

K&T #14

Inspection Overview, Observed Defects & Corrective Actions

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Overview

During the weekend of 11/17/17 to 11/19/17 I had the opportunity to perform a rather thorough inspection on the locomotive known as K&T 14. The first objective was to determine to what extent the previously contracted scope of work has or has not been completed. I am providing two percentages, the percentage of completion as it appears, and the percentage of the work which is salvageable.

The following is a breakdown of that list and what is observed of the locomotive as it sits:

Appears Complete, Salvagable (Percentages)

- **Engineering/Project management**

85%, 3% There is no documentation related to the repairs made to the boiler on site/ given the volume of rework required for the boiler to be made serviceable (among other issues) I consider there to have been no project management provided by the contractor.

- **Boiler, Steam, & Combustion Systems**

90%, 0% While work has been performed and there is the perception of completion, the work was performed contrary to what code or standard practice allows for. There are no MTR's (material test reports) available for any steel components installed into the boiler. Unfortunately, all of the work to the boiler must be corrected for reasons which will be explained in great detail in the final report. The ashpan is constructed of material which is too thin, and the grate supports are fabricated of thin steel weldments versus iron castings of an appropriate alloy.

- Assembly of Boiler to Frame

100%, 10% While the boiler is sitting on the frame, the method of attachment is not correct. The boiler is to be attached (in accordance with OEM and accepted railroad practices) via machined holes/taper fitted bolts to the cylinder saddle, and rivets at the smokebox joint.

As it sits, the boiler is attached via standard bolts through torch cut holes at the cylinder saddle and with hardware store carriage bolts at the smokebox joint. The furnace bearers (plates at front and rear of firebox) are also attached via torch cut holes but that is likely salvageable.

- Throttle & Control Systems

0%, 0% No work has been performed on these components

- Auxiliary System Application

30%, 0% While the air compressor and power reverse gear are mounted, the systems are not only incomplete but must be removed for boiler rework. Both appliances are mounted onto some studs which were replaced with pieces of all-thread, these must be removed and have proper studs put into their place.

- Cab/Jacket Operation System

85%, 10% The cab will need to be removed in order to facilitate the rework on the boiler. However, the interior wood work seems to have been done relatively well. The jacket is not installed correctly, there is no railway practice which calls for welding a framework to the boiler for the jacket to sit upon.

- Steam Piping Systems

0%, 0% No work has been performed on these components

- Air Systems

0%, 0%

- Running Gear & Valve Gear Systems

45%, 40% What work has been performed in reassembly of the machinery does appear to have been done correctly. It should be noted that all of the machine work to the machinery was performed by former contractors. Wasatch simply oversaw volunteers performing reassembly.

- Electrical

0%, 0% No work has been performed on these components

- Safety Systems

0%, 0% No work has been performed on these components

- Paint/Detail

20%, 20% What painting has been completed will not be affected by rework. This is presuming the paint utilized is of sufficient quality, the type of paint is not known.

- Operational/Mechanical Support

0%, 0% No work has been performed on these components

The second objective was to determine whether or not the boiler is salvageable. It IS, though there will be a significant amount of rework..

Applicable Codes

FRA:

The Federal Railroad Administration, the regulatory entity which has jurisdiction over the K&T 14. Regulatory information is contained within 49 CFR Part 230. Specifically stated within this component of the CFR is the following:

§ 230.29 Inspection and repair.

(a)Responsibility. The steam locomotive owner and/or operator shall inspect and repair all steam locomotive boilers and appurtenances under their control. They shall immediately remove from service any boiler that has developed cracks in the barrel. The steam locomotive owner and/or operator shall also remove the boiler from service whenever either of them, *or the FRA inspector*, considers it necessary due to other defects.

(b)Repair standards.

(1) All defects disclosed by inspection shall be repaired in accordance with *accepted industry standards - which may include established railroad practices*, or *NBIC* or *API* established standards - before the steam locomotive is returned to service. The steam locomotive owner and/or operator shall not return the steam locomotive boiler or appurtenances to service unless they are in good condition and safe and suitable for service.

(2) Any welding to unstayed portions of the boiler made pursuant to § 230.33 shall be made in accordance with *an accepted national standard for boiler repairs*. The steam locomotive owner and/or operator shall not return the steam locomotive boiler or appurtenances to service unless they are in good condition and safe and suitable for service.

While not explicitly stated, the FRA does recognize and often reference ASME standards.

NBIC:

The *National Board Inspection Code* (NBIC) was first published in 1946 as a guide for chief inspectors. It has become an internationally recognized standard, adopted by most US and Canadian jurisdictions. The NBIC provides standards for the installation, inspection, and repair and/or alteration of boilers, pressure vessels, and pressure relief devices.

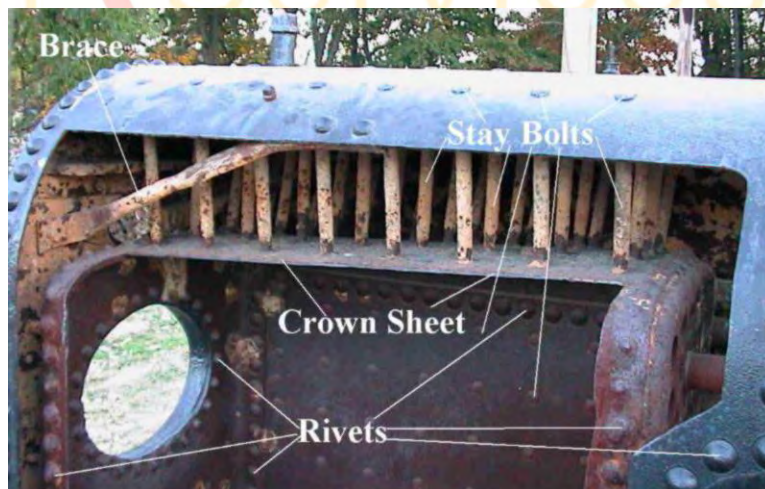
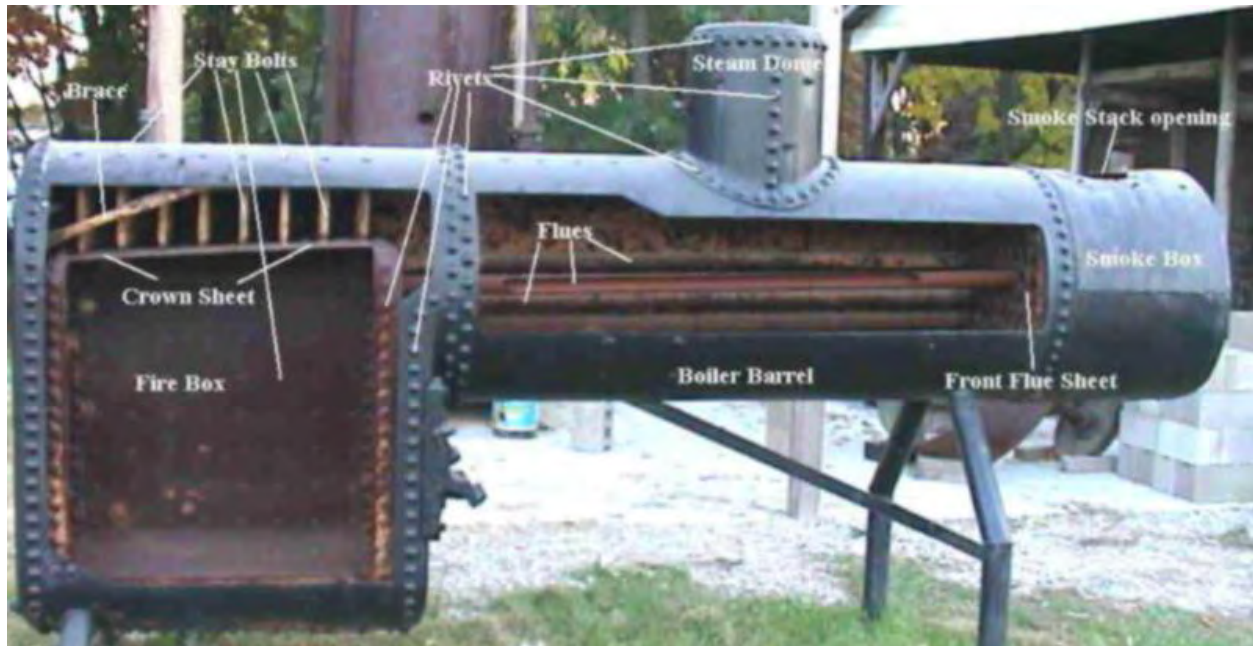
ASME:

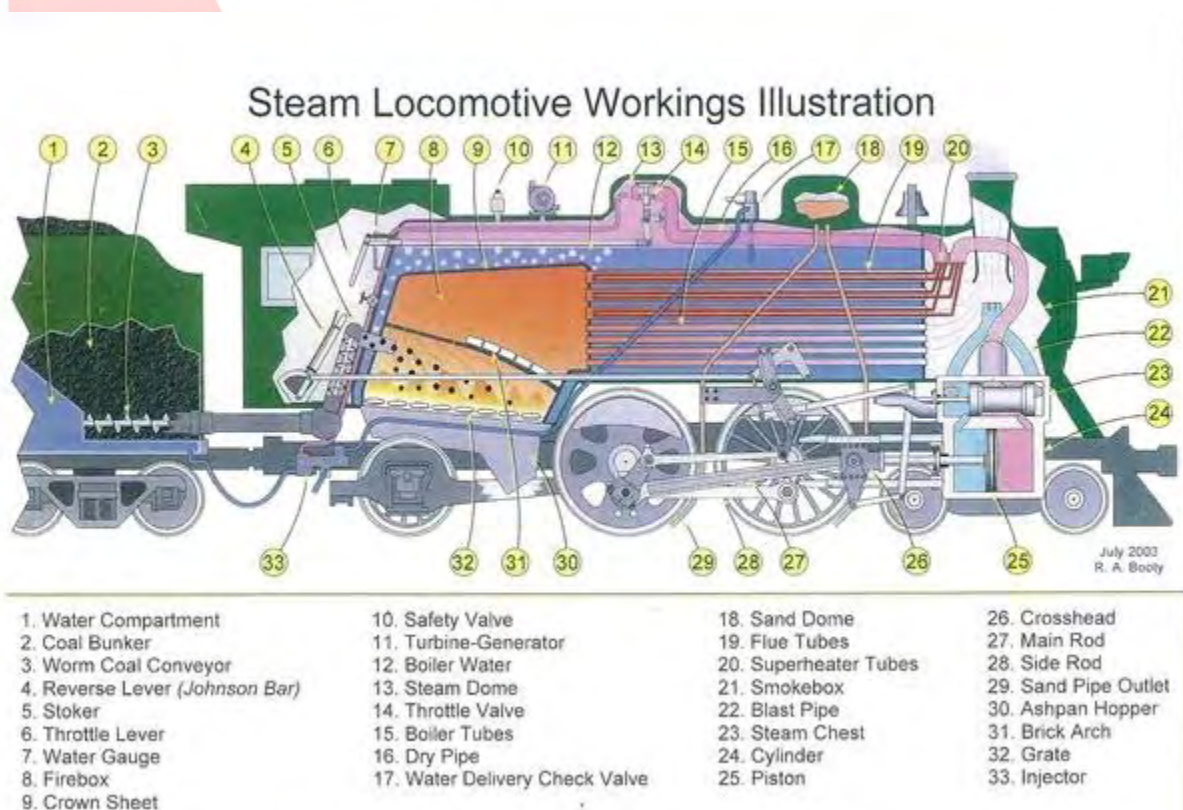
The ASME Boiler & Pressure Vessel Code (BPVC) is an American Society of Mechanical Engineers (ASME) standard that regulates the design and construction of boilers and pressure vessels. The document is written and maintained by volunteers chosen for their technical expertise. The American Society of Mechanical Engineers works as an Accreditation Body and entitles independent third parties such as verification, testing and certification agencies to inspect and ensure compliance to the BPVC.

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Locomotive Boiler Familiarity

The following images are provided for the purpose of lending visual aid in understanding the location of the mentioned components.





This image provides a perspective as to the manner in which the boiler is integrated into the locomotive.

Observed Defects

1) Rigid and Crown staybolts incorrectly installed.

The rigid bolts are installed utilizing a combination of fillet welding and threading. The FRA does not allow for the application of fillet welded bolts on non-chinese locomotives without prior written approval as it is not an accepted railroad practice nor (until summer of 2017) is it allowed by the ASME.

Though the ASME does now allow fillet welded installation, they must be applied under specific criteria as laid forth in PL-30. Specifically, parts PL-30.4, PL-30.4.2, and PL-30.4.4. This in turn violates CFR49 Part 230.29 (b) (1).

PL-30.4 Staybolts may be attached by fillet welds provided the following conditions are met.

PL-30.4.1 The stress value for the smallest cross sectional area shall not exceed 7,500 psi (50 MPa).

PL-30.4.2 The weld leg length parallel to the longitudinal axis shall be greater than or equal to 1/4 in. (6.5 mm). The weld shear area parallel to the longitudinal axis shall be no less than 1.25 times the minimum cross sectional area of the staybolt (minus the cross-sectional area of the telltale hole) as determined by the following equation(see Figure PL-[30.4.2-1](#)):

PL-30.4.3 Staybolt ends directly exposed to the products of combustion shall extend past the fireside of the sheet no more than 3/8 in. (10 mm).

PL-30.4.4 The hole through which the staybolt is inserted shall be 1/64 in. to 1/16 in. (0.4 mm to 1.5 mm) larger than staybolt head diameter. The finished holes shall be true, cleaned of burrs, and nominally coaxial. The staybolt shall be nominally centered in the hole.

PL-30.4.2: A number of bolts do not have sufficient projection through fire side of the sheet to allow for 1/4" of weld without consuming the end of the bolt as prohibited by PW-19.2.

PL-30.4.4: All rigid and crown staybolts which can be observed from within the boiler have 1/8"+ clearance between the bolt and the sheet. Double allowable.



- 2) Flexible bolts installed via filet through torch cut holes which are between 1/8" to 5/8" oversized. This violates PL-30.4.4, and also PW-29.3.

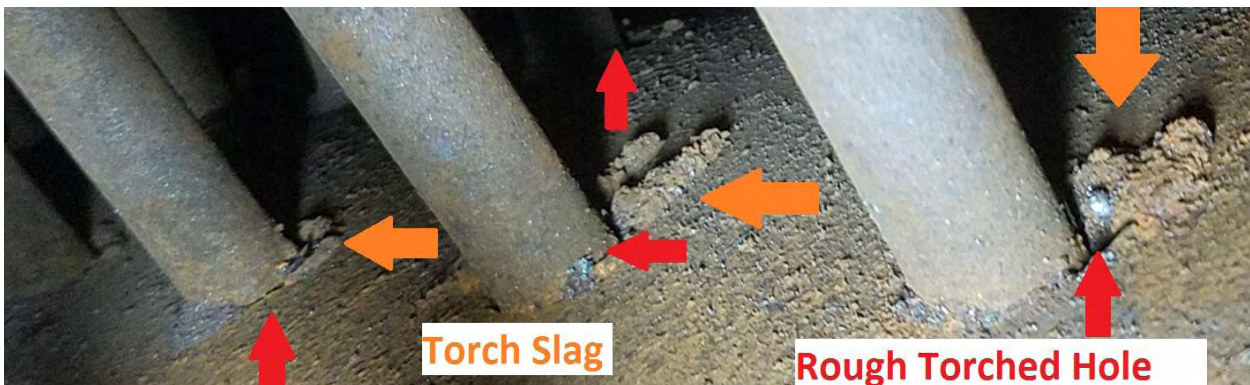
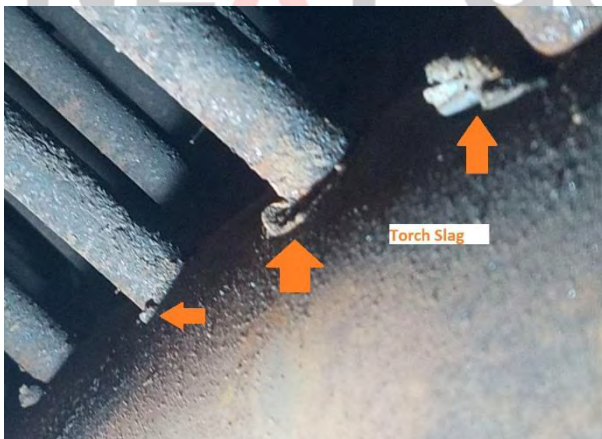
PW-29 BASE METAL PREPARATION

PW-29.1 The preparation of joints prior to welding may involve any of the conventional methods in use such as machining, thermal cutting, chipping, grinding, or combinations of these.

PW-29.2 Where thermal cutting is used, the effect on the mechanical and metallurgical properties of the base metal shall be taken into consideration.

PW-29.3 The method of base metal preparation used shall leave the welding groove with reasonably smooth surfaces and free from deep notches, striations, or irregularities. The surfaces for welding shall be free of all scale, rust, oil, grease, or other foreign materials.

PW-29.3: The surfaces left behind (throughout the firebox) by the torch cutting are not free of torch scale or slag (foreign material), and are also notched and consistently textured with deep striations. This in turn violates CFR49 Part 230.29 (b) (1). Hundreds such locations exist.





The above depicts holes well in excess of 1/8" oversize on fluesheet



Orange denotes 2" diameter torch cut holes.

Red denotes holes in excess of 1/4" oversize in FR crown sheet