

Recommendation of the Executive Director and assessment of cultural heritage significance under Part 3, Division 3 of the *Heritage Act 2017*

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Name	Brunswick West Tramway Substation
Location	196a Dawson Street Brunswick West, Moreland City
Provisional VHR Number	PROV H2397
Provisional VHR Categor(ies)	Registered Place Registered Objects Integral to a Registered Place
Hermes Number	201776
Existing Heritage Overlay	City of Moreland, HO64 (individual)



Brunswick West Tramway Substation, (November 2019)

EXECUTIVE DIRECTOR RECOMMENDATION TO THE HERITAGE COUNCIL:

- That the Brunswick West Tramway Substation be included as a Registered Place with Registered Object(s) Integral to the Place in the Victorian Heritage Register under s. 37(1)(a) of the *Heritage Act 2017*.

STEVEN AVERY

Executive Director

Recommendation Date: 20 November 2020

Advertising Period: 26 November 2019 – 24 January 2020

This recommendation report has been issued by the Executive Director, Heritage Victoria under s.37 of the *Heritage Act 2017*.

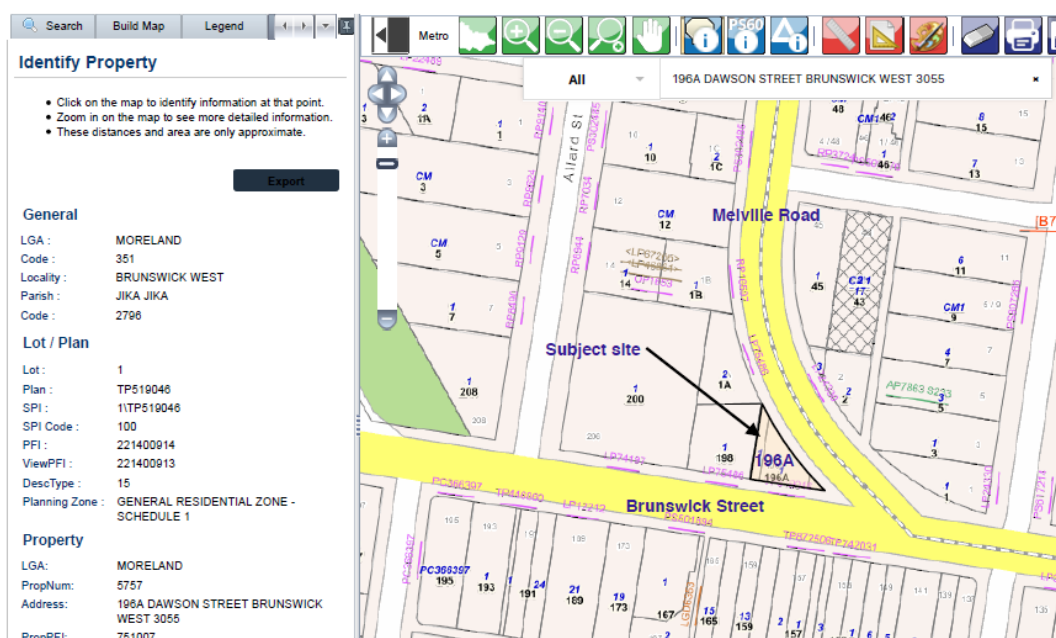
EXTENT OF NOMINATION

Date that the nomination was accepted by the Executive Director
23 July 2018

Written extent of nomination

- The block of land on which the substation building stands. (Lot 1, TP 519046)
- The electrical plant and equipment within the substation building:
 - Incoming 6.6 kV (AC) switchgear housed in three tall brick cells
 - An oil/air cooled step-down main transformer
 - A 600 kW Hewittic mercury-arc rectifier bank comprising four glass bulb units in metal cabinets
 - A DC negative side high-speed circuit breaker
 - An open five-panel switchboard with 600 Volt DC positive side circuit breakers and current limiting resistors

Nomination extent diagram



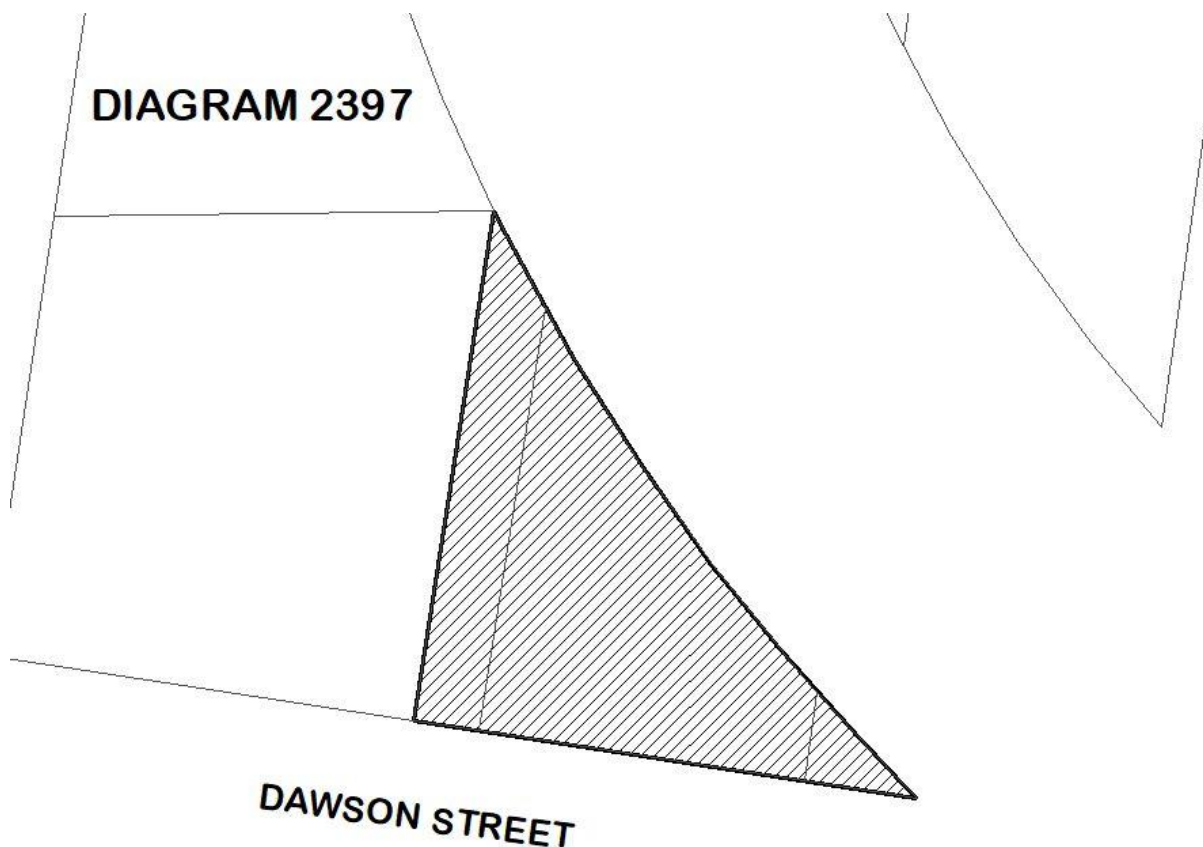
Is the extent of nomination the same as the recommended extent?

No. The following object(s) integral to the place are also recommended for inclusion in the extent of registration:

- The housings and connections to the nominated fixed items of electrical equipment
- Other items of electrical equipment including emergency resistance coils and an inductor
- A timber box for transporting one mercury arc rectifier bulb, substation operating tools and furniture
- Electrical schematic diagrams, substation diaries and other documents

RECOMMENDED REGISTRATION

All of the place shown hatched on Diagram 2397 encompassing all Lot 1 on Title Plan 680981, and Lots 1 and 2 on Title Plan 519046.



The recommended extent of registration for the Brunswick West Tramway Substation in the Victorian Heritage Register affects the whole place shown on Diagram 2397 including the land and the building (including the exteriors and interiors);

- the registration also includes all fixed items of rectification equipment;
- the registration also includes all fixtures attached to the building at the time of registration including the brick cells to hold the AC switchgear, light fittings, wire screens and gates, toilet and hand basin.
- the registration also includes all movable objects integral to the place listed in the inventory dated November 2019, held by the Executive Director, Heritage Victoria.

RATIONALE FOR EXTENT

The proposed extent of registration is the cadastral block comprising a triangular block of land at the corner of Melville Road and Dawson Street. The cadastral block is considered sufficient to protect the cultural heritage significance of the place.

AERIAL PHOTO OF THE PLACE SHOWING PROPOSED REGISTRATION



BACKGROUND

WHAT IS AT THE PLACE?

The substation at 196A Dawson Street, Brunswick West sits diagonally on its triangular block of land facing the intersection of Dawson Street and Melville Road. It is a simple square Moderne style structure of face red brick laid in English bond pattern. It has a large central opening on the south east side, double timber doors on the north east side, wire covered windows on all sides except the south west and a small roller door on the north west side. The large central opening surrounded by tapestry pattern brickwork is covered by a chain wire gate with the main transformer prominently located behind it. The three room building contains all the equipment needed to convert AC (Alternating Current) power to DC (Direct Current) power for trams. This includes three phase bus bars to bring AC power into the substation, 6.6kV AC switchgear, a mercury-arc rectifier bank consisting of four glass bulbs and its matching transformer, 600V DC switchboards, circuit breakers, control gear and interconnecting cables.

WHAT IS THE HISTORY OF THE PLACE?

The Brunswick West Tramway Substation was constructed in 1935 to serve the West Coburg tram line, which had begun operation in July 1925 and was completed in 1927. The line appears to have been initially powered from Sydney Road. The new substation on Melville Road was essential to supply DC power to increased traffic on the tram line. Mercury arc rectification equipment had become the preferred technology for the time and enabled the construction of smaller, more efficient unmanned substations that were cheaper to operate than earlier rotary converter systems. The West Coburg tram line contributed to the development of much of the western side of Brunswick and Coburg.

WHO ARE THE TRADITIONAL OWNERS/REGISTERED ABORIGINAL PARTY(IES) FOR THIS PLACE?

The Wurundjeri Woi Wurrung Cultural Heritage Aboriginal Corporation are the Registered Aboriginal Party for the land on which the place is located.

STATEMENT OF CULTURAL HERITAGE SIGNIFICANCE

WHAT IS SIGNIFICANT?

The Brunswick West Tramway Substation building, land and objects integral to the place including:

- The following fixed items of electrical equipment and their interconnecting cabling including: open three phase bus bars to bring high voltage (HV) AC power from Dawson Street; 6.6 kV AC switchgear; an air cooled transformer; a choke inductor; a bank of four mercury arc rectifier bulbs in steel cabinets; a 600 Volt DC switchboard including automatic control gear and current limiting resistors; a 600 Volt DC negative high speed circuit breaker; emergency resistor coils; three outgoing feeders to the overhead tram traction wires via isolators to carry DC power out of the building to the overhead tramway wires; underground cables bringing DC power from the tram rails back into the building and an AC switchboard.
- All fixtures attached to the building at the time of registration including the brick cells to hold the AC switchgear, light fittings, wire screens and gates, toilet and hand basin.
- The following movable items: a timber box for transporting one mercury arc rectifier bulb, electrical schematic diagrams, substation diaries and other documents, substation operating tools and furniture.

HOW IS IT SIGNIFICANT?

The Brunswick West Tramway Substation is of historical significance to the State of Victoria. It satisfies the following criterion for inclusion in the Victorian Heritage Register:

Criterion A

Importance to the course, or pattern, of Victoria's cultural history.

Criterion B

Possession of uncommon, rare or endangered aspects of Victoria's cultural history.

Criterion D

Importance in demonstrating the principal characteristics of a class of cultural places and objects.

WHY IS IT SIGNIFICANT?

The Brunswick West Tramway Substation is significant at the State level for the following reasons:

The Brunswick West Tramway Substation is historically significant for its association with the electrification of the existing cable Tramway in the 1920s and 30s, and the widespread construction of new electric Tramway beyond the reach of the cable tramway system. It serviced the West Coburg tramway which facilitated the development of much of the western side of Brunswick and Coburg. Operation of electric Tramway provided a number of advantages to the Melbourne and Metropolitan Tramway Board (M&MTB) over cable tram operation. These included lower capital costs, greater speed and flexibility, adaptability to extension and simplification of terminal shunting. While power was provided to the West Coburg line from Sydney Road there would have problems with voltage drop leading to slow and inefficient operation of the tramcars. The 1936 creation of the Brunswick West Tramway Substation on Melville Road overcame this. The refined Moderne design of the building with the prominent display of the large electrical transformer demonstrates the pride felt by the M&MTB in its establishment of a progressive electric tram system. (Criterion A)

The Brunswick West Tramway Substation is historically significant as a rare example of a substation with all its original equipment still located in the building. It is one of only three substations in Victoria known to retain mercury arc rectification equipment, and the only one which is complete. All the equipment is present and still connected which means that the substation could be returned to operation. The mercury arc bulbs, their matching transformer and some other equipment were made overseas and the automatic control equipment on the DC switchboard was designed and manufactured by the M&MTB. (Criterion B)

The Brunswick West Tramway Substation is significant because it is one of the few places which demonstrates the principal characteristics and functioning of a tramway substation utilising mercury arc rectifying equipment. The Brunswick West Tramway Substation is a notable example of a tram substation as it contains all the original rectification equipment showing how banks of mercury arc glass bulb rectifiers together with their matching specialised transformer, a choke inductor, switchgear, switchboards, circuit breakers, control gear and interconnecting cables converted AC power to DC power for the DC motors on trams. The location of the substation next to a tram line demonstrates how the DC motors in trams needed to be supplied by a 600 Volt DC source approximately every four kilometres in order to provide a stable power supply without excessive voltage drop limiting the tram's speed. (Criterion D)

RECOMMENDATION REASONS

REASONS FOR RECOMMENDING INCLUSION IN THE VICTORIAN HERITAGE REGISTER [s.40]

Following is the Executive Director's assessment of the place against the tests set out in *The Victorian Heritage Register Criteria and Thresholds Guidelines (2014)*.

CRITERION A

Importance to the course, or pattern, of Victoria's cultural history.

STEP 1: A TEST FOR SATISFYING CRITERION A

The place/object has a *CLEAR ASSOCIATION* with an event, phase, period, process, function, movement, custom or way of life in Victoria's cultural history.

Plus

The association of the place/object to the event, phase, etc *IS EVIDENT* in the physical fabric of the place/object and/or in documentary resources or oral history.

Plus

The *EVENT, PHASE, etc* is of *HISTORICAL IMPORTANCE*, having made a strong or influential contribution to Victoria.

Executive Director's Response

The Brunswick West Tramway Substation has a clear association with the electrification and substantial expansion of Melbourne's tram system in the 1920s and 30s. Between 1923 and 1930 the M&MTB constructed nineteen new electrified tram lines and converted seven cable tram lines to electric traction. Electric trams required DC power and the mains power was AC. This necessitated the construction of substations approximately every four kilometres to convert (or rectify) the mains AC power to DC power.

The association is evident in the physical location of the substation next to the tram line, the building itself and all the equipment which survives intact within the building.

Melbourne's tram system is of historical importance to Victoria and has made and continues to make a strong contribution to Victoria. From the 1880s Melbourne's extensive tram network, both cable and electric, contributed to the development of inner and middle suburbs. The tram system allowed workers and residents to travel quickly and easily around the city and has been a major employer, especially of immigrants.

Criterion A is likely to be satisfied.

STEP 2: STATE LEVEL SIGNIFICANCE TEST FOR CRITERION A

The place/object allows the clear association with the event, phase etc. of historical importance to be *UNDERSTOOD BETTER THAN MOST OTHER PLACES OR OBJECTS IN VICTORIA WITH SUBSTANTIALLY THE SAME ASSOCIATION*.

Executive Director's Response

The Brunswick West Tramway Substation allows the clear association with the 1920s and 30s electrification of Melbourne's Tram system to be understood better than most other substations in Victoria because it still contains all the mercury arc equipment needed to convert (rectify) mains AC power to DC power for trams. One other substation retains a full complement of rotary converter DC rectification equipment. Four other substations contain some components of both types of DC rectification equipment but not full sets. Other 1920s and 30s tram substations survive but are either

empty or contain modern (post 1960s) rectification equipment. The external form of the place, its location next to the tramlines and its internal connected equipment remain in the same state as they did when the substation was constructed and during its use.

Criterion A is likely to be satisfied at the State level.

CRITERION B

Possession of uncommon, rare or endangered aspects of Victoria's cultural history.

STEP 1: A TEST FOR SATISFYING CRITERION B

The place/object has a *clear ASSOCIATION* with an event, phase, period, process, function, movement, custom or way of life of importance in Victoria's cultural history.

Plus

The association of the place/object to the event, phase, etc *IS EVIDENT* in the physical fabric of the place/object and/or in documentary resources or oral history.

Plus

The place/object is *RARE OR UNCOMMON*, being one of a small number of places/objects remaining that demonstrates the important event, phase etc.

OR

The place/object is *RARE OR UNCOMMON*, containing unusual features of note that were not widely replicated

OR

The existence of the *class* of place/object that demonstrates the important event, phase etc is *ENDANGERED* to the point of rarity due to threats and pressures on such places/objects.

Executive Director's Response

The Brunswick West Tramway Substation has a clear association with the electrification and substantial expansion of Melbourne's tram system in the 1920s and 30s. The conversion of AC to DC power has evolved through several technologies. The M&MTB first used electro-mechanical rotary converters. The mercury-arc technology evident at the Brunswick West Tramway Substation was a significant advance and started to supplant rotary converters from the 1930s, especially for smaller and more remote substations. This is because these rectifiers had higher conversion efficiency, were very reliable, cheaper to operate, and required minimal maintenance. All these factors contributed to the rapid expansion of electrified trams across Melbourne.

The intact and functional mercury arc system at Brunswick West demonstrates how a bank of mercury arc glass bulb rectifiers and their matching transformer was used to convert AC power to DC power to run trams. The bulbs and transformer were made in the UK, and other equipment was made in the USA, and the automatic control equipment was designed and constructed by the Melbourne and Metropolitan Tramway Board (M&MTB).

The Brunswick West Tramway Substation is a rare example of a substation with all its original equipment still located in the building where it was used. This class of place is endangered to the point of rarity due to changes in technology and the decommissioning of substations. It is one of only three substations in Victoria known to retain mercury arc rectification equipment and the only one with a complete set of this equipment. All the equipment is still connected which means that the substation could be returned to operation. No other early substation has this property.

Criterion B is likely to be satisfied.

STEP 2: STATE LEVEL SIGNIFICANCE TEST FOR CRITERION B

The place/object is *RARE, UNCOMMON OR ENDANGERED* within Victoria.

Executive Director's Response

The original mercury arc rectification equipment at the Brunswick West Tramway Substation is rare because similar equipment has been removed from most other substations in Melbourne. In 1975, out of a total of twenty-six operating tram substations in Melbourne, there were thirteen mercury arc substations (one of which was mobile). In 2019 the Brunswick West Tramway Substation contains the only remaining complete tram mercury arc rectification system in Victoria while two other substations retain incomplete mercury arc rectification systems. The only other complete mercury-arc rectifier system known in Victoria is at the Russell Place Electricity Substation, however this did not provide power to trams.

The Brunswick West Tramway Substation contains a switch board which was laid out by the M&MTB and automatic control equipment which was designed and constructed by the M&MTB.

Criterion B is likely to be satisfied at the State level.

CRITERION C

Potential to yield information that will contribute to an understanding of Victoria's cultural history.

STEP 1: A TEST FOR SATISFYING CRITERION C

The:

- visible physical fabric; &/or
- documentary evidence; &/or
- oral history,

relating to the place/object indicates a likelihood that the place/object contains *PHYSICAL EVIDENCE* of *historical interest* that is *NOT CURRENTLY VISIBLE OR UNDERSTOOD*.

Plus

From what we know of the place/object, the physical evidence is likely to be of an *INTEGRITY* and/or *CONDITION* that it *COULD YIELD INFORMATION* through detailed investigation.

Executive Director's Response

The rectification equipment installed at the Brunswick West Tramway Substation demonstrates DC rectification used to power trams. Most of the equipment including the mercury bulbs was made in the UK or USA. The materials, design and functioning of these items is well documented and readily available from early electrical engineering publications.

The automatic control equipment on the DC switchboard at the Brunswick West Tramway Substation was designed and constructed by the M&MTB engineers. An article was written on this equipment in 1933. The DC switchboard was assembled by the M&MTB engineers, but this was common practice on many electrical installations at the time. Therefore, while the place does contain physical evidence of historical interest, this evidence is well documented and understood, particularly by members of the electrical engineering community. The Brunswick West Tramway Substation does not contain physical evidence of historic interest that is not currently visible or understood.

Criterion C is not likely to be satisfied.

CRITERION D

Importance in demonstrating the principal characteristics of a class of cultural places and objects.

STEP 1: A TEST FOR SATISFYING CRITERION D

The place/object is one of a *CLASS* of places/objects that has a *clear ASSOCIATION* with an event, phase, period, process, function, movement, important person(s), custom or way of life in Victoria's history.

Plus

The *EVENT, PHASE, etc* is of *HISTORICAL IMPORTANCE*, having made a strong or influential contribution to Victoria.

Plus

The principal characteristics of the class are *EVIDENT* in the physical fabric of the place/object.

Executive Director's Response

The Brunswick West Tramway Substation has a clear association with the electrification of Melbourne's trams which is of historical importance to Victoria. It demonstrates the principal characteristics of the class of pre-war, mercury arc, tram substations including mercury arc rectification equipment, small scale, architectural aesthetics and proximity to tram lines.

Criterion D is likely to be satisfied.

STEP 2: STATE LEVEL SIGNIFICANCE TEST CRITERION D

The place/object is a *NOTABLE EXAMPLE* of the class in Victoria (refer to Reference Tool D).

Executive Director's Response

The Brunswick West Tramway Substation is a notable example of the class of small tram substations in Victoria. While there are many similar buildings throughout Melbourne, the Brunswick West Tramway Substation is a highly intact example of the class due to the retention of all its original equipment that is still in its original location and still connected. This allows for the former function and use of the place to be fully understood. The intactness of the place also elevates it above similar small substations most of which are generally small in scale, architecturally pleasing and close to tram lines but are no longer intact.

Criterion D is likely to be satisfied at the State level.

CRITERION E

Importance in exhibiting particular aesthetic characteristics.

STEP 1: A TEST FOR SATISFYING CRITERION E

The *PHYSICAL FABRIC* of the place/object clearly exhibits particular aesthetic characteristics.

Executive Director's Response

The Brunswick West Tramway Substation building has a distinctive and well resolved Moderne architectural design which incorporates the prominent display of a large, streamlined transformer at the large front opening. Other tram substations constructed at the same time and earlier are also well-designed buildings with aesthetic values due to their architecture, however none include equipment as part of the building's design.

The operation of mercury arc rectifiers exhibits aesthetic characteristics because during operation the large glass bulbs fill with a bright and unearthly violet glow created by vaporising mercury. Although creating an aesthetic effect, this was not the intention of the inventor of the bulbs. While the

substation has been decommissioned it is possible to operate the mercury bulbs and create the aesthetic effect without generating any power.

Criterion E is likely to be satisfied.

STEP 2: STATE LEVEL SIGNIFICANCE TEST FOR CRITERION E

The aesthetic characteristics are *APPRECIATED OR VALUED* by the wider community or an appropriately-related discipline as evidenced, for example, by:

- *critical recognition* of the aesthetic characteristics of the place/object within a relevant art, design, architectural or related discipline as an outstanding example within Victoria; or
- wide public *acknowledgement of exceptional merit* in Victoria in medium such as songs, poetry, literature, painting, sculpture, publications, print media etc.

Executive Director's Response

The aesthetic characteristics of the Brunswick West Tramway Substation building, and its elegant transformer are appreciated by the tram enthusiast and electrical engineering communities, and heritage conservation professionals have noted the refined Moderne design of the building. But there has been no critical recognition or wide public acknowledgement of those characteristics.

Operating mercury arc rectifiers in general have featured in a Frankenstein film (*The Evil of Frankenstein*, 1964) and an early episode of Dr Who. Images of operating mercury arc rectifiers at the Russell Place Electrical Substation have been shared on social media. However, none of these have led to wide public acknowledgement of the exceptional aesthetic merit or critical recognition of operating mercury arc rectifiers in Victoria.

Criterion E is not likely to be satisfied at the State level.

CRITERION F

Importance in demonstrating a high degree of creative or technical achievement at a particular period.

STEP 1: A TEST FOR SATISFYING CRITERION F

The place/object contains *PHYSICAL EVIDENCE* that clearly demonstrates creative or technical *ACHIEVEMENT* for the time in which it was created.

Plus

The physical evidence demonstrates a *HIGH DEGREE OF INTEGRITY*.

Executive Director's Response

The Brunswick West Tramway Substation was one of the first mercury arc substations in Victoria. However, the adoption of mercury arc technology by the M&MTB mirrored the adoption of the technology by the railways and in the electrical transmission industry and was not a unique technical achievement.

The M&MTB designed automatic control equipment installed on the DC switchboard at the Brunswick West Tramway Substation is intact and demonstrates some creative or technical achievement but this is not of a high degree.

It was common for switchboards to be assembled from a number of components, some purchased and some fabricated. Therefore, the M&MTB's assembly of the DC switchboard was not an especially creative or technical achievement for the time in which it was created but used existing knowledge and technology.

Criterion F is not likely to be satisfied.

CRITERION G

Strong or special association with a particular present-day community or cultural group for social, cultural or spiritual reasons.

STEP 1: A BASIC TEST FOR SATISFYING CRITERION G

Evidence exists of a community or cultural group.
(A community or cultural group is a group of people who share a common interest, including an experience, purpose, belief system, culture, ethnicity or values.)

Plus

Evidence exists of a strong attachment between the COMMUNITY OR CULTURAL GROUP and the place/object in the present-day context.

Plus

Evidence exists of a time depth to that attachment.

Executive Director's Response

The community groups who share an interest in the Brunswick West Tramway Substation are the tram enthusiast and electrical engineering communities. Over many years, the tram enthusiast community have gathered historical material and undertaken research on this and other substations. The electrical engineering community have undertaken technical studies of the substation as well as studies of many other items of historic electrical infrastructure. They strongly support the retention of the substation because it is so intact. While these activities demonstrate attachment to the substation over time by both groups, they do not demonstrate a strong or special attachment to the Brunswick West Tramway Substation over other substations and other items of historic tram or electrical infrastructure.

Criterion G is not likely to be satisfied.

CRITERION H

Special association with the life or works of a person, or group of persons, of importance in Victoria's history.

STEP 1: A TEST FOR SATISFYING CRITERION H

The place/object has a *DIRECT ASSOCIATION* with a person or group of persons who have made a strong or influential *CONTRIBUTION* to the course of Victoria's history.

Plus

The *ASSOCIATION* of the place/object to the person(s) *IS EVIDENT* in the physical fabric of the place/object and/or in documentary resources and/or oral history.

Plus

The *ASSOCIATION*:

- directly relates to *ACHIEVEMENTS* of the person(s) at, or relating to, the place/object; or
- relates to an *enduring* and/or *close INTERACTION* between the person(s) and the place/object.

Executive Director's Response

The Brunswick West Tramway Substation has a direct association with M&MTB engineers who designed the automatic control equipment, assembled the DC Switch Board and installed all the equipment in the substation. This association is evident in the continuing presence of the equipment as well as in documentary resources and oral history. While the substation was operational (1936 – 2018) engineers from M&MTB and Yarra Trams installed, repaired and maintained the equipment at

the substation demonstrating an enduring interaction between tramway engineers and the place. Retired tramway engineers often join the tram enthusiast community who maintain an interest in the substation.

The role of M&MTB engineers is not well known to the wider community. While Tramway engineers have made an important contribution to the operation of trams in Melbourne, this is not considered to be an influential contribution to the course of Victoria's history.

Criterion H is not likely to be satisfied.

PROPOSED PERMIT POLICY

Preamble

The purpose of the Permit Policy is to assist when considering or making decisions regarding works to a registered place. It is recommended that any proposed works be discussed with an officer of Heritage Victoria prior to making a permit application. Discussing proposed works will assist in answering questions the owner may have and aid any decisions regarding works to the place.

The extent of registration of Brunswick West Tramway Substation in the VHR affects the whole place shown on Diagram 2397 including the land, all buildings (exteriors and interiors) and other features.

Under the *Heritage Act 2017* a person must not remove or demolish, damage or despoil, develop or alter or excavate, relocate or disturb the position of any part of a registered place or object without approval. It is acknowledged, however, that alterations and other works may be required to keep places and objects in good repair and adapt them for use into the future.

If a person wishes to undertake works or activities in relation to a registered place or registered object, they must apply to the Executive Director, Heritage Victoria for a permit. The purpose of a permit is to enable appropriate change to a place and to effectively manage adverse impacts on the cultural heritage significance of a place as a consequence of change. If an owner is uncertain whether a heritage permit is required, it is recommended that Heritage Victoria be contacted.

Permits are required for anything which alters the place or object, unless a **permit exemption** is granted. Permit exemptions usually cover routine maintenance and upkeep issues faced by owners as well as minor works or works to the elements of the place or object that are not significant. They may include appropriate works that are specified in a conservation management plan. Permit exemptions can be granted at the time of registration (under s.38 of the Heritage Act) or after registration (under s.92 of the Heritage Act). It should be noted that the addition of new buildings to the registered place, as well as alterations to the interior and exterior of existing buildings requires a permit, unless a specific permit exemption is granted.

Conservation management plan

It is recommended that a Conservation Management Plan is developed to manage the place in a manner which respects its cultural heritage significance.

Aboriginal cultural heritage

If any Aboriginal cultural heritage is discovered or exposed at any time it is necessary to immediately contact Aboriginal Victoria to ascertain requirements under the Aboriginal Heritage Act 2006.

Other approvals

Please be aware that approval from other authorities (such as local government) may be required to undertake works.

Archaeology

Any works that may affect historical archaeological features, deposits or artefacts at the place is likely to require a permit, permit exemption or consent. Advice should be sought from the Archaeology Team at Heritage Victoria.

Operation

The substation was in operation until early 2019 but it has now been decommissioned and replaced by a solid-state rectifier installation at another location. Because the mercury rectifier bulbs and their matching transformer as well as all the interconnecting cabling are still present, it would be possible to operate the mercury bulbs to demonstrate the operation of the equipment without outputting DC power to the tramway.

Objects integral to the place

All of the fixed and movable objects and interconnecting cables are integral to the significance of the place and should be retained at the place in their original positions so as to preserve the original operating environment of the place. Any external or internal alterations are subject to permit application.

Hazardous materials

It is recognised that some of the objects integral to the place contain hazardous materials and/or are hazardous in operation. These properties are important characteristics of these objects and should be retained. Procedures should be developed to minimise risk to anyone visiting the substation. Any external or internal alterations are subject to permit application.

- Standard personal protective measures around high voltage/ high amperage equipment should be followed.
- Each of the mercury arc bulbs holds several litres of mercury, but this is contained within the sealed glass bulbs. The mercury vapour generated during operation cannot escape. These items only become dangerous if the glass is broken. Accordingly, all access to and works in the place must be designed to reduce the risks of breakage.
- When the mercury inside the Mercury arc bulbs vaporises during operation, a small amount of ultraviolet light is emitted. Viewers may need to wear eye protection.
- Asbestos is found in the substation as panels and the corrugated Fibrolite (fibre asbestos cement sheet) roof.
- Asbestos is found in equipment as panels and on the arc chutes on some of the circuit breakers.

Security

The building should be secured to prevent access by vandals. Graffiti is also likely now that the substation is no longer being used.

Landscape

The lack of plantings appears to be a deliberate land management strategy and should be continued. Small areas of grass and weeds are visible which are likely accidental growth rather than deliberate plantings.

Cultural heritage significance

Overview of significance

The cultural heritage significance of the Brunswick West Tramway Substation lies in all of the registered building and all of the fixed and movable objects including the building with its external Moderne design, brickwork, the prominent display of the transformer at the front entrance and all of the fixed and movable objects comprising the mercury arc rectification system and associated items still connected and in their original locations.

EXECUTIVE DIRECTOR RECOMMENDATIONS FOR EXEMPTED WORKS OR ACTIVITIES (PERMIT EXEMPTIONS)

It should be noted that Permit Exemptions can be granted at the time of registration (under s.49(3) of the Heritage Act). Permit Exemptions can also be applied for and granted after registration (under s.92 of the Heritage Act).

General Condition 1

All exempted alterations are to be planned and carried out in a manner which prevents damage to the fabric of the registered place or object.

General Condition 2

Should it become apparent during further inspection or the carrying out of works that original or previously hidden or inaccessible details of the place or object are revealed which relate to the significance of the place or object, then the exemption covering such works shall cease and Heritage Victoria shall be notified as soon as possible.

General Condition 3

All works should ideally be informed by Conservation Management Plans prepared for the place. The Executive Director is not bound by any Conservation Management Plan and permits still must be obtained for works suggested in any Conservation Management Plan.

General Condition 4

Nothing in this determination prevents the Heritage Council from amending or rescinding all or any of the permit exemptions.

General Condition 5

Nothing in this determination exempts owners or their agents from the responsibility to seek relevant planning or building permits from the relevant responsible authority, where applicable.

Specific Permit Exemptions

The following works do not require a permit provided that they are carried out in a manner which does not harm the cultural heritage significance of the place.

Maintenance

- Minor patching, repair and maintenance of the building which replaces like with like. Repairs must maximise protection and retention of significant fabric and include the conservation of existing details or elements. Any new materials used for repair must not exacerbate the decay of significant fabric due to chemical incompatibility, obscure significant fabric or limit access to significant fabric for future maintenance.

- Maintenance, replacement and installation of existing fire services where this does not impact on significant fabric.

Safety and Security

- The erection of temporary security fencing, scaffolding, hoardings or surveillance systems not attached to the building or equipment to prevent unauthorised access or secure public safety.
- Emergency stabilisation necessary to secure safety where a site feature has been irreparably damaged or destabilised and represents a safety risk to its users or the public. All works are to be reported to the Executive Director within 21 days of completion of the works.

Landscape

- Mowing and weed control.

RELEVANT INFORMATION

Local Government Authority	City of Moreland
Heritage Overlay	HO 64
Heritage Overlay Controls	External Paint: Yes Internal Alteration: No Tree: No
Other Overlays	None
Victorian Aboriginal Heritage Register	No
Other Listings	None
Other Names	M&MTB Substation West Brunswick Substation Substation W

Comments

It was possible to see the resistance coils inside the small room with the roller door on the north east side of the building, but it was not possible to get access to this room. The doors of brick cells Y and Z were locked, and it was not possible to view this equipment.

HISTORY

Electrification of Melbourne's Tramway

Between 1885 and 1891 the Melbourne Tramway Trust (MTT), comprising eleven municipalities, constructed the world's largest united cable tramway system, which was leased to the Melbourne Tramway and Omnibus Company (MT&OC) for operation until 1916. The MTT also constructed two horse Tramway in conjunction with its cable lines, three other horse lines were constructed by private companies, and the MT&OC built its own horse tramway through Royal Park. A privately constructed cable tramway was operated through Northcote. During the world-wide era of experimentation with electric traction for Tramway in the 1880s a pioneer electric line operated between Box Hill and Doncaster from 1889 until 1896.

During 1906 the Victorian Railways opened an *Electric Street Railway* from St Kilda to Brighton, and an English company built electric Tramway through Essendon and Flemington in conjunction with its lighting and power operations. Local councils immediately saw the advantages of electric Tramway and five municipal Tramway trusts (Pahran & Malvern Tramway Trust, Hawthorn Tramway Trust, Melbourne Brunswick & Coburg Tramway Trust, Fitzroy Northcote and Preston Tramway Trust and the Footscray Tramway Trust) constructed them over the following decade.

A Royal Commission in 1910-11 recommended that the cable Tramway be converted for electric operation, and in 1916 an interim Tramway Board was established to operate the cable tramway system and the Royal Park horse tramway pending establishment of a body to integrate and operate the majority of Melbourne's Tramway. The advantages of electric Tramway were considered to be lower capital costs, greater speed and flexibility, adaptability to extension and simplification of terminal shunting. In 1919 the Melbourne and Metropolitan Tramway Board (M&MTB) was established to carry out this enormous task and took over all existing Tramway except for two electric lines operated by the Victorian Railways.

In 1923 the M&MTB formulated a comprehensive plan (*The General Scheme*) for integration and development of the system as a whole, with considerable extension of the electric lines and gradual conversion of most of the cable lines. Twenty new electric lines were opened during the 1920s and between 1925 and 1940 the cable Tramway were replaced with new electric lines or bus services. Many new tram depots and substations were required. Hundreds of new large electric trams were constructed to replace the fleets of smaller cars operated by the municipal tramway trusts.

Substations

Electricity to power Melbourne's tram lines was supplied from the public electricity supply. In Victoria both AC and DC electric power systems were used. [Electric current can be Direct Current (DC) or Alternating Current (AC). DC is the flow of electric charge in only one direction while AC reverses its direction at regular intervals.] In 1932 the State Electricity Commission of Victoria (SECV) decided to gradually phase out the DC system in favour of AC. This was because DC transmission lost a lot of power over long distances, and DC could not be easily stepped down to safe voltages for domestic and commercial use.

However, DC motors were well-suited to use on trams as they were compact and light and could easily be incorporated into the restricted space on the trams. Therefore, the M&MTB needed to convert (or rectify) the mains AC power to DC traction power to supply trams. Substations were constructed to hold rectifier plant. DC voltage drops quickly with distance and tram performance therefore suffers if the tram is much more than four kilometres from the power source. This meant that substations had to be constructed approximately every four kilometres along a tram route.

M&MTB substations were denoted by letters which related to their suburb, for example the West Brunswick Tramway Substation is known as 'W'. Some substations were co-located within tram depots, and others were free standing buildings. By 1933 there were nineteen substations. In order to reduce labour costs, the M&MTB constructed remote supervisory equipment of its own design for its substations. Fifteen of its nineteen substations were fully automatic unattended stations. The main central control room was in Queensberry Street at Carlton. By 2013 there were fifty-five substations, with more planned. Since the 1960s new substations have been constructed behind or near some earlier substations. In other cases, new equipment has been installed in existing substations (for example Carlton Tram Substation VHR H2325). Superseded equipment was usually removed and destroyed as part of the decommissioning process.

Rectification equipment

Substations constructed before 1930 contained rotary converters (which used electro-mechanical means to convert AC to DC). These early substations were specifically designed to house the massive rotary converters. The last new rotary converter in Melbourne was installed at South Melbourne in 1931 and many were still in use in the 1970s.

Mercury-arc rectifiers were invented by Peter Cooper Hewitt in the USA in 1902. Hewitt's company in the UK was *Westinghouse Cooper-Hewitt* (later the *Hewitt Electric Company*). By the mid-1920s reliable industrial mercury-arc rectifiers were available from several makers including the Hewitt Electric Company which made the glass bulbs in the Brunswick West Tramway substation. This

equipment was smaller than the rotary converter plant of similar capacity. A 'matching' rectifier transformer was needed for each rectifier bank. Hewittic mercury bulbs were always matched with transformers made by the UK based Hackbridge Electric Construction Co.

In Victoria from 1930, mercury-arc rectifiers started to supplant rotary converters because they were smaller and offered higher conversion efficiency. The mercury arc technology wasn't suited to locations with high power demands, such as the Malvern Tram Depot (VHR H0910) but was adequate for locations (and cheaper to run) at the outer ends of a line, like West Brunswick. As essentially 'static plant', maintenance was also minimal. The first example of Mercury Arc technology was installed at the North Fitzroy Electric Train Substation (VHR H0939) in 1930. By 1935 the capacity limit for a single glass-bulb mercury arc bulb was 150 V DC, however higher capacities could be achieved by operating two or more bulbs in parallel, as in many M&MTB substations, where up to four bulbs were typically used to create a 600 V rectifier system.

From the 1960s the tram system slowly started to progress to solid state silicon diode rectifiers. In 1975 out of a total of twenty-six operating tram substations in Melbourne there were ten rotary converter substations, thirteen mercury arc substations (one of which was mobile) and one combination rotary converter and mercury arc substation. In addition, there were two silicon rectifier substations in operation. At that time the M&MTB planned to replace the remaining rotary converter systems with silicon rectifier systems. Silicon rectifier systems are still used today, together with electronics to control switching.

West Coburg Tramway

The West Coburg Progress Association had lobbied strongly for the building of a tramline. The Melville Road route which now forms an important north-south transport link through the western side of Brunswick did not exist until the early 1920s. The eventual construction of the tramline contributed to the development of much of the western side of Brunswick and Coburg. Major estates in the area developed all through the 1920s with the new electric tramway promoted as a feature.

The West Coburg Tram Line was initially built as a branch line to a new electric line constructed to enable the existing Essendon electric system at Flemington Bridge to enter the city via Flemington Road, Peel and William Streets as far south as Collins Street. It was constructed in four stages. The initial section of the West Coburg line, which was known as the East Brunswick Tram Line opened on 19 July 1925, left Flemington Road at Abbotsford Street and traversed Royal Park, Grantham and Dawson Streets to Daly Street, Brunswick. An additional section via Melville Road to Albion Street opened on 10 October 1925. On 15 May 1927 the line was extended along Melville Road to Moreland Road, and on 26 June 1927 it was further extended to Bell Street, Coburg (now Ascot Vale South). The West Coburg Tramway was numbered route 55 or route 56 (on weekends) from 1934 until 2017 when route 55 was amalgamated with route 8 Toorak to become route 58.

The Brunswick West Tramway Substation was constructed in 1935 to serve the West Coburg Tram Line. The sources of DC power for the trams on the West Coburg line in the period between the opening of the line in 1925-7 and the installation of rectification equipment in the West Brunswick substation in 1936 are most likely to have been two substations on Sydney Road (where cable trams were still operating). These substations were located at the Former Cable Tram Engine House and Tram Substation (VHR H2332) and the Brunswick Tram Depot (H0171). On the West Coburg tram route at Grantham and Reynard Streets, approximately aligned to these substations, are two old M&MTB steel poles with remnant DC feeder cables which may have delivered the power to the West Coburg trams.

Brunswick West Tramway Substation

The M&MTB's 1934 Annual Report records the decision to convert the Sydney Road cable tramway to electric traction. The Annual Report for 1935 records that a new Brunswick West substation was being

built. It is possible that the new Brunswick West substation was needed both to provide power further along the West Brunswick route and to simultaneously free up the DC output of the substations at the former Cable Tram Engine House & Tram Substation (VHR H2332) and the Brunswick Tramway Depot (HO171) to supply the newly converted Sydney Road tram route. The other reason for the construction of the new Brunswick West Substation was probably in response to rising patronage which led to the need for larger and more frequent trams. Larger trams require more DC power. The location of the new substation at the intersection of Dawson St and Melville Rd, further out on the Brunswick West route would also have improved voltage distribution along the route.

The land for the substation was donated by Hoffman's Brickworks. The sharp turn from Dawson St into Melville Road was changed to a smooth curve which enabled higher speeds and less wear on the tram wheels and rails. Some other streets in the area were also altered. The re-alignment of Melville Road also created a small triangular plot of land which was used for the construction of the Brunswick West substation. The name of the architect of the substation is not known but would have been one of the M&MTB architects.

The prominent location of the large, air-cooled transformer in the large central opening has been suggested as demonstrating the Futurist architecture style. However, the remainder of the building is more conventional, and the prominent position of the transformer may instead have been a reflection of the M&MTB's pride and confidence in technology. There were also practical reasons, the transformer is air cooled and needs to be exposed to the exterior air. Transformers in other substations were sometimes located outside or on breezeways for the same reason.

The new Brunswick West substation building was completed at the end of 1935 and the mercury arc equipment was commissioned in 1936. From 1938-39 M&MTB designed supervisory equipment also known as 'Remote Terminal Equipment' was built at the Preston Tramway Workshops (VHR H2031) and installed in West Brunswick. The mercury arc bulbs assemblies, transformer and most individual switchgear items were made overseas and installation of all the mercury arc equipment and on-site assembly and construction of the 600 V DC switchboard was carried out by the MMTB.

Operation of the substation

High voltage electricity to power the substation was supplied at 6.6 kilovolts (kV) AC from the power pole at the corner of Dawson and Moule Streets, about 100 metres from the substation. A cable travels down the pole then underground to the substation.

Three phase bus bars transport the AC power into the substation at three brick cells containing 6.6kV AC switchgear. The cells are numbered X, Y and Z. Cells X and Z contain circuit breakers which protected the main transformer from overcurrent situations and short circuits. Cell X contains a small transformer to step down the 6.6 kV (66000 V) mains power to standard 240 V for the non-rectification equipment in the substation.

The main transformer stepped down the AC voltage from the public electricity supply to positive AC voltage that was suitable for the mercury arc rectifiers. It also operated the ignition circuits that kept the mercury bulbs operating as well performing as other tasks. The choke inductor smoothed and passed negative AC power.

The AC currents passed to a mercury-arc rectifier bank consisting of four glass bulbs. Operation of each rectifier relied on an electrical arc discharge in a sealed glass bulb containing a pool of liquid mercury. During operation the mercury is vaporised emitting characteristic blue-violet light.

The positive DC current passes to a 600V DC switchboard which contains circuit breakers and control gear and then out of the building through insulated holes (bushes) to the tram overhead lines. The DC current passed down the tram pole to the DC tram engine then into the rails completing the electrical

circuit. The power then returned to the substation via underground cables to a negative high-speed circuit breaker.

The resistance coils only operated in emergencies to stop dangerous currents.

CONSTRUCTION DETAILS:

Architect name:	Unknown M&MTB architect
Architectural style name:	Moderne
Builder name:	Unknown
Construction started date:	1935
Construction ended date:	1936

VICTORIAN HISTORICAL THEMES

03 Connecting Victorians by transport and communications

3.5 Travelling by tram

06 Building towns, cities and the garden state

6.3 Shaping the suburbs

PHYSICAL DESCRIPTION

Building

The Brunswick West Tramway Substation at 196A Dawson Street, Brunswick West faces the 'Y' junction where the number 58 tram line running west along Dawson Street turns northwards into Melville Road. The substation sits diagonally on its triangular block of land facing south east.

The building is a small, square red brick industrial structure with refined Moderne detailing. It is made of face red brick in English bond pattern. There is a large central opening on the south east side, double timber doors on the north east side, wire covered windows on all sides except the south west and a small roller door on the north west side. The large central opening is surrounded by tapestry pattern brickwork and covered by a wire gate with the main air-cooled transformer prominently located behind it. The roof is made of corrugated asbestos cement sheet (ACS).

The south east facade to the Dawson Street/Melville Road intersection has a protruding central section and a stepped parapet, unpainted rendered coping and a centrally placed brick Moderne motif. Beneath this is a trio of small, square cream brick bosses. There is also a centrally placed brick Moderne motif above the roller door and brick streamlining at the uppermost corners on all four sides. The rain heads are a tapered rectangular shape with square form down pipes. Rainwater goods and the timber and roller doors are painted in a terracotta colour.

The three room building contains all the equipment needed to convert AC (Alternating Current) power to DC (Direct Current) power for trams. This includes three phase bus bars to bring AC power into the substation, 6.6kV AC switchgear, a mercury-arc rectifier bank consisting of four glass bulbs and its matching transformer, 600V DC switchboards, circuit breakers, control gear and interconnecting cables.

High on the exterior of the north west side there are four ceramic bushes (insulated rings that allow an electrical conductor to pass safely through) with glass disc insulator units above them. Remnants of DC cables are still present in these bushes.

Objects integral

The substation was still fully functional in early 2019. Since then it has been switched off but not decommissioned. The equipment and its functions are documented at Attachment 1.

Interiors

The interior walls of the main room are unpainted concrete render. The interior timber window and door architraves are painted white or dark grey. The steel stair rails are painted mid green. Some doors are varnished plywood. The interior of the separate room where the transformer is located is unpainted brick. The interiors of the brick cells holding the switch gear are painted white and the exterior of the brick cells is unpainted cement render. There are no ceiling linings and the steel roof beams and unpainted ACS roof are visible from the interior.

Landscape

There are no designed plantings at the place and it appears that the triangular piece of land has been left deliberately bare for functional reasons. There is a tree stump on the north east side.

The triangular block of land is surrounded by a high wire fence with a gate on the north east side. There is a concrete apron in front of the main opening which would have been used if it was necessary to remove the transformer for maintenance. There is a concrete path leading to the roller door from the gate on the north east side.

Archaeology

There is no identified archaeology of State level significance at this place. There may be buried cables on the south west side which carried AC power from the public electricity supply into the substation and on the north east side which carried DC power from the tram rails back into the substation.

INTEGRITY/INTACTNESS

Intactness – The intactness of the Brunswick West Tramway Substation is excellent. The building and the internal electrical plant and equipment appear essentially unaltered from their original 1936 installation. (November 2019)

Integrity – The integrity of the Brunswick West Tramway Substation is excellent. The cultural heritage values of the place can be easily understood because the substation contains all the original equipment which allowed it to function as a substation and supply DC power to the trams running on the West Coburg line. It demonstrates the rectification of DC power during the mercury-arc period from the 1930s until the technology was progressively superseded by solid state electronic rectifiers from the 1960s. A few modern items have been installed such as light switches, a phone, electrical conduit, safety notices and a modern combined sealed battery and automatic charger assembly. These do not affect the integrity of the place. (November 2019)

CONDITION

The equipment is in good condition with only a light layer of dust visible on the upper surfaces of most items. The iron bases of the rectifier bulbs are somewhat corroded.

The building is in good to fair condition. There is considerable evidence of water entry to the interior walls with salt damage visible on the interior render in many areas, but it is not clear where this is coming from because the brickwork appears to be in fair to good condition with only small areas of mortar loss. It was not possible to examine the roof. The paint is peeling from the external painted rain-water goods with some corrosion visible. Some spray-painted tags are visible on the exterior. (November 2019)

COMPARISONS

Architecture of tram substations in the VHR

Following the formation of the M&MTB in the 1920s, impressive brick substations were constructed in the inner suburbs as part of the electrification and expansion of the tram system. All were large buildings designed to house massive rotary converters and required deep footings to prevent damage to the building fabric. They also had large doorways and high roofs, to permit easy handling of the electrical plant, and probably also to reduce overheating as the rotary converters produced a great deal of heat, as well as large high windows to provide natural light. Much of the significance of these substations is architectural and all are tall red brick Inter-war Stripped Classical style buildings which were designed by Alan Monsborough the M&MTB chief architect. Examples include the former Ascot Vale Tram Substation (VHR H2323) and the Carlton Tram Substation (VHR H2325), both constructed in 1925.



Ascot Vale Tram Substation



Carlton Tram Substation

Name: Brunswick West Tramway Substation
Hermes Number: 201776

Maribyrnong Tram Substation, Maribyrnong (VHR H2321)

This substation constructed in 1942 is significant as rare example of the use of war-time camouflage and for its role in providing transport for workers at the munitions and explosives factories in the Maribyrnong area during World War II.



Maribyrnong Tram Substation

1930s M&MTB buildings

M&MTB Headquarters Building, 616-622 Little Collins Street, Melbourne (HO1280)

This building was constructed in 1938 and was the last building designed by M&MTB architect Alan Monsborough. It is an intact and striking example of a large public utility building which combines elements of Moderne, stripped classical and art deco architecture. Features include a squared entry framed by brown marble faux Doric columns which sits below a cornice with the words "Melbourne Metropolitan Tramway Board" in a gilded font; vertical bands of piers inset with regular window and spandrel panels to the front facade, a setback roof profile with flagpole spire, brass entry doors and decorative metal panel gates. Notable features include a high standard design of cement rendered surfaces (now painted), and polished red granite stone facing to the entrance.



Former M&MTB Building, 616 Little Collins St, Melbourne

Malvern Tram Depot, Armadale (VHR H0910)

Following the 1920 takeover of the existing tram lines by the M&MTB, they undertook a major expansion and modernisation program at the Coldblo Road depot. In 1929 a new red brick, nine-track car shed was built on the north side of Coldblo Road. This type of wide clear-span structure, without interior columns, was a radical departure from earlier depot designs. The building is constructed of red bricks in a Moderne style with cream bosses.



Car shed, Malvern Tram Depot

DC traction substations containing rotary converter equipment

Malvern Tram Depot, Armadale (VHR H0910)

The c1929 substation at the rear of the 1909 Malvern Tram Depot, 1909 (VHR H0910) retains all its original rotary converters and all associated AC and DC electrical equipment in the same positions and still connected as it was when the substation was retired in the 1990s.



1929 Rotary converter rectification equipment at Malvern Tram Depot

Former Cable Tram Engine House & Tram Substation, Brunswick (VHR H2332)

The substation was constructed in 1929 in the back half of the original 1909 building. It contains two transformers, and a rotary converter formerly used at the site, but these are not installed or connected.



Transformer and rotary converter (not in original locations) at the former Cable Tram Engine House & Tram Substation, Brunswick

DC traction substations containing Mercury Arc equipment

In 2013, three substations besides Brunswick West contained remnant mercury arc equipment.

Essendon substation, 8 Queen St, Essendon, (not in the VHR or HO)

This substation now only contains the metal cabinets that used to contain mercury arc rectifiers.



Essendon Tram Substation, empty rectifier cabinets and heavy deposit of bird droppings

Deepdene substation, 4 Kitchener St, Deepdene, (not in the VHR or HO)

This substation has an almost completely intact interior with attractive wall and floor tiling. It contains two glass bulb mercury-arc rectifier assemblies, each consisting of four units in steel cabinets, with all of the bulbs and ancillary internal equipment intact. One bank of four mercury arc rectifiers is made by the Hewittic Electric Co and the other by British Thomson-Houston (BTH). The respective 600 V DC open panel switchboards and most of the DC switchgear is also still intact, however, the externally located transformers are missing and there are only some remnants of the 6.6 kV AC switchgear.



Interior of Deepdene substation showing tiles and rectifier equipment

Maribyrnong Tram Substation, Maribyrnong (VHR H2321)

When registered in 2009, this substation contained a 600 kW, four-unit glass bulb mercury-arc rectifier assembly and associated equipment. It was not possible to gain access to the interior of this substation in 2019, but the very limited view showed that while the transformer is still present, all the interconnecting cabling had been removed. It is not known if the mercury arc glass bulbs still remain or not, but as vandals have entered the building it is possible that they have been broken.



Transformer at Maribyrnong Tram Substation with cut cables at the top and vandalised components below

SUMMARY OF COMPARISONS

Architecture of substations in the VHR

All the rotary converter substations in the VHR are similar in materials and form but varied in their floor plans, and the degree of rendering and decoration on the exterior. They are all substantial buildings in order to house large items of equipment. They are also architecturally imposing with their stripped classical designs. In contrast the Brunswick West Tramway Substation is also architecturally distinguished but is smaller in scale and not imposing. It is Moderne not classical in style. The 1942 Maribyrnong substation (VHR H2321) has different heritage values to the above substations and is not directly comparable architecturally. The Maribyrnong substation and the nominated 1936 substation in West Brunswick used mercury bulb rectifier technology and were smaller than the rotary converter substations above as a result.

1930s M&MTB buildings

Both the comparator buildings were constructed at the same time as the Brunswick West Tramway Substation and all have elements of the Moderne style. The 1929 car shed at the Malvern Tram Depot has additional similarities to the Brunswick West Tramway Substation with its red brick construction and cream bosses as decorative elements. This demonstrates how the design of M&MTB buildings mirrored popular architectural styles of the time when they were built.

DC traction substations containing rotary converter equipment

The Malvern and Brunswick buildings are the only two remaining tram substations which still contain rotary converter equipment making them rare examples of once common early technology.

DC traction substations containing Mercury Arc equipment

The Brunswick West Tramway Substation contains a full set of mercury arc rectification equipment which demonstrates this rectification technology. It is the only remaining mercury arc tram substation in Melbourne to retain a full set of its rectification equipment.

The whole purpose of a substation is to convert (rectify) AC electricity from the public electricity supply system to DC to run trams. With the exception of the remaining rotary converter equipment at the Malvern Tram Depot substation, the Brunswick West Tramway Substation Together, the Brunswick West Tramway Substation with its mercury arc rectification equipment, and the Malvern Tram Depot Substation with its rotary converter equipment, fully represent the two major historical technologies to produce DC power for trams.

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- Miles Pierce and Owen Peake, Electrical Engineers, Engineering Heritage Victoria
- Robert Green, retired Heritage Victoria staff member
- Craig Tooke, Principal Electrical Networks Specialist, Metrotrains
- Benjamin Greig, Team Manager, Power and Substations, Frank Denino, Manager, Power & Overhead and Paul Tracey, Yarra Trams

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ADDITIONAL IMAGES



Rear of substation (north west) showing the bushes (holes where the positive DC cables exit the building to the tramlines) and the small room with roller door which houses the emergency resistance coils. November 2019



Side elevation (south west) showing the timber door, tree still present. Source: Google Earth, 2015.



South east elevation, November 2019



Glass bulb mercury arc rectifier in operation at Brunswick West Tramway Substation, March 2019.
The eerie blue glow is vaporised mercury. Source: Nomination document.



Top of transformer showing interconnected cables still present



Ramp from transformer room up into main substation room showing green stair rails



Interior showing documents and back of DC Switchboard, November 2019



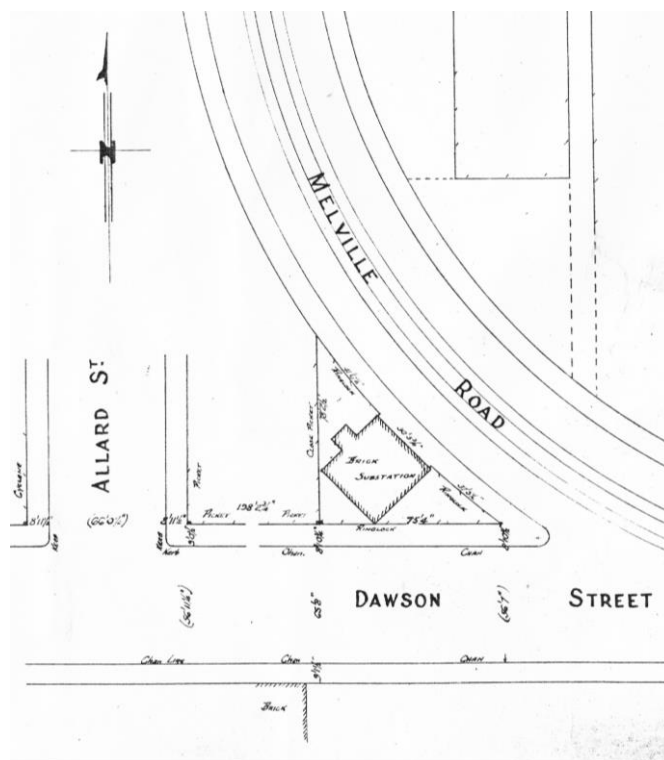
Interior showing salt efflorescence caused by damp, November 2019



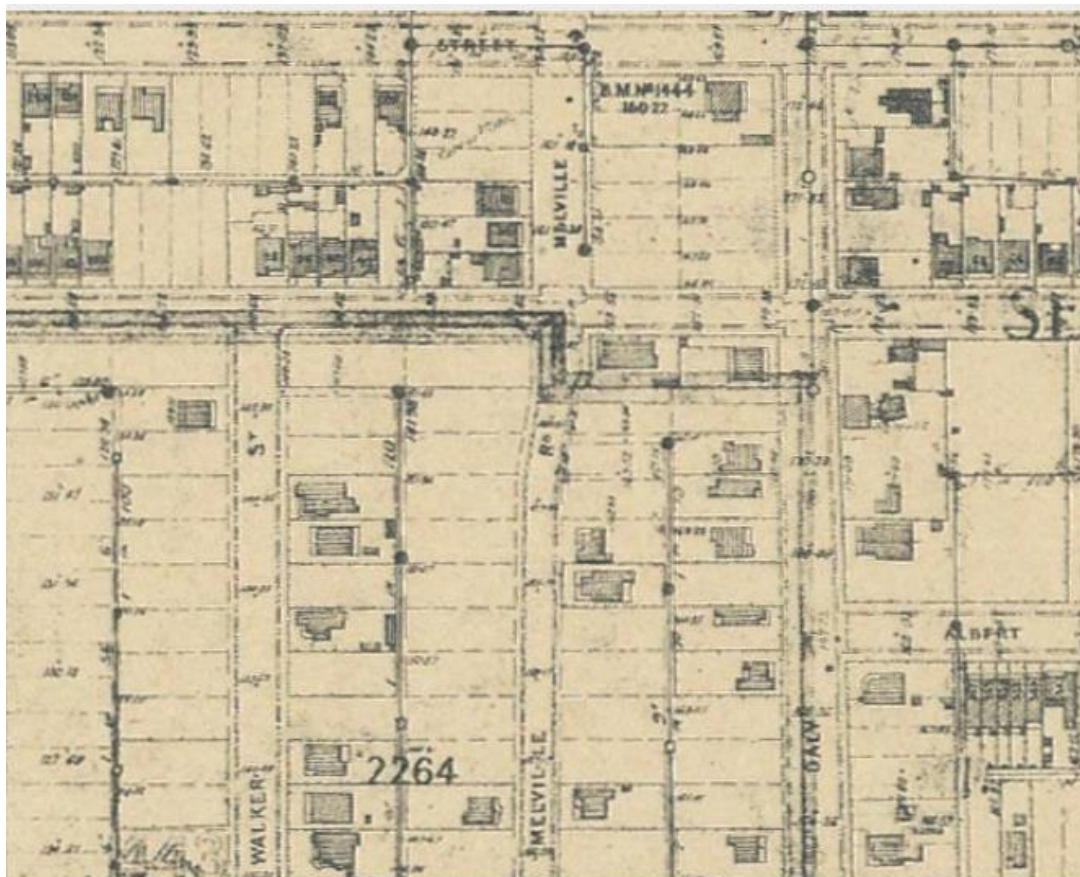
Interior fixtures showing both modern and historic items, November 2019



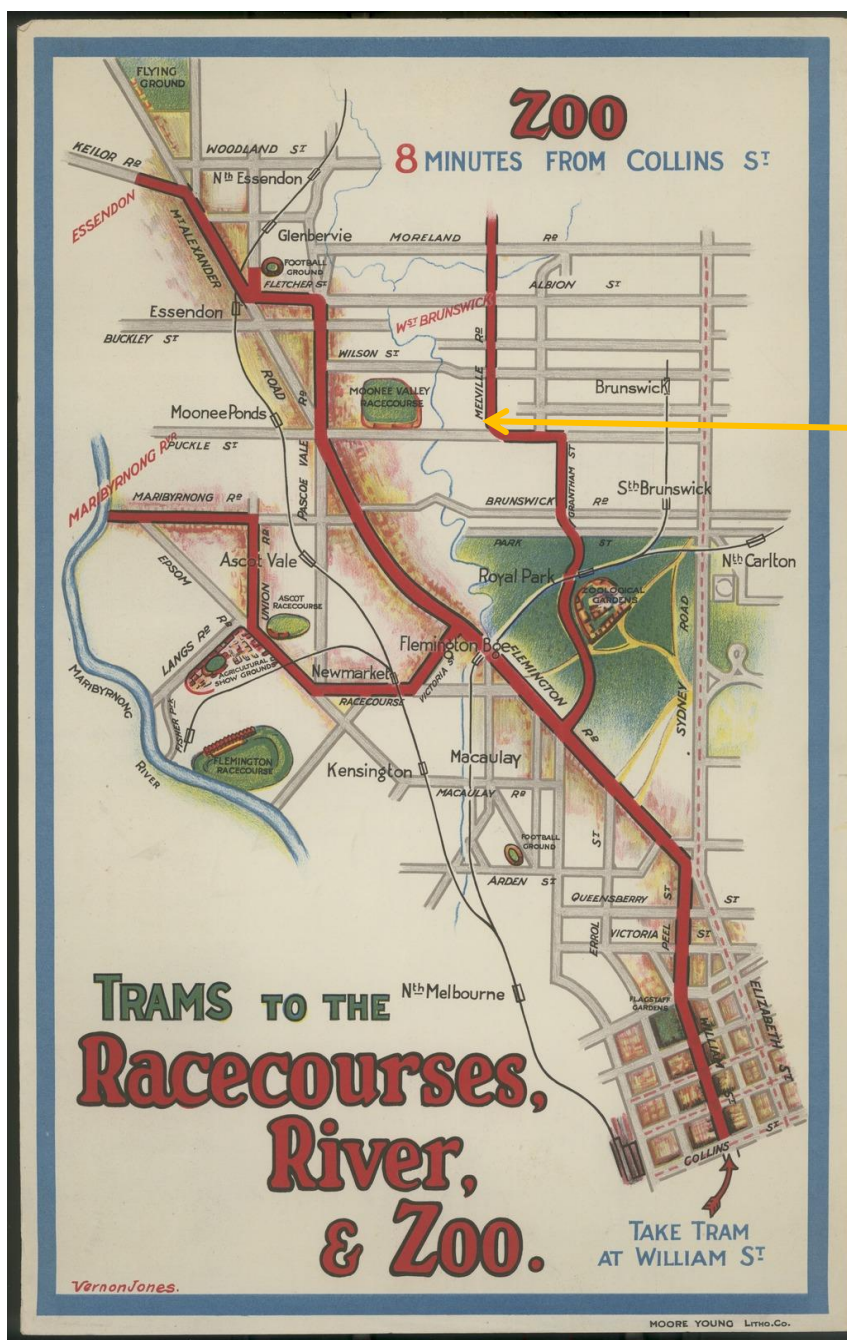
Roof interior, November 2019



Extract from M&MTB, Plan of Land P8390 (1936) showing position of substation on the street.
Source: Tram Museum



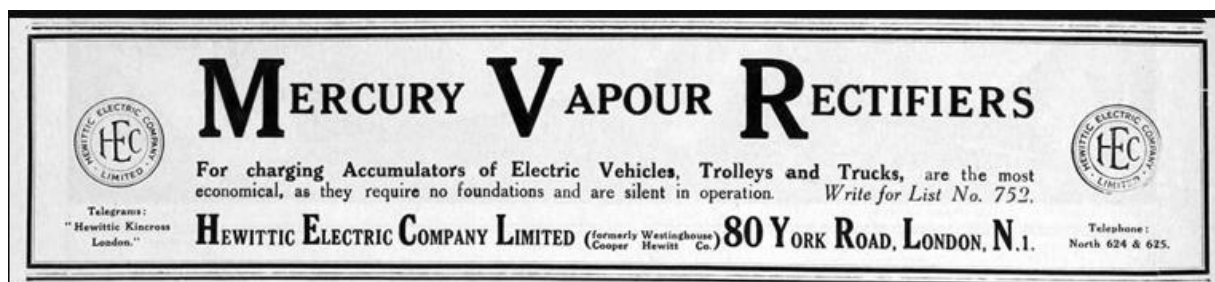
Extract from MMBW plan, no.97, Essendon & Brunswick. 1933, showing original alignment of Melville Road before construction of the Brunswick West Substation. Source: State Library of Victoria



Location of
Brunswick
West
Substation

Trams to the Racecourses, River, & Zoo ca. 1936 - ca. 1939, by Vernon Jones (1908-2002).

Source: State Library of Victoria <http://handle.slv.vic.gov.au/10381/214542>

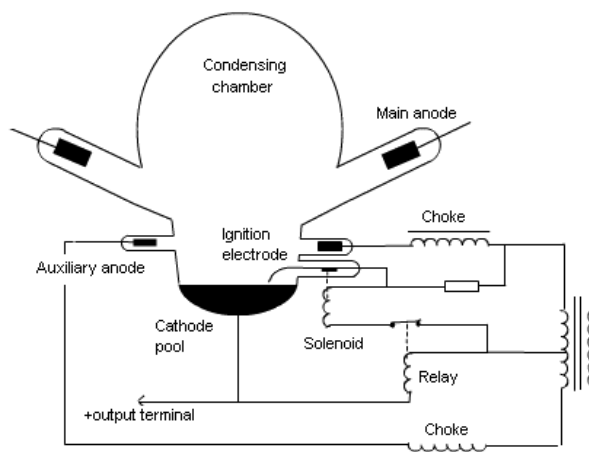


Advertisement for Mercury Vapour Rectifiers for Trams by the Hewittic Electric Company, 1921

Source: <https://www.gracesguide.co.uk/images/a/a1/Im1921EnV131-p632aad.jpg>

Name: Brunswick West Tramway Substation

Hermes Number: 201776



Simplified diagram of the components of a mercury arc rectifier, including the cathode pool of mercury at the base, undated. Source: Virtual Valve Museum, <https://www.valvecollector.uk/mercuryarc.htm>

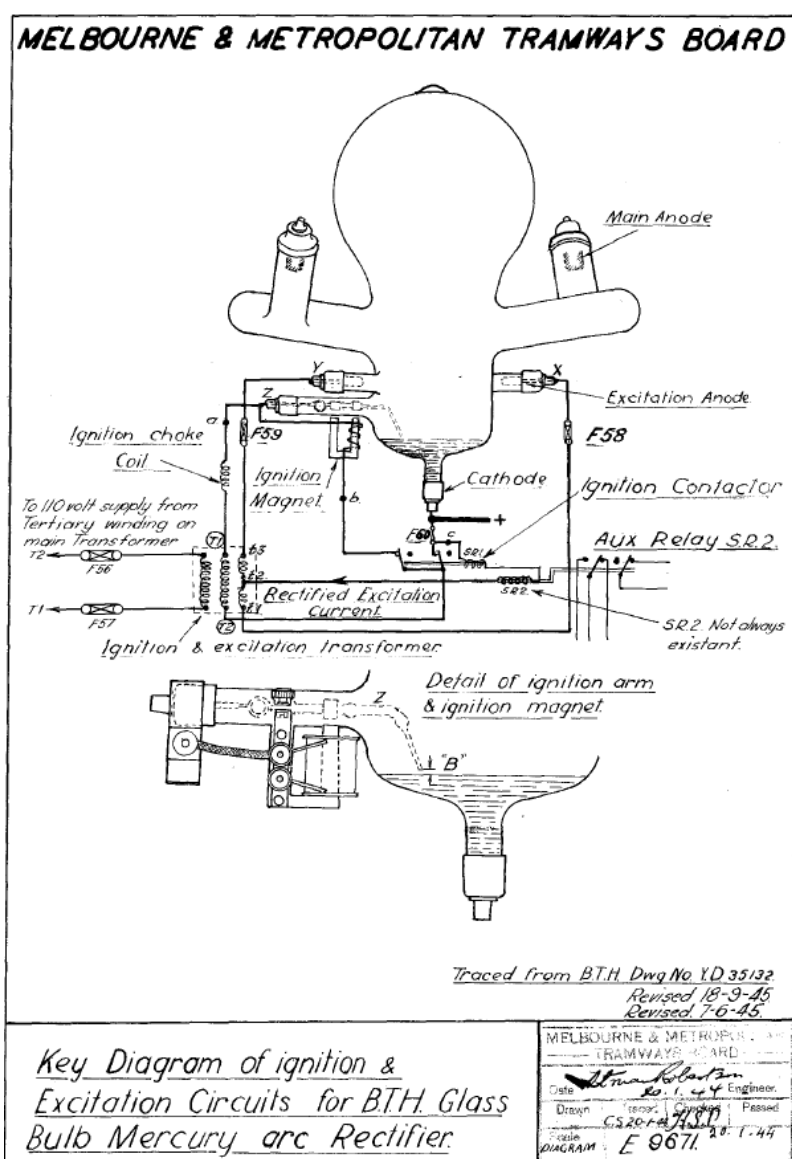
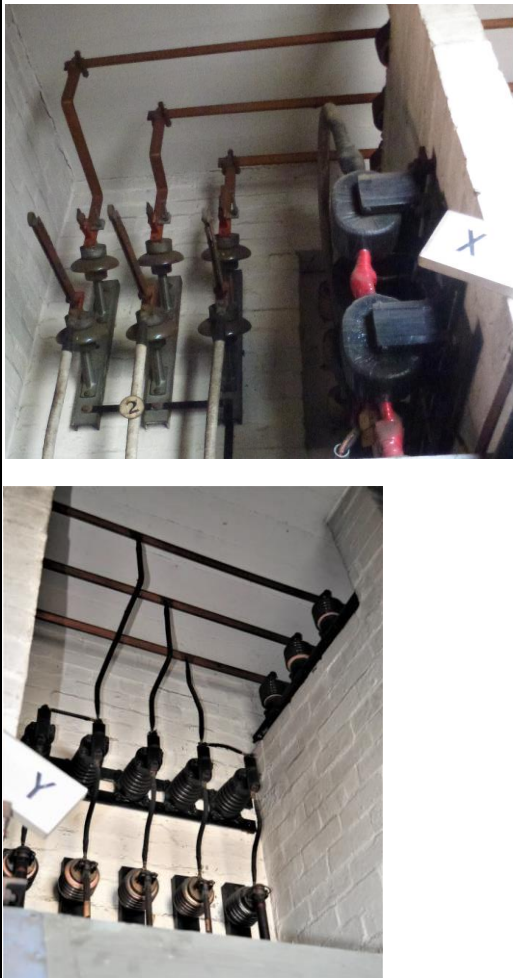


Diagram showing how a mercury arc rectifier is ignited, 1945. Source: Public Transport Victoria

Showing positions of equipment within the substation, numbered 1-7 in order of operation.


- Environment,
Land, Water
and Planning


ATTACHMENT 1 – OBJECTS INTEGRAL TO THE PLACE

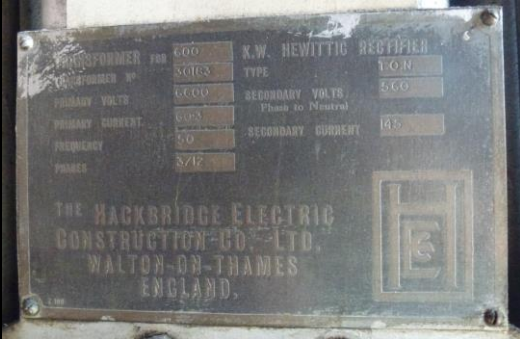

Object Name Maker & Date	1. Three phase busbars Unknown
Location	Above the three brick cells which hold the feeder switches (2. X-Z)
Photograph	
Item Description	Busbars carry high voltage power
Condition	Good
Provenance/ Historical Context	Original to the substation


Object Name Maker & Date	2. 6600 V Feeder Switches (also known as incoming 6.6 kV AC switch gear) Numbered Z-X Unknown maker
Location	Inside the block of three brick cells on the south west side of the building
Photographs	Detailed images below
Item Description	The High voltage AC 6.6kV cable bringing the AC power enters the building into switchgear housed in three tall brick cells. The switchgear was used to control the high voltage supply. It acts a circuit breaker and has three components Z to X
Condition	Good
Provenance/ Historical Context	Original to the substation



Object Name Maker & Date	Z - Incoming 6.6 kV supply from overhead circuit in Dawson Street
Location	In the most southern brick cell
Photograph	No image
Item Description	This is a circuit breaker to feed the main transformer.
Condition	Unknown
Provenance/ Historical Context	Original to the substation


Object Name Maker & Date	Y - Auxiliary Transformer 6.6 kV to 240 volts single phase
Location	In the central brick cell
Photograph	
Item Description	This is a single-phase auxiliary transformer of 5 kVA capacity to convert 6.6 kV to 240 volts single phase to provide power for the lights and other none rectification equipment in the substation.
Condition	Good
Provenance/ Historical Context	Original to the substation

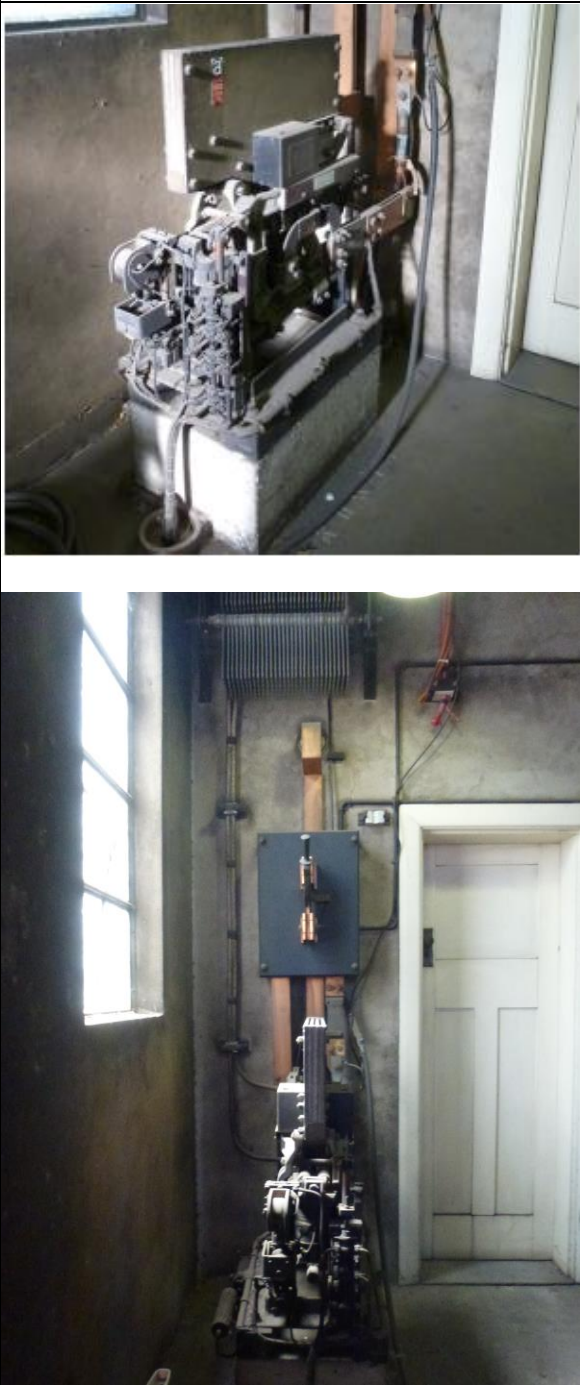
Object Name Maker & Date	X - Circuit breaker to feed main transformer	
Location	Inside the most northern brick cell of the block of three brick cells on the south west side of the building	
Photographs		
	Front	Back
Item Description	This circuit breaker is connected to the 6.6 kV busbar	
Condition	Good	
Provenance/ Historical Context	Original to the substation	

Object Name Maker & Date	3. Main transformer Hackbridge Electric Construction Co. Undated
Location	Inside the front opening on the south east side of the building
Photographs	 
Item Description	A large oil/air cooled step-down main transformer. It converted 6.6kV AC power to multiple voltage to drive the Mercury arc rectifiers. This transformer is located behind the large central steel and wire gates at the front of the building. This location would assist air circulation over the transformer oil cooling tubes. This is a complex transformer specially built for its purpose – the voltage it produces is designed to ensure that the mercury arc rectifiers are provided with AC power at a suitable voltage.
Condition	Good condition with no visible corrosion
Provenance/ Historical Context	Installed in 1936.

Object Name Maker & Date	4. Choke or Inductor	
Location	Next to the transformer	
Photograph		
Item Description	A small iron cored, oil cooled, inductor used to smooth the negative DC power	
Condition	Good	
Provenance/ Historical Context	Original to the substation	


Object Name Maker & Date	5. Mercury arc rectifier bank (4 bulbs) in steel cabinets Hewittic Electric Company
Location	Next to the wall dividing the transformer room from the main room
Photograph	 
Item Description	The 600 kW rated, Hewittic brand, mercury-arc rectifier bank has four, six-pole glass-bulbs each rated at 150 kW. Each bulb is housed in a dark grey painted, perforated sheet-steel cubicle, each with a propeller type metal cooling fan whose operating speed varies with the rectifier load current.
Condition	Good with a layer of dust. Light surface corrosion of the mounts below the rectifier
Provenance/ Historical Context	Original to the substation

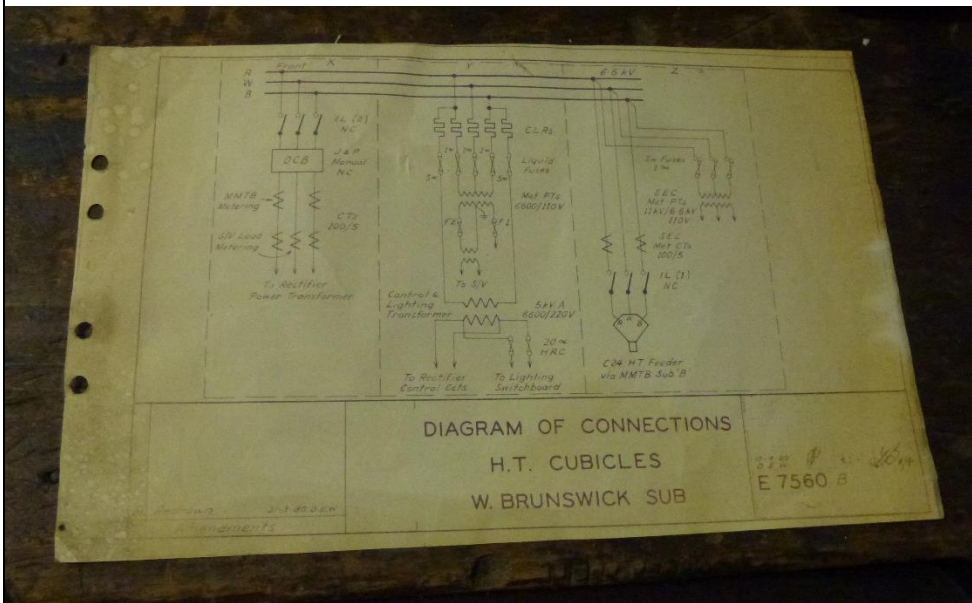

Object Name Maker & Date	6. Open five-panel DC switchboard
Location	Just inside timber doors
Photograph	
Item Description	<p>An open five-panel switchboard with 600 Volt DC positive side circuit breakers.</p> <p>The top section with the dials carries the power controls.</p> <p>The central section is the protection control relays, used in the event of a fault or overload</p> <p>At the base is the supervisory auxiliary equipment constructed by M&MTB. This sent information about the performance of the system to the Carlton Control room.</p>
Condition	Good
Provenance/ Historical Context	Original to the substation. The supervisory equipment was added in 1938-9.


Object Name Maker & Date	7. DC Negative High-Speed Circuit Breaker Unknown
Location	Next to the door leading to the bathroom
Photograph	
Item Description	This Air Circuit Breaker on the positive side feeds three outgoing feeders to the overhead tram traction wires via isolators.
Condition	Good but dusty
Provenance/ Historical Context	Original to the substation


Object Name Maker & Date	8. Resistance coils also known as a LIR (Limiting Current Resistor)
Location	In the small separate room to the north west of the main room.
Photograph	Not possible to photograph this item
Item Description	This item was only needed in emergencies to stop dangerous currents
Condition	Unknown
Provenance/ Historical Context	Original to the substation

Object Name Maker & Date	I. Toilet and II Handbasin
Location	
Photograph	No image available
Item Description	Not viewed
Condition	Unknown
Provenance/ Historical Context	Original to the substation

Object Name Maker & Date	III. Timber box to hold one mercury bulb Supplied by the Hewittic Electric Company
Location	In the same room as the transformer
Photograph	
Item Description	A large timber box with webbing inside to suspend a mercury arc glass bulb during travel. Resting on low table.
Condition	The timber is in good condition but dusty. The webbing is difficult to see but appears sagging and distorted
Provenance/ Historical Context	Presumed to have carried one of the mercury arc bulbs now installed in the substation

Object Name Maker & Date	IV. Electrical schematic diagrams, diaries and other documents Various
Location	In the main room on timber table
Photograph	 
Item Description	Not individually listed. Includes substation diaries and drawings of the electrical layouts in the substation. Resting on table with chair
Condition	Poor. Yellowed, brittle and dusty
Provenance/ Historical Context	Used to record data and check electrical layouts throughout the operating life of the substation

Object Name Maker & Date	V. AC switchboard Various
Location	In the main room on north east wall
Photograph	
Item Description	A tariff meter (uppermost) and main switchboard for a separate general lighting and power service at the substation.
Condition	Good
Provenance/ Historical Context	Used throughout the operating life of the substation

Object Name Maker & Date	VI. Substation operating tools Unknown maker and date
Location	In the transformer room
Photograph	
Item Description	Old high voltage operating stick, broom and other substation operating tools
Condition	Good
Provenance/ Historical Context	Used throughout the operating life of the substation