2 Operation of Live Steam Models

2.1 Safety Aspects of Operation

Most modellers probably judge that models driven by clockwork or low voltage electric mechanisms pose little hazard to the operator or onlooker but there is probably much less agreement on the degree of hazard from steam driven models. While minor 'incidents' with these are more common than we might wish, significant mishaps are extremely rare. The most hazardous thing about a steam powered model is probably its operator, so some thoughts on safety are not out of place.

Before dealing with potential hazards, a brief word on insurance. Most owners and operators of live steam locomotives rely on the 'all risks' section of their household insurance to cover them against claims arising from accident. However, where events such as garden 'open days' are organised it is as well to have an endorsement covering these activities or alternatively take out separate insurance with a specialist like the Guild's insurance broker.

Potential hazards fall into three main categories: burns and scalds, fire and explosion.

2.1.1 Burns and scalds

It is self evident that certain parts of live steam models are meant to get very hot. What varies is the ease with which human flesh is able to come into contact with those parts!

Ideally, with a sophisticated, internally fired model having much lagging, most parts of the model will be no more than warm; and some models do approach this ideal. At the other extreme, with some vintage commercial models of the 'flaming fury' externally fired type, practically everything is too hot to handle. So the watchword is CAUTION.

As a general guide, always use two hands to lift the model and handle it near its ends - by the front buffers or buffer beam and by the drag beam below the cab floor, or the rear buffer beam on a tank engine. If you do this you won't usually come to much harm. However, lifting from these low points can make the loco topple so be careful. To avoid this risk it is possible to make the rear of the cab roof the rear point of support but beware: some cab roofs are designed to lift off very easily to give ready access to the controls. The answer is to get to know your own model and not to handle other people's unless absolutely necessary. Where models have tenders, many feel that it is a good idea to have a robust, permanent coupling between tender and locomotive and to lift the two as a single unit. This certainly makes for safe and easy handling.

Steam delivers a very painful burn; boiling water and hot oil only a slightly lesser one. All three substances can be delivered in generous quantities from the exhaust pipe, particularly at the start of a run when the water level in the boiler may be high and when some steam inevitably condenses back to water in the cold cylinders. In practically all models the exhaust pipe discharges this steam, boiling water and oil mixture up the chimney. It can rise several feet above the model so, whether bench testing or track running, keep yourself and others away from the chimney area. If it does become necessary to approach closely some form of eye protection should be worn.

Similarly, the boiler safety valve can emit a sudden scalding mixture, so stay clear of this one too. These two between them often leave you only one safe place to stand when operating the locomotive - just to the rear of the cab. Happily, in most cases, this comes fairly naturally as it usually offers the easiest access to the controls.

2.1.2 Fire

Note: In Gauge 0, coal firing is very rare so comment here is restricted to firing by methylated spirit or gas.

a) Methylated spirit firing

This has been tried and tested for decades and, given good sense, presents very little hazard. The main drawback from a safety point of view is that, when burning with the proper amount of air, the flame is almost invisible in good light conditions. It may also be silent, or nearly so. Modern ways of using the fuel very seldom store it under pressure, so a fire resulting from any minor fuel leak can be contained and dealt with quite easily. A 'squirty bottle' containing water is usually more than adequate as a fire extinguisher.

Warning:

> Do not attempt to blow the fire out. This rarely works, often makes matters worse and wastes precious time.

The use of soft solder in the construction of tanks and burners for methylated spirit is not advisable, since it has been known for a minor fire to melt the soldered joints and thus discharge more fuel into the fire.

Flooding of the wicks and the consequent overflow is a fairly common source of minor flares when first lighting up; another is the over-filling of the main

reservoir and a failure to wipe up the consequent spillage. Care here is well rewarded. It is recommended that the tank be filled only to 3/4 capacity - with a measured quantity of fuel, using a syringe - to minimise the possibility of over-filling and flare up. On some models the temperature of the fuel reservoir can reach the boiling point of meths with the result that a very flammable stream of vapour is discharged from any tank vents. Such vents should be in the form of a pipe which discharges the vapour well away from any flame and the cab roof near the controls. Better still, design the model to avoid significant heating of the fuel tank.

Warning:

When refilling the model fuel tank:

1) Ensure that the burner is completely extinguished before commencing.
2) Replace the cap on the filling bottle and move the bottle well out of the way before relighting.

A metal can is a safer storage container than a plastic bottle, since the latter could easily melt if carelessly placed near a flame or on a hot soldering iron. Glass bottles are not a good idea either.

Ensure that all parts of the track are readily accessible, (particularly when operating indoors) and it is good sense to have a water saturated towel, a bowl or bucket of water and a conventional fire extinguisher ready to hand should the 'squirty bottle' of water prove inadequate. However, in many years of domestic and public running, the writers have not met a circumstance where the 'squirty bottle' was unable to deal rapidly with an incident involving burning meths.

b) Gas firing

The name is slightly misleading since, although it is a mixture of gases that is eventually burnt, the fuel itself is stored in liquid form under varying pressure, e.g. for butane at 86°F (30°C) the pressure is 27 lbs/sq.in (1.8 Bar). Storage pressure varies with temperature. Thus a leak in the tank or pipework can result in a very considerable discharge of fuel and a very unpleasant, spectacular and potentially dangerous fire can result. An additional hazard is that small leaks occur in the form of an invisible gas which, being denser than air, sinks slowly and hovers around the surface of the work bench or running track just waiting to be ignited.

Experience suggests that gas firing is very convenient and successful, but it does demand full concentration and care. The hazard is greatest at the time of fuelling and re-fuelling, since this is when leaks are most likely to occur.

The arrangement for re-fuelling on many gas fired models leaves a lot to be desired. In some cases reliance is placed solely on metal to metal contact with no rubber or other seals being used and the spillage when 'filling up' can be really alarming. In contrast, others seem to have evolved fully satisfactory systems.

Warning:

Do not use propane or propane/butane mixes in systems designed for butane. The pressures created by propane are much higher than those created by butane, with potentially catastrophic results.

Warning:

Never, under any circumstances, attempt to refill the gas tank on a loco whilst the loco's own burner is alight.

It is recommended that the following practices be observed:

1) Whenever possible, refuel in a well ventilated, quiet environment.

2) Fuelling and re-fuelling should be carried out at least 10 feet (3 metres) away from any other flame source and at least 10 feet (3 metres) from any running track on which another locomotive may pass.

3) Once fuelling has been completed, the locomotive should be moved at least 10 feet (3 metres) from the fuelling point before attempting to light up.

4) Metal fuel tanks should be constructed from at least 18 gauge brass or similar material, silver soldered and braced as required. The tank should be hydraulically tested before use to approximately twice working pressure, e.g. for butane test to 60 lbs/sq.in (4 Bar).

5) Flexible pipework should be made from thick-walled material which is not chemically attacked by the fuel being used; specialist steam model suppliers can supply or advise. For additional mechanical protection it is advisable to sheath flexible pipework with woven copper braid from electrical co-axial cables, as used for TV aerial leads.

6) Always work in a well ventilated area to ensure dispersal of obnoxious/toxic/combustible gases.

2.1.3 Explosion

a) Boiler explosions

These are extremely rare. A boiler that is properly made, tested and fitted with a suitable safety valve will not explode. At worst, if it runs out of water it will, if soft soldered, progressively reduce itself to a kit of parts or, if silver soldered, just get very hot. In the latter case the boiler must be allowed to cool before attempting to pump in cold water.

Warning:

> The admission of cold water to a boiler in this very hot state can induce serious thermal stresses and may result in a rate of steam generation greater than the safety valves can comfortably discharge. This situation is the cause of most boiler explosions that occur in the full size as well as the model world and is potentially very dangerous. If in the slightest doubt put the model to one side to cool naturally.

A commercially built boiler will have been properly tested. A home made one should be pressure tested with water, not with steam or compressed air. The reason for hydraulic testing is that water is, to all intents and purposes, incompressible and so stores very little potentially destructive energy. Should a joint fail under water pressure the pressure is quickly dissipated and the worst that can happen is a damp patch on the overalls. Details of pressure testing procedures are given in several of the recommended books listed in Appendix A. It is recommended that model boilers be pressure tested at regular intervals, preferably every year, before re-insuring the model. The safety valve on the boiler should be checked at the start of each running session, particularly if the locomotive has not been run for some considerable time, since scale from hard water and other water borne deposits can interfere with the proper working of the valve. In many cases it is possible to lift or press the valve off its seating by hand in order to check that it is not sticking.

Note: Valves with any form of rubber or other soft sealing ring should be checked particularly carefully since they are more prone to sticking than those with metal to metal contact faces. Most old Bassett - Lowke and other old commercially made models have soft seals.

Where a valve has an adjustable spring force, ensure that the correct setting is known and maintained.

Warning: Viton 'O' Rings

An incident occurred where a man had a finger badly burned while handling a Viton 'O' ring which had been exposed to high temperature. The burn resulted from chemical contamination of the skin due to the decomposition of the Viton. It was necessary to amputate part of the finger to remove the contamination.

Viton is a fluoorelastomer, i.e. a synthetic rubber-like material containing flourine. Other trade names include Flourel and Tecmoflon. When used under designed conditions they are perfectly satisfactory and safe, but, exposed to temperatures of 400°C or higher, the material does not burn but decomposes. One of the products of decomposition is hydroflouric acid which is extremely corrosive and is almost impossible to remove once it contaminates the skin. There is a special burn jelly formulated to combat hydroflouric acid burns but it is not readily available so medical aid is imperative.

It would be advisable when obtaining replacement 'O' rings for model locomotive use to check that they are not of this type. Whilst satisfactory for normal operation they could become damaged, and hence dangerous, if a boiler was allowed to run dry and become seriously overheated or if left in place while carrying out repairs involving high temperature, e.g. silver soldering.

Warning:

The spring setting of a safety valve should not be increased without first checking that the boiler can withstand the increased operating pressure by carrying out a pressure test.

When making safety valves, always ensure that there is ample passage space for the excess steam to escape, e.g. between the spring spindle and the hole through which it passes. The valve must be capable of discharging steam faster than the boiler can generate it. (In prototype practice boilers are subjected to an 'accumulation' test. This consists of firing the boiler at its maximum rate with all the outlet valves shut and all the steam generated escaping through the safety valves. Under these conditions the boiler pressure must not rise more than 10% above normal working pressure).

When setting the release pressure of such a valve, it is unwise to rely on the readings from a miniature gauge of the type fitted to small locomotives. Such gauges can be very inaccurate. A local garage or secondary school science department may be able to offer the use of a reliable gauge for setting. Once the safety valve is clean and free moving it should be given a light coating of steam oil, unless it is the variety having a rubber seal.

b) Fuel explosions

The risk of explosion in the fuel system is extremely small. An explosion requires just the right mix of fuel vapour and air. This is highly unlikely to arise in a Gauge 0 locomotive with the fuels discussed. When making repairs to a fuel tank involving the application of heat, it is sensible to flush out the remnants of fuel vapour by filling and emptying the tank several times with a good stream of water.

2.1.4 Exhibition running

This is the occasion when we least want mishaps but when, perversely, they are most likely to occur.

Note: If invited to take models to an exhibition, (or a Group meeting) it is wise to check that the organisers included provision for running live steam models when they hired the hall and arranged their exhibition insurance; the Home Office *Guide to Fire precautions in Existing Places of Entertainment* sets out the requirements and the consent of the management of the premises must be obtained in advance.

Some reasons for mishaps are that:

1) Operators' routines are adversely affected by the pressure of the occasion; they get hurried, distracted by questions and flustered into making mistakes that they would not make in the calm of home.
2) There are often several sources of flame nearby, some of them pounding around, forgotten about, on nearby running tracks.
3) The environment may be very noisy so that the usual tell-tale sound of escaping gas or steam leaks, or other problems, go unnoticed.

So the very small hazard that exists with the lone operator is substantially increased under public exhibition conditions. The public should be always kept at a safe distance and the operators should not be put under pressure. A battery or clockwork locomotive kept at the ready can do much to relieve operator stress and keep the public temporarily happy. Finally, observe the advice given in the sections above and noted in the checklist in Appendix B.

Note: We have, quite properly, drawn attention to hazards which can arise from the careless operation of steam powered models. However, it should be remembered that there are scores of Guild members who derive immense pleasure from regular, safe and trouble free operation of such 'real' locomotives. This and subsequent sections will show you how to join them.

2.2 General Points on Operation

Commercially produced models generally have leaflets supplied with them covering the methods to be followed to obtain satisfactory running. These methods tend to conform to a pattern and brief extracts from a number of them are summarised below.

Before starting a running session check that the axle bearings, crank pins and any sliding surfaces are correctly lubricated. Lack of lubrication can cause rapid wear.

Examine the safety valve, fuel filler cap and displacement lubricator filler plug fibre washers carefully for wear or damage. Replace them if they are faulty. Check that the safety valve is clean and free to move. Fill the boiler with a measured quantity of distilled or rain water. (See Appendix B).

If the model is spirit fired, check on the length of the wicks and that they stand at the correct height out of the wick tubes to give a 1/2" - 3/4" (12mm - 18mm)

flame. The speed of Bowman locomotives can be controlled by removing one or two of the wicks from their tubes and replacing them with tapered metal plugs.

The pistons, valves and cylinders should be kept well lubricated with a light steam cylinder oil; a brief discussion on suitable types is included in Appendix B. Ensure that the displacement lubricator is filled correctly before commencing a run.

The steam oil used for cylinder lubrication also acts as a piston seal in the older commercial models. One operator was having trouble with an early Bassett Lowke steamer that performed very sluggishly until the end of the run approached whereupon it began to exhibit the characteristics of the proverbial scalded cat. No fault could be found until it was noticed that he only half filled the displacement lubricator at the beginning of a run. The result was that it took a few minutes for the condensing steam to raise the level of the oil to the point where it began to flow into the cylinders. Once this occurred the pistons became sealed and steam leakage from one side to the other ceased with a dramatic improvement to the performance. Once the explanation had been made to him the lubricator was always refilled to the brim and the improved performance maintained.

Finally, at the end of the day's running, first empty the lubricator, empty out the meths tank (where fitted) and any remaining water from the boiler, oil the bearings and clean and dry the locomotive before storing it away. A useful tip is to refill the lubricator and push the engine backwards and forwards a few times to suck oil into the cylinders and valves; oil the valves and fittings, particularly plug type valves (plug cocks), while the engine is still hot to prevent them seizing up while the engine is out of use. In that way it will be maintained in good condition.

Note: When draining the boilers of Bassett-Lowke and other locomotives fitted with displacement lubricators in the smokebox, a check should be for the presence of oil in the water. If it is found this indicates that oil has back-flowed from the lubricator into the boiler and possibly formed a film on the metal surface which can reduce heat transfer from the flame into the water. It is recommended that, if found, the oil is removed by thoroughly washing out the boiler with a household detergent.