

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 eleven 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 the gold rushes has established its credibility as a major player in the interpretation 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 display made up of the boiler house, the winding house, the battery house and the beam pump.

Sovereign Hill's steam operations is a carefully-researched reconstruction of a late-nineteenth century quartz mine's surface installation. 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 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 battery, the soothing motion of the piston rods 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. Between them, they generate more than 100 horse power.

The boiler on the right was built in Bendigo by Roberts & Sons United Iron Works circa 1909, and worked in a number of mines in that area before being installed at Erskine Guest House, Lorne, sometime prior to 1933. 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.

The boiler on the left was built in 1909 by Thompson's in Castlemaine. It worked at the Central Ajax mine in Daylesford before it went into the Daylesford Woollen Mills and then the Daylesford Hospital. Sovereign Hill acquired it in 1982 and it was added to the boiler house 1984. It is 26ft 6in long and 6ft 6in in diameter.

The boilers consume approximately two tons of wood per day. This is significantly less than the eight tons of wood burned in a shift in the big mines in Ballarat, often using four or more boilers together.

In 2002 Harold Conder retired as manager of Sovereign Hill's Steam Operations after thirty years of service. During his years managing steam operations, he taught generations of boiler attendants and engine drivers the almost lost art of maintaining functional steam plant and inspiring a passion for steam heritage in mining. Even the most obvious things like firing a boiler properly have to be taught anew to 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 demand from the engines and auxiliary plant, the amount and quality of fuel in the boiler, the damper setting regulating the admission of air, the rate of admission of feedwater and its temperature, and the settings of the safety valves. It is a precise science, but experience and a 'feel' for the individual machinery are important. The art of firing a boiler is a 'little and often' approach. A good boiler attendant will watch the fuel, air and the water pump closely—maintaining a constant feed is better than having to introduce a lot of wood or feed-water at once, because these tend to kill the pressure in the boilers.

The original safety valves on top of the boilers were a weighted ball-and-lever which opened when the pressure was sufficient to overcome the weight on the valve. These have been replaced by tamper-resistant spring-loaded valves which meet current regulations.

Two pumps feed about 800 gallons of water through each boiler a day. If these boilers were working hard in Ballarat's mines at the end of the 19th century, they would have required about 2,000 gallons every day. Water for the boilers is supplied by two vertical Welch Perrin & Co Weir-type pumps. These vertical pumps were originally designed for use in ships because they take up very little space. Sovereign Hill acquired these pumps from the Victorian Inland Meat Authority works in Ballarat, locally known as the 'Vimmer'. There is also a Worthington duplex horizontal pump for use when one of the Weir-type pumps is undergoing periodic maintenance.

The Winding House

The Winding House is pot pourri 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 immense 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, and for accidents. 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, 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 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 poppet head 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, with public access to the mine via an inclined tramway system (complete with its own steam exhibit, a 1907 horizontal engine built by Walkers of Maryborough, Queensland). 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 engine houses were made in the mine's own blacksmith shop, powered by an inverted-vertical Buffalo 'bottle-frame' steam engine. 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 know where they are when we want them—nice and tidy'.

The winding engine at Sovereign Hill was supplied by Scottish machinery agent John Donald, and pre-dates 1908, perhaps, from its design, being considerably older. It drives a pair of first-motion drums controlling wire ropes 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 easily 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 had to be kept happy.

The winding engine and the Ingersoll Rand two-stage air-compressor used for the winder brakes (the latter dating from the period 1905-1911) were retrieved from an abandoned antimony mine at Costerfield in 1973 and 1974. They were previously at the Virginia South Extended gold mine at Bendigo from 1934-1948. Both were in a very derelict condition and many pieces—especially the brass fittings and name plates—had to be remade by Sovereign Hill or by local Ballarat firms. There was also a lot of scrounging, hunting around and 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 1853.¹

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 horizontal engine built in Lincolnshire in 1881. It's a single-cylinder horizontal engine, 10in diameter with a 24in 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 eighteen 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 ton. Add water from the mine, and each stroke is lifting nearly three-quarters of a ton. Day in and day out, it pumps water from the mine below at 5,000 gallons per hour.

The pump is only doing eight to ten strokes per minute at the most. Any faster doesn't help—the extra speed agitates the water so that it 'froths-up' and is too 'thin' to fill the pump chamber. 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 at the Last Hope mine near Majorca. The main bearings 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 by the Salisbury Foundry in Launceston, almost certainly in early 1891 for the Mount Wills South Tin Mining Company in Gippsland. After the tin 'bubble' burst, the battery was changed over to crushing gold-bearing ore in 1895, and eventually found its way to a machinery merchant in South Melbourne, from where it was purchased by Sovereign Hill. It now operates approximately two hours per day, seven days a week. The stamper heads were typically replaced every six to eight months (depending on the hardness of the ore).

The slurry from the battery passes through a number of gold extraction processes: we do not use highly-poisonous mercury at Sovereign Hill and, instead, rely on the traditional corduroy blankets to capture the heavier gold; a vibrating Wilfley table (which uses gravity separation to draw off gold and other heavy minerals); and a Berdan pan for crushing ore extremely finely. Both of the latter are driven by an early G. G. Norman true-vertical engine built in Ballarat.

¹ 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, pp 45-49.

The mines in the area around Sovereign Hill produced around half an ounce of gold on average per ton of ore.²

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 twenty 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 powered by a Ballarat-built Phoenix Foundry tandem-compound engine—the pride of Sovereign Hill's collection. It is the only extant Phoenix stationary engine and was almost the last item built by the Foundry. It generates around 175 horse power. The engine was built in 1905 to power the City of Ballarat's blue-metal quarry in Learmonth Street, Alfredton. It was used until the mid-1930s, and lay idle until donated to Sovereign Hill in 1972. It was in remarkable condition—the only things missing were the main bearing brasses and the brass sight-feed lubricators. The piston rods had to be 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 42rpm which is quite slow. As long as the engine driver looks after it and the lubricants are kept up to it, and the packings are not allowed to get hard on the rods. 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 thirty 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, barring it over by hand to make sure everything is free, 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

Comprehensive historical and engineering notes prepared by Tim Hobson and Peter McCarthy and stored in Sovereign Hill's archives were particularly helpful in the preparation of this article. The work of many local firms and individuals in providing support for Sovereign Hill in the development of its Steam Operations within the Mining Museum is again gratefully acknowledged, particularly Miller Bros., Ian Creelman, and Tom Wright.

² 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', In *Victorian Historical Journal*, 73/1, 2002.