FINAL REPORT

ECW GANTRY CRANE DESIGN DEFICIENCY

I. SUMMARY

The South Texas Project Electric Generating Station FSAR identifies the ECW Gantry Crane as a Seismic Category I structure. The STPEGS FSAR also requires that Category I structures be designed to withstand the effects of a design basis tornado. Contrary to these commitments, the ECW Gantry Crane which was purchased for the STPEGS, was not fully designed to meet these requirements. This crane has been manufactured and delivered to the Site.

The cause of this deficiency was a breakdown of the design change control program. This crane was designated as being non-safety related and, as a result, neither the design nor changes thereto were subjected to the design verification process.

The corrective action will be to extend the crane rails approximately one hundred feet beyond the building so that the crane can be parked and locked if tornado weather conditions exist. Concerning recurrence control, Engineering procedures have been revised to place the design of non-safety related Category I structures under the formal design verification program. This change has been identified as being retroactive.

Based upon calculated values, the ECW Gantry Crane in its original configuration, could fail during a design basis tornado and impact the ECW Intake Structure, which houses the Essential Cooling Pumps. In the redesigned configuration, such a failure is precluded.

II. DESCRIPTION OF THE INCIDENT

A. Component Description

The ECW Gantry Crane is designed to service the ECW intake structure. Its main function is to perform maintenance on the equipment within the structure. This includes lifting pumps, motors, strainers, piping, and if necessary, the entire traveling water screen, as well as the trash containers at the ends of the structure. The Crane is designed with the following characteristics:

a.	Capacity of crane/hoist	20 tons
b.	Crane span	65'
c.	Total span = span + cantilever span	98'-3"
d.	Maximum lift of hoist	76'
e.	Length of runway	136'
f.	Maximum full load speed of hoist	20'/min.
g.	Speed of trolley	76'/min.
h.	Speed of bridge	100'/min.
i.	Maximum pass through width of Gantry legs on the cantilever end of crane	13'
j.	Maximum pass through height of Gantry legs on the cantilever end of crane	49'

Bridge, sills, and gantry legs are constructed from A-36 welded box girders. Full depth diaphragms are used when possible. The crane is designed in accordance with CMAA specification 70.

The crane is a non-safety class component. Its location (on top of the ECW Intake Structure) requires it to meet the seismic Category I requirements. The fact that the ECW Crane will operate above safety equipment (ECW valves & pumps, etc.) also places the crane under certain operating limitations.

The crane will not carry a component over any other ECW cubicle. This means that each lift operation will have to be conducted within each ECW cubicle or between the cubicle and the outside laydown area. Operating limitations will preclude the crane from being operated during adverse weather conditions. Also, the crane is not operated during high wind (30 mph or above) conditions. An alarm will sound when 30 mph wind is detected by the anemometer which is located on the top of the Gantry Crane.

B. Source and Extent of the Deficiency

Table 3.2.A-1 (Sheet 17 of 21 of the FSAR) identifies the ECW Gantry Crane as a Category I structure and Subsection 3.3.2.1 of the FSAR requires Category I structures to be designed to withstand the effects of a design basis tornado. Subsections 9.2.1.2.2.3 and 3.5.1.1.3 together commit that the crane will not fail so as to impact the ECW structure. The design basis tornado loadings on the crane were 360 mph.

Contrary to the above requirements, the specification for this crane (No. 7P200NS061) failed to properly specify the correct loadings. The following sequence of events led up to this situation.

- The bid specification did not contain any requirements to design the crane structure to withstand tornado loadings, but such loadings were specified for locks and clamps.

- During part of the technical review process, this deficiency in the specification was discovered.

- Each potential supplier was contacted via telephone and informed that the requirement for tornado loadings was to be added. All potential suppliers acknowledged the additional requirement in writing, except for the eventual successful bidder who stated verbally that the additional requirement would pose no problem.

- Following the award of the purchase order, the specification was revised to include the tornado loadings. Unfortunately, the tornado loadings were not included in the main body of the specification, but were listed in the attachment concerning seismic loadings. The wind loading for the locks and clamps was 400 psf, which is approximately equivalent to the 360 mph tornado loading.

- Approximately two months after the purchase order for the specification was issued, the crane supplier sent a letter to B&R stating that further evaluation of the crane structure indicated it could not be designed to the tornado wind loading requirements even though the locks and clamps could accommodate the 400 psf loadings. B&R failed to respond to the letter. The crane supplier repeated this exception during a meeting with B&R a short time later. Again, the crane supplier's exception received no response.

- The ECW Intake Structure (upon which the crane rests) is designed to include the moments and reactions for tornado loadings on the crane when the crane is parked over the cross walls.

- The crane has been designed, fabricated, and shipped to the STPEGS Site.

In summary, the inconsistencies in the specification, combined with the failure of B&R to follow-up on the crane supplier's exception caused the deficiency in this crane to occur. The Engineering procedures were deficient because they did not provide proper means for detecting and correcting this deficiency, as explained below.

III. CORRECTIVE ACTION

A. Design Correction

Following the discovery of this deficiency, several design corrections were considered.

From these considerations, the current design correction was selected. It was determined that the crane rails would be extended a sufficient distance from the structure that in the unlikely event of a tornado wind induced failure of the crane, none of the crane structure would impact the Essential Cooling Water Intake Structure. This alternative was chosen primarily because of its operational and safety advantages.

As stated earlier, the structure, rails, and locks and clamps were designed to withstand the forces generated during a design basis tornado. Thus, it was most practical to design extensions to the rails on the same basis. Design calculations showed:

1. The crane will turn over before experiencing a structural bending failure.

2. The crane will not become an airborne missile by the design basis tornado loadings.

3. A side turn over was no impact on safety.

4. For an object to be safe from an impact of the over-turning crane, the crane must be parked at least 92 feet away.

Thus, the corrective action will provide for the ECW Gantry Crane to be normally stored on a rail structure that is 100 feet long extending North from the Essential Cooling Water Intake Structure. The 100 foot distance provides for the 67 foot over-turning clearance plus the 25 foot width of the crane plus 8 feet of margin. An artist's concept of the final design is shown in Figure 1. The crane rails and storm locks will be designed to withstand the forces created by a design basis tornado. During maintenance periods, the crane will be moved to a parked position over the cell in which the work is to be done. Operation limitations will be placed such that the crane must be moved back to its stowed position to preclude exposure to tornado loadings while operating over the ECW structure. The extension of the crane rails can be made without modification to other safety related structures, systems, or components.

B. Actions to Preclude Recurrence

Under the B&R Engineering design control system, formal design verification is required for those structures, systems, and components whose function is safety related; i.e., as described in Regulatory Guides 1.26 and 1.29. The design verification program meets or exceeds the requirements of ANSI N45.2.11. This program did have one weakness, however, which allowed this deficiency to occur. Formal design verification failed to include those structures that were classified as non-safety related Seismic Category I. The Engineering Procedure on Design Verification was revised to correct this deficiency. The provisions of this revision were made retroactive.

IV. SAFETY ANALYSIS

When the design error was discovered, an analysis was conducted to determine the effect on safety. It was assumed that under the postulated tornado loading, the bending moment in the legs of the crane would exceed the design resisting moment and bending would occur. Neither the locks and clamps nor the ECW Intake Structure supports would fail since their design margin is adequate. When bending occurs, it was assumed that the ultimate strength of the A-36 material would be exceeded and the crane girder would impact the ECW structure. Since the roof of the ECW Intake Structure was not designed to withstand such an impact, the roof was assumed to fail and impact the ECW pumps.

In the safety analysis for the design correction, the following assumptions were made (or validated):

- Except during maintenance periods, the crane will be in a parked and locked position at the end of the extended rails.
- Maximum tornado wind loading is assumed to occur normal to the longitudinal axis of the crane.
- The failure mode is an over-turning crane instead of a bending moment failure, as originally assumed.
- Sufficient warning of potential tornado conditions will be provided to move the crane to its parked position.
- The tornado is assumed to occur concurrently with a postulated single failure.

- The tornado loadings are assumed not occur at the same time as a seismic event.

- An assumed turn-over to the side or a backward turnover will not produce a loss of the ECW function.

- The crane cannot impact the ECW Intake Structure while the crane is in a parked position.

Thus, based on the above assumptions, the design correction is demonstrated to present no safety hazard to the safety related ECW structure.