The Introduction of Electric Power in Illawarra Coal Mines

In 1902, a steam driven electricity generating plant was installed at the Mount Kembla Colliery to supply surface and underground lighting and power to operate the coal cutting machines installed underground. Other coal mines in the Illawarra followed, and in 1905, an electric power generating plant was installed at the North Bulli Colliery, to supply two coal cutting machines, supplied by the Jeffrey Manufacturing Company USA. The installation of power plants followed at the Wongawilli, Coalcliff, and Metropolitan Collieries, as the use of in electrically powered mining plant increased.

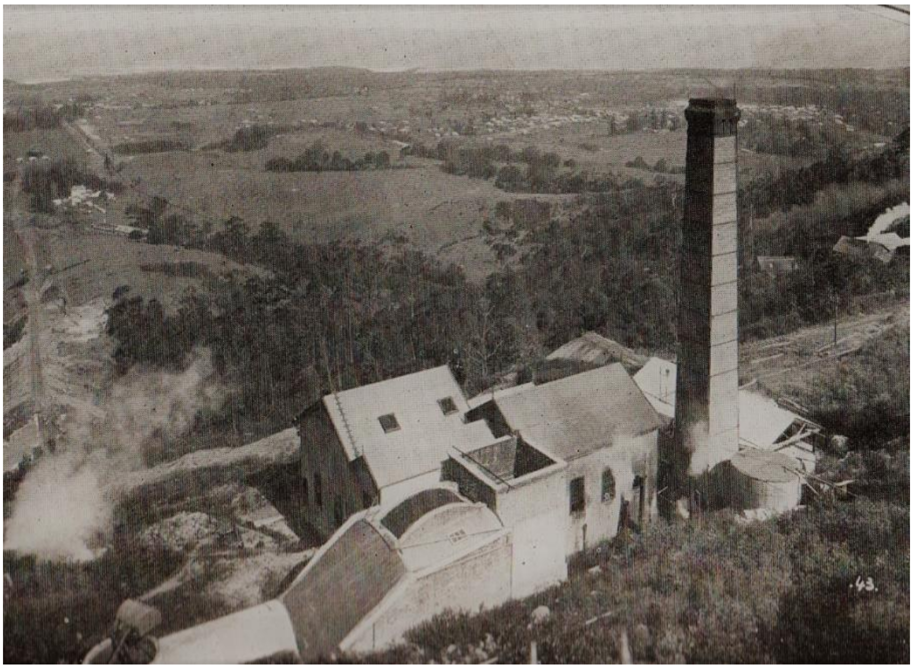
The Mount Kembla Colliery Boiler Power Plant -1903[i]

At this point time, a reticulated supply of electricity had not been established in the Illawarra area by the State Government. Some of the mines on the Escarpment harnessed the surplus mechanical power generated by self-acting incline haulages to provide a source of mechanical power. This drove endless rope haulages delivering coal skips to and from the surface and underground. At a number of the collieries air compressors were also installed, to provide compressed air to power coal cutting machines.

The installed power plants provided a relatively small Generating capacity, and whilst some chose the direct current (DC) supply system, the alternating current (AC) supply system, became the preferred option, and provided a power supply, operating at a frequency of either twenty-five, or fifty cycles per second. The latter frequency was to become the preferred option, and remains as such, to this point in time. The chosen power supply reticulation system voltage, were 2,200 Volts and the secondary voltage, 415/240 Volts. As the mining operations developed, the range of mine plant increased, to include rope haulages, water pumps, mine ventilation fans, screening plants and mine surface workshops. This demand, led to a need for an increased generating capacity, from the mine power plants, and an increasing need in other industries in the area, for a high capacity power supply system network in the Illawarra.

A powerhouse was erected at the South Bulli Colliery in 1904, above the pit top area of the Colliery. This plant comprised of four Lancashire steam boilers, with provisions to add more boilers later, and a generating plant of 2000 kW (2300 volts) capacity. The coal for the boiler plant was delivered from the pit top, in rail wagons by an incline rope haulage that linked the powerhouse to a screening plant, located down at the pit top. The cooling water required for the plant was supplied from a dam constructed behind the Escarpment, with the water pumped to a second dam located adjacent to the powerhouse.

A 450kW steam driven Walker mine ventilation fan, claimed to be the largest in the Southern Hemisphere at that time, was installed in a building adjoining the powerhouse.



South Bulli Colliery Powerhouse and Mine Ventilation Fan

The powerhouse provided the electric power required for the surface and underground mine plant, that included rope haulages, air compressors and a man-transport system.

In addition to providing power to the minesite, in 1913, a supply of power was made from the mine to the Bulli Shire Council. This power supply covered the Shire area, from Bellambi in the south to Stanwell Park in the north. In 1950, the Bulli Shire ceased using this source of supply, and transferred to the NSW Public Works Departments power supply network, followed the enactment, of the NSW Electricity Commission, Port Kembla Electricity Act, in 1935. A clause in that Act prohibited privately owned power houses from supplying electric power to other consumers.

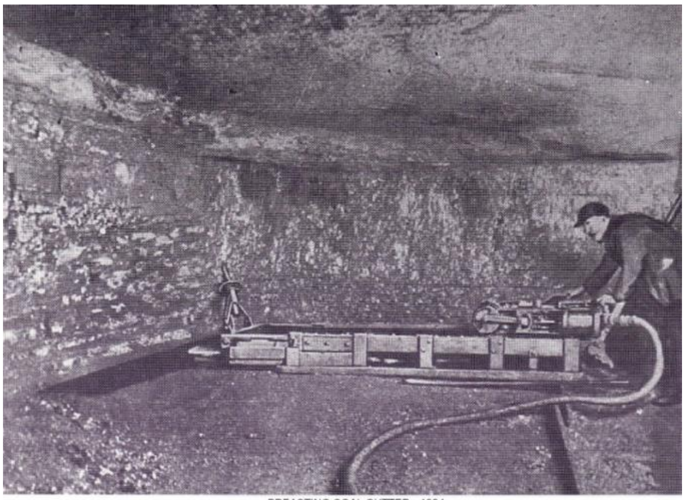
The South Bulli powerhouse closed in 1954, from when the colliery's power supply needs were provided from the State electricity supply network.

It is of interest to note that the Corrimal Coke Works generating plant also provided a source of electric power to the Corrimal Colliery and Coke works, and to Wollongong Council for residents in certain areas. This supply was later terminated, for the same reasons as those set out above in respect to privately owned power houses.

In 1914 the NSW Public Works Department (PWD) Powerhouse, was erected at Port Kembla. The initial generating plant had been installed earlier by others to support a recently completed coal loader, the State-owned metal quarries in that area, and the Municipality of the Wollongong.

The power demand placed on the Port Kembla Power Station led to the PWD increasing the installed generating capacity of the station, following the enactment in 1935 of the PWD and the NSW Electricity Commission, Port Kembla Electricity Act. These changes, led to the progressive abandonment of the power plants installed at the collieries, as access was now available for the collieries to the State power supply network.

The coal cutting machines referred to earlier in these notes reduced the amount of small size coal produced at the collieries, for which there were no markets. This coal was dumped as waste underground and at the mines' surface. The use of compressed air as the power source for driving coal cutters (rather than electricity), was favoured by the Mines Inspectorate, colliery management, and the coal miners. The electrically powered coal cutting machines that later followed, were driven by a direct current (DC) drive motor, with exposed control equipment, and a supply trailing cable. This package of plant was considered to be a potential source of ignition of methane gas in the coal face area, thereby creating an explosion. The earlier compressed air driven machines were considered unlikely to create this problem, as they exhausted 'spent' compressed air from the coal cutter in the coal face area. Electrically powered machines were subsequently withdrawn from the collieries, because of this issue.


BREASTING COAL CUTTER - 1904

The growing use of electricity in coal mines in Australia, followed its use in coal mines in the USA and the United Kingdom. Rules for the use of electricity in coal mines were progressively developed in the UK, and adopted, with some changes, in Australia. The developments made in the UK included the design of a ''flameproof enclosure'' to house the drive motor and the on-board control equipment, and the addition of a metal screening of the conductors in the trailing cable supplying the electric power to the coal cutter. While the earliest electrically powered coal cutters were supplied with DC, later machines were supplied with an alternating current (AC) drive motor and control gear, housed in a flameproof enclosure .

Power supply systems and AC drive motors for coal cutters were developed in the UK to replace the earlier DC power supply and drive motor. These developments resulted in the preparation and adoption of *Rules for the use of Electricity in Coal Mines* in the UK. These rules were reviewed by the coal mines Inspectorate and colliery officials in Australia, and adopted with some amendments in 1907/8.

Power Plants at the Collieries

Steam driven power stations were installed at the South Bulli, Bulli, Coalcliff and Metropolitan collieries, and coke ovens waste gas recovery power generating plants were installed at the Corrimal and Wongawilli coke ovens plants. In addition to supplying electric power to the collieries, the Corrimal and South Bulli Plants also provided electric power for domestic supply and street lighting in the Bulli and Wollongong Shire Council areas. The Metropolitan Colliery plant provided a domestic power supply to the Helensburgh village and the surrounding areas, including the nearby Waterfall Sanitorium.

During the 1930s rail mounted coal cutting machines were introduced at several mines in the area, and were to be the first steps, in the later adoption of the mechanised system of mining. These coal cutting machines initially filled a complementary role in the development of the bord and pillar workings of the contract system of mining.

In the late 1940s progressive abandonment of the contract system of mining was followed the introduction of the mechanised system of mining. The adoption of this system was not accepted by the Miners' Union, as they considered it would lead to a loss of jobs to their members. The mine owners were reluctant to invest the capital funds required, because of the attitude adopted by the Miners Union and its members

In 1949 a national coal strike by the coal miners led to the creation of the **Joint Coal Board** (JCB) in 1947/8. The JCB was established with the consent of both the State and Federal Governments, and was given the responsibility for a large measure of the conduct and control of the coal mining industry. The JCB moved into the coal industry when only five mines were considered to have been mechanised. By 1959, there were some forty mines mechanised, and others in the process of becoming mechanised. The JCB opened and operated mines in its own name, closed others, and provided capital funding to mining companies to purchase mining plant, and mechanise their mining operations. Health, safety and community issues were addressed, and while the number of employees in the industry was progressively reduced, these reductions included coal miners reaching the retiring age, and others who were ''compensated out'' of the industry because of health issues. Disputes and protracted negotiations relating to the use of machinery in the extraction of coal pillars took place between the owners and the miners, and were resolved, and the collieries proceeded and develop and were much safer and more productive.

The mechanisation of the mining operations brought with it the use of modern coal cutting and loading equipment, sourced in the main from the USA.

To support the installation of this upgrading of plant an increased capacity power supply system was required at the collieries. This need for electric power supply capacity led to the progressive abandonment of the earlier steam powered generating plants installed at some mines. An example of this change was the Australian Iron and Steel Company, who owned a number of collieries located along the escarpment, from Bulli in the north to Wongawilli in the south. They erected a 33kV overhead transmission line supplied from the company's steel works at Port Kembla to each of its collieries, located along the Illawarra Escarpment.

The major items of plant required to establish a mechanised mining panel included a track mounted coal cutting and a coal loading machine, a number of 5 and/or 10 tonne capacity wagons/mine cars, and two battery powered locomotives. The coal cutter was used to cut a slot (kerf) into and across the coal face. A handheld boring machine followed, to drill a number of holes into the coal face. Explosives were then inserted into each hole and detonated, to break the coal down. The coal loader gathered and loaded the coal into the waiting wagon/mine car. At the AIS Collieries, battery locomotives were used to deliver empty wagons to the coal loader to be filled, and to hauled from the mining panel to a marshalling yard and hauled to the surface by either a rope haulage or diesel locomotive to be unloaded and returned underground.

The coal cutting and loading machine were supplied with electric power by a flexible trailing cable, inserted into a flameproof 'Gate End Box'/load centre installed in the mining panel. This was supplied from a transformer installed to provide a three phase power supply in each mining place. Wire armoured reticulation cables were used to distribute power throughout the panel to a number of gate end boxes. Each machine trailing cable was fitted with a plug that could be inserted into the matching receptacle mounted on the gate end box/load centre. An enclosed terminal box was provided on each coal cutter and the loader to initially ''hard wire'' the trailing cable to the machine. This terminal box was later replaced with a cable plug receptacle mounted on each machine, to enable the trailing cable to be readily fitted and/or removed. (The name ''Gate End Box''originates from the UK, and the longwall mining systems used in that country. The use of standalone, single outlet gate end boxes was later abandoned as the power demand of the mining equipment increased, being replaced by multiple-outlet, flameproof load centres, supplying all of the electrical plant installed in the mining panel.

Developments in mining equipment resulted in the progressive move away from rail track, equipment to Caterpillar (track mounted) cutters and loaders and the continuous miner. This latter machine combined the operations of the coal cutter and the coal loader into one machine. While the use of on-track wagons and mine cars hauled by battery locomotive from the coal face continued at first, these items were later replaced by the rubber tyred shuttle car.

The Joy Manufacturing Continuous Miner - 1952

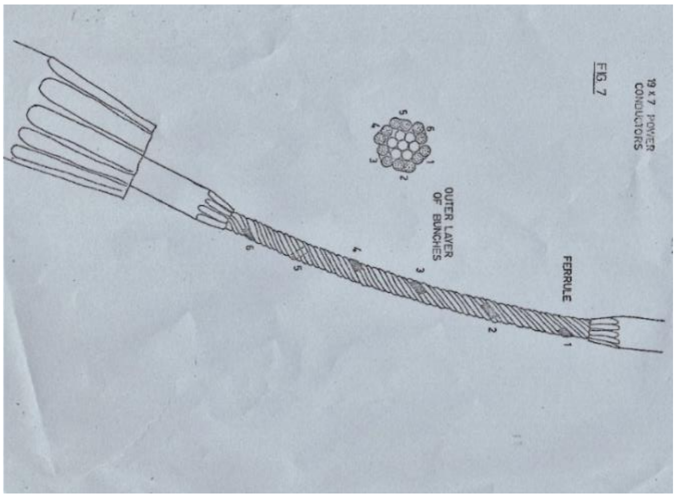
Machine Trailing Cables and Cable Repair Workshops

In the mid-1930s, a small number of track mounted coal cutting machines were introduced at the mines. The repair and testing of the trailing cables supplying power to these machines was carried out at the mine by electricians. The introduction of the mechanised system of mining created a large increase in the number and types of machines, and the specifications of the trailing and power cables required to support their operation.

These changes led to the setting up of cable repair shops at the mines, staffed by mine employees considered suited to acquiring the skills and practices required to prepare, repair, and test damaged trailing cables. As the number and types and tests required to repair and maintain the variety of cables increased however, the repair of cables at the mines was abandoned and carried out off site by qualified contractors.

These repair shops were equipped with the staff and equipment required, to thoroughly inspect and test the sheathing, and the power and minor cores of each cable, for defects and damage. On completion of each cable repair, the cable was subjected to a series of tests, and made ready for delivery back to the mine, on a cable drum in most cases, and ready to be despatched underground.

The repair and jointing of the individual strands of a damaged power or the minor core in the assembled cable, was carried out using soldered tinned copper jointing ferrules, designed to retain as far as possible the flexibility of the repaired conductor. This work was carried out by female employees who were found to have preferred skills in the fitting and soldering of the small diameter ferrules, applying the covering insulation to the individual cores and assembling the cores and outer sheathing in preparation for the vulcanising of the outer cable sheath.



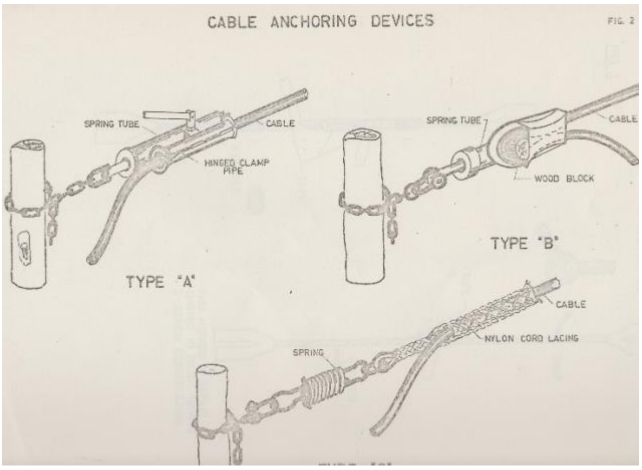
Repair to a Trailing Cable power core using soldered Ferrules

In the early 1950s the installation of Joy Manufacturing battery powered shuttle cars commenced and was closely followed by the 10 SC model, 250 volt direct current (DC) cable reel shuttle car. This shuttle car required a DC power supply provided by either an alternating current (AC) powered motor/DC generator (MG set) or a mercury arc rectifier AC/DC convertor set designed to provide power to each car using a flat sheathed, two core trailing cable.

Joy - 10SC Shuttle Cable Reel Shuttle Car

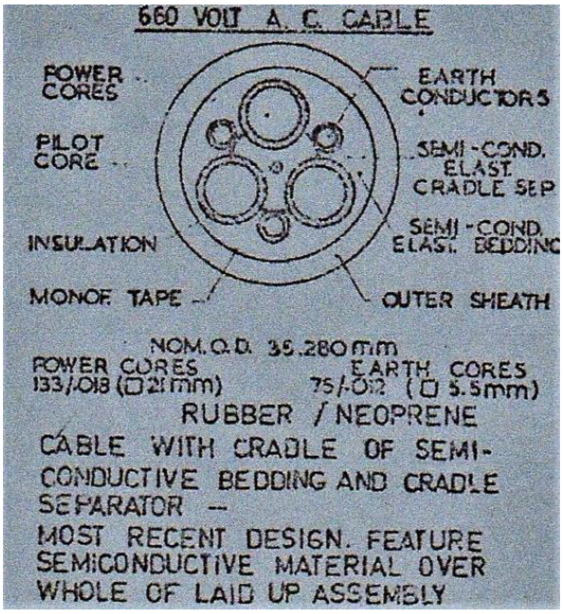
Later in the 1950s the 10SC and 15SC model cable reel Joy shuttle cars were designed to operate on a 415 Volts AC and later 950 Volts AC supply. These shuttle cars and in particular the 10SC model, were installed in very large numbers throughout the coal industry. The use of shuttle cars in the mining panel to support the operation of the coal loader or the continuous miner required two cars, one with the driver’s seating and controls on the right-hand side of one car, and on the left-hand side of the second car. The work duty imposed on the trailing cable supplying the shuttle car was very onerous. The trailing cable supplying each car had to be ‘’anchored’’ at a chosen location on or adjacent to the shared route used by each car travelling to and from the face and unloading point. This enabled one car to be loaded at the face and travel to the discharge point, and pass the empty car parked in its chosen ‘’shunt’’ off the shared roadway. Once the full car had passed the empty car emerged and travelled to the face to be filled. On discharging its load, the first car travelled back in to the panel and parked in its chosen shunt to await the passing of the full car and repeat the process of travelling to and from the face and the discharge point.

These movements required the trailing cable supplying each car to be anchored at a chosen location, and automatically wound on and off a cable reel mounted on the car. The anchoring and reeling process created severe stress and strain on the cable, and frequent damage. The replacement of a damaged trailing cable required the services of an electrician to access a hard wired terminal box and disconnect the damaged cable and connect the replacement cable. To reduce the time taken to carry out this replacement an angle shaped cable receptacle was fitted into the cable reel on the shuttle car and a matching plug fitted to the trailing cable.



Shuttle Car Cable Anchoring Devices

A typical cross section of a shuttle car trailing cable designed for use on 415Volt and 950 Volt (AC) supply systems and a flameproof cable reel receptacle and trailing cable plug are shown below.



Shuttle Car (SC) Trailing Cable

(SC) Reel Receptacle & Cable Plug

The first 10SC DC powered cable reel cars placed in service were supplied complete with a flat cross section, two power core sheathed trailing cable, manufactured in the USA. This two-core cable presented difficulties in repairing and maintaining the flexibility of the cable. This led to the development of Australian Standards for the design and manufacture of trailing cables for shuttle cars and other mining machinery using trailing cables in Australia. The variations required to meet this need included consideration of the size and flexibility of the laid-up power cores, and minor cores, the screening or collective screening of each power core and assembled core assembly and the outer sheathing of the cable. These requirements involved a close association with local cable manufacturers in the design of each cable and the establishment of offsite cable repair workshops. These latter facilities provided the thorough testing and repair of each type and size of cable used at the mines and the maintenance of cable records.

As the input power requirements for mining plant increased, the cables used in main power system and the flexible trailing and non- flexible reticulation applications followed. The early trailing cable designs employed a metal screening covering the insulation of each power core was later replaced by a conductive rubber sheath. This sheathing was applied to induce a earth fault and activate that protection device as opposed to generating a short circuit or potential electric shock to a person handling the cable. All trailing cables were progressively designed to meet these changes by adopting the most up to date materials and processes in their manufacture, and compliance with the relevant Mining Regulations.

The continuous miner and shuttle car remain in use as the mining plant required to develop the areas to be later mined by the longwall system. Both of these machines have enhanced features to support the rapid development of future longwall mining panels.

Longwall Mining

As the underground workings of the existing mines on the Illawarra Escarpment moved further west the levels of production realised from the bord and pillar system of mining using continuous miners and shuttle cars became uneconomical. This was due to the travelling time to and from the coal face, the levels of methane released in mining the coal seam, and the measures requires to accommodate those changes relative to gas make. In terms of access and future development as mines moved to the west of the escarpment, and under deeper surface cover, alternative mining systems were investigated. In the 1960s the mechanised Retreat Longwall mining system was introduced at the Coalcliff, Kemira and South Bulli collieries.

The longwall equipment packages purchased at that time were manufactured in the United Kingdom and required an 1100 Volt power supply system, as opposed to 415 Volt used in Australia. The electrical components of the package included gate end boxes, drive motors on the face shearing machine and the armoured face conveyor, hydraulic power pack supplying the fluid for the face roof supports and the ancillary items required for signalling and lighting.

There were many problems encountered over many years, and longwall packages sourced from a variety of suppliers before the longwall system finally achieved an acceptable level of production. The initial roof supports proved to be unable to support the roof of the Bulli Seam, and there were serious problems found in the design of the armoured face conveyor. Each of these problems were progressively overcome by making meaningful changes in design, and the longwall system has become the most widely adopted highly efficient, state of the art system, capable of achieving a high level of daily production.

Features of a present-day longwall mining equipment package include a very significant degree of automation, and an increase in the electric power demand and the system operating voltage. A supply voltage of 11000 Volt has been adopted, on some installations, for the major drive components of the longwall package.

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[i] Wigram Allen Collection