heaters. The reheaters can be blown out with low-pressure steam at high velocity through the turbine-bypass system.

Although much has been learned from both of the programs described, it is planned to operate both units indefinitely or until all aspects have been fully investigated.

Discussion

R. B. Donworth.[3] Are the irregular deposits of slag in the furnace likely to move the transition point to a less desirable place in the circuit?

G. W. Kessler.[4] This group of three papers[5] is an excellent presentation of the over-all concept of Eddystone unit No. 1, the background experience, and the continuing research and re-evaluations which are so necessary in a project of this type and magnitude.

In reviewing the papers, it is striking to note that many commonly accepted design features have been retained and utilized in the component equipment—and that there is good experience and research upon which the advance to supercritical-pressure units can be predicated.

In the development of supercritical-pressure steam generators greater emphasis must be placed on many of the design features and considerations which are taken for granted in the average unit. High-quality feedwater is an absolute necessity. Surface configuration and flow distribution are all important and, as the author points out, there is always more than one way to attain the desired end. Often, the best features of several possibilities are used. Special equipment—in the way of bypass lines and steam pressure and temperature-break-down valves—must be provided for start-ups, shutdowns, and emergencies. Finally, the controls must closely co-ordinate all components in the system and provide the extreme flexibility required.

In this country, eight once-through steam generators— two for subcritical and six for supercritical pressure—have been ordered to supply the steam for turbogenerators ranging in size from approximately 100 to 450 mw. All of these eight jobs required, and got, the excellent teamwork described by Mr. Harlow. The first unit—at Philo—is now going through shake-down operations, and the 450-mw units, which were ordered this year, will be placed in commercial service in 1959. Thus within the next three years the information derived from their final costs and their operating performance will form the plateau upon which future decisions regarding advance in steam pressures and temperatures can be made.

Their success in reducing the heat rate per kilowatt hour will set goals for both the users of fossil and atomic fuels and will contribute to keeping electricity America's best bargain. However, none of these accomplishments could have been possible without the courage and foresight of the utilities and the manufacturers to pioneer and develop new concepts on a commercial scale.

[3] Vice-President, Duquesne Light Company, Pittsburgh, Pa. Mem. ASME.

[4] Chief Engineer, Boiler Division, The Babcock & Wilcox Company, New York, N. Y. Mem. ASME.

[5] This discussion also includes a discussion of ASME Papers Nos. 56—A-165 and 56—A-156, published in this issue of the Transactions.

E. P. Partridge.[6] All those engaged in the adventure into the supercritical deserve our admiration. While applauding wholeheartedly their imagination, their courage, and their technical genius, the writer wishes to repeat one small warning[7] of a possible difficulty apparently not considered in translating the once-through boiler from the subcritical to the supercritical level of operation.

In brief, when the molecules of water are packed tightly together at 5000 psi and the water is then heated to 1200 F, its ability to dissolve iron oxide is increased significantly. If enough iron oxide is dissolved on the way through the generator, it may deposit in the turbine as reduction in pressure and temperature brings the water down again into the domain of ordinary steam as we have known it.

Will the turbine actually foul with iron oxide derived from the tubes in the generator? Only actual operation seems likely to give a sure answer. We shall watch eagerly for the reports from the first truly supercritical power plant, which started up during 1956 at the Chemische Werke Hüls in the Ruhr, and from the Philo plant of American Gas and Electric Service Corporation, which should be in operation in 1957.

Author's Closure

Mr. Donworth has questioned the effect of accumulation and shedding of ash on the furnace walls particularly with respect to the location of the transition from water to steam. This location, of course, depends on the relative heat absorption of the water heating surfaces and steam heating surfaces. There are two factors in the design and control of this unit which influence the distribution of heat.

The first factor is the use of tilting burners to regulate reheat steam temperature. This compensates for the over-all effect of furnace ash deposits and keeps the total heat absorption of the furnace walls essentially constant at a given load.

The second and over-riding factor is the feedwater control. The feedwater flow through the economizer, water walls, and transition section is automatically adjusted in accordance with heat absorption in these surfaces to keep the transition point in the desired location. The index is steam temperature at the outlet of the transition section. The water added at the desuperheaters is adjusted in accordance with heat absorption in the superheater surfaces to maintain the desired final steam temperature.

Mr. Kessler and Dr. Partridge have highlighted the interest which attends the initial operation of the three subcritical pressure and six supercritical pressure once-through units already purchased in this country. We have every confidence that the monotube boiler will prove to be a valuable tool in the future development of electric power generation. Dr. Partridge's comment regarding the solubility of iron oxide has not been left unconsidered. Our research program has included an investigation of this possibility but the results to date do not indicate the likelihood of trouble from this source with proper water treatment.

In closing we wish to thank all of the discussers for their interest, their questions, and their comment.

[6] Director, Hall Laboratories, Pittsburgh, Pa. Mem. ASME.

[7] "Water Problems in Power Generation at Supercritical Pressures—or Through the Looking-Glass," by E. P. Partridge, *Mechanical Engineering*, vol. 77, 1955, pp. 883-885, 901.