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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|---------------------------------------|
| <b>NAVISTAR, INC.</b>                                                                                                                                                                                                                                                                                                                   |                                  |                                       |
| <b>Material, Parts, and Process Specifications<br/>(MPAPS)</b>                                                                                                                                                                                                                                                                          |                                  | NUMBER:<br><b>MPAPS F-6034</b>        |
|                                                                                                                                                                                                                                                                                                                                         |                                  | Former Designation: <b>TMS-6034</b>   |
| TITLE:<br><b>Charge Air Cooler (CAC)/Turbo Hose</b>                                                                                                                                                                                                                                                                                     |                                  | CURRENT REV No.:<br><b>1702</b>       |
|                                                                                                                                                                                                                                                                                                                                         |                                  | DATE:<br><b>Feb. 2017</b>             |
| WRITTEN/EDITED BY:<br><b>M. Ghaddar</b>                                                                                                                                                                                                                                                                                                 | APPROVED BY:<br><b>R. Goluch</b> | SUPERSEDES:<br><b>1510 – Oct 2015</b> |
| <b>PRINTED COPIES OF THIS DOCUMENT MUST BE VERIFIED FOR CURRENT REVISION</b>                                                                                                                                                                                                                                                            |                                  |                                       |
| <i>This specification may involve hazardous materials, equipment, and procedures. This specification does not purport to address all of the safety issues associated with its use. The user is responsible to consult appropriate safety and health practices and to determine the applicability of regulatory limits prior to use.</i> |                                  |                                       |

## 1.0 APPLICATION

This specification covers different types of hoses used in engine turbo CAC systems. The hoses are used as connectors between the turbocharger, the charge air cooler, and the engine. Selection of the type shall be made by Materials Engineering.

## 2.0 SCOPE

This specification covers construction, property requirements, dimensional tolerances, identification, source approval and quality control for the several types of hose connectors used in the CAC system.

**NOTE:** *Successful design of the connections between the turbocharger, charge-air-cooler and the engine, requires careful consideration of the length, alignment, rigidity, and spacing of the elements that comprise the joint. Straight turbo hoses should be used for connectors. Curves and elbows should be designed into the metal pipes or other components whenever possible. See Section A.0 on DESIGN GUIDANCE.*

## 2.1 Restricted Chemical Substances

Effective January 1, 2007, all product supplied to the requirements of this specification must comply with the requirements of the MPAPS B-50 specification.

## 3.0 REFERENCE DOCUMENTS

Unless otherwise specified\* the latest issue of all referenced standards shall apply. The following Specifications, Standards, and Regulations are referenced in this specification.

|                                                     |                            |             |
|-----------------------------------------------------|----------------------------|-------------|
| Quality System Standard <i>ISO 9001 or TS-16949</i> | MPAPS DT-15                | ASTM D 1418 |
| NAVISTAR Supplier Packing and Shipping Std. D-13    | MPAPS P-9543               | ASTM D 2240 |
| NAVISTAR Eng. Design Std. A-16                      | MPAPS F-2                  | ASTM D 865  |
| NAVISTAR Eng. Dwg. PT12-16751                       | CFR Title 29, Section 1910 | ASTM D 395  |
| NAVISTAR MPAPS A-37                                 | ASME Y14.5M-1994*          | ASTM D 1171 |
| NAVISTAR MPAPS D-28                                 | ASTM D 380                 | ASTM D 2137 |
| NAVISTAR MPAPS F-1058                               | ASTM D 412                 | ASTM D 2000 |
| NAVISTAR MPAPS C-1059                               | ASTM D 413                 | SAE J20     |
| NAVISTAR MPAPS F-1                                  | ASTM D 471                 | SAE J30     |
| NAVISTAR MPAPS GT-31                                | ASTM D 624                 |             |

*\*Conformance to the 1994 version of ASME Y14.5M is required*

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## 4.0 GENERAL REQUIREMENTS

Unless otherwise specified all tests will be performed per SAE J20 and indicated ASTM Test Methods.

### 4.1 Classification and Construction

Grade designations are used to specify the application in the system and the allowed materials that can be used to meet those requirements. Suffix designations are used to specify the manufacturing method used to make the hose; the reinforcement fibers allowed; additional oil resistance required and higher heat or pressure requirements beyond the basic levels.

#### 4.1.1 Grades

**4.1.1.1 Grade C** – This grade of hose is used after the air cooler and in the part of the system considered the “cold” side of the charge-air-cooler system. The tube and cover stocks should typically be made to conform to Suffix R and should be made from chlorinated polyethylene (CPE), chlorosulfonated polyethylene (CSM,) or epichlorohydrin (ECO). If oil resistance is not required, then the tube and cover stocks shall be made from ethylene-propylene-diene (EPDM), similar to SAE J20 20R4 Class D-1. The cover shall be non-blooming. Polysiloxane elastomers may be used in place of EPDM if necessary. Polysiloxanes are acceptable for use on systems that are designed to recirculate oil and fuel vapors. Unless modified by other suffix call-outs, this grade of hose shall be rated to 125°C (257°F) and 345 kPa gauge (50 psig), suffix N. Polysiloxane elastomers with fluoro elastomer barriers may be used if other materials and manufacturing methods cannot meet the performance requirements of this specification.

**4.1.1.2 Grade H** – This grade covers hose used after the turbo charger and before the air-to-air cooler in the section of the system considered as the “hot” side of the charge air cooler. The tube and cover stocks should typically be made to conform to Suffix R which will usually require the use of fluoro elastomer barriers or other compound variations to meet both the temperature and the oil resistance required. If oil resistance is not required the tube and cover shall be made from polysiloxane elastomers. This grade of hose shall be rated to a minimum of 249°C (480°F), (260°C (500°F) suffix Y is encouraged), and 345 kPa gauge (50 psig), suffix N.

#### 4.1.2 Suffix Letters

**4.1.2.1 Suffix A** – Straight or formed hose reinforced with wrapped plies of woven cord nylon (Grade C only), polyester (Grade C only) or aramid fabric.

**4.1.2.2 Suffix B** – Preformed hose with ply or plies of lockstitch knitted aramid (blend of para and meta aramids for high fatigue performance) yarn. Design and application should be thoroughly tested to ensure a durable assembly.

**4.1.2.3 Suffix M (Obsolete)** – Mid high pressure rating to 210 kPa gauge (30 psig). **(Not for use in future designs)**

**4.1.2.4 Suffix N (Must be selected for all hoses)** - High pressure rating to 345 kPa gauge (50 psig).

**4.1.2.5 Suffix R** – Required for systems utilizing a closed breather system or any other method of introducing oil to the air stream. Must use oil resistant unless test data shows that negligible oil will be introduced by the turbocharger under all expected operating profiles.

**4.1.2.6 Suffix X (Obsolete)** – Temperature rating to 249°C (480°F). **(Not for future use since suffix H already meets 480°F.)**

**4.1.2.7 Suffix Y** – Temperature rating to 260°C (500°F)

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## **4.2 Stainless Steel Spring Insert or Construction Rings**

**4.2.1** Unless otherwise specified on the engineering drawing, a steel spring insert or rings may be used to insure compliance with the "Vacuum Collapse" or "Hot Swell" requirement of this specification. Under certain circumstances, a thermoplastic (glass filled nylon) may be appropriate for this application. Use of the insert, rings, or thermoplastic shall be approved by Materials Engineering.

**4.2.2** Unless otherwise specified, the steel spring insert shall be formed from a wire having a minimum diameter of 1.57 mm (a larger diameter wire may be used at the supplier's discretion). The spring shall exhibit a 25 mm pitch (a pitch of up to 35 mm is acceptable with larger diameter wire) and an OD approximately 3.0 mm less than the nominal ID of the hose. The wire shall be 300 series stainless steel, full hard, as per MPAPS A-37. The length of the spring shall be such that a minimum of 60 mm of free hose length remains on each end of the hose for ease of assembly and clamping.

## **4.3 Property and Performance Requirements - Elastomer**

Elastomer designation is as per ASTM D 1418 except where otherwise indicated. See Tables 1a and 1b for material property requirements.

### **4.3.1 Hardness – Durometer**

Measure hardness per ASTM D 2240, Type A. Initial and nominal hardness values shall be stated on qualification report. Material shall be controlled to within  $\pm 5$  points of nominal while the material is in production unless it is re-qualified to another value. Aging test values shall be measured as change from initial as listed in Tables 1a and 1b.

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**TABLE 1a – PROPERTIES OF TUBE AND COVER – Grade C**

| PROPERTIES OF TUBE AND COVER                                                                                      | TEST METHOD (ASTM) | TUBE AND COVER Grade C EPDM | TUBE AND COVER Grade C VMQ | TUBE AND COVER Grade C-R CM (CPE) | TUBE AND COVER Grade C-R VMQ | TUBE BARRIER Grade C-R FVMQ |
|-------------------------------------------------------------------------------------------------------------------|--------------------|-----------------------------|----------------------------|-----------------------------------|------------------------------|-----------------------------|
| POLYMER                                                                                                           | D1418              | EPDM                        | VMQ                        | CM (CPE)                          | VMQ                          | FVMQ                        |
| <b>ORIGINAL PROPERTIES:</b>                                                                                       |                    |                             |                            |                                   |                              |                             |
| TENSILE STRENGTH, MPA (PSI)                                                                                       | D412, DIE C        | 7.0(1015)                   | 6.0(870)                   | 11(1595)                          | 6.0(870)                     | 6.0(870)                    |
| ELONGATION, PERCENT MIN                                                                                           | D412, DIE C        | 250                         | 250                        | 180                               | 250                          | 250                         |
| 25% MODULUS, MPa (PSI), MIN                                                                                       | D412, DIE C        | Report*                     | Report*                    | Report*                           | Report*                      | Report*                     |
| 100% MODULUS, MPa (PSI), MIN                                                                                      | D412, DIE C        | Report*                     | Report*                    | Report*                           | Report*                      | Report*                     |
| TEAR RESISTANCE, kN/m (LBF/in), MIN                                                                               | D624, DIE B        | 17.5(100)                   | 12 (68)                    | 15.7(90)                          | 12 (68)                      | 15 (85)                     |
| <b>HEAT AGING CONDITIONS AND CHANGE LIMITS</b>                                                                    |                    |                             |                            |                                   |                              |                             |
| HOURS EXPOSURE                                                                                                    | D573               | 168                         | 168                        | 168                               | 168                          | 168                         |
| TEMPERATURE, C (F)                                                                                                | D573               | 135(275)                    | 135(275)                   | 120(248)                          | 135(275)                     | 120(248)                    |
| HARDNESS, DUROMETER, SHORE A                                                                                      | D2240              | 0 to 18                     | 0 to 10                    | 0 to 20                           | 0 to 10                      | 0 to 10                     |
| TENSILE STRENGTH, % MAX                                                                                           | D412, DIE C        | -35                         | -35                        | -20                               | -35                          | -35                         |
| ELONGATION, % MAX                                                                                                 | D412, DIE C        | -65                         | -65                        | -60                               | -65                          | -65                         |
| 25% MODULUS, % MAX                                                                                                | D412, DIE C        | Report*                     | Report*                    | Report*                           | Report*                      | Report*                     |
| 100% MODULUS, % MAX                                                                                               | D412, DIE C        | Report*                     | Report*                    | Report*                           | Report*                      | Report*                     |
| TEAR RESISTANCE, % MAX                                                                                            | D624, DIE B        | Report                      | Report                     | Report                            | Report                       | Report                      |
| <b>HEAT AGING, 1000 HOURS</b>                                                                                     |                    |                             |                            |                                   |                              |                             |
| TEMPERATURE, C (F)                                                                                                | D573               | 100(212)                    | 100(212)                   | 100(212)                          | 100(212)                     | 100(212)                    |
| ELONGATION, % MIN                                                                                                 | D412, DIE C        | 120                         | 120                        | 120                               | 120                          | 120                         |
| HARDNESS, MAX                                                                                                     | D2240              | 90                          | 90                         | 90                                | 90                           | 90                          |
| <b>PROPERTIES AFTER IMMERSION IN CEMS B-21 15W-40 Engine oil (P/N 2643576R1, Shell Rimula Premium IFF, 54267)</b> |                    |                             |                            |                                   |                              |                             |
| HOURS                                                                                                             | D471               | N/A                         | N/A                        | 70                                | 70                           | 70                          |
| TEMPERATURE, C (F)                                                                                                | D471               | N/A                         | N/A                        | 120(248)                          | 120(248)                     | 120(248)                    |
| HARDNESS, DUROMETER, SHORE A                                                                                      | D2240              | N/A                         | N/A                        | ±25                               | ±25                          | ±25                         |
| TENSILE STENGTH, % MAX                                                                                            | D412, DIE C        | N/A                         | N/A                        | -50                               | -50                          | -50                         |
| ELONGATION, % MAX                                                                                                 | D412, DIE C        | N/A                         | N/A                        | -60                               | -60                          | -60                         |
| 25% MODULUS, % MAX                                                                                                | D412, DIE C        | N/A                         | N/A                        | Report*                           | Report*                      | Report*                     |
| 100% MODULUS, % MAX                                                                                               | D412, DIE C        | N/A                         | N/A                        | Report*                           | Report*                      | Report*                     |
| TEAR RESISTANCE, % MAX                                                                                            | D624, DIE B        | N/A                         | N/A                        | Report*                           | Report*                      | Report*                     |
| VOLUME CHANGE, shrink/swell, %                                                                                    | D471               | N/A                         | N/A                        | -10 TO +70                        | -10 TO +70                   | -3 TO +10                   |
| <b>OTHER PROPERTIES</b>                                                                                           |                    |                             |                            |                                   |                              |                             |
| <b>COMPRESSION SET</b>                                                                                            |                    |                             |                            |                                   |                              |                             |
| HOURS                                                                                                             |                    | 70                          | 70                         | 70                                | 70                           | 70                          |
| TEMPERATURE C (F)                                                                                                 |                    | 100(212)                    | 100(212)                   | 100(212)                          | 100(212)                     | 100(212)                    |
| PERCENT MAX, PLIED                                                                                                | D395               | 25                          | 25                         | 90                                | 25                           | 25                          |
| OZONE RESISTANCE (COVER ONLY) – 100MPa partial pressure, RATING %                                                 | D1149 Method A     | 100                         | 100                        | 100                               | 100                          | N/A                         |
| LOW-TEMPERATURE RESISTANCE, NONBRITTLE AFTER 3 MINUTES AT: [°C]                                                   | D2137 METHOD A     | -40                         | -40                        | -40                               | -40                          | -40                         |

\* Report value determined in qualification and validation testing.  
N/A – not applicable

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**TABLE 1b – PROPERTIES OF TUBE AND COVER – Grade H**

| PROPERTIES OF TUBE AND COVER                                                                                      | TEST METHOD (ASTM) | TUBE AND COVER Grade H (H-X <sup>†</sup> ) | TUBE BARRIER Grade H-R (H-RX <sup>†</sup> ) | TUBE AND COVER Grade H-Y** | TUBE BARRIER Grade H-RY** |
|-------------------------------------------------------------------------------------------------------------------|--------------------|--------------------------------------------|---------------------------------------------|----------------------------|---------------------------|
| POLYMER                                                                                                           | D1418              | VMQ                                        | FKM                                         | VMQ                        | FKM                       |
| <b>ORIGINAL PROPERTIES:</b>                                                                                       |                    |                                            |                                             |                            |                           |
| TENSILE STRENGTH, MPA (PSI)                                                                                       | D412, DIE C        | 6.0(870)                                   | 7.0(1015)                                   | 6.0(870)                   | 7.0(1015)                 |
| ELONGATION, PERCENT MIN                                                                                           | D412, DIE C        | 250                                        | 175                                         | 250                        | 175                       |
| 25% MODULUS, MPa (PSI), MIN                                                                                       | D412, DIE C        | Report*                                    | Report*                                     | Report*                    | Report*                   |
| 100% MODULUS, MPa (PSI), MIN                                                                                      | D412, DIE C        | Report*                                    | Report*                                     | Report*                    | Report*                   |
| TEAR RESISTANCE, kN/m (LBF/in), MIN                                                                               | D624, DIE B        | 12 (68)                                    | 15 (85)                                     | 12 (68)                    | 15 (85)                   |
| <b>HEAT AGING CONDITIONS AND CHANGE LIMITS</b>                                                                    |                    |                                            |                                             |                            |                           |
| HOURS EXPOSURE                                                                                                    | D573               | 168                                        | 168                                         | 168                        | 168                       |
| TEMPERATURE, C (F)                                                                                                | D573               | 249(480)                                   | 249(480)                                    | 260(500)                   | 260(500)                  |
| HARDNESS, DUROMETER, SHORE A                                                                                      | D2240              | 0 to 15                                    | 0 to 15                                     | 0 to 15                    | 0 to 15                   |
| TENSILE STRENGTH, % MAX                                                                                           | D412, DIE C        | -35                                        | Report*                                     | Report*                    | Report*                   |
| ELONGATION, % MAX                                                                                                 | D412, DIE C        | -45                                        | Report*                                     | Report*                    | Report*                   |
| 25% MODULUS, % MAX                                                                                                | D412, DIE C        | Report*                                    | Report*                                     | Report*                    | Report*                   |
| 100% MODULUS, % MAX                                                                                               | D412, DIE C        | Report*                                    | Report*                                     | Report*                    | Report*                   |
| TEAR RESISTANCE, % MAX                                                                                            | D624, DIE B        | Report                                     | Report                                      | Report                     | Report                    |
| <b>HEAT AGING, 1000 HOURS</b>                                                                                     |                    |                                            |                                             |                            |                           |
| TEMPERATURE, C (F)                                                                                                | D573               | 249(480)                                   | 249(480)                                    | 260(500)                   | 260(500)                  |
| ELONGATION, % MIN                                                                                                 | D412, DIE C        | 120                                        | 120                                         | Report*                    | Report*                   |
| HARDNESS, MAX                                                                                                     | D2240              | 90                                         | 90                                          | Report*                    | Report*                   |
| <b>PROPERTIES AFTER IMMERSION IN CEMS B-21 15W-40 Engine oil (P/N 2643576R1, Shell Rimula Premium IFF, 54267)</b> |                    |                                            |                                             |                            |                           |
| HOURS                                                                                                             | D471               | 70                                         | 500                                         | 70                         | 500                       |
| TEMPERATURE, C (F)                                                                                                | D471               | 150 (302)                                  | 150 (302)                                   | 150 (302)                  | 150 (302)                 |
| HARDNESS, DUROMETER, SHORE A                                                                                      | D2240              | -30                                        | Report*                                     | -30                        | Report*                   |
| TENSILE STENGTH, % MAX                                                                                            | D412, DIE C        | -40                                        | Report*                                     | -40                        | Report*                   |
| ELONGATION, % MAX                                                                                                 | D412, DIE C        | -30                                        | Report*                                     | -30                        | Report*                   |
| 25% MODULUS, % MAX                                                                                                | D412, DIE C        | Report*                                    | Report*                                     | Report*                    | Report*                   |
| 100% MODULUS, % MAX                                                                                               | D412, DIE C        | Report*                                    | Report*                                     | Report*                    | Report*                   |
| TEAR RESISTANCE, % MAX                                                                                            | D624, DIE B        | Report*                                    | Report*                                     | Report*                    | Report*                   |
| VOLUME CHANGE, shrink/swell, %                                                                                    | D471               | +40%                                       | -3 TO +10                                   | +40%                       | -3 TO +10                 |
| <b>OTHER PROPERTIES</b>                                                                                           |                    |                                            |                                             |                            |                           |
| COMPRESSION SET                                                                                                   |                    |                                            |                                             |                            |                           |
| HOURS                                                                                                             |                    | 70                                         | 70                                          | 70                         | 70                        |
| TEMPERATURE C (F)                                                                                                 |                    | 150(302)                                   | 150(302)                                    | 150(302)                   | 150(302)                  |
| PERCENT MAX, PLIED                                                                                                | D395               | 50                                         | 50                                          | 50                         | 50                        |
| OZONE RESISTANCE (COVER ONLY) – 100MPa partial pressure, RATING %                                                 | D1149<br>Method A  | 100                                        | N/A                                         | N/A                        | N/A                       |
| LOW-TEMPERATURE RESISTANCE, NONBRITTLE AFTER 3 MINUTES AT: [°C]                                                   | D2137 METHOD A     | -55                                        | -25                                         | -25                        | -25                       |

\* Report value determined in qualification and validation testing.

\*\*Suffix Y requirement is currently being developed.

† Suffix X is obsolete for new Drawings

N/A – not applicable

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