with respect to safety of operations, limitations[14] of the Field Test make it impossible to provide an unqualified safety assessment. US DOT/Volpe staff agree that substantial alertness and vigilance by the operating control staff is necessary, particularly during peak bus-flow

[12] The outer radius of the turnout roadway will now expand to 60 ft. 4 inches, and the inner radius of the roadway will expand to 51 ft. 6 inches.

[13] During off-peak conditions, only the 11 deep saw-tooth bus berths are utilized within the ITC under the FCFS operating rule. In addition, the two berths on Race Street are utilized before the three shallow, saw-tooth berths within the ITC come into use.

[14] Limitations include the inability to simulate peak bus-flow conditions, poor visibility, passenger flows, and interactions with vehicular traffic on adjacent roadway facilities.

conditions. Also critical is adequate staffing for such conditions. We are suggesting design and operational procedural recommendations to address both concerns (**see Recommendations for Design Modifications** and **Recommendations for Operational Procedures**).

Orth-Rodgers & Associates have raised three additional concerns:

- Bus-to-controller communications
- Bus controller safety
- Pedestrian safety

During the field test, test drivers and the primary bus controller were given radios tuned to a common channel. This worked fine for the Field Test but this option is not available for the actual operation of the ITC Facility. Bus-to-controller communications are critical, however, under a positive control regime requiring controller intervention to resolve conflicting movements and assure safe operations. How to effect this safely is a non-trivial problem. US DOT/Volpe staff are suggesting operational procedural changes to address this issue (see **Recommendations for Operational Procedures**).

As direct participants in the Field Test (i.e., acting as bus controllers), US DOT/Volpe staff also share Orth-Rodgers concern for controller safety. Within the central aisle of the ITC Facility, there are no protected positions, and visibility by the bus drivers of the controllers is often limited. Closely spaced bus berths limit access by a controller to a driver's window while contiguous buses are in motion. To address these concerns, we are suggesting design and operational procedural changes (**see Recommendations for Design Modifications** and **Recommendations for Operational Procedures**).

US DOT/ Volpe staff are of the opinion that adequate and well-trained operating personnel, in conjunction with design elements[15] of the ITC Facility, are adequate to assure the safety of pedestrian flows. We are suggesting, however, two design modifications that will provide additional safety assurance for pedestrians/passengers (see **Recommendations for Design Modifications**).

The last objective of the ITC Field Test was to assess the efficiency of safe, control sequence operations during severe and worst-case scenarios. All parties agreed that the formal test sequences proceeded at a fairly quick and efficient pace. There was clearly a learning-curve aspect involved, and the participant bus controllers are not professional controllers. However, inherent limitations of the Field Test preclude an unqualified endorsement of the efficiency of control operations under a positive control regime during more realistic peak bus-flow conditions. There is still uncertainty as to what the actual throughput would be under these conditions.

Recommendations for Design Modifications

Based on the outcomes of the Field Test, including direct participation and observation, we make the following recommendations for design modifications:

- Increase the turning radii of the exit-turnout roadway

[15] These elements include walls and pedestrian fences on the eastern island to prevent passengers from intruding onto or crossing the central aisle used for bus maneuvers.

All parties agree that this would provide an additional margin of safety with respect to the position of the bus in the turnout and its potential to encroach on pedestrian spaces at the walkway adjacent to the exit-turnout roadway.

Turnout Radius before Change

Turnout Radius increased by 2 ½ feet

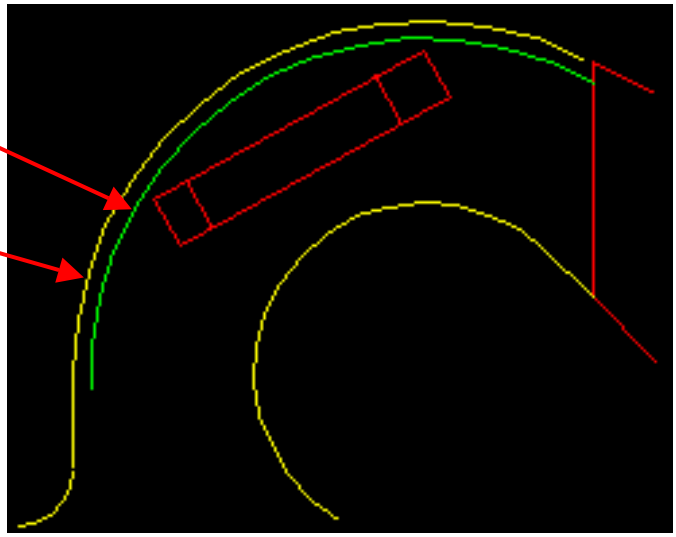

Figure 9, Increased Dimension on Exit Turnout

It should be noted, however, that the existing radii were sufficient to assure that the swept path of the bus was contained within the envelope of the exit roadway. The test drivers commented that this issue was the primary geometric design issue of concern to them. PCF has indicated that this design modification is feasible and will be implemented (see Figure 9).

- Shift the Race Street pedestrian crosswalk by 10 feet north of its current position

Test results indicated that a bus backing out from berth #11 completely envelops the full 8-ft. crosswalk width of the Race Street crosswalk (see Figure 5). The schematic of the ITC Facility indicates that there is a distance of 19-ft. ½ inch between the northern edge of the current placement of the Race Street crosswalk and the curb-line. By shifting the crosswalk by 10 ft., a bus backing from berth #11 will not encroach on the crosswalk or present a conflict with pedestrians within the crosswalk. The eight-foot width of the crosswalk will still allow a 1 ft 1/2 inch offset safety margin for pedestrians walking along the northern edge of the crosswalk with respect to the curb-line and the vehicular way (see Figure 10).

- Expand the length of the passenger loading platform (adjacent to the central aisle) by 4-ft. 2-in. at the shallow, saw-tooth bus berths

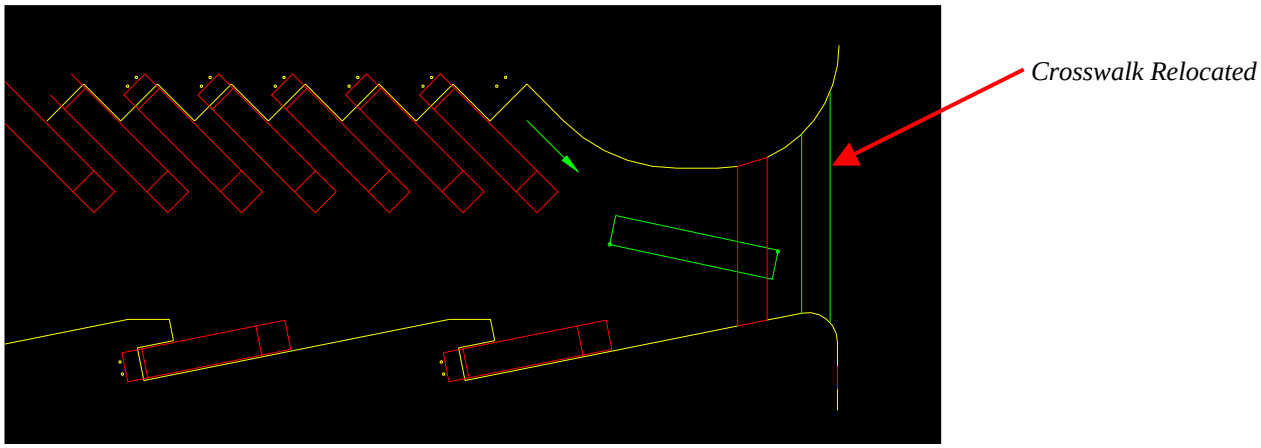

Figure 10, Entrance Crosswalk Relocated

Test results using a full-size school bus indicated a problem with the current design length of the passenger-loading platform at these berths (see **ITC Field Tests: Observations and Measurements**). PCF have redesigned the platform (see Figure 11). We endorse this design change.

- Establish a 30-inch continuous control strip parallel to the alignment of the second row of bollards along the western walkway, adjacent to the NCC, using yellow or red pavers.

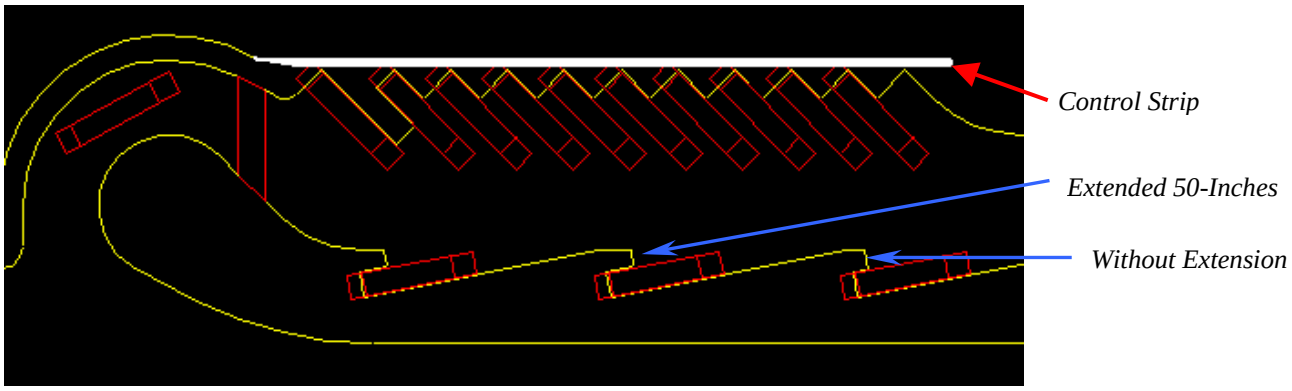

Figure 11, Thirty-Inch Control Strip and Berth Extensions

Figure 12 illustrates what we mean by this design modification. We are proposing to deploy the assistant bus controllers (responsible for control of berths #1-11) along this control strip (see **Recommendations for Operational Procedures**). The function of the control strip, its contrast in material and color, and its use by authorized operating staff only will assure that pedestrians (including children) do not encroach, intentionally or inadvertently, on the bus berths and central aisle. Bus controllers will assure crossing of the control strip for authorized passenger loading and unloading only. US DOI/NPS had suggested that a wall be placed between the berths to prevent children from accidentally running into the ITC Facility, including the bus berths and the central aisle. PCF correctly pointed out that this would work only when all bus berths are occupied! PCF also pointed out that any horizontal restriction, for example between the bollards, might engender greater risk and liability than it prevents. We are recommending this design modification, and changes in operational procedures to provide greater safety assurance and reduced risk for pedestrians/passengers. The width of the western walkway, adjacent to the NCC, is sufficient for

holding and circulation of pedestrians/passengers even with dedication of a continuous 30-inch strip for control purposes (buses and pedestrian flows).

Several additional, minor design modifications are also suggested:

- Verification that proposed 6 inch curbing is compatible with all intended vehicles that will use the ITC Facility; otherwise reduce the curb height to one which is compatible

Curbs can interfere with undercarriage elements (e.g., skeets to protect the bus against bottoming out on vertical curves) or with the kneeling features of many buses. A bus may pass over a curb or island, but have problems in backing off of the curb or island. The design height for the curb must allow free operation of all design vehicles.

- Add retroreflective pavement markers (RPMs) to the painted pavement markings between the bus berths

Painted pavement markings quickly fade in time, and have poor conspicuity in low-visibility weather conditions. Embedding RPMs will provide good delineation of the berths under all weather conditions, and assist in maintaining proper bus orientation within the bus berth when docking.

- Add a central aisle control line marking, and a guideline marking at the exit-turnout roadway.

The marking of the centerline of the central aisle for the Field Test was useful to the participant bus controllers. We think that it will be useful to the Chief bus controller in the actual ITC Facility. It may also be useful to the bus drivers in exiting the ITC Facility or initiating a go-around.

The guideline marking (a dashed line) at the exit turnout will provide drivers with a proper angle of attack at the exit to assure adequate safety margins with respect to encroachment on the adjacent pedestrian spaces. This suggestion also complements the design modification for increasing the turning radii. The driver can use the guideline marking throughout the length of the exit-turnout as a track-line for the driver's –side wheels.

- Add bus berth identification numbers at both termini of the bus berths in a suitable location and of sufficient character size that they are visible by bus drivers and bus controllers at all times

The bus berth identification numbers will be used by the bus controllers for clearance instructions and must be visible at all times. Bus drivers also need to see the bus berth number in order to respond to controller instructions as well.

Recommendations for Operational Procedures

Based on the outcomes of the Field Test, including direct participation and observation, we make the following recommendations for operational procedures:

- Endorsement of the use of the flasher signal capability of the bus to communicate a bus driver's intent to initiate a backing maneuver and exit the ITC Facility.

This protocol is simple and worked quite well for the Field Test. Bus controllers can easily detect the flasher signal, and use that information to detect potential conflicts, and develop a safe, efficient control sequence to resolve them.

- Use of four (4) active bus controllers deployed as follows under a positive control regime, and during peak bus-flow conditions: Only the Chief bus controller deployed and circulating within the central aisle; two (2) assistant bus controllers deployed within the delineated control strip on the western walkway (controlling berth #1-6, and #7-11 respectively); one (1) assistant bus controller deployed on the eastern island (controlling berths # 14-16).

The additional staffing is necessary during high workload conditions to assure safety of the operation, and the change in deployment will improve the efficiency of control and minimize risk and possible injury to the bus controllers.

- Change in functional distribution of workload of controller staff as follows.

  Chief bus controller:
  - detects bus intent to exit ITC Facility
  - determines potential conflicts
  - develops (real-time) a safe, efficient control sequence
  - issues clearance instructions in accordance with the control sequence to resolve conflicting movements
  - issues concurrent clearances when there is sufficient space separation between buses
  - provides surveillance of the actual movements that are executed.

  Assistant bus controller:
  - communicates clearance instruction to intended bus within his/her control zone
  - assures pedestrian safety[16] on western and eastern island walkways by controlling intentional or inadvertent encroachment onto the bus berths and/or central aisle

In order to effect this change, it is proposed that all bus controllers have on-person shoulder radios tuned to a common channel. It is also proposed that assistant bus controllers repeat the clearance instruction to confirm its correctness. It is proposed that the Chief bus controller, deployed and circulating within the central aisle, also have on his/her person a strobe light and safety vest to provide additional visibility and protection from a bus-to-controller collision.

- Use of a Controller Wand by each bus controller to communicate clearance instructions.

Ground control personnel at airports have what is referred to as a controller's wand to direct ground movements of aircraft. The controller wand proposed here is similar in concept (an 18 inch cylindrical stick that is highly visible due to its retroreflectance) but with a critical additional functional component. The wands would have a light-emitting capability. This would consist of (a) a high-intensity narrow light beam with coherence over a transmission distance of several hundred feet; and (b) a high-intensity pulse or blinking capability, also with coherence of the pulses over several hundred feet.

Assistant bus controllers would communicate clearance instructions in this way. They would direct the high-intensity light beam at the intended bus driver (to get the driver's attention). They would then activate a short pulse or blinking beam at the bus driver to authorize execution of the clearance instruction (i.e., a backing maneuver to exit the ITC Facility).

We also recommend initiation of a study that would examine the technical engineering and cost considerations for development of a long run intelligent transportation system (ITS) solution to the control problem. Through a system of control logic, hardware and software interlocks, and appropriate

[16] This would be a shared responsibility with the proposed Greeters.

sensors, it is possible to automate the functionality now allocated to the Chief bus controller and the three assistant bus controllers.

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Attachments

10/12/00
D. Spiller/49
B. Mickela/36

ITC Field Test Protocol

General

1. Final architectural drawing for ITC facility will be used to provide a ground layout of the ITC facility and Race Street approach at the test site. Race Street approach will include Race Street bus berths. "Bus-Use Only" lane, adjacent travel lane, Race Street centerline, NCC garage entrance and driveway cut.
2. PCF will verify and signoff prior to formal tests that the ground translation of the ITC Facility design and Race Street approach is accurate with respect to all included elements, distances and angles.
3. Only active participants[1] will be allowed within the bus movement areas of the ITC Facility and Race Street approach. All other observers will be sited outside of the bus movement areas for safety reasons. Active participants will wear safety worker reflective vests at all times.
4. The Field Test will consist of two phases in each of two sessions: (a) an initialization or setup phase for the purpose of taking at one time all the measurements; (b) a formal test sequence phase consisting of a set of tests within that session.
5. Five (5) 45' MotorCoach Tourist Buses will be used during the tests. Barrels will simulate other stationary buses. A letter will identify test buses: A, B, C, D, and E.
6. Staging of all five buses will use the "Bus-Use Only" lane, buses held in a queue bumper-to-bumper. This is solely for efficient test administration purposes and does not constitute an operational procedure with respect to stacking or holding of buses within the "Bus-Use Only" lane. Rapid entry from the queue will simulate peak period, high bus flow rates (>80 buses per hour) into the ITC Facility.
7. To preserve fidelity of the simulation[2], each driver for each test will be briefed (written sheet on clipboard to bring on-board bus) only with respect to his role, and actions to be taken by that driver (i.e., stationary bus, entering bus, exiting bus, or entering and exiting bus). Prior to the tests, drivers will be briefed on the nature of the tests, to proceed only when directed by the Bus Controllers (positive control regime[3]), and to stop when directed. Drivers will be told to drive normally. Drivers will be briefed on a standard phraseology that will be used by the Bus Controllers (see Section).
8. Only the Test Director and Bus Controllers will have a complete script with respect to the control sequence of operations affecting all subject buses for each Test.
9. Each bus will be directed by the Bus Controller to enter the ITC Facility and proceed to dock at its assigned bus berth during the setup phase for each test. Speed limit for the ITC Facility will be 5 mph. Buses are **NOT** to exceed this speed limit during either setup or formal test phases.
10. Each formal test will be conducted as follows. Each formal test will have its own setup and then a test sequence. Qualitative observations, including verification of physical feasibility of bus maneuvers, will be made during the test sequence. Timing of the complete control sequence (start of test to end of test) will also be measured. Buses will not be interrupted during maneuvers during the formal test sequence except for dire safety reasons. Drivers will complete a survey form after each formal test sequence.

    The formal set of tests has been organized into two sessions (Coffee break between the two!!). Prior to each session of formal tests, a separate setup or initialization phase will be executed for the purposes of collecting all critical measurement data. Quantitative measurements with respect to bus positions

[1] This includes the Test bus drivers, the Test Director, and the Bus Controllers.
[2] Drivers know their own intentions with respect to maneuvers involving their own bus, but have little or no information as to the intended maneuvers of all other buses using the ITC Facility.
[3] One formal test will require autonomous control by each driver; that is, Bus Controllers will not control the movement and safe separation of the buses. Even during the positive control regime, however, test bus drivers have final authority with respect to the safe operation of their vehicles.

relative to the ITC facility (including pedestrian/passenger spaces), and bus positions relative to each other will be made. This will necessitate stopping the buses at various times during each maneuver to chalk positions of buses on the ground.

The formal marking of bus positions will follow this format. 1AF1, 1AR2, 2BF1, etc. – the first position of the marking identifies the test maneuver (see Session 1, *Quantitative Measurements with Observations)*. The second position identifies the Test Bus. The third position identifies the front, driver bumper corner (F) or the rear bumper corner diagonal to the driver (R). The fourth position in the marking identifies a time-sequence of positions for a given maneuver. Approximate positions as marked on the ground will immediately be marked on scaled drawings of the ITC Facility as well. Encroachment onto pedestrian spaces will be determined by placing barrels along the edge-lines of such spaces, and observing as well as videotaping any contact between the subject test buses and the barrels, including any dropped barrels.

11. Bus berths will be marked with a number identification so that Test drivers, Test Director and Bus Controllers can see and identify the bus berth number at all times (including when occupied by a test bus).
12. Test drivers will communicate to the Test Director and Bus Controllers their intention to initiate a backing maneuver from a bus berth by activating the flasher on their bus. Flashers will stay activated until a bus is in a position and is cleared by the Bus Controller to move in a forward direction.

Objective of Field Tests

1. Verify that all physical maneuvers necessary to enter the ITC Facility, to dock or enter any bus berth, to back up from any bus berth, and to exit the ITC Facility are feasible irrespective of bus berth occupancy configuration.
2. Using qualitative observations and quantitative measurements, assess the safety of operations with respect to bus-to-bus separation, bus-to-control personnel separation, and bus-to-pedestrian/passenger separation.
3. Assess efficiency of safe, control sequence operations during severe and worst-case test scenarios.

Standard Control Phraseology

1. “BEGIN TEST # - “
2. “END TEST # - “
3. “BUS A, HOLD YOUR POSITION UNTIL CLEARED”
4. “BUS A, YOU ARE CLEARED TO EXIT”
5. “BUS A, YOU ARE CLEARED TO ENTER”
6. “BUS A, EXIT ITC AND INITIATE GO-AROUND”
7. “BUS A, STOP AND HOLD YOUR POSITION FOR MEASUREMENT”
8. “BUS A, YOU ARE CLEARED TO EXECUTE TEST #2” (Leap-frog test)
9. “CODE BLUE, CODE BLUE, CODE BLUE”

Under a Code Blue condition, all test buses immediately stop and engage their emergency brakes. Blowing a safety horn will also indicate a Code Blue condition, whether or not the phrase is annunciated or not.

Session 1

Session 1 Quantitative Measurements With Observations

Set up: All buses waiting in bus holding area (in consecutive order A to E).
Barrels placed along right side of exit-turnout and on both sides of entrance crosswalk.

Session 1 designated reference points: Lateral measurements shall be referenced from the perpendicular off the centerline. Longitudinal measurements shall be referenced from the perpendicular off the entrance crosswalk. See Figure #.

No.	Maneuver	Action	Quantitative & Measurement
1.	**Bus A** given the signal to enter ITC area and proceed to berth 9	Bus A enters berth 9 and parks.	Check radius of turn during the turning and entering.
2.	**Bus B** given the signal to enter ITC area and proceed to berth 10	Bus B enters berth 10 and parks.	Check orientation of buses WRT each other and the facility. Measure separation distance.
3.	**Bus C** given the signal to enter ITC area and proceed to berth 16	Bus C enters berth 16 and parks.	Check ease of maneuver
4.	**Bus D** given the signal to enter ITC area while stopping and pausing at 15-foot increments proceeding to berth 11	Bus D while entering the ITC area and berth 11, stops and pauses at every marker that are incrementally spaced at 15-feet (approx. 7 cones).	During the pauses at which Bus D stops at every marker, measure the distance of driver's front left and rear right quarter of the bus WRT session 1 designated reference points (CL & CW).
5.	**Bus E** given the signal to enter ITC area and proceed to berth 8 after stopping and pausing when passing by bus C in berth 16	Bus E enters berth 8 and parks.	Measure distance of left side of Bus E WRT the closest point on Bus C in berth 16. Measure distance of right side of BUS E WRT line formed by connecting left rear quarters of Buses A, B and D. Check clearances with Bus A to the right as Bus E enters berth 8
6.	**Bus A** given the signal to exit berth 9 and ITC area	Bus A reverses out of berth 9 stops and pauses when ready to shift into drive. When signaled returns to bus holding area. Bus A Driver may be asked to stop and pause numerous times during maneuver for recording measurements.	Check ease of maneuver and encroachment on Bus C in berth 16. Record distances of Bus A when fully backed into position ready for forward movement. Check clearances during exit-turnout, record measurements if necessary.
7.	**Bus D** given the signal to exit berth 11 and ITC area	Bus D reverses out of berth 11, stops and pauses when ready to initiate forward movement. When signaled returns to bus holding area.	Check ease of maneuver and encroachment on entrance crosswalk. Record distances of Bus D when fully backed into position ready for forward movement
8.	**Bus C** given the signal to exit berth 16 and ITC area	Bus C reverses out of berth 16, stops and pauses when ready to initiate forward movement. When signaled	Check ease of maneuver and encroachment on entrance crosswalk. Record distances of Bus C when

No.	Maneuver	Action	Quantitative & Measurement
		returns to bus holding area.	fully backed into position ready for forward movement
9.	**Bus B** given the signal to exit berth 10 and ITC area	Bus B exits bus ITC area and proceeds to bus holding area	
10.	**Bus E** given the signal to exit berth 8 and ITC area	Bus E exits bus ITC area and proceeds to bus holding area	

Coffee Time

Test #1 Setup

1. Buses A, B, C, D, E are holding in "Bus-Use Only" lane (holding-area on Race Street). Barrels placed at terminus of all bus berths except bus berths #9, #10, #11, and #16 to simulate stationary buses in the other bus berths.
2. Bus Controller directs Bus A: "BUS A, YOU ARE CLEARED TO ENTER"

   Bus proceeds to bus berth #9. Bus A driver has assigned berth # on his instruction sheet on his clipboard.
3. Bus Controller directs Bus B: "BUS B, YOU ARE CLEARED TO ENTER"

   Bus B proceeds to bus berth #10. Bus B driver has assigned berth # on his instruction sheet on his clipboard.
4. Bus Controller directs Bus C: "BUS C, YOU ARE CLEARED TO ENTER"

   Bus C proceeds to bus berth #16. Bus C driver has assigned berth # on his instruction sheet on his clipboard.
5. Bus Controller directs Bus D: "BUS D, YOU ARE CLEARED TO ENTER"

   Bus D proceeds to bus berth #11. Bus D driver has assigned berth # on his instruction sheet on his clipboard.

Formal Test #1 Sequence

1. Bus Controller: "BEGIN TEST #1". Timer is started.
2. Bus Controller: "BUS E, YOU ARE CLEARED TO ENTER"
3. When rear of Bus E crosses Race Street pedestrian crosswalk , Bus Controller: "BUS E, EXIT ITC AND INITIATE GO-AROUND"

   Verify that Bus E driver responds to Bus Controller direction and exits ITC.
4. When Bus E approaches bus berth #7, Bus A, B, C, and D communicate their intention to back and exit the ITC by activating flasher signals. Second Bus Controller will signal to Bus A, B, C, and D drivers to activate signal at this time point.

   Bus A, B, C and D drivers are given instructions on instruction sheet to hold until given direct clearance to move.
5. When Bus E approaches turnout pedestrian crosswalk, Bus Controller: "BUS A, YOU ARE CLEARED TO EXIT"

   Verify that Bus A can make a single smooth, fluid backing maneuver into the central aisle to a position which permits the bus to move forward and exit the facility without any collision with the other test

buses[4] in their respective berths. More than a single backing maneuver and a single forward maneuver constitutes a failed outcome.

6. When Bus A approaches turnout pedestrian crosswalk, Bus Controller: "BUS B, YOU ARE CLEARED TO EXIT"

   Verify that Bus B can make a single smooth, fluid backing maneuver into the central aisle to a position which permits the bus to move forward and exit the facility without any collision with the other test buses[5] in their respective berths. More than a single backing maneuver and a single forward maneuver constitutes a failed outcome.

7. When Bus B approaches turnout pedestrian crosswalk, Bus Controller: "BUS D, YOU ARE CLEARED TO EXIT"

   Verify that Bus D can make a single smooth, fluid backing maneuver into the central aisle to a position which permits the bus to move forward and exit the facility without any collision with the other test buses[6] in their respective berths. More than a single backing maneuver and a single forward maneuver constitutes a failed outcome.

8. When Bus D approaches turnout pedestrian crosswalk, Bus Controller: "BUS C, YOU ARE CLEARED TO EXIT"

   Verify that Bus C can make a single smooth, fluid backing maneuver into the central aisle to a position which permits the bus to move forward and exit the facility without any collision with the other test buses[7] in their respective berths. More than a single backing maneuver and a single forward maneuver constitutes a failed outcome.

9. When Bus C clears turnout threshold with 5TH Street, Bus Controller: "END TEST #1". Timer is stopped.

Test #2 Setup

1. Buses A, B, C, D, E are holding in "Bus-Use Only" lane. (holding-area on Race Street)
2. Bus Controller directs Bus A: "BUS A, YOU ARE CLEARED TO ENTER"

   Bus proceeds to bus berth #7. Bus A driver has assigned berth # on his instruction sheet on his clipboard.

3. Bus Controller directs Bus B: "BUS B, YOU ARE CLEARED TO ENTER"

   Bus B proceeds to berth #15. Bus B driver has assigned berth # on his instruction sheet on his clipboard.

4. Bus Controller directs Bus C: "BUS C, YOU ARE CLEARED TO ENTER"

   Bus C proceeds to berth # 5. Bus C driver has assigned berth # on his instruction sheet on his clipboard.

5. Bus Controller directs Bus D: "BUS D, YOU ARE CLEARED TO ENTER"

   Bus D proceeds to berth #6. Bus D driver has assigned berth # on his instruction sheet on his clipboard.

6. Bus Controller directs Bus E: "BUS E, YOU ARE CLEARED TO ENTER"

   Bus E proceeds to berth #14. Bus E driver has assigned berth # on his instruction sheet on his clipboard.

[4] Including simulated stationary buses in the other bus berths.
[5] Including simulated stationary buses in the other bus berths.
[6] Including simulated stationary buses in the other bus berths.
[7] Including simulated stationary buses in the other bus berths.

Formal Test #2 Sequence

1. Bus Controller: "BEGIN TEST #2". Timer is started.
2. Bus Controller: "BUS A, YOU ARE CLEARED TO EXECUTE TEST #2" (leapfrog test).

   Bus A driver is given instructions on his instruction sheet to activate Flasher signal, execute a backing maneuver from berth #7, deactivate Flasher signal when Bus A moves in a forward direction, and enter berth #4.
   Bus B, C, D, and E drivers are instructed to hold in berth until given clearance to move.

   Verify Bus A activates Flasher signal.
   Verify that Bus A can make a single smooth, fluid backing maneuver into the central aisle to a position which permits the bus to move forward and enter berth #4 without any collision with the other test buses[8] in their respective berths. More than a single backing maneuver and a single forward maneuver for entry into berth #4 constitutes a failed outcome.
   Verify that Bus A deactivates Flasher signal when initiating a forward movement to enter berth #4.
3. Bus Controller (first) observes Bus A enter berth #4.
4. Bus Controller (second) signals to Bus C to activate Flasher Signal indicating intent to back and exit ITC.
5. Bus Controller (first) observes Bus C Flasher Signal.
6. Bus Controller (first): "BUS C, YOU ARE CLEARED TO EXIT"

   Bus C exits the ITC and proceeds to holding-area.
   Verify that Bus C can make a single smooth, fluid backing maneuver into the central aisle to a position which permits the bus to move forward and exit the facility without any collision with the other test buses[9] in their respective berths. More than a single backing maneuver and a single forward maneuver constitutes a failed outcome.
7. When Bus C crosses 5th street threshold, Bus Controller (second) signals to Bus E to activate its Flasher Signal.
8. Bus Controller (first) observes Bus E Flasher Signal.
9. Bus Controller (first): "BUS E, YOU ARE CLEARED TO EXIT"

   Bus E exits the ITC and proceeds to holding-area[10].
   Verify that Bus E can make a single smooth, fluid backing maneuver into the central aisle to a position which permits the bus to move forward and exit the facility without any collision with the other test buses[11] in their respective berths. More than a single backing maneuver and a single forward maneuver constitutes a failed outcome.

10. When Bus E crosses 5th street threshold, Bus Controller (second) signals to Bus A to activate its Flasher Signal.
11. Bus Controller (first) observes Bus A Flasher Signal.
12. Bus Controller (first) : "BUS A, YOU ARE CLEARED TO EXIT"

    Bus A exits the ITC and proceeds to the holding-area.
    Verify that Bus A can make a single smooth, fluid backing maneuver into the central aisle to a position which permits the bus to move forward and exit the facility without any collision with the other test

[8] Including simulated stationary buses in the other bus berths, if any.
[9] Including simulated stationary buses in the other bus berths, if any.
[10] Note: Should the buses return to a fixed slot within the holding area so that they line up in the same sequence for each test (less confusion for the drivers with respect to each driver's instructions for each test)? Should we shift Bus id's among the drivers (more confusing, since each driver may have a different Bus id number for each test)?
[11] Including simulated stationary buses in the other bus berths, if any.

buses[12] in their respective berths. More than a single backing maneuver and a single forward maneuver constitutes a failed outcome.

13. When Bus A crosses 5th street threshold, Bus Controller (second) signals to Bus D to activate its Flasher Signal.
14. Bus Controller (first) observes Bus D Flasher Signal.
15. Bus Controller (first): "BUS D, YOU ARE CLEARED TO EXIT"

    Bus D exits the ITC and proceeds to the holding-area.
    Verify that Bus D can make a single smooth, fluid backing maneuver into the central aisle to a position which permits the bus to move forward and exit the facility without any collision with the other test buses[13] in their respective berths. More than a single backing maneuver and a single forward maneuver constitutes a failed outcome.

16. When Bus D crosses 5th street threshold, Bus Controller (second) signals to Bus B to activate its Flasher Signal.
17. Bus Controller (first) observes Bus B Flasher Signal.
18. Bus Controller (first): "BUS B, YOU ARE CLEARED TO EXIT"

    Bus B exits the ITC and proceeds to the holding-area.
    Verify that Bus B can make a single smooth, fluid backing maneuver into the central aisle to a position which permits the bus to move forward and exit the facility without any collision with the other test buses[14] in their respective berths. More than a single backing maneuver and a single forward maneuver constitutes a failed outcome.

19. When Bus B crosses 5th street threshold, Bus Controller (first): "End Test #2". Timer is stopped.

Coffee Time

Session 2

Session 2 Quantitative Measurements With Observations

Set up: All buses waiting in bus holding area (in consecutive order A to E). Barrels modeling pedestrians shall be placed on the west end of the exit crosswalk.

{Refer to Session 2 checklist}

Session 2 designated reference points: Lateral measurements shall be referenced from the perpendicular off the centerline. Longitudinal measurements shall be referenced from the perpendicular off the exit crosswalk. See Figure #.

No.	Maneuver	Action	Qualitative & Measurement
1.	**Bus A** given the signal to enter ITC area and proceed to berth 2	Bus A enters berth 2 and parks.	Check ease of berth entrance
2.	**Bus B** given the signal to enter ITC area and proceed to berth 14	Bus B enters berth 14 and parks.	Check ease of berth entrance
3.	**Bus C** given the signal to enter ITC area and proceed to berth 1	Bus C enters berth 1 and parks.	Check ease of berth entrance and orientation WRT berth 1
4.	**Bus D** given the signal to enter ITC area and proceed to berth 15	Bus D enters berth 15 and parks.	Check ease of berth entrance and orientation.

[12] Including simulated stationary buses in the other bus berths, if any.
[13] Including simulated stationary buses in the other bus berths, if any.
[14] Including simulated stationary buses in the other bus berths, if any.

No.	Maneuver	Action	Qualitative & Measurement
5.	**Bus E** given the signal to enter ITC area and directed to perform a go-around. When signaled **Bus E** returns to holding area.	Bus E enters ITC area and while performing go-around immediately stops when the driver spots the barrels placed in the west end of the exit crosswalk. Driver may be asked to repeat this operation a number of times.	Measure distances and record in Attachment B. Check clearances during exit-turnout.
6.	**Bus C** given the signal to exit berth 1 and ITC area	Bus C reverses out of berth 1 stops and pauses when ready to initiate foreword movement.	Check ease of maneuver. Record closest approach distance to Bus B in berth 14 and Bus A in berth 2. Record distances of Bus C when fully backed into position ready for foreword movement. Check clearances during exit-turnout, record measurements if necessary.
7.	**Bus D** given the signal to exit berth 15 and ITC area	Bus D exits ITC area	Check ease of maneuver. Check clearances during exit-turnout.
8.	**Bus A** given the signal to exit berth 2 and ITC area	Bus A exits ITC area and returns to bus holding area.	Check ease of maneuver. Check clearances during exit-turnout.
9.	**Bus B** given the signal to exit berth 14 and ITC area	Bus B exits ITC area and returns to bus holding area	Check clearances during exit-turnout.

Test #3 Setup

1. Buses A, B, C, D, E are holding in "Bus-Use Only" lane. (holding-area on Race Street)
2. Bus Controller directs Bus A: "BUS A, YOU ARE CLEARED TO ENTER"

   Bus A proceeds to bus berth #2. Bus A driver has assigned berth # on his instruction sheet on his clipboard.
3. Bus Controller directs Bus B: "BUS B, YOU ARE CLEARED TO ENTER"

   Bus B proceeds to bus berth #14. Bus B driver has assigned berth # on his instruction sheet on his clipboard.
4. Bus Controller directs Bus C: "BUS C, YOU ARE CLEARED TO ENTER"

   Bus C proceeds to bus berth #1. Bus C driver has assigned berth # on his instruction sheet on his clipboard.
5. Bus Controller directs Bus D: "BUS D, YOU ARE CLEARED TO ENTER"

   Bus D proceeds to bus berth # 15. Bus D driver has assigned berth # on his instruction sheet on his clipboard.
6. Bus Controller directs Bus E: "BUS E, YOU ARE CLEARED TO ENTER"

   Bus E proceeds to bus berth #3. Bus E driver has assigned berth # on his instruction sheet on his clipboard.

Formal Test #3 Sequence

1. Bus Controller: "BEGIN TEST #2". Timer is started.
2. Bus Controller (second) signals to Bus C to activate Flasher signal.
3. Bus Controller (first) observes Bus C Flasher signal.
4. Bus Controller (first): "BUS C, YOU ARE CLEARED TO EXIT"

   Bus A, B, D, and E drivers are instructed to hold until cleared to exit.
   Bus C exits the ITC and proceeds to holding-area.
   Verify that Bus C can make a single smooth, fluid backing maneuver into the central aisle to a position which permits the bus to move forward and exit the facility without any collision with the other test buses[15] in their respective berths. More than a single backing maneuver and a single forward maneuver constitutes a failed outcome.
5. Bus Controller (second) signals to Bus B to activate Flasher signal.
6. Bus Controller (first) observes Bus B Flasher signal.
7. Bus Controller (first): "BUS B, YOU ARE CLEARED TO EXIT"

   Bus A, D, and E drivers are instructed to hold until cleared to exit.
   Bus B exits the ITC and proceeds to holding-area.
   Verify that Bus B can make a single smooth, fluid backing maneuver into the central aisle to a position which permits the bus to move forward and exit the facility without any collision with the other test buses[16] in their respective berths. More than a single backing maneuver and a single forward maneuver constitutes a failed outcome.
8. Bus Controller (second) signals to Bus A to activate Flasher signal.
9. Bus Controller (first) observes Bus A Flasher signal.
10. Bus Controller (first): "BUS A, YOU ARE CLEARED TO EXIT"

    Bus D and E drivers are instructed to hold until cleared to exit.
    Bus A exits the ITC and proceeds to holding-area.
    Verify that Bus A can make a single smooth, fluid backing maneuver into the central aisle to a position which permits the bus to move forward and exit the facility without any collision with the other test buses[17] in their respective berths. More than a single backing maneuver and a single forward maneuver constitutes a failed outcome.
11. Bus Controller (second) signals to Bus E to activate Flasher signal.
12. Bus Controller (first) observes Bus E Flasher signal.
13. Bus Controller (first): "BUS E, YOU ARE CLEARED TO EXIT"

    Bus D driver is instructed to hold until cleared to exit.
    Bus E exits the ITC and proceeds to holding-area.
    Verify that Bus E can make a single smooth, fluid backing maneuver into the central aisle to a position which permits the bus to move forward and exit the facility without any collision with the other test buses[18] in their respective berths. More than a single backing maneuver and a single forward maneuver constitutes a failed outcome.
14. Bus Controller (second) signals to Bus D to activate Flasher signal.
15. Bus Controller (first) observes Bus D Flasher signal.
16. Bus Controller (first): "BUS D, YOU ARE CLEARED TO EXIT"
17. Bus D exits the ITC and proceeds to holding-area.

[15] Including simulated stationary buses in the other bus berths, if any.
[16] Including simulated stationary buses in the other bus berths, if any.
[17] Including simulated stationary buses in the other bus berths, if any.
[18] Including simulated stationary buses in the other bus berths, if any.

Verify that Bus D can make a single smooth, fluid backing maneuver into the central aisle to a position which permits the bus to move forward and exit the facility without any collision with the other test buses[19] in their respective berths. More than a single backing maneuver and a single forward maneuver constitutes a failed outcome.

18. When Bus D crosses 5th street threshold, Bus Controller (first): "END TEST #2". Timer is stopped.

Test #4 Setup

1. Buses A, B, C, D and E are holding in "Bus-Use Only" lane. (holding-area on Race Street).
2. Bus Controller directs Bus A: "BUS A, YOU ARE CLEARED TO ENTER"

   Bus A proceeds to bus berth #4. Bus A driver has assigned berth # on his instruction sheet on his clipboard.
3. Bus Controller directs Bus B: "BUS B, YOU ARE CLEARED TO ENTER"

   Bus B proceeds to bus berth #5. Bus B driver has assigned berth # on his instruction sheet on his clipboard.
4. Bus Controller directs Bus C: "BUS C, YOU ARE CLEARED TO ENTER"

   Bus C proceeds to bus berth #6. Bus C driver has assigned berth # on his instruction sheet on his clipboard.
5. Bus Controller directs Bus D: "BUS D, YOU ARE CLEARED TO ENTER"

   Bus D proceeds to bus berth #7. Bus D driver has assigned berth # on his instruction sheet on his clipboard.
6. Bus Controller directs Bus E: "Bus E, YOU ARE CLEARED TO ENTER"

   Bus E proceeds to bus berth #8. Bus E driver has assigned berth # on his instruction sheet on his clipboard.

Formal Test #4 Sequence

1. Bus Controller: "BEGIN TEST #4". Timer is started.
2. Bus Controller (first) signals Bus B to activate Flasher signal.
3. Bus Controller (second) concurrently signals Bus D to activate Flasher signal.
4. Bus B and Bus D are instructed to cautiously exit the facility without controller direction or sequencing.

   Verify that Bus B and Bus D can each make a single smooth, fluid backing maneuver into the central aisle to a position which permits each bus to move forward and exit the facility. Verify that this can be done without any collision[20] between the two moving buses (Test Buses B and D) and without any collision[21] with the other test buses[22] in their respective berths. More than a single backing maneuver and a single forward maneuver for each bus constitutes a failed outcome.
5. When Bus D crosses 5th street threshold, Bus Controller (first): "END TEST #4". Timer is stopped.

[19] Including simulated stationary buses in the other bus berths, if any.
[20] Or any unacceptable clearance
[21] Or any unacceptable clearance
[22] Including simulated stationary buses in the other bus berths, if any.

Attachment A

Session 1 Checklist

<table>
<tr><th>No</th><th>Observation</th><th>Yes</th><th>No</th><th>Measurements</th><th>Remarks</th></tr>
<tr><td>1.</td><td>Is the entrance radius adequate for safe and viable transportation?</td><td></td><td></td><td>N/A</td><td></td></tr>
<tr><td>2.</td><td>Is the orientation of Bus A and Bus B correct, i.e. parallel?</td><td></td><td></td><td>Bus separation distance (perpendicular between the two):
Separation =</td><td></td></tr>
<tr><td>3.</td><td>Does Bus C enter berth 16 problem free?</td><td></td><td></td><td>Distance of right rear quarter to centerline:

3CR/CL =</td><td></td></tr>
<tr><td rowspan="2">4.</td><td>Does Bus D enter berth 11 problem free?</td><td></td><td></td><td colspan="2"><table><tr><th></th><th>Cone 1</th><th>Cone 2</th><th>Cone 3</th><th>Cone 4</th><th>Cone 5</th><th>Cone 6</th><th>Cone 7</th></tr><tr><td>4DF/CL</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>4DF/CW</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>4DR/CL</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>4DR/CW</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td colspan="5">Observation 4 Remarks:</td></tr>
<tr><td rowspan="2">5.</td><td>Does Bus E enter berth 8 problem free?</td><td></td><td></td><td rowspan="2">Right Side Dist. =

Left Side Dist. =</td><td rowspan="2"></td></tr>
<tr><td>Does the distance between the two buses remain safe during turns?</td><td></td><td></td></tr>
<tr><td>6.</td><td>Does Bus A exit berth 9 and exit-turnout problem free?</td><td></td><td></td><td>Bus A fully backed:<table><tr><td>6AF/CL</td><td></td></tr><tr><td>6AF/CW</td><td></td></tr><tr><td>6AR/CL</td><td></td></tr><tr><td>6AR/CW</td><td></td></tr></table></td><td></td></tr>
<tr><td>7.</td><td>Does Bus D exit berth 11 and exit-turnout problem free?</td><td></td><td></td><td>Bus D fully backed:<table><tr><td>7DF/CL</td><td></td></tr><tr><td>7DF/CW</td><td></td></tr><tr><td>7DR/CL</td><td></td></tr><tr><td>7DR/CW</td><td></td></tr></table></td><td></td></tr>
</table>

No	Observation	Yes	No	Measurements	Remarks
8.	Does Bus C exit berth 16 and exit-turnout problem free?			Bus C fully backed: 8CF/CL 8CF/CW 8CR/CL 8CR/CW	
9.	Does Bus B exit berth 10 and exit-turnout problem free?			N/A	
10.	Does Bus E exit berth 8 and exit-turnout problem free?			N/A	

Attachment B

Session 2 Checklist

No	Observation	Yes	No	Measurements	Remarks
1.	Does Bus A enter berth 1 problem free?			N/A	
2.	Does Bus B enter berth 14 problem free?			*N/A*	
3.	Does Bus C enter berth 1 problem free?			*N/A*	
4.	Does Bus D enter berth 15 problem free?			*N/A*	
5.	Does Bus E stop leaving plenty of distance between pedestrians and bus?			Bus E sights pedestrians: **5EF/CL** **5EF/CW** **5ER/CL** **5ER/CW**	
6.	Does Bus C exit berth 1 problem free?			Bus C fully backed: **6CF/CL** **6CF/CW** **6CR/CL** **6CR/CW** **Right Side (Bus A) Dist. =** **Left Side (Bus B) Dist. =**	
7.	Does Bus D exit berth 15 and exit-turnout problem free?			N/A	
8.	Does Bus A exit berth 2 and exit-turnout problem free?			N/A	
9.	Does Bus B exit berth 14 and exit-turnout problem free?			N/A	

10/17/00
D. Spiller/49
B. Mickela/36

Driver of Bus A

Thank-you for participating in this Field Operational Test of the proposed Independence Transportation Center (ITC) bus facility. Your participation is critical to developing the best possible design that is safe and operationally efficient.

General Instructions for all drivers

1. There will be two parts to the Field Operational Test. At the beginning of each part, you will be directed to execute certain test maneuvers. You will be asked to stop your bus periodically, and position measurements will be taken. After all measurements are taken, you will participate in a series of formal tests in which you will enter, dock at an assigned bus berth, and exit the ITC bus facility when directed and cleared by a Bus Controller. You will not be interrupted during maneuvers during each formal test except for emergency safety reasons. At the conclusion of all formal tests, you will be asked to fill out a driver survey form.

2. Buses will be identified by a letter: A, B, C, D and E.

3. Bus berths will be identified by a number: 1, 2, 3, 4, 5, 6, 7, 8, 9,10, 11,14, 15, and 16. These are shown on the scaled drawing of the ITC Bus Facility that is attached to these instructions.

4. You will start each test maneuver and each formal test from an area marked "HOLDING-AREA" at the test site. You will park within the holding-area in parallel formation behind cones labeled with the bus identification letter (A, B, C, D and E). You will exit the ITC BUS Facility during each formal test and return to the holding-area. You will then park in the space corresponding to the bus identification letter.

5. At the direction of the Bus Controller, You will depart the holding-area and merge into the marked "BUS-USE Only" lane for entry into the ITC Bus Facility. You will do this for all test maneuvers and each formal test.

6. All bus movements will be under the positive control of the Bus Controller. You are to pay close attention to all Bus Controller instructions, and react accordingly. However, BUS DRIVERS HAVE FINAL AUTHORITY WITH RESPECT TO THE SAFE OPERATION OF THEIR VEHICLE.

7. Each of you will communicate to the Bus Controllers your intention to initiate a backing maneuver from a bus berth by activating the Flasher signal on your bus. You are to hold within the bus berth until directed and cleared by a Bus Controller. Flashers will stay activated until your bus is in a position and is cleared by the Bus Controller to move in a forward direction. For some formal tests, you will be instructed by a Bus Controller to activate you Flasher signal.

8. Speed limit for the ITC Facility will be 5 mph. You are **NOT** to exceed this speed limit during either test maneuvers or formal tests. You should, however, drive normally.

9. To the maximum extent possible, standard phrases will be used to direct the movement of buses.

Standard Control Phraseology

1. "BEGIN TEST # - "
2. "END TEST # - "
3. "BUS A, HOLD YOUR POSITION UNTIL CLEARED"
4. "BUS A, YOU ARE CLEARED TO EXIT"
5. "BUS A, YOU ARE CLEARED TO ENTER"
6. "BUS A, EXIT ITC AND INITIATE GO-AROUND"
7. "BUS A, STOP AND HOLD YOUR POSITION FOR MEASUREMENT"
8. "BUS A, YOU ARE CLEARED TO EXECUTE TEST #2" (Leap-frog test)
9. "CODE BLUE, CODE BLUE, CODE BLUE"

Under a Code Blue condition, all test buses immediately stop and engage their emergency brakes. Blowing a safety horn will also indicate a Code Blue condition, whether or not the phrase is annunciated or not.

Instructions for Bus A Driver

Part 1
Test Maneuvers

1. Bus A assigned to bus berth #9.

Formal Test #1

1. Bus A assigned to bus berth #9.

Formal Test #2

1. Bus A assigned to bus berth #7, held until cleared, then assigned to bus berth #4.

Part 2
Test Maneuvers

1. Bus A assigned to bus berth #2.

Formal Test #3

1. Bus A assigned to bus berth #2.

Formal Test #4

1. Bus A assigned to bus berth #4.

10/17/00
D. Spiller/49
B. Mickela/36

Driver of Bus B

Thank-you for participating in this Field Operational Test of the proposed Independence Transportation Center (ITC) bus facility. Your participation is critical to developing the best possible design that is safe and operationally efficient.

General Instructions for all drivers

10. There will be two parts to the Field Operational Test. At the beginning of each part, you will be directed to execute certain test maneuvers. You will be asked to stop your bus periodically, and position measurements will be taken. After all measurements are taken, you will participate in a series of formal tests in which you will enter, dock at an assigned bus berth, and exit the ITC bus facility when directed and cleared by a Bus Controller. You will not be interrupted during maneuvers during each formal test except for emergency safety reasons. At the conclusion of all formal tests, you will be asked to fill out a driver survey form.

11. Buses will be identified by a letter: A, B, C, D and E.

12. Bus berths will be identified by a number: 1, 2, 3, 4, 5, 6, 7, 8, 9,10, 11,14, 15, and 16. These are shown on the scaled drawing of the ITC Bus Facility that is attached to these instructions.

13. You will start each test maneuver and each formal test from an area marked “HOLDING-AREA” at the test site. You will park within the holding-area in parallel formation behind cones labeled with the bus identification letter (A, B, C, D and E). You will exit the ITC BUS Facility during each formal test and return to the holding-area. You will then park in the space corresponding to the bus identification letter.

14. At the direction of the Bus Controller, You will depart the holding-area and merge into the marked “BUS-USE Only” lane for entry into the ITC Bus Facility. You will do this for all test maneuvers and each formal test.

15. All bus movements will be under the positive control of the Bus Controller. You are to pay close attention to all Bus Controller instructions, and react accordingly. However, BUS DRIVERS HAVE FINAL AUTHORITY WITH RESPECT TO THE SAFE OPERATION OF THEIR VEHICLE.

16. Each of you will communicate to the Bus Controllers your intention to initiate a backing maneuver from a bus berth by activating the Flasher signal on your bus. You are to hold within the bus berth until directed and cleared by a Bus Controller. Flashers will stay activated until your bus is in a position and is cleared by the Bus Controller to move in a forward direction. For some formal tests, you will be instructed by a Bus Controller to activate you Flasher signal.

17. Speed limit for the ITC Facility will be 5 mph. You are **NOT** to exceed this speed limit during either test maneuvers or formal tests. You should, however, drive normally.

18. To the maximum extent possible, standard phrases will be used to direct the movement of buses.

Standard Control Phraseology

10. "BEGIN TEST # - "
11. "END TEST # - "
12. "BUS A, HOLD YOUR POSITION UNTIL CLEARED"
13. "BUS A, YOU ARE CLEARED TO EXIT"
14. "BUS A, YOU ARE CLEARED TO ENTER"
15. "BUS A, EXIT ITC AND INITIATE GO-AROUND"
16. "BUS A, STOP AND HOLD YOUR POSITION FOR MEASUREMENT"
17. "BUS A, YOU ARE CLEARED TO EXECUTE TEST #2" (Leap-frog test)
18. "CODE BLUE, CODE BLUE, CODE BLUE"

Under a Code Blue condition, all test buses immediately stop and engage their emergency brakes. Blowing a safety horn will also indicate a Code Blue condition, whether or not the phrase is annunciated or not.

Instructions for Bus B Driver

Part 1
Test Maneuvers

1. Bus B assigned to bus berth #10.

Formal Test #1

2. Bus B assigned to bus berth #10.

Formal Test #2

2. Bus B assigned to bus berth #15.

Part 2
Test Maneuvers

2. Bus B assigned to bus berth #14.

Formal Test #3

2. Bus B assigned to bus berth #14.

Formal Test #4

2. Bus B assigned to bus berth #5.

10/17/00
D. Spiller/49
B. Mickela/36

Driver of Bus C

Thank-you for participating in this Field Operational Test of the proposed Independence Transportation Center (ITC) bus facility. Your participation is critical to developing the best possible design that is safe and operationally efficient.

General Instructions for all drivers

19. There will be two parts to the Field Operational Test. At the beginning of each part, you will be directed to execute certain test maneuvers. You will be asked to stop your bus periodically, and position measurements will be taken. After all measurements are taken, you will participate in a series of formal tests in which you will enter, dock at an assigned bus berth, and exit the ITC bus facility when directed and cleared by a Bus Controller. You will not be interrupted during maneuvers during each formal test except for emergency safety reasons. At the conclusion of all formal tests, you will be asked to fill out a driver survey form.

20. Buses will be identified by a letter: A, B, C, D and E.

21. Bus berths will be identified by a number: 1, 2, 3, 4, 5, 6, 7, 8, 9,10, 11,14, 15, and 16. These are shown on the scaled drawing of the ITC Bus Facility that is attached to these instructions.

22. You will start each test maneuver and each formal test from an area marked "HOLDING-AREA" at the test site. You will park within the holding-area in parallel formation behind cones labeled with the bus identification letter (A, B, C, D and E). You will exit the ITC BUS Facility during each formal test and return to the holding-area. You will then park in the space corresponding to the bus identification letter.

23. At the direction of the Bus Controller, You will depart the holding-area and merge into the marked "BUS-USE Only" lane for entry into the ITC Bus Facility. You will do this for all test maneuvers and each formal test.

24. All bus movements will be under the positive control of the Bus Controller. You are to pay close attention to all Bus Controller instructions, and react accordingly. However, BUS DRIVERS HAVE FINAL AUTHORITY WITH RESPECT TO THE SAFE OPERATION OF THEIR VEHICLE.

25. Each of you will communicate to the Bus Controllers your intention to initiate a backing maneuver from a bus berth by activating the Flasher signal on your bus. You are to hold within the bus berth until directed and cleared by a Bus Controller. Flashers will stay activated until your bus is in a position and is cleared by the Bus Controller to move in a forward direction. For some formal tests, you will be instructed by a Bus Controller to activate you Flasher signal.

26. Speed limit for the ITC Facility will be 5 mph. You are **NOT** to exceed this speed limit during either test maneuvers or formal tests. You should, however, drive normally.

27. To the maximum extent possible, standard phrases will be used to direct the movement of buses.

Standard Control Phraseology

19. "BEGIN TEST # - "
20. "END TEST # - "
21. "BUS A, HOLD YOUR POSITION UNTIL CLEARED"
22. "BUS A, YOU ARE CLEARED TO EXIT"
23. "BUS A, YOU ARE CLEARED TO ENTER"
24. "BUS A, EXIT ITC AND INITIATE GO-AROUND"
25. "BUS A, STOP AND HOLD YOUR POSITION FOR MEASUREMENT"
26. "BUS A, YOU ARE CLEARED TO EXECUTE TEST #2" (Leap-frog test)
27. "CODE BLUE, CODE BLUE, CODE BLUE"

Under a Code Blue condition, all test buses immediately stop and engage their emergency brakes. Blowing a safety horn will also indicate a Code Blue condition, whether or not the phrase is annunciated or not.

Instructions for Bus C Driver

Part 1
Test Maneuvers

1. Bus C assigned to bus berth #16.

Formal Test #1

3. Bus C assigned to bus berth #16.

Formal Test #2

3. Bus C assigned to bus berth #5.

Part 2
Test Maneuvers

3. Bus C assigned to bus berth #1.

Formal Test #3

3. Bus C assigned to bus berth #1.

Formal Test #4

3. Bus C assigned to bus berth #6.

10/17/00
D. Spiller/49
B. Mickela/36

Driver of Bus D

Thank-you for participating in this Field Operational Test of the proposed Independence Transportation Center (ITC) bus facility. Your participation is critical to developing the best possible design that is safe and operationally efficient.

General Instructions for all drivers

28. There will be two parts to the Field Operational Test. At the beginning of each part, you will be directed to execute certain test maneuvers. You will be asked to stop your bus periodically, and position measurements will be taken. After all measurements are taken, you will participate in a series of formal tests in which you will enter, dock at an assigned bus berth, and exit the ITC bus facility when directed and cleared by a Bus Controller. You will not be interrupted during maneuvers during each formal test except for emergency safety reasons. At the conclusion of all formal tests, you will be asked to fill out a driver survey form.

29. Buses will be identified by a letter: A, B, C, D and E.

30. Bus berths will be identified by a number: 1, 2, 3, 4, 5, 6, 7, 8, 9,10, 11,14, 15, and 16. These are shown on the scaled drawing of the ITC Bus Facility that is attached to these instructions.

31. You will start each test maneuver and each formal test from an area marked "HOLDING-AREA" at the test site. You will park within the holding-area in parallel formation behind cones labeled with the bus identification letter (A, B, C, D and E). You will exit the ITC BUS Facility during each formal test and return to the holding-area. You will then park in the space corresponding to the bus identification letter.

32. At the direction of the Bus Controller, You will depart the holding-area and merge into the marked "BUS-USE Only" lane for entry into the ITC Bus Facility. You will do this for all test maneuvers and each formal test.

33. All bus movements will be under the positive control of the Bus Controller. You are to pay close attention to all Bus Controller instructions, and react accordingly. However, BUS DRIVERS HAVE FINAL AUTHORITY WITH RESPECT TO THE SAFE OPERATION OF THEIR VEHICLE.

34. Each of you will communicate to the Bus Controllers your intention to initiate a backing maneuver from a bus berth by activating the Flasher signal on your bus. You are to hold within the bus berth until directed and cleared by a Bus Controller. Flashers will stay activated until your bus is in a position and is cleared by the Bus Controller to move in a forward direction. For some formal tests, you will be instructed by a Bus Controller to activate you Flasher signal.

35. Speed limit for the ITC Facility will be 5 mph. You are **NOT** to exceed this speed limit during either test maneuvers or formal tests. You should, however, drive normally.

36. To the maximum extent possible, standard phrases will be used to direct the movement of buses.

Standard Control Phraseology

28. "BEGIN TEST # - "
29. "END TEST # - "
30. "BUS A, HOLD YOUR POSITION UNTIL CLEARED"
31. "BUS A, YOU ARE CLEARED TO EXIT"
32. "BUS A, YOU ARE CLEARED TO ENTER"
33. "BUS A, EXIT ITC AND INITIATE GO-AROUND"
34. "BUS A, STOP AND HOLD YOUR POSITION FOR MEASUREMENT"
35. "BUS A, YOU ARE CLEARED TO EXECUTE TEST #2" (Leap-frog test)
36. "CODE BLUE, CODE BLUE, CODE BLUE"

Under a Code Blue condition, all test buses immediately stop and engage their emergency brakes. Blowing a safety horn will also indicate a Code Blue condition, whether or not the phrase is annunciated or not.

Instructions for Bus D Driver

Part 1
Test Maneuvers

1. Bus D assigned to bus berth #11.

Formal Test #1

4. Bus D assigned to bus berth #11.

Formal Test #2

4. Bus D assigned to bus berth #6.

Part 2
Test Maneuvers

4. Bus D assigned to bus berth #15.

Formal Test #3

4. Bus D assigned to bus berth #15.

Formal Test #4

4. Bus D assigned to bus berth #7.

10/17/00
D. Spiller/49
B. Mickela/36

Driver of Bus E

Thank-you for participating in this Field Operational Test of the proposed Independence Transportation Center (ITC) bus facility. Your participation is critical to developing the best possible design that is safe and operationally efficient.

General Instructions for all drivers

37. There will be two parts to the Field Operational Test. At the beginning of each part, you will be directed to execute certain test maneuvers. You will be asked to stop your bus periodically, and position measurements will be taken. After all measurements are taken, you will participate in a series of formal tests in which you will enter, dock at an assigned bus berth, and exit the ITC bus facility when directed and cleared by a Bus Controller. You will not be interrupted during maneuvers during each formal test except for emergency safety reasons. At the conclusion of all formal tests, you will be asked to fill out a driver survey form.

38. Buses will be identified by a letter: A, B, C, D and E.

39. Bus berths will be identified by a number: 1, 2, 3, 4, 5, 6, 7, 8, 9,10, 11,14, 15, and 16. These are shown on the scaled drawing of the ITC Bus Facility that is attached to these instructions.

40. You will start each test maneuver and each formal test from an area marked "HOLDING-AREA" at the test site. You will park within the holding-area in parallel formation behind cones labeled with the bus identification letter (A, B, C, D and E). You will exit the ITC BUS Facility during each formal test and return to the holding-area. You will then park in the space corresponding to the bus identification letter.

41. At the direction of the Bus Controller, You will depart the holding-area and merge into the marked "BUS-USE Only" lane for entry into the ITC Bus Facility. You will do this for all test maneuvers and each formal test.

42. All bus movements will be under the positive control of the Bus Controller. You are to pay close attention to all Bus Controller instructions, and react accordingly. However, BUS DRIVERS HAVE FINAL AUTHORITY WITH RESPECT TO THE SAFE OPERATION OF THEIR VEHICLE.

43. Each of you will communicate to the Bus Controllers your intention to initiate a backing maneuver from a bus berth by activating the Flasher signal on your bus. You are to hold within the bus berth until directed and cleared by a Bus Controller. Flashers will stay activated until your bus is in a position and is cleared by the Bus Controller to move in a forward direction. For some formal tests, you will be instructed by a Bus Controller to activate you Flasher signal.

44. Speed limit for the ITC Facility will be 5 mph. You are **NOT** to exceed this speed limit during either test maneuvers or formal tests. You should, however, drive normally.

45. To the maximum extent possible, standard phrases will be used to direct the movement of buses.

Standard Control Phraseology

37. "BEGIN TEST # - "
38. "END TEST # - "
39. "BUS A, HOLD YOUR POSITION UNTIL CLEARED"
40. "BUS A, YOU ARE CLEARED TO EXIT"
41. "BUS A, YOU ARE CLEARED TO ENTER"
42. "BUS A, EXIT ITC AND INITIATE GO-AROUND"
43. "BUS A, STOP AND HOLD YOUR POSITION FOR MEASUREMENT"
44. "BUS A, YOU ARE CLEARED TO EXECUTE TEST #2" (Leap-frog test)
45. "CODE BLUE, CODE BLUE, CODE BLUE"

Under a Code Blue condition, all test buses immediately stop and engage their emergency brakes. Blowing a safety horn will also indicate a Code Blue condition, whether or not the phrase is annunciated or not.

Instructions for Bus E Driver

Part 1
Test Maneuvers

1. Bus E assigned to bus berth #8.

Formal Test #1

5. Bus E enters ITC then exits ITC on a "go-around" upon direction of Bus Controller.

Formal Test #2

5. Bus E assigned to bus berth #14.

Part 2
Test Maneuvers

5. Bus E enters ITC and while performing a "go-around" (exit from ITC) immediately stops when the driver spots the barrels placed in the west end of the exit crosswalk.

Formal Test #3

5. Bus E assigned to bus berth #3.

Formal Test #4

5. Bus E assigned to bus berth #8.

Independence Transportation Center Driver Information Questionnaire

Congratulations! You are driving today to help the National Park Service (NPS) conduct a driver acceptance test of a new bus depot facility design. Today will determine whether or not this new bus depot facility design will continue through the final design phases.

Your feedback is very important to the NPS. Your comments provide the opportunity to make cost-effective changes to the current depot facility design before this project continues into the final construction phases. Your comments will be thoroughly evaluated.

THANK YOU VERY MUCH FOR PARTICIPATING!

Considerations for Rating the ITC Bus Facility

Overall Maneuvering

Did the motor coach feel safe, was it uncomplicated to drive within the ITC and easy to maneuver?

Steering & Cornering

Are the corners designed in such a way to provide adequate space so that you felt safe and in control at all times?

Braking Ability

Does the ITC design provide adequate stopping distance throughout the entire facility?

Ease of Use

Were you able to easily find, enter and exit the correct berth? Did the procedure "feel" normal? Did you feel safe while backing-up?

Overall Handling	Satisfactory	Neutral	Unsatisfactory
Controller Interaction	Satisfactory	Neutral	Unsatisfactory
Cornering	Satisfactory	Neutral	Unsatisfactory
Turning / Steering	Satisfactory	Neutral	Unsatisfactory
Braking	Satisfactory	Neutral	Unsatisfactory
Accelerating	Satisfactory	Neutral	Unsatisfactory
Ease of Use	Satisfactory	Neutral	Unsatisfactory
Speed of 5-mph	Satisfactory	Neutral	Unsatisfactory

Do you have any safety concerns?	No	Yes, explain:
Do you have any concerns regarding pedestrian safety?	No	Yes, explain:
Do you have any operating concerns?	No	Yes, explain:
Do you have concerns with the controllers during maneuvering?	No	Yes, explain:

Driver Information:

Name of Driver	
Bus Identification (A, B, C, D, E)	
Number of Years of Bus Driving Experience	
Describe Your Average Route (Long Distance, Loop, Busy Streets, etc.)	