Western Maine Transportation Services
Review and Analysis
of the
Maintenance Department and Buses

December 2013

Halsey King and Associates, Inc.
Carlsbad, CA
# INDEX

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>3</td>
</tr>
<tr>
<td>Scope of Work</td>
<td>3</td>
</tr>
<tr>
<td>Methodology</td>
<td>3</td>
</tr>
<tr>
<td>On-Site Inspections</td>
<td>4</td>
</tr>
<tr>
<td>Verbal Recommendations</td>
<td>4</td>
</tr>
<tr>
<td>Visual Bus Inspections</td>
<td>6</td>
</tr>
<tr>
<td>Records</td>
<td>7</td>
</tr>
<tr>
<td>Regulations</td>
<td>9</td>
</tr>
<tr>
<td>Parts</td>
<td>10</td>
</tr>
<tr>
<td>Training</td>
<td>12</td>
</tr>
<tr>
<td>Part Two –</td>
<td></td>
</tr>
<tr>
<td>Supporting Documentation</td>
<td>15</td>
</tr>
<tr>
<td>Altoona Issues</td>
<td>28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Service Life</td>
<td></td>
</tr>
<tr>
<td>5.1 Normal Operation</td>
<td></td>
</tr>
<tr>
<td>1.2 Completeness</td>
<td></td>
</tr>
<tr>
<td>1.3 Materials</td>
<td></td>
</tr>
<tr>
<td>4.0 Service Life Maintenance</td>
<td></td>
</tr>
<tr>
<td>4.2 Repair Ability</td>
<td></td>
</tr>
<tr>
<td>12.2 Strength and Fatigue Life</td>
<td></td>
</tr>
<tr>
<td>12.5 Corrosion</td>
<td></td>
</tr>
</tbody>
</table>
**INTRODUCTION**

On September 13, 2013, Halsey King and Associates, Inc. was engaged by Western Maine Transportation Services (WMTS) and Lewiston Auburn Transit Committee (LATC) to provide a review and recommendation of the bus fleet located at 76 Merrow Road, Auburn, Maine. The fleet, which is maintained here, provides transit and paratransit service to the local and surrounding area.

**SCOPE OF WORK**

Halsey King and Associates, Inc., in their proposal included a review of the overall fleet maintenance management element, including:

- A review of the fleet records
- A review of the facilities and equipment
- A visual inspection of up to 25 percent of the fleet
- Interviews and discussions with staff
- Development of a draft and final report

This report is based upon information provided by WMTS staff, Blue Bird, U.S. Department of Transportation, Federal Transit Administration (FTA), Altoona reports, the Society of Automotive Engineers (SAE), and other FTA-funded fleets. This technical specification and information report contains three major parts: 1) the main report with findings and recommendations; 2) supporting documentation on technical systems and component issues, and; 3) addendums.

**METHODOLOGY**

Halsey King and Associates, Inc. traveled to the WMTS location and held a kick-off meeting, inspected buses, interviewed staff, and held an exit meeting. Following that, HKA developed a draft report with findings and recommendations. A final report is to be delivered within thirty
(30) days of the draft. While this methodology was being implemented, it became apparent after the inspection of two WMTS fixed route low-floor buses that other more pressing issues existed with WMTS, their client agency, and the buses as manufactured by Thomas and Blue Bird. While there were other issues related to operations, a number of issues centered around bus inspection, repair, P.M. service, and record management processes, and these same issues were noted and investigated by a private consultant working for the Maine Department of Transportation (DOT). The Maine DOT, as we understand it, then reported its findings to the Federal Transit Administration. These actions are well understood and apparently follow protocol as we understand it to be, but the report did not address what appears to be design issues with the low-mounted steering links and front air brake lines on the Blue Bird low-floor buses, or the massive rust issues on critical framing and support structures of the SLF buses.

While this finding did not impair our work schedule with the client, we tried to stay within the remainder of the work scope, short of the percentage of buses inspected.

**ON-SITE INSPECTION**

Immediately following the kick-off meeting with management, I toured the shop and held discussions with the shop technicians. There appeared to be some frustration among the staff, and it was aimed directly at two of the fleet’s transit style buses: the SLF and Blue Birds. Apparently, these buses are consuming man hours, parts, and the P.M. programs schedule far greater than anticipated. Awaiting parts for weeks, late returns from dealerships where repairs were being done, and repeated systems failures have become somewhat the normal.

**INITIAL VERBAL RECOMMENDATIONS**

I proceeded to discuss the history of the fleet, the P.M. program, repair and inspection processes, roadcall activity, the facilities, and records with key staff and the technicians. I also made verbal recommendations that:
• The shop needs to be cleaned of old (and rebuildable) parts

• WMTS should establish a U.S. DOT type inspection area, complete with a reflective floor and lights (to see frame cracks), and large parabolic mirrors at the front and rear of the inspection area (to check all bus lights from the driver’s seat)

• WMTS should purchase and put to use an electronic brake stopping meter during P.M. services and also use it to train drivers. (If done properly, this meter can cut the cost of brake maintenance and put “halo’s around” the bus drivers).

• Begin a post P.M. service check-off program to ensure that the bus has been tested before it is put back onto the ready line for passenger service. A sample of this form was sent to the shop manager, and discussions on its application into the WMTS preventive maintenance program will follow.
VISUAL BUS INSPECTIONS

While on-site I started to visually inspect buses in the garage where they sat.

- I started with bus #38 with its 201,496 miles and found the following:
  - ✔ Brake pedal rubber pad needs replacement
  - ✔ The driver’s seat belt needs replacement
  - ✔ Body rust issues

- I reviewed bus #72 with its 102,795 miles and found the following:
  - ✔ Bolts rusty on chassis
  - ✔ Pins worn at the back of pax seats
  - ✔ Console between seats is loose
  - ✔ Dome lights not working
  - ✔ Rear air conditioning housing is loose
  - ✔ Barrel locks on a door marked “emergency exit”

- SLF bus #0201
  - ✔ Interior needs cleaning
  - ✔ Frame and components are so heavily corroded from rust that it’s my opinion this bus may be illegal to operate under CFR 49 Parts 393, 201 (a)(b)
  - ✔ The bus wiring on SLF0201 may be in violation of CFR 49 Part 393.28 (wiring to be protected). This bus had apparently just returned from a dealership after being there for several weeks.
  - ✔ Electrical grounds appear to be small, in the least appropriate location and are causing electrical system problems

- Blue Bird #601
  - ✔ There are undeniable rust and corrosion issues with the treated steel sub-frame of this bus, which is just at its half-life (of the twelve year FTA requirement)
  - ✔ This bus along with the other three are experiencing many of the component failures that were outlined as “unscheduled maintenance repairs” in the Altoona Report, and these same failures are occurring with four other FTA funded fleets all the way west to California, south to Louisiana, and in Oklahoma, as reported to staff.
Next, we began to look at the overall P.M. program and records that WMTS keeps on location. This was done with the knowledge of the findings and recommendations that the Maine DOT consultant had submitted to others and back to WMTS.

The bus fleet maintenance records provide schedule, cost, and organizational management for all department activities. They also become legal documents in cases where death and injury occurs. The Federal Motor Carrier Safety Administration, the State DOT, and the FTA all require that fleets maintain records of service, inspection, major repair, and recalls. Records include all paperwork that circulates within the operations/dispatch office and the maintenance department. The forms for these papers must be designed around CFR 49, CFR 396.3 to 396.21, and the records can be maintained electronically. Most fleets try to ensure that their fleet records are an accurate reflection of their fleet’s true condition, which at times can be extremely difficult. Broken speedometers, incorrect mileage entry by drivers, mechanics and fuelers, change out of axle hub meters to dash speedometers, can all wreak havoc with the fleet records on a day-to-day basis. It can also become most confusing when a fleet uses a bad computer software program and hard-copy reports to make accurate comparisons, long after the work was completed. The FTA requires that all buses be serviced within the 80/20 rule. That means that 80 percent of bus records reviewed must meet the WMTS allowable window. For example, with WMTS P.M. program plan for their large buses set at 5,000 miles, the 20 percent rule would allow P.M.’s to be within the schedule at 6,050 miles. There is no penalty for early P.M.’s conducted.

It has been said that at least fifty-percent of the nation’s public and private fleets are experiencing accuracy issues with their fleet records at any given time (California Highway Patrol 2012 at Los Angeles). However, private fleets continue to work at achieving a ninety-five percent accuracy level. WMTS apparently fits into this group, and is working to make data accurate at this time.
Findings

According to the consultant’s report, WMTS must comply with the state DOT on all record retentions that DOT requests. As we understand it, this is being addressed.

- In a brief review, HKA found that some of the maintenance records were in fact askew
- WMTS now has three people working on cleaning up the records discrepancies
- HKA also is acutely aware of the parts and repair cost of the Blue Bird and SLF buses within the fleet, as gleaned from these records.

Recommendations

HKA has begun to see an improvement in records accuracy since the September visit.

- Keep staff on the point of ensuring that records are brought up to date
- Keep working with DOT representatives when they are at WMTS, and available to get their input on the means and ways the records are being cleaned up and keep them involved with the process
- Discuss with DOT representatives the amount and cost of repairs, parts, towing, and bus change-outs involving the Blue Birds and SLF buses. This will address the last bullet point of the consultant’s report.
- **UPDATE:** As of November 29, 2013, WMTS through their discussions and work with new DOT representatives believe they are at the accepted range of FTA’s 80/20 percent of PMI’s completed.
REGULATIONS

All bus fleets in the USA are virtually swimming in regulation. Some of these regulations that typically impact the maintenance department are:

- **FTA** maintenance plan, bus specific inspection and service (PM) facilities, maintenance reporting
- **State Departments of Transportation** (most states have their own bus regulations in addition to the above)
- **Americans with Disabilities Act** with regard to inspection, repair of the bus mobility equipment, lift, belts, heater, steps, lights
- **US EPA** for emission controls, chemicals on-site, any HazMat on-site, and lot runoff, and the newest one coming at public bus fleets FTA “Safety and Security.”
- **National Highway Traffic Safety Administration** (which investigates manufacturing defects)

**Findings**

- As we understand it, the DOT consultant has been holding classes on-site at WMTS covering CFR 49 Parts 396, which deals with inspection, repair, and maintenance. This also has become a part of the remedial recommendation passed on to FTA.
- HKA did not, however, uncover any special training regarding Parts CFR 49 Parts 393, “Parts and accessories necessary for safe operation.” This part deals with the critical inspection areas, such as systems and components that techs need to look at, including:
  - Wiring to be protected
  - Brake hoses to be protected
  - Frame rust and cracks
  - Steering components to operate freely
Recommendations

- HKA sincerely believes that having WMTS employees trained in the CFR is appropriate and appreciated. Our experience with fleets in 43 states shows that most employees are unaware of their obligations and responsibilities under these regulations. Keep it up! However, I believe that Part 393 should also be a part of the training effort.
- Currently, maintenance techs point out violations of the CFR as soon as some buses return to the shop with a sticker applied from the contracted inspector. Maine DOT should be notified of the condition of these buses as they return from the inspection contractor.
- More attention should be placed on inspection of bus framing, cross-members, gusset plates and attachments on and under the bus floor. As also outlined as an industry best practice, a chipping hammer should be used to ensure that heavy rust accumulation has not allowed frame cracks and therefore loss of bus frame integrity.
- Maintenance techs should be trained also in 49 CFR 37 and 38, which covers all ADA equipment inspection requirements on the buses.

PARTS

WMTS in the same manner of all bus fleets survives upon their ability to secure and inventory bus parts. Those parts come to us in three sectors, which are:

1) Fast Moving P.M. Parts
   These include oil filters, belts, lights, spark plugs, bulbs, and others that have no re-buildable possibilities. Therefore, we throw the old part in the trash.

2) Lifecycle Parts
   These include parts that we can have rebuilt, such as starter motors, water pumps, alternators, etc.

3) Proprietary Parts and Systems
These parts and systems come from the bus manufacturer. They are doors, hoods, frame, suspension, and steering parts.

Fast moving parts need to be available 24/7 so that the P.M. program (service and inspection) can keep its frequency and service schedule. A shop normally keeps a few lifecycle parts on hand (such as alternators and starters) as needed to be changed out under the predictive action of the P.M. program. The only time a fleet normally orders proprietary parts (like a door) is maybe when an accident damaged the door so badly it cannot be repaired. Normally, we call the plant where the machine shop will access the original specification and manufacture a new replacement door. This may not be the case where the manufacturer no longer builds the bus, or moves off-shore or goes bankrupt.

**Findings**

- The parts room at WMTS is extremely small and crowded at present
- The parts person, while working at WMTS for three years as a mechanic, has just recently taken this position
- A host of parts can be purchased for small buses locally, but not when it comes to the large Blue Birds
- Since, as I understand it, Blue Bird stopped the manufacturing of the L4 bus in 2009, parts are extremely difficult to find, even the U.S. made parts
- I am advised that some of the Blue Bird parts have to come in from Europe
- At times, a bus may be out of service for several weeks awaiting parts. This forces downward pressure on the maintenance and operations departments, and is a major cause of P.M. program bottlenecking and with drivers having to frequently jump from one assigned bus to another.
- Lack of parts is also a number one complaint by fleets, as to why there are no spare buses, and the deadline gets larger.
**Recommendations**

- Since it is difficult to get these specific bus parts in Maine, we need to expand the search nationwide.
- Follow-up on HKA research with NABI and contact people in central Ohio and in Anniston, Alabama to find Blue Bird parts there.
- Review the National Transit Database for other organizations who may have some of these buses and if it is possible purchase any of their inventory.
- Access all bus parts advertised on the Internet and as necessary, get an account or at least, get onto their mailing list.
- Get subscriptions to all bus magazines and look through their parts advertisements, to get on their parts mailing list.
- Send an e-mail request to all bus parts sales organizations and bus fleets as necessary to purchase parts from their supplier.
- Give thought and consideration to expanding the parts inventory to the upstairs space, using an outside wall-mounted elevator.
- **UPDATE:** As of November 29, 2013, we have located a number of parts suppliers and parts available around the country. Some private fleets are willing to sell their parts to WMTS now, because they sold their buses early on and have no use for them.
- **UPDATE:** As of December 6, 2013, we have located a private bus company in Los Angeles who has brake parts they will sell to WMTS. The maintenance manager has their contact information.

**TRAINING**

Through discussions with technicians, it became obvious that they, like so many across the nation, lacked a complete understanding of fleet maintenance and fleet management. At times, techs tend to see themselves as someone who changes oil, adjusts brakes, changes belts and shocks, and generally fix problems. I believe that they have never had a professional fleet.
consultant work on-site and provide training, direction, and a vision of what America’s bus fleets are involved with, into the future.

**Recommendation**

Practically all forty-three state DOT offices that I have worked with for thirty years include an office of transit or a “bus department” that administers the ADA, passenger buses, and training programs. These professionals will typically be connected directly to all service providers in the field. That direct connection usually includes a working relationship with the state transit and paratransit association as well. These groups have a lot in common with passenger service via vans, cutaways, park and ride, as well as rail and fixed route service. These people all recognize that the service provided to elderly and fixed route passengers does not come without a lot of work, planning, partnering, and communication. Indeed, these associated groups bring together the training, guidance, and fellowship at meetings and training seminars across the nation. The public is the benefactor of their efforts. My recommendation would be that Maine DOT network with the service providers (recipients) in a far reaching program that provides enhanced assistance, training, communication, and leadership.

**Community Transportation Association of America**

Community Transportation Association of America (CTAA) has a fleet maintenance and management training program that is especially targeted to those who work in maintenance and operations of small and mid-range buses. The program, “Vehicle Maintenance Management and Inspection,” or VMMI, has been ongoing for seventeen years and is funded by FTA through the RTAP program. We continually return to state DOT training sites around the country to provide this 2-½ day program that teaches people about buses, how they are made, their technology, the regulations, the P.M. program design, the ADA implications, and other components that round out their technical capabilities as technicians. The award-winning program was featured in an article in the January 2013 issue of Metro Magazine, and it has been provided to bus technicians in almost every New England state. CTAA can assist with
providing this program and others (dispatch, PASS, etc.) at WMTS with minimum effort and a lot of appreciation from attendees.

American Public Transportation Association
The American Public Transportation Association (APTA) is another valuable resource that DOT can access. APTA represents the large bus fleets across America and provides regular conferences, bus shows, training, consulting, and technical expertise by and through FTA, the National Academy of Science, and even with bus manufacturers. The maintenance professionals who regularly meet at APTA conferences discuss and display a number of best practices, technical information, and reports on a wide variety of information for fleets. APTA recently developed and put out such worthy documents as mid-range bus specifications, bus fire investigations, and the bus standards consortium.
PART 2

SUPPORTING DOCUMENTATION

ON

TECHNICAL SYSTEMS AND COMPONENT ISSUES
This part of the report lays out the two major in-service issues with these Blue Bird buses.

The first section deals with brake lines that are hanging lower than the structural frame parts of the bus. The second section deals with the steering links that at 7.2 inches (as measured at Altoona) from the ground are in the direct path of uneven road surfaces and any road debris. Again, as has happened here in Auburn, Lewistown routes and at the U.S. Bus Testing Center in Altoona (State College), PA.

1) Photo of red unprotected red air line and back-up information

2) Photo of damaged steering link with new blue link to be installed in its place
Red Air Brake Line

These air lines are hanging below the lowest part of the bus main framing structure. On page 29 of Blue Bird’s supporting documentation on technical systems and component issues, it states that debris impact is unlikely to occur. These lines (tubes) are unprotected and appear to not agree with SAE J1394 3.3(c).
This photograph depicts a local rock that we placed under the steering link.

WMTS has had impacts of this nature in the past.
rear brake chambers are type 24/24 combination parking brakes.

46.0 AIR SYSTEM.

46.1 The bus pneumatic system will operate all accessories and the braking system with reserve capacity. The engine driven Wabco compressor will be sized to charge the system from 40 psi to the governor cutoff pressure in less than three minutes while not exceeding the engine’s rated speed. Air lines are color coded and installed in accordance with the following standards:

a. Green primary brakes and supply
b. Red secondary brakes
c. Brown parking brakes
d. Yellow Compressor governor signal
e. Gray accelerator
f. Black accessories

46.2 Flexible lines are supported at two-foot intervals. All air lines are protected with rubber grommets at points where lines pass through structural components. Routing of air brake lines is such as to minimize corrosion from road salt or other chemicals or road hazards. Lines are sufficiently separated that simultaneous failure due to accidental damage or debris impact is unlikely to occur. Drain valves with lanyard pills are provided on air tanks.

46.3 All air lines will be blown clean before installation. All lines are routed to prevent water traps.

46.4 Provisions are made at the front and rear of the bus to apply shop air to the bus pneumatic systems using a standard tire inflation type valve. Air for the compressor is filtered through the main engine air cleaner system.

46.5 Air dryer is a Bendix AD-IS with spin-on desiccant cartridge. Air discharge is equipped with a 24-volt electric heater.
2. References

2.1 Applicable Documents—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE Publications—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAF J844—Nonmetallic Air Brake System Tubing
SAF J1131—Performance Requirements for SAF J844 Nonmetallic Tubing and Fittings Assemblies Used in Automotive Air Brake Systems
SAF J1149—Metallic Air Brake System Tubing and Pipe


3. Installation and Assembly Recommendations

3.1 End Fittings—End fittings are to be assembled to the tubing in accordance with the fitting manufacturer’s recommendations. The fitting may be of the design shown in the proposed metric version of SAF J246, or any other design suitable for use with metric size nonme-
talic air brake tubing. Performance test requirements for nonmetallic air brake assemblies are covered in SAF J1131.

3.2 Noncoiled Tubing—Noncoiled tubing should not be used in flexing applications such as frame to axle.

3.3 Support and Routing—When installed in a vehicle, this tubing shall be routed and supported so as to:

a. Eliminate chaffing, abrasion, kinking, or other mechanical damage.

b. Minimize fatigue conditions.

c. Be protected against road hazards by installation in a protected location or by providing adequate shielding at vulnerable areas.

d. Not be exposed to temperatures, internal or external, over +95 °C (+200 °F) or below -40 °C (-40 °F).

e. Not be exposed to attack by battery acid.

f. Avoid excessive sag.

4. Identification—Air brake tubing shall be labeled in contrasting color with the legend repeated every 389 mm (15 in) or less along the entire length of tubing in legible block capital letters.

The following minimum information, in the order listed, is required. Additional information and/or another lay line may be added, if necessary.

a. Metric air brake

b. SAF J1394

c. Type A or B

d. Nominal tubing OD in mm—6, 8, 10, 12 or 16

e. Tubing manufacturer's identification

5. Manufacture—The tubing shall be manufactured to comply with the requirements outlined in this document.

6. Construction—Type A tubing shall consist of a single wall extrusion of 100% virgin nylon (polyamide) containing additives that provide heat and light resistance. Type B tubing shall consist of a core extrusion of 100% virgin nylon (polyamide) containing additives that provide heat resistance. This core shall be reinforced with polyester braid or equivalent and covered with a protective jacket of 100% virgin nylon (polyamide) containing additives that provide heat and light resistance. The protective covering shall be bonded to the core through the interstices of the braid. The inner core and outer jacket shall be of contrasting colors.

7. Dimensions and Tolerances—The tubing shall conform to the dimensions shown in Table 1 under all conditions of moisture. If with this requirement shall be determined on samples that are subjected to 110 °C (230 °F) for 4 h in a circulating air or separate samples that have been immersed in boiling water. Mentioned tests shall be made after samples have been at room temperature for 0.5 to 3.0 h.

8. Mechanical Properties—The tubing shall conform to mechanical properties shown in Table 2, when tested according to this document.

9. Performance Requirements—The tubing shall satisfy the following performance tests (see Footnotes 3, 4, 5, and 7).

8.1 Leak Test—The tubing manufacturer shall subject a sample of tubing to test at a pressure of 1.4 MPa with an appropriate gas for a period of time sufficient to detect presence of any leaks. Defective sections shall be cut off and the remaining tubing shall be recoupled at the points where sections were removed and again subjected to the 1.4 MPa pressure test. The procedure shall be repeated until all sections designated for distribution to users have successfully withstood test.

8.2 Moisture Absorption—Expose sample of tubing to a circulating air at 110 °C (230 °F). Remove from oven immediately, and expose for 100 h at 100% relative humidity (75 °F). Within 5 min from humidity conditioning, wipe surface from both the interior and exterior surfaces of the tubing. Moisture absorption shall not exceed 0.2% by weight.

8.3 Ultraviolet Resistance—Place sample of tubing in a 450 mm (18 in) diameter, rotating at 35 rpm ± 5, with sunlamp or equivalent centrally located 230 mm (9 in) above the tubing. Sunlamp shall be operated for a period of time sufficient to ensure adequate exposure to the tubing.

9.1 Tubing OD in mm—6, 8, 10, 12 or 16

10.1 Tolerances in mm—0.004

10.2 Tolerances in in—0.001

Footnotes:

1. All test temperatures specified may vary by ± 5 °C (± 9 °F).

2. All times are minimum unless otherwise specified.

3. An inspection test conducted at the plant where a product is manufactured and where it is used as the output of one production shift of one size and color.

4. A qualification test.

5. A qualification test.

6. A qualification test.

7. A qualification test.

---

### Table 1—Dimensions and Tolerances

<table>
<thead>
<tr>
<th>Tubing Type</th>
<th>Tubing Size OD mm</th>
<th>Tubing Size ID mm</th>
<th>Minimum Wall Thickness mm</th>
<th>OD Tolerances</th>
<th>ID Tolerances</th>
<th>ID Tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6.0</td>
<td>0.236</td>
<td>0.157</td>
<td>0.9</td>
<td>0.035</td>
<td>20.1</td>
</tr>
<tr>
<td></td>
<td>8.0</td>
<td>0.315</td>
<td>0.236</td>
<td>0.9</td>
<td>0.035</td>
<td>20.1</td>
</tr>
<tr>
<td></td>
<td>10.0</td>
<td>0.393</td>
<td>0.215</td>
<td>1.33</td>
<td>0.053</td>
<td>20.1</td>
</tr>
<tr>
<td></td>
<td>12.0</td>
<td>0.472</td>
<td>0.354</td>
<td>1.35</td>
<td>0.053</td>
<td>20.1</td>
</tr>
<tr>
<td></td>
<td>16.0</td>
<td>0.629</td>
<td>0.472</td>
<td>1.8</td>
<td>0.071</td>
<td>20.1</td>
</tr>
</tbody>
</table>

### Table 2—Mechanical Properties

<table>
<thead>
<tr>
<th>Tubing Type</th>
<th>Nominal OD mm</th>
<th>Minimum Burst Pressure at 24 °C (75 °F) MPa</th>
<th>Minimum Burst Pressure at 100 °C (212 °F) PSI</th>
<th>Test Bend Radius 1 mm</th>
<th>Test Bend Radius 2 mm</th>
<th>Maximum Stiffness kN</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6</td>
<td>7.6</td>
<td>1100</td>
<td>20</td>
<td>0.75</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>6.2</td>
<td>900</td>
<td>32</td>
<td>1.25</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>8.2</td>
<td>1200</td>
<td>38</td>
<td>1.50</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>8.6</td>
<td>1000</td>
<td>45</td>
<td>1.75</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>6.0</td>
<td>875</td>
<td>70</td>
<td>2.75</td>
<td>225</td>
</tr>
</tbody>
</table>

1. With moisture content of tubing 0.06% max.

2. For test purposes only.
SECTION II (Bid Item #2)

TECHNICAL SPECIFICATIONS FOR

NEW BUS (NOT YET BUILT)

35 FOOT-DIESEL
12 YEAR/500,000 MILE
HEAVY DUTY LOW FLOOR TRANSIT BUS

1.0 LEGAL REQUIREMENTS

1.1 The buses as built will meet all applicable FMVSS and ADA regulations in effect at the date of manufacture. Blue Bird will comply with all applicable federal, state, and local regulations.

1.2 COMPLETENESS

A. The buses will be delivered in a complete condition, ready for service. All parts necessary for the operation of the bus will be included.

B. The price quoted includes all items of labor, material, tools, equipment and other costs necessary to fully complete the manufacture and delivery of the bus.

C. All units or parts used in the construction of the bus are of the best quality and conform in material, design, or workmanship to the best practices known in the industry. All parts are new. The parts on all vehicles, provided by the same manufacturer, are interchangeable.

1.3 MATERIAL

Material used in the construction of the buses conforms to the American Society of Testing Materials, Society of Automotive Engineers or similar association standards.
When the new steering link is placed next to the one that struck the street (or road debris) it can be seen in the background that major bus framing components are located higher from the road surface. This situation is very unusual among truck and bus manufacturers. The steering components are typically located behind the front axle and/or up higher through massive 50,000 psi frames. That way, it protects these components from anything that will take control of the bus out of the hands of the driver.
This photograph depicts a local rock that we placed under the steering link.

WMTS has had impacts of this nature in the past.
<table>
<thead>
<tr>
<th>CLEARANCES:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest Point Outside Front Axle</td>
<td>Location: Steering link</td>
</tr>
<tr>
<td>Lowest Point Outside Rear Axle</td>
<td>Location: Transmission</td>
</tr>
<tr>
<td>Lowest Point between Axles</td>
<td>Location: Body</td>
</tr>
<tr>
<td>Ground Clearance at the center (in)</td>
<td></td>
</tr>
<tr>
<td>Front Approach Angle (deg)</td>
<td></td>
</tr>
<tr>
<td>Rear Approach Angle (deg)</td>
<td></td>
</tr>
<tr>
<td>Ramp Clearance Angle (deg)</td>
<td></td>
</tr>
<tr>
<td>Aisle Width (in)</td>
<td>Front – 34.1 Rear – 23.7</td>
</tr>
<tr>
<td>Inside Standing Height at Center Aisle (in)</td>
<td>Front – 96.8 Rear – 76.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BODY DETAILS:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Structural Type</td>
<td>Monocoque</td>
</tr>
<tr>
<td>Frame Material</td>
<td>Steel</td>
</tr>
<tr>
<td>Body Material</td>
<td>Aluminum – fiberglass</td>
</tr>
<tr>
<td>Floor Material</td>
<td>Plywood</td>
</tr>
<tr>
<td>Roof Material</td>
<td>Aluminum – fiberglass</td>
</tr>
<tr>
<td>Windows Type</td>
<td>□ Fixed □ Movable</td>
</tr>
<tr>
<td>Window Mfg./Model No.</td>
<td>Blue Bird / ASJ M289</td>
</tr>
<tr>
<td>Number of Doors</td>
<td>1 Front 1 Rear</td>
</tr>
<tr>
<td>Mfr. / Model No.</td>
<td>Bode / Na</td>
</tr>
<tr>
<td>Dimension of Each Door (in)</td>
<td>Front – 35.5 x 76.2 Rear – 43.2 x 76.6</td>
</tr>
<tr>
<td>Passenger Seat Type</td>
<td>□ Cantilever □ Pedestal □ Other (explain)</td>
</tr>
<tr>
<td>Mfr. / Model No.</td>
<td>Freedman / Na</td>
</tr>
<tr>
<td>Driver Seat Type</td>
<td>□ Air □ Spring □ Other (explain)</td>
</tr>
<tr>
<td>Mfr. / Model No.</td>
<td>Bostrom Seating Inc. / S790869542</td>
</tr>
<tr>
<td>Number of Seats (including Driver)</td>
<td>31</td>
</tr>
<tr>
<td>DATE</td>
<td>TEST MILES</td>
</tr>
<tr>
<td>----------</td>
<td>------------</td>
</tr>
<tr>
<td>10-16-03</td>
<td>5,690</td>
</tr>
<tr>
<td>*10-20-03</td>
<td>5,823</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>*10-21-03</td>
<td>5,901</td>
</tr>
<tr>
<td>*10-22-03</td>
<td>5,948</td>
</tr>
<tr>
<td>10-27-03</td>
<td>6,095</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>10-27-03</td>
<td>6,095</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>11-04-03</td>
<td>7,097</td>
</tr>
<tr>
<td>*11-04-03</td>
<td>7,097</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>11-04-03</td>
<td>7,097</td>
</tr>
<tr>
<td>11-06-03</td>
<td>7,486</td>
</tr>
</tbody>
</table>

*Due to improperly installed shock mount.
and gradeability test data are provided in Section 4, Performance. The average time to obtain 50 mph was 31.34 seconds.

The Shakedown Test produced a maximum final loaded deflection of 0.253 inches with a permanent set ranging between 0.000 to 0.004 inches under a distributed static load of 24,750 lbs. The Distortion Test was completed with all subsystems, doors and escape mechanisms operating properly. Water leakage was observed during the test at the 2nd, 3rd and rear windows on the left side, and the 3rd window on the right side.

The Static Towing Test was performed using a target load (towing force) of 24,468 lbs. All four front pulls were completed to the full test load with no damage or deformation observed. The test bus was not equipped with rear tow eyes or tow hooks, therefore, a rear tow was not performed. The Dynamic Towing Test was performed by means of a front-lift tow. The towing interface was accomplished using a hydraulic under-lift wrecker. Clearance between the towing equipment and the steering linkage was limited, yet could be accomplished with no damage. The bus was towed without incident and no damage resulted from the test. The manufacturer does not recommend towing the bus from the rear, therefore, a rear test was not performed. The Jacking and Hoisting Tests were also performed without incident. The bus was found to be stable on the jack stands, and the minimum jacking clearance observed with a tire deflated was 3.7 inches.

A Fuel Economy Test was run on simulated central business district, arterial, and commuter courses. The results were 4.65 mpg, 5.08 mpg, and 9.15 mpg respectively; with an overall average of 5.56 mpg.

A series of Interior and Exterior Noise Tests was performed. These data are listed in Section 7.1 and 7.2 respectively.
ALTOONA ISSUES

During the Altoona test protocol, major defects, by their number were occurring to: steering (2), shocks (10), bolts (15), nuts (5), air bags (5), and leveling valves (4). WMTS has and continues to experience failure with these same systems and components.

FACTORY QUOTATION DOCUMENT

MAJOR STATEMENTS

4.1 SERVICE LIFE

This bus is designed as a twelve (12) year transit bus that will operate for twelve (12) years, or 500,000 miles (this is under review)

5.1

The coach will achieve normal operation in environmental conditions ranging from 20 degrees to 115 degrees with humidity at 5 to 100 percent.

(This area, according to intellacast.com has an average of -16.25 degrees, complemented by 10-inches of snow per month, not including 4-inches of rain, in the winter)

1.2 COMPLETENESS

All units or parts used in the construction of the bus are of the best quality and conform in material, design, or workmanship to the best practices known in the industry. All parts are new.

The parts on all vehicles, provided by the same manufacturer, are interchangeable.

- Most low-floor transit buses have the steering gear box, pitman arm, drag links, and other components mounted very high above the front axle. While this Blue Bird bus has no front axle, the steering components are designed in and located very low to the ground.

1.3 MATERIAL

Material used in the construction of the buses conforms to the American Society of Testing Materials, Society of Automotive Engineers, or similar association standards.
• SAE construction design standards (SAE J1273) for hoses (including air brake hoses) indicate that they shall be protected from the environment, which they are exposed. The ones on these buses are not protected from road junk, or snow.

4.0 SERVICE LIFE AND MAINTENANCE

4.1 SERVICE LIFE

*The bus is designed as a 12-year transit bus that will operate for 12 years or 500,000 miles, including at least 40,000 miles in the twelfth year.*

• It is my opinion that Maine DOT should take a serious review of the anticipated life left in these buses and this statement in the documents. HKA would start with an engineering review of the front box section, steering, brakes, and suspensions.

4.2 REPAIRABILITY

*The bus is designed for ease of access for repairs or service when needed. Parts are commonly available.*

• Brake parts, we are told, have to be shipped from Europe. This is a time consuming effort that has been placing buses out of service, and bottlenecking the P.M. program effectiveness.

12.2 STRENGTH AND FATIGUE LIFE

*The basic structure will withstand fatigue damage that is sufficient to cause Class 1 or Class 2 failure throughout the intended service life of the coach. The structure will withstand impact and inertial loads due to routine street travel throughout the bus service life without permanent deformation or damage.*

• According to the report at Altoona, part of the steering systems components of the bus struck the test track. That same failure has happened repeatedly at WMTS.
12.5 **CORROSION**

The bus will resist corrosion from both the atmospheric conditions and road salts. The bus will maintain original structural integrity and maintain appearance throughout its service life. Materials exposed to the elements and all joints and connections of dissimilar metals are corrosion resistant and are protected from galvanic corrosion.

- There needs to be an engineering study and report centered around the massive amount of corrosion on the chassis and related undercarriage components. This could help decision-makers determine the next steps to achieving 12 years/500,000 miles at an industry comparable cost, or to take other measures.

Blue Bird front framing corrosion

Also, SLF corrosion on support brackets

.....and the bottom of radiators
ADDENDUMS

A Collection of Photo D
Documentation with Comments
We measured less than Altoona’s 7.2” (when the bus was new) at steering link end to street (floor) surface – under 7” every time.
The frame components need to be evaluated by an engineering/metallurgist review to determine the road-worthiness, rehab possibilities, and why they are so deteriorated at this stage of their 12-year life.

This can destroy tires, bend rims, and cause handling problems for the driver.
Deep erosion tends to exacerbate frame and control system issues.

Road surfaces on routes where risers are in the street surface can impact various parts of the bus undercarriage and systems.

**Bus Specifications Development Recommendations**

It is my opinion that WMTS and MDOT should work together to develop a bus specification document that will ensure to the extent possible, that every bus purchased for sale and use within the state meet severe weather conditions.

In addition, there should be emphasis placed upon the fleet mix. Homogenized fleets (one or two types of vehicles) are known to cost less in the long life cycle and on a cost-per-mile basis. The current fleet at WMTS is suffering under the additional impacts of a mixed fleet operation, in that, 1) they have to buy parts, tools, tires, and also train techs and drivers for several makes. This is always costlier.