Triple Combination Pumper In-Service Inspection (Sample)

For

Any Town Fire Department
Any Town, U.S.A.

Your Name
Fire Chief

Prepared by

Big Red Trucks Fire Apparatus Consultants Inc.
Tel: 1-866-723-1075

DATE

DATE

Your Name, Fire Chief
Any Town Fire Department
123 Firehouse Lane
Any Town, U.S.A. 00000

Dear Chief Your Name,

Big Red Trucks Fire Apparatus Consultants (***BRTFAC***) has inspected Engine 1, A Blaze Fighter triple combination pumper operated by the Any Town Fire Department. This apparatus was inspected for overall physical condition, general maintenance and compliance with current operating and safety standards. In conjunction with the inspections and maintenance records the annual test records were also reviewed.

The National Fire Protection Association (NFPA) publishes NFPA 1901 Standard for Automotive Fire Apparatus which sets the minimum design and construction standards that manufacturers must meet or exceed for any emergency service apparatus with a gross vehicle weight of 10,000lbs or more. In the 1991 version of the NFPA 1901 standard, several design mandates that concentrated on operator and occupant safety were incorporated into the standard. As the standard continues to evolve, safety has become a major focus of apparatus design and construction.

In 2007, NFPA 1911, Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus was published. This standard consolidated several older standards that governed in-service testing of apparatus and their major components into one standard. New to this standard is the inclusion of criteria on apparatus inspection and maintenance, guidelines to service life of apparatus, establishment of out-of-service conditions, and recommendations for the retirement of apparatus. In conjunction with and often referenced in the NFPA standards are Department of Transportation (DOT), Federal Motor Vehicle Safety Standards (FMVSS), Society Of Automotive Engineers (SAE), along with other nationally recognized standards. Individual state motor vehicle regulations must also be adhered to.

The inspection of this apparatus and recommendations made as to maintenance, retirement and replacement are based on these NFPA standards, several industry standards and generally accepted industry practices.

The Insurance Services Office (ISO) sets and grades Fire Departments on their ability to respond and mitigate emergencies in their community. They have wide ranging criteria that in part reviews response times, apparatus needed, location of fire houses, water supply, communications, written mutual aide agreements and miscellaneous other criteria. In addition to their own criteria, ISO relies heavily on NFPA standards, codes and other referenced national codes in their risk assessment. Based on this analysis, the ISO then creates what they consider to be the minimum necessary resources for the community to mitigate fire and other property damaging events. Insufficient grades received as a result of an ISO review can cause an increase in insurance costs for property owners and renters.

When purchasing new equipment and maintaining existing apparatus, it is important to make sure ISO recommendations are followed so that the community's rating is maintained or improved.

A detailed report on this vehicle follows and recommendations pertinent to it is at the end of section. Overall recommendations are in the summary at the end of the report.

It is anticipated that this report will assist you with making fleet management decisions. If you have any questions or need any additional information on any of the points illustrated in this report, please do not hesitate to contact us. Thank you for selecting EWFAC to perform this inspection for you.

Sincerely,

Jeffrey D. Gaskin
President

Any Town Fire Department

Engine 1

Figure 1

2002 Blaze Fighter
Manufactured December 2002
VIN #: 1BFTCP23456789876
Registration #: 87654

Mileage: 27,881
Engine Hours: 2,412.2
Pump Hours: N/A

Vehicle Weight Chart		
	Rated	**Actual**
Gross Vehicle Weight	45,500 lbs.	
Front Axle	21,500 lbs.	
Rear Axle	24,000 lbs.	

This vehicle is a Blaze Fighter custom cab and chassis assembly powered by a Cummings ISM series diesel motor and an Allison 4000 series automatic transmission. This is a four wheel drive (4WD) vehicle with both the front and rear axles equipped with drum brakes. The apparatus body is extruded aluminum in design and construction.

Inspection of this vehicle indicates that it is in overall fair condition. The apparatus cab and compartment body are in good condition cosmetically and appear to be in good condition structurally. There is some "white" rust beginning to form, which is an aluminum deterioration caused by atmospheric conditions similar to what causes steel to rust, figures 2 & 3.

Figure 2

This type of deterioration was seen at various locations around the cab and body assemblies. This includes but is not limited to; wheel wells, compartment door hinges mounting for grab handles and light fixtures.

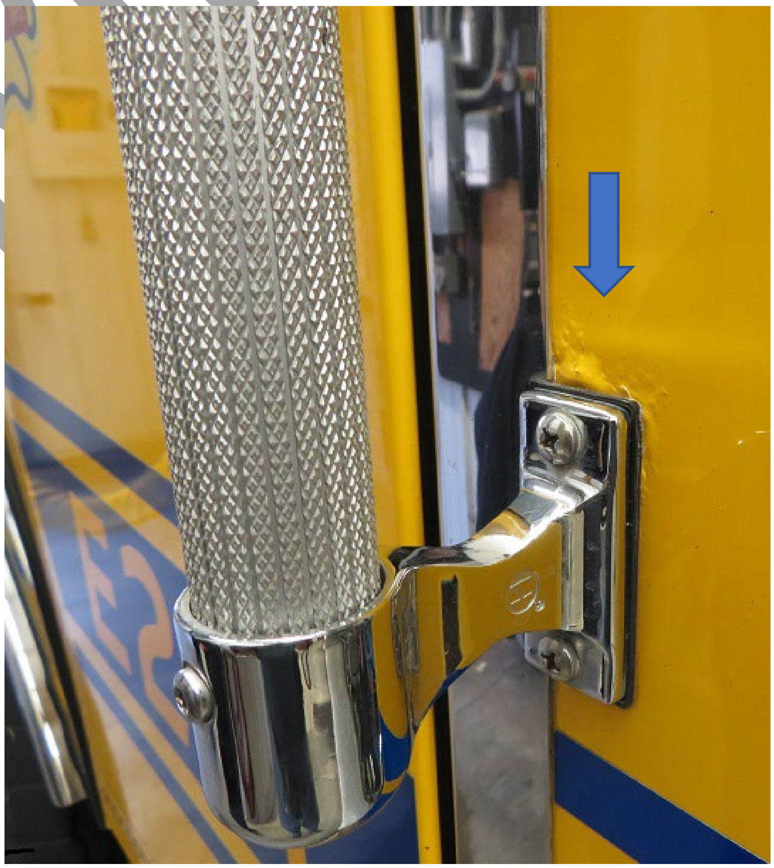

Figure 3

White rust is most often caused by a process referred to as electrolysis and reaction when two dissimilar metals come into contact with each other, as an example when stainless steel bolts are used to mount accessories on an aluminum truck body. There are chemical coatings available and some physical barriers that greatly reduce and, in some cases, eliminate this condition. While white rust is generally not as severe as rust in steel, it spreads quickly causing more cosmetic damage than structural damage to the vehicle. However, white rust can and in some case does cause structural damage which does not appear to be an issue on this apparatus at this time.

What is more troubling on Engine 1 is what was discovered reviewing the history of this vehicle and one observation on the rear of the apparatus. The Cast 4 housing, which contains the brake lights, turn signals, and reverse lights, on the rear of the apparatus shows a long line of white rust along is mount gasket, figure 4. I have never seen this condition before.

Figure 4

Since both the paint on the apparatus body and the gasket around the base of the light housing are both adequate isolation barriers this condition is the first indication that there is more going on than simple electrolysis.

There is also some paint bubbling taking place on compartment doors and on the apparatus body, figure 5. Reviewing the history of the Engine 1 reveals an interesting evolution with these body parts.

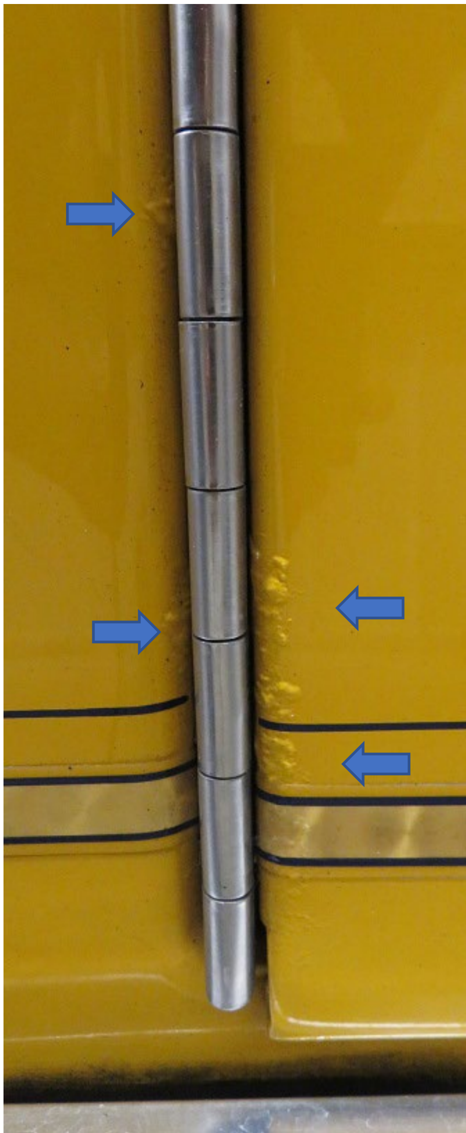

Figure 5

There was similar paint failure on the compartment doors earlier in the life of this apparatus. Repair attempts (multiple) were problematic and unsuccessful. Finally, the compartment doors were replaced with new stainless-steel doors.

What makes this interesting is that the compartment door (right side of photo), the door hinge, and the door hinges screws are all stainless steel. The compartment body is aluminum.

The paint deterioration visible is heavier on the compartment door side than it is on the compartment body side. Since electrolysis take place between dissimilar metals and not between similar metals you would expect that there would be little or no paint bubbling on the compartment door. The electrolysis damage should be confined to the compartment body side.

The conditions observed here are a second indication that there is more going on with this apparatus than electrolysis from dissimilar metals.

There is rust on various areas of the chassis and/or its components. A certain amount of rust can be expected with a vehicle of this age. The rust conditions are much less severe towards the front of the vehicle and commensurate with the age of the vehicle.

Figure 6 show a section of a chassis frame rail where a crossmember attaches towards the front the vehicle. There is some rust and minor paint delamination visible but overall the paint condition is good and the level of rust in line with the age of the vehicle. The white residue observed is from road deicing chemicals.

Figure 6

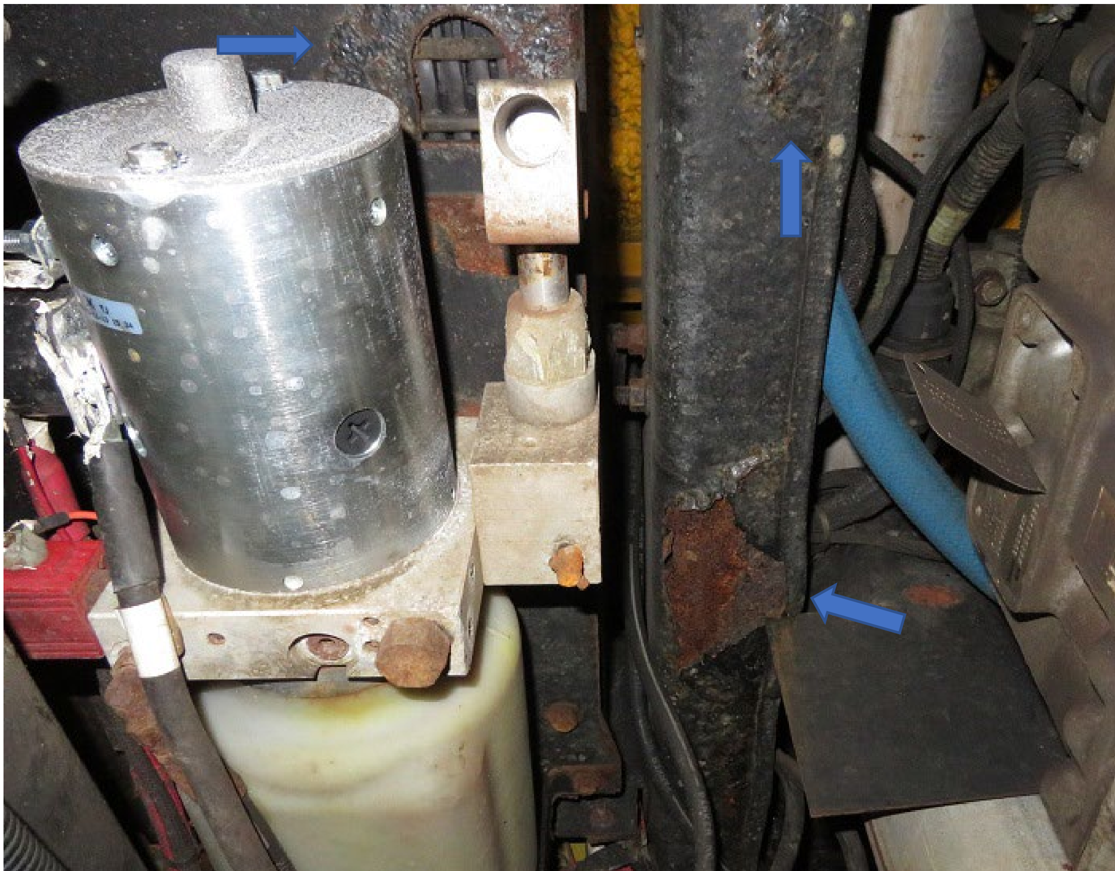

Figure 7

In figure 7 areas where there is paint blistering and missing paint which are caused by rusting conditions on both structural and non-structural chassis components. This area is towards the rear of the apparatus cab and you can already an increase in the amount of rust present as one moves toward the rear of the vehicle. Note the new pump assembly for the cab tilt assembly. Replacement was needed because the previous unit had corroded to the point of seizing and becoming non-functional.

The rust conditions and the level of damage being cause by the rust increases as you move towards the rear of the vehicle and are much worse that what you would expect to see with a vehicle of this age. The pump enclosure and some pump components are not in good condition.

As you move farther towards the rear of the chassis there is significant paint delamination taking place of the apparatus chassis and chassis components. This includes chassis rails, crossmembers, and mounting hardware. Delamination (defined by Merriam-Webster as: separation into constituent layers), is a common condition on Engine 1 and in my opinion indicates more problems than can be related to road chemicals or spilling of firefighting class A foam.

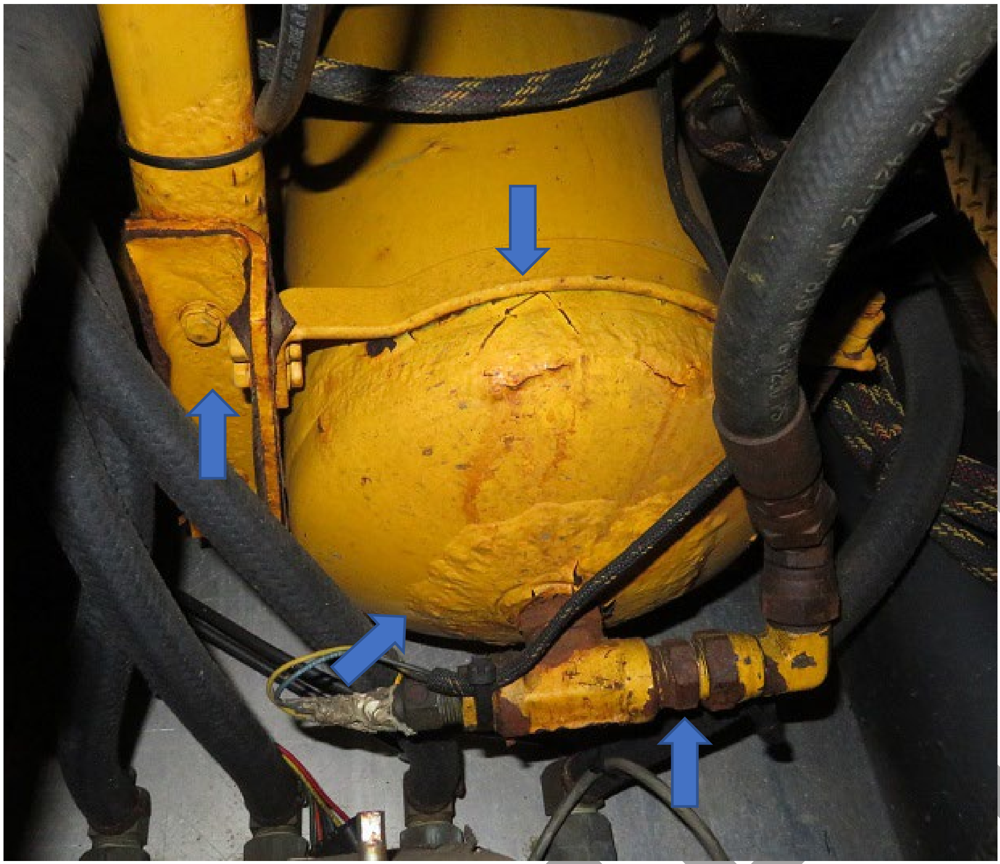

Figure 8

The air storage tank for the compressed air foam system, located in the pump enclosure, the mount bracket assembly, and the plumbing fittings all show heavy paint blistering, paint failure and rust conditions.

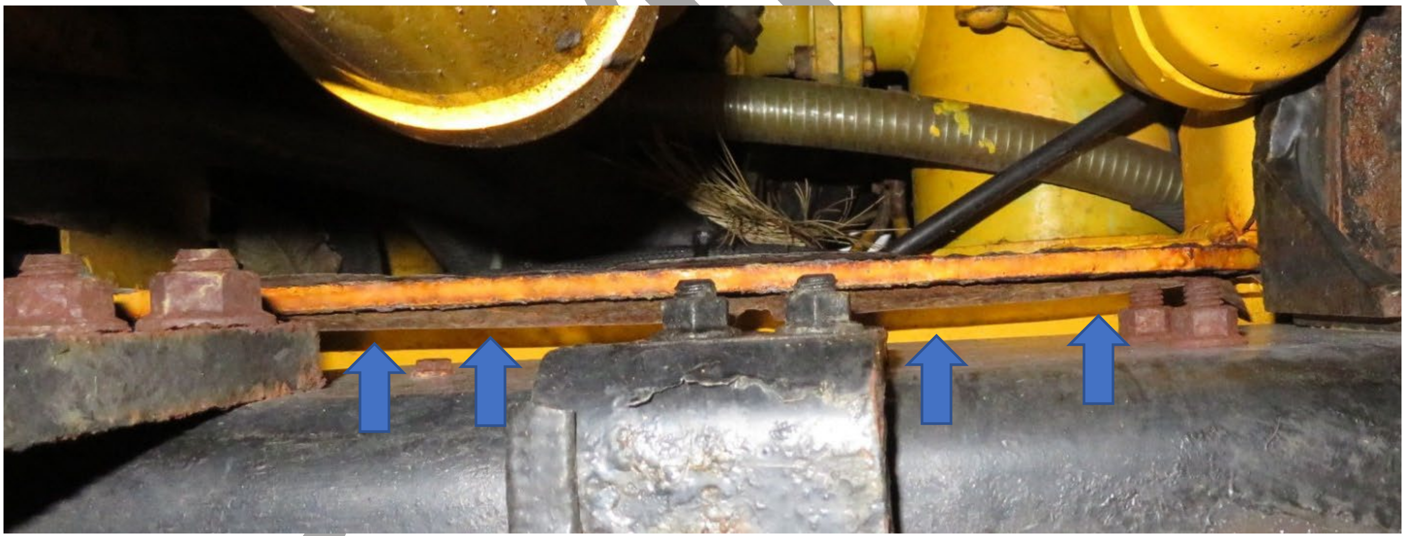

Figure 9

Figure 9 shows a good example of paint delamination. While it can be difficult to see in a picture the blue arrows point to the paint coming off the mounting bracket in a single sheet, almost like it is being pushed off metal from underneath.

Figures 10 and 11 on the following page are close-ups of other chassis mounting brackets that give a better idea of what delamination and you can more clearly see the extent of paint failure when this process is taking place. Figure 10 shows delamination taking place on both sides of the same bracket.

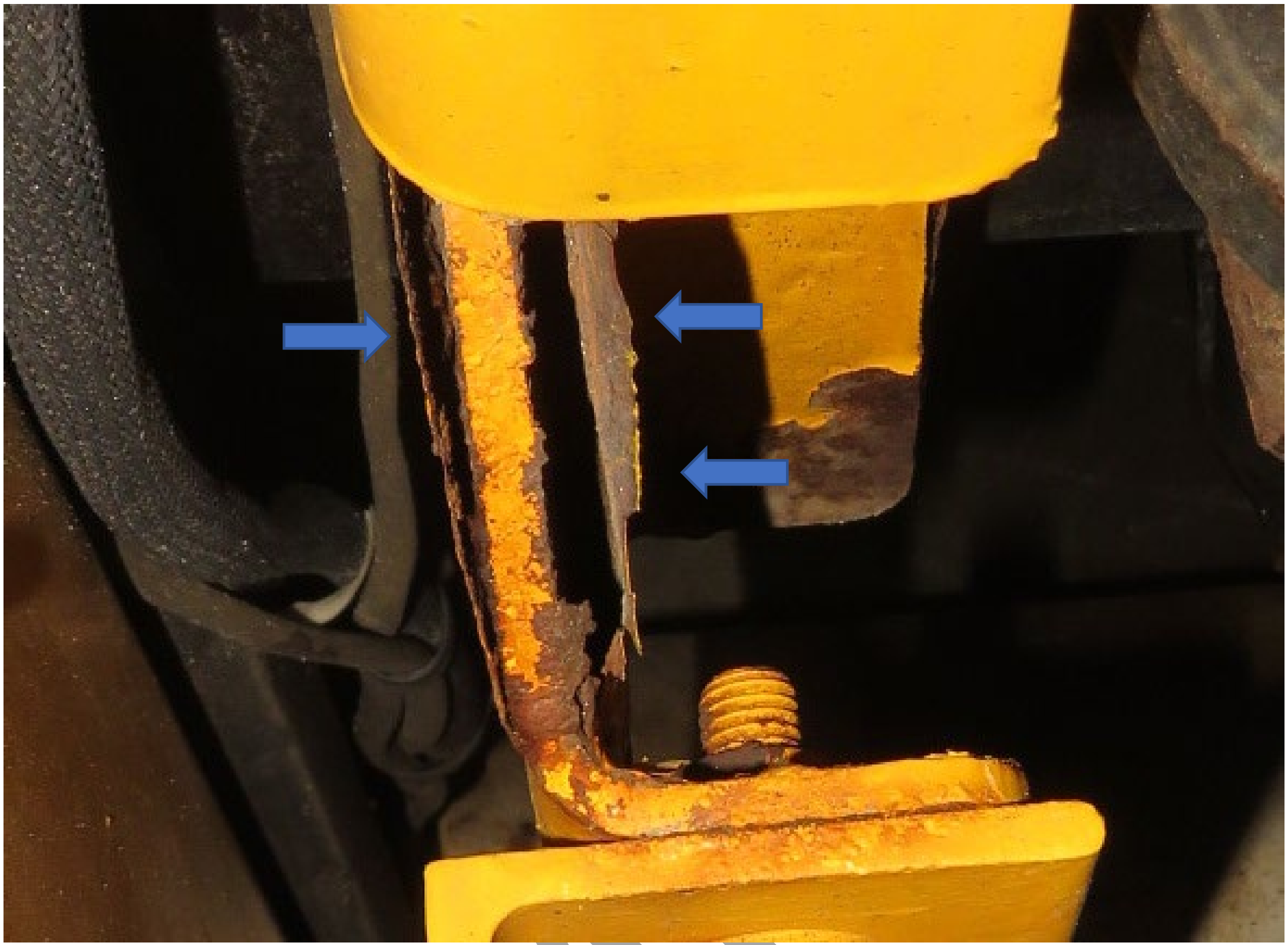
Figure 10


Figure 11

Figures 12 and 13 show a valve that is part of the vehicle's air brake system. The valve housing, mounting bolts and the crossmember plate above the house all show heavy corrosion. Figure 12 you can see that the mounting plate for the air valve is being virtually destroyed by rust and corrosion. There is also heavy paint blistering visible on the chassis crossmember.

Figure 12

Figure 13

Along the rear of the apparatus chassis the chassis rails are stacked vertically. This was done because this vehicle is a 4WD unit and that significantly raises the front of the vehicle in order to match that and make the vehicle sit level the rear has to be raised. Figure 14 shows rust jacking taking place between the stacked chassis rails.

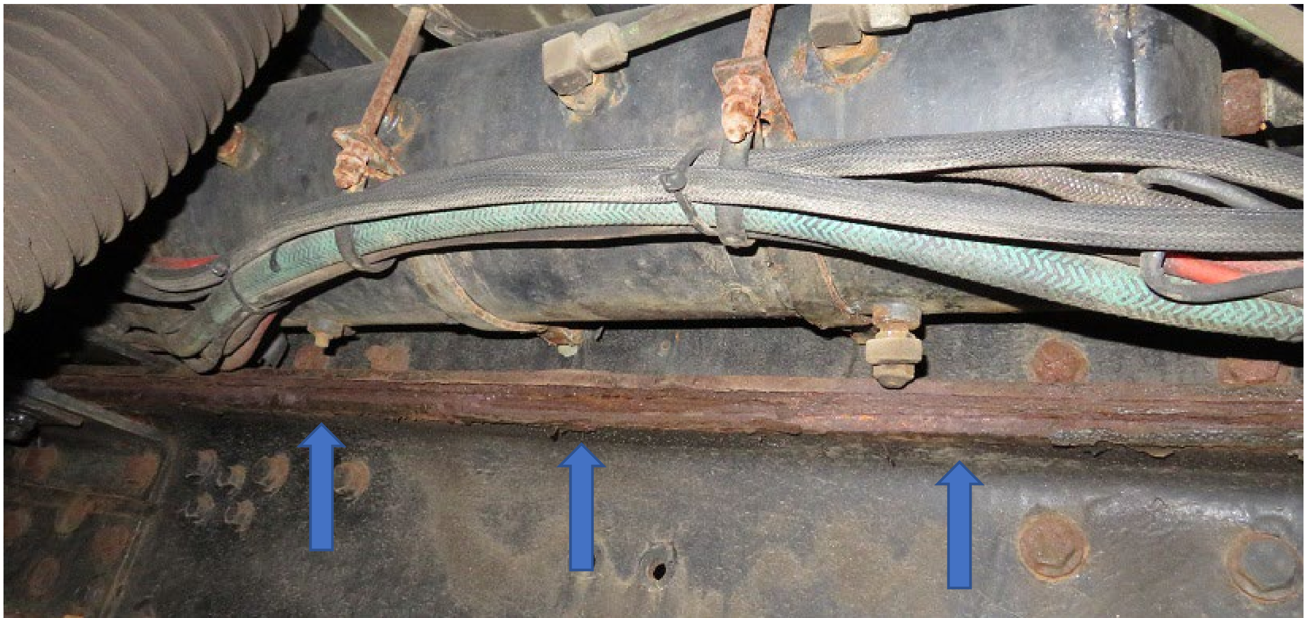

Figure 14

As steel rusts it expands, when the steel parts that form a fixture or component are closely mated the rusting and expanding steel begins to push the mated steel surfaces apart this is referred to as rust jacking.

In figure 15 you can see a chassis rail and the corrosion along the top and bottom flanges and the web. On the chassis air tank in the top of the photo its mounting brackets are both rusting and there is a band around the middle of the tank, blue arrow, where there was at some point another bracket.

Figure 15

Figure 16

Figure 16 shows an upright support in the pump enclosure/body area. The corrosion along left side support has completely stripped the paint from one side of the square tube and there is delamination along the side. The yellow supports show heavy corrosion.

A chassis section, figure 17, where there is heavy rust deterioration (blue arrow), extensive paint blistering, some delamination and substantial rust and corrosion.

Figure 17

Figure 18

Looking into the back of a rear axle wheel well, figure 18, you can see broad side of the stacked chassis rails and the support plates that hold them together. The lower rail is the one that the rear suspension and axle is mounted to. Also visible is paint blistering and rust corrosion that is seen on many areas of the chassis.

Another section of the vehicle chassis, figure 19, showing delamination, blue arrow, and rust deterioration. Like conditions observed on other areas of the chassis this is more extensive than what you would expect to see on a vehicle of this age.

Figure 19

There are many more photographs showing different level of rust/corrosion and deterioration of body and chassis components both structural and non-structural on Engine 1. I think the point has been well made in the examples given.

Review of the repair records for Engine 1 for the last three years and discussing this vehicle with the Supervisor from the Township Garage shows that in addition to the rust and corrosion issues highlighted in the photos there are other problems with Engine 1. The fuel tank and its mounting straps rotted away and had to be replaced. There are various electric actuating motors on the vehicle that need to be replaced on a fairly regular basis, prematurely. The support structure for the winch rotted off the rear undercarriage of the vehicle. As these issues are addressed, they add to the annual cost of keeping this vehicle in service. These types of issues get worse with age so that cost will only increase.

Reviewing the pump test records for Engine 1 shows that pump performance is strong and consistent but not without some problems. There is a pressure gauge for the Compressed Air Foam System that is frozen, apparently due to corrosion. This particular gauge is no longer available, which complicates the needed replacement, which usually means the cost is higher. A previous photo (figure 8) showed extensive rot to a pressure tank critical to the Compressed Air Foam System that needs to be replaced.

Figures 20 &21 show two (2) electrical connection points where the wiring is worn or not properly terminated. This type of wiring/connection was not uncommon when Engine 1 was built. It is not something that you would find on apparatus today.

Figure 20

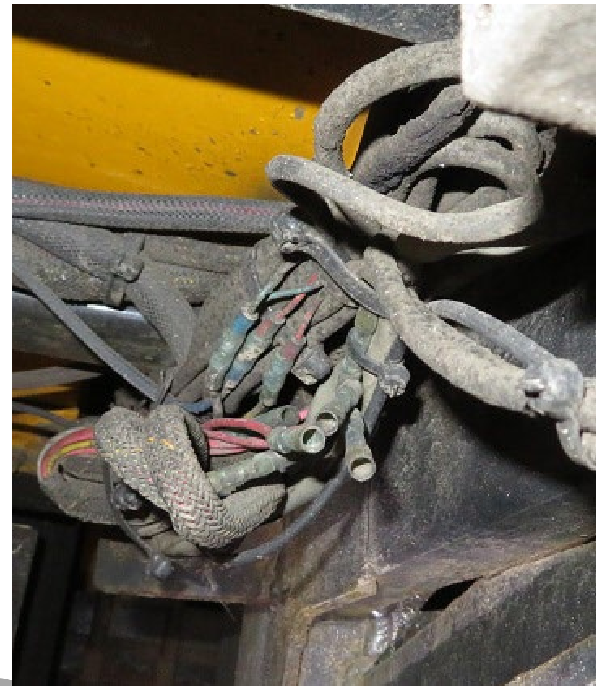

Figure 21

General Observations and Recommendations

Engine 1 has rust and rot conditions beyond what could be considered normal for its age. The rust and rot is more substantial towards the rear of the vehicle than it is towards the front. It is easy to dismiss the rusting conditions as something that is being caused by the winter driving conditions especially since this apparatus is in use in the north east, or by the spilling of class A firefighting foam. But neither is really a fair or accurate statement to make. The chemicals and salts, in particular magnesium chloride, being used on roads today are contributing factors to some rusting and rot conditions. Class A foam is a corrosive but reasonably mild and the type of corrosion seen on the vehicle would indicate a chronic spill problem and even then, the deterioration caused by the foam would be in places the foam came into direct contact with, not spread out all over the vehicle.

The problems that are being caused by road deicing chemicals are being increasingly well documented. Along with that comes a better understanding of the maintenance requirements needed to combat the damage caused. Much of the damage cited in reports and the types of conditions found are coming from the over the road trucking industry who's vehicles see a much greater exposure to road chemicals than fire apparatus. The lessons learned from the trucking industry can be very valuable to the fire service.

Any Town Fire Department operates other apparatus that is older Engine 1. The other vehicle does not have rust or rot conditions anywhere near as extensive as Engine 1. Since the other vehicle is older it is reasonable to conclude that it has been exposed more often and over a longer period of time to winter road conditions. Since the rust and rot conditions observed on the older vehicle isn't as extensive as Engine 1 it is also reasonable to conclude that road deicing chemicals are not the sole source of the rust/rot conditions but a contributing factor.

Rust and rot in fire apparatus has been a problem since the late 1960s. At that point the quality of steel was being cited as the problem. The reality is that the design and assembly of the body components probably contributed just as much to the rust and rot as did the quality of the steel. Booster tanks were another weak link in the fire apparatus body. They were always wet and often made of steel, tank rot was common. As the fire service moved to poly tanks rust and rot damage moved to other parts of the apparatus, primarily the fire pump and plumbing system. This is when it became apparent that electrolysis played a major part in the booster tank rot, the tank being the sacrificial surface. The use of sacrificial anodes in the fire pump has relieved some of the problems as has the move from galvanized pipe to stainless steel and high pressure rubber.

The first electronic diesel engine controls were introduced in the late 1980s. At that point the electrical systems in fire apparatus were still reasonably basic, complex in layout but simple in form and function. Through the next fifteen years electronics became a major component of fire apparatus. From the single electronic control module used on the diesel engine in the 1990s a fire truck today can have upwards of ten (10) control modules, more lights than ever, and increased communication equipment. As the electronics in fire apparatus grew so did issues that presented themselves, components out-of-service, ground problem, electro-mechanical interference, radio frequency interference, and the list goes on. Talk with anyone involved in the care and maintenance of fire apparatus and you will find that there is certainly no shortage of wiring/electrical horror stories around. Manufacturers reacted to the problems and worked on improving electrical systems, which is in some ways on-the-job training.

Many lessons have been learned through the evolution of fire apparatus. Electric systems and electrical problems make up a majority of the problems/lessons learned. Some lessons were learned though testing, some through problems that became apparent as apparatus were put into service and others through observation over a period of time. Each time the fire service was presented with a problem, solutions were sought and implemented. The solutions often treated the symptoms rather than the disease. As changes were made to the methods and materials being used in the construction of apparatus the corrosion issues moved to different components of the apparatus.

Beginning in the mid-1990s the use of electronics in fire apparatus grew exponentially and possibly in some ways improperly from the standpoint of what some of the side effects are. As the use of electronics has increased the amount of electrical current flowing around the vehicle body has also significantly increased. Some industry personnel are not sure that even now the industry has a complete understanding of how the increase in electrical components has effected and increased the metal deterioration associated with electrolysis. What has become apparent is that the electrical systems need to be much more stable and that stray voltage and electrical interference needs to be better managed.

Improper or inadequate grounding was having a much greater affect than anyone realized and may be a factor in the significant corrosion/electrolysis that has been observed in fire apparatus, especially those built between the late 1990s and mid-2000s. As the grounding of apparatus electrical systems has improved other issues have lessened, corrosion being one of them. Corrosion and electrolysis will always be with the fire service and continue to be something that needs to be managed on fire apparatus, with no complete fix. The solution or solutions will involve understanding the electrical, corrosion, and electrolysis issues better and how these issues are interrelated with each other. Making changes to the design and installation of the electrical system and components to limit problems caused by these issues along with better management of the maintenance part of the equation will be beneficial. Grounding of the chassis and body including the fixtures and components is critical. Grounding needs to be well installed and just as importantly well maintained.

All of this brings us back to Engine 1 and it’s corrosion problems. It is entirely possible that the corrosion issues are being exacerbated by electrical issues and electrolysis further compounded by grounding problems.

Is Engine 1 a good candidate for refurbishment? This question needs to be answered in stages each dealing with different parts of the equation.

The current estimate is for refurbishment of Engine 1 is $ 360,000.00 and this does not include rewiring the vehicle. For budgetary and realistic purposes, you have to add a minimum of 25% to the estimate figure on a refurb project. I have been involved in several refurbs over the years and none have been less than 25% more than estimate cost. This vehicle is 17 years old now. Does it really make good financial sense to spend over half the cost of a new apparatus on one that is only 7 years shy of its projected lifespan?

Is it a good decision to refurbish this vehicle without rewiring it? No, in my opinion. Figure 22 & 23 show a 2002 pumper made by the same manufacturer as Engine 1. This vehicle was refurbished because of rust and deterioration similar to Engine 1. It’s a body off refurb with the chassis rails being cleaned and repainted, not replaced. A few years after the refurb the rust and deterioration is back as bad as if not worse than prior to the refurb. The green arrows highlight areas where the chassis paint appears rough in texture these are areas of rust and delamination prior to the refurb.

Figure 22

Figure 23

Absence of clearly defining and correcting the causes of the rust/corrosion problems only succeeded in moving the problems around the chassis assembly. In a fairly short period of time the fire department found itself in the same position they were in a few years earlier.

What are the drawbacks to refurbishing rather than replacing? The single biggest, financial liability, there is no warranty on the major components. The diesel motor, automatic transmission, front and rear drive axles, fire pump, compressed air foam system, etc. are all being reused and there will be no warranty in place of any of these major components. From an operator/occupant safety standpoint you will still have a vehicle with all drum brakes, no cab air bag system, and no electronic stability control system. From a green perspective a diesel motor that has greater pollution potential than those be produced post 2007.

The type of paint, both primer and finish coats should be confirmed with Blaze Fighter for Engine 1. The information sought should be the paint manufacturer and type of paint, along with the color numbers. Once Any Town Fire Department has this information the paint manufacturer should be contacted and asked to inspect the vehicle. Explain to them that your apparatus has large scale delamination and other rusting issues. Also explain that the department is considering having the vehicles refurbished and that you are trying to get some definitive answers as to what is causing this problem so that the refurb specifications can properly address a solution.

Most paint companies will have their area representative check a reported problem like this. They may even take samples to send to their lab for further analysis. Either way you get an independent and authoritative source as to what may be causing or contributing to the delamination issues.

It is anticipated that this information will help with fleet decisions. ***BRTFAC*** is available to discuss this report in detail and answer any questions you may have. If you have any questions or need any additional information, please don't hesitate to contact us. Thank you for selecting ***BRTFAC*** to perform this inspection for the Any Town Fire Department.