

ALLIED
VEHICLE TESTING
PUBLICATION

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NATO INTERNATIONAL STAFF-DEFENCE SUPPORT DIVISION

TRIAL SERIES : PERFORMANCE

TEST TITLE : DYNAMIC STABILITY

REFERENCE : STANAG 4357
STANAG 4358
ISO 4138
ISO TECHNICAL REPORT 3888

EQUIVALENT : WEU 4FT6 NO.: TM 03-160

FOR COMPLIANCE
WITH : -

ABSTRACT : This AVTP describes how to determine the lateral dynamic stability of a vehicle during obstacle avoidance and manoeuvres when turning.

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NORTH ATLANTIC TREATY ORGANISATION
MILITARY AGENCY FOR STANDARDIZATION (MAS)

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RECORD OF CHANGES, AMENDMENTS AND RESERVATIONS *)

Identification of Change or Amendment and Reg.No.(if any) and date	Date Entered	NATO Effective Date	By whom entered Signature, Rank, Grade or Rate, Name of Command

*) See Reservations Overleaf

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Trial Series: PERFORMANCE

Test Title : DYNAMIC STABILITY

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1. SCOPE

This document describes two methods of evaluating the dynamic stability of vehicles when taking avoiding action or cornering.

2. FACILITIES AND INSTRUMENTATION

2.1 Facilities

a. Track:

- hard and level (uniform paved surface)
- good grip (coefficient ≥ 0.7)
- sufficiently large to carry out tests in safety
- slope of $\leq 2\%$ in all directions.

b. Safety device with supporting wheels on either side of the vehicle, if required.

c. Cones or other means of marking lanes; their lay-out is given at ANNEX A.

d. Video equipment (if required).

2.2 Instrumentation

DEVICES FOR MEASUREMENT OF:

PERMISSIBLE ERROR OF MEASUREMENT

a. Vehicle Speed	1 %
b. Time	1 %
c. Distance	2 %
d. Tyre Pressure	10 kPa
e. Tyre Wear	0.5 mm
f. Weather Data:	
(1) Ambient Temperature	1 °C
(2) Wind Direction	50 mrad
(3) Wind Speed	5 %
(4) Relative Humidity	3 % of full scale
and, if necessary:	
g. Turning Angle (Steering Wheel)	20 mrad
h. Turning Torque (Steering Wheel)	2 %

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- i. Roll Angle 5 mrad
- j. Lateral Acceleration 0.15 m/s²
in the Horizontal Plane

* The permissible error of measurement for instrumentation is the two-sigma value for a normal distribution; thus, the stated errors should not be exceeded in more than 1 measurement of 20.

3. REQUIRED TEST CONDITIONS

3.1 Test vehicle

Ensure that:

a. The vehicle is prepared and equipped to the standard anticipated for operations or as specified by the test plan.

b. Maintenance and service operations have been performed to ensure that the vehicle is operating within manufacture's specifications. Give particular attention to the suspension, steering and tyres.
(The test may be performed with tyres in any state of wear, so long as, at the end of test, a minimum of 1.5 mm of tread depth remains over the whole circumference of the tyre. However, for a standard tyre condition, new tyres shall be used after being run-in for 150 to 200 km in the appropriate position on the test vehicle.)

c. Reference fuels and lubricants as specified by relevant NATO authority, (after ratification) have been used. Until NATO agreement is ratified, developer-specified POL will be used.

d. The proper quantities of lubricants have been used.

e. Normal operating temperatures of fluids and components are reached before testing begins.

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3.2 Test course

- Clean and dry.
- Any other conditions laid down in the test plan.

3.3 Environment

- Wind speed ≤ 3 m/s.

4. TEST PROCEDURE

4.1 Steady state circular tests

- a. The tyres shall be warmed up.
- b. Drive the vehicle to the desired turning circle for a right turn (minimum diameter greater than 60 m).
- c. Start the test at the lowest possible speed (≤ 5 km/h). Data shall be recorded with the steering wheel in a fixed position and the vehicle speed constant.
- d. Drive the vehicle at the next speed at which data shall be taken. The increments of lateral acceleration should not be more than 0.5 m/s^2 . At each speed level, the steering wheel position and speed shall be maintained as constant as possible while data are taken. Whatever radius is chosen (vehicle shall not deviate from the specified path by more than 0.3 m). Data shall be taken with the vehicle in steady state condition for at least 3 s for each trial condition. It is recommended that the highest gear ratio compatible with the conditions of the test should be used. The value of speed shall be increased and data shall be taken until it is no longer possible to maintain steady state conditions.
- e. Repeat tests for a left turn.
- f. Repeat the procedures above with all the circle diameters laid down in the test plan.

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4.2 Double lane change tests

- a. Cross the line 1-1a with the lowest vehicle speed laid down in test plan and drive in a straight line through the first section (See ANNEX A).
- b. Keep the speed as steady as possible while crossing the entire test area.
- c. Repeat the trial at the various speed increments laid down in the test plan until:
 - the maximum speed laid down in the test plan is reached
 - or
 - the limit of the vehicle's stability is attained
 - or
 - it becomes impossible to cross the test area without knocking the cones down.
- d. Record parameters and note the vehicle behaviour during the test.
- e. Repeat the test in the opposite direction.
- f. Repeat the test with two different drivers.

5. DATA REQUIRED

5.1 General parameters

- a. Vehicle configuration:
 - weight distribution
 - mileage.
- b. Note parameters laid down in the Test Plan.
- c. Tyre wear and pressure.
- d. Meteorological conditions:
 - temperature
 - wind speed.
 - wind direction
- e. Vehicle characteristics:
 - steering wheel turning angle.

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5.2 Steady state circular tests

- a. Test number.
 - b. Direction of turn.
 - c. Vehicle speed.
 - d. Gear ratio.
 - e. Radius of turning circle
 - f. Vehicle behaviour (with video film, if required)
- and, if necessary:
- g. Steering wheel turning angle.
 - h. Lateral acceleration in the horizontal plane.
 - i. Roll angle.

5.3 Double lane change tests

- a. Characteristics of test course.
 - b. Test number.
 - c. Direction of course.
 - d. Speed during test.
 - e. Gear ratio.
 - f. Time taken to cross test area.
 - g. Vehicle behaviour (views given by drivers and independent observers or video film).
 - h. Extent to which the vehicle has kept to the driving lane (number and position of cones knocked down).
- and, if necessary:
- i. Steering wheel angle versus time.

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- j. Lateral acceleration, in the horizontal plane.
- k. Roll angle.
- l. Maximum speed during test without steering wheel correction.

6. PRESENTATION OF DATA

Present the required data in narrative, tabular, graphical, pictorial or other format as appropriate.

Include:

6.1 Steady state circular tests

Table giving for each course diameter:
- maximum speed
- vehicle behaviour.

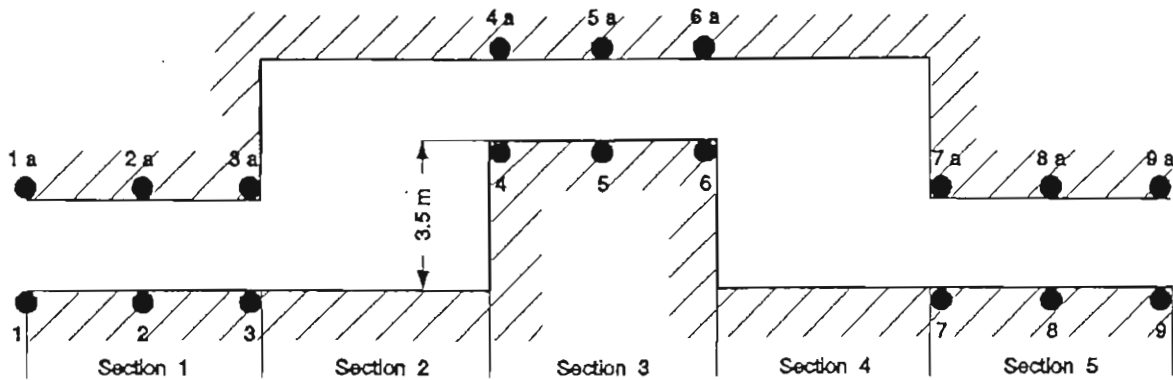
6.2 Double lane change tests

Drawing of test course showing actual dimensions.

Table giving for each speed:
- crossing time
- vehicle behaviour
- maximum speed during the test without steering wheel correction.

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ANNEX A



Lane - change track dimensions

- Section 1 : Length = 15 m
 Width = 1.1 . vehicle width + 0.25 m
- Section 2 : Length = Overall length of vehicle^{*)} + 24 m
- Section 3 : Length = 25 m
 Width = 1.2 vehicle width + 0.25 m
- Section 4 : Length = Overall length of vehicle + 24 m
- Section 5 : Length = 15 m
 Width = 1.1 . vehicle width + 0.25 m

^{*)} Overall length of vehicle, measured at 0.50 m from the ground.

