b) Perform a complete boiler flush to remove scale that has flaked off during storage as a result of the expansion and contraction of the metal due to temperature changes.

c) Clean handhole plate gasket surfaces (both boiler and handhole plate). These surfaces must be flat and free of scale, rust, and dirt in order to seal.

d) Inspect feedwater inlet connection to boiler. There should be a tee at each inlet; remove plug and inspect for lime deposits and clean if necessary. This should be done once a year; more often if conditions warrant it.

e) Remove gage glass and valves, and inspect these connections for lime deposits and clean if necessary. This should be done once a year; more often if conditions warrant it.

f) After inspection, replace glass (clean if necessary). Also inspect gage glass sealing washers and replace if necessary.

g) During cold weather, the historical boiler should be moved into a heated area and the boiler allowed to warm up in the air for several days until it is the same temperature as the air.

h) The initial fire-up should be done slowly to allow even heating of the boiler.

i) Before movement, the cylinder(s) should be warmed up by allowing a small quantity of steam to blow through them and out the cylinder cocks and exhaust passage(s). This is necessary to reduce the stress in the casting from thermal expansion of the metal.

j) Steam should be discharged through the cylinder cocks for several minutes to aid removal of any solvent, debris, or rust that may have formed in the steam pipes, cylinder, valve chest, and dry pipe.

k) All appliances should be tested under steam pressure before the historical boiler is moved or put under load.

S2.14 SAFETY PROCEDURES[1]

This chapter of text covers procedures in certain situations or emergencies that may occur.

S2.14.1 EXPERIENCE

a) Reading check lists and procedures can be of some value to get you thinking about what you are doing, but nothing can replace the experience gained by working beside conscientious and knowledgeable engineers. Ask questions, observe, read, listen, study, and think.

b) Safe operations depend upon thorough attention to detailed routines. Having procedures thought out, planned, and practiced before they are needed could minimize accidents and improve public safety. Know your abilities as well as the limitations of the machine that you are operating. In most cases knowing and keeping your machine in top operating condition can prevent most emergency situations from occurring. However, sometimes problems or situations beyond your control do occur. In any situation the first rule to remember is to keep a cool head. Haste and panic can never solve any emergency.

c) Don't be afraid to ask for help or advice. A lot of shows and public demonstrations have a designated individual in the area to ensure safe operation and assistance should a problem arise.

S2.14.2 STOPPING ENGINE IN AN EMERGENCY

a) Know how to stop the engine suddenly. For example, if someone or something runs out in front of the engine or some problem happens with whatever it is belted up to:

   1) Close throttle.

   2) Reverse valve quadrant position.

   3) Open throttle for a moment (this will quickly stop your engine).

   4) Close throttle.

   5) Open cylinder cocks.

b) Steam traction engines do not have brakes, so this is a maneuver worth knowing and practicing. However, it should be practiced with the dome valve shut as this method of stopping the engine tends to be very hard on gears and castings. In regards to belt work, it is extremely important that total undivided attention be given to what it is belted up to. Be prepared to shut down quickly should something happen.

S2.14.3 WATER GLASS BREAKAGE

Having a properly guarded water glass will prevent objects from coming in contact with the glass. However, water glasses do break. If the machine is operating when water glass breakage occurs:

a) Close throttle.

b) Set valve quadrant to neutral (middle notch).

c) Disengage clutch.

d) Close damper.

e) Locate bottom water glass valve and shut off.

   1) The first four procedures will be difficult if the water glass is mounted back by the operator's platform.

   2) The bottom water glass valve is essential to locate and close first. This valve is below the waterline and can take the water dangerously close to the crownsheet if water is allowed to escape unchecked. This is where having the automatic type gage valves would be most desirable. Most traction engines do not have automatic-type gage valves. Caution must be exercised at this time because 300 °F (150 °C) steam and water will be spraying in every direction! There will be an inability to see much of anything except a cloud of water vapor. Use a shovel or a coat or something to deflect the spray to be able to find that lower valve.

f) Next, close the top gage valve; this one should just be blowing steam and obscuring visibility. There is no serious problem with steam being released because this valve is above the water line.

g) Next, use the try-cocks to determine water level of boiler. If bottom try-cock blows water, then inject water and replace water glass. However, if bottom try-cock does not blow water, and only blows steam, do not inject water and proceed to kill fire immediately. Do not move engine. Another method of determining the water level in the boiler other than using the try-cocks is to wet down a burlap sack and lay it on the barrel part of the boiler. Quickly pull it away and there will be a "sweat line" of where the actual water level is.

S2.14.4 RUNAWAY ENGINE AND GOVERNOR OVER SPEED

a) Probable cause: governor malfunction. Usually the governor belt either slips or breaks. Know the governor belt condition and keep its tension snug but not too tight. Also, packing nut could be too tight, causing a binding on valve spindle; more often this will cause the engine not to respond to load and usually will not “run away.”

b) What to do in a runaway situation: Never leave the operator’s platform while engine is at governed speed.

In the case of a runaway engine:

1) Quickly close the throttle;

2) Move forward/reverse lever to center of quadrant;

3) Open cylinder cocks;

4) Close dome valve; and

5) Close damper and steam down (this is not a boiler emergency; once the engine has stopped there should be no danger).

c) In the unlikely event the throttle were to jam in conjunction with governor malfunction:

1) Move forward/reverse lever to center of quadrant. This will stop the engine even though steam is still being sent to the valve chest;

2) Close the dome valve; this would be the same as closing the throttle. Steam flow would then be stopped and the engine should be safe;

3) Close damper and steam down.

S2.14.5 KILLING A FIRE

This is an important procedure to know, should a low water situation ever occur.

a) Close all dampers. This will stop incoming air, which supports fire. Capping the smokestack is an additional way of checking draft to fire. However, it will cause a lot of smoke to emit around fire door.

b) Shovel dry sand or dry earth on the fire; this should immediately cool the fire to a safe level. Have a pile of dry sand or dirt in or around the steam engine area should a situation occur. It is important to remember that when trying to extinguish a fire, never stir the fire; this will only intensify the fire’s heat.

c) Close the fire door.

d) Close the dome valve.

e) Leave the engine alone. It is especially important not to move the engine as this could slosh water onto a possibly overheated crownsheet.

S2.14.6 INJECTOR PROBLEMS

Injector problems are the number one reason for boiler operation malfunctions. An injector can be a very sensitive device. The ability to identify the reasons why it’s not working is the most important thing a steam engineer needs to know. The following are various problems and their causes:

a) Failure to raise water from supply tank.

1) Suction pipe clogged or tank supply valve turned off.

2) Leaks in suction pipe or hose, allowing air to enter above the level of water supply. A common problem when rubber or plastic hoses are used on suction side of injector.

3) Water supply too hot. Hot water will prevent injector from lifting water.

4) Obstruction in the lifting or combining tubes of the injector.

b) Injector lifts water but will not force it into the boiler.

1) Choked suction pipe or strainer/incomplete obstruction.

2) Supply valve not opened all the way.

3) Boiler valve closed.

4) Boiler check valve stuck closed.

5) Obstruction in delivery tube on injector.

6) Leaking injector overflow check valve.

7) Injector choked with lime.

c) Other injector problems.

1) Usually you have a hot injector because of improper operation. This is where a removable rubber hose on your water suction is handy. Remove hose, turn steam valve on to injector and put your thumb over suction side of injector. You should feel a smooth, steady suction. If not, wrap a rag around injector body and soak rag with cool water. Your objective is to cool down the injector. Now turn steam back on to injector, allowing cool air to suck into injector. At the same time, place suction hose back onto water supply line and it should go. Remember to tighten suction side connections so you don't lose your vacuum.

2) If injector still does not lift after following the previous instructions, it probably has some foreign matter in the lifting or combining tube. Simply remove bottom square nut on injector body, taking care not to lose flat washer that will come out with injector combining tube, clean and re-install. This should restore injector to working order.

3) When having injector problems, watch your injector overflow. Steam only and no water at overflow usually is an indication of a water lifting problem (no water to the injector). Steam and water at the overflow is usually a delivery problem, meaning your injector is lifting water but not forcing it into boiler.

4) The problem with delivery is usually associated with a stuck boiler check valve. After assuring yourself that the isolation valve to the boiler is open, try lightly tapping on the boiler check valve. More than likely though you will have to disassemble and clean boiler check valve; scale may be is holding the check valve from opening. This can be done with steam pressure on the boiler, providing the valve to the boiler holds pressure and the boiler check valve has been properly piped in. A boiler check valve may not close, causing steam and hot water to blow back through injector and into your feedwater tank. Again, you would have to turn off the valve to the boiler, disassemble and clean the check valve. If the injector will not force water into the boiler, there may be an obstruction in the delivery/combining tube of the injector. Remove bottom nut of the injector, disassemble and clean as explained above.

S2.14.7 FOAMING OR PRIMING BOILER

a) A foaming boiler is usually caused by dirty or impure water in the boiler. Oils, detergent, etc., are the biggest problems and have no business being on the waterside of a boiler. A good rule of thumb is, "If you wouldn't drink it, don't put it in your boiler." Foaming can be especially bad because you have no way of discerning your water level. The water glass and try-cocks will appear full. Foaming is usually really intensified with a heavy fire and a heavy engine load. Reduce or stop your engine load and reduce your fire until it settles down, steam down, wash out your boiler, and refill it with clean water. The first indication of a foaming or priming boiler is usually a "wet stack" and a discernable difference in the exhaust sound. Open cylinder cocks immediately and close throttle and determine your water level.

b) Priming is similar to foaming; you're pulling water into your engine. This is especially bad because it can wash the oil from valves and cylinders and risk severe damage to the engine. Priming is caused more from carrying too-high a water level. It also occurs from working steam while ascending and descending hills. Know the machine you are operating, and what the safe water level is.

c) If an engine starts priming (it will show a wet stack), open cylinder cocks, reduce throttle, get engine to level area, and determine the water level. If possible, safely blowdown boiler to proper water level. Ensure no bystanders are close-by for safety.

S2.14.8 HANDHOLE GASKET BLOWS OUT

a) Special care should be taken to ensure proper installation of handhole gaskets to prevent a blowout.

b) New gaskets need special attention on the first fire-up. When installing, ensure plate surface and mating surface on boiler are free of loose scale and debris. Firmly snug the gasket after it is properly centered on the handhole. Do not over-tighten as this tends to cut the gasket. A common cause of handhole gasket blowout is improper fitting of gasket to handhole plate. It is very important that the gasket fits center of handhole plate very snug. When steaming up, carefully "follow up" gaskets by ensuring nut stays snug. Special care must be exercised to ensure that there is no rotation of the handhole plate or gasket. Caution should be used if boiler has any pressure built up on it. The best time to follow up on handhole gaskets is when steam is almost down after first fire-up. It is important to snug them up before boiler cools, because as a boiler cools, it forms a vacuum, and if handholes are loose, they can collapse and drain your boiler.

c) If a handhole gasket blows out:

1) Close damper. Prepare to steam down. If there is a large fire, be prepared to kill the fire. Depending on how fast the boiler is losing water and where on the boiler the handhole is leaking. Under no circumstance attempt to operate engine! Periodic operation of the injector is recommended to keep water level up until fire-down is complete.

2) Do not attempt to remove handhole plate and gasket until steam is down. Carefully remove handhole plate and gasket. Inspect for cause of blowout.

S2.14.9 TUBE BURST

Tubes will deteriorate and corrode over time. Usually a pit in the tube surface works its way through the tube and a pinhole develops. Rarely will a tube actually "burst". Usually just a small leak occurs. If the leak occurs on firebox end or if leak is a large one, it usually puts the fire out. Leave the engine on a level surface and let it cool down. If the leak is toward the smoke box end of the boiler, water will come out of the smoke box door. Watch water level, close damper and prepare to steam down, or kill the fire if it hasn't died out so already depending on how fast the boiler is losing water. Do not continue to operate the engine.

S2.14.10 LEAKING VALVES

Several situations can cause a leaking valve. The most common would be a piece of scale or debris between valve seat and valve disc/plug. Another reason would be a break between valve stem and disc/plug (on a globe-type valve). Assuming scale on the valve seat, try opening and closing the valve to try and dislodge any debris. If the valve is broken or disc/plug has pulled off the end of the valve stem, there is nothing that can be safely done. Determining when to steam down or kill the fire will depend on the rate which the boiler is losing water. In most cases a normal steam down procedure will be required.

S2.14.11 BROKEN PIPES

Broken pipes on an engine normally will not occur if engine has been piped with proper materials and correct procedures have been followed. Close attention should be paid to pipe and pipe fittings and their condition. However, should a pipe or pipe fitting break, carefully try and locate a up-line valve and isolate the break. Follow normal steam down procedures. If there is no up-line valve that can be shut off, kill the fire immediately.

S2.14.12 SAFETY VALVE PROBLEMS

Testing of this critical safety device should be done each time the boiler is fired up. This is essential to ensure its continued safe operation. In the event the safety valve does not open at its preset pressure and trying to manually trip open valve lever is unsuccessful, close the damper and follow steam-down procedure. After closing damper, start the injector. This will decrease the steam pressure. Under no circumstance should the blowdown valve be used to release pressure (blowing down will lower the water level considerably). Killing the fire should not be necessary provided the water level is at a safe level and the steam pressure is dropping from running the injector. Do not continue to run engine; remove the valve and send to a certified shop for repair or replace the valve.

S2.14.13 SAFETY VALVE OPENS BUT WILL NOT CLOSE

This problem is more prevalent than valves that don't open. There is no immediate danger in a safety valve that won't close; the boiler is only losing steam. Try to manually open the valve a few times under pressure. This may seat the valve. Bringing your steam pressure down by approximately 25 psi (170 kPa) will let the valve seat. If after dropping the pressure and it still does not seat, there may be an obstruction in the valve or a binding in the action of the valve. Follow normal steam-down procedure. Remove valve and send to a certified shop for repairs or replace the valve.

S2.14.14 LEAKING PIPE PLUGS

Usually threads were not properly cleaned before installation or thread tape/sealant was not properly applied. Under no circumstance should plugs be tightened with boiler under pressure. Usually the leak is very small and does not mean any immediate danger. Follow normal steam-down procedure.

S2.14.15 MELTED GRATES

a) Closing damper with a hot coal fire restricts air flow to the grates. Although it is rare for a grate to melt from this, it is possible to warp or ruin a good set of grates. Grates need air flow to keep them cool. Closing damper all the way with a hot coal fire should only be done in an emergency.

b) Carrying ashes too high in ash pan is usually the reason for melted grates. The hot coals in the ash pan touching the grates and the restricted air flow is going to damage the grates. In some cases a grate bar can entirely melt out leaving a huge hole in your fire bed and an intense fire burning in your ash pan. Follow normal steam-down procedure.

S2.14.16 FIRING OF HISTORICAL BOILERS WITH LIQUID OR GASEOUS FUELS.

Hand firing of historical boilers with liquid or gaseous fuels poses significant additional safety concerns beyond those encountered when firing with solid fuels for which these boilers were originally designed, such as coal, straw or wood. The cautionary notes listed below are provided as examples to remind the owner or user that additional safety concerns do exist when firing historical boilers with these alternate fuels. These notes are not meant to be all-inclusive so each boiler's fuel system should be designed appropriately.

a) JURISDICTIONAL ACCEPTANCE: The owner or user shall check with the Jurisdiction as applicable to determine if this alternative firing method is allowed.

b) OWNER OR USER KNOWLEDGE: The owner or user shall have an extensive knowledge of the fuel used, fuel transfer system, on board fuel storage, burner, firing controls, emergency shut off devices and procedures.

c) PURGING: To prevent a firebox explosion, the furnace shall be purged of combustible gasses prior to applying the fuel ignition source.

d) FLAME IMPINGEMENT: Direct flame impingement of the metal surfaces within the furnace can damage the boiler. Installation of refractory or fire brick in the firebox is a common practice to prevent this potential damage.

e) LOW WATER: The owner or user shall have a procedure in place to immediately shut off the fuel supply to the burner when a boiler low water condition occurs.

f) FUEL CONTAINMENT: The fuel storage system shall be suitably designed with the appropriate shut off devices for the specific fuel product. The mounting method and proximity of the fuel storage container to the furnace shall be considered to prevent the fuel from accidental ignition.

g) FUEL SYSTEM: The fuel delivery system and routing from fuel source to the burner shall be suitably designed for the specific fuel product including appropriate emergency shut off devices.

h) FUEL AIR MIXTURE: The burner utilized shall be designed to operate within the confines of the boiler furnace and provide the proper fuel/air mixture.

i) SAFETY VALVE: The boilers minimum relieving capacity shall be computed for the type of fuel used.

j) COMPRESSED NATURAL GAS (CNG) vs LIQUID PETROLEUM GAS (LPG): CNG is lighter than air and LPG is heavier than air. The owner or user should understand the properties of the fuels to ensure the gas will not accumulate in the boiler (see Purging above).

S2.15 TABLES AND FIGURES

a) TABLE S2.8.1, Minimum Pounds of Steam per hour per Square Foot of Heating Surfaces

b) TABLE S2.10.2, Sizes for Rivets Based on Plate Thickness

c) TABLE S2.10.3.1, Maximum Allowable Working Pressure for Cylindrical Components – Single-Riveted Lap Joint

d) TABLE S2.10.3.2, Maximum Allowable Working Pressure for Cylindrical Components – Double-Riveted Lap Joint

e) TABLE S2.10.3.3, Maximum Allowable Working Pressure for Cylindrical Components – Triple-Riveted Lap Joint

f) TABLE S2.10.3.4, Maximum Allowable Working Pressure for Cylindrical Components – Buttstrap Double- Riveted Lap Joint

g) TABLE S2.10.3.5, Maximum Allowable Working Pressure for Cylindrical Components – Buttstrap Triple-Riveted Lap Joint

h) TABLE S2.10.3.6, Maximum Allowable Working Pressure for Cylindrical Components – Buttstrap Quadruple-Riveted Lap Joint

i) TABLE S2.10.4, Maximum Allowable Working Pressure for Stayed Surfaces

j) TABLE S2.10.4.1, Maximum Allowable Working Pressure Based on Load Capacity of a Single-Riveted Staybol

The National Board of Boiler and Pressure Vessel Inspectors
INITIAL BOILER CERTIFICATION REPORT (Form C-1)

BOILER INFORMATION	
JURISDICTION NO.	Owner
MANUFACTURER	Owner ADDRESS
YEAR BUILT	Owner CITY/STATE
BOILER TYPE	USER
ENGINE NO.	USER ADDRESS
OTHER NO.	USER CITY/STATE
HEATING SURFACE	OPERATOR & LICENSE NO.

BARREL INFORMATION	
INSIDE DIAMETER	SEAM TYPE
TUBE SIZE/NUMBER	SEAM EFFICIENCY (from Table S2.10.3)
TENSILE STRENGTH OF SHELL	MAXIMUM PITCH OF SEAM RIVETS
MIN. THICKNESS OF SHELL	JACKET FULLY REMOVED FOR INSPECTION
MIN. THICKNESS OF TUBESHEET	MAWP OF BARREL (from Table S2.10.3)

FIREBOX AND WRAPPER SHEET
STAYBOLT DIAMETER (Base of Threads) OF THINNEST STAYBOLT
STAYBOLT PITCH (Max) AT CROWNSHEET
TYPE OF STAYBOLT (Telltale?)
MINIMUM THICKNESS OF STAYED SURFACE
MAWP OF STAYED SURFACES (from Table S2.10.4.1)
TYPE OF BOTTOM (Ogee, Wet Bottom, etc.)
CONDITION OF THREADED MOUNTING STUDS
GRATES, GRATE SUPPORTS, DAMPERS, ASHPAN — SATISFACTORY?
CLEANED FOR INSPECTION?

SAFETY EQUIPMENT AND CONTROLS				
SAFETY VALVE (per S2.8.1)	MANUFACTURER	SET PRESSURE	CAPACITY	SIZE
FUSIBLE PLUG (per S2.8.4)	NEW “ASME” PLUG	OLD PLUG REMOVED FOR CROWN INSPECTION?		
FEED METHODS	INJECTOR(S) BRAND/SIZE	PUMP TYPE	PREHEATER TYPE	
WATER COLUMN		DRAIN	WATER LEVEL VERIFIED?	
GAGE GLASS (per S2.8.2)		GUARD	TYPE	
TRY-COCKS (per S2.8.3)		NUMBER	OPERABLE?	
PRESSURE GAGE (per S2.8.5)		DIAL RANGE	SIPHON TYPE	

INITIAL BOILER CERTIFICATION REPORT (Form C-1) *continued*

VALVES AND PIPING (per S2.9 and S2.9.1)	
MAIN STEAM (dome) VALVE	MAIN STEAM PIPING
THROTTLE VALVE	PIPE NIPPLES AT SHELL
FEEDLINE STOP VALVE(s)	FEEDLINE CHECK VALVES
FEEDWATER PIPING TO INJECTORS & PIPING	BLOWDOWN PIPING
STEAM PIPING TO INJECTORS & PIPING	BLOWDOWN VALVES
INJECTOR ISOLATION (steam & water) VALVES	PIPING SUPPORTS
BLOWER VALVE	BLOWER PIPING

EXISTING REPAIRS AND ALTERATIONS

EXTERNAL VISUAL INSPECTION FINDINGS

INTERNAL VISUAL INSPECTION FINDINGS

MAWP CALCULATIONS USING ULTRASONIC THICKNESS MEASUREMENTS	
BARREL: P = (TS x Tmin x E)/(R X FS) [per Table S2.10.3]	FIREBOX: P = (T^2 x S x C/Pitch Max^2) [per Table S2.10.4]
HYDROSTATIC PRESSURE TEST (per S2.6.1)	
TEST PRESSURE — PSI	TEST TEMPERATURE — °F
TEST DATE	TEST PROBLEMS

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INITIAL BOILER CERTIFICATION REPORT (Form C-1) *continued*

OPERATING INSPECTION AT PRESSURE	
ABSENCE OF LEAKS	TEST OF INJECTOR(S) & PUMP (if used)
TEST OF TRY-COCKS	OPERATION OF THROTTLE & GOVERNOR
TEST OF BLOWDOWN VALVE	TEST OF SAFETY VALVE(S)
	VALVE POPPING POINT & BLOWDOWN

NOTES

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