

## **Steam Operations at Sovereign Hill**

**by Tim Sullivan, Anna Kyi and Harold Conder**

Sovereign Hill is Australia's leading Outdoor Museum. It opened its gates in 1970 as a community-based, not-for-profit museum to interpret Ballarat's rich gold mining heritage from discovery in 1851 through to World War I.

In that period, Ballarat's mines produced approximately 11 million ounces of gold: nine million ounces from the alluvial and deep lead mines which dominated until the 1880s, and two million from the later period dominated by quartz mining.

Sovereign Hill has steadily grown into an iconic heritage tourism attraction for visitors from all over Australia and internationally. Its museum values are as strong today as they were in the founding days. Attention to detail and rigorous scholarship in researching and interpreting the gold rushes has established its credibility as a major player in the conservation of gold mining heritage.

A Poppet head dominates the skyline over Sovereign Hill, a symbol of the city's mining heyday and a drawcard to its Mining Museum, incorporating original underground workings and a working Steam Operations made up of the boiler house, the winding house, the battery and the beam pump.

Sovereign Hill's Steam Operations is a carefully researched reconstruction of a late-nineteenth century quartz mine's surface operations. It was put together during Sovereign Hill's first decade with great care and commitment by many people—museum and technical professionals and steam enthusiasts with backgrounds in machinery trades—using original pieces gathered from many parts of Australia.

The wisdom of that investment in the steam operations is paying off handsomely today—the underground experience is still one of the most valued by thousands of visitors to Sovereign Hill. The scream of the whistle, the rumble of the batteries, the soothing breathing of the power strokes in the engine room and the arterial gush of the pump are a signature of a visit to Sovereign Hill.

### ***The Boiler Room***

Two Cornish boilers provide the steam to drive Sovereign Hill's mining museum. They generate between 120 and 140 horse power.

The Number 1 boiler was built in Bendigo by Roberts & Sons United Iron Works in 1911 and worked in a number of mines in that area before being installed at the Erskine Guest house, Lorne, in 1926. Sovereign Hill acquired it in late 1971 and brought it on-site to install in 1972. It is 27ft 6in long and 6ft 6in in diameter.

Number 2 was built in 1909 at Thompson's in Castlemaine. It worked on the Ajax mine in Daylesford before it went into the Daylesford Hospital. Sovereign Hill acquired it in 1982 and it was installed next to Number One in 1984. It is 26ft 6in long and 6ft 6in in diameter.

The boilers consume approximately 1.5 tonnes of wood a day. This is significantly less than the eight tonnes of wood burned in a shift in the big mines in Ballarat using often 4 or 5 boilers in a row.

Harold Conder retired as Sovereign Hill's Steam Operations Manager after 30 years of service from 1972-2002. During his years managing the steam operations, he taught generations of boiler hands and drivers the almost lost arts of maintaining a

functional steam plant and inspiring a passion for the steam heritage in mining. Even the most obvious things like stoking a boiler properly have to be taught anew for successive generations.

Conder says

*'every boiler is different and every engine is slightly different. That's the beauty and the challenge of working with steam engines—they talk to you, they tell you how they are going and what they need—most of the time!'*

The production of steam from the boilers is controlled by the amount of fuel in the boiler, the amount of air admitted by the dampers, and the sensitivity of the safety releases. It is a precise science, but experience and a 'feel' for the individual machinery is important. The art of firing a boiler is a 'little and often' approach. A good boiler hand will watch the fuel and air and water pumps closely—maintaining a constant feed is better than having to introduce a lot of wood or cold water at once because it kills the pressure in the boilers.

The original safety valves on top of the boilers were a counter-weighted ball lever which were triggered when the pressure build up was sufficient to overcome the weight on the valve. Eventually, they were replaced by more reliable spring-loaded valves.

Two pumps feed about 800 gallons of water through each boiler a day. If these boilers were working in Ballarat's mines at the end of the 19th century, they would have pushed through about 2,000 gallons every 24 hours.

The banjo pump (so called for its resemblance to the musical instrument) came from the Baldwin collection in Sydney in the early 1980s. It had been used in a plant building sugar cane locomotives. Sovereign Hill acquired it when the business closed. It is typical of wall pumps used in the late nineteenth century.

Until the banjo was acquired to feed the second boiler, the operation used two vertical Welch Perrin & Co Weir-type pumps. The vertical pumps were originally designed for use in ships because they take up less space. Sovereign Hill acquired its Weir pump from the Victorian Inland Meat Authority works in Ballarat, locally known as the 'Vimmer'.

### ***The Winding House***

The Winding House is pot porri of oil, grease, and kerosene. Conder says

*'it's the traditional smell of steam operations. It's like gold fever: once it gets into your blood you never lose it.'*

The steam operations of the great mines in Ballarat were presented with great pride. The commissioning of a new steam plant or a new battery was akin to the launch of a new ocean liner. There were competitions amongst the mines to recognise the best presented surface operations, and the staff who worked in them had enormous pride in their attention to detail in maintenance and presentation. The floors were kept clean and oiled to preserve them, the brass was always shiny and the paintwork impeccable. Equipment and tools were always stowed tidily.

The Winding House was like the bridge of a ship with communication by bell tones (called the 'knocker') from the men working in the drives and tunnels in the mine below, signalling to bring up ore or waste rock, equipment or men changing shifts. The winding engine driver only ever responded to signals—he never initiated them.

The engine driver was required to reply with precisely the same signal as was sent to him. If it was incorrectly responded, the man on the knocker in the mine would immediately cancel the command, and re-send it until he received a precisely accurate response. An engine driver who got signals wrong was a danger to everyone in the mine: his job took great concentration, and on the platform in the winding house, he was unapproachable.

As Conder says

*'The engine driver couldn't lose his concentration. He had to remember which way his engine was running, which way his ropes were going, where his cages were. The driver was also watching all the 'clocks' around him—the gauges showing steam pressure and air pressure. If the steam pressure got too low he couldn't move the cages. If the air pressure dropped, he might lose his brakes.'*

The same signals were heard at the brace on the mine poppet head, or headframe, over the shaft. The brace was a platform about half way up the poppet head where trucks coming out of the mine carrying ore went to the battery house, and those carrying waste went out to the mullock heap. The man working at the brace could also cancel signals if needed.

Sovereign Hill's steam operations were planned 'backwards' from the original mullock heap of the Normanby North Mine. A new shaft was developed as part of the interpretation of a late-nineteenth century quartz mine, although public access to the underground tour and exhibits was through an adit 30 metres further down the ridge below the headframe. In developing the underground mine, Sovereign Hill intersected old workings and stopes which are now included in the mine tour, and found the original three-compartment shaft of the Normanby North Mine.

Many of the tools used in the machine areas were made in the mine's own blacksmith shop. The ones on display in Sovereign Hill's Winding House were all hand made from mild steel and forged in the blacksmith's shop. 'We have big spanners,' according to Conder, 'because we have big nuts and bolts! They are always laid out so we knew where they are when we want them—nice and tidy.'

The winding engine at Sovereign Hill is a John Donald reciprocating engine, built in Glasgow in December 1908. It drives a first-motion winding engine pulling a wire rope connected to the cages which pass each other in the shaft: as one cage is going down, the other is coming up. A large dial near the winding engine driver's platform shows precisely where the cages are at any time.

*'The levels are usually marked in something temporary, like chalk. Temperature makes a lot of difference in a big mine as cables stretch or contract and you can be six inches out. A good engine driver', says Conder, 'has to be able to stop a cage precisely at the level it is needed: if he is short, the men below have to get loaded trucks up over a lip and they didn't like doing that, naturally! If he went too far, there'd be a drop from the plat to the cage, which was no good either. Everyone has to be kept happy.'*

The engine and the compressor for the air brakes were retrieved from an abandoned antimony mine at Costerfield in 1973 and 1974. They were in a very derelict condition and many pieces—especially the brass fittings and name plates—had to be remade by Sovereign Hill or with local Ballarat firms. There was also a lot of scrounging, hunting around, networking to find things.

Local expertise and interest was vitally important. The contribution of a local foundryman, Ian Creelman, is fondly remembered. Conder says 'Ian was a very clever man—nothing ever beat him. For example, the gears in the governor on our air compressor were machined by Ian from a Model T Ford gearbox'. Others like Jim Whitehead, who was working with Ingersoll Rand (Australia), sourced catalogues and technical descriptions from the American parent company in New York and had some crucial bearings and gauges made up for Sovereign Hill.

### ***The Beam Pump***

Pumping groundwater from Ballarat's mines was a constant challenge—even from the earliest days. The first steam engine used in Victorian mining powered a pump on Ballarat's Gravel Pits lead in July 1853<sup>1</sup>.

Sovereign Hill's pump is a Cornish Beam Pump, typical of many used in Ballarat's large mines. It is driven by a Ruston Proctor reciprocating engine, built in Lincolnshire 1881. It's a single-cylinder horizontal engine, 10 in (254 mm) diameter and a 24 in (610 mm) stroke. It was shipped from Liverpool in July 1881 to Armidale in New South Wales where it drove a sawmill on a cattle station. Sovereign Hill acquired it from a scrap yard at Moama to restore it for use in interpreting the quartz mine. It was installed in 1982 after 18 months of preparation and re-building.

The peculiar rhythm of the beam pump engine is something like a weightlifter's breathing: the steady, long, deep inhaling on the way up, and then the rapid exhaling after the effort on the downstroke. The crank weighs a quarter of a tonne. Add water from the mine, and each stroke is lifting nearly three-quarters of a tonne. Day in and day out, it pumps water from the mine below: 12,000 gallons an hour.

The pump is only doing 8 to 10 strokes a minute at the most. Any faster doesn't make any difference—the extra speed agitates the water so that it 'froths' up in the chambers below and is too 'thin' to fill the reservoirs. So the throttle is set to ensure the engine is getting just enough power to maintain a constant flow.

The beam itself was built around some old castings found in the old Last Hope mine near Majorca. The main blocks were acquired from a Bundaberg sugar mill, and some new pieces were fabricated when original cast ones could not be found. It was rebuilt by a local Ballarat firm, Miller Bros.

### ***Inside the Battery House***

Sovereign Hill's ten-head Californian-style battery was built in Launceston—probably in the 1860s—but was mostly worked around Woods Point in the lower Victorian Alps. It now operates approximately four hours a day, seven days a week. The stamper heads were typically replaced every 6 to 8 months (depending on the hardness of the ore).

The slurry from the battery passes through a number of gold extraction processes: mercury tables which form a gold amalgam for smelting; a coarse corduroy blanket to capture the fine, free gold; a vibrating Wilfley table which uses gravity separation to draw off gold-bearing mineral for later roasting and smelting; and a berdan pan.

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<sup>1</sup> McCarthy, P. 2001. '150 years of gold in Victoria', in Edwards, A. and Sullivan, T. (eds.), *A Toast to the Days Of Gold*, AIMM/Sovereign Hill, Melbourne, pp45-49.

The mines in the area around Sovereign Hill produced around 2-3 ounces of gold on average per tonne of ore<sup>2</sup>.

Most of the big mines in Ballarat had 40-60 head stampers, whilst the biggest one in Ballarat, the Star of the East, had 100 head running in 20 banks of five. It is local lore in Ballarat that when all the batteries shut down at midnight on Saturday night, the sudden silence would actually wake people up.

The Sovereign Hill battery is operated by a Phoenix tandem compound engine—the pride of Sovereign Hill's fleet. It was made in Ballarat at the Phoenix Foundry in about 1877. It generates around 180 horse power.

The engine was most likely used in the South Imperial mine in Buninyong for 10-12 years until the mine shut down. In 1903, the City Council needed an engine to drive a blue metal crusher and bought this engine by tender. It was used until 1963 and lay idle until donated to Sovereign Hill in 1972. It was in remarkable condition—the only things missing were main bearing brasses and the brass side feed lubricators. The piston rods were also replaced because of severe pitting.

Conder can't see any reason why this engine won't continue to run for another 100 years:

*It is only doing around 50rpm which is quite slow. As long as the engine driver looks after it and the lubricants are kept up to it, and that the packings are not allowed to get hard on the cylinders. You can't let them get too tight—if they get too hard then you score all the piston rods. The piston rods can be replaced, but if you happen to break the casting you are in real trouble.*

### **The future**

There are a number of challenges for the future in maintaining historic steam operations. After 30 years, Conder reflects that the biggest challenge was getting the bits and pieces of machinery together: 'it is getting increasingly difficult to find original cast pieces'.

Finding and retaining staff is also a challenge: according to Conder,

*The first generation of Steam Operations staff grew up amongst steam plant and brought that experience to Sovereign Hill. But now many young people have never seen steam in a workplace until they come to work here. Even so, the thrill of putting an engine together, getting it ready to run, turning it over by hand to make sure everything is going, turning on the steam for the first time—that is magic. It is the smell of the oil and the steam, it sticks in your blood, it is like gold fever, you can't get it out.*

### **Acknowledgements**

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<sup>2</sup> For a detailed analysis of the types of gold extraction, refer to Davey, C. J., and McCarthy, P. L., 'The development of Victorian gold mining technology', Victorian Historical Journal, 73/1, 2002