Auchenharvie Pumping Engine House, Saltcoats, North Ayrshire
(NS 25684 41384)

View from south west [SC437923,1974, John Hume Collection,

Survey and Recording Section, Heritage Directorate, HES, 2020.
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"A fire or steam engine was erected near Saltcoats in 1719, the second then in Scotland. The small cylinder of it was brought from London, only 18 inches in diameter, not much larger than their present pumps. It could, therefore raise little water."

Rev. Dr James Wodrow, 1793

1. Summary

The Newcomen atmospheric engine was the first viable, commercially produced mine water pumping engine. The first Newcomen engine known to have been installed was at the Coneygree Coal Works, Tipton in the West Midlands of England in 1712. Auchenharvie engine house is traditionally held to have accommodated a Newcomen-type mine pumping engine installed in 1719. It is known that an engine was installed in that year to pump the coal measures 'near Saltcoats' in order to drain them. The Auchenharvie beam engine house's location in the Stevenston coalfield where the earliest shafts were sunk and coal worked and its structure suggests that it is a very early engine house.

Photographic evidence from c.1910 shows what can be interpreted as 'sommer beam' or engine beam holes in its west wall. These apertures were about 22 inches apart at the inner edges of each aperture and could have supported the 18-inch engine cylinder with which the 1719 engine was reportedly equipped.

The engine house does not appear on maps of 1775 or 1798, although this may be simply because it had fallen into disuse. The Ordnance Survey map evidence indicates that the engine house was already ruinous by 1856, suggesting a significant period of abandonment prior to the mid-19th century.

However, without further documentary evidence or perhaps archaeological excavation to 'bottom out' the floor, in order to ascertain its original level, it is difficult to be certain if this is, either in whole or in part, the engine house that was originally constructed in 1719 to house the 'fire or steam engine' (i.e. the Newcomen engine) to which Wodrow refers in 1793.

1 Rev. Dr James Wodrow, 'Parish of Stevenston', Statistical Account of Scotland, County of Ayrshire (Edinburgh, 1793), Vol. 7, p.11. The size of cylinder selected may have had something to do with either the sheer cost of the undertaking or the overestimation of the new technology. The building is known by several names such as Saltcoats Engine House and Stevenston Engine House. I have chosen to use the name Auchenharvie, as it is some little distance from both these towns' centres. The first 'fire or steam' or Newcomen engine in Scotland may have been installed at Tranent, East Lothian, see Baron F. Duckham, A History of the Scottish Coal Industry (David & Charles: Newton Abbot, 1970) Vol.1, p. 363 and http://coalpitheath.org.uk/engines/details?q=23~tranent. Only 'six or seven' such Newcomen Engines are known to have been built in Scotland by 1759, see Baron F. Duckham, A History of the Scottish Coal Industry (David & Charles: Newton Abbot, 1970), Vol.1, p.14.

2 Rev. Dr James Wodrow, 'Parish of Stevenston', Statistical Account of Scotland, County of Ayrshire (Edinburgh, 1793), Vol. 7, p.11.

3 These apertures, which may have held the ends of wooden beams that would have supported the engine and acted as part of the building structure, are now lost.

4 See section 5.

5 Rev. Dr James Wodrow, 'Parish of Stevenston', Statistical Account of Scotland, County of Ayrshire (Edinburgh, 1793), Vol. 7, p.11. A materials analysis of the building to be undertaken in 2021 may yield more information, although this will only provide a relative sequence.
2. Introduction

Coal has been an important commodity in the Saltcoats and Stevenston area since at least the 16th century. By the 17th century many Scottish landowners were beginning to see the possibility of mineral extraction as a commercially viable venture alongside traditional estate exploitation. In the area around Saltcoats, limited local supplies of wood and peat for small scale saltpanning, domestic cooking and heating meant that the plentiful coal in the area became valuable as a domestic fuel. It was also important to the expansion of saltmaking and was exported to Ireland by the local landowner.6

3. Coal Extraction

The coal was ‘won’ using various methods. Initially, coal mined in this area was dug up by:

‘poor people…They digged up the coal near the surface of the ground, at a very small expence, and lived in huts on the shore’.7

Exploitation was commercially developed in the 17th and early 18th centuries by the Cunninghame family. Adits, tunnels dug at an angle to the coal deposits to permit water drainage, ventilation as well as allowing colliers to access the coal workings were dug. ‘Stoop and room’ (otherwise known as ‘pillar and stall’ working) was also introduced. This was a system of coal removal where the seam was worked by leaving pillars of coal to hold up the roof as the colliers cleared the spaces between them. so creating square open areas. The roof was then allowed to collapse as the miners moved forward into new areas of working.

The motive power used to raise coal and spoil was usually provided by ‘horse-gins’ or horse engines. The horse or pony would be put into a yoke, which in turn was attached to a horizontally positioned drum with ropes or chains that lifted the load vertically. The flooding of mines by underground water hampered the mining of coal. Keeping coal mines dry was a constant problem and pumping engines were developed to do this. Atmospheric engines, which included the Newcomen engine, named after the 18th century inventor Thomas Newcomen could produce power for pumping using heat, condensed steam, a partial vacuum and atmospheric pressure8 to raise and lower a piston, or plunger, within a cylinder. This in turn rocked a large wooden beam up and down, which was attached at one end to pump rods that removed water from the workings up to the surface. As steam technology developed, engines continued to be used to keep the coal workings dry whilst being sunk or worked. ‘Crank engines’, a pump with an arm at right angles to the rotating part of a pump allowing reciprocal motion without the need of a heavy beam, were also used to keep the

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8 Also known as air or barometric pressure. Atmospheric pressure is the preferred term.
coal workings dry whilst being sunk or worked. The coal would have been hewn by hand and then carried by men and women in creels up ladders to the surface.

The later 18th century saw further expansion of the coal mines in the Stevenston area, many linked by the first commercial canal in Scotland, which was opened by Robert Reid Cunningham and Patrick Warner of Ardeer in 1772. An early geological survey commissioned by Sir Robert Cunningham in 1678 has not survived but by 1778 the coalfield was known to extend from Saltcoats in the west to Glengarnock River in the east.

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9 Baron F Duckham, *A History of the Scottish Coal Industry*, Vol 1, 1700-1815 (David & Charles: Newton Abbot, 1970), p. 110. Further investment in ‘cutting edge’ technology occurred in 1800-1 when the first rotative Boulton and Watt winding engine (as opposed to pumping only) was installed in the Stevenston coalfield – the first at a Scottish colliery.


11 Cunningham had sunk the Deep Shank Pit east of Stevenston Kirk by 1678, using a water wheel to drain the mine and return the water back to the Stevenston Burn. He also set up the saltworks and the harbour, effectively building Saltcoats (by an Act of Parliament of 1686). See Baron F. Duckham, *A History of the Scottish Coal Industry* Vol 1, 1700-1815 (David & Charles: Newton Abbot, 1970), pp.155-6.
and to dip under the the Firth of Clyde to the south. The 19th century saw further coal exploitation as can be seen on the Ordnance Survey maps for the area with the Stevenston coalfield proving to be lucrative over time.

The Stevenston coalfield had about eleven workable seams, running from east to west, in the late 18th century. They were said to extend to 104 fathoms (190.2m). It was noted, however, that a pumping engine working on the coalfield in 1792/3 was pumping from 54 fathoms (324ft/99.0m). This engine was reported as having a 5 ft diameter cylinder (1.5m) and a pump plunger with a diameter of 16 inches (0.41m) that could barely keep the pit dry. The 1719 pumping engine mentioned by Wodrow in 1793 would have struggled with its 18-inch cylinder (0.45m) to make any headway. The uppermost seam noted by Wodrow was at 20 fathoms (120ft/36.6m), suggesting that this was the depth to which seams were being explored around 1719.

12 “…from Saltcoats on the west point, to the river Garnock on the east; an oval piece of ground, above four miles in length, and a mile or more in breadth. In this field there are eleven strata of coal or seams of workable coal…”, Rev. Dr James Wodrow, ‘Parish of Stevenston’, Statistical Account of Scotland, County of Ayrshire (Edinburgh, 1793), Vol. 7, p.11.

13 Ordnance Survey 2nd Edition 25-inch to the mile map (Ayrshire 1896, sheet XVI.6) shows Auchenharvie Colliery and its 4 pits (Nos. 1,2,4,5) and Auchenharvie Brickworks. By the late 19th century there were 16 pits in operation; see also Ayrshire Roots website at https://www.ayrshireroots.co.uk/Towns/Stevenston/History/Stevenston%20Coalfield.htm (retrieved: 11/06/2020).

14 Rev. Dr James Wodrow, ‘Parish of Stevenston’, Statistical Account of Scotland, County of Ayrshire (Edinburgh, 1793), Vol. 7, pp 11-12. 37ft of ‘good coal’ was undertood to be available for exploitation across the coalfield by 1793. Wodrow is referring to the Dip Engine Pit, depicted on OS 1st Edition 25-inch to the mile map (Ayrshire 1856, sheet XVI.6) at NGR NS2685 4144, now under housing.

15 See https://www.ayrshireroots.co.uk/Towns/Stevenston/History/Stevenston%20Coalfield.htm (retrieved: 11/06/2020). For comparison, the Dysart Coal at Thornton, Fife (the pumping engine was of late 18th/early 19th century date) was accessible (i.e. could be kept dry) to 30 fathoms (54.9 m/180ft) allowing access to the ‘9 feet or upper seam [of coal] only…’, J. Sieveright, ‘Parish of Markinch’, Statistical Account of Scotland, County of Fife (Edinburgh, 1845, account of 1834-5), Vol. 9, 661. This would have dictated the power needed to pump and thus the size of the cylinder required and the engine stroke needed at this time.

4. The Newcomen Engine

The Newcomen atmospheric engine was the first viable, commercially produced steam pumping engine. The stone-built Auchenharvie engine house is reputed to have been built to house a Newcomen engine. Newcomen engine houses tended to be tall, relatively narrow buildings with an internal chimney. The 1725 illustration (Figure 2) shows an example of a Newcomen engine house. It clearly illustrates its relative height in comparison to its width.

Pumping engine houses were built in a sequence. A shaft would have been be sunk to allow access to the water flooding the coal seam being worked. This would have included any water management arrangements for the removal of pumped water. The top of the shaft and the foundations of the engine house would then have been built. The blacksmith work would then have begun on site. The engine house, including the ‘bob’ wall on which the engine ‘beam’ was rested, would then have been built, the ‘beam’ (originally of wood) being installed prior to the more fragile engine components. This was especially true of the cylinder in which the piston, working under the forces of a partial vacuum and atmospheric pressure, would have moved up and down. The cylinder, piston and the boiler would have been some of the most expensive parts of an engine. The rest of the building work and engine installation would then have been carried out and the engine would have been tested and tuned. An engine builder would have been engaged by the colliery owner to construct, advise and train those who were to maintain and run it. 17

The housing would have had an open central area extending up through the building in which the pumping engine would have sat. The first and second levels allowed access to the engine to enable operation, repair and maintenance. The ground floor (and possibly an undercroft or sub-basement) 18 was probably where the boiler (probably in a brick casing) and the firebox would have been located, while the cylinder containing the piston would have been positioned above. The engine cylinder would have extended up into the first level, with its wooden rocking beam sitting half in and half out of the engine house. The bob-wall acted as the fulcrum for the beam. One end of the beam would have rocked ‘in house’ on the piston down-stroke within the cylinder. The beam is always heavier than the piston, so an idle position would drop the other end of the beam, which was located outside the engine house and above the shaft.

The first successful Newcomen engine was built to serve the Coneygree Coal Works, Tipton, in the West Midlands of England in 1712. 19 The Auchenharvie engine is recorded as being acquired in 1719 and is therefore an early example, but the oldest surviving Newcomen engine is currently in the USA and dates from 1760. 20

18 See Figure 2: Early Newcomen engine houses would accommodate the lower portion of the boiler and its housing along with the fuel store below ground level.
19 Forty-three Newcomen engine are known to have been installed in the UK by 1722, see R. Smith, ed., The Newcomen Engine in the Greater Bristol Coalfield, in International Early Engines Conference: programme, visit, guide and compendium, Elsecar Ironworks, Yorkshire (2017), unpaginated.
20 Known as ‘Fairbottom Bobs’. It had no enclosed engine house and was acquired from Ashton Under Lyne by The Henry Ford Museum, Dearborn, Michigan in 1929. It has a cylinder measuring 27½ inches in diameter. See https://www.thehenryford.org/collections-and-research/digital-collections/artifact/21566#slide=gs-245752, (retrieved: 12/06/2020).
The basic principle behind the Newcomen engine is that it works under normal atmospheric pressure (5 psi). The earliest cylinders and boilers would have been of cast brass, finished by hand.\textsuperscript{21} Steam from the boiler was introduced into the heated cylinder. The pump end of the great balancing beam would drop as the piston was pushed up inside the cylinder. When the piston reached the top of the cylinder, cold water was introduced from a cistern, causing the steam to condense and form a vacuum at which point the piston would drop. The cycle would be repeated and so the beam would rise and fall and with each return water could be extracted from the shaft and be drained away from the workings. By the 1770s, such engines consisted of a cast-iron cylinder (which would have had a larger diameter) with a piston attached to a wooden rocking beam set above a haystack-shaped boiler of rivetted wrought iron plates. The steam pressure possible from such an engine would be very low, (about 1-2 psi) and thus the motive power produced would be low in comparison with later engines.\textsuperscript{22} Newcomen and Newcomen type engines continued to be made throughout the 18\textsuperscript{th} century and, if maintained, could operate for many decades.

\textsuperscript{21} Cylinders were also made of cast-iron. Casting produced a rough surface making it difficult to seal the piston into it. This would reduce the efficiency of the engine. As technology developed, later engine cylinders were bored by machine to create a smooth surface, rather than cast.

\textsuperscript{22} In comparison, a steam locomotive boiler could operate at a pressure of 200-250 psi by the early 20\textsuperscript{th} century.
Figure 4: Interior of the replica 1712 Newcomen Engine House (built 1986) at the Black Country Living Museum, Dudley, West Midlands. The replica engine inside the replica engine house has a cylinder 21ins (0.51m) in diameter and 7ft 10ins (2.39m) in height. The boiler is 6ft 1in (1.85m) in height within a brick housing. Note that this engine house has four ‘sommers’ beams to reinforce the building as the engine pumped. (Image acknowledgment: http://andrewconway.net/wp-content/uploads/2017/07/P1030658-768x576.jpg)

5. Auchenharvie Engine House

The sandstone-built Auchenharvie pumping beam engine house\(^{23}\) was constructed to accommodate a pumping beam engine which drained the coal workings in the western part of the Stevenston coalfield. It is now an isolated building, any associated structures such as shaft heads have been demolished. It is now situated within a Council-owned public golf course.

Traditionally, the Auchenharvie engine house is held to be the original building for the 1719 Newcomen mine pumping engine acquired by a partnership which included James Cunninghame.\(^ {24}\) The engine house does not appear on either Armstrong's map of 1775 or on the 1798 ‘Plan of the Stevenston Coaliery’, although it may be that by this point it had been abandoned and was no longer a working asset.\(^ {25}\)

Photographic evidence (Figure 5) shows that Auchenharvie’s west wall had two large square apertures which survived into the early 20th century, but these were no longer visible by

\(^ {24}\) Auchenharvie is in the coal bearing lands in the ownership of the Cunninghame family who bought it from the Earl of Eglington in 1656, though Robert Cunninghame II sold it in 1707 and thenceforth coals were worked by partnerships, see I. Hughson, The Auchenharvie colliery, an early history (Ochiltree Ayrshire, 1996), pp. 4-5 for background. It is also said to have been the second Newcomen engine installed in Scotland and that it was ‘replaced’ by an engine of 1732 but it is not clear whether the engine in the Auchenharvie engine house was replaced physically or if it was abandoned and the later engine took up its function at another location; see John Butt, The industrial archaeology of Scotland, The industrial archaeology of the British Isles series (David & Charles: Newton Abbot, 1967), p.85.
\(^ {25}\)The engine house is not depicted on the Andrew Armstrong map of 1775 ‘A New Map of Ayrshire’, see: https://maps.nls.uk/view/74400947; retrieved 19/06/2020; National Map Library (EMS.s.515). See also 1798 ‘A Plan of the Stevenston Coallery’ at http://www.futuremuseum.co.uk/collections/life-work/key-industries/mining-quarrying/coal/a-plan-of-stevenston-coallery-and-canals.aspx (retrieved: 11/06/2020); ‘new pits’ not linked to the canal as well as working pits linked to the Stevenston and Misk canals are shown but not Auchenharvie. Baron F. Duckham, A History of the Scottish Coal Industry, Vol 1, 1700-1815 (David & Charles: Newton Abbot, 1970), p.82 mentions the remains of a 1732 engine seen near Saltcoats by John Clerk of Eldin in 1764. How this was related to the 1719 engine is unclear. The second Misk pit on the Stevenston Coalfield completed in 1784/5 was sunk to 40 fathoms and had a Newcomen engine for pumping.
1974. Early representations of Newcomen engines and their engine houses (Figure 4) show similar square apertures for 'sommer beams'. These beams strengthened the engine house and supported the engine cylinder vertically to mitigate any lateral movement as the pumping engine beam rose and fell during each cycle. There is, however, no equivalent evidence for the 'sommer beam' apertures on the west wall as this only survives to a height of 3.7m (see Figures 7). The wall itself appears to have been heavily consolidated in the recent past if Figure 5 and 11 are compared. Alternatively, these apertures could have been the structural element of a bolting system securing the beam pivot bearing (the trunnion) to the west or bob wall, as seen at other engine houses dating to a later period (cf. Thornton in Fife). This might explain the lack of confirmatory evidence on the re-consolidated east wall. Yet, given the reports for the presence of a Newcomen engine at an early stage in the Stevenston Coalfield and the location of the Auchenharvie engine house in the area where the earliest exploitation of the coal seams would have been located, it seems on balance that there is possibility that these are indeed the 'sommer beam’ apertures of a Newcomen engine house.

![Figure 5: Auchenharvie, Stevenston (also known as Saltcoats) Beam Engine House c. 1910 showing the original wall height at the north gable and the apertures on the west wall (now gone) and the shaft (left, now gone). Door showing collapse (https://www.flickr.com/photos/nayesterdays/6346479941/in/album-72157622752963661/; copyright North Ayrshire Council: this archival image has been made available by The North Ayrshire Council in good faith for reference and/or educational purposes only and without intent to breach any proprietary rights which may subsist in the work).](image-url)
The earliest surviving Newcomen engine house is currently considered to be at Dannemorra, Sweden, dating from 1728.\textsuperscript{26} However, given the evidence\textsuperscript{27}, there is a possibility that Auchenharvie can make that claim. Excavation and material analysis could perhaps shed further light on the matter.\textsuperscript{28}

Although the date when it ceased operation is unknown, Auchenharvie’s abandonment suggests that the engine was no longer powerful enough for the mine levels it served.\textsuperscript{29} Its inability to successfully drain these early pits may mean that it was not economically viable to continue operating the pumps. It may also have not been economically viable to upgrade to a more powerful engine as technology improved. The pump shaft located on the west side of the engine house (Figure 5) would have been capped after 1910 for safety reasons. Only a water-filled depression indicating its location was visible by 1974 (Figure 6) and the area has since been heavily relanscaped.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{engine_house_M%C3%A5rten_Triewald.JPG}
\caption{View of Auchenharvie or Saltcoats Engine House from the south. Note that the windows are unblocked. The body of water to the left is the site of one of the shafts down which the pump rods of the engine ran. Colliers may also have used the shaft to get out of the mine workings at the end of their shift. [SC 437924, 1974, John R Hume Collection, National Record of the Historic Environment]}
\end{figure}

\textsuperscript{26} Built by Marten Triewald, see https://en.wikipedia.org/wiki/Dannemora_mine#/media/File:Engine_house_M%C3%A5rten_Triewald.JPG
\textsuperscript{27} David Hulse, \textit{The Early Development of the Steam Engine} (Tee Publishing, 1999), p.95.
\textsuperscript{28} It has been suggested that the engine house at Auchenharvie has been rebuilt to accommodate a later rotative engine, see John Hume, \textit{The Industrial Archaeology of Scotland}, vol. 1 (Batsford, 1976), p.43.
\textsuperscript{29} Wodrow notes that ‘The first western division next Saltcoats was wrought improperly in the 1719s and the greatest part of it remains, very much incommoded with water open to future adventures…’, Rev. Dr James Woodrow, ‘Parish of Stevenston’, \textit{Statistical Account of Scotland}, County of Ayrshire (Edinburgh, 1793) Vol. 7, 13.
There is fragmentary evidence for an internal chimney in Auchenharvie (see Figure 10). This chimney would have extended up into a chimney stalk which was possibly incorporated into the angle of the north gable and east wall.

The first Newcomen engine built in 1712 at Tipton, West Midlands, is known to have had a cast brass cylinder measuring 21ins (0.53m) in diameter and 94 ins (2.4m) in height above a boiler measuring 6ft 1in in height (1.85m).\textsuperscript{30} The 1719 engine cylinder installed at Auchenharvie is said to have been 18ins in diameter (0.45m) and was of cast iron\textsuperscript{31}. With the addition of a boiler housing, connecting pipes and the piston connector to the beam, the Tipton example would have stood to a height of about 8m. The surviving wall-head at Auchenharvie is visible where the east wall joins the north gable and measures 7.5m in height. This indicates that Auchenharvie could also have housed an early Newcomen engine. Excavation could bottom out the internal floor level to ascertain whether there was a half-basement or undercroft. The maximum height of the rocking beam arch could have been accommodated within the gabled roof space (see Figure 8).

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure7.png}
\caption{Elsecar Newcomen Beam Engine House, near Barnsley, South Yorkshire before restoration. Built in 1795, the bob wall is the side wall as at Auchenharvie and not the usual gable wall. (Copyright: J.Crompton)}
\end{figure}

The orientation of the north gable wall at Auchenharvie in relation to the west bob wall is similar to the arrangement at Elsecar (see Figure 7). This Newcomen engine house of 1795 also utilises its side wall as the bob wall.

\textsuperscript{30} David Hulse, \textit{The Early Development of the Steam Engine} (Tee Publishing, 1999), pp.46-8; see also pp. 41-82 for further discussion of the Tipton Engine. The Tipton cylinder would have weighed about 1.13 metric tonnes and would have been difficult to transport given the poor state of early 18\textsuperscript{th} century roads.

Hume notes that the engine house was ‘... supposed to have been the site of the second Newcomen engine in Scotland. The masonry of the gable suggests that the house has been occupied by a rotative engine at some time’. No evidence is offered for this claim other than masonry arrangement. Figure 5 does, indeed, only show the two apertures on the bob wall and it is possible that these supported the frame of a rotative engine. This might explain why it does not appear on Armstrong’s map (1775) or possibly even the 1798 ‘Plan of the Stevenston Colliery’, as rotative engines only began to be developed in the 1780s. If it did house such an engine, it would have been a winding engine and not a pumping engine. As there is little evidence of the working life of the building then it is possible that it had been remodelled over the years to hold a subsequent engine design to serve a different function.

6. The Survey

There follows a series of labelled drawings and digital scans. These are used to show observations relating to the fabric of the beam engine house. HES produced one ground plan, one section showing the most complete surviving wall at a scale of 1:50 and photogrammetric models of the structure.

Overall Dimensions

Auchenharvie engine house measures externally 7.1m from north to south by 6.7m transversely and 10.1m in height – its west wall surviving to a height of 7.2m and its east wall.

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33 The building would have been abandoned when the coal seams it served were worked out; change of engine suggested by John Butt, *The industrial archaeology of Scotland*, The industrial archaeology of the British Isles series (David & Charles: Newton Abbot, 1967), p. 85, suggesting that a later 1732 engine could have been housed in Auchenharvie engine house or a rotative engine (for winding) suggested by John Hume, see *The Industrial Archaeology of Scotland*, vol. 1 (Batsford, 1976), p.43.
34 For the photographs, a Canon EOS-1Ds Mark II camera body was used, focal length of the lens was set to 24mm for minimal distortion. For the on-site survey, a differential GPS (dGPS) was used to measure 7 ground control points (GCPs). The GCPs were then used to resection the total station around the beam engine. At each resection, the total station was used to measure targets on the ground and on the beam engine house to later georeference the photogrammetric model.
wall to 7.5m. The north wall measures 0.79m in thickness, the east 0.78m and the south wall 0.7m. The east portion of the south wall and the south portion of the east wall survive at foundation level. The north gable is the only substantial elevation and stands to just below the original roofline. The west wall measures 0.9m in thickness. This thicker wall is the ‘bob’ wall or fulcrum on which the beam of the pumping engine rocked (see Figure 9).

**Ground floor**

The internal dimensions of the engine house measure 5.45m (16ft 9ins) from north to south by 4.24m - 5.0m (13ft 9ins - 16ft 4ins.) transversely. The interior has been relatively even since 1910 (see Figure 5). The floor level is 0.8m higher than the modern ground surface. The west and east walls partially survive at the northern end, but little of the south east corner remains.

*Figure 9: Plan with possible beam position (scale 1:50), (DC62121, 2019 HES Copyright)*
North Gable

The height of the north gable at its highest point is 10.1 m. The wall heads survive to 7.2 m (west wall) and 7.5 m (east wall) respectively. There are three blocked windows, a blocked doorway and a blocked unidentified opening probably related to the management of waste water or the boiler. The door blocking dates from after c.1910 (see Figure 5), the window blockings after 1974 (see Figure 6).

The now partially ruinous wall-head could have supported the beam of the pumping engine. The in-house end of the beam could then rock into the roof space during each pumping cycle.

Approx. top and bottom of northernmost bob wall aperture visible in c. 1910 image: approx. 0.640 m (27 ins) in height

The bob wall 0.90 m in width, which would have supported the rocking beam trunnion (?and the sommer beams which in turn supported the cylinder of a Newcomen Engine)

Blocked north windows, measuring 0.950 m x 1.10 m

Blocked post-1974

Remains of internal chimney

Blocked north facing doorway, 1.086 m wide; blocked between c.1910 and 1974 and showing an earlier door remodelling. It is possible that the original boiler would have been brought through this doorway.

Blocked opening

Demolished south wall foundations consolidated

Figure 10: Section (1:50) of north gable wall interior, (DC62121, 2019 HES Copyright)
The blocking of the north gable door shows two phases (Figure 10 and 12) - the complete blocking of post-1910 (Figure 5) and a straight joint showing a reduction of the door width presumably whilst it was still in use. The blocking of the door after 1910 may have been partly for safety reasons and partly for consolidation because it was already considered to be of historical interest as a structure. The windows were blocked after 1974, probably for the same reasons.

Figure 11: Photogrammetric view of the engine house from the south west.
Wall head at 7.5m from ground level

Blocked north facing doorway. Voussoirs mostly lost; Blocked between c.1910 and 1974

Later straight joint when building was still in use?

Blocked drainage outlet (?) – associated with boiler/ water management

Bob wall 0.90m thick

Blocked north facing windows, measuring 0.95m x 1.10m. Blocked post-1974 probably for consolidation.

Voussoirs partially survive changes to door opening, unclear to which building episode they belong

Edge of original door opening or rebuilt after collapse?

Figure 12: Photogrammetric view of north gable exterior
Apertures in West wall

Figure 13: Measurements of now missing apertures in west wall extrapolated from a 1910 image. The image was scaled using plans sliced from a referenced point cloud created from photogrammetric data gathered on site. The inset shows the ‘slices’ of the plan at 0.25m, 0.73m and 2.35m above current ground level.
Figure 13\(^{35}\) uses photogrammetry to measure the west wall square apertures (now lost), which are visible in an early 20\(^{th}\) century image of the engine house (Figure 5). The extrapolation from the photograph to data gathered during fieldwork supplies three measurements of interest: the north aperture is 0.697m in width (27\(^{hi}\) ins); the space between the inner edge of the north aperture and the inner edge of south aperture is 0.566m (approx. 22 ins) and the width of the south aperture is 0.688m (approx. 27 ins).

A comparison between the scaled image c.1910 image and the survey data indicates that the two apertures could be `sommer beam' support holes between which a cylinder in a Newcomen engine house would sit. The width of the cylinder bought in 1719 was 18ins in diameter and the measurements imply that this beam engine house did accommodate a pump cylinder of this diameter at some point, as the gap of 22 ins between the inner edges of both apertures could have readily accommodated a cylinder of this size with a 2ins gap. This gap would have allowed for wrought-iron straps to be fitted to secure the cylinder between the top edge of the supporting beams on either side.\(^{36}\)

7. The Site on Ordnance Survey Maps

The four map extracts which were published between 1856 and 1937 show the area around the present ruins of the mine pumping engine house (Figures 14-17). They were published by the Ordnance Survey (OS) at 25-inches to a mile and so at a scale which can show some detail. The OS map of 1856 annotates the building ‘Old Engine Ho. (Ruins)’ and illustrates two ‘Old Coal Pits’ close-by - the northernmost of which would have been where the pump rods were positioned. The engine house is shown as missing its south east corner. The OS depiction of 1896 denotes only an 'Air Shaft', but provides a footprint of the building missing its south wall completely – although this may be because the wall had deteriorated to such an extent that it fell below the criteria for the mapping of features below a certain height. By 1910, the building is depicted as missing its south wall completely. By 1937, neither the building nor the air shaft are named or depicted at all, despite the survival of substantial physical remains.\(^{37}\)

\(^{35}\) Auchenharvie beam engine house, 1910 image measurements process. First, a dense cloud of the Auchenharvie model was converted from Agisoft Metashape into Cloudcompare (CC). Using CC, three slices of the dense cloud were cut along the x-y plane at 0.25 m, 0.73 m and 2.35 m above ground level. Each slice was roughly 5mm in depth. The three slices were then imported into AutoCAD creating a 2D compilation plan which was placed directly below the 1910 photograph. Because the photograph revealed no perspective distortion on the y-axis, this was used for the alignment parameters. After that, the plan was rotated while simultaneously scaling the photograph so that the external south-west, internal north-west and external south-east corners of the engine house on plan matched the vertical lines of those corners in the photograph. Once the orientation of the plan matched the scale of the photograph, four vertical lines were dropped from the two openings of the west wall on the photograph down to the plan until they intersected. The distance between the intersections were measured and provided the width of the openings.

\(^{36}\) The method of connecting the cylinder to the beams in the early 18\(^{th}\) century is uncertain, see R. Smith, ed., From Calley to Curr: the development of the Newcomen Engine in the 18\(^{th}\) century' by Steve Grudgings in International Early Engines Conference: programme, visit guide, and compendium, Elsecar Ironworks, Yorkshire, (2017), p.42.

\(^{37}\) Ordnance Survey 1\(^{st}\) Edition 25-inch to the mile map (Ayrshire, 1856, sheet XVI.6); Ordnance Survey 2\(^{nd}\) Edition 25-inch to the mile map (Ayrshire, 1896, sheet XVI.6); Ordnance Survey 25-inch to the mile map, (Ayrshire, 1910, sheet XVI.6); Ordnance Survey 25-inch to the mile map (Ayrshire, 1937, sheet XVI.6).
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