NATIONAL TRACTION ENGINE TRUST

Preserving our heritage with steam on the road

ENGINE OWNER'S CODES OF PRACTICE

PART 1

OPERATION AND MAINTENANCE

Registered Charity Number 291578

PART 1 OPERATION & MAINTENANCE of Traction Engines and other Steam Driven Road Vehicles

1.1 INTRODUCTION

1.1.1 No *engine* shall be driven or have steam raised in the boiler on any public road, at any *public event* or in any other public place unless: -

(a) the *pressure system* has been thoroughly examined in the manner specified in Part 4 of this Code, or under some other written scheme of *examination* approved by *SAFed* or *UKAS*, and there is in force a current report and certificate, issued by a *Boiler Inspector*, or an *Approved Inspecting Organisation*, and containing the specified particulars.

(b) a mechanical examination as specified in Part 5 of this Code has been carried out by a *Competent Person* or by the *Owner*, if competent, within the preceding fourteen months.

(c) any repairs required as a result of either of the above examinations, have been satisfactorily carried-out.

(d) any restrictions or conditions imposed because of defects, or any other matters found during any *examination* are observed.

(e) it is properly maintained in a safe state.

(f) it is under the control or direct supervision of a competent driver who holds, or has held and is not disqualified from holding, a license to drive a vehicle of that class or description.

(g) it is correctly insured.

1.1.2 Owners and Drivers of all vehicles used on a road or other public places are reminded that although older steam powered vehicles are generally exempted from many of the conditions imposed by the Road Vehicles (Construction and Use) Regulations 1986, they are responsible to ensure that no vehicle is used, caused to be used or permitted to be used by another if that vehicle is in a dangerous condition, i.e. involving danger or injury to any person whether present or not. (Sec 40A Road Traffic Act 1988)

This relates to

1. the condition of the vehicle or trailer drawn thereby, accessories or equipment
2. the purpose to which it is used
3. the number of passengers carried or the manner in which they are carried
4. the weight, position or distribution of any load and the manner in which it is secured

Furthermore, to knowingly use a vehicle in a dangerous condition as above may constitute a further offence of Dangerous Driving.

1.1.3 Steam Rollers – Motor Vehicle Driving Licence Regulations 1999 state that the driver of a road roller must hold a Group G driving licence. There is no statutory exemption from holding a Group G driving licence due to the vehicles age or it being a "Historic Vehicle".

1.1.4 Drivers of any steam powered vehicle must be over 21. See para 2.5.1.2

1.1.5 No *engine* shall be taken on to any public road, be at any *public event* or be in any other public place unless there is in force a policy of insurance in respect of third party risks which complies with the requirements of the Road Traffic Acts for the time being in force.

1.1.6 At all times whilst any *engine* is on any public road, at any *public event* or in any other public place, the driver or other person in charge of it, shall use all due diligence to ensure that no person is endangered by its presence there, by any movements made by it, or by the movement of any trailer, implement or other thing towed or otherwise propelled by it, or by any machinery to which the *engine* is supplying mechanical power by belt drive or otherwise.

1.1.7 It shall be the responsibility of the *owner* of every *engine* to ensure that at all times whilst it is in steam and is on any public road, at any *public event* or in any other public place, it is under the constant supervision of a person who is competent to ensure that it will not be a source of danger to himself or to any other person, and that it will not be subject to any unauthorised interference or make any uncontrolled movement. At all other times it shall be the responsibility of the *owner* or other person authorised by him to be in charge of an *engine*, to ensure that it is secured in a manner, which will prevent it being a source of danger to any person or property.

1.2 INSURANCE AND DISC SCHEME

1.2.1 As described elsewhere in this COP it is a requirement that; before an *engine* is steamed in a public place an insurance policy to a minimum of RTA (Third Party Liability), a current *boiler* inspection certificate and limited indemnity for *boiler* explosion is held by the *owner*.

1.2.2 Meeting these requirements results in the *owner* holding several pieces of paper as proof; the clarity and level of description of which varies depending upon the organisations issuing the documentation. Because of these inconsistencies interpretation can often be difficult and more so when scrutinised in poor light or poor weather conditions or if the paperwork has become grubby.

1.2.3 Where an *engine* is presented at a Rally or similar event it is in the event organisers' interest to ensure that the exhibitor meets the conditions of insurance and inspection.

1.2.4 In order to make this task easier the NTET manages its 'Insurance Disc Scheme'. This Scheme uses a circular coloured disc, similar in size to a Road Fund Licence Disc, upon which is displayed the following information:

a. Disc Number and Issuing Agent

b. Owner/Keeper's Name

c. Maker

d. Engine Identity – Registration Number or Engine Number

e. Date of Expiry of Public Liability Insurance

f. Date of Expiry of Boiler Explosion Insurance

g. Date of Expiry of Boiler Inspection Report

h. Whether RTA insurance is held (Not applicable to Stationary Engines)

i. The *Safe Working Pressure* as indicated on the Boiler Inspection Report.

1.2.5 Discs are issued by accredited Insurance Brokers and for those using ad-hoc insurance arrangements, by the NTET's Insurance office.

1.2.6 This scheme has grown in popularity and the displaying of an 'insurance disc' is now a prerequisite of attendance at all NTET Authorised Events and at the majority of popular annual events.

1.2.7 Discs will only be issued when the inspections have been carried out in accordance with Part 4 of this Code or with another *SAFed* or *UKAS* accredited scheme.

1.2.8 The Disc at all times remains the property of the NTET and must be returned to the NTET if requested.

1.3 BOILER CONSTRUCTION AND ATTACHMENTS

1.3.1 Every *boiler*, all its *fittings* and every other part of the *pressure system* shall be of good construction, sound material, adequate strength and free from patent defect, and shall be properly maintained.

1.3.2 As a general rule, every *boiler* shall be provided with *fittings* of the type specified and fitted by the manufacturer at the time of its original construction. However, it is recognised that changes in working practices and legislation may require the fitting of additional devices. The fitting of these devices shall be agreed with the inspecting authority.

1.3.3 Any new *boiler* shall be constructed to conform to current EU Harmonised Codes of Practice.

1.3.4 Any *boiler* substantially rebuilt after the coming into operation of this Code, shall be constructed in accordance with, and be provided with *fittings* of the quality specified by the appropriate British Standard Codes of Practice, EU Harmonised codes or ASME code. If, however, compliance with such Codes of Practice is not appropriate for the purpose for

which the *boiler* is intended, any deviation from the said Codes shall not be such as to result in any lower standard of materials, workmanship or structural strength. Any such deviation must be agreed in advance between the *Owner* and the *Approved Inspecting Organisation* or *Boiler Inspector* and confirmed in writing, supported by such drawings and other data as may be necessary. Any *boiler* substantially rebuilt may, however, be re-fitted with its original *fittings*, whether they comply with the appropriate British Standard or not, provided that they are in good condition and suitable for the purpose.

1.3.5 The Pressure Equipment Directive (*PED*) may influence repairs and advice should be sought.

1.3.6 Notwithstanding the general rule in 1.2.2 above, every *boiler* shall have attached to it the following devices: -

(a) one or more suitable safety valve, separate from any stop valve, which shall be so adjusted as to prevent the *boiler* being worked at a pressure greater than the *safe working pressure* specified in the current Report and Certificate of thorough *examination*. The safety valve or valves must be capable of safely discharging the maximum amount of steam, which the *boiler* is capable of generating. The safety valve(s), if not mounted on the cylinder block, shall be directly mounted on the boiler shell and shall have no means of isolation from the steam space.

(b) a correct steam pressure gauge connected to the steam space of the *boiler* and easily visible to the driver, which shall indicate the pressure of steam in the *boiler* and have marked upon it a red line indicating the *safe working pressure*. The pressure gauge should be connected to the boiler by means of a suitable siphon or siphon tube and should preferably be of the 'correct' traction *engine* type.

(c) at least one water gauge which, if the gauge is of the glass tubular type, shall be fitted with an efficient protector, capable of preventing, so far as is reasonably practicable, the danger to any person on or near the *engine* of being scalded by steam or hot water in the event of breakage of the gauge glass. Any such gauge glass protector shall not be so constructed as to obstruct the reading of the gauge.

(d) if any *boiler* was originally fitted with test cocks in addition to a water gauge, these should be retained and maintained in good working order.

(e) a suitable *fusible plug.*

1.3.7 Every *engine* shall be provided with effective means for delivering an adequate supply of water into the *boiler*. Wherever practicable there should be at least two independent means, which may be either pumps or injectors, or one of each. All such devices shall be maintained in efficient working order.

1.4 BOILER MANAGEMENT

1.4.1 In order to achieve good, safe and efficient *boiler* operation and management, it is necessary to understand what goes on, both inside and outside a *boiler* whilst it is in use. The whole purpose of a steam *boiler* is to transfer heat from a fire to the water contained in the *boiler* and to turn it into steam; this process creates conditions under which the steel from which the *boiler* is constructed deteriorates very rapidly if good management techniques are not employed. The following are the main causes of deterioration in boilers: -

1.4.2 SCALE. Although it can vary greatly in composition, scale is always a very poor conductor of heat and even as little as 1/16th inch on the water side of the plates and tubes can reduce the rate of heat transfer quite dramatically. Whilst the resulting loss of efficiency may not be of serious concern to engine owners the slowing down of the rate of heat transfer through the firebox plates and the tubes leads to overheating and consequent deterioration of the steel. If thicker incrustations of scale are allowed to build up, this deterioration can be both rapid and severe.

1.4.3 STRESS CORROSION FATIGUE. This often occurs in the tube plates and is due to differential expansion when a *boiler* is 'forced' or heated up too quickly and/or by rapid cooling of the firebox tubeplate due to admission of cold air to the firebox. Repeated, rapid heating and cooling of the tubeplates causes metal fatigue which eventually causes cracking between the tube holes. This form of deterioration occurs far more rapidly if scale is allowed to build up on the water side of the firebox tubeplate, with consequent overheating of the metal.

1.4.4 GROOVING. Uneven expansion brought about by rapid heating or cooling of the *boiler* causes minute bending of the firebox stays and of the boilerplates at the junctions with the foundation ring and between the front tube plate and the barrel. Over time this may cause metal fatigue, particularly in the firebox stays. However, the more rapid effect is to cause the phenomenon known as 'grooving' in which the metal is eroded away at the junction of two plates. Grooving can be particularly severe in double riveted longitudinal lap seams. It also occurs at the junction between the plates and foundation ring, and at the junction between the front tube plate and the barrel. The effect can be reduced by heating up and cooling down the *boiler* slowly, so minimising the temperature difference between the inner and outer parts of the *boiler*.

1.4.5 CAUSTIC CRACKING. Care should be taken when running with high levels of caustic salts in the *boiler* water as this could lead to Caustic Cracking.

1.4.6 SCABBING. Scale on tubes is sometimes found to be 'scabbed'. When these scabs are dislodged, deep active black pits of corrosion are revealed. This phenomenon can lead to early failure of the tubes and, as with all scale-related problems; the only prevention is careful attention to water treatment.

1.4.7 OIL. If oil is allowed to get into the feed water, the immediate effect can be quite serious foaming. In the longer term, however, the oil tends to find its way to the hottest surfaces of the tubes and firebox where it forms a thin but highly insulating deposit leading to overheating and consequent deterioration of the metal. If oil accidentally gets into the feed water tanks, it can be floated of the surface and then the tank cleaned with an alkaline wash (a solution of washing soda).

1.4.8 CORROSION IN THE STEAM/WATER SPACE. Iron and oxygen combine naturally at ambient temperatures, but the process is greatly accelerated by the presence of heat and/or water. The presence of heat and water in the steam/water space of a *boiler* is inevitable so the reduction of the rate of corrosion depends upon reducing, as far as practicable, the amount of free oxygen present and preventing what remains from coming into contact with the metal. Untreated feed water contains dissolved oxygen, carbon dioxide and, depending upon its source, various minerals, all of which are released as the water is heated. Chemical reactions can take place bringing about corrosive conditions and the minerals are deposited as scale upon the inner surfaces of the *boiler*. Good *boiler* management therefore demands a programme of feed water treatment aimed at reducing the oxygen content and preventing the excessive deposit of scale. As a *boiler* cools at the end of a period of steaming and the remaining steam inside it condenses, air is drawn-in creating a warm, damp, oxygen rich and therefore highly corrosive atmosphere in the steam space. It is therefore helpful, at the end of a period of steaming, to fill the *boiler* as full as practicable so as to reduce the air space above the water. It is also helpful to vent the *boiler* when raising steam.

1.4.9 CORROSION ON THE FIRE SIDE. Corrosion and erosion by the action of the fire upon the firebox plates, stay heads, tubes and tube plates is inevitable but the process can be slowed down by the using suitable fuel and careful firing. Leaving acidic soot deposits and ashes in the firebox when the engine is not in use, even for relatively short periods, can cause rapid deterioration. Very severe corrosion can occur at the lower part of the smokebox tubeplate if soot is allowed to pile up against it and subsequently becomes wet, either due to leakage from tubes or handholes, rain coming down the chimney or just winter damp. Severe general corrosion of the fire side of the *boiler* plates and smokebox can also occur if the metal is not adequately protected during periods when the *engine* is laid-up.

1.4.10 EXTERNAL CORROSION. The major cause of localised external corrosion of boiler shells is water leaking from defective piston and valve rod glands, condensate dripping from the blast pipe, leaking manhole and mudhole joints and leaking joints where *fittings* are attached to the *boiler*. In the last case, the securing studs quickly become wasted, and, in all cases, severe localised wastage of the boilerplates can occur, necessitating difficult and expensive repairs. Occasional leakage from glands is almost inevitable and engines should be fitted with means for catching the water and draining it away. All leaks should be attended to without delay and particular attention should be given to *fittings* where any leakage could be hidden by lagging. Care should be taken to adequately protect the *boiler* in front of the cylinder block, particularly during winter storage.

1.4.11 General external corrosion occurs if an *engine* is left outdoors for extended periods and, to a lesser extent if kept under cover in damp conditions. Corrosion can be particularly severe under lagging if water retentive materials such as mineral fibre, are used for *boiler* insulation and become wet due to rain or water leakage.

1.4.12 DETERIORATION WHILE OUT OF USE. Unless special precautions are taken, boilers deteriorate very rapidly when not in use, particularly if left part full of water and standing in the open. Even if a *boiler* is drained and kept under cover, condensation

occurs, both inside and out causing corrosion of any unprotected metal. The guidelines in Part 3 of this Code are designed to minimise this deterioration.

1.5 BOILER OPERATION.

1.5.1 The efficiency and wellbeing of any steam *boiler* depends very heavily upon the use of suitable fuel, skilled firing, good quality feed water and the maintenance of water quality within the *boiler*. Industrial users, with an eye to economy both in fuel and cost of repairs, have given these factors high priority since the early days of steam power. Conversely, during the working lives of traction engines, etc. their operators had to take whatever water they could get and frequently had very little control over fuel quality. Such engines probably had an original design life of about 20 years (some survived for much less) and it is a great tribute to their builders and operators that so many have survived into preservation.

1.5.2 Those engines, which have survived, are now cherished by their owners and are worth a great deal of money. It is therefore in everyone's interests to maintain them in the best possible condition for as long as possible and the purpose of this section is to provide guidelines which will help to achieve that purpose.

1.5.3 The effects of air, water and dissolved minerals upon the internal surfaces of boilers have been described in section 1.3. of this Code. Although there are many forms of water treatment available to reduce these problems to a minimum, those that consist of compounds, which are added to the feed water, are probably the most practical and convenient for traction engines, etc. A good treatment compound of this type will achieve three results: firstly, to mop-up free oxygen in the feed water, secondly to provide a protective coating on the internal surfaces of the *boiler* and, thirdly, to retain dissolved minerals in suspension in the water rather than being deposited as scale.

1.5.4 Water treatment compounds should be used strictly in accordance with the manufacturer's instructions. These usually require a simple test, which shows how much compound, should be added to the next tank of feed water. It is not necessary to have a detailed analysis of the water supply although, if available, it does enable economies to be made in the quantity of treatment compound used. Rally organisers should obtain a general analysis from the water supply company and make this available to engine owners.

1.5.5 Because water treatment compounds cause dissolved minerals to be retained in suspension in the water, the concentration of those minerals will steadily increase during a period of steaming. If the *boiler* is not regularly blown down, the point will be reached where foaming and eventually priming will occur. The frequency with which a *boiler* needs to be blown down will be learned by experience but obviously depends upon the quantity of water used and its mineral content. As a general guide, if a *boiler* is blown down so as to reduce the level in the gauge glass by 2 to 3 inches at the end of a day's steaming, no problems are likely to arise. In soft water areas it may only be necessary to blow down every 2 to 3 days. All engines should be fitted with at least one *blowdown valve.*

1.5.6 Before blowing down a *boiler*, the *engine* should be in a position well away from people, buildings, caravans, etc. and other engines. The *boiler* pressure should be as low

as practicable. A length of old fire hose or similar attached to the *blowdown valve* will conduct the hot water and sludge well away from the driver and the *engine* but the end of the hose should be placed where the driver can see it; it should also be pegged down to stop it whipping about. A good *blowdown* is noisy and quite spectacular and may attract a curious audience, who should be kept at a safe distance.

1.5.7 The *blowdown* cocks originally fitted to most engines can be difficult to maintain watertight and may have become brittle with age. These may be replaced with modern type valves with the agreement of the *competent person*. The operating handles of these valves should be removed between blow downs to prevent unauthorised or accidental operation.

1.5.8 Various methods of water treatment, the chemicals used for treatment and testing, and the precautions to be taken are fully described in British Standard BS 1170: 1983, “Treatment of water for marine boilers" and in BS 2486 “Water Treatment for Land Boilers”. Although this fully describes how to make up treatment compounds, such a course is not likely to be economic for users of comparatively small quantities. The British Standard is recommended only to those who wish to make a further study of the science of water treatment.

1.5.9 In addition to internal corrosion, consideration must be given to reduction of damage due to uneven expansion and contraction. A *boiler* that is 'forced' - that is raising steam rapidly by building too fierce a fire and excessive use of the *blower* or *engine* exhaust to draw it up - will soon suffer serious damage. Damage to the tube plates can be particularly severe as they are distorted and forced apart by longitudinal expansion of the tubes whilst the *boiler* shell remains at a relatively low temperature. Similarly, the firebox stays suffer distortion leading to early fracture when the temperature of the firebox plates is raised too rapidly in relation to the outer shell.

1.5.10 When raising steam from cold, the aim should always be to do so as slowly and gently as possible to allow the heat from the firebox to dissipate into the water and the rest of the *boiler* structure. The fire should be built so as to cover the whole of the grate area as soon as possible but kept at a slow rate of combustion by careful use of the damper. No set time can be given for raising steam but as a rough guide, two hours or more would not be exceptional.

1.5.11 As steam is being raised, the fire should be kept even and bright but not drawn up excessively. The *blower* may be used in moderation if the fire becomes too dull, but it must never be used to 'force' the *boiler*.

1.5.12 At the end of a period of steaming the *boiler* should be allowed to cool as slowly as possible. The fire should be allowed to die down slowly with the damper closed and the chimney capped to reduce air circulation to a minimum. Never rake out the fire leaving the damper open and the chimney uncapped as the circulating cold air will cause excessively fast cooling of the firebox and tubes, which can lead to cracking of the tube plates. If a *boiler* is to be steamed on successive days, the fire may be left banked overnight if suitable fuel is available.

1.6 DAILY OPERATION

1.6.1 Daily Boiler and Mechanical Checks

1.6.1.1 Check that the water level is as expected i.e. slightly lower than when the *boiler* was last in steam. If it is much lower, check for leaks. Another reason for a low water level can be a check valve that is not seating properly and allowing water to run back into the tank. If the water level is higher, it is probably because the steam condensing in the *boiler* as it cooled has drawn water from the tank via the feed pump.

1.6.1.2 When replenishing the oil cups, any that have only used a small quantity of oil should be checked for blocked oil ways, for wicks not siphoning, or water in the bottom of the oil cup. Also check that the corresponding bearings have not suffered from lack of oil by examining the oil that has run out of the bearings for metallic debris.

1.6.1.3 If it is suspected that the cylinder lubricator (mechanical type) is not working, first check that there is plenty of oil inside it (level gauges can give a false reading), then check the driving linkage and ratchets. If this does not show the cause, disconnect the pipe from the lubricator at the point where it connects with the steam chest and operate the lubricator by hand; oil should flow from the end of the pipe. If it does, unscrew the non-return valve (if fitted) from the steam chest and re-connect it to the pipe and operate the lubricator by hand again. If oil still flows freely, check that the passage into the steam chest is clear.

1.6.1.4 While oiling round and cleaning, look out for loose nuts and bolts, missing cotter pins and signs of steam or water leakage. If a set routine is established which covers the *engine* from chimney top to rear drawbar, the checks take only a short time and can prevent inconvenience or even a major breakdown. Check that the drive pins are secure in the rear wheels.

1.6.2 Lubrication

1.6.2.1 If in doubt, it is better to over, rather than under lubricate. Bearings that are over lubricated seldom run hot. If the bearings are cool running and it is found that more oil is being used than on comparable engines it may be possible to reduce consumption, but it is a false economy to damage a bearing for the sake of a little oil. Only try to reduce the rate of oil flow to one bearing at a time; and then constantly check bearing temperatures and look for signs of metallic debris in the oil that runs out of the bearings.

1.6.2.1 If the cylinder lubricator has a sight glass, an oil delivery of about 3 drops 3 times per minute at about 150 RPM is usually satisfactory. If the valves or pistons squeak, increase the supply of cylinder oil and/or check that the right grade of cylinder oil is being used.

Regarding the type and make of lubricating oils, it is often helpful to talk to other *engine* owners to find out what they use and how they use it. Apart from cylinder oil (which must be of the right type) the final choice may have to depend upon what is available from local suppliers.

1.6.3 Safety Valves

1.6.3.1 Check safety valve(s) for correct setting and operation. Safety valves should always start to release steam at the maximum permitted working pressure as stated in the Written Scheme of Examination and should be capable of discharging all the steam that

the *boiler* can generate at a pressure not exceeding 10% above the maximum permitted working pressure, per BS 5500. On falling or 'Blowdown' pressure they should shut off steam tight just below working pressure. A slight wisp of escaping steam is not detrimental. Safety valves, which are fitted with a lifting device, should be tested regularly to ensure that they lift freely and shut off correctly.

1.6.4 Water Gauges

1.6.4.1 Water gauges should be blown down at least once during a working day. Although the test need not be done at full working pressure, it should not be done at low pressures below half that figure.

1.6.4.2 The following sequence should always be followed: -

1. Close the top steam cock and bottom water cock.
2. Open the column drain cock; the water should disappear from the glass. After a few moments, check that water and/or steam do not continue to discharge from the drain pipe; if they do, it means that the steam and/or water cocks are not shutting off properly.
3. Keeping the drain cock open and the steam cock shut open the bottom water cock; water & steam should discharge vigorously from the drain pipe. Re-close the water cock.
4. Keeping the drain cock open and the water cock shut open the top steam cock; steam should discharge vigorously from the drain pipe.
5. Close the drain cock and check that water does not rise into the glass.
6. Open the bottom cock. The water should rise in the glass without hesitation.

1.6.4.3 When the *engine* is travelling the water level should move up and down the glass freely.

1.6.5 Maintaining Correct Water Levels

1.6.5.1 On *locomotive type boilers* the water level must be maintained high enough to cover the firebox crown and the fire tubes. When travelling on a hilly road, this may mean working at a higher water level than normal. If the regulator has to be opened when facing downhill, open it gradually and with the cylinder drains open to make sure that water is not being carried over with the steam. If severe priming occurs, it can result in very serious damage to the *engine*. It is not good practice to have the safety valves blowing when at the top of a hill before descending.

1.6.6 Correct Use of The Blower (Where fitted)

1.6.6.1 Because, in the past, bad drivers often made excessive use of the *blower* to 'force' a cold *boiler* into steam, many owners still regard their use as a bad thing. There can be no objection, however, to the correct use of a *blower* to maintain a bright, clean fire when required. In fact, a bright fire, however it is maintained, is far better for the *boiler* than a dull smoky one.

1.6.6.2 If the tubes are clean and a good supply of dry wood has been used to start the fire, the use of the *blower* is usually not necessary when raising steam from cold.

1.6.6.3 On the other hand, if the coal is of poor quality, firewood in short supply, the wind in the wrong direction or buildings are causing down draught in the chimney then the use of the *blower* is very beneficial. Use the *blower* in moderation, just sufficient to brighten the fire and keep the smoke going into the tubes instead of out through the firehole door when it is opened to add more fuel. Keep the firehole door closed until fuel is added and shut the door between shovel fulls.

1.6.6.4 When an *engine* is in steam and has had its fire de-clinkered, it is advantageous to use the *blower* while the fire is made up with fresh coal. This minimises smoke and the *boiler* being near working temperature, there is no danger in causing unequal expansion, but still use the *blower* moderately.

1.6.6.5 When an *engine* has been fired up on smoky coal, or the fire has been banked overnight, it may be necessary to sweep the tubes before putting the *engine* to work. Gentle use of the *blower* while tube sweeping keeps the soot away from the person who is sweeping the tubes, but make sure that it is not being a nuisance to anyone else.

1.6.6.6 When an *engine* has been banked down or the fire is refusing to burn brightly, it may be necessary to use the *blower* to draw the unburnt gasses out of the firebox prior to opening the Firehole door to minimise the risk of a 'blow back'.

1.6.7 Maintaining the Fire Between Periods of Driving

1.6.7.1 If it is known that the *engine* is due to be shut down, fill the *boiler* to a high water level and close the damper. This will reduce *boiler* pressure and deaden the fire and prevent blowing off as soon as the *engine* is shut down. If the fire is allowed to cool down for a few minutes after stopping the *engine*, any clinker will solidify and is more easily removed in large pieces. After removing the clinker, fire up and leave the damper open until a good fire is established then close the damper. It should be possible to hold the pressure below blowing off and still have a fire, which will respond quickly when the *engine* is again set to work.

1.6.7.2 The techniques for firing a *boiler* under varying conditions and with various types of fuel can only be learned by observation and experience.

1.6.8 Shutdown at the End of the Day

1.6.8.1 At the end of the day the *engine* should be left with the brake screwed on and a driving wheel "scotched". The driving gears should be left disengaged. The regulator should be closed, the reversing lever in middle position, the cylinder drain cocks open and the crank set in such a position that any steam leaking past the regulator can escape through one of the cylinder drain cocks. The water level should be at or above working level. The fire should have been allowed to die down and with the damper and firehole door closed. Place a cap on top of the chimney. Some people like to lift the lubricator wicks out of the siphon tubes to save oil.

1.6.8.2 If the fire is to be banked overnight, the water level should be a high as possible. The fire should be cleaned i.e. ash and clinker removed and a small fire should be burning brightly before the banking coal is added. Some authorities advocate pushing the fire to the front of the firebox so that it can be raked back over the firebars at the start of the next period of steaming but there are really no fixed rules for banking fires, and it is largely a matter of experience and personal preference. The one thing that must be avoided, however, is the risk of currents of cold air passing through a hot *boiler*.

1.6.8.3 On completion of the shut-down procedures, the *engine* should be sheeted to protect it from the weather and to reduce the risk of unauthorised interference.

1.7 ACTION IN AN EMERGENCY

1.7.1 An emergency may arise in the operation of a steam *pressure system* resulting from: -

(a) failure of the water supply to the *boiler*.

(b) failure of a joint or other component and

(c) melting of the *fusible plug* ('dropping the plug').

1.7.2 All of the above may result in the need to quickly extinguish the fire. **NEVER ATTEMPT TO EXTINGUISH THE FIRE BY THROWING WATER ON TO IT**. A gallon of cold water thrown on to a coal fire will immediately flash into seventeen hundred gallons of steam. This is enough to blow burning coal and scalding steam out of the fire door and straight into your face. It could also blow the ash pan off with resulting injury to anyone nearby.

1.7.3 The safest method of extinguishing the fire is to smother it with sand, soil, spent ashes or other inert material and then ‘riddling’ it out into the ash-pan. If this is not appropriate you may have to resort to shovelling out the fire. **Warning:** Be very careful in handling the hot embers in a restricted area and be selective where you throw the burning coals; there is no point in starting a bush fire to add to your troubles.

1.7.4 Failure of the water supply

1.7.4.1 Most engines are fitted with a mechanical pump and an injector and, provided they are well maintained, the failure of both at the same time is a rare occurrence. Both pumps and injectors can, however, be temperamental, even when well-maintained so one or the other on its own should never be relied upon to keep the *boiler* supplied - particularly on a road journey. Injectors sometimes fail to lift if they get too hot (usually due to hot water blowing back through a leaking check valve on the *boiler*); a bucket full of cold water poured slowly over it will usually cure the problem. Pump valves sometimes stick open and a smart tap with a hammer on the pump body is usually enough to get them back on to their seats. The feed check valve(s) on the *boiler* can also sometimes stick open; this is indicated by steam issuing from the injector or loud bubbling noises from the water tanks. Here again, a smart tap on the check valve body will usually get the clack back on to its seat. If any of the above occurs frequently, the cause should be investigated and corrected without delay. A feed pump may fail to lift if the plunger gland has become worn and is allowing air to be sucked in; this may be corrected by tightening the gland nuts

slightly but, if it does not, the gland will have to be re-packed. Never over-tighten the gland as this can cause serious damage to the plunger. Before attempting any of the above, make sure that the 'failure' is not simply due to lack of water in the tanks.

1.7.4.2 If you run out of water or if both the pump and injector fail and simple remedies do not get one of them going again, the fire must be smothered (see above) and the *boiler* allowed to cool before the *fusible plug* melts and/or serious damage is done to the *boiler*.

1.7.5 Failure of a joint or other component

1.7.5.1 If a manhole or mud-hole door joint blows out, a pipe or boiler tube bursts, or some other component fails, the only possible course of action is to draw the fire and allow the pressure to fall in its own time. If the water level is falling fast, the injector may be put on to maintain the level above the firebox crown whilst the fire is shovelled out. Once the fire is out, keep the dampers and fire door closed to prevent uneven cooling of the *boiler*. **Warning:** If a tube has failed, the *fusible plug* melted or some other failure has caused steam to blow into the firebox, do not open the firehole door. The force of the steam could blow hot coals into your face. Therefore, do not attempt to shovel out the fire; the steam will put it out but make sure that the fire is completely out when the steam finally stops blowing.

1.7.5.2 If the *boiler* has welded firebox stays, these should have 'tell-tale' holes drilled in the ends. If a stay breaks, steam will blow through these holes, either to the outside or into the firebox. A single broken stay, thus indicated, is not a matter for immediately killing the fire and, provided that no more stays 'blow', it is safe to continue a journey. It is recommended that the *boiler* pressure should be reduced as much as possible consistent with completing the journey. Two or more stays 'blowing' in quick succession is however a matter of serious concern calling for immediate action; the steam pressure should be lowered as quickly as possible while the *engine* is got safely off the road or out of a rally ring.

1.7.5.3 If a gauge glass breaks, the protector will deflect the broken glass, steam and boiling water, which will be discharged. Some *water gauge* fittings incorporate a ball valve that shuts off the flow but if these are not fitted, an old coat or a sack thrown over the gauge will further deflect the steam/water whilst the steam and water cocks are turned off. Where ball valves are fitted, the balls should be checked and proved that they are made from bronze and the retaining wires checked for corrosion on an annual basis.

1.7.6 Melting of the fusible plug

1.7.6.1 Melting of the *fusible plug*, or 'dropping the plug' as it is more generally known, occurs when the water level falls below the crown of the firebox and can rarely be anything else but the result of carelessness by the driver. The low melting point alloy in the plug does, however, eventually become 'tired' and most owners change the plug at yearly or two-yearly intervals. If you do drop the plug, the only course of action is to get the *engine* to the side of the road while there is still some steam left, stop, and let the jet of steam

from the plug put the fire out. if it is safe to do so attempt to get water into the *boiler*. Make sure that the fire is fully out when the steam stops blowing and then fit a new plug once the *boiler* has cooled down. **DO NOT OPEN THE FIREHOLE DOOR**

1.7.7 The following should be carried for use in an emergency: -

- spare *fusible plug*.
- spare gauge glasses and sealing rings.
- spare manhole and mudhole joints.
- water pump gland packing; steam valve gland packing.
- sufficient spanners, etc. to carry out minor repairs and adjustments.
- a water bucket for extinguishing small external fires caused by sparks or hot ashes.
- a long-handled shovel for throwing the fire out.
- a first aid kit.

1.7.8 An old donkey jacket or a thick sack is useful to throw over the *water gauge* if a glass goes or to contain the jet of steam/water if a joint or steam valve gland 'blows'.

Piston and valve rod gland packing are not usually subject to catastrophic failure, but it is a wise precaution to carry spare packing.