

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J2014

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Submitted for recognition as an American National Standard

PNEUMATIC TIRES FOR MILITARY TACTICAL WHEELED VEHICLES

Foreword—This specification was developed by the SAE Military/Industry Tire Technology Subcommittee, made up of the members listed in the Rationale. This document reflects the dedication and hard work of all the members, past and present, who played an active role in generating this state-of-the-art specification for the procurement of new and retreaded tires. It is intended for Military use by all branches of the Department of Defense.

This specification shall remain open for comments and recommendations by the user(s) and shall be reviewed periodically by the SAE Military/Industry Tire Technology Subcommittee. In addition, this document shall be revised when necessary to incorporate adopted comments, recommendations and advancements in government and industry tire technology.

1. Scope

- 1.1 This SAE Recommended Practice applies primarily to all combinations of pneumatic tires for military tactical wheeled vehicles; original equipment, new replacement, and retread tires.
- 1.2 All or selective requirements of this specification shall be used as the basis for procurement of tires for military tactical wheeled vehicles.

2. Applicable Documents

2.1 Government Documents

2.1.1 SPECIFICATIONS, STANDARDS AND HANDBOOKS—The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

2.1.1.1 *Department of Transportation (DOT)*—Available from the Department of Transportation, National Highway Safety Administration, Washington, D.C. 20591, or the Government Printing Office.

Regulation 49CFR Part 574.5 —Tire identification and record keeping

Regulation 49CFR Part 571.109—New pneumatic tires for passenger cars

Regulation 49CFR Part 571.110—Tire selection and rims—passenger cars

Regulation 49CFR Part 571.119—New pneumatic tires for vehicles other than passenger cars

Regulation 49CFR Part 571.120—Tire selection and rims for motor vehicles other than passenger cars

2.1.2 SPECIFICATIONS

2.1.2.1 *Federal*

2.1.2.1.1 Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

ZZ-I-550—Inner tube, pneumatic tire
ZZ-P-112—Patch, repair for inner tubes and tubeless tire liners
ZZ-V-25—Valves and valve spuds, caps, and cores, pneumatic tire

2.1.2.2 Military

2.1.2.2.1 Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.

MIL-T-004—Tire, pneumatic, and inner tube; tire with flap, packaging and packing of

MIL-T-116—Preservation packaging methods of

MIL-P-11520—Preservative coating, rubber for rubber surfaces

2.1.3 STANDARDS

2.1.3.1 Military

2.1.3.1.1 Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.

MIL-STD-105 —Sampling procedures and tables for inspection by attributes

MIL-STD-129 —Marking for shipment and storage

MIL-STD-1190 —Minimum guidelines for Level C preservation, packing and marking

MIL-STD-45662—Calibration system requirements

2.1.3.2 Military Qualified Products List

2.1.3.2.1 Qualified Products List—Unless otherwise indicated, copies of the QPL can be obtained from U.S. Army Tank-Automotive Command, (Tire Technology Section, AMSTA-UE), Warren, MI 48397-5000.

QPL-SAE-J2014—Pneumatic Tires for Military Tactical Wheeled Vehicles

2.2 Non-Government Publications—The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

2.2.1 SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

2.2.1.1 *SAE Publications*—Application for copies should be addressed to the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J57 —Sound Level of Highway Truck Tires

SAE J751 —Off-Road Tire and Rim Classification—Construction Machines

SAE J1269—Rolling Resistance Measurement Procedure for Passenger Car, Light Truck, and Highway Truck and Bus Tires

SAE J1379—Rolling Resistance Measurement Procedure for Highway Truck and Bus Tires

SAE J1466—Passenger Car and Light Truck Tire Dynamics Driving Traction in Snow

SAE J2013—Military Tire Glossary

2.2.2 RUBBER MANUFACTURERS ASSOCIATION (RMA)

2.2.2.1 *RMA Publications*—Application for copies should be addressed to the Tire Division, Rubber Manufacturers Assn., 1400 K Street N.W., Washington, D.C. 20005.

Tire Reference Maintenance Manuals as published by RMA, as applicable

Tire Information Services Bulletin Nov 80, Vol 8/No. 1 and Jul 85, Vol 23/No. 1—Tire Storage Recommendations.

2.2.3 TIRE & RIM ASSOCIATION, INC. (T&RA)

2.2.3.1 *Tire & Rim Publications*—Application for copies should be addressed to the Tire & Rim Association, Inc., 175 Montrose West Ave., Copley, OH 44321.

Tire & Rim Association Yearbook

Tire & Rim Association Military Supplement

Engineering Design Information

2.2.4 UNIFORM CLASSIFICATION COMMITTEE

2.2.4.1 *Uniform Classification Publications*—Application for copies should be addressed to the Uniform Classification Committee, 202 Union Station, 516 West Jackson Blvd., Chicago, IL 60506.

Uniform freight classification rules

2.2.5 AMERICAN TRUCKING ASSOCIATION, INC. (ATA)

2.2.5.1 *American Trucking Association Publications*—Application for copies should be addressed to the American Trucking Association, Inc., 2200 Mill Road, Alexandria, VA 22314-4677.

National Motor Freight Classification Rules

All references to tire maintenance recommended practices from the Maintenance Council of ATA.

2.2.6 AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

2.2.6.1 *ASTM Publications*—Applications for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM D 746 — Standard Test Methods for Brittleness Temperature of Plastics and Elastomers by Impact

ASTM D 1149—Standard Test Methods for Rubber Deterioration

ASTM F 408 — Method for Testing Tires for Wet Traction in Straight-Ahead Braking, Using a Towed Trailer

ASTM F 414 — Surface Ozone Backing in a Chamber

3. Requirements

3.1 Qualification—Tires furnished under this specification shall be products which have qualified by meeting the specified requirement of Table 1A, and Table 1B, when specified, and have been listed on, or approved for listing on, the applicable Qualified Products List.

3.2 Materials—The materials for all parts of the tire can be any materials which are compatible with the strength, mileage, and other performance requirements specified for the tire. The contractor will certify that the materials used to manufacture the tires to be delivered are the same materials used to construct the pre-contract qualification tires. Certification will be submitted at the time of acceptance of the production tires. If during production the materials used are changed, the contractor shall notify the procuring activity in writing of such changes.

3.3 Design and Construction—The tire shall be of radial or bias, tube type or tubeless construction, and shall conform to the Tire and Rim Association (T&RA) Military Tire Supplement dimension standards for the tire size selected. The tire size selected must also have a T&RA Military Tire Supplement load-inflation rating equal to or above the maximum tire position load on the vehicle for the maximum vehicle speed capability. Tire size, load, and percentage of primary, secondary, and off-road mobility for original equipment (OE) tires will be based on the design and mission profile of the vehicle. This information will be provided to the contractor by the vehicle manufacturer prior to tire and/or vehicle qualification by the tire manufacturer. For procurement of replacement

TABLE 1A—CLASSIFICATION OF INSPECTION AND TEST

Title	Requirement Paragraph	Method Paragraph	Qualification Inspection	Quality Conformance Inspection		
				Inspection Examination	Testing	Control Test
Retreadability	3.3.1	4.7.19	X	A		A
Repairability	3.3.2	4.7.18				
Balance Limits	3.4.1	4.7.3	X*		B	B
Hidden Defects	3.6	4.7.2	X*			C
Tire Markings	3.5	4.7.20	X*	A		A
Age of Tires	3.3.4	4.7.21	X	A		A
Materials	3.2	4.7.1	X*			
Plunger Energy	3.4.3	4.7.5	X			
Operational Temperature Environment	3.4.12.1	4.7.14	X			
Design and Construction	3.3	4.7.1				
Treadwear Indicators	3.3.3	4.7.22	X*	A		A
Storage	3.4.13	4.7.15	X	A		A
Tire Dimensional Constraints	3.4.8	4.7.10	X*	A		A
Ozone Resist. Preservation of Tires	3.4.10	4.7.12	X			
Tire Packaging	3.5.1	4.7.23	X			C
	3.5.2	4.7.24	X*			

Note: X—new/replacement tires
X*—retread tires

tires, the tire size, load, and percentage of usage for primary, secondary, and off-road mobility will be included in the solicitation package by the procuring activity (see 4.7.1).

- 3.3.1 **RETREADABILITY**—The construction of the tire shall be such that the casing shall be retreadable (see 4.7.19).
- 3.3.2 **REPAIRABILITY**—Design and construction of the tire shall be such that repair/reinforcement of an injured area can be accomplished utilizing those guidelines specified by the Rubber Manufacturer's Association (RMA) repair criteria. Pneumatic: Retread and Repair Materials; and Military Specification ZZ-P-112, Patch, Pneumatic Tire Repair, Uncured (see 4.7.18).
- 3.3.3 **TREADWEAR INDICATORS**—Except as specified below, each tire shall have at least six treadwear indicators spaced approximately equally around its circumference so that it can be visually determined when tread depth has worn to 1.5 mm ($1/16$ in). Tires with 12 in or smaller rim diameter shall have at least three such treadwear indicators. The tread pattern shall be in conformance with the Engineering Design Information of the Tire and Rim Association, Inc.
- 3.3.4 **AGE OF TIRES**—When the contract or purchase order specifies a quantity of less than 100 tires, the age of the tires when shipped shall not be more than 18 months old from the date of manufacture. When the contract or purchase order specifies a quantity of 100 or more tires, the age of the tires when shipped shall not be more than 12 months old from date of manufacture. The date of manufacture shall be determined by the Department of Transportation (DOT) or the Department of Defense (DOD) codes molded into the sidewall of the tires.

TABLE 1B—CLASSIFICATION OF INSPECTION AND TEST

Title	Require- ment Paragraph	Method Paragraph	Qualifi- cation Inspection	Quality Conformance Inspection		
				Inspection Examination	Testing	Control Test
Tire Noise Level	3.4.2	4.7.4	X*			
Tire Traction Test	3.4.4	4.7.6	X*			
Bead Unseating	3.4.5	4.7.7	X*			
Rolling Resist.	3.4.6	4.7.8	X*			
Tire Thermal Reliability Test	3.4.7	4.7.9	X*			
Ride Handling and Stability	3.4.9	4.7.11	X*			
Tire Mechanical Reliability Test	3.4.11	4.7.13	X*			
Carcass Percent Deflection	3.4.15	4.7.17	X			
Dynamic Thermal Profile	3.4.14	4.7.16	X*			

Note: X—new/replacement tires
X*—retread tires

3.3.5 TUBES/VALVES—The inner tubes shall be in accordance with ZZ-I-550. Valves and valve spuds, caps and cores shall be in accordance with ZZ-V-25.

3.4 Performance

3.4.1 TIRE BALANCE LIMITS—Tires shall be balanced as part of production to assure conformance to the static unbalance limits of Table 2 (see 4.7.3).

TABLE 2—BALANCE LIMITS (IN.OZ.)

Group	Rim Diameter	Tire Design Section Width	Max in.oz. Highway Tires (Class r/t, s/s, t/o)	On/Off Highway Tires (Class s/t, a/t, o/o, d/a)	All- Terrain Tires	
1 (passenger)	ALL	8.00 in or smaller	30	N/A		
		8.01 in or larger	35	N/A		
2 (light truck)	13 in	ALL	60	75		
		14 in 14.5 in	ALL	60	75	
			8.00 in or smaller	75	105	
			8.01 in or larger	105	135	

TABLE 2—BALANCE LIMITS (IN.OZ.) (CONTINUED)

Group	Rim Diameter	Tire Design Section Width	Max in.oz. Highway Tires (Class r/t, s/s, t/o)	On/Off Highway Tires (Class s/t, a/t, o/o, d/a)	All-Terrain Tires	
2 (light truck) (continued)	15 in	8.00 in or smaller	60	75		
		8.01 in to 12.00 in	75	105		
	16 in	12.01 in or larger	105	135		
		8.00 in or smaller	60	75		
		8.01 in to 9.00 in	75	105		
		9.01 in to 10.00 in	105	135		
		10.01 in or larger	135	175		
		16.5 in	8.00 in or smaller	60	75	
	17.5 in	8.01 in to 10.00 in	75	105		
		10.01 in to 12.00 in	105	135		
		12.01 in or larger	135	175		
		8.00 in or smaller	60	75		
		8.01 in to 10.00 in	75	105		
		10.01 in or larger	105	135		
	3 ¹ (truck)	15 in to 18 in	8.00 in or smaller	75	105	
			8.01 in to 9.00 in	105	135	
19.5 in		9.01 in to 10.50 in	135	175		
		10.51 in to 11.25 in	175	215		
		11.26 in to 12.00 in	215	265		
		12.01 in to 14.00 in	265	315		
		14.01 in or larger	315	365		
		8.00 in or smaller	105	135		
		8.01 in to 12.00 in	135	175		
		12.01 in to 15.00 in	175	215		
		15.01 in to 16.00 in	215	265		
		16.01 in to 17.00 in	265	315		

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TABLE 2—BALANCE LIMITS (IN.OZ.) (CONTINUED)

Group	Rim Diameter	Tire Design Section Width	Max in.oz. Highway Tires (Class r/t, s/s, t/o)	On/Off Highway Tires (Class s/t, a/t, o/o, d/a)	All-Terrain Tires	
3 ¹ (truck) (continued)	20 in/ 21 in	17.01 in to 18.00 in	315	365		
		18.01 in or larger	365	415		
		9.00 in or smaller	105	135	200	
		9.01 in to 10.50 in	135	175	260	
		10.51 in to 11.25 in	175	215	325	
		11.26 in to 12.00 in	215	265	400	
		12.01 in to 14.00 in	265	315 AV/500 max	500	
		14.01 in to 15.00 in	315	365 AV/550 max	550	
		15.01 in to 16.00 in or larger		500 AV/700 max	700	
		22 in	10.50 in or smaller	175	215	
			10.51 in to 12.00 in	215	265	
			12.01 in to 14.00 in	265	315	
		14.01 in to 16.00 in	315	365		
		16.01 in or larger	365	415		
	22.5 in	8.00 in or smaller	105	135		
		8.01 in to 10.50 in	135	175		
		10.51 in to 11.75 in	175	215		
		11.76 in to 14.00 in	215	265		
		14.01 in to 16.00 in	265	315		
		16.01 in to 17.00 in	315	365		
		17.01 in or larger	365	415		
	24 in	11.00 in or smaller	215	265		
		11.01 in to 13.00 in	265	315		
		13.01 in to 15.00 in	315	365		
	15.01 in or larger	365	415			
24.5 in	10.50 in or smaller	175	215			

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TABLE 2—BALANCE LIMITS (IN.OZ.) (CONTINUED)

Group	Rim Diameter	Tire Design Section Width	Max in.oz. Highway Tires (Class r/t, s/s, t/o)	On/Off Highway Tires (Class s/t, a/t, o/o, d/a)	All-Terrain Tires
3 ¹ (truck) (continued)		10.51 in to 12.00 in	215	265	
		12.01 in to 14.00 in	265	315	
		14.01 in to 16.00 in	315	365	
		16.01 in or larger	365	415	

¹ The balance limits shown for truck tire sizes apply to tires with aspect ratios of 65 and above 80. For aspect ratios of 70, 75, and 80, reduce these balance limits by 8% for "highway" and "on/off-highway" tires. For 80 aspect ratio "all-terrain" tires, reduce these balance limits by 30%.

3.4.2 TIRE NOISE LEVEL—Tire noise level requirements are applicable to all tire sizes. Each tire design supplied under this specification must be certified by the tire contractor as meeting the requirements of the vehicle specification when tested in accordance with SAE J57.

3.4.3 PLUNGER ENERGY—The sample tire shall be mounted on the specified rim and tested in accordance with FMVSS 571.109 (for passenger car tires) or 571.119 (for all other tires).

3.4.4 TIRE TRACTION—A tire traction test shall be conducted as described in Appendix A, Sections A.2, A.3, and A.4 to determine tire performance in mud, sand, and snow. Minimum acceptable tire driving traction values of the candidate tire shall be rated as a percentage of the control tire performance at 100% (see 4.7.6).

3.4.5 BEAD UNSEATING—The vehicle fully equipped and operating at maximum Gross Vehicle Weight (GVW) (curb weight of base vehicle plus payload capacity, but without towed loads) shall run on paved surfaces approximately XX miles in circumference, with a length of approximately XX miles and width of approximately XX miles. Test tire mounting is right front only with a complete complement of the same group coding on the other wheel positions. The test tires are mounted, with lubricant, prior to the test. Test runs are begun with initial tire inflation of 35 psig (or as recommended by the tire manufacturer). The test tire pressures are reduced by 10 psig for the next two runs and then by 05 psig increments until unseating occurs. Test curves can be 30, 45, and 60 ft radius curves at speeds that permit the complete XX turn with maximum side force. Direction of turn is to the left and bead unseating always occurs with the tire in right front wheel position. To insure reproducibility of data, a minimum of two tires are unseated (see 4.7.7).

3.4.6 ROLLING RESISTANCE COEFFICIENT (UNIT)—Tires will have the rolling resistance coefficient (for highway loads and pressures) equal (within a 5% deviation) or better than that of the control tire (see 4.7.8).

NOTE—This procedure only applies to replacement tires.

3.4.7 THERMAL RELIABILITY—In order to assure that tires will operate at specified temperatures for a given number of miles, thermal reliability testing will be conducted in accordance with the procedures described in Section A.6 (see 4.7.9).

3.4.8 DIMENSIONAL CONSTRAINTS—To assure correct dimensional requirements for vehicle tire application, tires shall comply with dimensional and load requirements as specified in the T&RA Military Tire Supplement. Additional requirements such as bead width, tire weight, and maximum speed may be specified for a particular application.

- 3.4.9 **RIDE HANDLING AND STABILITY**—The tires considered for replacement purchase must provide acceptable ride, handling and stability characteristics. To determine acceptance or nonacceptance of the tires supplied, a jury rating system will be used. This jury will be made up of a minimum of three (3) qualified drivers who will each conduct the same test described in Section 4 of this specification (see 4.7.11).
- 3.4.10 **OZONE RESISTANCE**—All tires, as part of production, shall contain antioxidants and antiozonants and shall conform to the quality assurance requirements of Section 4, and shall be free of cracks and crazing when examined under a 7 power magnification (see 4.7.12).
- 3.4.11 **MECHANICAL RELIABILITY**—Testing shall be conducted as described in Section A.7 for tire durability in an off-road condition. The test samples shall be subjected to 90 miles of secondary roads, 90 miles of Belgian Block, and 120 miles of cross-country. The tests shall be extended to a maximum of 2400 miles for acceptable durability of the tires (see 4.7.13).
- 3.4.12 **TEMPERATURE**
- 3.4.12.1 **Operational Temperature**—The operational environment requires that each tire shall be capable of operating in environments down to ambient -40°C (-40°F) and up to ambient 52°C (125°F). Below -20.5°C (-5°F) special operating conditions and special low-temperature equipment accessories, etc., if required, are acceptable in order to meet this requirement (see 4.7.14). Temperature requirements below -40°C (-40°F) must be specifically required by the vehicle specification.
- 3.4.13 **STORAGE**—Unmounted tires shall withstand extended storage for a minimum of three years in ambient air temperature of 29°C (85°F) without checking or cracking (see 4.7.15) per RMA Bulletin, Nov 1980, Vol 8/No. 1 and July 1985, Vol 23/No. 1.
- 3.4.14 **DYNAMIC THERMAL PROFILE**—In order to assure the thermal properties of a tire, rate of rise/cool down, and stabilization temperature, for any particular dynamic work mode, a dynamic thermal profile test will be conducted in accordance with 4.7.16.
- 3.4.15 **CARCASS PERCENT DEFLECTION**—To assure conformance with vehicle mission profile requirements, the tires' percent deflection for the speeds and terrains referenced in the Carcass Percent Deflection chart (4.7.17) shall be furnished by the tire manufacturer and/or the system developer.
- 3.5 **Tire Markings**—Tires normally requiring Department of Transportation (DOT) markings shall be marked with standard DOT coding method in accordance with 49 CFR Part 574.5. Tires exempt from DOT markings shall be marked with DOD markings. The coding structure for DOD markings is the same as DOT, however, using only the first two and last three digits to identify the manufacturer and date of manufacture are required. Remaining places of the code may be used for manufacturer unique information or shall be zero filled.
- 3.5.1 **PRESERVATION OF TIRES**—The tire manufacturer shall comply with the requirements of 5.1 through 5.1.2.1.
- 3.5.2 **TIRE PACKAGING**—The tire manufacturer shall comply with the requirements of 5.2 through 5.3.1.
- 3.6 **Hidden Defects**—Tire samples shall be examined for hidden defects in accordance with 4.7.2 of this specification.

4. Quality Assurance Provisions

- 4.1 **Responsibility for Inspection**—Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein with approval by the Government. The Government reserves the right to perform any of the in-

inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

- 4.1.1 RESPONSIBILITY FOR COMPLIANCE**—Items must meet all requirements of Sections 3 and 5 as specified. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of the known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.
- 4.1.2 TEST EQUIPMENT AND INSPECTION FACILITIES**—Test and measuring equipment and inspection facilities of sufficient accuracy, quality, and quantity to permit performance of the required inspections shall be established and maintained by the tire contractor. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with MIL-STD-45662. Test equipment and/or procedures used by different testing agencies need not be identical with those described herein; however, a given agency must demonstrate that the equipment and procedures it used produce test results essentially identical to those produced by the corresponding equipment and procedures described in this section to the satisfaction of the Government.
- 4.2 Classification of Inspection**—The inspection requirements specified herein are classified as follows:
- Qualification Inspection (4.4)
 - Quality Conformance Inspection (4.5)
 - Control Test (4.6)
- 4.3 Inspection Conditions**—Unless otherwise specified (see 6.2), all inspections shall be conducted under the following conditions:
- Air temperature: $23\text{ }^{\circ}\text{C} \pm 10$ ($73\text{ }^{\circ}\text{F} \pm 18$)
 - Barometric pressure: $725\text{ mm Hg} \pm 50$ – 75
 $28.5\text{ in Hg} \pm 2$ – 3
 - Relative humidity: $50\% \pm 30$
- 4.4 Qualification Inspection**—Qualification for all tires, whether original equipment, replacement or retreaded shall consist of all the qualification tests listed in Table 1A, and any additional qualification tests listed in Table 1B. (Qualification testing for retreaded tires shall consist of only those tests marked by an asterisk in Tables 1A and 1B, and only tire casings marked with a Department of Transportation (DOT) or a Department of Defense (DOD) code shall be used for retreading.) The approval of tires tested in accordance with Tables 1A and 1B, in whole or in part, may, at the discretion of the qualifying activity, be extended to the sizes in that tire family.
- 4.4.1 RETENTION OF QUALIFICATION**—To assure retention of qualification, every 24 months the procuring activity shall notify in writing those tire contractors listed in the Qualified Products List (QPL) that certification is due. The tire contractors shall then, within 30 days, submit to the procuring activity written certification stating that during the previous 24 months the tire contractor has been in production or still has the capability and facilities necessary to produce those tires listed on the QPL. If there have been any significant changes to the production methods and/or materials, the tire contractors shall indicate it in their written certification. In addition, during the previous 24 months, if the tire contractor was in production, the production test data required under 4.7.25 shall be submitted with the certification. Based upon the evaluation of the data submitted, requalification may be required at the discretion of the procuring activity. If the contractor fails to submit the certification and data requested, the Government reserves the right to remove the contractor from the QPL.

- 4.4.2 **REQUALIFICATION**—Manufacturers' tires, new/retreaded that have been approved for listing on the QPL, shall remain on the QPL for a period of 8 years before requalification is required; providing, however, the data specified in 4.4.1 is submitted by the manufacturers. In addition, if poor quality trends develop as the result of field reported deficiencies, the qualifying activity, at its discretion, may require requalification or removal from the QPL.
- 4.5 **Quality Conformance Inspection (QCI)**—Inspection of product for delivery shall consist of the A and B examinations and tests under the quality conformance inspection listed in Table 1A.
- 4.5.1 **CLASSIFICATION OF QUALITY CONFORMANCE INSPECTION**—Quality conformance inspections shall be classified into Groups A, B, or C in accordance with the following groupings, when applicable:
- 4.5.1.1 *Group A*—Nondestructive inspections of all items produced or of all samples from an inspection lot to demonstrate product compliance with contractual requirements. Group A inspections examine characteristics most affected by variations in production processes or skills and functions vital to successful completion of the design mission.
- 4.5.1.2 *Group B*—Generally nondestructive inspections that are more complex or of a longer duration than Group A. Group B inspections examine characteristics more affected by part of equipment quality and less affected by variations in production processes or skills, and functions requiring special fixtures or environments, and tests that are more complex and of longer duration than Group A tests. Fewer samples are inspected than for Group A inspections and tested articles may be offered for acceptance with little or no refurbishment. Each commodity should be individually evaluated regarding its issue after performing Group B and C inspections.
- 4.5.1.3 *Group C*—Periodic and generally destructive tests of characteristics depending on product design and materials. Group C inspections are more complex tests, usually including simulated service environments, are generally destructive or require major refurbishment before tested articles can be used by the services. Tests are performed on fewer samples than for Group B inspection and are based on production quantities or time period.
- 4.5.2 **INSPECTION OF PRODUCT FOR DELIVERY**—Inspection of product for delivery shall consist of Groups A, B, and C inspection.
- 4.5.3 **INSPECTION LOT**—Unless otherwise specified, a lot shall consist of tires from an identifiable production period, from one manufacturer, submitted at one time for acceptance.
- 4.5.4 **GROUP A INSPECTION**—Group A inspection shall consist of the inspections specified in Table 1A.
- 4.5.5 **SAMPLING FOR QUALITY CONFORMANCE EXAMINATION/TESTING**—Samples for quality conformance examination shall be selected in accordance with Inspection Level II of MIL-STD-105 and inspected for defects listed in Table 3. The Acceptable Quality Level (AQL) shall be 1.5% defective.
- 4.5.6 **ACCEPTABLE QUALITY LEVEL (AQL)**—All tires shall be inspected visually on removal from the curing mold for outside and inside defects. All tires selected for sampling shall be inspected by use of x-ray or holography for internal tire body flaws, buckled or wavy cords, and placement of belts. Quality shall be judged by the standards of commercial practice for pass or fail for overall appearance and shall be subject to inspections for the unacceptable defects listed in Table 3.
- 4.5.7 **REJECTED LOTS**—If an inspection lot is rejected, the contractor may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.
- 4.5.8 **GROUP B INSPECTION**—Group B inspection shall consist of the inspections specified in Table 1A and shall be made on sample units which have been subjected to and have passed the Group A inspection.
- 4.5.9 **SAMPLING PLAN**—The sampling plan shall be in accordance with MIL-STD-105 for special inspection level S-3. The sample size shall be based on the inspection lot size from which the sample was selected for Group A inspection. The AQL shall be 1.5% defective.

TABLE 3—CLASSIFICATION OF DEFECTS

Category	Defect	Inspection Method
101	Cord buckles or kinks in beads	V
102	Insufficient ply coat	V
103	Sidewall cracks or craters more than 0.1 in	V + M
104	Tread or mold folds	V
105	Open tread, sidewall or liner splices	V
106	Light sidewalls (incomplete molding)	V
107	Sidewall blisters larger than 6.35 mm ($1/4$ in) dia.	V + M
108	Tread pock marks deeper than 1.27 mm (0.05 in)	V + M
109	Sharp edges & airbag roughness greater than 0.020 in	V + M
110	Foreign material in outside surface of tire	V
111	Mold tearing except for tread block edges, where two tears not more than 6.35 mm ($1/4$ in) deep and 12.70 mm ($1/2$ in) long are allowed per tire	V
112	Exposed fabric, either textile or steel	V
113	Off register treads of more than 3.18 mm ($1/8$ in)	V + M
114	Tread flash at mold register line greater than 2.54 mm (0.1 in) thickness	V + M
115	Wavy cords (rejected beyond contractors design/tolerances) in radial ply or belts	X or H
116	Cut or damaged cords	V, X or H
117	Belt or breaker edge defects larger than 6.35 mm ($1/4$ in) dia.	X or H
118	Tread blows (voids) larger than 6.35 mm ($1/4$ in) dia.	X or H
119	Inner liner, voids, tears, creases and blisters	V
120	Waviness of steel belts (snaking), no more than 3.16 mm ($1/8$ in) tolerance for straightness of belts (radial tire only)	X or H

4.5.10 REJECTED LOTS—If an inspection lot is rejected, the manufacturer may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection and shall not, therefore, be tendered for acceptance unless the former rejection or requirement of correction is disclosed. Such lots shall be separate from new lots and shall be clearly identified as reinspected lots.

4.5.11 DISPOSITION OF SAMPLE UNITS—Sample units which have passed all the Group B inspection may be delivered on the contract or purchase order, if the lot is accepted.

4.5.12 GROUP C INSPECTION—Group C inspection shall consist of the inspections specified in Table 1A and shall be made on sample units which have been subjected to and have passed the Groups A and B inspection.

4.5.13 SAMPLING PLAN—The sampling plan shall be in accordance with MIL-STD-105 for special inspection level S-1. The sample size shall be based on the inspection lot size from which the sample was selected for Group A inspection.

4.5.14 DISPOSITION OF SAMPLE UNITS—Sample units which have been subjected to Group C inspection shall not be delivered on the contract or purchase order.

4.6 Control Test—Control test samples shall consist of three tires, three tubes, and one flap, if required. Samples shall be selected at the rates shown in Table 4.

4.6.1 APPLICABLE TEST—Unless otherwise specified in the contract or purchase order (see 6.2), tires and flaps selected as specified herein shall be tested by the contractor. Control test samples shall be examined for the defects specified in Table 3 and subsequently subjected to the applicable test specified in Table 1A.

TABLE 4—CONTROL TEST SAMPLE RATES

Calendar-Year Production (per plant)	Control Test
1-2500	1 sample
2501-5000	2 samples
5001 and up	2 samples plus 1 add'l. sample for each 5000 but not more than 1/month

4.6.2 FAILURE— Failure of a control test tire or flap to pass any of the specified examination or tests shall result in the following, at the option of the Government:

- a. Retest of two additional tires or flaps and no acceptance made of the tires or flaps on hand at the contractor's plant until retest is completed.
- b. Refusal of the Government to authorize shipment of previously manufactured tires or flaps, either from untested or acceptance-tested lots, on hand at the contractor's plant.

4.6.3 PROCEDURE SUBSEQUENT TO FAILURE OF TIRES OR FLAPS—When tires or flaps are rejected on the basis of failure of retested sample, production and acceptance of new tires or flaps can be resumed in accordance with the following provisions, at the option of the Government:

- a. Contractor shall submit to the Government satisfactory evidence that the deficient condition has been corrected.
- b. The contractor shall then submit a control test sample, representative of the corrected condition, for test. Successful completion of test shall be required before acceptance of new production will be made by the Government.

4.6.4 SAMPLE INSPECTION—Initial control test sample shall be taken at or near the start of production under each contract. Control testing shall be accomplished by the contractor.

4.6.5 CONTRACTOR'S PRODUCTION INSPECTION—If the contractor performs tests similar to those specified in Groups A and B inspections, during and/or as a final step of his production process, the test data generated may be substituted for the Group A and B inspections. Authority to make the substitution shall be granted by the qualifying activity only. The following criteria must be met:

- a. Tests conducted by the manufacturer during production shall be clearly identical to or more stringent than those specified for Group A/B inspections.
- b. Contractor subject 100% of the product supplied under this specification to his production tests.
- c. The parameters measured and the failure criteria shall be the same or more stringent than those specified herein.
- d. The lot rejection criterion is the same or more stringent than that specified herein.
- e. The contractor shall make available all information concerning the test procedures and instrumentation used in his production tests. The manufacturer shall also make available to the Government all records of all detail test data resulting from production tests.
- f. Once approved, the contractor shall not change the test procedures or criteria without prior notification and concurrence by the qualifying activity.

4.6.6 NONCOMPLIANCE—If a sample fails to pass Group C inspection, the contractor shall notify the qualifying activity and the cognizant inspection activity of such failure and take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which are manufactured under essentially the same materials and processes, and which are considered subject to the same failure. Acceptance and shipment of the product shall be discontinued until corrective action, acceptable to the qualifying activity, has been taken. After the corrective action has been taken, Group C inspection shall be repeated on additional sample units (all tests and examinations or the test which the original sample failed, at the option of the qualifying activity). Groups A and B inspections may be reinstated; however, final acceptance and shipment shall

be withheld until the Group C inspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure shall be furnished to the cognizant inspection activity and the qualifying activity.

4.7 Methods of Inspection

- 4.7.1 **MATERIALS AND CONSTRUCTION**—Conformance to 3.2 and 3.3 shall be determined by inspection of contractor's records providing proof or certification that design, construction, processing, and materials conform to requirements. Applicable records shall include drawings, specifications, design data, receiving inspection records, processing and quality control standards, vendor catalogs and certifications, industry standards, test reports, and rating data.
- 4.7.2 **HIDDEN DEFECTS**—To determine conformance to 3.6, the sample tires shall be examined in accordance with the tests specified in Section A.1.
- 4.7.3 **TIRE BALANCE LIMITS**—To determine conformance to 3.4.1, tires shall be tested for static unbalance in accordance with the balance limits of Table 2.
- 4.7.4 **NOISE LEVEL**—To determine conformance to 3.4.2, tires shall be tested in accordance with the procedures specified in SAE J57.
- 4.7.5 **PLUNGER ENERGY**—To determine conformance to 3.4.3, tires shall be tested in accordance with the procedures specified in MVSS 571.109 (for passenger car tires) or 571.119 (for all other tires).
- 4.7.6 **TIRE TRACTION**—To determine conformance to 3.4.4, tire traction test shall be performed to determine traction performance of a tire(s) under specified conditions in accordance with the procedures described in Sections A.2, A.3, and A.4.
- 4.7.7 **BEAD UNSEATING**—To determine conformance to 3.4.5, a bead unseating test shall be conducted in accordance with the procedures described in Section A.5.
- 4.7.8 **ROLLING RESISTANCE**—To determine conformance to 3.4.6, a rolling resistance test shall be conducted in accordance with SAE Lab Test J1269 and SAE J1379.
- 4.7.9 **TIRE THERMAL RELIABILITY TEST**—To determine conformance to 3.4.7, the tire thermal reliability test shall be conducted in accordance with the procedures described in Section A.6.
- 4.7.10 **TIRE DIMENSIONAL CONSTRAINTS**—To determine conformance to 3.4.8, tires shall be examined using Standard Inspection Equipment (SIE). Tires shall meet the requirements specified in 3.4.8. For these dimensions that require the tire to be mounted and inflated, the tires shall be inflated to the recommended air pressure and allowed to grow for 24 h before measurements are taken. All data shall be recorded.
- 4.7.11 **RIDE HANDLING AND STABILITY TEST**—To determine conformance to 3.4.9, the qualification tires will be subject to an on-vehicle road test as described in Section A.8.
- 4.7.12 **OZONE RESISTANCE**—To determine conformance to 3.4.10, five test specimens of the formulated rubber measuring $3.75 \times 1 \times 0.075$ in shall be conditioned for $24 \text{ h} \pm 1$ at $73.6 \text{ }^\circ\text{F} \pm 3.6$ and $50\% \pm 5$ relative humidity. The test specimens shall then be elongated 25% and placed in an ozone chamber in accordance with ASTM D 1149 and exposed to a mixture of ozone and air in the proportion of 50 parts of ozone and pphm of air by volume ± 5 for $200 \text{ h} \pm 2$ or 100 parts of ozone pphm of air by volume ± 10 for $100 \text{ h} \pm 1$ at a temperature of $104 \text{ }^\circ\text{F} \pm 2$. The specimens shall then be moved and examined for compliance.
- 4.7.13 **MECHANICAL RELIABILITY**—To determine conformance to 3.4.11, testing shall be conducted in accordance with the procedures described in Section A.7.
- 4.7.14 **OPERATIONAL TEMPERATURE ENVIRONMENT**—To determine conformance to 3.4.12.1, this test shall be performed to determine the tire's ability to operate successfully during low temperature. Testing

shall be conducted in accordance with the requirements specified in ASTM D 746, at a temperature of -40°C (-40°F).

- 4.7.15 **TIRE STORAGE**—To determine conformance to 3.4.13, the manufacturer shall provide written certification that tires will withstand extended storage for the time and temperature specified.
- 4.7.16 **DYNAMIC THERMAL PROFILE TEST**—To determine conformance to 3.4.14, the tire dynamic profile test shall be conducted in accordance with the procedures described in Section A.9
- 4.7.17 **CARCASS PERCENT DEFLECTION TEST**—To determine conformance with 3.4.15, the tires shall be tested in accordance with Section A.9 for the speed, terrain, and percent deflection as specified.
- 4.7.18 **REPAIRABILITY**—To determine conformance to 3.3.2, repair/reinforcement shall be accomplished utilizing those guidelines specified by the Rubber Manufacturers Association (RMA) repair criteria. Pneumatic: Retread and Repair Materials; and Military specification ZZ-P-112, Patch, Pneumatic Tire Repair, Uncured.
- 4.7.19 **RETREADABILITY**—To determine conformance to 3.3.1, the contractor shall certify in writing that the tire casings are of retreadable design. In addition, the tires that are not retreadable shall be permanently marked with the words NOT RETREADABLE. Letters shall be a minimum of $\frac{5}{16}$ in high.
- 4.7.20 **TIRE MARKINGS**—To determine conformance to 3.5, the tires shall be examined for marking requirements.
- 4.7.21 **AGE OF TIRES**—To determine conformance to 3.3.4, tires shall be examined to assure that age of tires is not in excess of the time specified.
- 4.7.22 **TREAD INDICATORS**—Tires shall be visually examined for treadwear indicators to assure conformance to 3.3.3 requirements.
- 4.7.23 **PRESERVATION**—To determine conformance to preservation requirements, prior to acceptance of tires by the Government, the contractor shall provide written certification that the tires have been preserved in accordance with Section 5 for the level specified.
- 4.7.24 **INSPECTION OF TIRE PACKAGING**—To determine conformance to 3.5.2, the tires prior to shipment shall be examined for the specified packaging and packing requirements as required by Section 5.
- 4.7.25 **SUBMITTAL OF PRODUCTION TEST DATA**—Every 24 months the contractor shall forward a report to the qualifying activity. The qualifying activity shall establish the initial reporting date. The report shall consist of:
- A summary of the results of tests performed for inspection of product for delivery (Groups A & B) indicating as a minimum the number of lots that have passed, the number that have failed, and the group which they failed.
 - A summary of the results of tests performed for periodic inspection (Group C), including the number and mode of failures. The summary shall include results of all periodic inspection tests performed and completed during the 12-month period. If the summary of the test results indicates nonconformance with specification requirements, and corrective action acceptable to the qualifying activity has not been taken, action may be taken to remove the failing product from the QPL.
 - Failure to submit the report within 30 days after the end of each 24-month period may result in loss of qualification for the product. In addition to the periodic submission of inspection data, the contractor shall immediately notify the qualifying activity at any time during the 24-month period that the inspection data indicate failure of the qualified product to meet the requirements of this specification.

5. Packaging

5.1 Preservation shall be at level A or C, as specified (6.2).

5.1.1 LEVEL A

5.1.1.1 *Cleaning*—Tires shall be cleaned in accordance with MIL-T-116, Process C-1.

5.1.1.2 *Drying*—Tires shall be dried in accordance with MIL-T-116 Process D-1.

5.1.1.3 *Preservation*—Tires shall be preserved in accordance with MIL-STD-1190.

5.1.2 LEVEL C

5.1.2.1 *Preservation*—Tires shall be preserved in accordance with MIL-STD-1190.

5.2 **Packing**—Packing shall be Level A, B, or C, as specified (see 6.2).

5.3 **Marking**

5.3.1 LEVELS A, B, AND C—In addition to any special or other identification marking required by the contract (see 6.2), each unit shall be marked in accordance with MIL-STD-129.6.

6. **Notes**—(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 **Intended Use**—This specification is for military tactical wheeled vehicles, original equipment, new replacement, and retread tires.

6.2 **Ordering Data**

- a. Title, number, and date of this specification.
- b. Issue of DODISS to be cited in the solicitation and, if required, the specific issue of individual documents referenced (see 2.1 and 2.2).
- c. If responsibility for inspection and place of inspection is other than as specified (see 4.1).
- d. Qualification inspection, if other than as specified (see 4.4).
- e. Sample size for examination and QCI acceptance criteria (see 4.5).
- f. Control test sample size, frequency of tests, and disposition of lots and defective items (see 4.6).
- g. Selection of applicable level and packaging requirements (see Section 5).

6.3 **Qualification**—For products requiring qualification, awards will be made only for products which are, at the time set for opening of bids, qualified for inclusion on the QPL, whether or not such products have actually been listed by that date. The attention of manufacturers is called to these requirements and they are urged to arrange to have their products that they propose to offer to the Federal Government tested for qualification. And, if approved, they may be eligible to be awarded contracts or purchase orders for the products covered by this specification.

NOTE—The activity responsible for the QPL is the U.S. Army Tank Automotive Command, 28151 Van Dyke Avenue, Warren, MI 48397-5000, and information pertaining to qualification of products may be obtained from that activity.

APPENDIX A—TESTS

A.1 Hidden Defects Test—This test is to determine in a laboratory either through dissecting, x-ray, and/or holographic inspection if there are any separations of ply, belts, cord, or bead.

A.1.1 Test Equipment and Materials—Standard Inspection Equipment (SIE) used to dissect tires; x-ray and/or holographic equipment.

A.1.1.1 SAMPLE TIRES—Tires used for hidden defects testing shall be those that were subjected to the plunger energy tests.

A.1.1.2 TEST—Sample tires shall be cut radially into ten equally spaced sections. Each section shall then be cut circumferentially in midcrown and on each side of crown near breaker edge at point of maximum shoulder thickness. If deemed necessary, additional cutting shall be done in order to do a more complete inspection of the tire samples. The cut samples shall then be examined for evidence of separation of tread, ply, belt, cord, or bead.

A.1.1.3 The contractor, as an alternative, may use x-ray and/or holographic examination. However, if there is doubt as to the validity of the results of x-ray or holographic examination, the Government may require the contractor to subject the sample tires used for plunger energy to the cutting method as specified in A.1.1.2.

A.2 Tire Traction Test—This test determines the tire traction performance of a tire relative to a specified control tire or to other specified tires, all tested under similar specified conditions. The objective is to develop uniform test procedures for use in evaluating traction performance of tires for military vehicles.

A.2.1 Methodology

A.2.1.1 The traction performance of an established reference (control) tire shall be used as a basis to compare the performance of candidate tires. Tests shall be conducted on, but not limited to, mud, sand, snow, and wet pavement sections for both the reference and candidate tire tests. Desired surface conditions shall be made known in advance of the testing. Test results shall be used to determine the traction coefficient of both the reference tire and candidate tire and the traction coefficient¹ from the tests shall be comparatively evaluated. The candidate tire must show a traction performance equal to or greater than the performance of the reference tire to satisfy the stated traction criteria with an acceptable margin of test error of $\pm 5\%$ deviation. Two methods of tests may be used for this determination: the single wheel traction test and/or the drawbar pull test. The single wheel traction test shall facilitate a more expedient means of selecting from multiple tire candidates. Drawbar pull tests shall then be used in making the final selection(s).

A.2.1.2 The wet pavement evasive maneuver test procedure shall be used to evaluate tire maneuver traction, Section A.4. This test shall be conducted on wet pavement only.

A.2.2 Facilities**A.2.2.1 TEST VEHICLE**

A.2.2.1.1 Single Wheel Tests—A test bed capable of providing single driving tire traction shall be equipped with an instrument package capable of measuring the longitudinal and vertical wheel forces as well as the velocity of the test wheel and ground speed. The capability of logging of the

¹Traction coefficient is defined as the longitudinal force from the tire divided by vertical load.

data at a minimum sampling rate of 20 samples per second is required. The driving test tire shall be positioned to eliminate the test tire tracking another tire through the test course.

A.2.2.1.2 Drawbar Pull Tests—The test vehicle shall be all-wheel drive equipped with the control or candidate tires in all wheel positions. The test vehicle shall be run together with a dynamometer vehicle of adequate size and load to permit controlling the test vehicle speed. The connection between the vehicles shall be a cable or a towbar parallel to the ground containing a load cell capable of measuring the drawbar force. Instrumentation recording the drawbar force, time, wheel speed(s), and ground speed shall be installed in the dynamometer vehicle. Sampling rate for the above measurements shall be a minimum of 20 samples per second. The drawbar pull test procedure described in J1466 OCT85 is an acceptable alternative for snow tests. However, this procedure must employ a front-wheel drive vehicle (J1466 Section B.3).

A.2.2.2 SOIL TEST COURSES—Tests shall be conducted on courses prepared to the following specifications:

A.2.2.2.1 Soil Tests—At least two courses for each selected condition shall be required to provide a large enough area to accommodate testing. The test sections shall be uniform, level, relatively smooth, with no vegetation, a minimum of twice the tire section width by 500 ft long for single wheel tests and 20 ft wide by 300 ft long for drawbar tests. Prior to testing, the courses shall be prepared to a uniform depth and strength and exhibit no evidence of previous usage. Cone penetrometer measurements shall be taken in a cross-hatch pattern not exceeding 10 ft to determine uniformity of compaction. Soil samples shall be collected at three locations in the test courses at the surface, and 6 in in depth.

A.2.2.2.2 Snow and Ice Tests—The source procedure as in SAE J1466.

A.2.2.2.3 Fine-Grained Soil (Mud)—This test section shall be constructed of silt (ML—as defined by Unified Soil Classification System). The depth of the ML soil shall be at least 30 in and compacted to provide a cone index of at least 300 throughout the soil profile prior to wetting. Before the start of the tests on each course, an amount of water that simulates 0.5 in of rainfall shall be sprayed uniformly over the course. A 5-min waiting period shall be observed between the end of wetting and the start of traction testing, and testing shall be completed within 15 min of water application. Each test shall be conducted on untracked material. Soil moisture content shall be determined at three locations in the test section at 0 to 1 in, 1 to 3 in, and 3 to 6 in depths.

A.2.2.2.4 Coarse-Grained Soil (Sand)—This test section shall be constructed of sand (SP—as determined by USCS). The depth of the SP soil shall be at least 30 in, tilled to at least 8 in, and dried to a moisture content of less than 2.0% in the top 3 in of sand. The cone index at the 3-in depth shall not exceed 100.

A.2.2.2.5 Snow—Fresh fallen snow 6.0 to 12.0 in deep shall be of a compaction such that a first untracked pass of the test tire exhibits a sinkage of between 1 and 3 tread depths. The snow shall have a uniform profile in its upper 6 in. If compaction or grooming is necessary to obtain the required snow surface the test course shall be aged 24 h before testing begins. Temperature at 1 in below the test surface shall be between +5 °F and +15 °F. Each test shall be conducted in a fresh test surface.

A.2.2.2.6 Instrumentation

A.2.2.2.6.1 Longitudinal and vertical forces on the test, along with test wheel and vehicle speeds, shall be measured within 2% accuracy as established by annual National Bureau of Standards traceable calibration.

A.2.3 Preparation for Tests

A.2.3.1 All transducers and instrumentation must be calibrated according to recognized procedures.

A.2.3.2 TIRES—Two new tires for the single wheel tests and two new tires for each tire position for the drawbar test shall be required as test samples for each variable. These samples shall be produc-

tion tires (or experimental), inspected by the maker to be free of defects and conforming to applicable standards of manufacture. Test tires must be less than 6 months old when tested.

A.2.3.3 RIMS—The tires shall be mounted on rims specified in the military supplement of the T&RA yearbook as preferred for the size and load range being tested.

A.2.3.4 INFLATION—Tire pressures shall be adjusted to attain the specified deflection based on the mission profile applicable.

A.2.3.5 BREAK-IN—Each of the test samples shall be driven at maximum vehicle speed (not to exceed 55 mph) on a dry paved surface for 100 miles inflated to the highway tire pressure. The tires shall be free of mold flash, lubricants, and shall have tread labels removed. In addition, test and control tires shall not have any force or runout grind.

A.2.3.6 MEASUREMENTS—The tires shall be inspected and measured following the break-in. Measurements shall be at three locations around the periphery of the tire and shall include: tread depth at crown and shoulders, tread profile, section width, tread radius, tread arc width, and outside diameter.

A.2.4 Test Procedure

A.2.4.1 Warm up electronic test equipment as required for stabilization.

A.2.4.2 Test tires must be stabilized at ambient temperature and shielded from direct sunlight before testing.

A.2.4.3 Subject the test tire to the specified test load $\pm 2\%$.

A.2.4.4 Adjust tire inflation pressure immediately before testing to the specified test inflation pressure ± 7 kPa (± 1 psi).

A.2.4.5 Record tire identification and other data, including date, time, ambient temperature, test surface temperature, type of test surface, etc.

A.2.4.6 Record all test data information relative to the actual test.

A.2.4.7 SINGLE WHEEL METHOD—The test vehicle shall be equipped with either the control or candidate tire inflated to the appropriate deflection and the load adjusted to the static load requirement. Operation shall be at a ground speed of 2.5 mph driven by the test wheel and controlled by the action of the operator on the brakes of the nontest wheels. The vehicle shall enter the test area, and the operator engage a throttle actuator while maintaining a ground speed of 2.5 mph. The actuator shall be adjustable to allow at least 1.5 s for a wheel speed acceleration from 2.5 to 15 mph. A minimum of ten of these spin-ups shall be made with each test sample and control tire.

A.2.4.8 DRAWBAR METHOD—For each test, the test vehicle shall be positioned outside the test course and immediately in front of and connected to the dynamometer vehicle with a cable or drawbar. The test vehicle shall operate in the lowest gear for a ground speed of approximately 2.5 mph at its optimum engine rpm for maximum torque and proceed into the test course lane with no load on the drawbar. Load shall be gradually applied to the drawbar by the dynamometer operator, increasing the power required by the test vehicle to maintain a constant engine rpm. The test vehicle progresses in steps from a 0 load—0 slip condition to a high load—max slip condition. Immediately following completion of the first test, the vehicles shall be repositioned at the beginning of the test lane offsetting the tracks of the first test. A minimum of three drawbar tests shall be conducted.

A.2.4.9 TIRE LOAD—For the drawbar pull test the test vehicle shall be loaded to equal individual static tire load(s) within $\pm 3\%$ and to within $\pm 5\%$ of the minimum and maximum tire load of the intended usage vehicle. The single wheel tests shall measure the average dynamic tire load for a series of test runs for calculation of tractive coefficients. All control and candidate tires shall be run at the same tire deflection for a particular comparison. Tires shall be tested at minimum and maximum tire deflections. Also, the tire may be tested at intermediate deflections.

A.2.5 Data Analysis

A.2.5.1 **SINGLE WHEEL TESTS**—Both tabular and graphical data from the ten runs shall be obtained expressing the tractive coefficient of the control tire and the candidate tire as a function of the slip velocity. The mean peak traction coefficient shall be shown as well as the area of the traction curve from 1.0 to 10.0 mph slip velocity. A statistical analysis showing standard deviation and coefficient of variation of the peak and area for the group of runs is also made. The candidate tire(s) shall be rated as a percentage of the control tire performance at 100%.

A.2.5.2 **DRAWBAR TEST**—Traction in terms of traction coefficient at various slip values for each test shall be obtained from the test record and plotted as tractive coefficient versus percent wheel slip (wheel speed-ground speed/ground speed \times 100). A line of best fit shall be drawn through the data to produce the performance curve for each test condition. The highest average traction coefficient value of a 40 point range of slip between 0 and 90% slip from the performance curve shall be determined from the tests. Further, the mean slip value of the 40% slip range for the highest average traction coefficient shall be determined. These values for the control and candidate tires for the same surface condition shall be used to compare tire performance. The candidate tire(s) shall be rated as a percentage of the control tire performance at 100%.

A.3 Tire Traction Test—Drawbar Pull Test Procedure: This method covers the measurement of driving traction of a pair of tires designed for and mounted on passenger cars or light trucks traveling straight ahead on a prepared snow surface using the two-vehicle drawbar pull system.

A.3.1 Summary of Method—The test is conducted by towing a hold back vehicle (dynamometer) behind the test vehicle moving in a straight line. A constant speed is maintained by increasing the brake application of the dynamometer to compensate for increasing throttle setting of the test vehicle. The dynamometer braking is increased only as much as is necessary to maintain a constant test speed. The test progresses with increased throttle setting and dynamometer brake application until the test tires spin through the desired slip range.

A.3.1.1 TEST SPEED

A.3.1.1.1 The nominal recommended vehicle test speed is 8 km/h (5 mph).

A.3.1.1.2 The actual vehicle speed must be within ± 1.6 km/h (± 1 mph) of nominal recommended.

A.3.1.1.3 Speed variation during any individual test run must not exceed 1 km/h (0.5 mph).

A.3.2 Equipment

A.3.2.1 TEST VEHICLE

A.3.2.1.1 The test vehicle may be any vehicle which adequately simulates the intended usage of the tire candidate. Vehicle may be rear-wheel drive or all-wheel drive. Front-wheel drive is acceptable when test requirements dictate.

A.3.2.1.2 The test vehicle should be designed to carry the load "for the tire candidate" on the drive axle. The use of overload springs, air shocks, or suspension blocks is acceptable.

A.3.2.1.3 The test vehicle should incorporate an automatic engine throttle applicator capable of providing a smooth increase of driving torque.

A.3.2.2 TOWED HOLD BACK VEHICLE

A.3.2.3 OTHER EQUIPMENT

A.3.2.3.1 **Drawbar Assembly**—The drawbar assembly consists of a load transducer in series with a flexible (chain) or solid (tube) connection between the test vehicle and hold back vehicle. The attachment of the drawbar to the rear-wheel-drive test vehicle is directly to the test vehicle's frame or rear axle assembly through a freely rotating joint. Springs can be provided to counterbalance the static weight of the force transducers and drawbar assembly.

A.3.2.3.2 *Intercom*—An intercom should be used between the test and dynamometer vehicles for proper coordination of the test activities.

A.3.2.4 INSTRUMENTATION

A.3.2.4.1 The test system measuring instrumentation shall have specifications sufficient to meet accuracy, filtering, and digital requirements as outlined in ASTM F 408.

A.3.2.4.2 Force transducer, to measure drawbar pull force. An analog or digital readout may be provided (optional) in the test vehicle for on-site calibration purposes.

A.3.2.4.3 Vehicle speed sensor, to determine vehicle speed accurately. This may be accomplished with a speed pickup from a front wheel of the test vehicle, a fifth wheel, or some other appropriate device.

A.3.2.4.4 Tachgenerator, to measure average angular velocity of the two test wheels, installed on the test vehicle.

A.3.2.4.5 Multichannel recorder or XXY or XYY function plotter, to provide a permanent record of transducer output signals prior to any data processing. This recorded data can be used for hand processing of data or to provide an information source for confirming outputs of any digital or analog data processors. A visual display of this data is appropriate as an aid to the operator, but is not required.

A.3.2.4.6 Microprocessor, used for on-board data processing. This unit is not required, but simplifies data processing.

A.3.3 Preparation of Equipment

A.3.3.1 TEST VEHICLE

A.3.3.1.1 All transducers and instrumentation should be calibrated to recognized procedures.

A.3.3.1.2 The same tires are to remain on the nontest wheel positions throughout the test.

A.3.4 Calibration

A.3.4.1 Calibrate the force transducer, speed sensor, test wheel speed, tachgenerator, and all other intermediate instrumentation, in accordance with the manufacturer's recommended procedure.

A.3.4.2 All instrumentation is to be calibrated prior to each test program, and provisions should be provided for daily field calibrations.

A.3.5 General Test Conditions

A.3.5.1 Conduct the tests on a level surface meeting the requirements of 4.2 (SAE J1466).

A.3.6 Procedure

A.3.6.1 Warm up electronic test equipment as required for stabilization.

A.3.6.2 Test tires should be stabilized at ambient temperature and shielded from direct sunlight before testing.

A.3.6.3 Apply test tires to the test positions.

A.3.6.4 Adjust the vehicle test wheel static weight by ballasting to match the static wheel load specified for test tires.

A.3.6.5 Check and adjust tire inflation pressure as required immediately before testing.

A.3.6.6 Record tire identification and other data, including date, time, ambient temperature, and test surface information (see A.3.4.2).

A.3.6.7 Approach a test site moving in a straight line at a constant nominal speed of 8 km/h (5 mph) and adjust the hold back vehicle speed to obtain near zero drawbar pull force.

A.3.6.8 Turn on the recorder drive just prior to reaching the test site.

A.3.6.9 Activate the automatic throttle applicator to obtain a maximum 1800 N/s (400 lb/s) measured drawbar force before spin.

NOTE—An invalid snow traction test run occurs when a tire digs through to either the base road material or to glare ice during tire acceleration or spin.

A.3.6.10 Record test data. Data plotted or recorded shall include drawbar force or traction coefficient vs. Differential Interface Velocity (DIV)—(the difference between the tire speed and the test vehicle speed), ground speed, and a time reference.

A.3.6.11 Repeat A.3.6.8 to A.3.6.10 to obtain a minimum of eight acceptable curves according to the criteria in 6.2.1 (SAE J1466). Determine mean and standard deviation of test sequence. Eliminate outlier test data, which is defined as any individual test value more than 1.5 standard deviations from the calculated mean. After eliminating outlier test values, recalculate the mean and standard deviation of the test sequence.

NOTE—Tests should not be conducted over the same surface without adequate surface reconditioning between tests.

A.3.6.12 Run a Snow Monitoring Tire (SMT) at the beginning and end of each test sequence and every third test the between (SMT-T-T-SMT-T-T-SMT, etc.).

A.3.6.13 Each test tire will be tested three times, preferably on different days.

A.3.6.14 Every effort should be made to have the same test drivers perform the same test functions through a sequence of tests.

A.4 Tire Traction Test—Wet Pavement Evasive Maneuver

A.4.1 Scope—This test procedure is intended to be used as a field test procedure; however, the basic criteria are also intended to provide a standard reference for simulation of the basic maneuvers through various mathematical modeling techniques.

This document provides a procedure and instructions for:

A.4.1.1 INSTRUMENTS AND EQUIPMENT

A.4.1.2 VEHICLE PREPARATION

A.4.1.3 TEST OF SINGLE AND COMBINATION VEHICLES

A.4.2 Purpose—This procedure provides a method to evaluate the stability of vehicles under simulated highway conditions. Overturn and loss of control are of primary concern, and other stability problems such as off-tracking and under/oversteering are also evaluated.

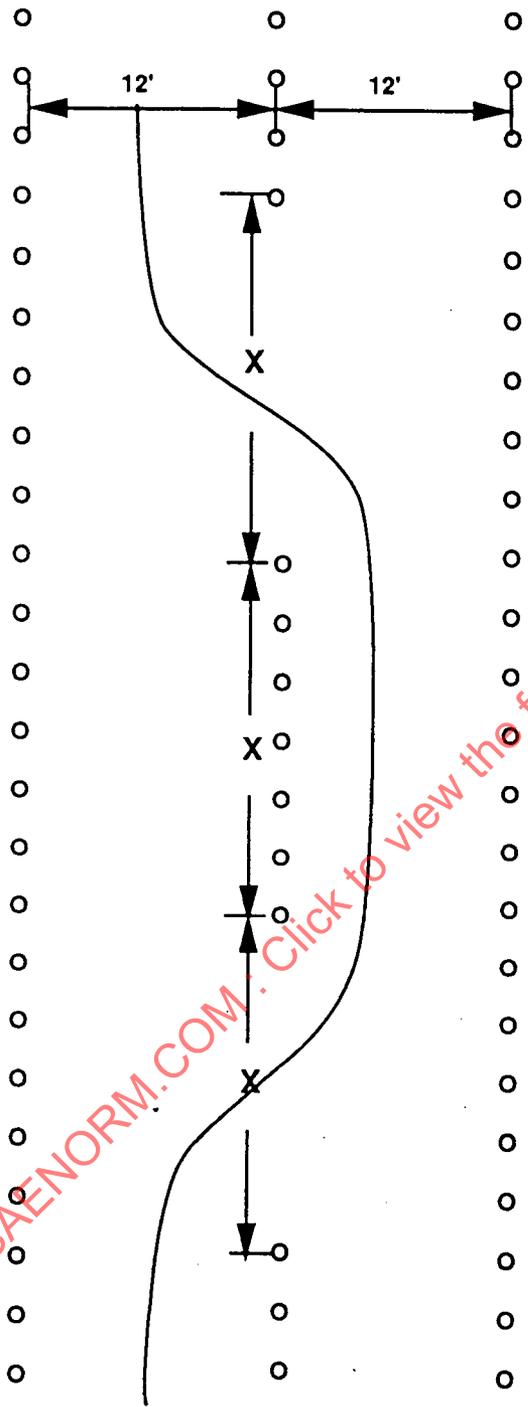
A.4.3 Facilities, Instrumentation, and Equipment

A.4.3.1 A flat, level (not to exceed 1% grade) surface of concrete or black-top large enough to contain the course shown in Figure A.1, as well as adequate acceleration and deceleration lanes. An adequate safety zone on each side of the course is also required.

A.4.3.1.1 The test surface shall be free from any loose material before wetting.

A.4.3.1.2 The wind velocity shall not exceed 8 km/h and both velocity and direction shall be recorded in the test results.

A.4.3.2 Vertical pylons of expendable or deformable material to mark the course as indicated by the "o" marks on Figure A.1. Pylons shall be sufficiently high to assure no portion of the vehicle passes over the top without contacting the pylon.



$$X = (2 \times WB) + L$$

WHERE

WB = WHEELBASE OF VEHICLE

L = OVERALL LENGTH OF VEHICLE

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NOTE:
PYLONS TO BE LOCATED AT 4 FOOT INTERVALS AND BE
NUMBERED TO IDENTIFY THEIR LOCATION ON THE COURSE

FIGURE A1—COURSE LAYOUT

A.4.3.3 A calibrated fifth wheel shall be used to measure vehicle speed.

A.4.4 Vehicle Preparation

A.4.4.1 Vehicles to be tested shall be serviced in accordance with manufacturers' recommended procedures.

A.4.4.2 Payloads shall be loaded and secured in accordance with normal commercial practice except that testing with abnormal payloads should be considered; i.e., loads with high center of gravity, live loads, such as partially full tank trucks, etc. It is strongly recommended that reasonable loads of these types be investigated to assure stable operation under normal usage. In particular, van bodies should be loaded with a payload distributed throughout the van interior such that the center of gravity is in the center of the van volume vertically, transversely, and longitudinally. Consideration should be given to testing with representative "worst case loads" with the load off-center transversely.

A.4.5 Calculation of Test Course Dimensions

The dimension "X" on Figure A.1 shall be calculated as follows for each vehicle of vehicle combination tested:

$$X = (2 \text{ WB}) + L \quad (\text{Eq. A.1})$$

where:

WB = wheelbase of vehicle

L = overall length of vehicle or vehicle combination

A.4.6 Method

A.4.6.1 The vehicle shall be driven by a competent test driver well trained and thoroughly familiar with the test vehicle. Successive trials shall be conducted through the test course at gradually increasing speeds to determine the maximum speed at which the vehicle (or vehicle combination) can negotiate the course without contacting any of the pylons and without overturning or other loss of control. Repeat runs shall be made until the test director is satisfied that the maximum speed has been defined within ± 1 mph. The test driver shall be permitted to call any run invalid based solely on his/her judgment. For each run the vehicle shall enter the test area in the center of the lane and shall not initiate any turn until the front of the vehicle has passed the start of the "gate."

A.4.6.2 Observers shall be stationed to:

- observe all wheels of the vehicle(s) in order to note any "lift-off," and
- observe any contact between the vehicle and the pylons.

A.4.7 Tabulation of Data

A.4.7.1 The configuration of each vehicle payload combination tested shall be recorded in the format shown in Figure A.2. (Additional columns should be added as needed for vehicle combinations consisting of more units.) Payload center of gravity and moments of inertia are desirable when available. When these detailed data are not available, a full description of the payload shall be included and as a minimum the individual axle loads shall be recorded for each payload configuration.

A.4.7.2 For each test run the data on Figure A.3 shall be recorded.

A.5 Military Bead Unseating Test

A.5.1 **Scope**—This document specifies a test method to measure the speed and inflation pressure at which the outside tire bead will become unseated from its normal location as a critical component of the tire/wheel assembly.

Configuration code (for cross-reference) _____

Vehicle Description:

Truck/Tractor

Trailer/Semi-Trailer/

Trailer

Make: _____ Make: _____ Make: _____

Model: _____ Model: _____ Model: _____

Year Mfr'd: _____ Year Mfr'd: _____ Year Mfr'd: _____

VIN (or Ser.No.): _____ VIN (or Ser.No.): _____ VIN (or Ser.No.): _____

Weight as tested: _____ Weight as tested: _____ Weight as tested: _____

Wheelbase: _____ Wheelbase: _____ Wheelbase: _____

Suspension:

Frt: _____ Rear: _____ Frt/tag: _____ Rear: _____ Frt/tag: _____ Rear _____
 Rate/type (leaf, torsion bar, air, etc.)

Axle loads:

Frt: _____ Rear: _____ Frt: _____ Rear: _____ Tag: _____ Rear: _____

Payload narrative description:

Center of gravity height from ground (if available)

Truck: _____ Truck payload: _____ Truck with payload: _____

Trailer: _____ Trailer payload: _____ Trailer with payload: _____

Trailer: _____ Trailer payload: _____ Trailer with payload: _____

Moments of inertia (as available):

FIGURE A.2—DESCRIPTIVE INFORMATION

Date _____ Wind velocity: _____ Direction: _____ Friction coefficient: _____
 Configuration code: _____ Run number: _____ Direction: _____ Start from right or left: _____
 Gate dimension ("X"): _____
 Vehicle speed at entry: _____ Vehicle speed at exit: _____
 Pylons displaced (area/number): _____/_____/_____/_____
 Wheel lift-off observed: _____
 Comments: _____

FIGURE A.3—TEST DATA

A.5.2 Definitions—For the purpose of this procedure, the following definitions will apply:

- A.5.2.1 **VEHICLE SPEED**—The actual over-ground velocity of the test bed vehicle at the time test speed (reference 2.1) is recorded.
- A.5.2.2 **TEST TIME**—The time taken to cover the test distance, or duration of the test run, expressed in seconds (s).
- A.5.2.3 **TEST DISTANCE**—The measured distance traveled by the vehicles during the test time, expressed in meters (m) or feet (ft).
- A.5.2.4 **TEST BED MASS**—The mass of the test bed as tested, including operator, fuel, and all fluid compartments at their specified levels, expressed in kilograms (kg) or pounds (lb).
- A.5.2.5 **HOT TIRE PRESSURE**—Air inflation in each test bed tire as tested, expressed in kilopascals (kPa) or pounds per square inch (psi).
- A.5.2.6 **COLD START TIRE PRESSURE**—Air inflation of each test bed tire at 60 °F air change temperature, expressed in terms of (reference 5.2.5).
- A.5.2.7 **AMBIENT TEMPERATURE/RELATIVE HUMIDITY**—Wet bulb and dry bulb readings which are recorded at the start and finish of each test run, expressed in terms of degrees Celsius (°C) or degrees Fahrenheit (°F).
- A.5.2.8 **TEST RUN**—Total test distance at each test speed in terms of test course laps.
- A.5.2.9 **TEST COURSE LAYOUT**—Equal radius Figure 8 configuration of predetermined asymmetrical curvatures on a level graded surface within 0.5% grade.

A.5.2.10 TEST COURSE BASE MATERIAL—Sand or clay with test tire travel path pre-rutted to a depth equal to one-half the tire's section height at the outside sidewall.

A.5.2.11 TEST COURSE RADIUS OF CURVATURE—Outer one-half of the opposing curvatures bisected by the length of the course to be:

The radius at the centerline of the vehicle's front axle travel path is that which is produced by the steering the vehicle at 90% of its specified full lock turn.

A.5.2.12 TEST TIRE LOADS—Those loads expressed in pounds, specified as maximum tire loads by the Military Tire Supplement of T&RA Yearbook on the vehicle manufacturer.

A.5.2.13 TEST BED—The vehicles for which the test tire is intended to be used on.

A.5.2.14 TEST TIRE RIMS—Rims which are of equal size for each test bed wheel position and within the dimensional limits specified by T&RA Military Supplement or vehicle manufacturer for the tires being tested.

A.5.3 Instrumentation Required

A.5.3.1 SPEED

- a. A velocity sensor attached to the transfer case speedometer gear output shaft or fifth wheel.
- b. A lap time measurement device.

A.5.3.2 PRESSURE—A calibrated pressure gauge.

A.5.3.3 RIM/BEAD SEAT DIMENSION—T&RA ball tape for bead seat diameter and caliper with steel rule for other rim dimensions.

A.5.3.4 TIRE BEAD INSIDE DIAMETER—Steel tape for bead sole circumference or internal bead diameter caliper with steel rule.

A.5.3.5 LOAD SCALES—Mechanical or electronic wheel scales with $\pm 2\%$ full scale accuracy.

A.5.3.6 ENVIRONMENTAL MEASUREMENTS—Ambient temperature and % relative humidity at beginning and end of each test sequence.

A.5.3.7 CONE PENETROMETER—To measure Cone Index (CI) and Remolded Cone Index (RCI) of test area berm soil before and after each test sequence (ref. NRMM procedure).

A.5.4 Test Procedures

A.5.4.1 VEHICLE—Calibrate speedometer indicator at 5, 10, and 20 mph with loaded vehicle and tires equal to test tires in revolutions per mile.

A.5.4.2 TIRES AND WHEELS—Inspect and measure test tires and rims separately. Code each rim and mating tire indicating the SS bead match with its rim bead seat. Tire position (serial no.) on rim should be indexed with valve hole.

Tires should be mounted for this test using manufacturers' recommended procedures for lubricant. Record maximum inflation pressure required to seat bead. Inflated tires at test pressure should be stored for at least 24 h prior to mounting on vehicle.

Test tires should be broken in by operating them on a hard surface road for 50 miles at test load and maximum test inflation pressure at 50 mph ± 5 average.

Test tires should be measured 24 h after break-in and before test start, i.e., outside diameter (crown), cross-section, tread depth (shoulders and crown), tread arc (profile) shore "A" (crown).

A.5.4.3 TEST TIRE POSITIONS—Both front steering positions. Any nontest wheel positions should have tires and wheels of the same size, inflation pressure, and normal maximum load distribution.

A.5.4.4 Test sequence should start at the intersection of the Figure 8 and proceed clockwise into the first turn. Test speed constant should be achieved after first Figure 8 lap. Cumulative lap timing

for six laps at constant speed should begin after first lap is completed. No more than 30 min should elapse between six lap test sequences. If more than 30 min is required, the first sequence should be repeated before proceeding to the next sequence in order.

A.5.4.5 Test tire pressures should be set at 35 psi (corrected to 60 °F air charge temperature) for initial six lap sequence. Test tire pressures should be reduced for 25 psi (hot) and second six lap sequence should be completed. The third six lap sequence should begin with test tire pressures reduced to 15 psi (hot) and the fourth sequence should be completed. The fifth six lap sequence requires the tire pressures to be reduced to 10 psi (hot). The sixth sequence requires six laps at 5 psi (hot). If no air loss is measured or tire/rim rotational displacement is measured, the tire and rim system is considered qualified to operate without additional modifications (bead locks, bead spreaders, or safety humps).

A.5.4.6 Test vehicle constant speeds limit—maximum controllable safe speed.

A.5.4.7 The effective test course rut depth (berm height at outer wheel path) should be maintained at one-half the loaded section height ± 1 in of the test tire by lowering the untraveled outer berm height.

A.5.5 Data Requirements

A.5.5.1 DATA REDUCTION—Data reduction should include:

- a. Average mph each completed sequence
- b. Total sequence distance to air loss or rotational displacement
- c. Total sequence time to air loss or rotational displacement
- d. Measured air loss at each sequence or event
- e. Measured rotational displacement at each sequence or event
- f. Measured rut depth at each sequence
- g. Measured temperature (ambient °F) each sequence
- h. Measured inflation pressure at start and finish of each sequence
- i. Measured RCI and measured CI at each curve prior to and end of test

A.5.5.2 All test data shall be recorded.

A.6 Tire Thermal Reliability Test—This test is designed to validate a tire's thermal capabilities in order to determine its ability to operate at a specified temperature for a period of time/miles. Two evaluations are accomplished by this test.

- a. Accomplish a minimum period of operation without tire failure.
- b. Determine the mode of tire failure when it does occur.

A.6.1 General Test Conditions

A.6.1.1 TIRE TEMPERATURE—Threshold tire temperature as specified by the requirements of the vehicle mission profile.

A.6.1.2 TIRE INFLATION PRESSURE—Minimum possible to achieve threshold tire failure temperature.

A.6.1.3 TIRE LOAD—Maximum possible to achieve threshold tire failure temperature.

A.6.1.4 VEHICLE SPEED—Maximum possible to achieve threshold tire failure temperature.

NOTE—Tire inflation pressure, tire load, and vehicle speed counterbalance affect one another, necessitating the adjustment of all to accomplish the threshold tire temperature. In no instance should this test condition be less severe than most severe service the tire will experience in its mission profile. Specific test conditions shall be selected based on the results of the thermal profile test.