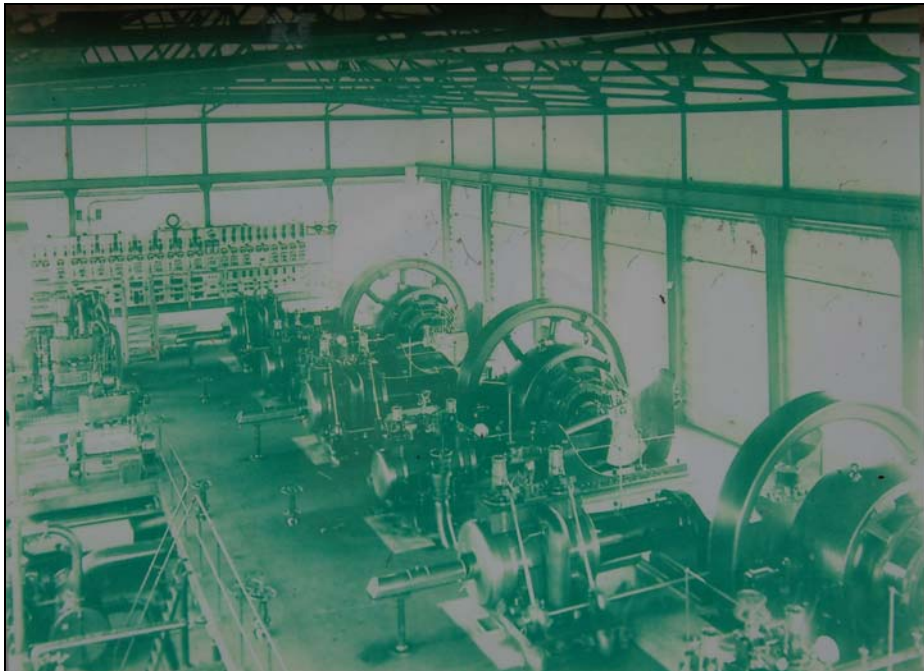


**POWER HOUSE AND ACCUMULATOR
THE ROYAL GUNPOWDER MILLS
POWDERMILL LANE
WALTHAM ABBEY
ESSEX**

HISTORIC BUILDING RECORD



Essex County Council

Field Archaeology Unit

May 2008

*Cover depicts the interior of the engine house with Bruce Peebles generators c.1915
(RCHME neg. no. BB92/16742)*

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Prepared By: A. Letch Position: Project Officer	Signature: Date: 29th May 2008
Checked By: P. Allen Position: Project Manager	Signature: Date: 29th May 2008
Approved By: M. Atkinson Position: Unit Manager	Signature: Date: 29th May 2008

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As part of our desire to provide a quality service, we would welcome any comments you may have on the content or the presentation of this report.

Please contact the Archaeological Fieldwork Manager at the

Field Archaeology Unit

Fairfield Court, Fairfield Road, Braintree, Essex CM7 3YQ
Tel: 01376 331431
Fax: 01376 331428
Email: fieldarch@essexcc.gov.uk

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**POWER HOUSE AND ACCUMULATOR
THE ROYAL GUNPOWDER MILLS, POWDERMILL LANE
WALTHAM ABBEY**

HISTORIC BUILDING RECORD

Client: Hill Partnerships Ltd

FAU Project No.: 1841

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OASIS No.: essexcou1-42927

Planning Application: EPF/501/07

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1.0 INTRODUCTION

A programme of building recording monitoring was undertaken by Essex County Council Field Archaeology Unit (ECC FAU) on two early 20th century industrial buildings at the Waltham Abbey Royal Gunpowder Mills (WARGPM), as a condition on planning consent prior to office conversion. The work was commissioned by the developer, Hill Partnerships, and carried out in accordance with a brief issued by the Historic Environment Management team of Essex County Council (ECC HEM), who also monitored the work.

The buildings were included in a survey undertaken by the Royal Commission on Historic Buildings for England (RCHME) in 1993 and identified as an electricity power house and accumulator, primarily involved in the manufacture of cordite, a modern high explosive. Neither structure is statutorily listed, but they are included in the European Route of Industrial Heritage (ERIH) along with the extensive mainly 19th-century remains of Mills. The site is virtually unique, with only two other Royal Gunpowder Mills existing, at Faversham in Kent and Ballincollig in Ireland. Of the three, the mills at Waltham Abbey are the best preserved (RCHME 1993).

Copies of this report will be supplied to ECC HEM and to the Essex Historic Environment Record (EHER) at County Hall, Chelmsford. The archive will be kept at the Royal Gunpowder Mills. An online OASIS record has been created at <http://ads.ahds.ac.uk/oasis/index.cfm>.

2.0 BACKGROUND

2.1 Site location and description (fig.1)

The Royal Gunpowder Mills occupied two large areas of land to the north and south of Waltham Abbey (fig.1), split into two, North Site and South Site. The buildings subject to the planning condition are located within North Site, on a large derelict area of land between modern housing estates to the south and the Royal Gunpowder Mills museum and visitor's centre to the north, on the other side of the canal. The eastern boundary is defined by the River Lea (fig.1). South Site was redeveloped for housing in the 1990s after the factory closed.

The power house is built on a south-east to north-west orientation respecting the canal, with the accumulator aligned on its north-west frontage. Both structures are canted slightly away from the main 19th century buildings on the opposite side (fig.1). A service road known as Powdermill Way leads from the older site across the canal footbridge and past the west side of the power house. As 'The Straits' the road forks up to the engine house on the east side of the power house (fig.1). Powdermill Way continues southwards past 'The Lodge' and its grounds, a more formal building believed to also be scheduled for refurbishment.

2.2 Planning background

Epping Forest District Council received a planning application for conversion of both structures for B1 (a) office use in May 2007 (EPF/501/07). Mindful of the possible effects on the historic integrity of the buildings and the already established importance of the site, the ECC HEM team recommended a full archaeological condition be placed on any future planning permission, based on advice given in Planning Policy Guidance Note 16: Archaeology and Planning (DoE 1990).

2.3 Historical background

The Royal Gunpowder Factory was an important manufacturing site for around 300 years and its history, being a government establishment, is well-documented. For the purposes of the report, therefore, the history of the site is discussed in general terms. More detailed accounts can be found in the RCHME survey (1993), 'Dangerous Energy' by Wayne Cocroft (2000) and the WARGPM website at <http://www.royalgunpowdermills.com>.

Gunpowder was being produced at North Site in 1661 (ERO Q/SR 388/42) at a late-medieval fulling mill on the River Lea. By the 18th century Waltham Abbey was one of the main suppliers to the Royal Ordnance (RCHME 1993). With concerns for the quality, quantity and

reliability of the product in private hands, the mills at Waltham Abbey were brought under government control in 1787. Those at Faversham had already been purchased by the government in 1759. The purchase of Waltham Abbey coincided with an increase in demand for gunpowder during the French Revolutionary and Napoleonic Wars.

The works expanded again in the mid 19th century when moulded nitro-cellulose and nitro-glycerine chemical-based explosives and propellants began to be produced as cannon powders. Research between Waltham Abbey and the Royal Laboratory at Woolwich created guncotton, which was then produced on the site in large quantities. Further research in the early 1890s led to the manufacture of cordite (a blend of nitro-glycerine and guncotton) that had replaced gunpowder as the main propellant by the end of the century.

The power house and accumulator were built in 1915 to increase cordite production during the First World War and are two of the last remaining structures to be built on the site. The power house contained boiler and engine houses that generated electricity to power buildings and machinery on North Site and to power the accumulator next door, which consisted of an interlinked pump house and accumulator tower. Piped water was transferred into hydraulic power from the accumulator to the cordite press houses (fig.1), and further afield to power other hydraulic mechanisms as necessary (RCHME 1993). There is some speculation that the pump was powered by steam rather than electricity (RCHME 1993). In reference to this, it should be noted that it was not clear that the two structures were contemporary when the RCHME survey was conducted.

Architect's drawings of the power house in 1915 (fig.2a WARGPM 901/66), show six openings on the west side of the boiler house to bring coal in for the boilers. A large steel chimney stood on the south side, linked to the boilers by an underground flue and supported on an octagonal concrete base. The south end of the engine house had two large double doors, providing the main access into the building. The front cover picture shows the engine house in operation around this time.

In 1916 the engine house was extended to the south, probably to accommodate another engine and dynamo (RCHME 1993).

Explosives ceased to be produced at Waltham Abbey in 1943, in favour of more remote factories in the north-west of Britain safer from bombing raids by the Luftwaffe. After the Second World War the factory became a government research establishment, concerned for a while with the development of rockets and their propellants. New Dansk boilers were

installed c.1947 and apparently remained in use until closure. Big coal hoppers were built into the roof, linked to an elevator and overhead conveyer that fuelled the boilers. In c.1951 the power house ceased electricity production and the engine house was converted to a machine shop. A new workshop was built close by to the north-east that has since been demolished (fig.2b, WARGPM 3346/5/19). At the same time, the pump house and accumulator tower were stripped-out to become staff changing facilities and washrooms.

A new coal elevator was installed in 1960 to feed the overhead hoppers (WARGPM 210.B35) and a new chimney was installed in 1968 (WARGPM 210.B59) to work with the existing boilers that continued to provide heating and steam for processes on North Site (RCHME 1993).

The facility closed in 1991, after which South Site and the southern part of North Site below Flagstaff Road were decontaminated and redeveloped as housing. The area of North Site north of the canal was preserved as a heritage park, while the area around the power house and accumulator was abandoned after the buildings were stripped-out.

2.4 Cordite manufacture and the weight-loaded accumulator

Dried guncotton was mixed with nitro-glycerine by hand on lead tables inside one of the Mixing Houses to produce cordite 'paste'. After testing in the laboratory, the paste was taken to the Cordite Incorporating Mills or Paste Store. Each mill had a tub with two bladed spindles that worked off leather bands from a steam-powered driveshaft. Cordite MD, a modified blend with lower nitro-glycerine content to prevent excessive barrel corrosion, was produced at Waltham after 1901. Specific quantities of the solvent acetone and mineral jelly were incorporated with the paste. The latter ingredient deposited a metal coating from the shot as it exited the barrel to prevent the gun fouling, and also, unexpectedly, acted as a chemical stabiliser (RCHME 1993).

From the Incorporating Mills, the cordite paste was then taken to one of the Press Houses to extrude the cordite into its distinctive strands or cords, after which it is named. Screw presses were used for making the smaller diameters needed for rifle cartridges and hydraulic presses for the large diameter field guns. Regardless of size, each worked off hydraulic rams. Press Houses L157, 159, 167 and 169 (fig.1) were originally built as gunpowder presses in the 19th century and were initially steam-driven, but were latterly powered hydraulically by the accumulator (RCHME 1993) recorded in the recent survey. Figure 8 demonstrates the process involved in powering the cordite presses using a weight-loaded accumulator and brief mention is made here as an accompaniment. Hydraulic power works on the principle

that a small force acting on a small area over a long travel will produce a large force on a large area with short travel (Cocroft 2000). In this case, water was pumped through a mains pipe into the accumulator tower which raised a weight-loaded ram inside, increasing the pressure of the water (Cocroft 2000). The weight commonly consisted of a bin full of scrap pig iron or other such material, weighted correctly to maintain pressure within a large metal cylinder made of boiler plate sheets (Smith 1991). When the weight reached the top, the pump was deactivated and the weight travelled down the tower, which operated an upward ram on the press, some distance away that squeezed the cordite.

Once produced, the small-diameter cords were wound onto wheels for drying and the larger cordite cut to the lengths required and transferred to the Drying Houses. Here they were dried by heated steam pipes for between 3 ½ and 15 days, depending on size. Once dry, the cords were transferred to the Reeling House. Here the small cords were blended together into untwisted 60 strand ropes to ensure quality and uniformity. The larger cords were blended by hand. Lastly the finished cordite was taken to the Reel Magazine for shipment to cartridge- or charge-packing factories (RCHME 1993).

3.0 OBJECTIVES

The purpose of the historic building survey was, as outlined in the brief (ECC HEM 2007), to provide a detailed record of the power house and accumulator structure to English Heritage level 3 standard (2006).

In addition, the survey was required to consider the following: plan form of the site; materials and method of construction; building chronology, development and modification; function and internal layout; surviving fixtures and fittings; process flow; and relationships between the standing structures and similar works.

4.0 DESCRIPTION OF RECORDING WORKS

Each of the standing buildings was assigned a number and referenced to a phased block/location plan (fig.1). Architect's drawings were supplied by the client and used in the survey and as the basis for the illustrations included in the report. External and internal architectural descriptions were made and the function of each building discussed and assessed with reference to the existing survey by RCHME (1993).

A series of photographs (digital and 35mm black and white print) were taken to record the buildings internally and externally. Specific shots were taken of any areas of important architectural detail, fixtures or fittings. A representative selection of all photographs is reproduced at the back of the report as plates 1-20. The remainder can be found in the archive.

The Royal Gunpowder Mills archive was examined and references to cited material are prefixed as WARGPM throughout this report. Copies of historic design drawings (figs.2a-c) were provided by the client and, as these are believed to derive from the same source, are given WARGPM references also. The RCHME report (1993) provided background information to the buildings surveyed (referenced as MOD A210 and A214 in their report) and how they functioned.

5.0 HISTORIC BUILDING DESCRIPTIONS

5.1 General description

The power house and accumulator are brick built structures with deep concrete foundations and steel-framed roofs typical of large early 20th century industrial buildings. Each contains two parts. The power house contains a large boiler house and engine house while the accumulator holds the pump house and weight-loaded accumulator tower. The fabric of both structures has been altered and converted during their lifetime, especially with the alterations carried out in c.1951. Since the establishment closed in 1991, the buildings have been left in a state of disuse and, inevitably, decay. The surrounding area has become overgrown with trees, grasses and other vegetation.

In the following text, each of the two main structures is firstly described externally, followed by separate descriptions of the interiors of their component parts.

5.2 Power House (Boiler House 1 & Engine House 2)

The power house is a large single-storey building with a triple-pile plan whose tripartite gables face the north-west and south-east. The boiler house occupies the west side, extending across two thirds of the floor plan, and is separated from the engine house by a partition wall.

Original plans of the power house give a construction date of 1915 (fig.2a). Initially the plan form was broadly rectangular and symmetrical, measuring 24.4 x 29.2m, consisting of nine

gable bays by six and two half-width bays. A further three and a half bays (11.5m) were added to the engine house in 1916 (fig.3). The walls are constructed in 9" unfrogged yellow stocks manufactured by 'Hickman & Co., Stourbridge' behind a white-painted exterior. The bricks are laid in English bond on deep (1.7m +) concrete foundations. Brick piers carry bolted angle iron trusses on every 3m (10ft) bay, reaching a full height of 9m to the top of the roof.

Originally the south-west side was lined with doorways large enough to admit vehicles. Foot access was on the north-west elevation, facing the canal, or through similar doors on the south-east side of the engine house. The partition wall between boiler and engine houses contained openings either end, both of which are now blocked.

5.2.1 External descriptions

Each of the gable ends are built flush-faced and feature large arch-headed central windows flanked by narrower side windows, the central one being taller and wider than the others. The windows are steel-framed and made up of small c.6 x 9" panes. Immediately below the arch shoulder, the central panes pivoted open by cord-operation from below. They are plainly-decorated like industrial buildings tend to be, with concrete sills at the base and two courses of brick headers forming the arch. Light wooden frames of wire mesh have been added for protection. Above the central windows are oculi featuring wooden ventilation slats.

The two side elevations are built in pier and panel, with the piers, carrying the iron trusses inside, framing the arched windows. They contain historic fabric partly adapted during the life of the building, mainly in the early 1950s.

The triple-pile roof retains its original slate covering. Pointed gable parapets contain and conceal three long ridge vents, which expelled gases through wooden side vents and provided extra light to the working floors.

The north-west elevation (plate 1) faces the buildings on the other side of the canal and may be described as the principal elevation. The two western gables are intact, with a small doorway located on the western gable and arch-headed windows. Those on the eastern (engine house) elevation were blocked and six square-headed 'factory type windows' (WARGPF AB5/1) added in 1951 when the north end was converted to stores/offices for the newly-established machine store. Otherwise the elevation has changed very little.

The north-east elevation, on the side of the engine house (plate 2), faces the accumulator across unmade ground. There is no obvious join to the 1916 extension and, indeed, most of the later changes to the fabric on both structures have been neatly done. Two door openings were inserted when the later workshop (fig.2b) was built on this side, one of which, now blocked, provided a link between the two buildings. A third original doorway in the first full north bay was enlarged to provide access into the stores at the same time (fig.3), though is now half-blocked. All but the two end bays were originally fenestrated in arched steel-framed windows featured on all elevations. On this side they are at full height, measuring 1.3 x 3.6m. Half of these had square steel-framed windows inserted below the sills during the conversion, which have since been blocked. The window on the first full bay from the north (plates 2 & 17) was blocked when the windows on the north-west elevation were changed during the office/stores conversion.

The south-east elevation includes the boiler house and engine house extension, the former of which is now hidden by trees and other vegetation, as shown in plate 3. Plate 4 shows the boiler house elevation as it was soon after closure of the site, with contemporary attachments such as the coal elevator/bunker, gantry and concrete chimney.

The gable on the west side (plate 4) retains the characteristic arched windows, but with post-World War II square metal windows for internal staff/storage areas added in the corner below. Associated with these is a square door opening (fig.3). The round vent at the top of the gable was blocked-in when the elevator was installed, the brackets and coal chute for which remain on the wall. The concrete bunker was probably removed with the chimney. The main attribute of the central gable (boiler house east) was the large flue aperture in the centre, measuring 3.8 x 2m. This is now blocked, but there is a second smaller slot cut into the fabric that probably fed to the 1968 chimney. The original aperture was flanked by shorter arched windows, also observed in the engine house extension. An arched doorway beside the 1916 extension (fig.3), appears to be an historic feature but is not included on the 1915 drawings (fig. 2a) and is therefore later, but in the same style.

The 1916 engine house gable originally contained two large door openings on the south-east elevation (fig.2b). One of these was blocked in the post-World War II conversion and replaced by a metal framed window, while the other remains, but without its fixtures (plate 5). No other changes have been made.

The south-west (boiler house) elevation (plate 6) originally contained six paired doorways on all but the two half bays at either end (fig.2a), leading onto a concrete hardstanding off

Powdermill Way. Most of these were presumably blocked during the post-war period and replaced with square metal-framed casement windows, similar to those on the engine house (south-east) elevation. Only the doorways into the fourth and fifth full bays (from the north end) were retained and knocked-through to create one large opening, shown in plate 6 with its own metal 'roller door'. The window sills above seem to have been raised to accommodate this change.

Uniform roof vents are built onto all three ridges. Each bay has a central timber-slatted vent with three-pane side lights either side (plate 3). The vents in the engine house are clad in metal sheeting. Alterations have been carried out to the inside of the ridge by adding safety glass and blocking-off the vents on the power house.

5.2.2 Boiler House 1: internal description

Steam was necessary to run the turbines in the engine house and for heating and steam-powered processes on North Site (RCHME 1993). The boiler house was built as one large open-plan area, containing fifteen 8 x 30ft Lancashire boilers (Waltham Abbey Information Board) stood on large concrete bases and linked by a large flue to the steel chimney to the south (fig.2a). Drawings from 1947 (RCHME 1993), show three large Dansk boilers with steel hoppers on the west side, ready for installation in 'No. 5 Boiler House' (RCHME 1993). Further details on the equipment used at this time is included in the RCHME report. A later photograph (plate 9) shows the three boilers arranged in a north-west to south-east line along the centre of the building with coal hoppers sited above (plate 9, WARGPM wai_1014_07). The elevator that supplied the hoppers may be seen against the outer wall in plate 4 (WARGPM wai_1014_05), which also shows a replacement reinforced concrete chimney fitted in 1968 (MOD A.120.B.59) after the original steel one was demolished.

By the time of the survey, all boiler vestiges, flues, hoppers and other equipment had been stripped-out and much of the interior covered in scrap iron and other waste, including upcast from engineer's test pits dug to examine the stanchion footings. The post-war staff area remained on the southern corner but otherwise there were no features evident internally that were not recorded externally.

Internal walls (plates 7 & 8) show painted brickwork in typical dual colour scheme, with a relatively strong colour (blue) up to 6ft working height to hide grime and oil and a lighter colour (light grey) above to reflect light. In many areas the paint is peeling off the walls through damp. Plate 7 shows the later flue on the left side and the larger blocked one between the two windows (see also fig.3) on this bay, and staff areas to the right. Sawn-off

brackets and pipes protrude from the north-east partition wall to the engine house where the steel hopper frame was attached. Plate 8 shows inserted square windows on the south-west wall that, despite their plain appearance, feature Art Deco style cast handles (plate 10).

The roof valley is supported by steel joists sat on four steel stanchions. These carry the bolted angle iron roof trusses that span across the boiler and engine house (fig.4). The stanchions stand on 1.8m deep concrete piers encased within 1.0m of reinforced concrete flooring (fig.2a).

5.2.3 Engine House 2: internal description

The engine house is constructed in the same manner as the boiler house. Its south-east extension follows on from the main structure in fabric and style. The fact that the join between the two is unnoticeable suggests the extension may have been built before the main part was completed.

The front cover photograph, viewed to the north from the crane gantry, shows three *Bruce Peebles & Co* generators stood on a wide platform with three smaller ones of unknown make on the platform to the left (Waltham Abbey Information Board). The switchboard stands along the north-west wall and there is a metal stair leading up from machinery on the main floor. It is believed the extension was created to contain further engines and dynamos (RCHME 1993). All these features were removed when the engine house was converted to a machine shop in 1951. The plans from the preceding year (fig.2b) show lathes, grinders, pillar drills and other equipment stood on a hardwood floor with a first floor office area replacing the former turbine platform, and tool/component stores below. The visible changes recorded inside the engine house (fig.3) belong to this phase and apparently lasted until closure.

The interior (plates 11 & 12) is laid out over 10½ by 3 bays represented by 7 x 9 inch steel stanchions at 10 foot/3.1m intervals tied in horizontally by rails either side for the travelling crane (the horizontal steel joists seen in both plates) at the north-west end (plate 13). Steel trusses are identical to those in the boiler house and embedded within the walls. The ironwork is painted yellow while the walls are a blue-grey/'eggshell' colour in a similar condition to the boiler house. Blocked doorways in the partition wall are evident alongside blockings to the 1951 square windows and doorways on the outer wall, carried out in Fletton brick of recent date, presumably when the machine shop was demolished; currently unknown. The interior is relatively free of clutter and the concrete floor has little or no evidence of the later machinery.

At the north-west end is the former stores/offices introduced in the 1951 conversion. A doorway and service hatch connecting the stores and working area either side of the partition wall are now blocked. A modern doorway has been cut into the external wall into the tool store as the only existing access. The stores have been stripped-out, leaving nothing of note inside. A plain iron stair leads up to the first floor offices whose floors are supported on steel girders cut into the existing brick pillars. Initially there were three offices on this level, but the wall between the second and third was latterly knocked through and the doorway into the central office blocked (fig.4). Like the ground floor below, the offices retain no features of interest.

By far the most interesting feature is the travelling crane which rests above the office area (plates 13 & 14). Plates on the crane girders show it was manufactured by *John Smith (Keighley) Ltd* and installed by *Babcock & Wilcox Ltd, London & Renfrew* in 1915. According to the plates, the carrying load was 10 tons. The crane was moved along its track manually via a series of cogs and wheels operated by a long chain reaching to the ground floor (plate 13). A second chain fixed its position laterally in the building and the lower, largest cog worked the cable hoist (plate 14). An iron gantry is bolted to the front that would have added considerably to the weight. The carrying joists are cast by *Rodingham Iron & Steel Co. Ltd., England* and the wheel axels by *Shelton*.

5.3 Accumulator (Pump House 3 and Accumulator Tower 4)

The accumulator building (plates 15 & 16) used electricity generated in the power house to pump water and transfer it under pressure to provide hydraulic power to work the cordite presses on the north side of the canal. Hydraulic power is a way of transferring energy through water or 'other incompressible fluid' (RCHME 1993) and means the power source could be remote to the process, which had obvious advantages for explosive manufacture. There was also no chance of sparks being produced. Constant water pressure in the system was maintained by a heavy weight in the accumulator tower that switched the pump off when it reached the top of the tower. The process from engine house to cordite presses is shown in figure 8.

The building is aligned perpendicular to the power house, both respecting the line of the canal which was part of an extensive network of waterways used to float explosives around the site on simple wooden barges (plate 17). Its plan form can be roughly described as 'L-shaped' with the main part, the pump house, extending beyond the tower on the south-east side (fig.1). Each building component is single-storeyed and constructed in pier and panel from hard yellow stocks in English bond on a chamfered Staffordshire blue brick plinth. Pump

house 3 has a square two by three bay plan form, measuring approximately 7.5m² (fig.5) and a gabled slate roof. The accumulator tower is of the same pier and panel form, built in two stages with two panels to each elevation. The 6m-wide square base of the tower sits on a 2.5m deep concrete foundation and rises to a height of 16m to a fully-hipped slate roof. The structure is widest at the base and batters inwards in two close stages from the 5m point (fig.7). The walls are thick, being 0.8m on three of the sides and 0.4m on the other (fig.5).

Architect's drawings from 1915 show how the structure appeared before conversion. Entry into the pump house was originally by concrete steps up to a door in the south-west gable (fig.2c). A second wider, more utilitarian entrance was positioned on the north-west side, with another further along into the accumulator tower (WARGPM H423 1915). This elevation is now obscured by trees and other vegetation. An internal doorway, which is still present, connected the two areas. Original fenestration consisted of round-headed windows (fig.2c) that now only remain in the upper parts the tower.

After explosives manufacture finished, the accumulator became redundant and in c.1951 the building was stripped-out and converted to new changing rooms/washrooms and toilets for workers using the new workshop and machine shops. New entrances were created, square steel-framed windows added and the interior altered to accommodate new toilets, changing rooms and showers. A low timber lean-to structure attached to the north-east side of the tower was removed at the same time (RCHME 1993).

5.3.1 External description

The most prominent elevation is on the south-east side (plates 15 & 18), viewed across the large expanse of vegetation that has sprung up since closure. All five rectangular panels have either single or double casement steel windows with concrete sills and heads inserted, depending on their location. Original elevations show a round-headed steel window in the central panel with arched head (WAGPM H423, May 1915), similar in style and proportion to those in the power house and with the same tilting upper four panes. In the tower, two lancet-style steel-framed windows are placed in the long panels towards the top, which also remain on the north-west elevation. The semi-circular heads are dressed in red brick (plate 15).

On the south-west side, the end-gable comprises one large recessed panel with steel casements either side (plate 16). Two patterned cast iron 'air bricks' (fig.2c) are sited at the top of the pier immediately below the stepped corbel slate roof. More air bricks are arranged around the top of the tower (plates 15 & 16). The 1915 elevation (fig. 2c) confirms the former existence of a central doorway on this side, approached by steps, with two round-headed

windows either side. These remains could not be detected in the existing wall fabric, but the location of the doorway was observed below ground level in an engineer's test pit dug against the wall foundations. The tower on this and the opposite side is built blind, but there are features of interest, namely the square tie plates that rise in pairs up the central pier and secured the weight bin guide inside the tower (plate 20). Again, more are viewed on the opposite section.

The north-west elevation is partly overgrown in ivy and difficult to photograph properly for young trees that have grown up here in the past 17 or so years. Steel casements have been inserted into the two westerly panels of the pump house and a pair of doors set into the formerly blind third panel (fig.4). Originally there was a similar entry point in the middle bay, but when the interior was divided-up a more central entrance was required with access to showers, WCs and urinals. The original doorway into the tower on this side was made into two when washrooms/WCs were created inside (fig.5).

No remains were observed of the former wooden structure on the north-east side (RCHME 1993) and its function remains unknown. A short steel vented window has been inserted on the low panels of the tower (fig.5).

5.3.2 Pump House 3: internal description

The interior was cleared of the pump and any other fittings c.1951 when the buildings were converted (RCHME 1993). A wall was inserted to define the new shower/changing rooms and WCs (fig.5) and the interior painted an eggshell blue. As the paint extends beyond the bottom of the trusses, it is assumed there was no ceiling installed, though this seems unlikely (plate 18). In recent years, netting has been hung between the walls in the pump house and tower, trapping several pigeons in the process.

No evidence for fittings were seen in the concrete floor, which was re-laid after the pump was removed. Three longitudinal bays are formed from steel joists and angle-iron roof trusses (figs.6 & 7) laid at c.2.2m intervals (plate 18).

5.3.3 Accumulator Tower 4: internal description

The single-bayed open plan area that housed the weight bin, ram and cylinder was partitioned by brick walls into toilet areas (fig.5) during the 1951 conversion. As part of the conversion the floor was re-laid, removing or covering-up important floor fixtures. The main one of these was the 10 foot wide hexagonal accumulator platform with its 5 foot-wide cast-iron base (WARGPM H426 1915).

Although nothing remains on the accumulator floor, there are remnants of accumulator fittings surviving inside the tower. A long unpainted scar on the facing brick piers show where the guides to the weight bin were attached (plate 19), secured by the iron ties at regular intervals, removed on the inside but recorded externally. At the top of the tower are two parallel steel joists laid on the piers, with two concrete block pads either side (figs.5 & 7, plate 20). These acted as buffers for the bin at the end of its travel. The roof above is a fully-hipped light timber structure.

6.0 DISCUSSION

The power house and accumulator were built in 1915 to increase the manufacture of cordite during the First World War. An extension was added to the engine room of the power house soon after in 1916. Steam was raised in the boiler house which was run through turbines in the engine house to create electricity. This was then relayed across to various other buildings in North Site and used to power the accumulator pump house. Water was drawn up and forced through a mains pipe to activate hydraulic cordite presses. Along the way, the water pressure was maintained by a weight inside the accumulator tower that rose with the increase in water flow. When it reached the top a switch de-activated the pump and the weight bin kept the water under pressure until the pump was re-activated. Such a system was invaluable to the production of explosives, being safer and more reliable because it could be carried out remotely and without the risk of sparks or fire that could be caused by steam engines or electrical power.

All of the internal fixtures and fittings associated with cordite manufacture were removed after the Second World War. In c.1951, when new workshops were constructed, the engine house was converted to a machine shop with new offices and stores, and the accumulator was converted to washrooms and toilets. It seems it was only after decommissioning in 1991 that the boilers were shut down and removed. This leaves only the bare built fabric of the two buildings and large unoccupied spaces. Fortunately there are good records of the site to give an impression of how the buildings appeared, and were used, and of the machinery and fixtures therein.

Development and technological change over a 75-year period have led to small changes in the fabric and appearance of both structures but without affecting their original character. With few exceptions, quality of the workmanship is exceptionally high. The form of the power station is typical of a generating plant, containing boiler and engine houses. Its imposing

scale, pier and panel construction, bolted iron trusses long windows and ridge lights/ventilation is typical of such large industrial buildings constructed in the late 19th and early 20th centuries. The accumulator shares many of these facets, but its different functional requirements resulted in quite specific differences; in particular the distinctive structure of the accumulator tower, a rare and unusual structure.

7.0 CONCLUSION

Hydraulic power was brought to Waltham Abbey in the late 1860s when the first weight-loaded accumulator was built to power hydraulic presses for a pellet powder machine, working off a steam engine (Cocroft 2000). The 1915 accumulator tower was the second and last to be built on North Site and used electricity generated in the adjacent power house to operate the old presses in the manufacture of cordite.

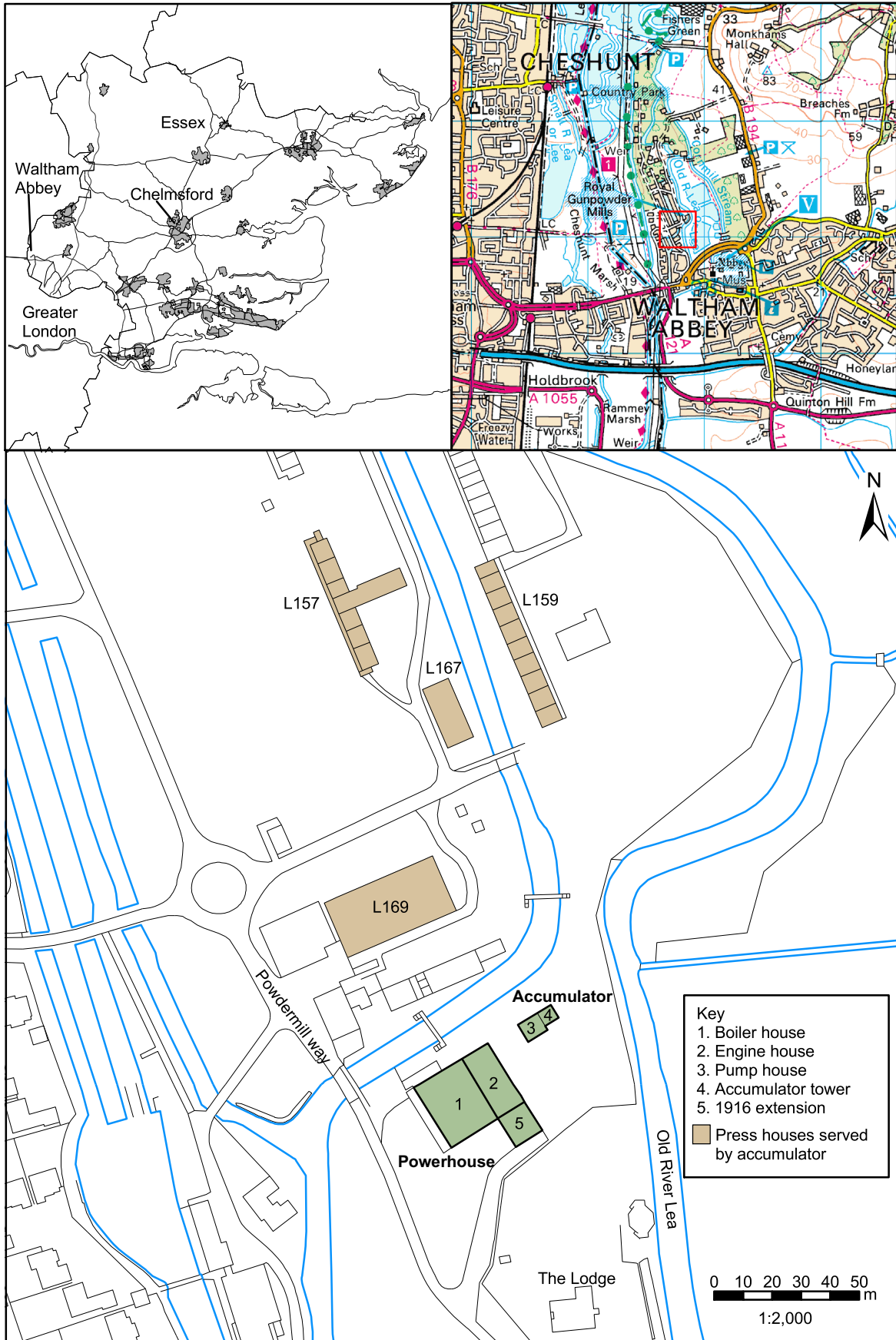
The 1915 power house and hydraulic accumulator form parts of an extensive and well-documented group of standing structures concerned with the manufacture of explosives on this site from 1787 until 1943, and thereafter as a Cold War government research institution until closure in 1991. Continuous ownership and protection of the site has ensured the survival of an important group of buildings and machinery, much of which are now maintained as a vibrant and modern historical resource. The site has almost unique status as the main producer of gunpowder and other explosives over 200 years, and many of the important developments in modern warfare were developed and produced at Waltham Abbey, up until recent times. As well as an important national asset, the Mills at Waltham Abbey were also at the forefront in technological developments in hydraulics and the change from steam power to electrics. Of the three Royal Gunpowder Mills in Britain, none has survived in such complete and well-documented condition as those at Waltham Abbey (RCHME 1993). The conversion of the power house and accumulator to new use will preserve the overall character of these important elements of the Gunpowder Mills complex.

ACKNOWLEDGEMENTS

Thanks are due to the client, Hill Partnerships, for commissioning the works and in particular to David Devane for supplying architects and historic drawings. Also to Les Tucker senior archivist and Lyn Leonard from Royal Gunpowder Mills, for their assistance. Fieldwork, recording and photography were undertaken by the author. Illustrations were prepared by the author and produced by Andrew Lewsey. The site was monitored by Pat Connell of ECC HEM on behalf of the LPA.

BIBLIOGRAPHY

- | | | |
|------------------|------|---|
| Cocroft, W. | 2000 | <i>Dangerous Energy</i> , English Heritage, Swindon |
| DoE | 1990 | <i>Planning Policy Guidance Note 16: Archaeology and Planning</i> HMSO, London |
| English Heritage | 2006 | <i>Understanding Historic Buildings: A Guide to Good Recording Practice</i> Swindon |
| ECC HEM | 2007 | <i>Brief for Historic Building Recording of the Power House and Water Accumulator Tower, Royal Gunpowder Mills, Waltham Abbey</i> ECC HEM |
| RCHME | 1993 | <i>The Royal Gunpowder Factory, Waltham Abbey, Essex: an RCHME survey</i> |
| Smith, T. | 1991 | <i>Hydraulic Power in the Port of London</i> , Industrial Archaeology Review, Autumn 1991 |

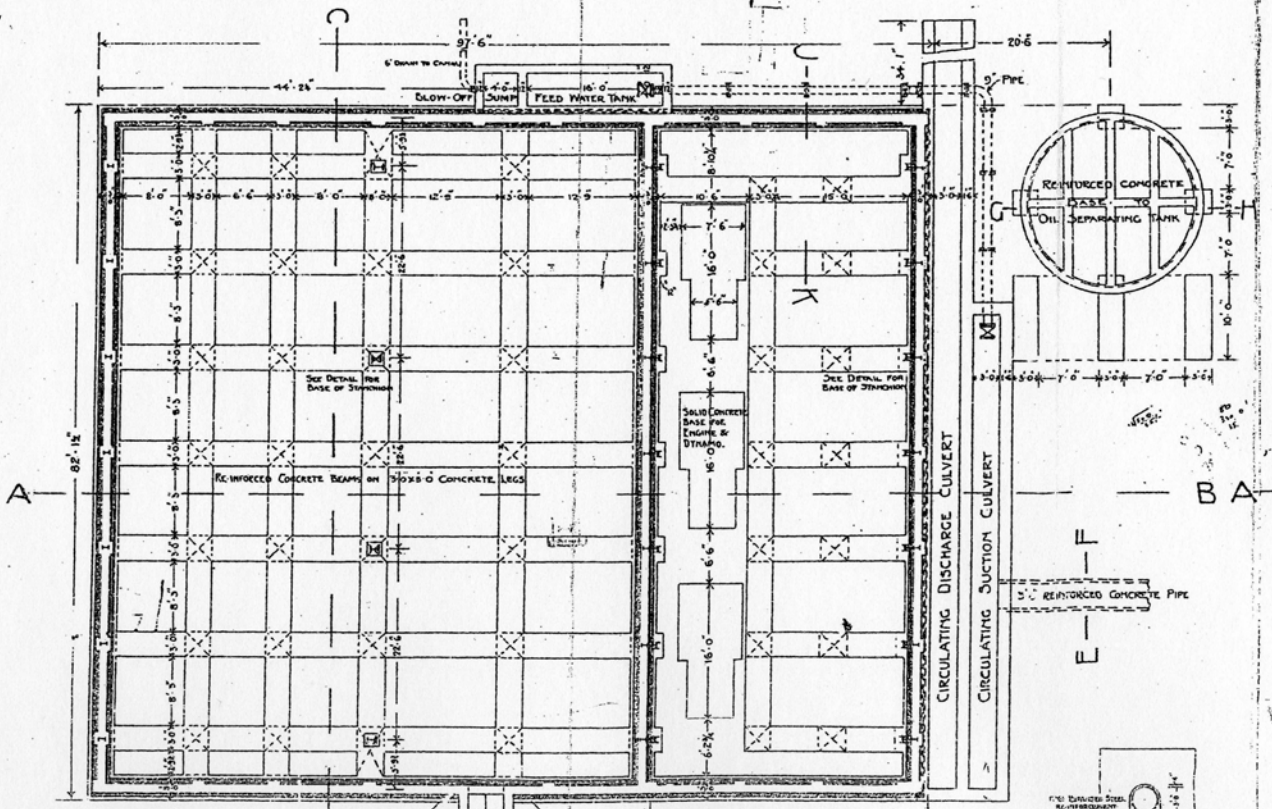
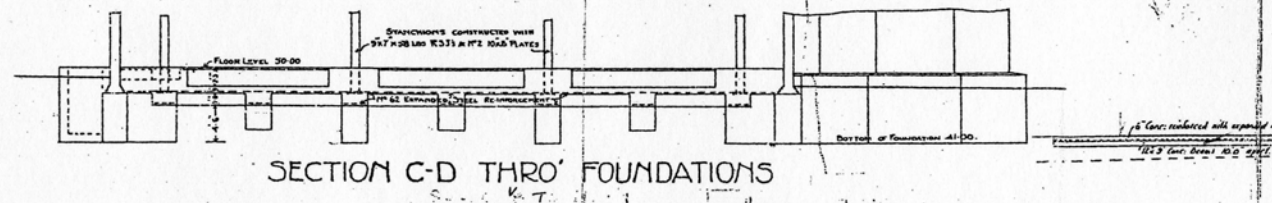


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Fig.1. Site location and block plan

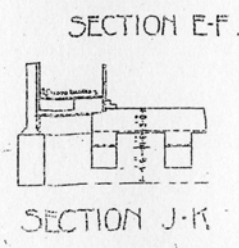
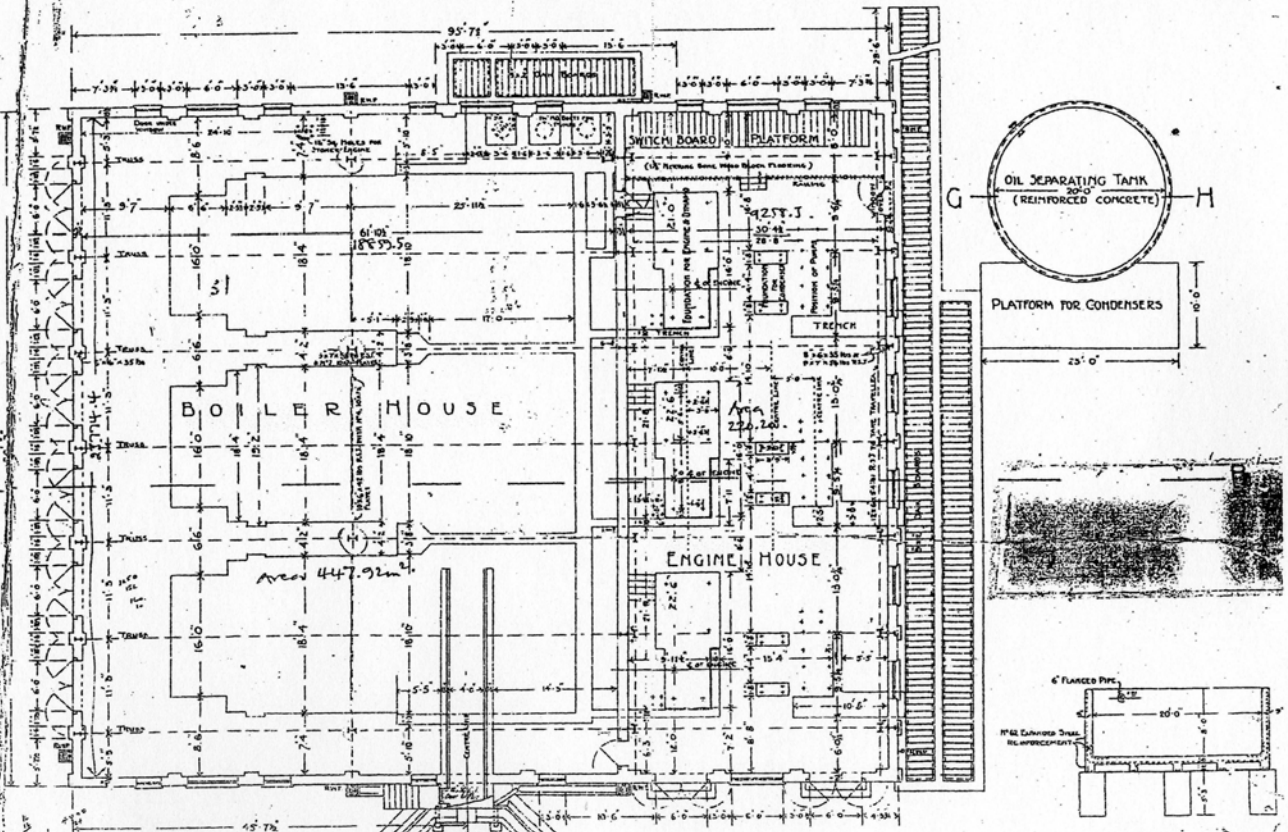
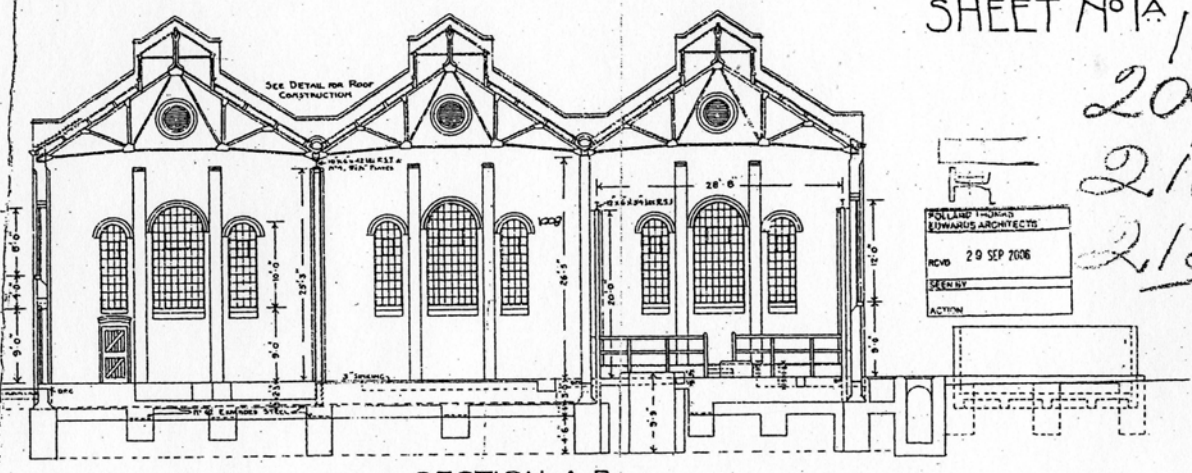
R.G.P.F. WALTHAM ABBEY. NEW POWER HOUSE.

SCALE 8 FT TO AN INCH.



RECORD DRAWING.

D.B.C. No. 17623
SHEET No. 15
209
213
213



LARRY H. M. O'NEILL
F.R.I.B.A.
DIRECTOR OF BARBACK CONSTRUCTION
WAR OFFICE, 80 PAUL MALL, LONDON, S.W.

Fig.2a. Original plan of power house, 1915 (WARGPM 901/66)

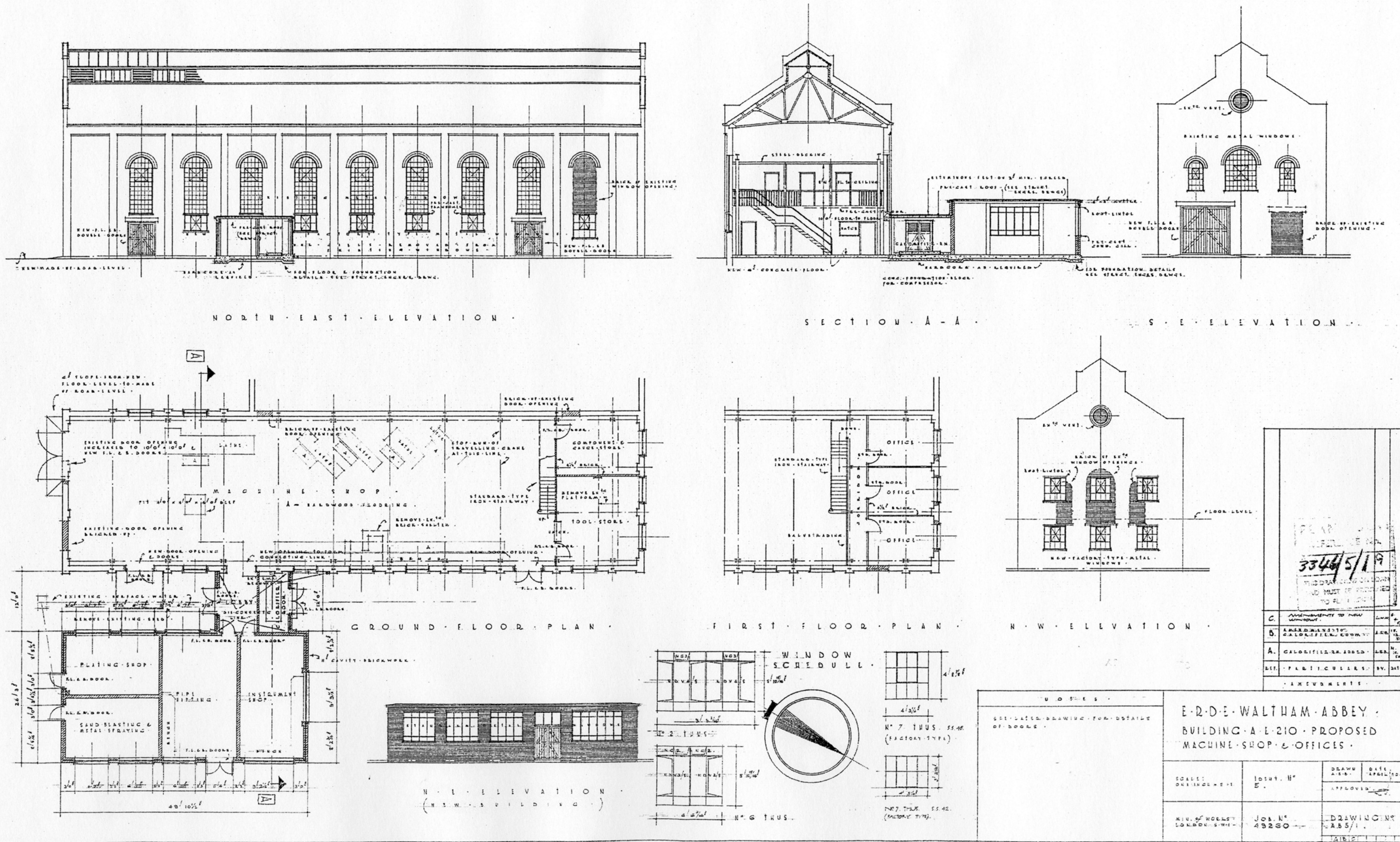


Fig.2b. Conversion plans of engine house 1, 1950 (WARGPM 3346/5/19)

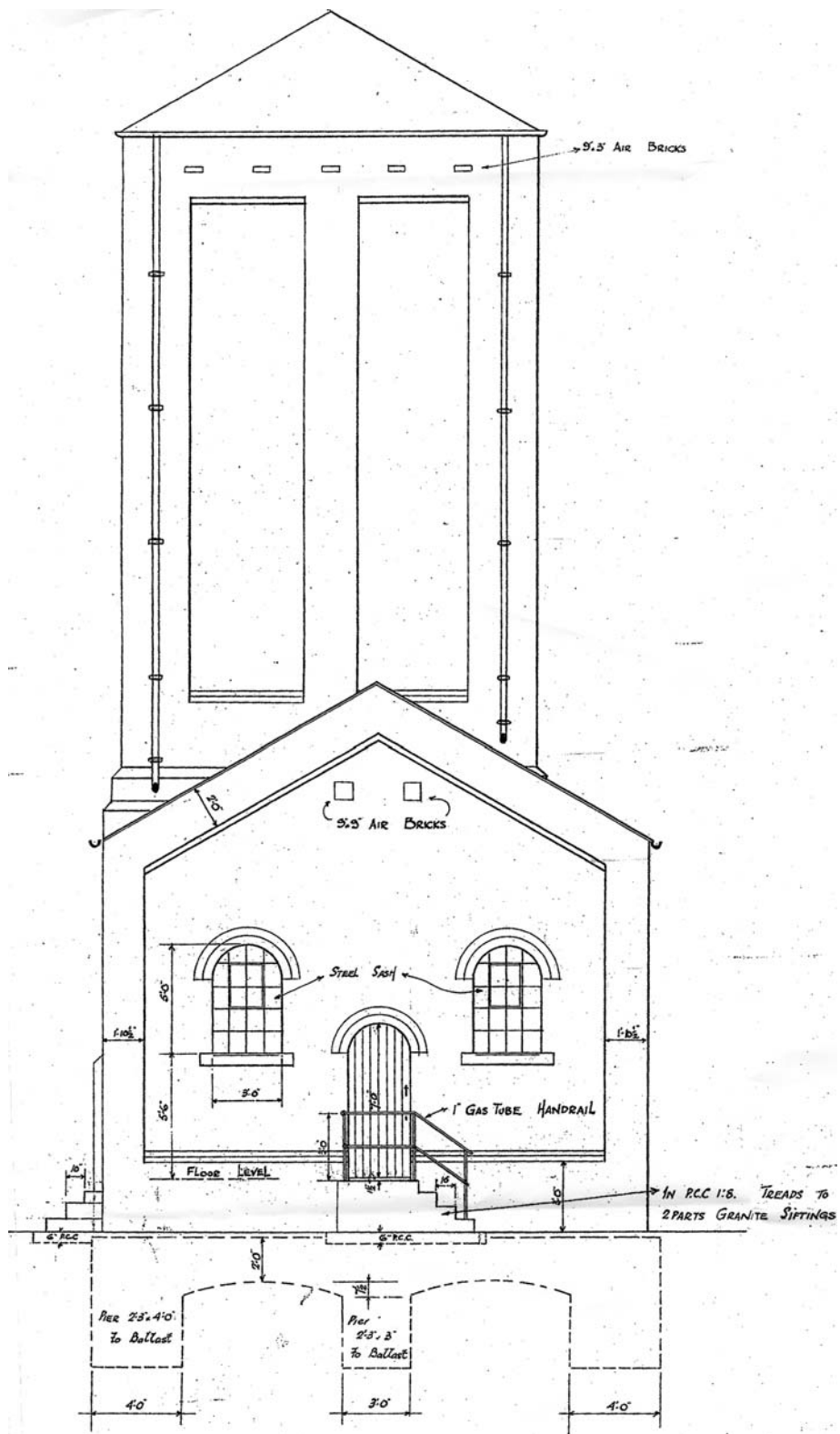


Fig.2c.South-west elevation of pumphouse / accumulator tower, (1915)

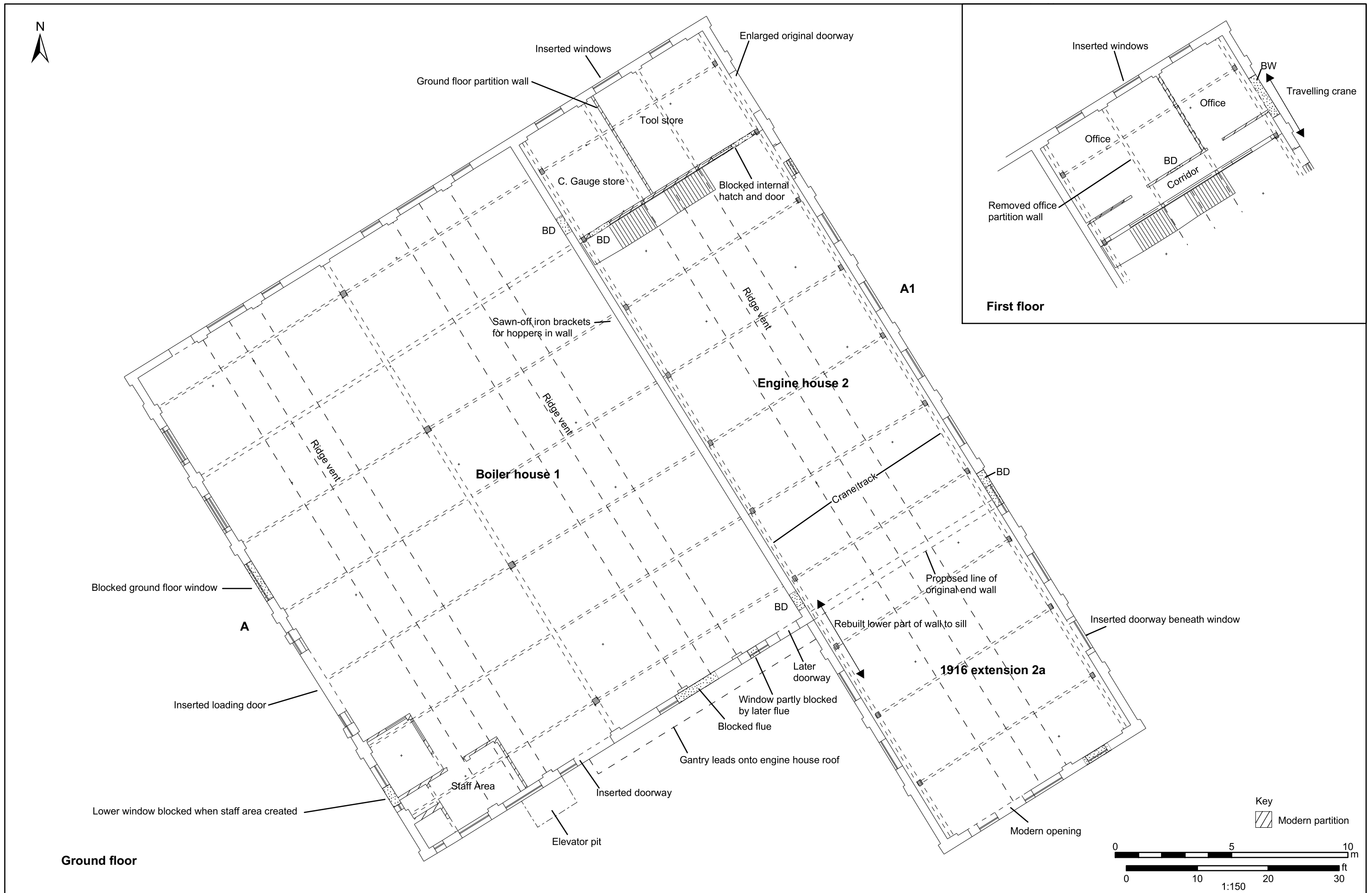


Fig.3. Existing floor plans of power house

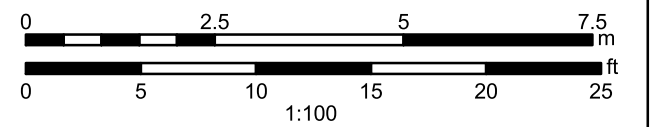
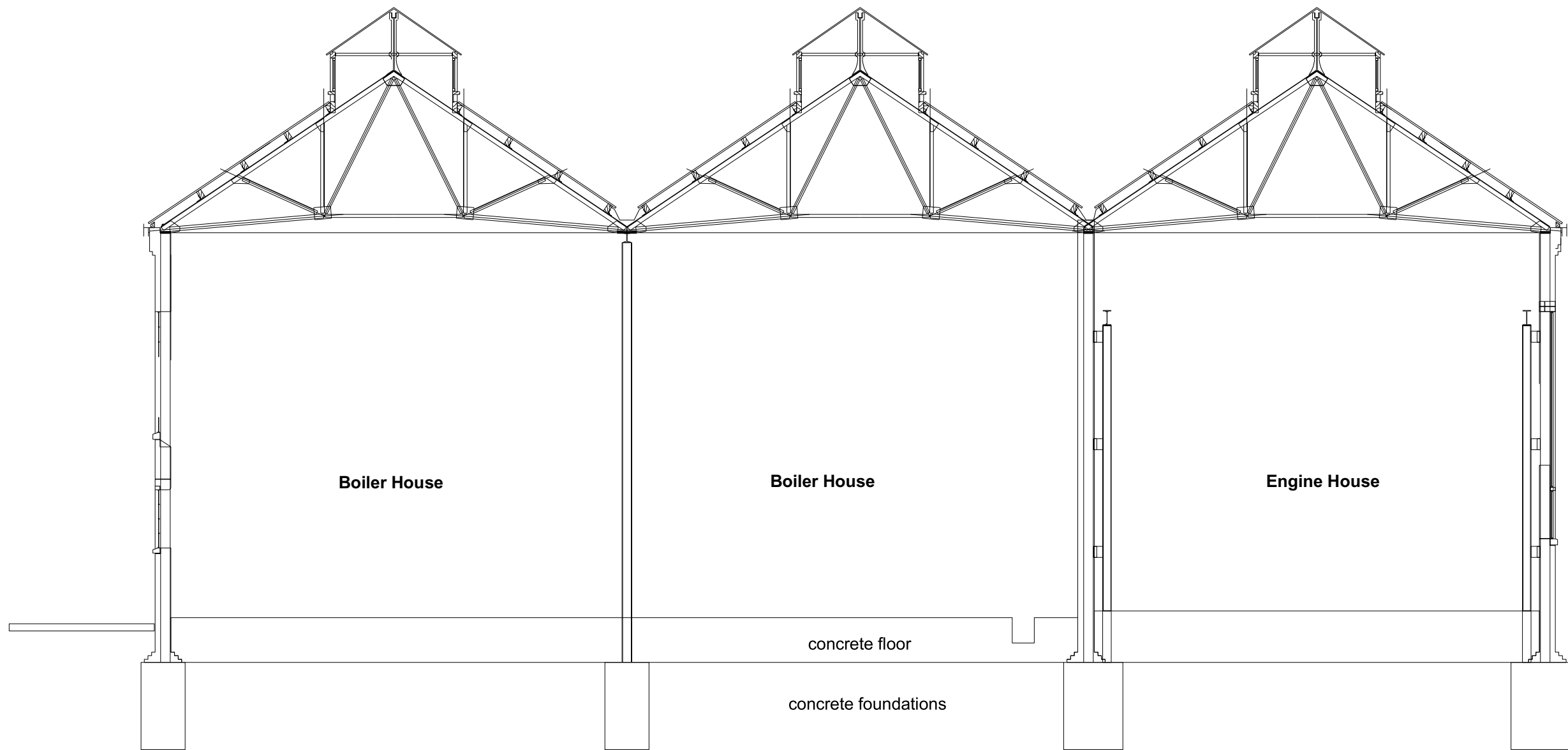


Fig.4. Section A - A1 through power house

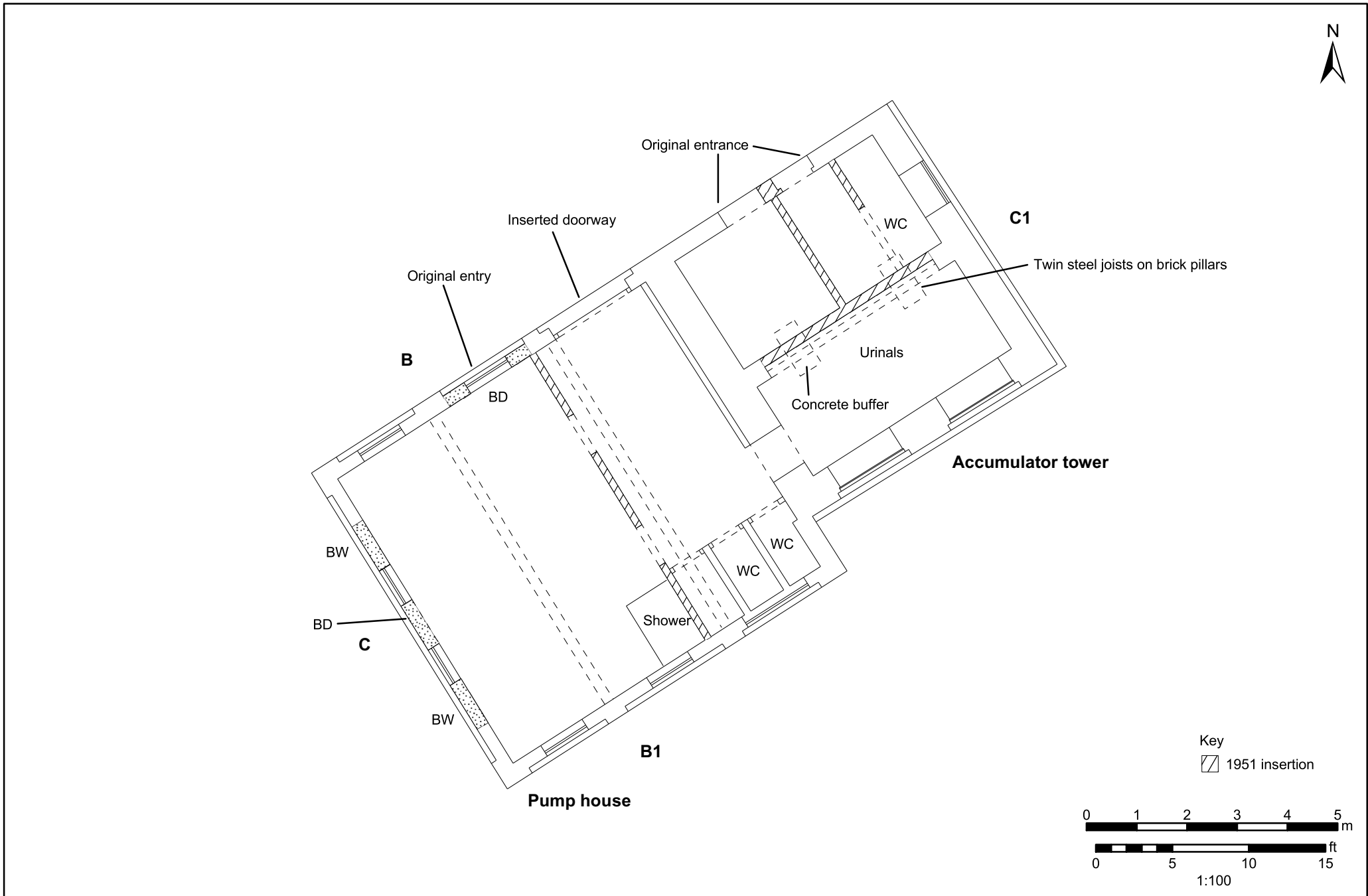


Fig.5. Existing plan of pump house and accumulator tower

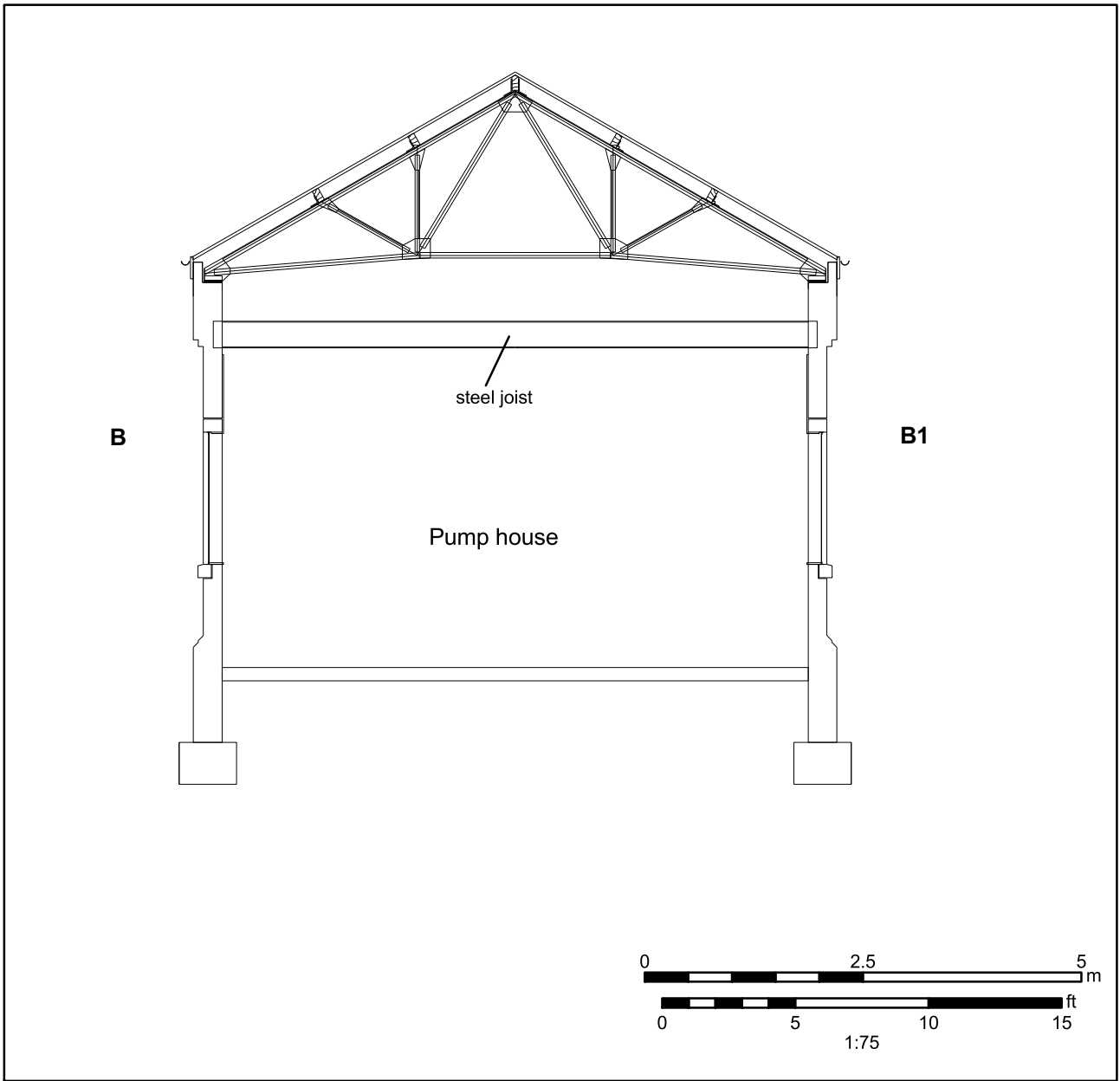


Fig.6. Section B-B1 through pump house

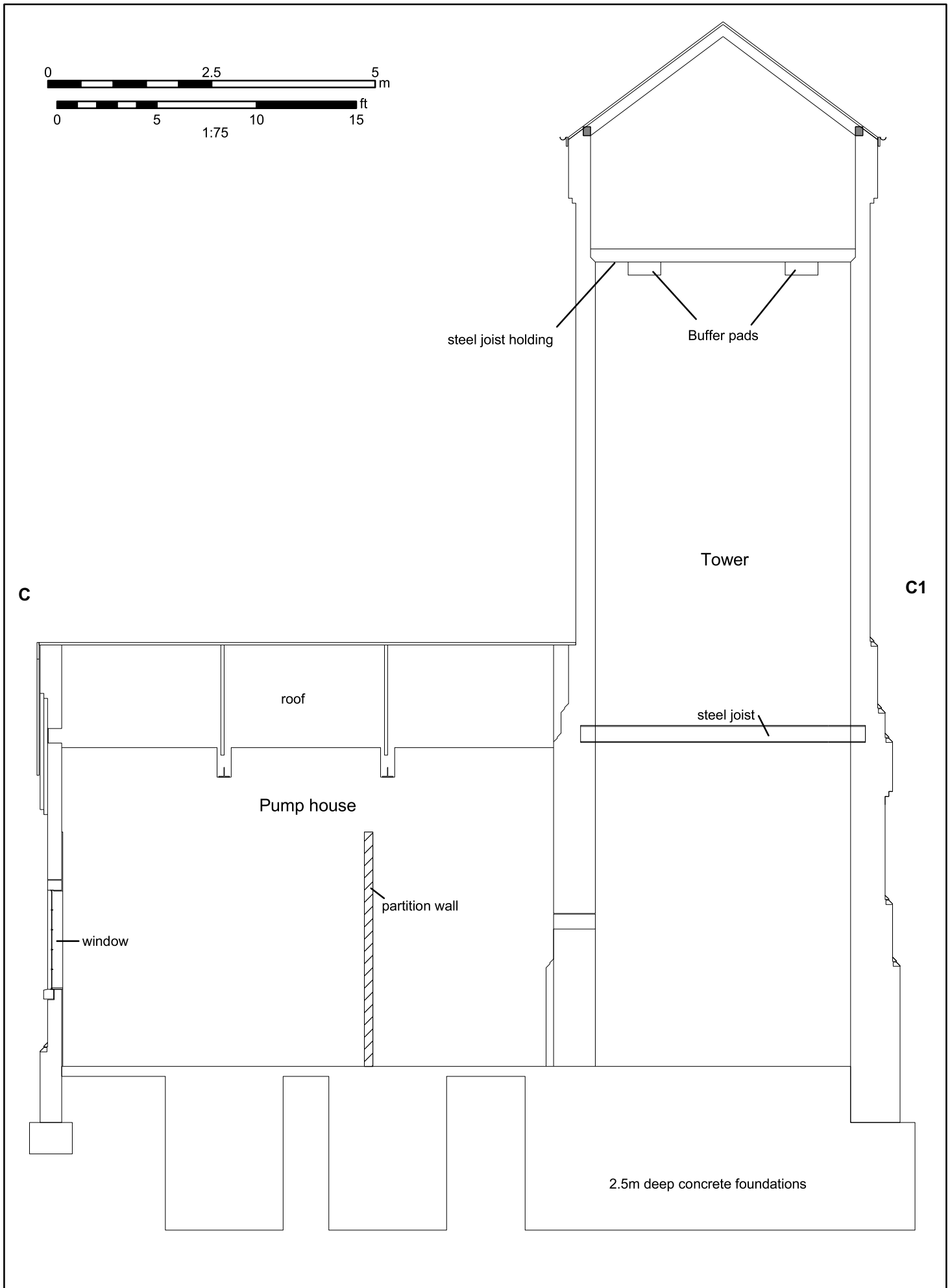


Fig.7. Section C-C1 through accumulator tower

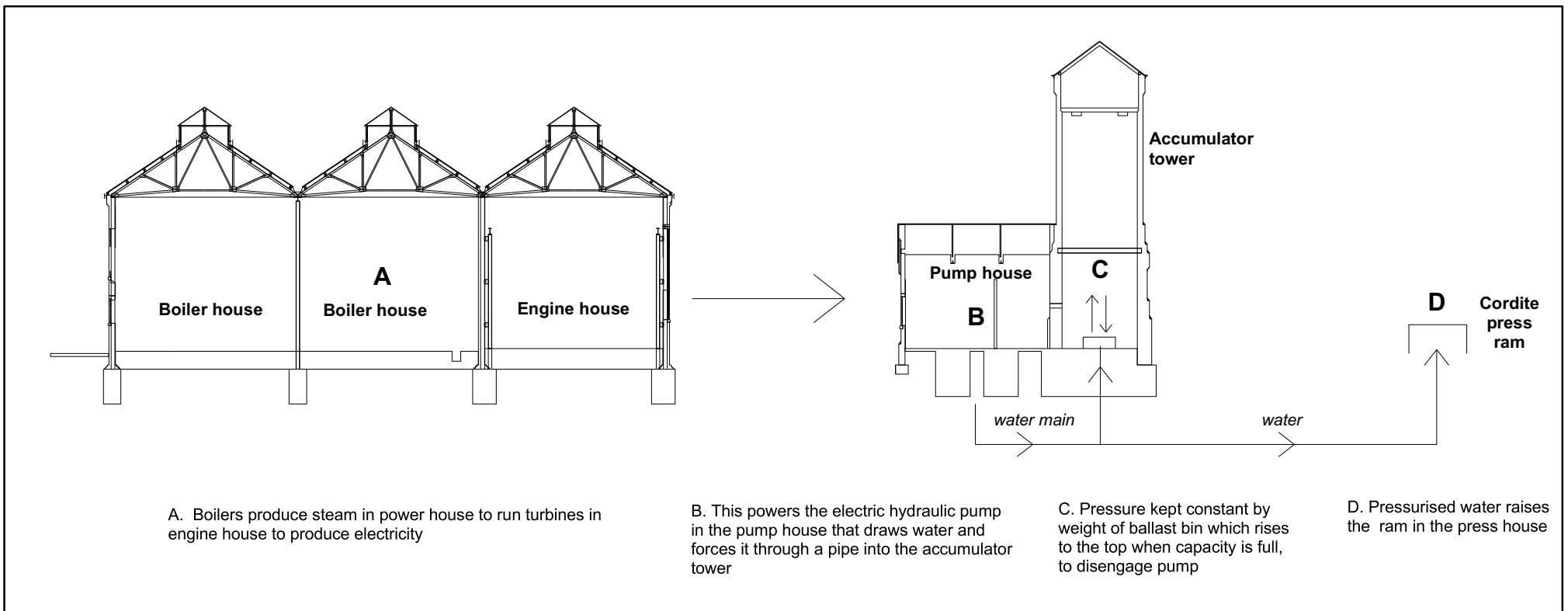


Fig.8. Process flow diagram



Plate 1 Power house and accumulator viewed from west



Plate 2 Power house and accumulator viewed from east



Plate 3 Power house viewed from south



Plate 4 Power house viewed from south after closure



Plate 5 1916 engine house extension viewed from south



Plate 6 South-west boiler house elevation



Plate 7 Interior of boiler house viewed to east



Plate 8 Interior of boiler house viewed to west

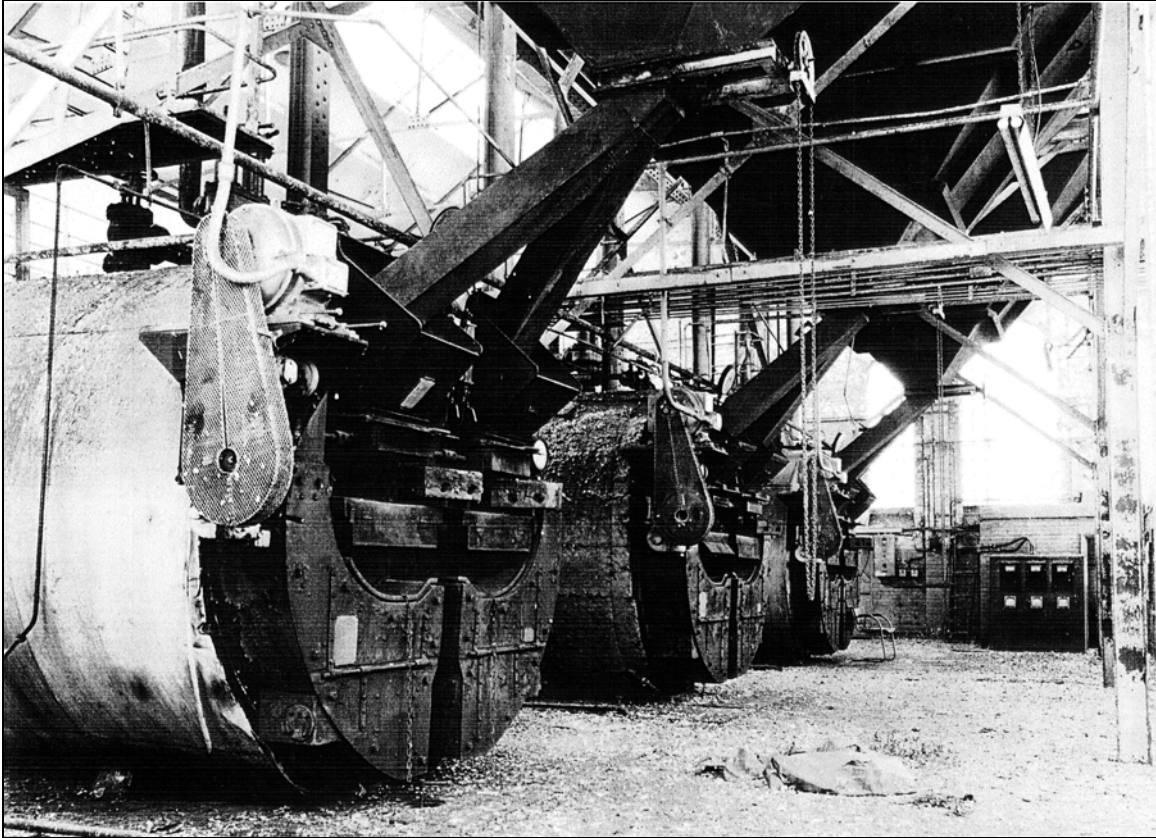


Plate 9 Dansk boilers viewed to west before stripping-out



Plate 10 Detail of decorous steel window handle on south-west elevation



Plate 11 View of engine room to south-east from first floor



Plate 12 View of engine room to north-west



Plate 13 Stairs to offices and travelling crane gantry



Plate 14 Detail of travelling crane manufactured by John Smith of Keighley



Plate 15 Accumulator viewed toward pump house (north-west)

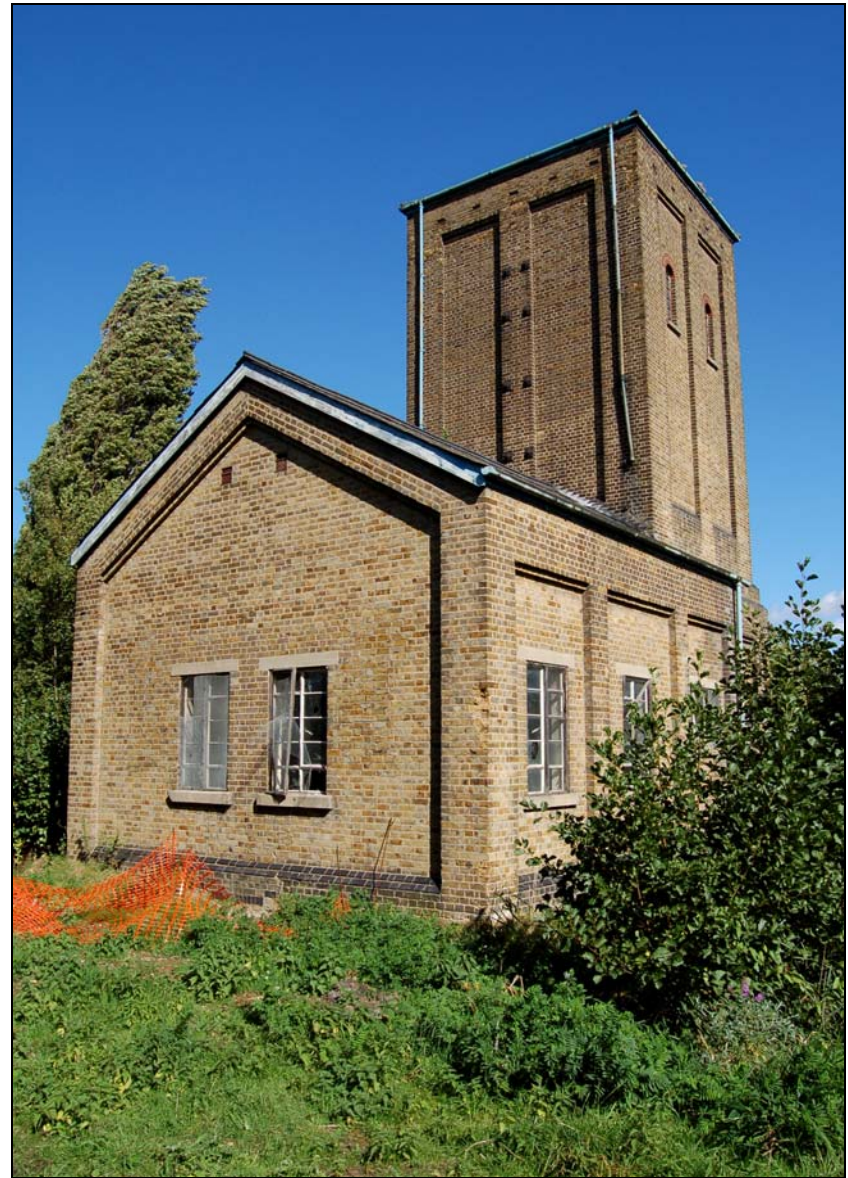


Plate 16 Accumulator viewed toward tower (north-east)



Plate 17 South-east accumulator elevation with explosives barge in foreground



Plate 18 Interior of pump house viewed toward east



Plate 19 Inside the accumulator tower



Plate 20 Weight bin buffers at top of tower

Appendix 1: Contents of Archive

Site name: Power House & Accumulator, the Royal Gunpowder Mills, Waltham Abbey

Project no. 1841

Index to the Archive

Document wallet containing:

1. Research Archive

- 1.1 ECC HEM design brief
- 1.2 ECC FAU written scheme of investigation
- 1.3 Two copies of client report (one unbound)
- 1.4 CD containing digital images, architects drawings & copy of report (pdf-formatted)

2. Site Archive

- 2.1 Photographic registers
- 2.2 Photographic record (digital & 35mm monochrome prints & negatives)
- 2.3 Site notes & annotated survey plans
- 2.4 Historic architects drawings supplied by client

Appendix 2: EHER Summary Sheet

Site Name/Address: Power House & Accumulator, The Royal Gunpowder Mills, Powdermill Lane, Waltham Abbey	
Parish: Waltham Abbey	District: Epping Forest
NGR: TL 3777 0099	OASIS Record No.: essexcou1-42927
Type of Work: Building recording	Site Director/Team: Andrew Letch ECC FAU
Dates of Fieldwork: November 2007	Size of Area Investigated: N/A
Curating Museum: Epping Forest	Funding Source: Hill Partnerships Ltd
Further Work Anticipated? None	Related EHER Nos.:
Final Report: Summary in EAH	
Periods Represented: Modern, c.1915-present	
<p>SUMMARY OF FIELDWORK RESULTS:</p> <p>A power house and accumulator were constructed in 1915. The power house comprised a boiler house and engine house that generated electricity to power the accumulator and other buildings on North Site. The accumulator consisted of a pump house and a 16m-high accumulator tower. Both were used in the production of cordite during the First World War. The pump house supplied water to a hydraulic system that operated the cordite presses remotely on the north side of the canal.</p> <p>Cordite ceased to be manufactured on the site after 1943 and after the war the site became a Cold War research facility, concentrating on rockets and other propellants. Electricity ceased to be produced, although the boiler house was still used. The engine house became a machine shop c.1951 and the pump house and accumulator tower were converted to washrooms and toilets at the same time, involving significant changes to the fabric. The buildings were stripped of pump and accumulator and are now empty. The boilers were removed when the facility closed.</p> <p>The power house is typical of late 19th and early 20th-century design; a large brick built structure with gabled ends, arched steel windows steel trusses and ridge vents on the roofs. In the 1940s it housed three large Dansk boilers. In comparison, the accumulator building is a diminutive one, with a small pump house and tall brick tower that housed a large weight on a ram that travelled up and down the tower keeping the hydraulic pressure constant. The accumulator tower is an unusual and rare structure and both are important to the technological development of the Gunpowder Mills in the early 20th-century.</p>	
Other Reports: The Royal Gunpowder Factory, Waltham Abbey, Essex: An RCHME Survey	
Author of Summary: A.R. Letch	Date of Summary: 29th May 2008