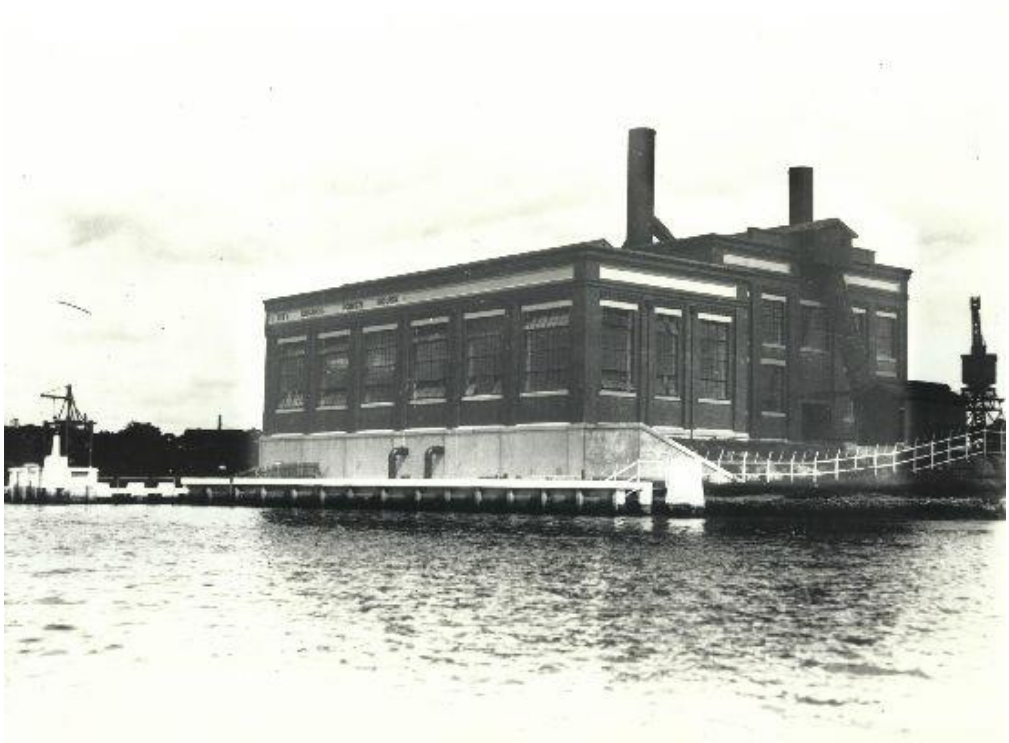
Brisbane City Council Tramways and Powerhouse Department

by Mick Topp.
Based on information from the late Ken Pollard

Now an arts centre, the New Farm Powerhouse today as viewed from across the river. Photographer unknown



The New Farm Powerhouse as originally built. (BCC Photo)

Time Line of Brisbane's Electricity History to 1928.

1882:- A public demonstration of street lighting is carried out in Queen Street.

1886:- Parliament House in George Street is lit by electricity supplied by an 8½ h.p. generator installed in the Government Printing Office to provide lighting for the printing presses.

1888:- Messrs. E.G.C. Barton and C.F. White, Electrical Engineers, supply power to the GPO and nearby premises from a building in Edison Lane behind the GPO -in liquidation by 1894 - later reformed as Brisbane Electric Supply Company Ltd.

1896:- The Electric Light & Power Act allows Governmental control of Electricity Supply.

1897:- First order in council allows BES Co Ltd to reticulate and sell energy in a small part of the city adjacent to the GPO - extended to Roma St railway gates and the Botanic Gardens in 1903.

1897 :- Brisbane Tramway Company builds a powerhouse in Countess Street for electrification of the Tramway system and offers to supply power for the electrification of the suburban railways in 1898, an offer not accepted but some supply from the traction system is later sold to consumers in South Brisbane and Ithaca Shire.

1899:- BES Co transfers their powerhouse to Ann Street with a load of 40kW.

1899:- Brisbane Municipal Council granted an Order-in-Council for the whole of its area at that time but lacks funds to carry out works required.

1904:- BES Co Ltd becomes the City Electric Light

1913:- New CEL powerhouse commissioned in William Street.

1920:- Suburban reticulation begins with Municipal Councils buying their power from either the CEL or the Brisbane Tramway Trust, the successor to the Brisbane Tramway Company.

1923:- Amalgamation of a number of small councils under the Metropolitan Electricity Board. Greater Brisbane Act vests the functions of the Metropolitan Electricity Board in the Electricity Supply Department of the Brisbane City Council.

1926:- Bulimba "A" Powerhouse built by CEL.

1928:- New Farm Powerhouse built by the BCC after their offer to buy the CEL is refused. This led to a division of responsibility for Brisbane's power supply for the next 34 years.

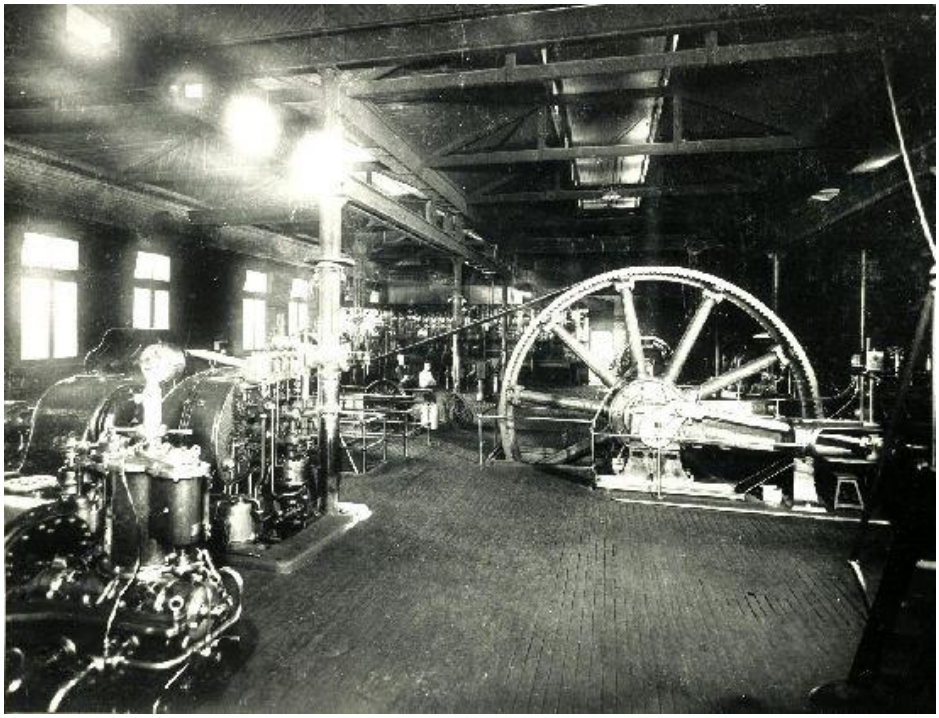
Brisbane's Tramway Power Supply.

Prior to 1927-28, the 550V (later 600V) DC supply for the Tramway system originated from the Countess St premises built by the Brisbane Tramway Company (BTCo) as a workshop and powerhouse and from other BTCo powerhouses located at Light St, Fortitude Valley and Logan

Rd, Woolloongabba. The Countess St powerhouse was commissioned in 1897 and consisted of three Robey cross-compound, horizontal, non-condensing steam engines, each driving a 300kW, 550V DC generator via a 17ft diameter flywheel and belt. Each belt was 3ft wide and 90ft long. There were four hand-fired boilers of 150lb steam pressure and a 150ft brick chimney.

The Countess St property in its final form, with Roma St railway yards beyond (BTMS archives)

In 1902 the plant was supplemented with a 400kW McIntosh & Seymour vertical compound steam engine, direct connected to a DC generator and complete with surface condenser and cooling tower. Boilers 5 and 6 were also installed at this time, followed shortly after by No 7 boiler, which was the first to incorporate mechanical chain grate stoking.

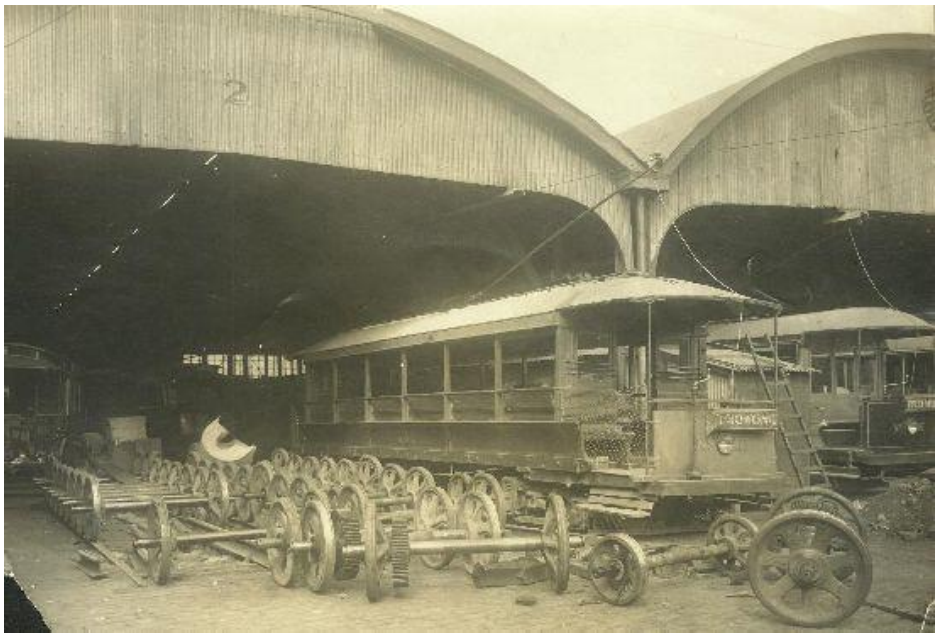


Countess St Powerhouse engine room showing flywheel and belt. (BTMS archives)

In 1908 a 500kW Parsons turbine running at 3000rpm was put into service. It was originally direct coupled to a high speed DC generator, however commutator and other problems led to replacement of the generator with a 600rpm type with double reduction helical gearing. Condenser cooling was via a pipeline from a pumping station on the bank of the Brisbane River.

1911 saw the first of three BTH 750kW turbo-alternators installed with the other two units installed in 1913 and 1915. Each six-phase alternator was electrically coupled to a rotary converter producing 550V DC.

No 8 boiler, with chain grate stoker and induced draft fan was installed in 1912 and No 9 boiler, the last to be installed at Countess St, was in service in 1914 and was a three drum land type Babcock & Wilcox unit with chain grate stoker, superheater, induced draft fan and 6,000 sq ft heating surface. This last boiler had a capacity of 30,000lb steam/hr and, due to its better efficiency, carried a large share of the load until decommissioned in 1928.



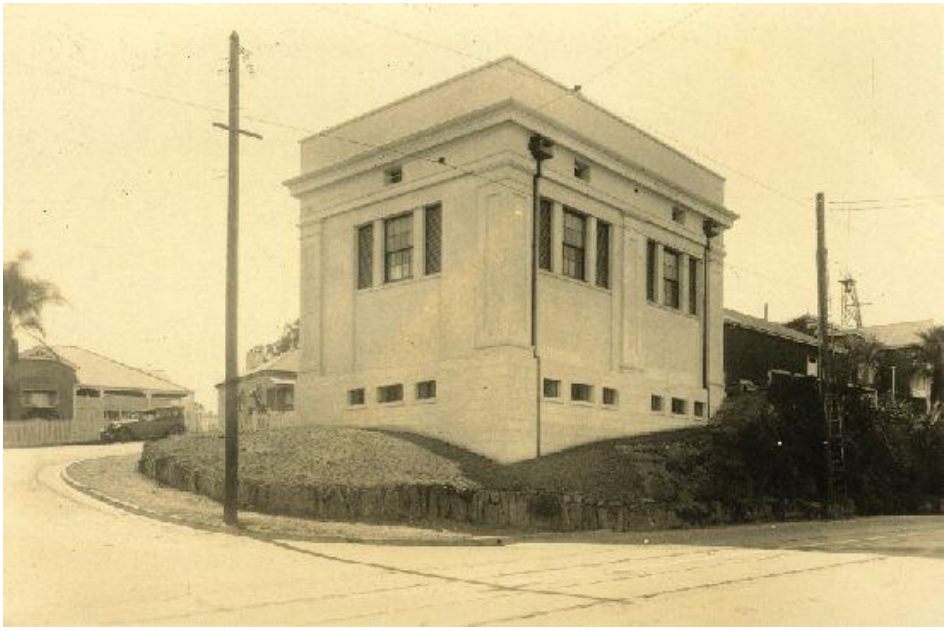
Trams awaiting repair at Countess St workshops (BTMS archives)

As the Tramway network expanded outwards from the city, it became impossible to supply it from the one point in Countess St, so in July 1913 the first of two producer gas engines went into service at Light St on the site which later served as one of Brisbane's three tram depots. These were large vertical engines running at 200rpm, one having six cylinders driving a 450kW generator and the other eight cylinders driving a 600kW generator. These coke-fired engines were very maintenance intensive, but formed an important point of supply until the Powerhouse at New Farm was built.

A feed point for the south side of the river was provided in 1915 by transferring two of the three original Robey engine sets from Countess St to a building in Logan Rd Woolloongabba, where they were connected to a barometric condenser with a wooden cooling tower. Two new Babcock & Wilcox double drum land type boilers with chain grate stokers, induced draft fans and economisers were installed to supply steam. The Robey engines had run for thirty years when scrapped in 1928.

Prior to the completion of New Farm Powerhouse, additional power was obtained from the City Electric Light Company (CEL) at two points. One was from a rotary converter at CEL's

Boundary St substation, which became available due to the gradual change of commercial power in the city from DC to AC. The second was by purchase of high voltage energy at Light St for conversion to 600V DC through a secondhand motor generator unit obtained from Sydney.



Paddington substation when new in 1930 (BTMS archives)

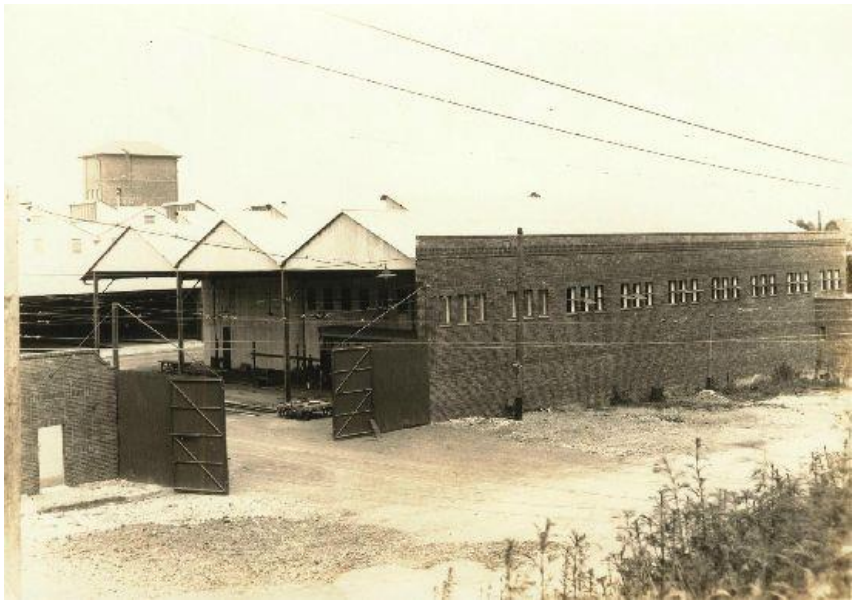
By February 1927, with the transfer of ownership of the tram system from the BTCo to the Brisbane Tramway Trust (1922-1925) and thence to the Brisbane City Council, new substations had been built at Russell St, South Brisbane and at Lutwyche Rd Windsor. They were equipped with two 1000kW automatic rotary converters and one 500kW automatic mercury arc rectifier respectively. Supply was temporarily taken from the CEL network at high voltage until New Farm powerhouse was available for use.

Three 1000kW manually controlled rotary converters were installed at a new substation and control room complex in Ballow St, near the Valley Junction. This was the only substation with manual equipment as operating staff were always stationed there - all other substations were automatically controlled from there via pilot wires. The substation workshops and maintenance staff were also located at Ballow St. These rotary converters, together with one each at substations built at Logan Rd and Petrie Terrace, and a 1000kW mercury arc rectifier at the new Newstead substation were put into service in July 1928 when New Farm powerhouse came on line. This allowed the three obsolete power stations at Countess St, Logan Rd and Light St to be decommissioned.

Experience with the mercury arc rectifier units at Newstead and Windsor led to the installation, from 1935 onwards, of fifteen more of these units, two being the sealed glass bulb type, four being the water cooled steel tank type with vacuum pumping gear and nine of the sealed pumpless steel tank type, due to their better efficiency and lower installation and maintenance costs.

During the years of ownership by the City Council, the installed capacity of the substation plant increased from 8,500kW in 1928 to 23,500kW in 1955, when the last mercury arc rectifier was installed at Coorparoo.

The Brisbane City Council Tramways and Powerhouse Department constructed new offices and workshop buildings in 1927 at the corner of Coronation Drive and Boomerang St, Milton, using bricks and material salvaged from the demolition of the former tramway headquarters on Countess St. All fleet construction, major maintenance and repair work was carried out at Milton, until the demise of the system in April 1969.



Milton Workshops from the railway embankment, 1927 (BCC Photo)

The first stage of the New Farm Powerhouse was built in 1927-28, in conjunction with the construction of the Ballow St (Valley) No 1 Substation Building.

The 11kV power supplied by New Farm extended in a ring system to Ballow St - Petrie Tce - Russell St - Logan Rd - Norman Park substations and back to New Farm Powerhouse. Another northside ring system connected Windsor, Kedron and Newstead substations. Feeders radiated out from the ring to connect Paddington, Annerley and Coorparoo substations.

In the late 1940's and early 1950's, the last group of Tramway substations was built and fed from the Electricity Department's 11kV supply network. Newmarket and Holland Park substations were supplied from nearby Electricity Dept substations and Ascot and Ashgrove were purpose-built as combined Electricity Department and Tramway facilities, incorporating a public toilet block in the design. A second 11kV feeder was connected to Coorparoo substation from the nearby Electricity substation. There were a total of sixteen substations for 109km of tram routes and 30km of trolleybus routes.

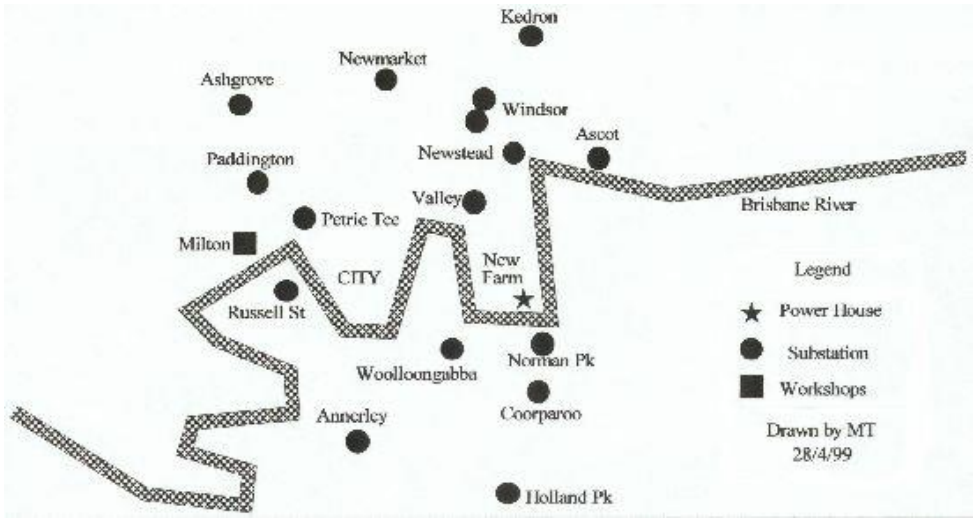
The substations were built to keep up with the expansion of the Tramway system from 1927 through to 1955 when a new No 1 rectifier at Coorparoo substation became the last one installed on the system.

One of the 187.5kW BTH Glass Bulb Mercury Arc Rectifiers at Ferny Grove (photo Mick Topp)

The Brisbane Tramway Museum substation at Ferny Grove consists of a 750kW BTH glass bulb cubicle rectifier, plus control and feeder panels salvaged from Kedron and Coorparoo substations and has been designated Brisbane Tramways Substation No 17. Temporary arrangements for rectification are currently being made, while repairs to the substation can be made following the big storm at the end of 2008.

In the course of the life of the substations, four-wheel trams such as the 63 Combination cars, 28 Ten Bench cars, 25 converted horse cars or trailers and 20 Bogie Brills, all of which had 2 x 50HP motors were scrapped. They were superseded by 191 Dropcentre cars with 2 x 60HP motors and 144 of the eventual 155 FM cars with 4 x 40HP motors.

These newer cars along with 65 Dreadnoughts with 2 x 60HP motors and 30 of the eventual 36 Trolleybuses with 120HP motors placed an ever-increasing strain on the power system.



Location of Tramway Substations

Route extensions also increased the need for power and led to the following adjuncts to the substation system -

1927:- "Old" Windsor substation built to supply existing Lutwyche Cemetery route, Windsor to Grange extension (completed June 1928) and Kedron Park to Kalinga extension (completed February 1929).

1930:- Paddington substation built to bolster supply on Bardon and Ashgrove lines and to supply Rosalie to Rainworth extension (completed October 1930).

1935:- Norman Park substation constructed to supply Balmoral line extension (completed November 1935). Kedron substation built to augment supply on Kalinga and Lutwyche Cemetery routes and later supplied power for the Chermside extension (completed March 1947).

1936:- Annerley substation built to supply Annerley to Moorooka extension (completed May 1937).

1940:- No 2 rectifier installed at Kedron to supply Lutwyche to Stafford extension (completed January 1940).

1943:- Second rotary converter (No 1) installed at Petrie Tce to cater for wartime loadings.

1948:- No 2 rectifier installed at Annerley to supply increased traffic on Salisbury and Dutton Park routes. Ascot substation was commissioned to relieve the load on Newstead substation during race days at Ascot and Doomben. There is a logbook record of circuit breakers at Newstead being held in with a broomstick after a feeder operation caused by the number of race day trams in this section. It was common practice for motormen to engage first notch with the brakes applied during power failures so the car would jump when power was restored. With approximately 90 trams in the area at the time, the circuit breaker settings were exceeded by around 300% and resulted in a fiery memo to motormen from the duty electrician who had been forced to wield the broom amidst showers of molten copper.

1949:- "Old" Windsor replaced by "new" Windsor substation - constructed to cater for increased traffic on the Grange, Stafford, Kalinga and Chermside lines. Rectifier tank from old substation presented to Queensland Museum.

1951:- Old Valley No 4 manual rotary converter replaced with mercury arc rectifier in preparation for trolleybus traffic in the Fortitude Valley area. As the old No 4 converter was only used during the Royal National Show each August, it may be appropriate at this point to give some idea of the load during this 10 day period. People's Day Holiday and the final Saturday night after the fireworks saw a constant flow of trams through the Exhibition loop (Gregory Tce, Alexandra St and St Pauls Tce) and extremely heavy electrical loading on the Bowen Bridge Rd feeder at the Valley substation. On many occasions the ammeter would be hard over on 2000amps and the feeder cables would be hot enough to make the solder run out of the cable ferrules, while several times the positive feeder cable sagged low enough to contact the negative cables along the same route, thereby "locking-out" the feeder circuit breaker on temporary short-circuit until the fault could be found. Usually someone would report seeing aerial fireworks in the Valley area and thus help pinpoint the fault location for the repair crew.

1952:- Newmarket substation built due to increased traffic on the Newmarket to Enoggera extension (completed August 1949). Ashgrove substation built due to increased loading on the Ashgrove line.

1953:- Holland Park substation built to cater for extra traffic on the Holland Park to Mt Gravatt extension (completed March 1951) and also to feed the Cavendish Rd, Coorparoo trolleybus route (completed November 1955) which replaced and extended the former tram route.

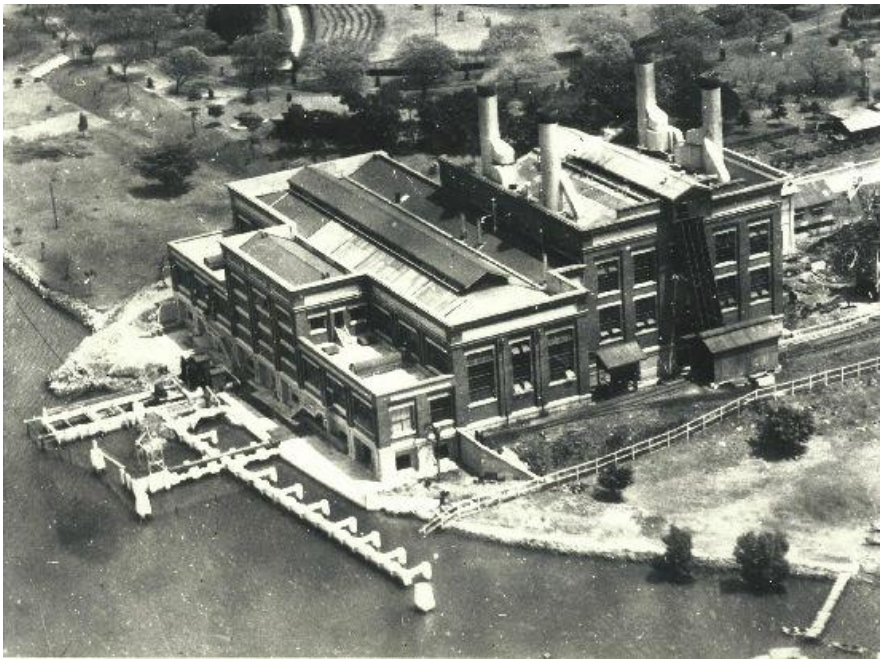
1954:- No 3 rectifier installed at Russell St to cater for trolleybus loading in the City and South Brisbane area.

1955:- Second rectifier (No 1) installed at Coorparoo to supply extra traffic on the Camp Hill to Belmont extension (completed July 1948) and the Seven Hills, Carina and Cavendish Rd trolleybus routes.

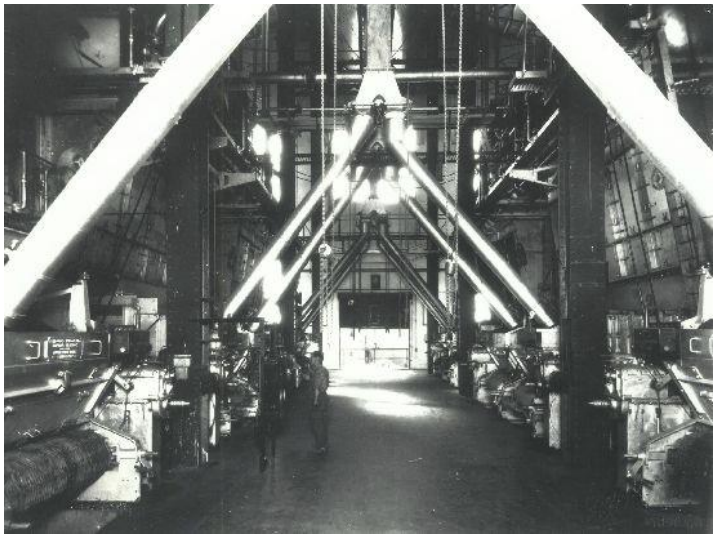
New Farm Powerhouse

Supply from the CEL and Tramway powerhouses was not very reliable due to large areas being fed from single 5000Volt radial feeders that were turned off during frequent summer thunderstorms to protect the equipment from lightning surges.

Once the BCC decided to build New Farm Powerhouse, basic decisions also had to be made regarding how to distribute reliable supply throughout the City area.



New Farm Powerhouse, with substation and control room extension overlooking the river. (BCC Photo)



New Farm Powerhouse boiler floor showing mechanical chain grate stoking equipment at front. (BCC Photo)

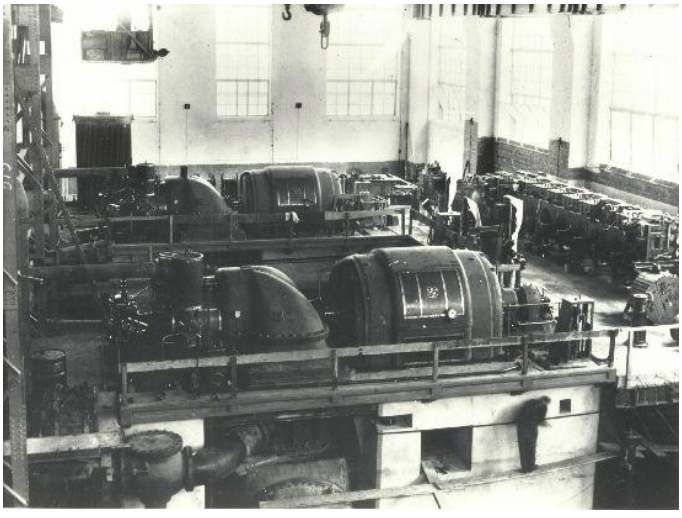
It was decided to feed the inner suburbs by means of an underground cable ring feeder system, divided into four sections, each originating on a separate bus section at New Farm, with reactors installed between bus sections.

This fundamental concept, particularly the use of an underground ring feeder system with metal clad switchgear in switching substations, was most advanced for its time and led to the Council being regarded as a leader in high voltage underground cable techniques.

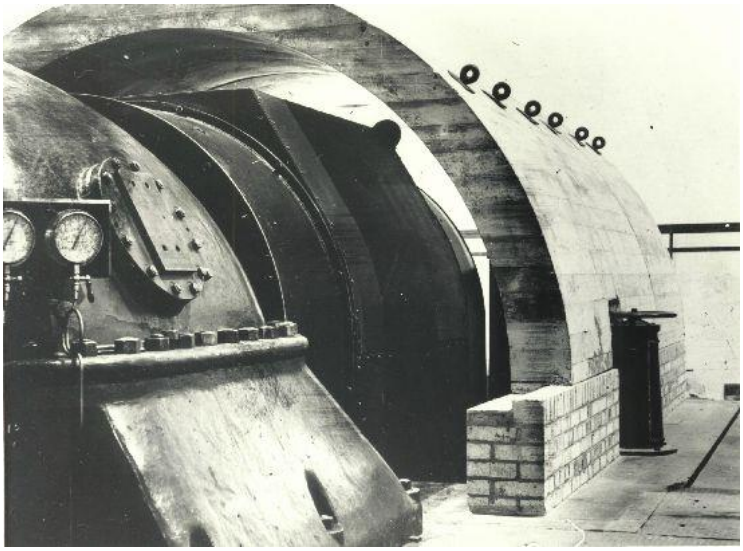
The use of underground cables was in itself a great advance in reliability, but the idea of using ring feeders meant that a fault could occur and be isolated by switchgear operated by protection relays, without any interruption to consumers supply.

The first four of these 11,000Volt substations were commissioned in 1929 and the system was expanded to meet needs as bulk supply agreements to previous Municipal Council areas expired and new Tramway substations were built to cope with network expansion.

In its final configuration circa 1944, the powerhouse comprised ten Babcock and Wilcox cross drum marine boilers with economisers, superheaters and mechanical chain grate stokers and five British Thomson Houston 18.75mW turbo alternators. The accompanying photographs show various stages of development and some of the installed equipment.



The machine floor at New Farm showing two of the original 7.5mW turbo alternators. (BCC Photo)



Steel and concrete covers over alternators inside turbine hall during World War 2. (BCC Photo)

The output was shared as approximately one quarter to the Tramways and three quarters to the Electricity Department, with occasional exports to the CEL via an interconnector installed in April 1940.

In 1963 the Electricity Rationalisation Agreement transferred operations to the Southern Electric Authority but the property was retained by the BCC and upon cessation of operations in 1968, all plant and equipment reverted back to the Council. Several pieces of equipment from the powerhouse were presented by the BCC to the Queensland Institute of Technology (QIT), now Queensland University of Technology (QUT).

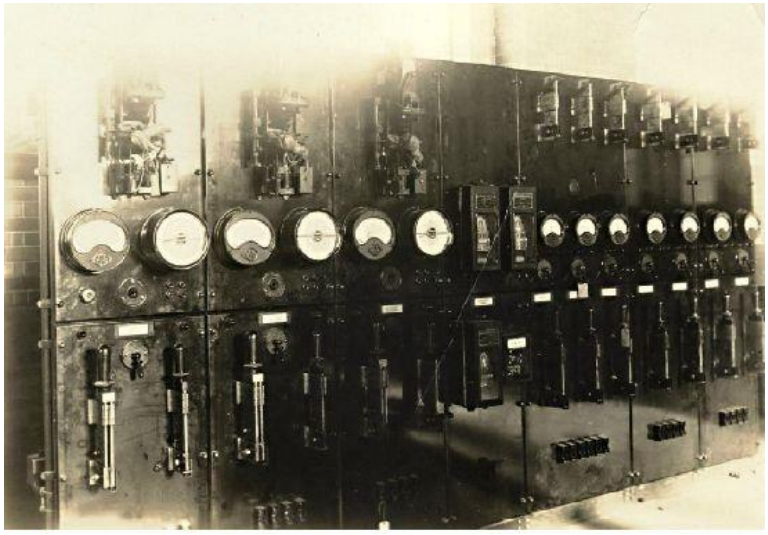
Ballow St Tramway Substation No 1 and Electrical Control Room

The Council's Tramways and Powerhouse Department was responsible for the planning and design of new substations to keep pace with the expansion of the Tramway system and the power needs of the larger, more powerful Dropcentre and FM trams and in 1951, the Trolleybus network. Ballow St was the colloquial name for the No 1 Tramway Substation and Control Room located on a block of land between Ballow and Constance Streets in Fortitude Valley, near the Valley Junction.

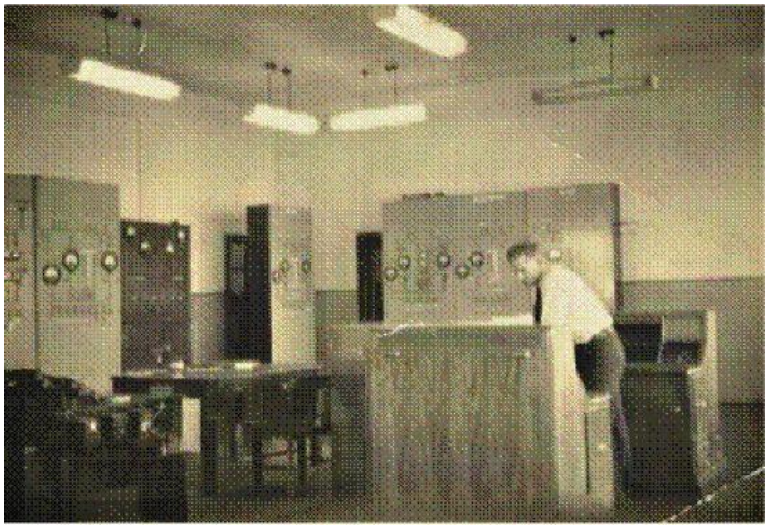
Construction was completed by 1928, at the same time as the New Farm Powerhouse was being built to replace small power houses scattered around Brisbane, including Countess St near the city, Logan Rd at Woolloongabba, Ann St and William St. The building housed the rotary converters, 11kV switchgear, control panels and a light workshop. All main cables left the building via an easement laneway off Ballow St and the Constance St entrance laneway gave access to the loading dock

Tramway Workshops and Substations staff manufactured some of the machine and DC track feeder control panels. Before supervisory control was installed at No 2 Substation, Russell St, the only control was a start plug and indicator light when the machine came on line. Three-pair multi-core control cables were run from Ballow St, through the city and across the Victoria Bridge to Russell St. The control cabling system was later extended around the city and suburbs, using the Department of Electricity's underground multi-core control cabling. This

allowed control and indication of Tramway Substation machines and DC track feeder high speed and slow speed circuit breakers. The control gear was British Telephone uniselector equipment that gave many years of reliable service as a supervisory system.



The main DC board at Ballow St, 1928. LHS panels are for Rotary Converters 1,2 & 3, RHS panels are DC track feeders and ammeters. (BCC Photo)



Ballow St Control Room in Tramway days (BTMS archive)

Part of the Valley work group in Tramway times (BTMS archives)

The Ballow St building was extended in 1948 to provide more modern offices, staff change room, storeroom, light workshop and instrument repair facilities. A modern control room with control desk was planned and built to cater for the future expansion of the system. One of the feeder route panels showed a trolleybus route to St Lucia that never eventuated due to the opposition of Coronation Drive residents to overhead wiring.

The complex was the centre for all Tramway control and substation repair operations until the Tramway network was scrapped in April 1969. The building was then cleared of all Tramway equipment and converted by the Council's Electricity Department to a depot for several work groups that eventually combined as Substations Group, Valley Depot. Energex, formerly SEQEB, absorbed the Electricity Department in July 1977 and sold the Valley Depot in April 1998, after their Metro North Substations Branch moved to new premises.

Crude But Effective

The staff at the Valley came up with some novel ways of carrying out their tasks as the following examples show. Crude but effective.

When breakdown repairs were necessary on a 1000kVA transformer from Russell St, there was a need to unbraze the 11kV connecting copper conductors. As there was a high current low voltage battery unit at the Valley, capable of delivering 4000Amps for calibration tests on DC circuit breakers, someone suggested it may generate enough heat to unbraze the joints. Large flexible cables were connected from the battery bank to each transformer copper connection by a large carbon brush on either side of the joint and firmly clamped together. The battery current was increased to 3000Amps and the whole connection of carbon and copper glowed and began to separate.

Another use for the battery unit was to braze silver contact surfaces onto the main contact faces of slow speed DC circuit breakers. The same principle was used with the current being passed through a carbon/copper/silver/ carbon sandwich.

Headway Recorders (Cheeta-Meters)

One of the more unusual jobs was a request for a means of recording the arrival and departure of trams from various termini for the purpose of knowing the "Headway" time (i.e. the time that the tram stayed at the terminus and when it arrived and departed). Evershed & Vignoles portable recorders were modified to indicate on a moving chart the electrical activity when the tram arrived and departed. After a week at a location the meters would be removed and shifted to another location, the chart removed and the marks on the chart translated to check sheets as arrival and departure times. The installation and servicing of the recorders was done out of hours when there were no inquisitive running staff to ask too many questions.

It was most interesting to note the time it took for the last tram to return to the depot when waiting to do switching on the overhead system. Monitoring of diesel and trolleybus headways by electronic means was being investigated as the tramway system came to an end.