Construction of Oyster Creek Nuclear Reactor*

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Introduction

The Oyster Creek Nuclear Power Plant at New Jersey, USA, was the first of the large scale plants built under turnkey contract between Jersey Central Power and Light Co. and the General Electric Co. The BWR unit, had a guaranteed capacity of 540 MW gross electrical with a designed capability of 670 MW and had been built at high cost because many features differed from conventional pressure vessel units.

The station has had one increase in its initial licensed capacity from 540 to 583 MW. A licence application is pending before the USAEC to uprate to 620 MW. Oyster Creek has demonstrated its reliability in the first 20 months of operation by producing approximately 7,000,000 MWH of power before its first shutdown to remove the poison curtains.

Welding Problems

During construction of the station special field welding requirements were experienced and some of the welding probelms encountered were overcome. Some welding difficulties were due to jurisdictional disputes which may not be encountered at other locations. Examples of these problems are given below.

1. The first requirement for welding came in the installation of the reinforcing steel for the structures. A number 18 bar was used which was 2¼" in diameter, and economical considerations did not allow lapping of the bars to develop full bond but instead required welding. It was elected to do this welding by the Cadweld process (similar to Thermit) in which 85% of the strength of the bar was developed. The quality inspection and control required cutting out a representative number of samples at random and testing to determine if the strength of the bar was fully developed. These cutouts were replaced by two other Cadwelds. With this reactor, the criterion of acceptance was not clear, and some of the AEC definitions were not adequate. Difficulties were accentuated by construction of the reactor building before designs had been fully completed, but conservative design of foundations had helped. First work commenced nine months after signing of the contract.

2. A problem arose on the high radiograph rejection rate of welding the torus suppression chamber plates. The torus had a major diameter of 101 feet and the cylindrical segments had a diameter of 30 feet with a shell thickness of 0.385 in. After investigation of the high reject rate it was noted the film had been switched and it was so sensitive that scratches on the welds were being detected. Thus there was corrective grinding and rewelding for apparent defects which were of no concern. Film sensitivity was an important consideration in an examination.

3. Another problem concerned trade disputes and involved the 4 feet diameter steam distribution pipe in the torus around the vessel. Some trades regarded this as a vessel and thus in the province of boilermakers for its welding and fabrication. However, pipe fitters felt that it was a pipe and subject to their operations.

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4. During the first hydrostatic test on the reactor vessel, in the field near the end of construction, a small leak was detected in the vicinity of the control rod drive nozzles. During the reinspection of the field welds using dye penetrant, the dye was accidentally sprayed on the side of a control rod drive nozzle. Small cracks were noted which led to further dye checking over all of the surface of the 137 control rod drive nozzles and it was noted that cracks appeared on all of the nozzles. The nozzles were shop-fabricated of Type 304 stainless steel which had been installed in the vessel prior to heat treatment. The heat treatment apparently sensitized the material and made them subject to stress-corrosion cracking in the order of 1/8″ to ¼″ long. After a thorough investigation it was finally decided to overlay the nozzles with Type 308 steel to prevent the possibility of continual propagation of the cracks. The investigation and the overlay welding of the nozzles resulted in a plant delay of approximately one year. Welding equipment had to be developed to weld the nozzles of varying lengths which were in the bottom of the spherical head of the vessel.

5. Since Oyster Creek was cooled by seawater, it was decided to weld the condenser tubes to the tube sheets for leak tightness. Automatic welding equipment was developed by Phelps Dodge and they provided the supervision for this operation. The guns required a cycle for each tube of about 12 seconds per tube and were of very light construction. Whereas it was possible to weld 1200 to 1500 tubes per shift per gun, this rate was never accomplished in the field. The average ran about 300 tubes per shift, partly due to trade restrictions and because damage to guns was fairly high due to their light construction. If downward pressure was applied to the gun when a tube was being welded the weld would be skipped at the top of the run and thus an unsatisfactory weld would be produced which required chipping and rewelding.

6. One of the criteria for pipe welding that considerably increased the manhours for the job over the estimated time, was the use of fusible insert welding for all systems with possible radioactive contamination. While this was a necessary requirement, it was not forseen in the original stages of the Oyster Creek project. The manpower requirements were considerably increased due to the requirement of having a second welder to watch the root run of the pipe weld. The pipe fit-up time was increased and the quality control of the pipe end preparation became critical. The out of roundness of rolled and welded pipe added to the problems. Also, although most piping was conventional carbon steel, many of the arguments which occurred on the nuclear plant were also carried over to the conventional portion of the plant.

7. Jurisdictional disputes arose over the welding of the electrical penetrations to the primary containment vessel. The operation was claimed by both the Electricians and the Boilermakers, it was finally resolved by having the Electricians weld on the inside of the vessel and the Boilermakers on the outside, with all being qualified to move their capability of welding to the required standard.

8. While there was tight control on bleed steam piping, it was noticed in the X-ray of the weld to the turbine/generator nozzle that defects existed which did not give a sound system. Considerable repair of the nozzles was necessary to bring the nozzles up to the pipe requirements. Normally the turbine/generator was not required to meet code requirements. However, experience had dictated that restrictions were necessary on this equipment to meet the required integrity of the system.

Conclusion

From this experience, it might be possible to indicate what industry should do in preparation for this type of operation. It was a good time to look closely at the overall problem and learn from the experience of those that struggled through the early stages to develop the criteria for plants being built today. It was essential to plan and design properly before commencing the operation. Construction personnel would wish to freeze designs and resist any changes during construction. Separate quality control departments would be essential and, where these did not exist, they would need to be set up. Industry should be able to go into the business fully knowing the requirement which should reduce the chance of financial loss which has been experienced by those that started in this field in the early stages.