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Why Heavy Vehicles Catch Fire

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1 Overview

There are far too many truck, trailer and bus fires. A careful examination of many burnt-out vehicles suggests there are a few common causes. This document summarizes these common causes and makes suggestions on how to avoid truck fires.

Whilst fire is possible under many initiating conditions, it is rare that conditions are suitable for fire propagation. Indications of hot spots on wiring, plastic shields in the engine compartment or bearings should never be ignored.

The most common causes of heavy-vehicle fires are:

- Arcs on the starter (or battery cables), the alternator cable or the positive feed wire into the cabin.
- Flammable material resting against the turbo charger or the exhaust;
- Fuel line rubs or failures that result in leaks / sprays of fuel onto the exhaust.
- Lubrication oil line failures near to the exhaust.
- Turbo charger failures that cause excessive temperatures in the exhaust;
- Leakage of hot gases from the exhaust.
- Electrical arcs at terminals or connectors resulting from hot terminals that cause insulation to melt and catch fire.
- Addition of heavy add-on loads onto a circuit not intended for it. If the fuse rating is increased, the wiring may not be adequately protected.
- Collection of carbon dust / organic residue in alternators leading to short-circuit.
- Tyres catching fire because they are flat or poorly inflated or rubbing on hard surfaces.
- Wheel bearing failures resulting in bearing grease catching fire. Sometimes overheated brakes cause the bearing grease to catch fire.
- Road debris that catches under vehicles and is combustible.

To minimize risks:

- Specify that vehicles have circuit breaker protection on the alternator, trailer feed and cabin power supplies from the batteries.
- Specify that the starter motor cable is double insulated, conduited and taped closed.
- Use plastic conduit to protect electrical cables that has fire-retardant properties.
- Insist on rubber-block clamps to hold main electrical cables in place. Avoid clamps that have a metal spine and a thin rubber insert. If the rubber insert come out, a sharp metal edge will cut into the loom.
- Keep combustible parts, such as noise shields and fiberglass engine tunnels, well away from the turbo and exhaust.
- Check and adjust the wheel bearings regularly.
- Don't add heavy electrical loads onto existing electrical circuits.
- Use compressed air to blow residue out of alternators and starter motors.
- Check for rubs on the fuel lines and on the turbo charger oil line. Ensure that that fuel hoses are clamped at the ends and properly fixed.
- Keep fittings in hoses that carry oil or fuel well away from the exhaust. Anticipate whether a failed fitting could spray the fluid onto the exhaust pipe.
- Check that the tyres are pumped up and cannot rub on hard surfaces.
- Ensure that heat shields that might be on the exhaust (for diesel engines) are tight and in-place. Exhaust clearance to combustible materials should exceed 150mm.

Other useful precautions are to carry a fire extinguisher and to open circuit the batteries using an isolation switch when the vehicle is parked.

2 Necessary Conditions for Fire to Occur

Fire takes hold under the following three conditions:

- Some (combustible) material is heated to its ignition temperature;
- There is an adequate supply of oxygen (air);
- There is a propagation path for the fire.

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The rate at which a fire spreads also depends on these factors. Well-oxygenated fires in materials that have low ignition temperatures spread quickly while fires in, for example, wheel bearing housings are usually slow to propagate.

The obvious materials that burn are:

- Wiring insulation (normally has an ignition temperature about 150ºC).
- Plastic and polymer materials used as noise shields, insulation, flooring, trim, etc.
- Fiberglass used in the cabin.
- Hydrocarbon fluids such as diesel fuel, lubricating oil, bearing grease,….
- Rubber tyres.
- Plastic tubing, straps, and air hose rubber coatings.
- Hydrogen build-up in batteries leading to explosion.

Experience shows that metals are never the initiating materials. Solder always melts and aluminium often melts as a result of fire, but this is consequential.

Copper, brass and steel are oxidized by exposure to fire but only melt at electrical arc points. Electrical short circuits may produce local hot spots with temperatures sufficient to melt these metals. Therefore, electrical short-circuits can usually be identified from solidification globules and arc craters on either electrical or adjacent earthed metal.

1 *Aluminium can melt during a truck fire. Steel and copper do not, other than at arc points.*

3 Causes of Truck, Trailer and Bus Fires

The potential causes of vehicle fires will be considered under the following categories:

- Electrical causes.
- Turbo charger and exhaust fires.
- Hot brakes and wheel bearings.
- Tyre fires.
- Road debris.

3.1 Electrical causes

There are seven mechanisms by which electricity can start a fire. These are:

1. An electrical component gets excessively hot and ignites nearby combustible material.
2. Failure of the insulation on a live part leads to an electrical arc between a live conductor and a neutral or return conductor (or metal).
3. A coating of grime or carbon dust from pollution settles on an electrical circuit (such as exposed circuit boards) and resulting in bridging out of the circuit. This causes localized heating and leads to arcing. Sometime the grime comes from leaking electrolytic capacitors or from poor circuit board construction that allows moisture to penetrate the board.
4. An intermittent connection in the circuit (either in the live side or the return side) results in sparking as the circuit makes and breaks. The sparking ignites nearby flammable materials.
5. Current flow through a poor electrical connection results in excessive heating at a terminal. The increased temperature melts nearby plastics and ignites flammable materials.
6. Static electricity builds up on an insulator attached to a moving part and there is a consequential spark that ignites volatile gases or liquids.

7. Internal failures in a component (such as a polypropylene capacitor) generate gases that lead to explosion and fire.

Note that when an electrical circuit carries current there is always some magnetic energy stored in the space around the circuit. When the current is interrupted the magnetic energy is transformed into its electrical form. If the transformed voltage is sufficient a spark may occur.

In the automotive domain these seven causes can lead to fire in the following ways:

- <u>Failure of electrical insulation leading to short-circuit and arcing.</u>

This cause also requires failure or inadequacy of the circuit breaker or fuse protection (if fitted) because the purpose of this protection is to turn off the circuit when a high, dangerous current level occurs.

In particular insulation rubs on unprotected battery cables to the starter motor, alternator, cabin supply and trailer box supply can cause fusion / arcs.

The fault current potential on the alternator line (assuming that it has circuit breaker protection in the battery box) is roughly equal to the alternator current rating. A circuit breaker is never fitted at the alternator terminals. Therefore, the alternator electrical cables should be designed to withstand more than the alternator current-rating level continuously – 150% of the alternator rating as a guide.

Note that the starter motor terminals are usually uncovered, even on fuel-haul trucks! If a spanner is dropped across them, a short-circuit and fire could result.

Some manufacturers run the alternator and cabin supply cables from the starter motor terminals rather than the battery terminals. When this is done these cables are electrically unprotected. This is expediency. Cabin and alternator power cables could and should have circuit breaker protection in the battery box.

The starter motor cables are never protected by circuit breakers because it is impractical. This means that they are vulnerable to short-circuits.

Manufactures rely upon the mechanical protection (outer conduit and double insulation) of the starter cables and suitable stand-offs. Sometimes a metal protrusion separates the split conduit covering and causes a rub on the cable insulation.

Insulation failure sometimes occurs as a result of rubbing due to road vibration between the wire insulation and a vehicle part or against the corrugated internal ribs of protective plastic tubing.

2 *The result of a rub between the alternator cable and an engine stud. The alternator cable was double-insulated with a split-conduit covering but the split worked its way around to the stud position. There was no circuit breaker protection at the battery end.*

- Excessive current flow leading to hot wiring and burning insulation.

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This can result from inadequate wiring design. Trucks can operate continually with high electrical loads under hot ambient conditions.

A conservative rule is to limit the continuous current draw to $5A/mm^2$ of copper cross sectional area. For example, using this guideline, the current rating of a $2.5mm^2$ V75 stranded automatic cable is 12.5A. Many designers would regard this as an excessively conservative rating. However, in my experience it is sensible for Australian conditions, because of high loads, hot conditions and some inevitable degradation with age of the electrical system.

Occasionally a blanket screw used to hold the trim in place will damage a cable within the cabin wall. A hot point can occur with road use. Circuit breaker protection should be adequate to protect against this but sometimes is not.

Electrical fires should not happen on circuit-breaker (or fuse) protected circuits. If they do the protection is poorly designed or has been modified. The protection level is sometimes inadequate when a light gauge wire (say for instrumentation purposes) is taken off a heavy current circuit. A fault on the light gauge wire is not adequately protected.

Sometimes a heavy electrical load, such as a refrigerator, is connected to a light gauge circuit and the fuse rating is increased. If the wiring gets hot due to the high current level, there is a risk of fire.

Automatic reset circuit breakers were commonly used on American trucks. These reset after cooling down and continually energized a faulted circuit. They are no longer popular because of the poor level of protection they offer. Their use on fuel-haul trucks has long been outlawed under AS 2809.

Manual reset circuit breakers (or fuses) that have an excessive rating for the wiring they protect also offer poor protection against faults.

Fires sometimes start on additional heavy current cables that are run as a separate power supply to the trailer(s). If no circuit breaker is installed at the battery end, there is the possibility that a rub will lead to fire.

- <u>Hot terminals develop at slip connector points leading to melting of plastic housings and potentially to fire</u>. A mix of poor design and long-term deterioration of terminals contribute to this. Current levels can be within specifications although some specifications are too high. For example, as a rule a ¼" (6.3mm) blade terminal should be limited to a maximum of 15A continuous current. Automotive relays with ¼" blade terminals are often rated at 30A!

Note that terminal contacts often degrade over time due to temperature cycling and the ingress of dust.

- Stall of blower motors in the HVAC leading to excessive speed-resistor temperatures. Fire may result when surrounding flammable materials experience elevated temperatures from the resistor overheating. A circuit breaker cannot protect against this because the resistors limit the current to tolerable levels. However, they may get unacceptably hot if the motor is stalled.

- Combustible material resting against blower speed resistors. Speed control resistors should be encased within a protective enclosure. Sometimes they are not! If materials such as leaf litter gets in via the air intake, combustible material can rest against the hot speed control resistors (which are often located in the air flow).

- Batteries produce hydrogen gas. Batteries produce hydrogen gas during normal operation. If there is a poor contact inside the battery, then a spark may occur and the battery can explode. This does happen occasionally but fire generally does not follow. Suitable ventilation of the batteries is sensible.

- Occasionally starter relays weld on due to high inrush currents. If the relay contacts weld together the starter motor will run continuously and overheat potentially leading to fire.

- Occasionally carbon dust or organic mater that has collected inside an alternator or starter motor will result in minor current leakage that over time can grow into a short-circuit.

- A loose terminal on the starter motor return terminal can force current to return via minor earth paths between the starter motor and the battery via the chassis rails. This can cause overheating on light-gauge earthing cables.

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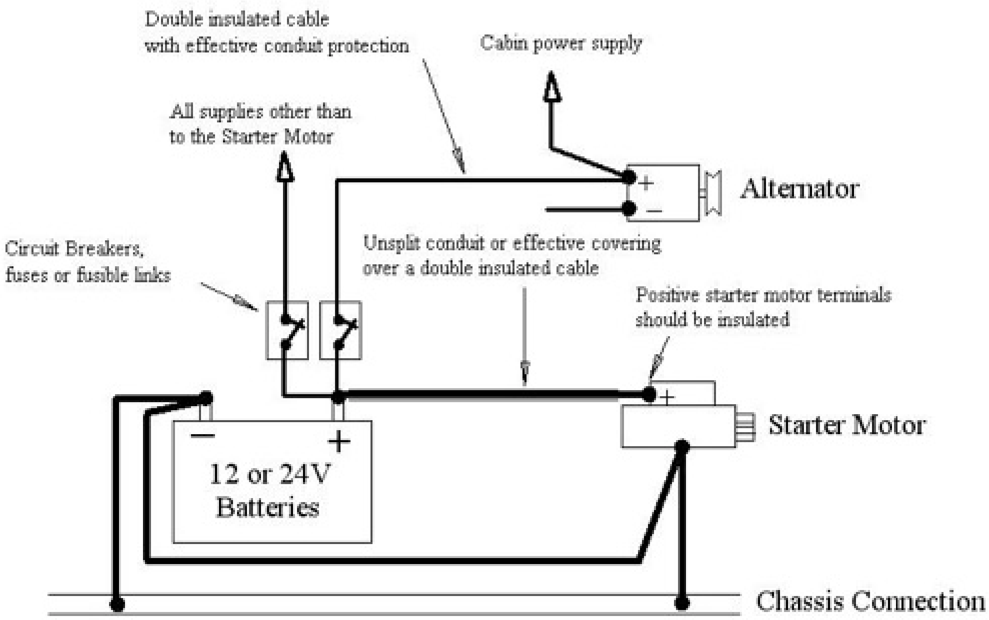
3 A starter motor cable tucked between a bolt stud and the battery box cover ignited this fire. The plastic conduit on the cable was split and the split worked around to the stud position. Note that the steel stud melted.



4 *A suitable electrical protection scheme for the starter, alternator and cabin circuits.*

5 *The alternator on this flow motor engine caught fire whilst off. The accumulation of grain dust around the diode assembly resulted in leakage current that increased over time into a short-circuit.*

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3.2 Turbo Charger and Exhaust Fires

Potential causes are:

- Failure of turbo charger oil seals leading to engine oil being pumped into the exhaust causing internal fire and excessive temperatures. The oil seal failure can be the result of a mechanical clash between the rotor and the housing.

- Fires that occur inside turbo chargers are usually captive within the exhaust. However, occasionally the fire spreads to the air-intake side where it readily burns through the aluminium or rubber tubes and gets into the engine compartment.

- Failure of the oil hose / tube leading to the turbo charger causing oil to be squirted onto the turbo-charger or the exhaust.

- Flammable materials being too close to the turbo charger or the exhaust. Sometimes these materials come out of the cabin via the shift tower hole.

- Fuel line leaks or failure resulting in aerosol fuel mixture on the exhaust side of the engine. Very occasionally, a retread tyre blow out will damage fuel lines.

- Dripping of flammable fluids from the bottom of the cabin onto the exhaust / turbo. Occasionally this results from fuel line failure on the left side of the engine.

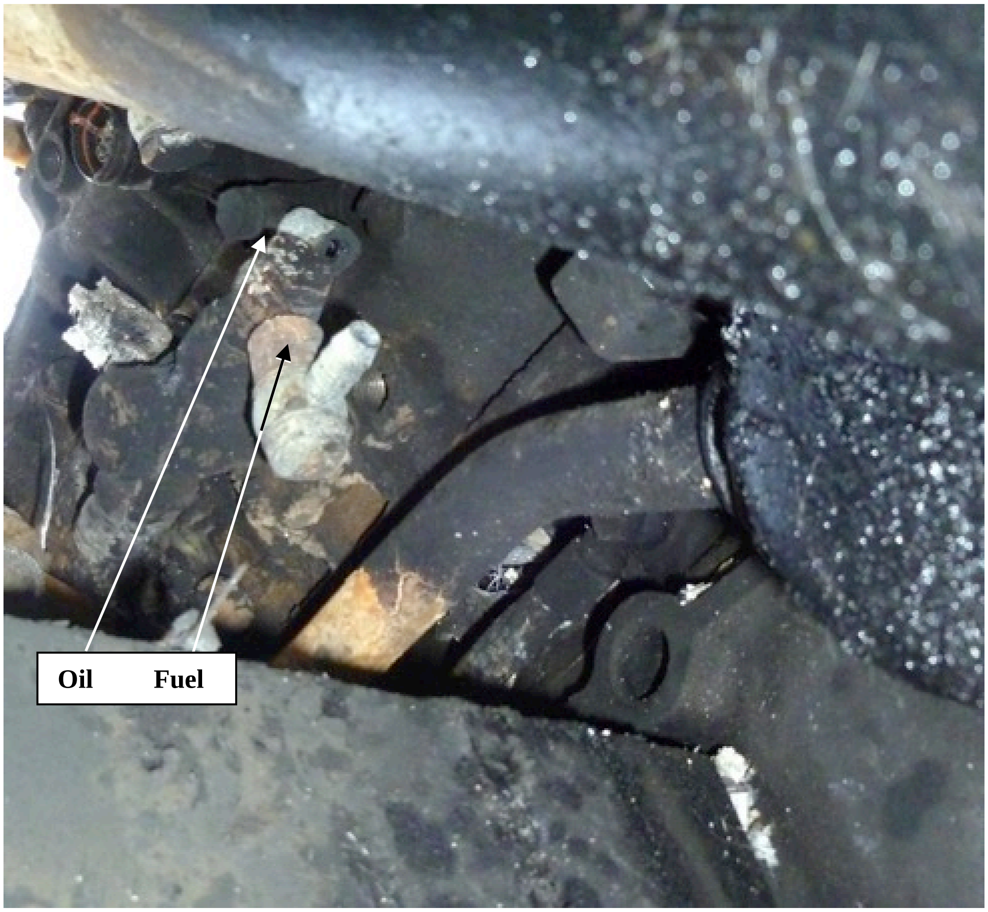
- Debris such as cloths coming through the gear shifter mounting hole and touching the turbo or exhaust.

- Gaps or holes in the exhaust pipe that allow hot gases to escape and strike combustible material (noise shields, cab insulation etc).

- Failure of a hydraulic brake hose close to an engine extractor pipe resulted in a spray of brake fluid which resulted in an explosive fire.

6 A failed turbo charger blade led to bearing failure and then seal failure. Oil pumped into the exhaust caused an exhaust-fire that destroyed the truck.

7 Failed bearing seals as a consequence of shaft failure. Oil from the bearings caused a fire in the air-boost side that melted the aluminium air delivery pipe and escaped into the engine compartment. Fires in the *exhaust side will always occur when seals fail. Fires in the air intake side are rarer but do occasionally occur.*



8 A failed oil lubrication on a fuel pump probably caused this engine fire.

3.3 Hot Brakes and Wheel Bearings

These can occur from:

- Dragging brakes resulting in excessive brake temperatures and wheel-end fires in bearing grease that spreads to the tyres. Very hot bearings may also cause the grease to ignite.
- Dragging brakes commonly occur on the last trailer in a road-train because the air supply to the rear trailer is often depleted and slow to recover.

- Very occasionally, very poor brake balance results in disc brakes overheating causing the bearing grease to ignite. This can occur if one vehicle in a combination is providing most of the braking effort.

- Failure of wheel bearings can result in dragging brakes. Stub axles invariable have two bearings separated by ~ 100 mm. Excessive bearing wear or failure results in the wheel axis being slightly off the centre line of the axle. This leads to dragging brakes. Failure of one bearing Usually leads to degradation and eventual failure of the second bearing due to circulating metal fragments.

9 *A failed outer wheel bearing on this semi-trailer front axle failed and the brakes dragged in consequence. Excessive brake drum temperature led to a tyre fire. The tyre fire resulted in total fire loss of the trailer.*

Fire initiation is due to the brakes dragging and this causes the wheel rim and then the tyres to experience an excessive temperature. The tyres catch fire. Fires resulting from bearing failures are common, particularly on trailers. Trailer wheel bearing maintenance is often missed compared to prime-mover / truck / bus wheel bearing maintenance.

Drum-brake trucks are more vulnerable than are disc-brake trucks because theability of the heat to transfer to the wheel rim is easier for a drum-brake than a disc-brake, however, the disc brake gets hotter faster and may become red-hot. There is a danger that combustible material close-by, such as grease, might catch fire.

10 This fire started from failure of bearings on the front axle.

Note that both bearings on the front axle have been destroyed. It can be difficult to identify the failure mechanism afterwards.

The brake linings have bevel wear on the outer line. This occurred because the brake drum was not running centrally on the axle because of bearing failure.

Extreme brake temperatures resulted from the dragging brakes and this eventually causes the tyres to catch fire.

There are five causes of wheel bearing failure, which are:

1. Inadequate or contaminated lubrication.
2. Overloading leading to excessive forces on the bearing.
3. A faulty bearing.
4. Inadequate pre-load due to the axle nut being set too loose.
5. Excessive pre-load due to the axle nut being too tight.

Note that wheels that have been submerged in water should be inspected and re-greased before sustained use. Water and the debris that it brings in, may destroy lubricant.

Setting the bearing pre-load requires skilled mechanical installation work. Typically the adjuster nut is over-torqued and then released whilst the wheel is manually rotated. The nut might be backed off 1/4 turn before being locked. The following chart summarizes recommended adjustment practice for truck and trailer wheel bearings. Note the recommendation that a dial indicator and torque wrench be used.

Tapered Roller Bearing Adjustment Procedure RP 618A

Step 1: Lubricate the tapered roller bearing with clean axle lubricant of the same type used in the axle sump or hub assembly.
NOTE: Never use an impact wrench when tightening or loosening lug nuts or bolts during the procedure.

Initial Adjusting Nut Torque	Initial Back Off	Final Adjusting Nut Torque	Axle Type	Threads Per Inch	Final Back Off	Nut Size	Torque Specifications	Acceptable End Play
Step 2	Step 3	Step 4	Step 5		Step 6	Step 7		Step 8
200 lbf•ft (271N•m) While Rotating Wheel	One Full Turn	50 lbf•ft (68 N•m) While Rotating Wheels	Steer (Front) Non-Drive	12	1/6 Turn*	Install Cotter Pin to Lock Axle Nut in Position		0.001" - 0.005" (.025 - .127 mm) As Measured Per Procedure With Dial Indicator
				18	1/4 Turn*			
				12	1/3 Turn*	Less Than 2 5/8"(66.7 mm)	200-300 lbf•ft (271-407 N•m)	
				14	1/2 Turn*			
				18				
			Drive	12	1/4 Turn*	Dowel Type Washer	300-400 lbf•ft (407-542 N•m)	
				16		Tang Type Washer**	200-275 lbf•ft (271-373 N•m)	
			Trailer	12	1/4 Turn*	Less Than 2 5/8"(66.7 mm)	300-400 lbf•ft (407-542 N•m)	
				16				

* If dowel pin and washer (or washer tang and nut flat) are not aligned, remove the washer, turn it over and reinstall. If required, loosen the inner (adjusting) nut just enough for alignment.
** Bendable type washer lock only: Secure nuts by bending one wheel nut washer tang over the inner and outer nut. Bend the tangs over the closest flat perpendicular to the tang.

Verify end play with a dial indicator. Wheel end play is the free movement of the tire and wheel assembly along the spindle axis.

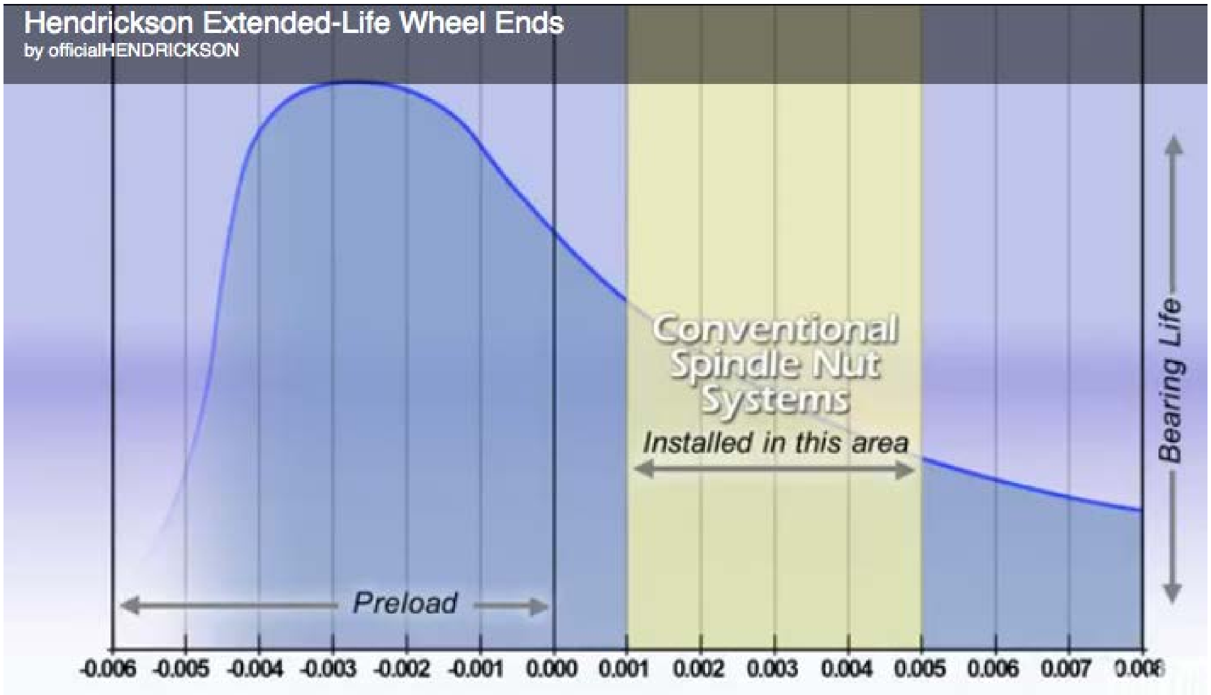
a) Make sure the brake drum-to-hub fasteners are tightened to the manufacturers' specifications.
b) Attach the dial indicator with its magnetic base to the hub or brake drum.
c) Adjust the dial indicator so that its plunger or pointer is against the end of the spindle with its line of action approximately parallel to the axis of the spindle.
d) Grasp the wheel assembly at the 3 o'clock and 9 o'clock positions. Push the wheel assembly in and out while oscillating it to seat the bearings. Read the bearing end play as the total indicator movement.

NOTE: If end play is not within specification, readjustment is required.

11 An excerpt from the TMC (USA) Recommended Practice RP618; that is on the Timken website.

The following graphic from the Hendrickson website shows how critical bearing pre-load is. The optimum preload is about -0.001" . If the bearing preload is set to -0.004", premature bearing failure is predicted. Correct setting requires experience and the proper equipment.

Mechanics sometimes over tighten wheel bearings because they sense slackness but this is due to wear on the axle stub. No degree of bearing tensioning will overcome the axle wear. Carefully inspect the bearings to see that they are properly engaged on an axle that has acceptable wear levels.



12 Hendrickson general information about the relationship between Bearing Life and Preload for class 8 truck axle bearings.

3.4 Engine Fires

Engine failures can result in oil getting out onto the exhaust. Failure of a pushrod occasionally occurs and the pushrod cover through an aluminum rocker cover. If the hole is close to the exhaust then fire is possible.

Another failure mechanism is that a hole in a piston can result in pressurization of the oil lubrication system. This can result in excessive pressure under the rocker cover. If the rocker cover is made of relatively weak material (such as fibre-reinforced plastic) cracking and oil leakage can occur. If the leak is above the exhaust then a fire will result.

13 An engine failure resulted in the engine cover breaking. Oil leakage onto the nearby exhaust caused a fire that destroyed the truck.

3.5 Tyre-Related Fires

Tyre fires can occur because:

- Flat or poorly inflated tyres can rub either on guards, chassis or other tyres. Tyres can get hot enough to ignite.

  Once alight, tyres are extremely hard to put out. It is probably useless to use a single extinguisher on a tyre fire. One approach is to keep driving with the tyre on fire because the cooling air tends to keep the fire under control! This may or may not save the vehicle.

- Hoses, electrical wiring or plastic wheel guards not tied back can rub on tyres. This will produce high temperatures but generally just rub damage because the cooling air from the tyres tends to keep the rub point below ignition temperature.

- Plastic wheel guards can rub and become hot. In all cases in my experience they wear away without catching fire.

- Hoses rubbing on the tail shaft might be a minor risk.

- Air bag failures can cause tyres to rub on the underside of solid bodies. The tyres then heat up to ignition temperature.

- Overheated brakes can cause the tyre rubber to soften and cause bead failures. Heat from a very hot drum can ignite the tyres.

14 Poor brake balance resulted in hot brakes on one side of a trailer axle. The brake drum was so hot that the tyre caught fire.

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15 Evidence of pre-fire tyre rub on a metal mudguard. The bearings have not failed.

3.6 Road Debris Fires

Occasionally trucks run over road debris that lodges under front or rear axles. If the debris has metal in it and is combustible (such as a mattress) the sparks from the dragging metal can cause the debris to ignite. Tree branches with dead leaves attached can also catch fire under a truck.

Drivers who know they have driven over road debris need to stop to check that it did not get caught.

3.7 Specialist Vehicle Fires

Specialist vehicles may be at risk of fire due to the nature of the operation. Three examples come to mind:

- Elevated metal parts touching bare overhead power lines. This is an obvious safety hazard for bystanders. It can also result in tyre explosions leading to fire.

**Photo no. 2:
Tire that burst, semi-trailer hit by an electric arc near a high voltage line.**

16 If an elevated metal part of a vehicle touches a medium- or high-voltage line, tyre explosion can occur.

- Waste compaction trucks can accumulate volatile liquids in the sump of the compactor. The sump is usually at the back of the engine compartment where it is heated by the exhaust and by waste heat from the engine. The heating might occasionally result in ignition of volatile liquids.

17 *Proximity of the waste compactor body to the exhaust pipe and rear of the engine compartment should be considered when volatile waste might be carted.*

- Fuel-tankers are vulnerable to static electric sparks that can occur during fuel discharge. Fuel flow through rubber or plastic hose generates static electricity. The static electricity is neutralized by providing a conducting (wire) path from one end of the hose to the other. If the path is broken then a spark is likely to occur. If the spark occurs where there is an explosive atmosphere, a fire is likely to occur. Incidentally, fuel-delivery hoses at fuel-stations are made with a definite level of electrical conductivity. The metal filler nozzle should contact the metal structure the fuel tank at the filler hole. In this way the build-up of static electricity can be controlled during filling.

  Static electricity is also generated when grain is pumped through rubber or plastic pipes. Sparking can ignite airborne dust leading to explosion and fire. Particular care is needed when designing vehicles that discharge non-conductive materials through insulated hoses or tubes.

18 *Fuel tankers have some particular vulnerabilities to fire.*

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4 Investigations

After the fire, whether large or small, the cause should be determined.

Before electrical fires occur it is common for there to be a smell of electrical insulation and / or faulty operation. Such tell-tale signs should not be ignored. Insulation failure often develops over time.

It is usually obvious where the fire started because of the distribution of the damage and the smoke and heat patterns. Usually (but not always) the damage is most intense near the source of the fire.

If the fire started under the cabin floor on the left side (the starter side), suspect an electrical fault on the starter / alternator / cabin wiring.

If the fire started on the right-hand side of the engine compartment suspect a turbo charger / exhaust fire.

Fire starting in the cabin is likely to be electrical in origin. Possible sites are at relay bases, switch bases and at heavy-duty terminal housings.

The main power harness run is a potential region of rubs leading to arcing damage. This is likely to be under the console towards the front.

Remember that fire will often damage electrical wiring and that arcs may occur as a consequence rather than as the initiating event. Electrical fires can either be caused by insulation damage leading to arcs or from excessive heat leading to burning (plastic) insulation or components. In the latter case arcs may not occur.

The starter motor cables and wiring inside the battery box should always be scrutinized for signs of arc damage. Evidence that steel parts have been exceedingly hot (causing bluing and / or melting) often indicates the site of a short-circuit.

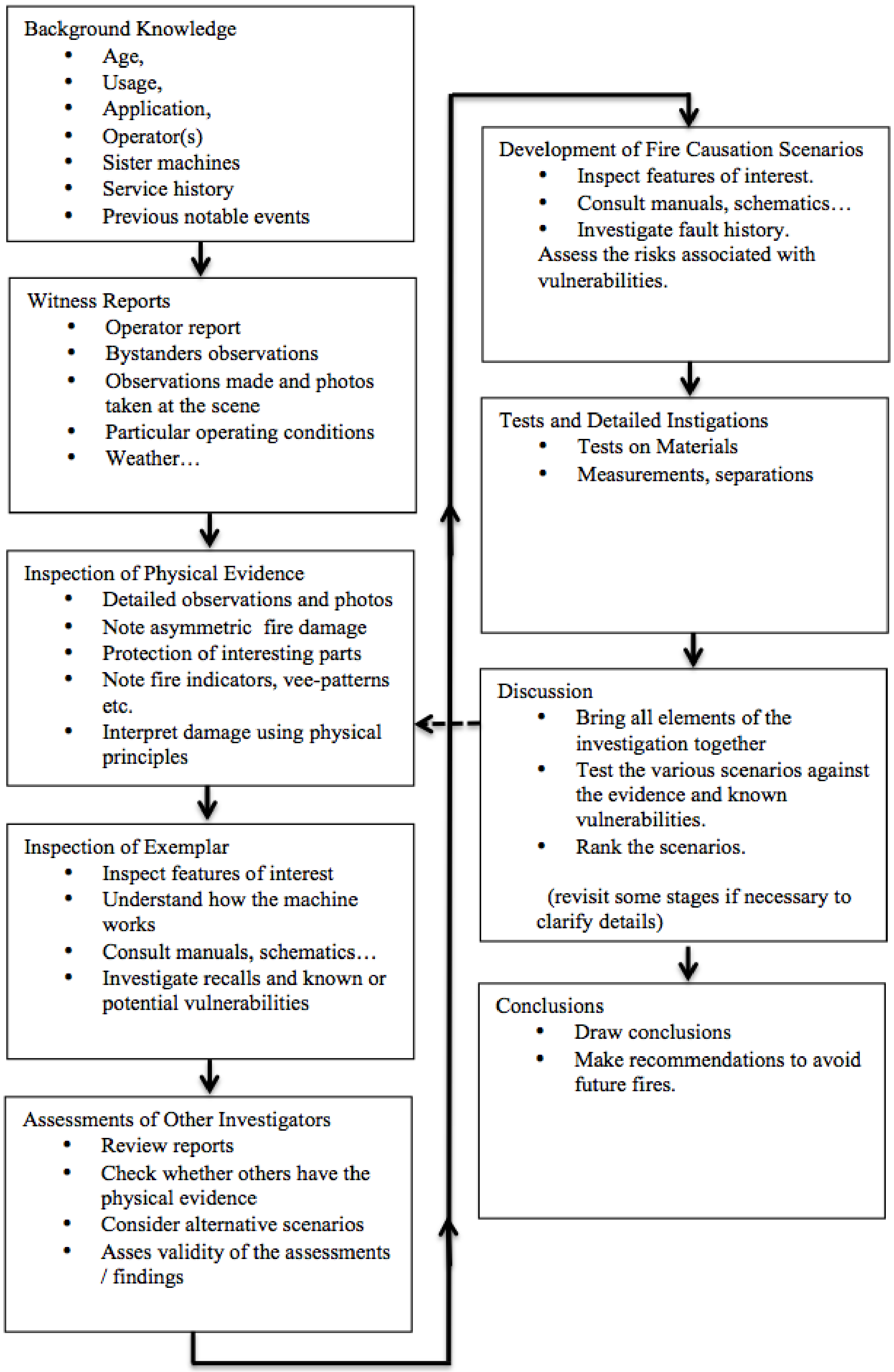
Fires in the heater / air–conditioner unit will usually cause smoke to come out the vents. This is a tell-tale sign of a developing problem. Sometimes a fire outside the heater / air conditioner gets into the cabin via a melted duct or air intake.

Fuel lines usually run along the left-side of the engine and then along the left-hand chassis rail to the fuel tank(s). Developing rub marks may be evident at clamp points. Fuel related fires are usually explosive and will be heard or felt early on.

An outline of the forensic investigation process is shown in Figure 18. Often there is doubt about forensic assessments because the evidence is imperfect. A guide to the strength of opinions that can be reached is:

Strength of opinions:

Proven	Level of certainty = 100%
Compelling but not proven	
Likely	
Plausible	
Possible	Level of certainty = 50%
Implausible	
Very unlikely	
Excluded	Level of certainty = 100%



19 Stages in the forensic investigation process.

5 Inspections

A suitable fire extinguisher should always be carried in the cabin of a heavy vehicle.

The next best protection is to deliberately inspect for possible problems that could initiate a fire. Check to see that the equipment is in good condition. Every few months spend an hour scrutinizing the condition of:

- The starter motor positive cables and other positive cables coming from the battery. Look for rub marks. Repeat this on the alternator and cabin feed power cables. Tape up gaping splits in the conduit.

- Trace along any electrical cable that comes directly off a battery terminal and has no electrical circuit breaker at the battery. This cable is a potential fire initiator.

- The connectors and relay housings in the electrical control box. Any signs of excessive heat?

- Any signs that circuit breakers or fuses have operated? If so why?

- Fuel lines. Any rubs under clamps or elsewhere? Are the hoses and tubes in good condition?

- The turbo charger oil line. In good condition?

- Any leaks from the exhaust pipe?

- Any signs of debris building up near the turbo charger or the exhaust pipe?

- Any rubs between moving parts and hoses?

Additionally, ensure that drivers check the tyres regularly during a journey. Look for flat or poorly inflated tyres. Note any rubs. Correct the situation.

Complaints by drivers of electrical smells or of electrical misbehavior on unrelated functions should not be ignored. When the truck is parked up ensure that the battery terminals are disconnected.

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Drivers should be instructed to check that debris has not lodged under the vehicle whenever they run over bulky road debris.

Draw up an inspection checklist and have it actioned at each major service.

6 Vehicle Specification and Precautions

When choosing a vehicle, consider the following features that could affect the vulnerability to fire:

- The main electrical cable from the battery to the cabin and the alternator should have a circuit breaker at the battery end.

- The starter motor cable should be double insulated and have additional plastic conduit protection. Unsplit conduit or split conduit that is taped the full length are preferred because there will be no gaping open at bends. The split line can get caught on protrusions which results in the internal cable rubbing against the protrusion.

- Automatic reset circuit breakers should not be used.

- All electrical connections to the battery positive terminals other than the starter motor cable should have a circuit breaker, fuse or fusible link at the battery.

- Fuel lines running inside the engine rather than externally are to be preferred.

- Fixtures such as noise shields and mud flaps should be well away from the turbo charger and the exhaust pipes. A minimum clearance of 200mm is recommended but this may need to be greater depending upon the circumstances.

- Engine tunnels too close to turbo chargers without adequate heat shielding could be a problem.

- Check that electrical circuits are not taken directly from the battery terminals without circuit protection (fuses or circuit breakers).

- Check that additional electrical loads are not connected onto existing electrical circuits as there is a risk of overload.

- Insist that truck manufacturers put plastic covers over the positive starter-motor terminal(s). These terminals are always live and should be covered by insulation. Very few manufacturers do this!

- Check that the oil line to the turbo charger cannot rub and is not pulled tight.

- Poor brake balance, particularly on combination vehicles, is a potential cause of wheel-end fires. Avoid over-braked vehicles in combination with under-braked vehicles (particularly those with load proportioning valves). Disc brakes that are working too hard get very hot and grease could catch fire.

- Vehicle manufacturers should be able to demonstrate that a stalled fan motor in the low speed setting does not catch fire.

- Check that the air intake for the cabin air-conditioner is not located where it can catch leaf matter. (A lit cigarette butt drawn into an air intake apparently caused a serious truck fire in the Mt Blanc tunnel in Europe!).

- A battery isolation switch is a worthwhile protection because it allows the batteries to be disconnected on an unattended truck.

- Check that the tyres do not rub on hard surfaces when the airbags are deflated.

- Regularly check the tyre pressures. Nitrogen over compressed air can reduce tyre temperatures.

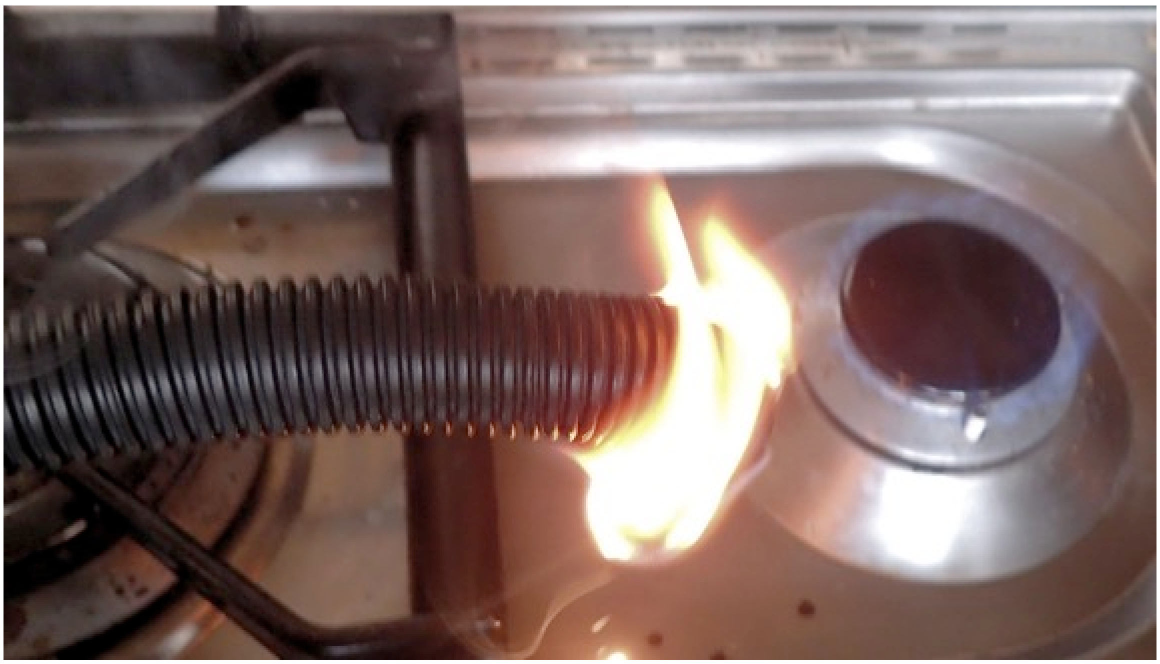
- ‘P-clamps’ are a common site of rubs on electrical cables, fuel lines and hoses.

- Check that the wire gauge used on heavy current circuits (such as the air-conditioner fans, the headlamps and the trailer lighting circuits) have generous wire gauges and do not rely upon a single ¼” blade terminal.

- Check that there is electrical insulation between the battery terminals and metal covers.

- The ratings of electrical devices should be conservatively chosen by manufacturers because components sometimes degrade over time due to prolonged operation in high ambient temperatures and dust ingress.

- Keep sufficient separations between parked vehicles to minimize the risk of fire propagating from one vehicle to the adjacent vehicle.



20 Plastic conduits used on vehicles will usually burn freely.

- Vehicle manufacturers should use plastic conduits that have flame retardant properties. Usually the cable inside the conduit has flame-retardant insulation and it will not burn easily. If a rub occurs that cuts the conduit and the cable insulation, a sparking point will develop. It is the conduit that is likely to burn freely. The conduit will spread the fire. Use of flame-retardant plastic conduits would reduce vehicle fire substantially. Maybe by half !

Following pages: The distressing loss of a truck due to an engine compartment fire.


ROAD
TRAIN

21 A road-train on fire in outback Australia.