Two pumps are motor driven, and one is dual driven. The latter connects solidly to the driving motor on one end and through a clutch-type coupling to a turbine drive on the other end. The clutch-type coupling allows the turbine to remain at rest when the motor drives the pump, but engages automatically as the turbine comes up to speed. The boiler-feed-pump turbine operates in emergencies only, exhausting to the deaerating heater.

The boiler feed pumps discharge through the 14th, 10th and 7th stage heaters and feedwater regulators to the economizers and superheat-control condensers in the saturated-steam headers of the superheaters. From here the feedwater passes into the boiler drum for evaporation.

Air-Gas Cycle. One vane-controlled forced-draft fan serves each boiler, discharging through a regenerative air preheater. Air leaving the preheater at about 510 F passes to the burners as secondary air with a small percentage going to the pulverizers to serve as primary air. A tempering fan between the two pulverizers of each boiler supplies tempering air to the primary air at the pulverizer inlet. Primary air passes through the pulverizers and exhausters to the burners, mixing with the secondary air as it enters the furnace. Flue gas leaving the boiler passes through the economizer and air preheater before entering electrostatic precipitators at about 310 F.

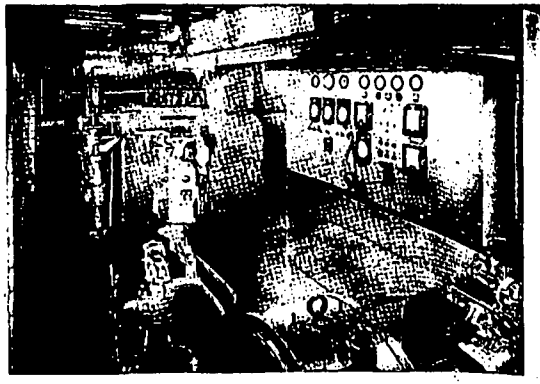
The precipitators, which have a guaranteed flyash-removal efficiency of 94%, are used both to minimize induced-draft fan erosion and eliminate, as much as possible, any smoke nuisance. Smoke would be particularly objectionable to the Middletown airport adjacent to the station.

Gas leaving the precipitator passes through one induced-draft fan for each boiler to a single reinforced concrete chimney common to both boilers. Each i-d fan has a double-extended shaft with a 500-hp 900-rpm motor on one end and a 250-hp 720-rpm motor on the other. Flexible couplings attach both motors rigidly to the fan. The 720-rpm motor may rotate at 900 rpm without ill effects. These 2-speed fans have inlet-vane controls.

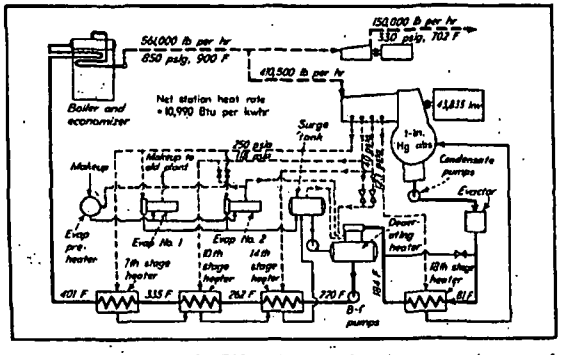
Fuel-Ash Cycle. Coal is delivered on a double railroad siding, which passes through a new track-hopper house. Car-thawing equipment consisting of four pits, each with two oil burners, precedes the track hopper house. Cars entering the house are spotted over either of two 70-ton coal hoppers. A car vibrator carried over these hoppers by a small overhead crane speeds up coal-car emptying. Six reciprocating feeders remove coal from the hoppers at 300 tons per hr feeding it to a flight conveyor, which discharges to a 2-roll crusher.

After reducing coal to 1¼-in. size the crusher discharges it to a gravity-discharge elevator carrying it to either an inclined belt conveyor for transportation to a transfer tower, or to a swivel-type stocking-out chute. A bulldozer moves coal to the stock pile. When needed the bulldozer moves it back to a reclaiming hopper at the track hopper house. An apron feeder then moves it to the crusher inlet from where it can either pass through or around the crusher to the gravity-discharge elevator.

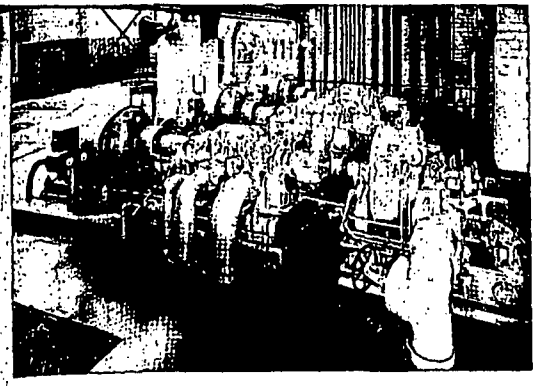
Coal delivered to the transfer tower discharges either to a second inclined belt carrying it to the new coal-bunker room, or to a reversible-flight conveyor delivering to the bunkers in the old section of the plant. This conveyor can be fed at the opposite end by two elevators in the existing plant, during repair of the gravity-discharge elevator. Flight conveyor, when operated in reverse, discharges at the transfer tower to the inclined belt serving the new bunker room. Coal entering the new bunker room discharges to a short horizontal belt conveyor, which feeds a reversible shuttle belt conveyor. This distributes the coal through a rubber bunker feed to the new bunkers.



3000-KW TURBINE-GENERATOR takes high-pressure steam and exhausts it to main in existing 325-psig station. Exhaust helps develop full output of 1-p turbine.



CONSTANT-PRESSURE DEAERATOR receives steam from three sources, the output of one evaporator, 10th turbine stage at light loads, 14th stage during heavy loads



ONE DUAL-DRIVEN AND TWO MOTOR-DRIVEN feedwater pumps for the high-pressure boilers are located on the main turbine-room floor level near backpressure unit

Coal leaving the bunkers passes through two feeders per boiler to its respective Hardinge pulverizers and exhausters to the burners. Each boiler has six burners horizontally opposed, three in front and three in rear of each furnace. This type firing was selected on the basis of results at the Gilbert, West Reading and Westover Stations, which indicated the effectiveness of opposed firing in lowering carbon losses in the flyash. New furnaces at Crawford are provided with overfire air nozzles so this feature may be added at a later date if considered necessary to improve operation.

Hydraulic jets remove ash from the boiler ash hoppers, the ash then sluices to a clinker grinder mounted over an ash sump.

A vacuum system, which collects soot from the chimney base and precipitator hoppers, mixes it with water when passing through an ejector immediately preceding the ash sump. Soot from the last passes of the boilers flows by gravity to the ash hoppers.

Either of two rubber-lined centrifugal pumps passes the ash and soot from the ash sump to a settling basin adjacent to the station.

Plant Makeup. Water for makeup flows from the Susquehanna River through a mechanical trash rake and traveling screen, and is chlorinated. The water is then pumped to a Spaulding precipitator where chemical coagulation and clarification are effected by aluminum sulphate and soda ash. Following this process gravity-type filters complete the mechanical filtering. From the filtered-water clear well, pumps pass water through fully automatic zeolite softeners to a deaerating-type evaporator preheater. Part of the vapor from the No. 2 evaporator heats water in the tray-type deaerating preheater.

Makeup water flows by gravity from the evaporator preheater to the shells of two evaporators. One receives its heating steam from the 10th-stage bleed and discharges all its vapor to the deaerators in the old plant. The second evaporator, No. 2, takes its steam from either the 10th- or 14th-stage bleed, depending on the load the turbine carries. Part of the vapor goes to the evaporator preheater for heating as mentioned, and the remainder flows to the new deaerating heater where it joins the cycle feedwater.

Continuous blowdown lines maintain boiler-drum concentration at a level not exceeding 500 ppm.

Cooling Water. Circulating water from the Susquehanna enters an intake channel with its mouth slightly downstream from the screen houses. This forces the water to make a turn of about 130 degrees when leaving the river, in this manner keeping a large percentage of the large pieces of floating debris and ice cakes from entering the channel. A bypass channel with an adjustable weir connects the discharge channel with the mouth of the intake channel. The weir level is lowered during periods when needle ice forms in the river. This recirculation has proved very successful in minimizing difficulties encountered from ice in the intake channel and in the screen houses.

A mechanical trash rake clears the trash rack, composed of wrought iron bars on 4-in. centers, during floods or when the river is filled with leaves during the fall of the year.

After passing through the trash rack, water flows through two traveling screens. These screens have segregating sluice gates so either screen well may be pumped out and the screen repaired without use of stop logs and without interfering with operation of the other screen. Each screen has a screen-wash pump and a differential-pressure switch. The latter automatically starts the proper screen-washing pump when the water-pressure drop across the screen exceeds 2 in. of water. The pump builds up pressure and provides a cleaning spray for the screen. A pressure switch connected to the spray line automatically starts the screen rotating. A time-delay relay prevents the pump from stopping before the screen has made at least one complete revolution during an operation.

Intermittent chlorination of the water leaving the screens prevents organic growth in the tunnels, pumps and condenser. Water flows through two horizontal centrifugal circulating pumps to two MacNeill reversing valves, and then proceeds through the 2-pass surface condenser, which is equipped with internally bronze-sprayed welded-steel divided water boxes, to the discharge tunnel; and over a sealing-chamber weir to the river.

The MacNeill reversing valves, which are motor operated, allow the condenser to be backwashed without interfering with normal operation.

Summary. Crawford Station was designed for reliable, troublefree, efficient operation at reasonable cost. It was necessary to balance these items against each other; reliability and low maintenance were given primary consideration. This procedure was responsible for the decisions to (1) equip all closed feedwater heaters with drain cooler sections to minimize flashing of heater drips and resulting higher maintenance (2) select closed heaters in place of open (3) select 94% efficient precipitators to minimize i-d fan erosion and smoke nuisance (4) select a coal-handling system that serves the entire plant and can be fed by two independent sets of elevators (5) select a makeup system that provides distilled makeup for the old plant as well as the new, since the cycles will be interconnected.

This station lays no claim to the lowest heat rate on record, nor to the lowest cost per kw installed capacity, but engineers and operators will consider the project well worthwhile if it proves reliable in operation, requires a minimum of maintenance, is simple to operate at reasonable cost.

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