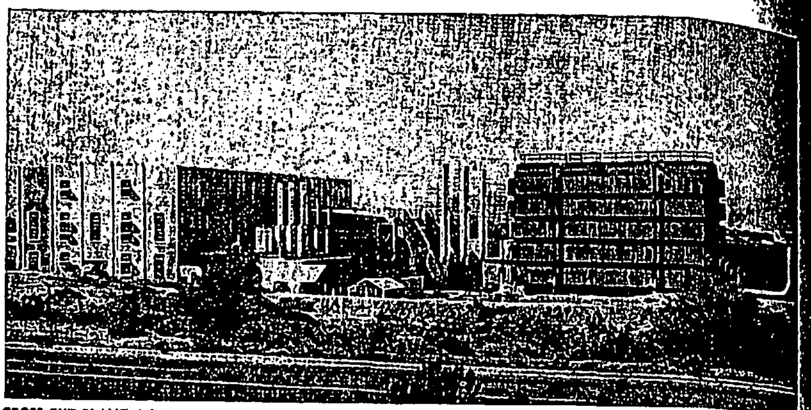
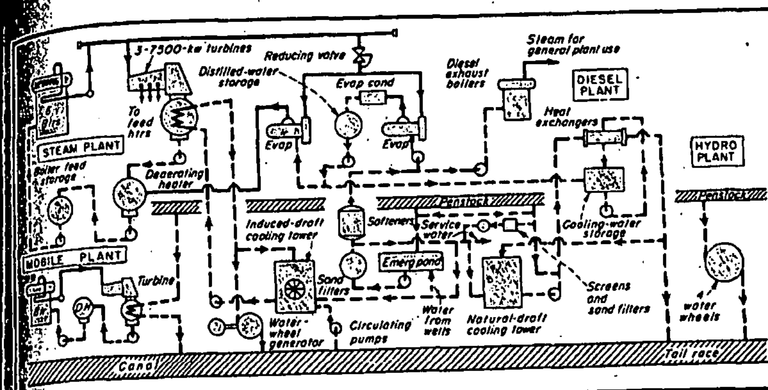


CROSS CUT PLANT: left, building housing diesels and turbines; center, diesel exhaust stacks with boilers and their stacks behind; right, natural-draft cooling tower with induced-draft tower and oil-storage tanks behind it. Emergency storage pond is at rear



CROSS CUT HOOKUP: Four plants (steam, mobile, diesel, hydro) connect through an essentially common water system. Note provision for supplying cooling water from either towers or tailrace, and waterwheel recovering part of pumping energy

Project History. Although ancient remains indicate cultivation in prehistoric times, irrigation by white settlers began about 1867, but erratic river flow and consequent need for storage made these efforts relatively ineffective. Under the Reclamation Act of 1902, the U. S. Government financed and built Roosevelt Dam to create storage and regulation for the waters of the Salt River. Placed in service in 1910 and completed in 1911, this project included a complete system of canals and laterals, and a supplemental water supply was made available by pumping plants tapping underground water. To supply power for pumping and other project operations, hydro-generating capacity was installed at Roosevelt Dam and at four drops in the main canals, with the necessary transmission lines and other distribution facilities.

In November 1917, the project was turned over to the farmers as a going concern, subject to payment of the unpaid balance on construction costs. They formed the Salt River Valley Water Users' Association (SRVWUA), a corporation in which each share represents an acre of land owned. From 1922 to 1930 the Association built Horse Mesa, Mormon Flat and Stewart Mountain Dams and power plants on the Salt River below Roosevelt Dam. It also participated in construction of the Cave Creek Flood Control Dam. The years 1935-39 saw construction of Bartlett Dam on the Verde River and spillway improvements at the four Salt River storage dams by the U. S. Bureau of Reclamation. The map shows location of hydro plants and the watershed supplying them, while table on p 95 lists essential data on dams and hydroelectric plants.

Water System. The water system of today is not essentially different from that of 1939. The Salt and Verde Rivers furnish the main supply, draining about 13,000 sq mi of mountain watershed varying in elevation from 1300 to over 9500 ft. The four storage reservoirs on the Salt River form a continuous chain of lakes nearly 60 miles long and, with Bartlett reservoir on the Verde River, will hold 1,954,000 acre-ft of stored water, enough to cover the project's *irrigated lands to a depth of over eight feet.* To furnish additional water and to control ground-water table in the farming area, 200 pumping plants are installed.

Granite Reef Dam, below the confluence of the Salt and Verde rivers, diverts water into the two main canals: Arizona Canal serving the north side of the project, and South Canal the south side. Combined capacity will permit use of all river flow up to 4000 sec ft. Bartlett Dam on the Verde and Stewart Mountain Dam on the Salt River regulate irrigation flow. From the two main canals water is diverted to secondary canals and laterals which serve the farms. Annual water use varies from three to five acre feet per acre, depending on rainfall and crops grown.

Power System. In the original development, provision was made for taking advantage of the 723-ft fall between high water at Roosevelt Lake and tail water at Stewart Mountain Dam to generate power *for the project's own use* and for its farms. Thus Horse Mesa, Mormon Flat and Stewart Mountain Dams are primarily power dams although they add 373,000 acre ft to storage. The four plants on the Salt River have a combined capacity of 94,500 hp and four other hydro plants on the canal system in the valley add 12,000 hp to make a total of 106,500 hp.

As a major source of power in the state of Arizona, it was natural for the Association to dispose of power above its own needs and those of its shareholders so that today its 1850 miles of transmission lines and 27 substations furnish wholesale and retail power to copper companies, to various public utilities, which serve towns in three counties, and to *many irrigation districts, which depend on pumped water* for their irrigation.

Load Growth. This growth in importance of the power phase of operations introduced some new factors into the picture. Load growth tended to become independent of the project's irrigation development program and new requirements of service continuity were imposed. The need for firm power became acute in 1937 and since that time has been a more or less continuous problem. The Cross Cut plant, to be described in some detail because of its unusual features, now provides a total of 51,000-hp firm capacity. Construction in 1940 of a 140-mile transmission line from Parker Dam to Phoenix makes available power from the Colorado, and steam plants of the Central Arizona Light and Power Co and Inspiration Copper Co are also interconnected with the Salt River system. Nevertheless, as will become clear later, additional firm power is still needed.

CROSS CUT PLANT

To divert a large part of the water from Arizona Canal to Grand Canal by a short route, the Cross Cut Canal was built, and since there was some 100-ft fall between the canals, a hydro plant was installed in 1914. As built by the Bureau of Reclamation, the original Cross Cut plant had six 800-kw 25-cycle generators driven by Pelton wheels. Later modernization of the hydro plant and installation of a frequency changer and diesel and steam prime movers made this Cross Cut plant the nerve center and major unit of the Salt River system.

In the hydro plant, three of the original generators were removed and the space made available was used for installation of a 3000-kw generator driven by a francis wheel, better suited for the head conditions than the original wheels, and of a 9000-kw frequency changer. This conversion unit became necessary in 1940 when the Parker Dam tie brought 30,000 kw of 60-cycle power to the Cross Cut bus. Two other frequency changers are on the system, one rated at 3000 kw, and the other at 1800 kw.

Diesels Put In. Water shortage in 1936-37 brought home the need for standby power on the Salt River system, and in 1938-39 two 7000-hp double-acting 2-cycle diesels were installed, then the largest engines put into service in this country (five identical units are installed at Vernon, Calif.). Continued load growth, however, required that these 5000-kw units serve as base-load machines practically from the date of first operation. They have operated nearly 80% of the hours since their installation. Continuous preventive maintenance has kept them on the line for these long periods without major overhauls until now. Both engines have just gone back into service after thorough reconditioning.

Steam Installation. By 1940, an even greater need for firm power existed and it was decided to build a steam plant at Cross Cut. Under the general direction of Clyde R. Williams, Supt of the Cross Cut plant, C C Moore Co designed and installed three outdoor 100,000-lb-per-hr boilers and three 7500-kw turbine-generators in a steel-frame structure extending the building originally housing the two diesels.

Choice of diesels and steam was largely dictated by circumstances at the time of the installations, with quick delivery paramount. It then remained to integrate these units with the existing hydro plant, to make an effective and efficient generating station. The one-line diagram above shows how this was done, representing the plant as it is today.

Cooling-Water Hookup. The diesel engines now operate with a closed cooling system, served by a natural-draft cooling tower, with three heat exchangers, for the two engines. Makeup water comes from two sources: wells at the plant and at Indian Bend discharge into a 750,000-gal emergency storage pond, and water is taken from the canal at the hydro-plant penstock. Makeup is screened and sand-filtered before admission to the towers. Circulating water for the steam-plant condensers normally comes from an induced-draft cooling tower, but can also be pumped from the tailrace of the hydro plant by a separate set of pumps. In summer months, when the cooling towers become less effective under high wet-bulb conditions, both diesels and steam condensers are cooled by canal water, which is available at lower temperatures. Water discharged from the condensers passes through a waterwheel at the tailrace elevation; power thus generated offsets about 70% of the extra pumping involved.

Boiler Feed. Makeup water for the steam plant is drawn from the storage pond and sand filtered and softened. It then is evaporated and the distilled water stored in the boilerhouse. A second evaporator draws from the distilled-water tank to supply the boilers. Using now mainly canal water, which is better