INTRODUCTION TO

ARDNACRUSHA GENERATING STATION.

At the time Dr. Tommy McLoughlin returned to Ireland from Germany in 1923, the annual consumption of electricity in this country was a mere 48 million units, 36 million of which was consumed in Dublin. By comparison, the annual consumption is 9,000 million units.

Dr. McLoughlin had spent his first post-graduation year gaining engineering experience in Germany and while there had found ample confirmation of his belief that a cheap and plentiful supply of electricity was essential for rapid growth and consequent prosperity.

With the help of a college friend Patrick McGilligan, who was soon to be appointed Minister for Industry and Commerce, Dr. McLoughlin set about convincing the Government to adopt his plans for a Shannon Scheme. Having eventually received a hesitant green light in Dublin, McLoughlin then had to persuade his German employers Siemens Schuckert to prepare a report with a design and economic justification for the Scheme. Siemens produced this report in the incredibly short time of six months and it was presented to the Government on 1st September, 1924.

After much debate, the Shannon Electricity Bill was passed unopposed by Dáil and Senate in June, 1925, the contract with Siemens was signed in August, 1925 and work began immediately.

The conventional design of a large storage basin formed by a high dam with a power station at its foot was not possible due to the topography of the area. The design instead involved the construction of a small dam or weir on the river just upstream of O'Briensbridge and three miles south of Kilalloe. A canal was then constructed from this weir to the site of the power station seven and a half miles away, following the slope of the hills to minimise the amount of material required for the embankments on either side. At Ardnacrusha, the canal terminated in a 30 metre high dam through which the 6 metre diameter penstocks feed the water to the turbines in the power station at the foot of the dam.

The water emerging from the power station is then carried by way of a tailrace canal one and a half miles long back to the river one mile upstream of Limerick.

The initial design was for three turbines with the facility for adding a further three at a later stage. The first three were completed in 1929, and a fourth was added in 1934. The fifth and sixth units were not built.

Construction work involved the removal of nine million cubic meters of earth and one million cubic meters of rock, four major bridges were built and nine rivers and streams diverted. To do this work, numerous machines including 58 locomotives and 500 wagons were transported from Germany to Limerick. Five thousand men, German and Irish, were employed, many of them being accommodated in camps at Ardnacrusha, Parteen Weir, O'Briensbridge and Clonlara.

The work took four years to complete. On 22nd July, 1929, Mr. W. T. Cosgrave, President of the Executive Council of the Irish Free State, started the mechanism which opened the sluice gates at Parteen Weir and allowed the river Shannon to begin filling the Headrace Canal.

On 21st September, current was first generated on a trial basis and on 24th October, 1929, the Scheme was handed over to the E.S.B.

The construction of the Shannon Scheme was a mammoth undertaking for a country the size of Ireland, especially when the State was barely three years old. The cost of five and a half million pounds consumed a huge proportion of the new state's finances and caused bitter argument in the Dáil and elsewhere. However, those who dubbed the Scheme 'McGilligans White Elephant' were soon proved wrong when electricity consumption began to rise at a phenomenal rte as soon as Shannon power became available.

In 1020, when Ardnacrusha joined Pigeon House as the major suppliers of electricity, there were over 300 other producers in Ireland, most of them very small. The E.S.B. on its foundation in 1927, set about supplying cheap power to all of the nation and gradually took over all the small utilities.

Ardnacrusha at this time was the headquarters of the E.S.B. The decision as to which machines in the system would supply the demand at any time were made by the Control Room Operators at Ardnacrusha and they retained this function until the Load Dispatch Office was established in Dublin in 1954.

In its early life, Ardnacrusha could supply practically all the electricity needs of the country. The highest proportion of system demand supplied by Ardnacrusha was 87% in 1936/37.

Although at the present time, Ardnacrusha supplies only about 4% of the annual demand, it is still vitally important to the system as a 'rapidly available' source of peak power and for cover in cases of emergency or a sudden breakdown of other plant.

The river Shannon is 150 miles long from its source in the Cuilcagh Mountains, County Cavan to Ardnacrusha and in that distance it drains 4,000 square miles or 1/8th of the area of Ireland. It flows through three major lakes, Lough Allen, Lough Ree and Lough Derg which together have a storage capacity of 600 million cubic metres. As the station used 6,000 million cubic metres annually, this storage is used ten times in the course of the year.

The station at full load consumes 400 cubic metres or tonnes of water per second and produces 85,000 units per hour. The average flow in the river is 190 tonnes per second but this ranges from 600-700 tonnes per second in Winter floods to as little as 10 tonnes per second in Summer dry periods. Contrary to popular opinion, we do occasionally have some of the latter.

To allow for the passage of migratory fish - Salmon, Trout and Eels - there are fish passes at Ardnacrusha and Parteen Weir. Your guide will explain the Ardnacrusha Fish Pass to you on your tour. Hopefully, he will also be able to answer any questions you may have on what has been said here.

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DETAILS OF THE SHANNON WORKS, PLANT & EQUIPMENT.

Plant commissioned 1929. Capital cost 5½ million.
Capacity 85MW (4 machines).

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Average annual output 322 million units.
Record annual output reached in 1960/61 with 432 million units.
Record weekly output 14.72 million units 1965/'66.

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WEIR, O'BRIENSBRIDGE:

Controls the flow of water from the Shannon into both the and the old river bed. Six sluice gates on the old river outlet. Three sluices and a navigation gate on the canal outlet. The average flow in the Shannon is 200 tons per second. This can increase to over 900 tons during flood. A minimum quantity of 10 tons per second must be allowed down the old river bed for fishery and environmental purposes. In flood water, this quantity will be greatly increased if the extra water cannot be stored without danger of flooding the country upstream. A fish pass of 13 steps allows for the passage of fish from the river to the highest level above the Weir and so on upstream. A 600KW set to use $10m^3$/sec. was commissioned July 1980.

HEADRACE (EMBANKMENTS):

Brings water from Shannon at O'Briensbridge to Power Station, a distance of 7½ miles.

TAILRACE:

(1½ mile cutting in solid rock) Conveys the used water from the turbines back to the Shannon near Limerick.

STORAGE:
The total storage in the Shannon river and lakes is approximately 600 million tons. Total water used at Power Station in 1960/'61, was 6,767 million tons, i.e. eleven times the storage capacity. This gives some idea of the dependency on rainfall. It takes the potential energy approximately of 15 tons of water at a head of 96 feet to keep a 1KW electric fire heated for one hour.

POWER STATION:
Penstocks: Four of these, six metres in diameter, convey the water from the intake building to the four turbines. At maximum load, each penstock delivers approximately 100 tons of water per second.

Tailrace: Water from turbines is discharged here through the draft tubes, the bellmouthed openings of which are below the surface.

110KV Transformers: Four of these on tailrace platform, rated each at 30,000KVA step up the generated voltage (10.5KV) to 110KV for long distance transmission lines. Each transformer weighs about 100 tons.

Turbine Gallery: Four turbines, three Francis and one Kaplan design, each rated about 30,000HP. Each turbine has its own high pressure motors for supplying the power to the servo motors to open the guide vanes controlling the amount of water entering the turbines. Auxiliary plant consists of guide and thrust bearing oil pumps supplying lubricating oil to the bearings, coolers for cooling the thrust bearing oil, compressed air plant for renewing the air supply to the high pressure containers, water leakage pumps for getting rid of leakage water, fire-extinguishing apparatus, operated by generator protection relays, for protection of generators in case of fire due to internal faults in the windings.

Each unit has its own oil-operated governor which serves to control speed variations of the machine (within limits) and provides means of starting, stopping, loading up and unloading of the unit.

Generators 1, 2 and 3 are rated at 30,000KVA and run at a speed of 150R.p.m., while 4 is rated at 25,000KVA and runs at 167R.p.m. One generator can produce an average of 21,000 units of electricity every hour, when on full load.

Control Room: The circular desk contains a mimic diagram of the busbar system and switchgear and provides an illuminated signalling system by means of which the positions of the actual switches ('on' or 'off') are indicated. Switches are operated electrically by push-buttons on this desk. The vertical panels contain the measuring instruments by which the frequency, voltage and current of the various machines, transformers and outgoing lines are indicated. Voltage of the machine is controlled by regulators which can be seen on the respective generator panels.

A teleprinter sends and receives messages and instructions from the Load Dispatch Office relating to the loading of the machines in accordance with the demands of the system.

__40KV Transformers & Lines:__ Situated at front of building. Four main transformers each rated at 8,000KVA. These step-up the generated voltage (10.5KV) to 40KV for distribution purposes. In addition to these 10/40KV transformers, there is also a 110/40KV transformer rated at 31.5MVA feeding into the 40KV system. This is situated in the 100KV station. The 40KV system comprises of lines feeding to: Caherdavin (2), Corbally, Gillogue, Patrickswell, Bruff, Cappamore, Silvermines, Birdhill, Tulla, Ennis/Shannon.

__110KV Station:__ Switching station for the 110KV Transformers and for 110KV lines to Ennis, Drumline (Shannon), two lines to Limerick city and two spare bays.

__Intake Building:__ Houses the sluice gates for controlling the flow of water into the four penstocks. These gates usually remain at a fixed opening except when a machine is shut-down for repairs or overhauls. They can be dropped, in emergency, by push-button in about 30 seconds. Screens in front of the gates prevent debris from running on tracks the full length of the building.

__Navigation Locks:__ Provides passage for boats on their way from Limerick to Dublin on the Grand Canal. Boats are raised in two stages through a height of 96ft., when passing from the tailrace to the headrace; the time taken for this operation being about 35 minutes.

__Fish Pass:__ The Borland type fish-pass was commissioned in April, 1959, to facilitate the passage of fish past the power station. It is 15' in diameter and has a vertical lift of 100ft., and uses 1½ tons of water per second. The equipment incorporates an automatic electronic fish counter, which records the number of salmon passing upstream (record 7,036 - 1965).

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THE CONTROL ROOM

The Control Room is the control centre for the station. The four generators which you have seen on the machine floor are loaded and unloaded here.

The generators produce electricity at 10,000 volts. This is transformed straight away to 40,000 or 110,000 volts for transmission purposes. On the indicating tableau shown on the semi-circular desk panels, lines or busbars carrying 10,000 volts are shown in blue, the 40,000 volt busbar is shown in yellow and the 110,000 volt busbar is shown in red.

All generation from this station is fed into a common network or grid which links the whole country.

The 100,000 volt lines feed bulk load to major centres where the voltage is reduced to 40,000 for a more local network. Transformers in these smaller areas in turn reduce the voltage to 400 volts for power purposes and 220 volts for domestic distribution.

Some local areas can be fed direct from Ardnacrusha at 40,000 volts. The names of these areas can be seen on the top of the wall panels behind the semi-circular desk.

Throughout its 55 year life, considerable modernisation has taken place in the control room but there still remains some of the original equipment installed by Siemens Schuckert. The round meters on the wall panels and the wheel regulators on the fron of the desk panels are original equipment.

The meters you see here all indicate the levels of voltage, current, etc. in generators and transformers in the station and some also show the present water levels in the headrace and tailrace.

The tableau on the large semi-circular desk indicate the position of different switchgear or links in remote switch locations in the station. Anything irregular with these such as a tripping due to a fault will be indicated by a flashing light and may be accompanied by an alarm bell. On receipt of this alarm signal, the tripping or fault will be attended to be the staff on duty.

To the left of the wall panels can be seen the Standard and Frequency clocks. The standard clock is checked each day with Greenwich Mean Time. The frequency clock is controlled by the system frequency as shown by the frequency meter just below the clocks. If the frequency could be kept at exactly 50 cycles per second then the time on both clocks would always coincide. In practice this is not possible. If the frequency is above or below 50 cycles per second for any period, then the frequency clock and all the electric clocks in the country will run fast or slow as the case may be. The aim is to balance the frequency at 50 over 24 hours and thus keep all clocks correct with standard time.

The tableau on the central desk has 240 alarms and control switches. These cover all sensitive points of control. Anything out of the ordinary, for example, an increase in temperature or fault in a generator or relay will be shown here by a flashing light and alarm bell. When this happens, the control room staff may request maintenance on certain parts of the plant or may have to carry out switching to isolate the faulty plant for immediate attention.

On the upright panel behind the central desk are recording meters showing the load at any time on the generators and transformers. They also keep a graphical record of the load situation. Two temperature indicating meters are situated at the end of the panel. Readings of these are taken and recorded every hour.

The large instrument in the centre of the panel gives an indication of the level of water in the headrace and tailrace. The difference between these is shown as the available head.

The rate at which the level is reduced, called the drawdown, is very critical. Too quick a drawdown may cause damage to the head race banks. A cursor onthe headrace elvel side of the recorder indicates when the drawdown is becoming excessive and a danger zone may be necessary to allow the water level in the headrace to rise again.

The control room staff pay particular attention to this. In many cases it dictates the amount of load the station can carry or pick up. The instrument shows in graph form the levels in headrace and tailrace and the load on the station at any time. At the end of the day the graph of the previous 24 hours is stored for reference.

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