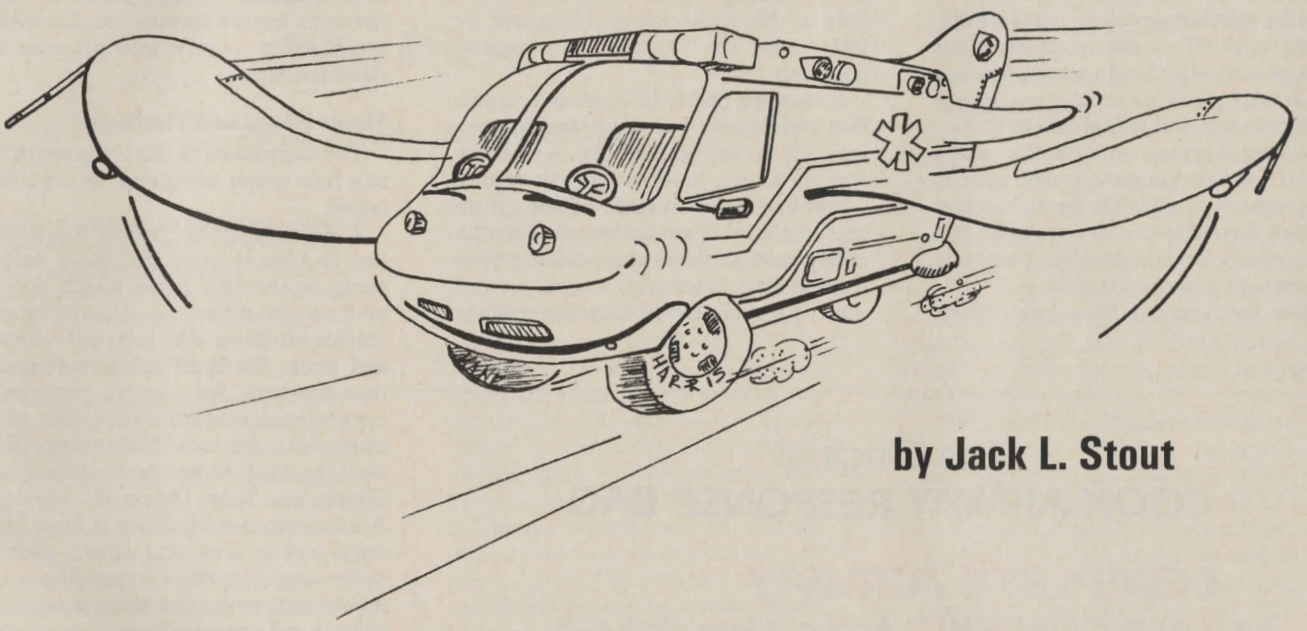
Ambulance Maintenance



by Jack L. Stout

Aircraft Standards Should Prevail

Roger Hickerson and Eric Maloy (and others like them) save as many lives every year as the best paramedics – maybe more. Their victories over death, though, never show up on the six o'clock news or in the local papers. They're the best in the business, yet hardly anyone knows it or would be impressed if they did. They maintain ambulance fleets.

Years ago, I began to notice that you can learn a great deal about an ambulance company by talking to its maintenance people and studying its maintenance programs. Over the years, I have found that every ambulance maintenance program falls into one of three categories: fix it when it breaks (deadly and stupid); good preventive maintenance (less deadly and saves money); and, rarely (but increasing), highly refined programs designed primarily to eliminate equipment failures during emergency runs.

No one defends the "fix it when it breaks" approach, though too many providers can honestly claim little more. But I've met owners and managers of large and well established ambulance operations who were actually proud of a preventive maintenance program that, if they ran a taxi company or a trucking firm, would be just fine. If they only knew the differences between their own maintenance programs and those developed by the best in the business, they would be more embarrassed than proud.

Prevent What?

Roger Hickerson, maintenance manager for Medevac's Kansas City Operations, was addressing a group of dignitaries from a California city interested in Kansas City's ambulance system. During his talk, he said, "Of course, ambulance equipment can't fail." The audience laughed, thinking Roger was making a little joke. He wasn't.

You see, he believes that, from a maintenance standpoint, an ambulance should be treated more like an aircraft than a taxi or delivery van. The question to ask about a preventive maintenance program is, *"What are you trying to prevent?"* The primary aim of conventional fleet maintenance programs is to prevent repair expen-

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ditures and to maintain fuel economy. Costs of the maintenance program must be balanced against the potential losses being prevented.

If the main objective of a maintenance program is to save money, then obviously it would be stupid to spend more money preventing a given type of potential equipment failure than it would cost to effect repairs after failure has occurred. That logic is entirely appropriate in most commercial transportation industries, especially those involving primarily local service. Few ambulance service providers understand, or have even considered, why that logic is out of place in the ambulance industry.

The logic underlying aircraft maintenance is different. The primary purpose of an aircraft maintenance program is to keep the vehicle from falling out of the sky. Saving repair bills is also an objective, but a distant second to the primary purpose of preventing equipment failure. Roger Hickerson and Eric Maloy believe that an ambulance en route to a cardiac arrest *must not fail* for the same reason aircraft equipment must not fail in the air. In actual practice, this difference in orientation creates ambulance maintenance programs that are light years ahead of the rest.

Over the years, I have been lucky enough to come in contact with a number of superb ambulance operations, and to see how their various maintenance programs work. Now and then, I come across impressively talented people managing equally impressive maintenance programs. For the most part, each of these programs is impressive in its own unique way. There is little communication going on among the maintenance people of the various organizations.

In fact, there has been so little communication going on, that the best in the business didn't know they were the best, and they didn't know there were others like them worthy of trading knowledge with. This lack of communication has made it difficult for manufacturers to collect organized feedback which would be useful in designing into their vehicles the very modifications that are being used by folks using the "aircraft maintenance" approach.

Something had to be done. In conjunction with some of its own regular meetings, the American Ambulance Association sponsored sessions on maintenance – mostly conducted by Eric Maloy, manager of Metro's Tulsa operations. Unfortunately, most of those in attendance were owners and managers – not persons directly responsible for large fleet maintenance. The result, while beneficial, was not the technical *exchange* that appeared to be necessary.

We decided to use what influence The Fourth Party has to encourage attendance by the *maintenance people themselves* – not just owners and top managers. I was certain that once the best in the business got together, they would be as impressed with each other's knowledge as I was, and they would see the benefit of organized exchange.

We figured if it worked, we'd do it every year, and try to figure a way to pay for it. If it didn't, at least we'd have a great time hanging out with the boys for a couple of days in Little Rock. It worked – far better than I could have imagined.

During this first symposium, we decided against inviting equipment manufacturers, mainly because we didn't want the meeting to turn into a forum for salesmanship.

Major Issues and Findings

The discussions of the symposium fell into nine major categories, as described below.

1. *Record Keeping Systems.* It is important to keep in mind that many participants represented firms which operate under some of the most demanding geographic situations, with large call volumes, and under the most stringent response time standards. For example, participants represented Eastern Ambulance (Syracuse, NY.), Medevac MidAmerica (Kansas City, Mo.), Metro Ambulance (Cobb County, Ga., Tulsa, Okla. and Little Rock, Ark.), Acadian Ambulance (a huge Louisiana service area) and others. Each of these companies has a demanding equipment testing ground, partly because of call volume and annual mileage accumulated, but mostly because of the extraordinary demands placed upon equipment by the combination of stringent response time requirements, paramedic level capability, and the private firm's need to achieve efficiency – or die.

Collectively, these companies and others like them generate enough equipment use experience to quickly locate equipment and maintenance program weaknesses – information needed by manufacturers and designers of maintenance programs. But unlike the aircraft industry, our industry has no industrywide system of record keeping capable of isolating subtle flaws for remedial engineering or special maintenance procedures. Perhaps as our industry matures such information will become available to manufacturers and maintenance managers.

In the meantime, the best in the business have developed their own internal record keeping systems – *systems designed mainly to isolate and eliminate equipment failure capable of interrupting an*

emergency response. Several participants have automated their maintenance data systems. Most employ means of recording problems reported by field crews, with feedback loops to let crews know the actual diagnosis of the reported symptoms, as well as the corrective action taken.

Besides keeping track of routine maintenance schedules, repair costs, and so on, these record keeping systems are designed to look for problem patterns so that equipment modifications can be made to eliminate failures during runs. Nearly every company has developed a laundry list of custom modifications it makes to new equipment before that equipment hits the streets. It is the dogged keeping and analysis of data that has most often proven the need for such modifications.

2. *Standard Service Programs Inadequate.* It was universally agreed that manufacturers' recommended service programs are totally inadequate in the setting of high performance paramedic systems. That's probably because, as mentioned earlier, those programs were never intended to approach aircraft standards of reliability.

3. *Fleet Standardization.* Participants placed a premium on standardization of fleets. Of course it's easier and less expensive to maintain a standardized fleet (e.g. smaller parts inventory and uniform factory training on new systems), but that's not the main advantage of standardization. Rather, participants preferred standardized fleets for three more important reasons. First, crews working in different units (especially in a disaster situation) are familiar with both equipment and stowage arrangements in all vehicles. Second, if a variety of equipment is used, there may not be sufficient use experience to detect patterns of failure so that corrective customization can be designed. Finally, when it is learned that some component needs beefing up or other modification, it is much more feasible to engineer and install the modification in a standardized fleet. In fact, such modifications may even be financially impossible in the context of a mixed fleet.

4. *Fleet Size.* It was generally agreed

Why Diesel?

By Rodger Hickerson and Wayne Brandon

The Kansas City ambulance system is currently undergoing a season of change. The change is from gasoline-powered to diesel-powered ambulances. The reasons for the change are discussed below.

What is a Diesel Engine?

The basic diesel engine was invented by Rudolph Diesel in 1892 and has been refined throughout the years. Instead of using spark plugs, distributor and ignition components, the diesel engine uses compression and heat to run. Diesel fuel is injected into each cylinder under high pressure, along with air. As the piston compresses the fuel and air mixture, it explodes, driving the piston downward to produce power. For cold weather starts, diesels have "glowplugs" which heat the combustion chamber for starting.

With a diesel engine package, you automatically get dual batteries, group 24 or larger, extra capacity engine cooling, a heavier suspension (both front and rear), and engine oil cooling. From this you can see that the diesel chassis has most of the extra equipment we normally order for any ambulance.

The maintenance equipment required to service a diesel engine costs approximately $1,500 vs. a $12,000 diagnostic machine with an infrared analyzer to service a gasoline engine. These equipment costs include timing, lights, tach/duall meters, voltmeters, ampmeters and pressure testing equipment.

The diesel engine is made to be rebuilt easily for long service life. The cylinders have replaceable liners in them. The valves have replaceable valve seats. It is common practice for the trucking industry to run a diesel chassis in excess of 500,000 miles with proper maintenance and reconditioning.

How does a diesel drive in comparison to a gasoline chassis? Today, diesels are available with automatic as well as manual transmissions. The only difference is in starting. On colder days, you turn the key to the run position and the glowplugs will come on to heat the combustion chambers. These will stay on less than six seconds, then the engine can be started. The glowplugs will cycle on and off until the combustion chamber reaches operating temperature.

Diesels can operate in extremely cold weather as well as hot. Below 32 to 36 degrees F, a weather front is placed over the grille of the vehicle. This restricts the air flow which builds up heat for patient and crew areas. In colder climates, there is a fuel additive to prevent jelling. Most diesels preheat the fuel before pumping it to the injectors. The warm fuel that isn't used by the injectors is then sent back to the tank. This keeps the tank warm.

A 110-volt block heater is standard with most diesel engines. In extremely cold climates, you would need a second block heater, a tank heater for each fuel tank, and a battery heater for each battery.

Performance for each type of chassis is the same. With a gasoline engine, your top speed is achieved with horsepower. A diesel achieves its top speed with gear ratios due to its low revolutions per minute. The diesel engine has more torque at the rpm end of the scale than does a gasoline engine.

Diesels develop more low end torque than gasoline engines, which have high end torque. The Ford 6.9L diesel, for example, developed 70 percent of torque at 1200 rpm. The difference translates to a faster initial acceleration by gasoline engines – a difference that most drivers would not notice in day-to-day driving. In that smooth acceleration and deceleration are more important to ambulance operation than "jackrabbit" starts and stops, the difference probably will not be noticeable.

What about fuel mileage? A gasoline type I or type III chassis gets between four and eight miles per gallon. A type II chassis will get from 10 to 14 MPG. A diesel type I or type III gets between 18 and 22 MPG; a type II gets between 20 and 26 MPG. These figures were taken from an ambulance service currently operating a fleet of five units in the midwest. Figure 1 translates all this into the financial impact of each type of engine.

As seen in Figure 1, the initial cost of the diesel is approximately 16 percent higher than the gasoline chassis. Maintenance of equipment is 87.5 percent cheaper for a diesel than a gasoline engine.

A fleet of 20 diesel vehicles driven one million total miles in a year would pay for the added expense of diesel engines in four months with savings from fuel costs alone.

These are some of the important reasons why the Kansas City EMS system is changing to diesel – we can't afford not to. □

Rodger Hickerson has been a truck mechanic for 25 years and has 15 years of fleet management experience. Wayne Brandon, a nationally registered EMT-P, has a degree in engineering and experience in fleet management. Both work for Medevac MidAmerica in Kansas City.

that the fleet should be, *at a minimum*, 25 percent larger than the ambulance system's highest anticipated peak load coverage schedule including long distance transfer units. Topping the list of reasons was more reliable response time coverage, followed by cost savings from less crew downtime when equipment must be replaced mid shift, elimination of mechanics' overtime caused by need for emergency repairs, smoother and faster crew changes and full opportunity for vehicle checkout and restocking between crews. (Alan Jameson has previously documented the false economies of low equipment quantities, and the saving to be had by slower depreciation of larger equipment inventories vs. more rapid depreciation of smaller equipment inventories. See "Financial Strategies for Surviving the '80s, Part 3," *jems*, May 1983, p. 42.

5. *"Failsafe Driving" Program a Winner.* Several of the companies reported tremendous results from using the "Failsafe Driving" program. Besides driver training and other features, this program uses a small computer, usually mounted under the driver's seat, to measure and record forces generated during acceleration, braking and cornering. This "performance driving computer" consists of two linear accelerometers, solid state electronics on a printed circuit board, two six-digit counters, a speaker and a 12-volt battery pack all self-contained and sealed in a tamper-proof steel mounting case. The system helps sensitize drivers to the stresses their driving patterns generate, building habits of smoother driving without sacrificing response time performance. Participants reported lower accident rates, much improved fuel economy, an improved ride for patients, and dramatic reductions in maintenance and repair costs. Some "Failsafe" users reported using driver incentive programs, tying cash bonuses to performance measured by the "Failsafe" computer.

6. *Diesel Wins.* The jury seems to be back with the final verdict on the question of the best fuel type for ambulance services. Participants had extensive experience with gas, propane and diesel. The vote of the most experienced firms went heavily toward diesel (see accompanying article by Brandon and Hickerson).

7. *Custom Modifications of New Equipment.* It was clear that most participants either make or specify extensive custom modifications to new equipment before putting it on the street. Louvered hoods to dissipate heat, custom molded silicone radiator hoses, larger capacity transmission oil coolers, and numerous other modifications are made to improve reliability as well as extend equipment life. (Again, the aircraft analogy rears its head in the form of louvered engine compartments, zero-failure hoses, and high performance lubri-

cant cooling systems.)

8. *A Thousand Little Things.* It has been said that the thing that most distinguishes successful firms from less successful firms is "a thousand little things done right." There were at least that many "little things" discussed at the conference, such as keeping battery tops clean to avoid electrical leakage across posts, keeping color-coded springs straight during brake jobs, and avoiding use of paraffin-based oils. Somewhere down the line, someone will live instead of die because one little thing was done right.

9. *Alternative Technology.* For some time now, I have been intrigued by the prospect of adapting certain technologies which I have seen used successfully in the offshore marine environment and in the oil exploration industry. Both of these environments place tremendous demands upon equipment. Extreme reliability is essential. Huge electrical loads and environmental control requirements are combined with long periods of engine operation under both adverse operating conditions and long-term idling.

For the most part, these industries have long ago separated the power plant which moves the vehicle from the power plant which drives compressors and generates electricity. I learned that Frasier, Inc., a company based in Houston with extensive experience designing and building off-road vehicles for the oil industry, had recently built a special unit for use as an ambulance by the Houston Fire Department. That vehicle employed a skid-mounted auxiliary engine to drive air conditioning compressors and to generate electricity, effectively eliminating those loads from the main engine, eliminating the umbilical cord from the main engine to the patient compartment, adding redundancy to electrical systems, and greatly simplifying future remount procedures.

Personally, I believe this alternative technology is right for our industry, but I was nearly alone in that view at the symposium. Still, it seems to me that much of what we are doing with our custom modifications and super maintenance systems is really just trying to overcome the built-in disadvantages of relying upon a single engine to do several, essentially unrelated jobs. Just as we used to believe in highly complex and centralized main frame computer systems, and are now seeing the advantages of distributed data processing, it seems to me that several simple and functionally independent power systems may ultimately prove more reliable and easier to maintain than a single complex network of highly interdependent components and subsystems.

We invited John Griffin, president of Frasier, Inc., to discuss his views on this alternative approach to reliability with workshop participants. The discussion was fascinating and brain stretching for us all. We will continue to include a session on new or alternative technologies in future conferences.

Next Time

That first *Fourth Party Maintenance Symposium* proved more than we had hoped for. Every participant strongly supported continuing the program. Some suggested that manufacturers be allowed to attend, but only as observers, except for a limited opportunity to ask additional questions. It is a suggestion with merit.

To be honest, if we had better anticipated the wealth of knowledge, facts, informed opinions and nuts and bolts details that came out of this meeting, we would have arranged for professional transcription and production of edited "Official Proceedings." Instead, what we have are our own notes and our memories. Next year we promise a bigger and better symposium, and a full set of "Official Proceedings" which can be purchased by manufacturers and provider organizations. □