SteamRanger's Heritage
- an insight into our past

BACKGROUND

This download contains two reports by SteamRanger's Loco Manager describing a major restoration of Loco 621 following condemning of its boiler in 1979 after eight years of operation as a tours loco and 50 years service since commissioning in 1936.

The first report, written in January 1987 describes the complete restoration from condemning of the loco in 1978 until its return to service to operate the official opening train on the VHTR in October 1986

The second, written 12 months earlier, provides more detail on work carried out in 1985

This download contains a selection of photographs published in the printed articles

LOCOMOTIVE 621

Report on major restoration 1979 - 1986
Reported by ARHS Locomotive Manager Ian Johnston

ARHS Recorder January 1986 and January 1987

Part A - ARHS Recorder, January 1987, pages 66-70

'The Return of the Duke"

621 with cylinder cocks open departs Blackwood with VIP train to Victor Harbor on 18th October 1986
Photo: Roger Currie

A long time ago, way back in 1978, an internal memo from the Islington Boiler Inspector spelt the death knell for engine 621 or so it seemed to all concerned at the time. The reported troubles with the boiler of the "Duke of Edinburgh" were quite foreboding and on top of this the piston valves were completely shot.

The prognosis was therefore fairly grim and it seemed 621 was destined to be a very well preserved static exhibit. In 1981 during idle conversation with our DLI Boiler Inspector at the time, the late Terry Middleton, the problems of the boiler were discussed and put into two categories, those which could be attended to easily and those which required considerable effort and/or finance. The main problem was the reported star cracking around the cups of the flexible crown stays. If these were checked out and found to be either repairable or of no significance then the rest of the boiler work was reasonably straight forward.

Non-destructive testing (NOT) such as x-rays and by ultrasonic means is expensive so was only carried out as finances permitted. Gradually a picture was built up of the areas concerned and while a small amount of surface cracking was detected it fortunately was not significant. It should be mentioned that these testing methods were not readily available during the days of steam on the SAR and when boilers of this era gave trouble they were invariably condemned with refurbishment never really being considered. The NOT results were encouraging so during 1982 the boiler tubes were removed and the bottom third of the barrel needlegunned. However work came to a halt when the underside of the flues were found to be heavily pitted and DLI recommended that all flues be removed. Heavy boiler work involving a complete retube and reflue was underway on engine 520 so 621 was again shunted to the rear of the shed.

It was not until 1984 that work recommenced. The 22 flues were removed, grit blasted and the repairable ones sorted out. The remainder of the boiler clothing and fittings were removed. The condition of the boiler interior had to be seen to be believed with scale up to 12 mm thick —the result of years of neglect and improper water treatment. The removal of this scale was to be the main reason for slow progress on the boiler. It all had to be removed so that the Boiler Inspector could inspect the steel boiler shell. The interior then had to be completely Apexior painted. The flues were reconditioned which included trimming the ends, swaging one end, welding on a make-up length and welding the corrosion marks. Because of the condition of the tubeplates various combinations of flue lengths and diameters had to be worked out beforehand.

At this stage a series of five hydro tests on the boiler were undertaken. The first two were with hot water (from Rx207) at 1.25 times full pressure (250 psi) with element blanks fitted to the header These tests were mainly to check and take up leaks from the expanded tubes and flues The third test with cold water to 100 psi with elements fitted was to check them, header, regulator and other fittings Two cracks were detected in the massive cast iron header — an almost insurmountable problem we thought, until we came across a chap with a metal stitching and plugging process which is claimed to have greater strength than the original casting — only time will tell. These cracks were relatively small and appeared to have been present for some time. They may have even been the result of flaws in the original casting. A leak was also detected from the riveted seam of the feedwater connection compensating plate on the front top of the boiler. This eventually had to be completely seal welded then entirely x-rayed to ensure that there were no underlying problems. Fortunately there weren't any.

The fourth and fifth hydros were the same as the third but needed to check the repaired header and compensating plate. Further work included renewing the "whipcord" seals in the injectors with Viton”O” rings - the same as has been done on enginee 520, firebox doors overhauled, new brick arch installed in the firebox, ash pan door operating cylinder overhauled, buckets of scale removed from the tender, a new stainless steel sieve for the tender water filler and the exterior of the tender prepared and painted with Hawthorn Green.

A series of steam tests followed, the first being before the piston valves were boxed up and was to see what worked, what worked, what leaked and to set the safety valves. First the good news. The air compressor, blower, injectors and regulator all worked OK. It was a very impressive and satisfying sight when the regulator was opened and enormous clouds of steam roared from the open valve cylinders and enveloped everything and everyone. The bad news was that the turbo-generator spun OK but generated no volts (later found to be a short circuit) and there was a significant leak from the feedwater connection up front. It became obvious this was an old problem which was responsible for the seam leak and took many hours of patient lapping to get all sealing surfaces true again. As well the safety valves had been feathering too early and had to be reworked.

Meanwhile other work had been progressig including:

(a) sandbox cleaned, painted and fitted.
(b) 3 inch double-foil backed rockwool insulation fitted around the boiler
(c) some new boiler clothing panels fabricated.
(d) boiler clothing undercoated and fitted. This was not a straight forward job as many difficulties were encountered aligning and fitting the panels.
(e) piston valve assemblies were fitted and valve timing set.
(f) right-hand-side blow down valve overhauled — it tended to stick open especially when in steam.

During 1985 considerable work was carried out on 621 as detailed in "The Recorder" of January 1986. (Ed: see attachment following)

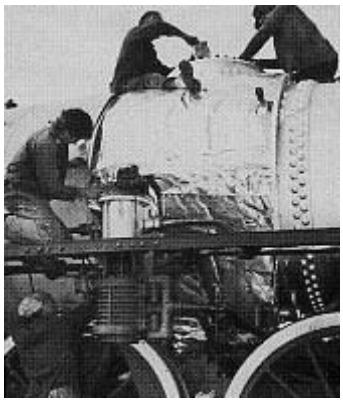
Briefly, this work included further NDT of tubeplates, boiler barrel seams etc., renewing 3 palm stay pins, new whistle pipe, new feedwater tray, continued needle-gunning, reboring of out of shape flue holes in firebox tubeplate, many attempts to free seized regulator valves finally ending in success, safety valves rebuilt, welding repairs to smokebox tubeplate, valve cylinders rebored and castings for valve components ordered.

As the list of jobs shortened, the tempo of work began to quicken as everyone became more enthusiastic over the prospect of seeing 621 steam again. However there was still plenty to do and during the first few months of 1986 the following work was undertaken:

(a) needlegunning of boiler interior finally completed followed by the Apexior painting
(b) exterior of boiler cleaned, treated with rust converter, Apexior painted then finally coated with heat-resistant aluminium paint.
(c) guide bushes in regulator housing rebored to remove ovality and a buildup of hard scale (which caused the seizure) followed by machining the valve seats. The reboring proved to be an extremely difficult task as most of the work had to be done blind due to a complete lack of access both by feel and sight once the boring machine was in position
(d) three new stainless steel regulator valves were machined to suit the rebored holes
(e) the regulator was then reassembled, adjusted to correct opening sequence and sealed
(f) the piston valve components were machined from the castings and then reassembled by members of Dads Army.
(g) 102 reconditioned boiler tubes fitted.
(h) 22 reconditioned boiler flues fitted.

(i) a reconditioned set of 22 superheater elements were fabricated from various sections of elements on hand, mainly from 710 class locomotives,
(j) a new mud ring plate fitted to the boiler, (k)all gauges recalibrated
(l) all boiler fittings installed.
(m) the steam head valves were refurbished as were the air compressor and its governor the injector starting valves and steam turbo.

During routine checking of 621's motion the left-hand-side eccentric crank was found to be a loose fit and required building up and remachining. This situation was probably due to some engines being cannabalised to keep others going. Parts of 621's motion gear came from 622. Engine 624 preserved at the Mile End Railway Museum has parts from 629. An unfortunate incident then followed as the crank was being prepared for machining when it suffered a nasty crack. Repairs were not practical and as no other crank was readily available a new one had to be manufactured from a block of steel costing $500. A sympathetic engineering firm (not the original) spent one week machining the new crank at a cost of $1000. Roy Stanley from Dads Army and our full time fitter, Ron Williams, then spent more time on the delicate job of hand fitting the crank to the crank pin to get the correct tolerances.



Peter Hoye and Peter Soar tightening dome cover nuts as Glen Smythe and Andrew Gramp work on insulation cladding (L)
and Richard Bonney and Roger Currie fit insulation to 621's cylinders (R)

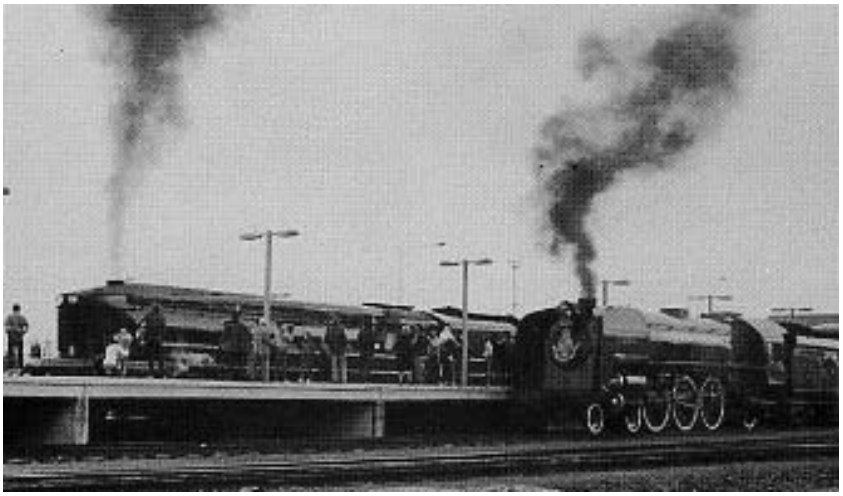
Ian Johnston on the crane, Peter Soar and Peter Hoye guide 621's dome cover into position as Ben Greeneklee looks on.
(All above photos Roger Currie)

Another two steam tests followed before everyone was happy and during the latter the engine was moved under its own power for the first time in 8 years. A knock was detected from somewhere underneath but because of limited room to move the engine the source was not located. The body of the headlight had rusted out mainly because it gets a steam bath every time the whistle is blown. A new headlight was fabricated from stainless steel using only the original glass ring and number frames. All electrical wiring at the front of the engine was replaced. The rest of the wiring will be progressively renewed.

During 621's first trial run to Gawler in September 1986 the knock underneath was soon identified as driving wheel axlebox movement caused by improperly adjusted wedges (a result of incomplete maintenance before we took over the running of this engine). Some slack was taken up at Salisbury and even more on our return to Dry Creek. The second part of the trial run to Bridgewater went without a hitch, the most difficult part being turning the engine on the manually operated Bridgewater turntable.

The engine was then put in the painters' hands for three weeks during which time it was degreased and given eight coats (that's right EIGHT coats) of Hawthorn Green paint plus associated fiddly painting. With its smoke deflectors refitted 621 made a triumphant return to service by successfully hauling the VIP train to Victor Harbor on the official opening day of the Victor Harbor Tourist Railway during October 1986. On the tender — first movement with the Cockle Train the axlebox knock was apparent and closer inspection revealed the automatic adjusting wedges had now run out of adjustment. The simplest way to cure this was to fit slightly thicker floating wedges and although it has yet to be proven it is now expected that the knock has been eliminated.

A lot of effort by a lot of people over a long time went into getting 621 back into service again. It is not practical to mention individuals here but they all know their efforts have been appreciated at Steamranger. The return to service by 621 certainly generated lots of interest as indicated by the largest number of people ever seen lining the tracks to Bridgewater during the trial run.



621 and 520 at Adelaide Terminal on 18th October 1986 before each went to Victor Harbor
Photo: G Doecke

Part B - ARHS Recorder January 1986, pages 52 - 53

Work on the recommissioning of engine 621, a favourite of many people, has progressed steadily over the past year. Considerable work has been done but equally a lot more work and finance is still required before this unique engine can proudly take it's place at the head of a steam special again.

A short recap on the recent history of 621 would not go astray.

1969: 621 was rescued from the cutter's torch but only when the ARMS raised $10,000 to carry out work necessary to get the engine running again.

1971: 621 began it's "second life" hauling numerous steam train specials on a regular basis during the winter months to various destinations around S.A. The engine gave solid service for a number of years with only the usual running maintenance required. However, there had been ominous clouds building up over the boiler.

1979: The boiler of 621 was condemned by Islington account apparent star cracking around some stay holes and evidence of grooving around some stay ends. Most of the trouble was located around the firebox crown and the underside of the barrel crown

1982-1983: DLI boiler inspectors advised that the boiler may well be recoverable but this could only be ascertained by extensive testing. Some non-destructive testing was carried out as finances permitted. All tubes and flues were removed for progressive inspections.

1984: The testing revealed that main problem areas were not as serious as first thought and could be repaired where necessary. The boiler was completely stripped and exploratory work continued as required by the boiler inspector.

At this stage in excess of $3,000 had been spent on non-destructive testing which included:

(a) magnetic particle testing of
- both sides of each tubeplate
- top radius of firebox tubeplate
- inside radius of firehole •
- cupholes around some flexible stays

(b) ultra-sonic testing of
- nearly all of flexible crown stay cupholes on barrel crown

c) X-Ray testing of :
- longitudinal and circumferential rivetted barrel joints.

No problems requiring further attention were encountered. Overall the boiler was considered to be in good condition for its age (the boiler was originally commissioned int 1936) but there are a few areas which will have to be monitored. The boiler inspector also required palm stay pins to be removed from 3 smokebox tube-plate mounts for inspection. On removal these were found to be quite sound. While all tubes and flues are out of the boiler, the opportunity has been taken to carry out a few other tasks while there has been good access:

- renew the main whistle steam pipe.

- renew the top feedwater tray.

- needlegun the entire interior to remove large scale deposits after years of neglect.

- treat all non-heating surfaces with Apexior paint.

- Rebore the 22 flue holes in the firebox tubeplate to remove unacceptable levels of ovality and taper. It is suspected these resulted from attempts by Islington to correct flue-end cracks by overexpanding the flues. To expand reconditioned flues into these holes would have been a complete waste of time as good sealing would have been impossible to attain.

The valve cylinders were rebored some months ago. The boring machine was kindly loaned by the Pichi Richi Railway Preservation Society. The extensive grooving in the valve cylinders which gave the firemen heaps of extra work to do due to copious steam leakage has now been completely removed. The piston valve assemblies (bobbin shaped with a pair of rings at each end designed to admit and exhaust steam to and from each end of the main cylinders) proved very stubborn to dismantle. The saga began at the Depot with a 10 tonne hydraulic "porta-power" but no sign of movement. The assemblies were taken to Perry Engineering and placed in their 100 tonne press but neither would budge, even at full load. Next trick was to soak them in diesel fuel for two weeks and try again. Not bad stuff because both valves came apart at 45 tonnes. However the valve ends and bull rings as recovered were useless as extensive corrosion had taken place, for instance, one section which was supposed to be 8mm thick had wasted to 3mm. So lots of new castings were repaired and even though we have various casting patterns Murphy's Law prevailed and there were none of these. Between making new patterns and the required castings over $1100 has been spent and this is before any machining has begun.

Since 621 last worked in 1978 the regulator has become well and truly siezed. Unfortunately 621 being an early member of it's class was built with a header type regulator located in the smokebox rather than in the dome. These regulators were popular in the United States but they can give trouble,
so much so that from 623 onwards they were put back in the dome. Dome regulators usually have a small pilot valve in tandem with a single main valve and these are relatively simple in operation and easy to work on.

The 621 regulator consists of a pilot valve plus 3 main valves arranged vertically across the header casting and connected to progressive cams on the operating shaft. Each valve is located in a rather large guide in the header and this is where each was jammed due to build-up of corrosion. All sorts of tricks were tried over a period of weeks but good access was always difficult. Initially the operating shaft was also siezed in the cast iron stuffing box — this was finally freed but only by unintentionally fracturing the poorly-designed casting. Another job for the foundry and again no pattern.

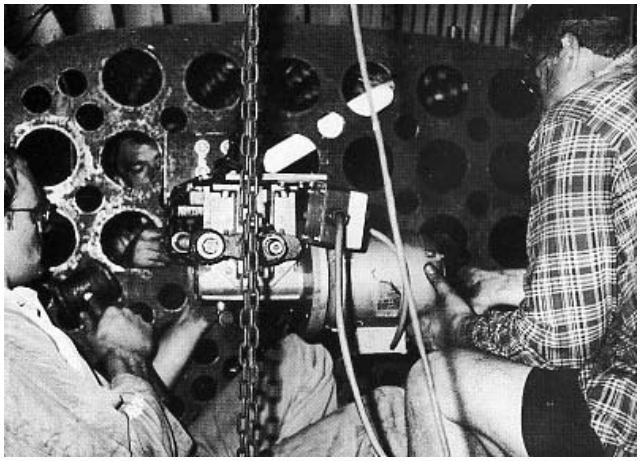
Copious quantities of diesel fuel were poured into the regulator assembly to soften and loosen the corrosion but the more we put in the more that poured out in the wrong places. Eventually each valve was drilled and tapped, a laborious job considering the stainless steel had gone rock hard with heat and age. By using high tensile bolts and a puller plate the middle valve was freed first.

Then by comparison much less effort was required to release the other two valves by applying pressure to the operating shaft while tapping the valve heads. Our group of retirees (Dads Army) assisted in the last stages. After about six weeks the diesel fuel had finally got right through the layers of gunk.

At the time of writing it had not been decided whether to have three new valves made and being of stainless steel they will be expensive or try and make do with the old valves, one of which has a broken base. All would still require considerable refurbishing work.

Over the summer months most work will be concentrated in the boiler. Jobs such as finishing cleaning, Apexior painting, fitting the feed water tray and whistle pipe followed by the tubes and flues will be done. Most boiler fittings have been overhauled but still have to be fitted and checked out. Whether we need a new set of superheater elements or the old set can be successfully reconditioned has yet to be ascertained. The usual hydro and steam tests will follow before a complete reinstallation job, some new clothing and repaint. It is also planned to fit the air-compressor which failed on 520 this year. This unit has had the steam cylinder rebored and fitted with new piston rings to overcome the excessive wear.

All being well it is hoped that 621 will be ready for trial runs sometime towards the middle of 1986 and will become a back-up engine for 520 on the Victor runs. One should keep in mind that on the 7th September 1936, just 50 years ago, 621 first entered service on the South Australian Railways.



Reboring 621's flueholes in the firebox tubeplate.
Ian Johnston (in the firebox)sets up the special boring machine
with Peter Brown (adjusting tool at the ready) and Peter Soar at the right.
Photo: Roger Currie

Ian Johnston checks measurements of the rebored valve cylinders.
Note one of the four new bull ring castings on slide bars.
Photo: Roger Currie

Needlegunning inside 621's boiler.
Never a popular job but Howard Johnston
has spent many hours removing layers of scale
Photo: Roger Currie