## THERMAL POWER STATION OPERATION

Electrical energy is produced in power stations by generators, each driven by a steam turbine. Heat or thermal energy is released when fuel is burnt in the boiler. Steam produced in the boiler transfers energy to the turbine where it is converted to mechanical energy that drives the generator.

The circuit or path of the steam flow from the boiler to the turbines and water flow from the condenser to the boiler is known as the **Thermal Cycle**.

The circuit or path of airflow to the boiler and gasses of combustion from the boiler furnace back to the atmosphere is known as the **Air/Gas Circuit**.

## THE THERMAL CYCLE

The Boiler Feed Pump raises the pressure of the feedwater sufficiently for the water to flow through the High Pressure (HP) Feed Heaters, the feedwater regulating valve and into the boiler.

The HP feed heaters use steam bled from the High and Immediate Pressure (HP & IP) turbines to pre-heat the feedwater.

The feedwater-regulating valve controls the amount of water entering the boiler to maintain the correct water level in the boiler drum.

The economiser is situated in the flue gas path; it is a tubular heat exchanger, which further pre-heats the feedwater using the flue gasses leaving the boiler as the heat source.

The boiler drum distributes the feedwater into downcomers (large bore external pipes), which delivers the water to the bottom distribution headers, where the water enters the tubes forming the waterwalls of the boiler furnace.

The boiler water in the waterwalls is heated by the heat released by the combustion of fuel in the furnace. The water rises in the waterwalls gaining more heat; hence some of it is changed into steam.

The steam/Water mixture is collected from the waterwalls in the top or collection headers and returned to the drum where it is separated, the water returning to the boiler water circulation pattern, the steam passing to a heat exchanger known as the super heater where its temperature (thus energy level) is increased.

The superheated steam flows from the boiler to the HP turbine via the governor valves, which controls the steam flow to the turbine **ie.** the energy input to the turbine.

Steam entering the turbine is expanded through the nozzles and the rotating turbine blades producing torque at the turbine shaft. Hence, the steam pressure and temperature is reduced - that is, heat energy (enthalpy) is transformed to mechanical energy (torque).

The steam leaves the HP turbine to return to a heat exchanger located in the boiler flue gas path known as the "reheater" where its temperature (energy level) is increased. The "hot reheat steam" flows to the IP and finally to the Low Pressure (LP) turbine, expanding on the way through as it does its work spinning the turbine blades.

The steam exhausts from the LP turbine to the condenser, where the steam space is held at a high vacuum ensuring maximum expansion (work) from the steam through the LP turbine. The exhaust steam is condensed in the condenser turning back into water known as condensate.

The Cooling Water (CW) system supplies vast volumes of seawater to the condenser to condense the exhaust steam.

The extraction pump removes the condensate from the condenser and delivers it to the deaerator via the LP feed heaters.

The deaerator and LP feed heaters use steam bled from the IP and LP turbines to pre-heat the condensate (LP feedwater).

The Boiler Feed Pump draws water from the deaerator storage tank and so the cycle is complete.

## POWER GENERATION

The turbine(s) provide the driving energy for the generator rotor.
The magnetic field produced by the electromagnetic rotor cut the conductors in the stator inducing a voltage in them; a current flows when the circuit is completed, thus electrical energy is supplied to the interconnected grid.

## THE AIR/GAS CIRCUIT

Air for combustion is drawn from the atmosphere by the Forced Draught (FD) fan and delivered to the windbox after passing through the Air Heater.

The Air Heater is a heat exchanger where heat is recovered from the flue gasses to pre-heat the combustion air.

The combustion air flows from the windbox into the burner assemblies where the fuel and air are mixed in the correct ratio for stable, efficient combustion.

The fuel/air mixture burns in the boiler furnace in a continuous process releasing heat energy, which is absorbed by the boiler components (water walls, super heater, reheater, economiser and air heater)

The hot gasses from combustion are drawn from the furnace and through the boiler and air heater by the Induced Draught (ID) fan and discharged up the stack.

Boilers burning coal have a precipitator or some other method of particulate collection located in the flue gas path between the air heater and ID fans to prevent fly ash discharge into the atmosphere.

# KWINANA POWER STATION

## FACTS

<table>
<tr><th></th><th colspan="2">STAGE A</th><th colspan="2">STAGE B</th><th colspan="3">STAGE C</th></tr>
<tr><td>Boilers</td><td colspan="2">2 Riley Dodd</td><td colspan="2">2 ICAL</td><td colspan="3">2 ICAL</td></tr>
<tr><td>Fuel</td><td>Gas</td><td>Coal</td><td>Gas</td><td>Oil</td><td>Gas</td><td>Oil</td><td>Coal</td></tr>
<tr><td>Output</td><td>120MW</td><td>108MW</td><td colspan="2">120MW</td><td colspan="2">200MW</td><td>120MW</td></tr>
<tr><td>Evaporation</td><td>103.3 kg/s</td><td>87.38 kg/s</td><td colspan="2">103.3 kg/s</td><td colspan="2">170 kg/s</td><td>103.3 kg/s</td></tr>
<tr><td>Stop Valve Pressure</td><td colspan="2">11.03 MPa</td><td colspan="2">11.03 MPa</td><td colspan="3">16.55 MPa</td></tr>
<tr><td>Stop Valve Temperature</td><td colspan="2">540 deg C</td><td colspan="2">540 deg C</td><td colspan="3">540 deg C</td></tr>
<tr><td>Reheater Inlet Pressure</td><td colspan="2">2.91 MPa</td><td colspan="2">2.91 MPa</td><td colspan="3">4.31 MPa</td></tr>
<tr><td>Reheater Inlet Temperature</td><td colspan="2">372 deg C</td><td colspan="2">372 deg C</td><td colspan="3">341 deg C</td></tr>
<tr><td>Reheat Outlet Pressure</td><td colspan="2">2.74 MPa</td><td colspan="2">2.74 MPa</td><td colspan="3">4.12 MPa</td></tr>
<tr><td>Reheat Outlet Temperature</td><td colspan="2">540 deg C</td><td colspan="2">540 deg C</td><td colspan="3">540 deg C</td></tr>
<tr><td>Superheater Control</td><td colspan="2">Spray Attemperation</td><td colspan="2">Spray Attemperation</td><td colspan="3">Spray Attemperation</td></tr>
<tr><td>Reheater Control</td><td colspan="2">Gas Bypass Damper</td><td colspan="2">Tilting Burners/Heat Exchanger</td><td colspan="3">Tilting Burners</td></tr>
<tr><td>Economiser Type</td><td colspan="2">Plain Tubes</td><td colspan="2">Finned Tubes</td><td colspan="3">Finned Tubes</td></tr>
<tr><td>Airheater Type</td><td colspan="2">Tubular</td><td colspan="2">Tubular</td><td colspan="3">Rotary</td></tr>
<tr><td>Firing Configuration</td><td colspan="2">Front</td><td colspan="2">Corner</td><td colspan="3">Corner</td></tr>
<tr><td>Number of Burners</td><td>12 gas</td><td>12 coal</td><td colspan="2">12 gas</td><td colspan="2">12 gas</td><td>8 coal</td></tr>
<tr><td>Burner Turndown Ratio – Gas</td><td colspan="2">2.5:1</td><td colspan="2">3:1</td><td colspan="3">3:1</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>MCR Fuel Consumption</td><td colspan="7"></td></tr>
<tr><td>Coal</td><td colspan="2">60 T/hr</td><td colspan="2">-</td><td colspan="3">65 T/hr</td></tr>
<tr><td>Gas</td><td colspan="2">25.92 T/hr</td><td colspan="2">25.92 T/hr</td><td colspan="3">40.32 T/hr</td></tr>
<tr><td>Oil</td><td colspan="2">-</td><td colspan="2">27.4 T/hr</td><td colspan="3">43.7 T/hr</td></tr>
</table>

## ACTS

| FANS | TAGE A | TAGE B | TAGE C |
|---|---|---|---|
| Induced Draught | | | |
| Number per Boiler | | | 2 |
| Type | ouble Inlet Centrifugal | xial Flow | Axial Flow |
| Capacity per Fan | ).89 kg/s | .04 kg/s | 123 kg/s |
| Motors | i0 kW 4 pole | )0 kW 4 pole | 795 kW 4 pole |
| | | | |
| **Forced Draught** | | | |
| Number per Boiler | | | 2 |
| Type | xial Flow | xial Flow | Axial Flow |
| Capacity per Fan | .2 kg/s | .28 kg/s | 109.4 kg/s |
| Motors | )2 kW 4 pole | 0 kW 4 pole | 560 kW 4 pole |
| | | | |
| **Primary Air Fans** | | | |
| Number per Boiler | | | 2 |
| Type | entrifugal | | Centrifugal |
| Capacity per Fan | .4 kg/s | | 66.7 kg/s |
| Motors | 20 kW 4 pole | | 485 kW 4 pole |
| | | | |
| **Boiler Feed Pumps** | | | |
| Number per Boiler | | | 3 |
| Speed | 60 RPM | 70 RPM | 5785 RPM |
| Capacity per pump | .59 kg/s | .11 kg/s | 95.76 kg/s |
| Motors | 30 kW | 30 kW | 2985 kW |

# KWINANA POWER STATION

## FACTS

**Fuel**

| | | |
|---|---|---|
| Oil Storage | 2 tanks holding | 6,200 tonnes each |
| | 2 tanks holding | 10,000 tonnes each |
| | 2 tanks holding | 14,000 tonnes each |
| | 3 tanks holding | 30,000 tonnes each |

Delivery    Pipe Line from BP – Jetty – On road tankers

| | | |
|---|---|---|
| Coal Storage | Maximum storage | 170,000 tonnes |
| | Average Stocks | 150,000 tonnes |

Delivery    Trains from Collie, normally 3 per day:
2 x 28 wagons, 1 x 20 wagons
Each wagon holds 50 tonnes.

| | | |
|---|---|---|
| Unloading Rate | Normal 750 TPH | Maximum 1500 TPH |

If the units are “On Load” 24 hours per day, the station would burn:

| | |
|---|---|
| 6,000 | tonnes of coal per day |
| 2,190,000 | tonnes of coal per year |

A train to carry all that coal would require 43,800 wagons.

# KWINANA POWER STATION

## FACTS

## PLANT COMMISSIONING INFORMATION

| | OIL | COAL | GAS |
|---|---|---|---|
| Unit K1 | September 1970 | August 1983 | June 1987 |
| Unit K2 | November 1971 | December 1982 | December 1987 |
| Unit K3 | October 1972 | - | November 1983 |
| Unit K4 | December 1973 | - | April 1984 |
| Unit K5 | March 1976 | April 1979 | October 1984 |
| Unit K6 | April 1978 | April 1978 | October 1984 |

# Kwinana Power Station

## ***Station Capacity***

| | | | | |
|---|---|---|---|---|
| STAGE "A" | 2 x 120 M.W. | 120 M.W.<br>108 M.W. | ON<br>ON | GAS<br>COAL |
| STAGE "B" | 2 X 120 M.W. | 120 M.W. | ON | OIL – GAS |
| STAGE "C" | 2 X 200 M.W. | 200 M.W.<br>120 M.W. | ON<br>ON | OIL – GAS<br>COAL |
| | 1 X 20 M.W. | 20 M.W. | GAS | TURBINE |

TOTAL 900 M.W. = NINE MILLION LIGHT GLOBES OF 100 WATTS.