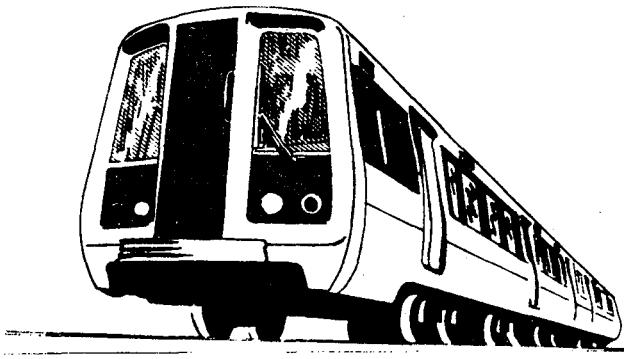
TECHNICAL NOTE



U.S. Department of Transportation
Urban Mass Transportation Administration

TRANSPORTATION TEST CENTER

TTC-015 (UMTA-TN84)

July 26, 1984

WAYSIDE AND INTERIOR NOISE FROM THE TRI-COUNTY METROPOLITAN TRANSIT AUTHORITY'S VEHICLE

by
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1.0 OBJECTIVE

The objective of this test was to measure the wayside and interior acoustic noise levels emitted from the TRI-MET vehicle for a comparison with TRI-MET Light Rail Vehicle Specification.

2.0 TEST SPECIFICATION

Bombardier Inc., Test Procedure BTP83-14151

2.1 WAYSIDE NOISE

2.1.1 Stationary Car

Test Conditions	Noise Level
• All auxiliary equipment operating	72 dBA maximum
• Tangent Track with tie and ballast construction	
• Recording equipment located fifty (50) feet from track centerline	

2.1.2 Moving Car

Test Conditions	Noise Level
• All auxiliary equipment operating	75 dBA average
• Tangent Track with tie and ballast construction	
• Car traveling at forty (40) mph	
• Recording equipment located fifty (50) feet from track centerline	

2.2 INTERIOR NOISE

2.2.1 Stationary Car

Test Conditions #1	Noise Level
• All auxiliary equipment operating	70 dBA maximum
• Car stationary on tangent track	
• All windows and doors closed	
• Recording instrument located three (3) feet from any carbody surface	

Test Conditions #2	Noise Level
• Any auxiliary unit or system except ventilation	65 dBA maximum
• Car stationary on tangent track	
• All windows and doors closed	
• Recording instrument located three (3) feet from any carbody surface	

2.2.2 Moving Car

Test Conditions	Noise Level
• All auxiliary equipment operating	75 dBA maximum
• Car traveling at forty (40) mph	
• All windows and doors closed	
• Recording instrument located three (3) feet from any carbody surface	

3.0 METHODOLOGY

3.1 WAYSIDE NOISE

3.1.1 Setup and Instrumentation

The wayside noise measurements were taken with a wind-protected, non-directional microphone placed on a tripod 50 feet from the track centerline on the converter side of TRI-MET vehicle 103. The output from the microphone was fed into an "A-weighted" precision sound-level meter, then recorded on a Nagra acoustic tape recorder and plotted on a strip chart. All equipment was calibrated with a 96 dBA pistonphone.

The location of the wayside measurements was adjacent to station 33.750 on the Transit Test Track. This site was chosen because the track is level and tangent, the 119 lb/yd rail is in new condition, and because there are no large sound reflecting barriers nearby. The track is made of concrete ties and slag ballast.

The weather was sunny, dry, and approximately 60°F with wind gusts up to 8 mph on the day of the measurements.

3.1.2 Measurements

After all of the instrumentation was set up and calibrated, the maximum noise level was identified and recorded for ambient noise, for the stationary vehicle with all auxiliary equipment on, and for the vehicle moving at 20, 40 and 55 mph with all auxiliary equipment on.

3.2 INTERIOR NOISE

3.2.1 Setup and Instrumentation

The instrumentation setup for the interior vehicle noise measurements was similar to the wayside noise measurements in that a non-directional microphone was connected to an "A-weighted" precision sound-level meter, and the output was recorded on both a Nagra acoustic tape recorder and on a strip chart. The microphone was hand held by the test person at arm length.

All windows and doors of the TRI-MET vehicle 103 were closed.

The interior noise measurements were made while the vehicle was moving or stationary on tangent, level track made of wood ties, slag ballast, and good-condition 100 lb/yd rail.

The weather on the day of the measurements was overcast, approximately 45°F and the maximum wind speed was 3 mph.

3.2.2 Measurements

Interior noise levels were measured at various locations inside vehicle 103. The major points of interest were inside the cab, under the ventilation fan, in the general passenger area, over an HPCU, and over the converter.

In general, the noise emissions were measured at approximately 50 inches above the floor with all auxiliary equipment on. The maximum levels were recorded.

4.0 RESULTS

4.1 WAYSIDE NOISE

The wayside noise measurements were taken with the non-directional microphone in two positions. Position 1: The microphone was 8 feet

above the ground, which is equal to 4 feet above the track. Position 2: The microphone was 4 feet above the ground or at equal elevation to the track. No significant difference was found in any of the noise measurements due to the 4 foot difference in microphone elevation.

The results of the wayside noise measurements are as follows:

- Ambient noise 35 dBA
- Vehicle idling with all auxiliary equipment on 47 dBA
- Vehicle operating at 20 mph with all auxiliaries on 64 dBA
- Vehicle operating at 40 mph with all auxiliaries on 73 dBA
- Vehicle operating at 55 mph with all auxiliaries on 79 dBA

This indicates that wayside noise is a linear function of the vehicle speed such that the idling noise 50 feet from the vehicle is 12 dBA greater than the ambient noise level, and the vehicle emissions increase the total noise level by 0.6 dBA for each mph of operating speed.

4.2 INTERIOR NOISE

The results of the interior vehicle noise are as follows:

4.2.1 Ambient

- Ambient noise inside vehicle with all systems off 26 dBA

4.2.2 Stationary Car

- Inside cab with cab fan off 52 dBA
- Inside cab with cab fan on high position 63 dBA
- Under operating ventilation fan 67 dBA
- Passenger seat area, ventilation on 64 dBA
- Over converter, ventilation off 41 dBA
- Over HPCU, ventilation off 52 dBA
- Over articulated area, ventilation on 62 dBA

4.2.3 40 MPH Operation

- Inside cab with cab fan on high position 64 dBA
- Under operating ventilation fan 71 dBA
- Passenger seat area, ventilation on 68 dBA
- Over articulated area, ventilation on 70 dBA

Objectively, the vehicle is comfortably quiet in the general passenger area and neither the HPCUs nor the converter contributed excessively to the overall interior noise level.

TECHNICAL NOTE

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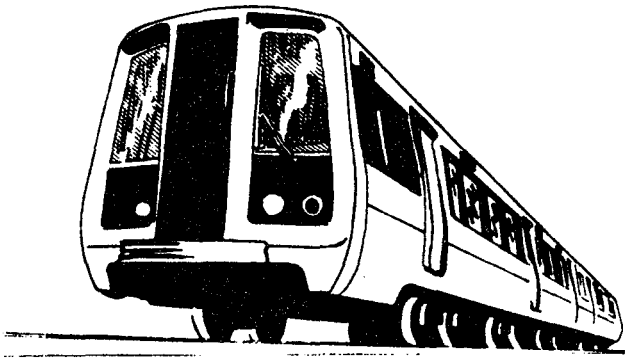


TRANSPORTATION TEST CENTER

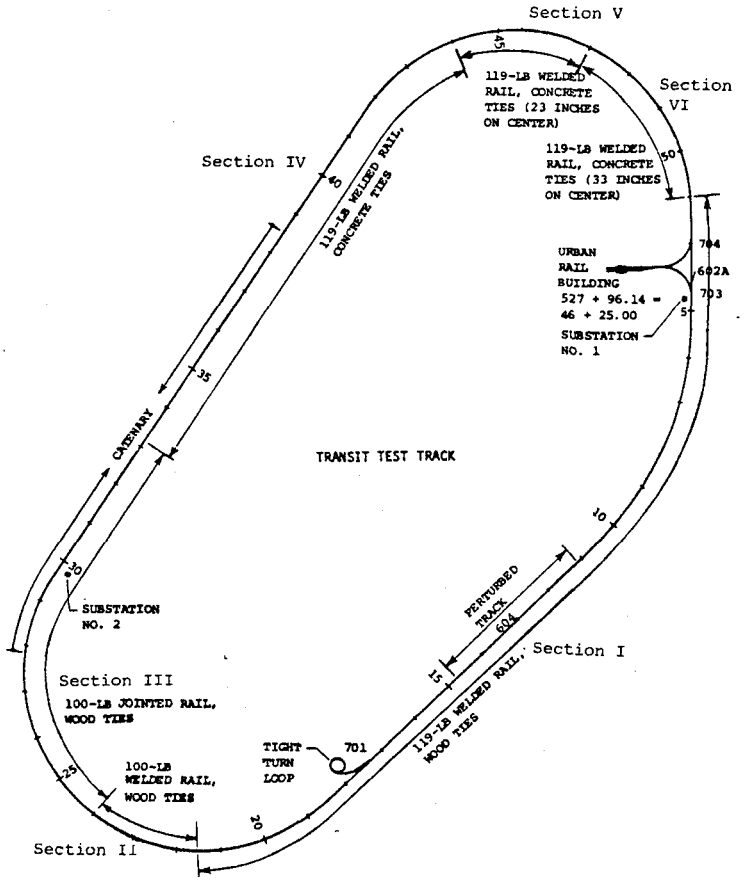
Test and evaluation activities of the Urban Mass Transportation Administration (UMTA) are coordinated through The Office of Technical Assistance in Washington, D.C., and are conducted by The UMTA Program Office at the Transportation Test Center (TTC) in Pueblo, Colorado.

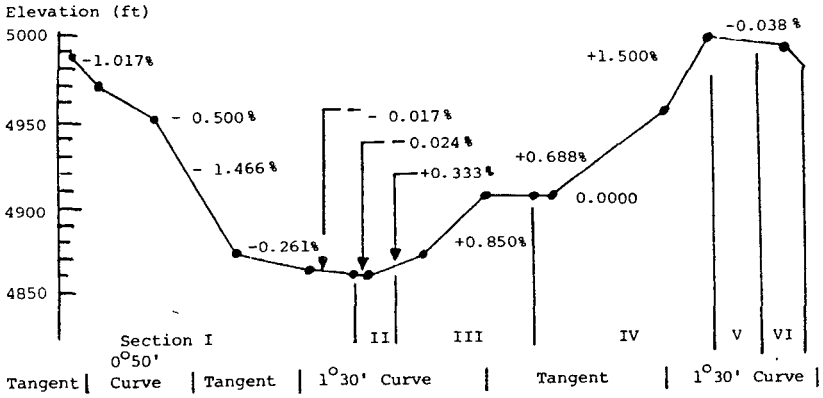
The urban rail transit test facilities at the TTC provide for test and evaluation of urban rail vehicles, subsystems, track, and structural components in an environment that is both safe and free from the scheduling constraints imposed by revenue service operations.

The Transit Test Track (TTT) is a 9.1 mile oval (see next page) designated for sustained 80 mi/h vehicle operation with the exception of the perturbed track section, which is subject to a speed limit based on ride quality test requirements and safety considerations. Power is provided either by a conventional third rail or a section of overhead catenary cable; the third rail was constructed to New York City Transit Authority specifications.

The rectifier station voltage can be varied infinitely from 400 to 1,200 V.d.c. with a current limit of 11,000 A. The stations each feed from one bus to all of the TTT and are designed to operate in several alternate modes, including computer control. Voltage can be controlled at a constant level at the substation, or at the position of the vehicle and held within the above constraints to a constant value at the vehicle regardless of demand or voltage drop through the rails. In alternate modes of operation the test vehicle can be subjected to a voltage profile or a voltage step such as might occur in revenue service at the transition between one substation and another.

The Test Center's technical support capabilities include test management, engineering instrumentation, calibration and electronic repair, photo-optical instrumentation, and data processing. In addition, TTC has the capability to assist users in developing test plans and requirements, and preparing reports.





NOTES:

Track Curvature:

Sta. to Sta.		Degree of Curve
55.3	10.3	0° 50"
18.9	29.4	1° 30"
41.8	50.8	1° 30"

Elevation:

Minimum - 4863 ft at Station 22.0.
Maximum - 5003 ft at Station 46.0.

Curve Superelevation:

1° 30' curves are superelevated a maximum of 4.5". The maximum superelevation on the 0° 50' curve is 2".

Tight Turn Loop

150 ft radius.
119 lb AREA Head Hardened running rail.
85 lb ASCE restraining rail installed as per Massachusetts Bay Transit Authority specifications.