<table>
<thead>
<tr>
<th>UNCLASSIFIED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**AD NUMBER**

AD467896

**NEW LIMITATION CHANGE**

**TO**

Approved for public release, distribution unlimited

**FROM**

Distribution authorized to U.S. Gov't. agencies and their contractors; Administrative/Operational use; Feb 1965. Other requests shall be referred to Army Tank-Automotive Center, Warren MI.

**AUTHORITY**

ATAC ltr 18 Mar 1966

**THIS PAGE IS UNCLASSIFIED**
SECURITY
MARKING

The classified or limited status of this report applies to each page, unless otherwise marked. Separate page printouts MUST be marked accordingly.

THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18, U.S.C., SECTIONS 793 AND 794. THE TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U.S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.
DEVELOPMENT OF TIRES
FOR
THE FAMILY OF MEDIUM TACTICAL TRUCKS

United States Rubber Tire Company
Detroit 32, Michigan

R. A. Reichert/E. D. Rogers-ATAC

FINAL REPORT
PHASE I AND II
FEBRUARY 1965

DETROIT PROCUREMENT DISTRICT U. S. ARMY

CONTRACT NO. DA 20-018-AMC 0585T

Technical Supervision by Research and Engineering Directorate
Army Tank Automotive Center
Detroit Arsenal, Center Line, Michigan

Delivered by the United States Rubber Tire Company
Pursuant to Contract No. DA 20-018-AMC-0585T
Government's Use Controlled by General Provision Hereof
Entitled, Data Which Is ASPR 9-203.1, 9-203.4 and APP 9-203.1
This document is the best quality available. The copy furnished to DTIC contained pages that may have the following quality problems:

- Pages smaller or larger than normal.
- Pages with background color or light colored printing.
- Pages with small type or poor printing; and or
- Pages with continuous tone material or color photographs.

Due to various output media available these conditions may or may not cause poor legibility in the microfiche or hardcopy output you receive.

☐ If this block is checked, the copy furnished to DTIC contained pages with color printing, that when reproduced in Black and White, may change detail of the original copy.
The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

DDC AVAILABILITY NOTICE:

U.S. MILITARY AGENCIES MAY OBTAIN COPIES OF THIS REPORT DIRECTLY FROM DDC. OTHER QUALIFIED USERS MAY REQUEST FROM U.S. ARMY TANK-AUTOMOTIVE CENTER, ATTN: SMOTA-RC, WARREN, MICHIGAN 48090

Destroy this report when it is no longer needed. Do not return it to the originator.
DEVELOPMENT OF TIRES
FOR
THE FAMILY OF MEDIUM TACTICAL TRUCKS

United States Rubber Tire Company
Detroit 32, Michigan

R. A. Reichert/E. D. Rogers-ATAC

FINAL REPORT
PHASE I AND II
FEBRUARY 1965

DETROIT PROCUREMENT DISTRICT U. S. ARMY

CONTRACT NO. DA 20-018-AMC 0585T

Technical Supervision by Research and Engineering Directorate
Army Tank Automotive Center
Detroit Arsenal, Center Line, Michigan

Delivered by the United States Rubber Tire Company
Pursuant to Contract No. DA 20-018-AMC-0585T
Government's Use Controlled by General Provision Hereof
Entitled, Data Which is ASPR 9-203.1, 9-203.4, and APP 9-203.1
NOTICES

When government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibilities nor any obligation whatsoever and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as conveying any rights or permission, to manufacture, use, or sell any patented invention that may in any way be related thereto.

The findings in this report are not to be construed as an official Department of the Army position.
The overall objectives of this contract were -

1. To supply thirty (30) 11.00-20 size radial ply tires, 6 ply nylon carcass with 2 ply wire belted treads, designed to provide increased performance over tires previously produced on Contract No. DA 20-018-ORD-20410.

2. Conduct a radial ply tire design investigation into the larger tire size (16-20) with low profile construction.

3. Perform a feasibility study of the replaceable tread tire concept.

Work was directed toward -

1. Increasing resistance to breaker separation, liner splitting and circumferential splice opening.

2. Increasing durability and improving general off-the-road performance of the tires.

Field testing of the 11.00-20 tires, under the direction of the Army Tank Automotive Center showed that the tires were much improved over previous radial tires tested. However, a few tires still failed from sidewall cracking.

The contract was revised to emphasize improvement in sidewall cracking resistance. This was accomplished by changing from a synthetic stock compound in the sidewall to a natural rubber compound with a neoprene veneer. Indoor sidewall cracking test results of tires with the natural rubber/neoprene veneer sidewalls indicate a vast improvement in cracking resistance over tires with previous sidewall construction.

Excellent test results were obtained with 16-20 low profile tire on all types of indoor tests. Due to the performance level of these tires on indoor testing, we feel that this tire is more than adequate for field endurance tests.

The experimental test results of the replaceable tread tire were very favorable and we feel that this concept should be broadened to include the highway-type tire.
ACKNOWLEDGMENT

TABLE OF CONTENTS

1. CONTRACT OBJECTIVE 1
   1.1 Phase I 1
   1.2 Phase II 1

2. SUMMARY 1
   2.1 11.00-20 Integral Tires 1
   2.2 16-20 Low Profile Tires 1
   2.3 11.00-20 Replaceable Tread Tires 2
   2.4 Testing:
      2.4.1 Indoor Tests 2
      2.4.2 Endurance Tests 2
      2.4.3 Sidewall Cracking Tests 3
      2.4.4 Head Adequacy Tests 4
      2.4.5 Stopped Down Inflation Test 4
      2.4.6 Hydroburst Test 5
      2.4.7 Plunger Test 5

3. DISCUSSION 5
   3.1 Tire Design
      3.1.1 11.00-20 Integral Tire 5
      3.1.2 16-20 Low Profile Tire 5
      3.1.3 11.00-20 Replaceable Tread Tire 6
   3.2 Mold Design
      3.2.1 16-20 Low Profile Tire 6
      3.2.2 11.00-20 Replaceable Tread Tire 7
   3.3 Rim Design 7
   3.4 Fabrication of Tires
      3.4.1 11.00-20 Integral Tires 7
      3.4.2 16-20 Low Profile Tires 7
      3.4.3 11.00-20 Replaceable Tread Tires 7
   3.5 Tubes 8
   3.6 Tire Mounting 8
   3.7 Measurements 8
   3.8 Weight Data 9

4. CONCLUSIONS AND RECOMMENDATIONS 10
   4.1 Phase I 10
   4.2 Phase II 10
### Table of Contents (cont'd)

**List of Tables and Figures**

<table>
<thead>
<tr>
<th>Table No.</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table I</td>
<td>Indoor Endurance Tests</td>
<td>3</td>
</tr>
<tr>
<td>Table II</td>
<td>Sidewall Cracking Test</td>
<td>4</td>
</tr>
<tr>
<td>Table III</td>
<td>Bead Adequacy Test</td>
<td>4</td>
</tr>
<tr>
<td>Table IV</td>
<td>Measurements</td>
<td>8</td>
</tr>
<tr>
<td>Table V</td>
<td>Spring Rates</td>
<td>9</td>
</tr>
<tr>
<td>Table VI</td>
<td>Engineering Data</td>
<td>9</td>
</tr>
</tbody>
</table>

**Photographs**

<table>
<thead>
<tr>
<th>Figure No.</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>11.00-20 Integral Tire Section</td>
<td>11</td>
</tr>
<tr>
<td>Figure 2</td>
<td>16-20 Tire</td>
<td>12</td>
</tr>
<tr>
<td>Figure 3</td>
<td>16-20 Tire Section</td>
<td>13</td>
</tr>
<tr>
<td>Figure 4</td>
<td>11.00-20 Replaceable Tread Tire</td>
<td>14</td>
</tr>
<tr>
<td>Figure 5</td>
<td>11.00-20 Replaceable Tread and Carcass</td>
<td>15</td>
</tr>
<tr>
<td>Figure 6</td>
<td>11.00-20 Replaceable Tread Tire Section</td>
<td>16</td>
</tr>
<tr>
<td>Figure 7</td>
<td>20x12.00 Rim</td>
<td>17</td>
</tr>
</tbody>
</table>

**Footprints and Tread Pressures**

<table>
<thead>
<tr>
<th>Figure No.</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 8</td>
<td>11.00-20 Integral Tire Footprint</td>
<td>18</td>
</tr>
<tr>
<td>Figure 9</td>
<td>11.00-20 Integral Tire Tread Pressure</td>
<td>19</td>
</tr>
<tr>
<td>Figure 10</td>
<td>16-20 Low Profile Tire Footprint</td>
<td>20</td>
</tr>
<tr>
<td>Figure 11</td>
<td>16-20 Low Profile Tire Tread Pressure</td>
<td>21</td>
</tr>
<tr>
<td>Figure 12</td>
<td>11.00-20 Replaceable Tread Tire Footprint</td>
<td>22</td>
</tr>
<tr>
<td>Figure 13</td>
<td>11.00-20 Replaceable Tread Tire Tread Pressure</td>
<td>23</td>
</tr>
</tbody>
</table>

**Profiles**

<table>
<thead>
<tr>
<th>Figure No.</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 14</td>
<td>11.00-20 Integral Tire</td>
<td>24</td>
</tr>
<tr>
<td>Figure 15</td>
<td>16-20 Low Profile Tire</td>
<td>25</td>
</tr>
<tr>
<td>Figure 16</td>
<td>11.00-20 Replaceable Tread Tire</td>
<td>26</td>
</tr>
</tbody>
</table>

**Graphs - Closed Loop Load Deflection Curves**

<table>
<thead>
<tr>
<th>Figure No.</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 17</td>
<td>11.00-20 Integral Tire</td>
<td>27</td>
</tr>
<tr>
<td>Figure 18</td>
<td>16-20 Low Profile Tire</td>
<td>28</td>
</tr>
<tr>
<td>Figure 19</td>
<td>11.00-20 Replaceable Tread Tire</td>
<td>29</td>
</tr>
</tbody>
</table>

**Graphs - Vertical Load Deflection Curves**

<table>
<thead>
<tr>
<th>Figure No.</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 20</td>
<td>11.00-20 Integral Tire</td>
<td>30</td>
</tr>
<tr>
<td>Figure 21</td>
<td>16-20 Low Profile Tire</td>
<td>31</td>
</tr>
<tr>
<td>Figure 22</td>
<td>11.00-20 Replaceable Tread Tire</td>
<td>32</td>
</tr>
</tbody>
</table>
1. **CONTRACT OBJECTIVES**

1.1 Phase I

To supply thirty (30) nylon radial carcass, belted tread design 11.00-20 tires designed to provide increased performance over tires previously supplied on Contract DA-20-016-CON-20420. The breaker and carcass ply stocks are of a natural rubber composition and the tread of synthetic rubber.

1.2 Phase II

Conduct a radial ply tire design investigation into the larger tire size (16-20) with low profile construction and to perform a feasibility study of the replaceable tread tire concept in the 11.00-20 size tire.

2. **SUMMARY**

2.1 Phase I - 11.00-20 Integral Tires

Field test results of the 11.00-20 integral tires indicated an improvement in performance over tires previously tested. However, with the increased mileage a sidewall cracking deficiency was noted. We believe that we have a method of correcting this problem as evidenced by the indoor sidewall cracking test results on the 16-20 size tires.

All experimental tires tested prior to shipment passed endurance test requirements.

2.2 Phase II - 16-20 Low Profile Tires

With the information obtained from the test results on Phase I tires, we were prompted to revise the construction features of the 16-20 low profile and 11.00-20 replaceable tread tires.

We proposed and received a contract modification to change from synthetic tread and sidewall stock to a natural rubber compound with a neoprene veneer on the sidewall. This revised construction showed a vast improvement on indoor sidewall cracking test over results obtained with the previous construction.

The initial fourteen (14) 16-20 field evaluation tires were fluoroscoped and some irregular spacing of the cords in the breakers at the splice was found. The quality of these tires was questionable for penetration resistance and tread wear.

It was necessary to rebuild the fourteen (14) field evaluation tires in order to obtain tires with the desired quality level, as determined by visual and fluoroscopic examination, for field testing at Camp Bullis.

To establish the performance level of the tires with irregular spacing in the breaker cords, an agreement was reached with Messrs. Heinrich,
2. SUMMARY (cont'd)

2.2 Phase II - 16-20 Low Profile Tire (cont'd)

Jackson, and Rogers at the Detroit Arsenal to field test seven (7) of the first group of tires.

The 16-20 low profile tactical tire performed exceptionally well on all types of indoor testing. Based on these test results, we feel that this tire is more than adequate to meet the requirements for application to the new family of medium tactical trucks.

2.3 Phase II - 11.00-20 Replaceable Tread Tires

The indoor test results on this tire were very favorable. Although the testing of this tire was limited, there was no displacement of the tread band on the carcass during the test.

2.4 Testing

2.4.1 Indoor Tests

To establish the laboratory performance level of the experimental tires, the following test programs were conducted:

**Phase I**

Two tests were used - the stepped down inflation test and the 30 mph smooth wheel endurance test.

**Phase II - 16-20/10 P.R. Tire**

Four tests were used, the 30 mph smooth wheel endurance test, bead adequacy test, sidewall cracking test, and the average breaking energy plunger rupture test.

In addition to the above tests the 16-20/10 P.R. tire was subjected to a hydroburst test to establish the burst strength of the tire.

**Phase II - 11.00-20 Replaceable Tread Tire**

Testing of this tire was limited to the 30 mph smooth wheel endurance test.

2.4.2 Indoor Endurance Test

The 30 mph smooth wheel stepped up load endurance test was used to evaluate the separation resistance of the 11.00-20 and the 16-20 radial ply tires.
2. SUMMARY (cont'd)

2.4 Testing (cont'd)

2.4.2 Indoor Endurance Test (cont'd)

Loads and inflations for this test were as follows:

<table>
<thead>
<tr>
<th></th>
<th>11.00-20</th>
<th>16-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Inflation</td>
<td>50 psi</td>
<td>50 psi</td>
</tr>
<tr>
<td>Initial Load</td>
<td>3850#</td>
<td>4125#</td>
</tr>
<tr>
<td>Load increment increase at 65 hours and every 24 hours thereafter</td>
<td>350#</td>
<td>375#</td>
</tr>
</tbody>
</table>

The results of the tests which are listed in Table I indicate a vast improvement in the 16-20 low profile tire for breaker and ply separation resistance as compared to 11.00-20 integral tire.

<table>
<thead>
<tr>
<th>Total Load at Failure</th>
<th>11.00-20 Integral Tire Radial Ply</th>
<th>16-20 Radial Ply Tire</th>
<th>11.00-20 Replaceable Tread Tire Radial Ply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of Failure</td>
<td>201.0 Fabric Fatigue</td>
<td>280.9 Removed complete</td>
<td>136.3 Removed complete</td>
</tr>
<tr>
<td>Load at Failure</td>
<td>5150#</td>
<td>7500#</td>
<td>4900#</td>
</tr>
</tbody>
</table>

2.4.3 Sidewall Cracking Tests

The sidewall cracking test for the 16-20 low profile tire was conducted on a smooth wheel. The tire was run at slow speed (25 mph), low inflation (20 psi) and loaded to 3750# (rated tire load).

Two groups of tires were evaluated for sidewall cracking. Group I tires featured a natural rubber sidewall and Group II tires a natural rubber sidewall with a neoprene veneer. The results listed in the following Table II indicate a definite improvement in sidewall cracking resistance with the natural rubber/neoprene veneer combination.
2. SUMMARY (cont'd)

2.4 Testing (cont'd)

2.4.3 Sidewall Cracking Tests (cont'd)

Table II

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Hours</th>
<th>Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16-20 Radial Tire</td>
<td>(%) 220.0</td>
<td>Sidewall cracking</td>
</tr>
<tr>
<td></td>
<td>(%) 220.0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group II</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-20 Radial Tire</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

(*) Sidewall cracking was initiated at 110.0 hours. The tires were kept running to study rate of crack growth.

2.4.4 Bead Adequacy Test

To establish the performance level of the 16-20 low profile tires for bead adequacy, two tires were tested on a flat belt machine. The tires were inflated to 35 psi and mounted diametrically opposite on a vertical flat belt. The tires were then over-loaded to 6675# and run at speed of 23 mph. These conditions were designed to produce a flex strain in the bead area of the tire without generating excessive heat in tread.

Results listed in Table III indicate that the performance level of the beads is more than adequate since 200 hours on this test is considered very good.

Table III

<table>
<thead>
<tr>
<th>Total Hours</th>
<th>Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-20 Radial Tire</td>
<td>264.7</td>
</tr>
<tr>
<td></td>
<td>264.7</td>
</tr>
<tr>
<td></td>
<td>Removed - complete</td>
</tr>
<tr>
<td></td>
<td>Slight sidecover</td>
</tr>
</tbody>
</table>

2.4.5 Stepped Down Inflation Test

Test conditions for this test are as follows: load 3500#; speed 30 mph; inflation 50, 40, 30, 20, and 10 psi for 24 hours each on a smooth wheel.

One 11.00-20 integral tire was subjected to this test and failed from fabric fatigue one hour after entering the 10 psi phase.
2. SUMMARY (cont’d)

2.4 Testing (cont’d)

2.4.6 Hydroburst Test

A 16-20 tire was subjected to a hydrostatic burst test. The tire failed with a broken bead bundle at 115 psi. The actual burst value agrees with the calculated burst value for this tire.

2.4.7 Plunger Test

Plunger tests were conducted on the 16-20 low profile tire at 35 psi. The average breaking energy was 46,181.28 in.lbs, which is more than ample for rupture resistance for the tire.

3. DISCUSSION

3.1 Tire Design

3.1.1 11.00-20 Integral Tire

In order to meet the objective for Phase I a revised construction of the 11.00-20 radial ply, wire belted tire, as compared to that featured in previous Contract DA 20-018-ORD-20440, was designed. The revised construction featured 6 full plies of 1680/2 denier nylon cord and 2 low angle breakers of 5x7x.0059 flexible steel cable. The sidewall featured a layer of wire loaded stock with a cover of synthetic stock. Chlorobutyl (a stock which is highly resistant to liner cracking) was featured as the liner stock in this construction.

To increase the resistance of tire to rim chafing an SBR-CisBR stock with excellent elongation and flex cracking properties was used as a rim flange strip. An SBR-CisBR/NR cement was used at all tread and sidewall junctions to increase splice opening resistance of the tire.

The six nylon plies provided the required carcass strength and the two wire breakers provided the needed circumferential strength of the tire.

Load deflection curves, Figures 17 and 20, are shown on pages 27 and 30 and engineering data are shown in Table VI.

3.1.2 16-20 Low Profile Tires

From the knowledge gained with the Phase I tires tested at Camp Bullis, the 16-20 radial ply tire was designed to provide a tire with increased sidewall cracking resistance.

The construction of this tire featured 6 full plies of 1680/2 denier nylon cord and 2 low angle breakers of 5x7x.0059 flexible.
3. DISCUSSION (cont'd)

3.1 Tire Design (cont'd)

3.1.2 16-20 Low Profile Tires (cont'd)

Steel cable. The sidewall featured a layer of wire loaded stock covered by a natural rubber sidewall with a neoprene veneer. Six nylon plies and two wire breakers provided the required structural strength of the tire. A chlorobutyl liner was featured in this construction also. The neoprene veneer reduces checking and sidewall cracking (see Sidewall Cracking Test Results).

Since the 16-20 size tire was entirely new, experimental tires were required to verify constructions.

Load deflection curves, Figures 18 and 21, are shown on pages 28 and 31 and engineering data are shown in Table VI.

3.1.3 11.00-20 Replaceable Tread Tire

The carcass construction features of the 11.00-20 replaceable tread tire were identical to those of the 16-20 size tire. The tread band featured two circumferentially wound breakers of flexible steel cable to provide maximum restraint of movement of the breaker band on the carcass.

Experimental tires were required to verify the construction.

The initial construction check tire revealed a slight misfit of the tire band and carcass. The carcass rings were modified to provide a more uniform fit or mating of the carcass and tread band.

Load deflection curves, Figures 19 and 22, are shown on pages 29 and 32 and engineering data are shown in Table VI.

3.2 Mold Design

3.2.1 16-20 Low Profile Tire

The tire mold was designed to the low profile principle using a section height to section width ratio of .74. The mold has a 43.950 inch outside diameter, a 15.30 inch cross section and a 15.30 inch crown radius. The tread pattern was similar to the tread designed for the 11.00-20 integral tire, a tactical design with the tread pattern ending at the tread shoulder.

Prints of the mold and letter drawings are included with this report.
3. DISCUSSION (cont'd)

3.2 Mold Design (cont'd)

3.2.2 11.00-20 Replaceable Tread Tire

The 11.00-20 replaceable tread tire mold was designed to produce a carcass and tread band which when assembled would yield a tire of the same dimensions as the 11.00-20 integral tire with an overall diameter of 42.540 inches and a 11.600 inch cross section.

3.3 Rim Design

The rim for the 16-20 size tire was designed for tubed type tires. The rim has a semi-drop center, 12" width, 20" nominal diameter with heel diameter .188" over nominal, 5° tapered bead seat and a modified safety hump to prevent slippage or bead displacement under emergency conditions.

3.4 Fabrication of Tires

3.4.1 Phase I - 11.00-20 Integral Tires

Existing equipment was utilized in the production of the thirty (30) 11.00-20 integral tires for this phase of the contract.

No manufacturing difficulties were encountered.

3.4.2 Phase II - 16-20 Low Profile Tires

The only special equipment required to produce the 16-20 size tire was a tire mold. Curing bags and toe rings available from a previous government contract were used in the manufacturing of these tires.

Building procedures, shaping bagging and curing of the 16-20 low profile tires were similar to those for radial ply tires previously produced for highway service.

3.4.3 Phase II - 11.00-20 Replaceable Tread Tires

Equipment needed to manufacture the 11.00-20 replaceable tread tires comprised a tire mold, carcass rings, drum building core, segmented tread rim and one bottom toe ring.

The breakers for this tire were circumferentially wound. No preshaping of the carcass was necessary prior to cure.

A slight recut of the carcass rings was necessary to provide a tighter fit of the carcass to the tread band (see mold profile attached to this report which shows recut).
3.5 Tubes

16-20 size tubes were supplied in compliance with applicable requirements of Government Specification ZII-550. Tube weight was 15 lbs.

Although flaps were supplied, the design of the 16-20 tire beads and the rim seat permitted tubed tire operation without the use of flaps.

3.6 Tire Mounting

In Phase I mounting checks were made on the 16-20 tire on the rim designed for this vehicle by Ford Motor Company. Mounting and dismounting were satisfactory.

As a safety precaution 40 psi should not be exceeded during tire mounting.

3.7 Measurements

The measurements taken in conjunction with the test program were load deflection curves, vertical spring rates, tread pressures, footprints, weight, cross section, outside diameter, loaded radius, rolling radius and gross and net contact areas.

Table IV lists all measurements taken on the specified tires. The pages which follow contain Figures 8 through 22 which are the load deflection curves, footprints, tread pressures and closed loop load deflection or spring rate curves.

<table>
<thead>
<tr>
<th>Table IV</th>
<th>11.00-20 Integral</th>
<th>16-20 Rep.Trd.</th>
<th>11.00-20 Rep.Trd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross Section</td>
<td>13.79</td>
<td>16.92</td>
<td>13.84</td>
</tr>
<tr>
<td>Outer Diameter</td>
<td>42.50</td>
<td>43.85</td>
<td>42.59</td>
</tr>
<tr>
<td>Loaded Radius</td>
<td>19.25</td>
<td>20.19</td>
<td>19.39</td>
</tr>
<tr>
<td>Tread Width</td>
<td>8.09</td>
<td>10.41</td>
<td>8.39</td>
</tr>
<tr>
<td>Deflection at 3750# load and 35 psi inflation</td>
<td>2.004</td>
<td>1.708</td>
<td>1.902</td>
</tr>
</tbody>
</table>
3.7 Measurements (cont'd)

### Table V

<table>
<thead>
<tr>
<th>Measurement</th>
<th>11.00-20</th>
<th>16-20</th>
<th>11.00-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical Spring Rate</td>
<td>Integral</td>
<td>2315#/in.</td>
<td>2600#/in.</td>
</tr>
<tr>
<td>at 3750# load and 35 psi inflation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>201# 2 oz.(1)</td>
<td>211# 10 oz.(1)</td>
<td>210# 2 oz.(1)</td>
</tr>
<tr>
<td>Rim</td>
<td>8.00</td>
<td>12.00</td>
<td>8.00</td>
</tr>
</tbody>
</table>

(1) Includes weight of tire, rim, tube and flap.

### Table VI

Engineering data of the 11.00-20 integral 16-20 low profile, and the 11.00-20 replaceable tread tires.

<table>
<thead>
<tr>
<th></th>
<th>11.00-20</th>
<th>16-20</th>
<th>11.00-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load (lbs.)</td>
<td>3500</td>
<td>3750</td>
<td>3500</td>
</tr>
<tr>
<td>Inflation (psi)</td>
<td>30</td>
<td>35</td>
<td>30</td>
</tr>
<tr>
<td>Rim Dimensions</td>
<td>20x8.0</td>
<td>20x12.0</td>
<td>20x8.0</td>
</tr>
<tr>
<td>(Diameter and Width)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. Cross Section (in.)</td>
<td>12.17</td>
<td>15.84</td>
<td>12.27</td>
</tr>
<tr>
<td>Overall Diameter (in.)</td>
<td>42.50</td>
<td>43.85</td>
<td>42.59</td>
</tr>
<tr>
<td>Mold Antiskid (in.)</td>
<td>.65</td>
<td>.67</td>
<td>.65</td>
</tr>
<tr>
<td>Loaded Radius (in.)</td>
<td>19.25</td>
<td>20.19</td>
<td>19.39</td>
</tr>
</tbody>
</table>

3.8 Weight Data

Tire and rim assembly weights were as follows:

<table>
<thead>
<tr>
<th></th>
<th>11.00-20</th>
<th>16-20</th>
<th>11.00-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tire</td>
<td>117#</td>
<td>158#</td>
<td>119#</td>
</tr>
<tr>
<td>Tube</td>
<td>10# 10 oz.</td>
<td>14# 6 oz.</td>
<td>10# 10 oz.</td>
</tr>
<tr>
<td>Flap</td>
<td>6# 0 oz.</td>
<td>8# 4 oz.</td>
<td>6# 0 oz.</td>
</tr>
<tr>
<td>Rim</td>
<td>73# 8 oz.</td>
<td>61# 0 oz.</td>
<td>73# 8 oz.</td>
</tr>
</tbody>
</table>
h. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions can be based on laboratory measurements, indoor testing and field testing information gained on this contract.

4.1 Phase I

1. The 11.00-20 integral tires performed better on indoor tests than tires previously supplied for field testing.

2. A definite improvement was realized in the 11.00-20 integral tires for circumferential splice opening and liner cracking resistance.

3. An advantage for tread wear traction and puncture resistance for the radial ply tires was indicated by the performance of the tires tested at Camp Bullis.

4. The 11.00-20 integral radial ply wire-belted tire showed a sidewall cracking deficiency during field testing; however, we believe this problem has been corrected.

4.2 Phase II

1. Indoor test results indicate that the 16-20 profile tire is more than adequate to meet the demands of the tire.

2. Based on the closed loop deflection curves, the radial ply tactical tires have a low hysteresis loss.

3. The radial ply wire-belted tires afford a more uniformly distributed load in the deflected area.

4. Indoor test results were very favorable for the replaceable tread tire.

5. It is recommended that the feasibility study of the replaceable tread concept be expanded to include the highway type tire.

6. It should be noted that the sidewall cracking resistance of the 16-20 low profile radial ply tire was greatly improved with a natural rubber neoprene veneer sidewall construction. We believe this type sidewall construction would have increased the sidewall cracking resistance of the 11.00-20 integral tires tested at Camp Bullis.
11.00-20
INTEGRAL TIRE SECTION
FIGURE 1
16-20
LOW PROFILE RADIAL PLY TIRE
FIGURE 2

12
16-20
LOW PROFILE RADIAL PLY TIRE SECTION
FIGURE 3
11.00-20
REPLACEABLE TREAD TIRE
FIGURE 4
11.00 20
REPLACEABLE TREAD AND CARCASS
FIGURE 5
11. 00–20
REPLACEABLE TREAD TIRE SECTION
FIGURE 6
MODIFIED SAFETY HUMP, SEMI-DROP CENTER RIM
20 x 12.00 for 16-20/10 P.R. NDCC RADIAL PLY LOW PROFILE TIRE

Figure 7
FIGURE 9
Inflation - 35 psi

Load 3750#

Deflection Curve for the
U. S. Royal Radial
Tactical Integral Tire
Nylon Carcass (6 Ply) Wire Belt
11.00-20/12P.R.

Figure 17
Closed Loop Load
Deflection Curve for the
16-20/10P.R. U.S. Royal Radial Tactical
Nylon Carcass (6Ply) Wire Belt

Figure 18
Load Deflection Curves
For the U.S. Royal Radial Tactical Integral Tire
Nylon Carcass (6 Ply)
Wire Belt
11.00-20/12 P.R.
Load Deflection Curves
For the 16-20/10P.R.
U.S. Royal Radial
Tactical Tire
Nylon Carcass (6 Ply)
Wire Belt

Vertical Load - Pounds

Deflection - Inches

Figure 21
U. S. Rubber Tire Co., Detroit, Michigan
Development of Tires for the New Family of Medium Tactical Trucks, R. A. Reichert/E. D. Rogers-ATAC
Final Report Phases I and II
Contract No. DA 20-018-AMC-0585T
Phase I - Field testing of the 11.00-20 tires under the direction of the Army Tank Automotive Center revealed a much improved performance over previous radial tires tested.
Phase II - Conduct a radial ply tire evaluation of the 16-20 size tire featuring a wide base, low profile tire design. Perform a feasibility study of the tire concept in the 11.00-20 size tire, using a radial ply carcass construction in combination with a removable tread.

U. S. Rubber Tire Co., Detroit, Michigan
Development of Tires for the New Family of Medium Tactical Trucks, R. A. Reichert/E. D. Rogers-ATAC
Final Report Phases I and II
Contract No. DA 20-018-AMC-0585T
Phase I - Field testing of the 11.00-20 tires under the direction of the Army Tank Automotive Center revealed a much improved performance over previous radial tires tested.
Phase II - Conduct a radial ply tire evaluation of the 16-20 size tire featuring a wide base, low profile tire design. Perform a feasibility study of the tire concept in the 11.00-20 size tire, using a radial ply carcass construction in combination with a removable tread.
1/8 DRILL THRU - 1 9/16"
1/8 DEEP, 4 HOLES 30
HALF EQUALLY SPACED

4.030 REF.
5.500
11.000

BOTTOM HALF
19 C BORE 5 BOTTOM
PAVED.

7 3/4

2

TOP HALF
F EACH PART THUS IN 2 PLACES
GRIND SCR. N. 2 PLY

1/2 DRILL - 1 3/8 DEEP
1/8 X 45° SHAMFER
2 HOLES EACH HALF.

-8 N.C. TAP - 1/2
DEEP 4 HOLES
TOP HALF.

PRY BLOCK
2 REDD ON EACH TREAD
RING SEGMENT

3
NOTE:
FOR CAVITY DETAILS SEE PROFILE DKG P.14991-B

27/64 DRILL THRU 5 C-MORE
8 HOLES EACH HALF.
(20.815 x 72° DRILL "JIG."
*F. 3988)

ON A-A

SIZE

<table>
<thead>
<tr>
<th>STEEL</th>
<th>12</th>
<th>WELD TO SEGMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEAL PLATE CASTING</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>EL PLATE</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>EC</td>
<td>1</td>
<td>WELD OR CAST ON</td>
</tr>
<tr>
<td>EL PLATE CASTING</td>
<td>6</td>
<td>PATTERN *T.5655</td>
</tr>
</tbody>
</table>
RING SEGMENT

DETAIL OF TREAD RING SEGMENT. ITEM NO. 1

CHORD = 12520
ARC = 20.441

PLAN VIEW SHOWING STAMPING ASSEMBLY

STAMP SEGMENT MATCH NA WITH 1/2 FIGURES ON TREAD SEGMENTS
Plan View
3/8 Size

1/16 Drill Thru-1" C'BoRE
1/2 Deep-G Holes

Section B-B
1/4 Size

These holes used for bolting to rings shown on M-EG80-E

UNITED STATES RUBBER COMPANY
CENTRAL RUBBER SERVICES
DETROIT - MICHIGAN

1100-20 Final Mold

Segmented Tread

Machining DWG.

FOR 55 & 65 M'NEN

NOTICE
Construction and method of manufacturing this tire may be revised by one or more of the following processes:
• 3055 M'NEN, 3300 M'NEN, 3307 M'NEN, 3700 M'NEN, 3707 M'NEN
ACH RING THUS IN 2 PLACES.
NO. SER. NO. PLY

FIT TO MOLD BACK.

BREAK ALL EDGES AT REGISTER

12° 1

10°

30°

12° 0.25 x 45°

30°

5°

TOP HALF
1/4 DRILL - 7/8 DEEP
1/8 x 45° CHAMFER
2 HOLES EACH HALF

3/8 - 11 N.C. TAP - 7/8 DEEP
5 HOLES TOP HALF ONLY.

WELD ALL AROUND

1/16 DRILL THRU
MATERIAL: STEEL PLATE
**For Match Up Purposes**

**Notice**

Construction and method of manufacturing tests have been carried out in accordance with the following patents:

- Patent No. 2,345,678
- Patent No. 3,456,789
- Other patents pending

**United States Rubber Company**

Central Mold Division

Detroit - - Michigan

1100-70 Tread Rings (Carcass)

For use in M-2679-R

(55" & 65" McNeil Only)

**Reference**

M-2680 R

**Drawn by**

**Checked by**

**Superseded by**

**Date Started**

**Date Finished**

**Approved by**

**Reference**

**Mold DWG.**
12 VENTS 1ST ROW.
STAGGER 10 VENTS
IN 2ND ROW WITH
BOTTOM ROW AS
SHOWN

12 VENTS EQUALLY
SPACED IN LINE
WITH BOTTOM ROW.

UNITED STATES RUBBER COMPANY
DETOIT - MICHIGAN

VENTING P.O.
455 ROYAL TACT;
AL EXPERIMENTAL

NOTE: OMIT ALL VENTS WHICH FALL INTO LETTERING
SPECIFICATIONS FOR DRILLED VENTS.
NO. 90 (Q70) 0.10 IN. DRILL - BREAK SHARP
EDGE ON CAVITY SIDE WITH 1/64 X 45° CHAMFER.
TREAD VENTS MUST BE RADIAL ± 10°.
ALL SIDEWALL VENTS MUST BE PERPENDICULAR
TO PARTING LINE OF MOLD
STANDARD VENT PATTERN - ANY PORTION MAY BE
ILLUMINATED AT LOCAL PLANT DISCRETION.
16 vents equally spaced, both halves

Top half
DECIMAL DIMENSIONS ± .005
FRACTIONAL DIMENSIONS ± 1/8
EXCEPT WHERE NOTED.
Slot & Plate for Brand
Name - Change per Shop
Order Ref: L-2400-R

Toe Ring No T-779
T.W. = 72.5% or 11.47
T.R. = 150% or 11.47
P.H. = 10.589
P.S. = 11.600
Rim Fit = 7.5 A.D.Y. (Tight)

![Diagram](image_url)
T.W. = 72.5% or 11.47

TR. = 150% or 11.47

RM FIT = 75 A.M. (Tight)
SECT A-A
(ENLARGED)

MAST PLATE
NO US 7404
(BOTTOM HALF ONLY)

Screwed in serial tin
(B.O.M. press)
SEE DWG. L 29061 J

FRONT OF MOLD

U.S. RUBBER

U.S.R.
THE WORD "U.S. ROYAL" MUST APPEAR DIAMETRICALLY OPPOSITE IN TWO

ALL LETTERING IN MOLD IS LEFT HAND, MAX. DEPTH = .031

ALL PITCHES TAKEN AT TOP OF LETTERS AND FIGURES
All must appear diametrically opposite in two halves of mold

Mold is left hand, max. depth = .031

Open at top of letters and figures

Screwed in serial Tin (W5 metal press)

See Dwg. L-2914-1

Top half

U.S. Royal 4
16 VENTS EACH ROW
EQUALLY SPACED
STAGGER AS SHOWN

SHOULDER EDGE

SAME ALL VENTS WHICH FALL INTO LETTERS
SPECIFICATIONS FOR SCHEDULED VENTS

16 VENTS EACH ROW
EQUALLY SPACED & STAGGERED

STAGGER AS SHOWN

SHOULDER EDGE
THIS IS A TREAD VIEW OF THE TIRE.
ALL DIMENSIONS SHOWN ARE DEVELOPED.
TEMPLETS:
#US 54566 CAVITY SHAPE & CENTER RIB
54567 TREAD DESIGN

20.062 DIA. BAR GA #US 10611-B
<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. P.</td>
<td>8.00</td>
</tr>
<tr>
<td>T. W.</td>
<td>73.02% of 15.75</td>
</tr>
<tr>
<td>T. R.</td>
<td>97.14% of 15.75</td>
</tr>
<tr>
<td>D.H.</td>
<td>11.274</td>
</tr>
<tr>
<td>C.S.</td>
<td>15.300 = .737</td>
</tr>
<tr>
<td>RIM FIT</td>
<td>W-14L</td>
</tr>
<tr>
<td>N/G</td>
<td>61.9%</td>
</tr>
<tr>
<td>TOE RING NO.</td>
<td>7-1854</td>
</tr>
<tr>
<td>VENTING DWG. NO.</td>
<td>LV-3169 R</td>
</tr>
<tr>
<td>MODEL NO.</td>
<td></td>
</tr>
</tbody>
</table>

**United States Rubber Company**

**Detroit - Michigan**

**16-20 U.S. Royal**

**Tactical C.C**

**Type "D"**

---

**Dev. ER Add Lettering/Peeling**

**DATE**

**REF.**

**CHANGE**

**MOLDO DIVISION**

**SCALE = FULL**

**D-110107**