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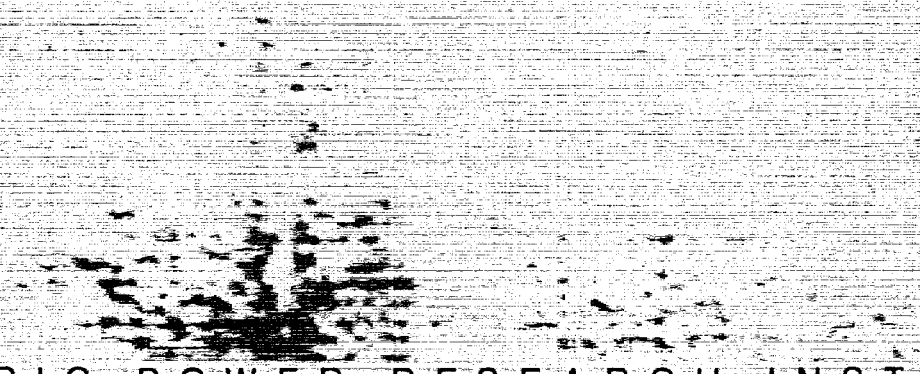

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ACHIEVING TECHNICAL PERFORMANCE

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Introduction The group discussions relating to achieving technical performance addressed the facilities for handling, conversion and utilization of geothermal energy for electric power production. The discussion specifically excluded reservoir performance as this was the subject of a parallel workshop.

It became obvious during the session that time would not permit adequate coverage of the topic without extensive generalization in areas where the problems are not generic but in fact very site specific. The problem of achieving technical performance can be totally different from one site to the next depending on the characteristics of the energy source and the site conditions that may affect the facility design.

Under these constraints, the group addressed the issue of performance achievement as related to standards of measurement or goals. It was generally agreed that an acceptable measure of performance should relate to plant availability. If the plant has a high annual availability factor, then it should be capable of sustaining a good capacity factor as well. While there was no overwhelming agreement on the concept that plant availability would necessarily equate directly to capacity factor, it was generally accepted by the group that plant availability was a good measurement of acceptable technical performance. A goal of 90 percent was proposed by the group.

Performance Problems The problems relating to achieving technical performance identified by the group are summarized below. The problems cited are not necessarily generic but rather related to the knowledge and experiences of members of the discussion group based on operating experience, special studies, or research and development work. They covered Geysers dry steam operation and hydrothermal direct flash and binary facilities.

- Production Well Piping

  Reliability and cost continues to be a problem. Where downhole pumping is required on the low to medium temperature hydrothermal reservoirs, redundancy is the current solution to achieving good plant availability. For the moment it appears that industry will solve this problem.

- Well Completion

  Representatives of the CFE indicated that problems are being experienced at Cerro Prieto with well casing and joint seal failures. This problem has had a continuing impact on steam production and requires a high well redundancy ratio in order to support their capacity factor goals. They believe this problem can be solved by industry without need for any special R&D.

- Steam Separation and Scrubbing

  Technology and equipment for steam separation and scrubbing appears to be in hand based on limited operational experience. Performance is generally predictable. However, scaling and fouling problems are site related, not generally predictable and require equipment outages for descaling. Solutions are not generally available on a generic basis.

- Two Phase Flow

  Problems of designing for two phase flow are not well defined. To date, system designs have avoided two phase flow through the use of well head separators, pumped wells and production island concepts. Some form of R&D would be useful to the plant designer. Indications are that two phase systems are being successfully operated in Japan.

- Steam Quality Measurement

  Maintaining design steam quality in a hydrothermal flash cycle is primarily a function control dynamics and separator/scrubber performance. The consequences of decreasing steam quality which usually result from deteriorating separation performance, are solids buildup in the turbine and reduced turbine performance.

  The consequences of low steam quality could be materially reduced if online steam quality monitoring was available to the plant operator. According to the members of the discussion group, online equipment of this type is not available. Further investigation was recommended.

- Environmental

  H_2S abatement systems are being installed at The Geysers which employ technology developed for other industries. Other new concepts are also being tested for next generation applications. According to discussion group members, ongoing development of alternative processes will be necessary before this problem is fully and economically controlled.

  Another problem area involves condensate pH control when ammonia is present. Online monitoring techniques are not presently available to the plant operator for proper control. Hardware development is needed in this area.

Summary In relating technical performance to the goal established at the beginning of the discussions, the consensus of the group, in the opinion of the writer, on the status of achievement can be summarized as follows:

1. Geysers dry steam is in a commercial operation mode but still experiencing operational and environmental problems that must be resolved if full success is to be achieved.

2. Hydrothermal flash steam is in a commercial operation mode around the world and on the threshold within the United States. At Cerro Prieto the CFE appears to be achieving 90 percent availability.

3. Commercial acceptance of the binary cycle by industry will not occur until the process is successfully proven in a demonstration plant.