APPENDIX A

U. S. NUCLEAR REGULATORY COMMISSION
REGION IV

NRC Inspection Report: STN 50-482/85-13 Construction Permit: CPPR-147

Docket STN 50-482

Licensee: Kansas Gas and Electric Company
P. O. Box 208
Wichita, Kansas 67201

Facility Name: Wolf Creek Generating Station

Inspection At: Wolf Creek Site, Coffee County, Burlington, Kansas

Inspection Conducted: January 2 through February 23, 1985

Inspector: L. E. Ellershaw, Reactor Inspector
Project Section A, Reactor Project Branch 2 — Date 2/25/85

Approved: L. E. Martin, Chief, Project Section A
Reactor Project Branch 2 — Date 2/25/85

Inspection Summary

Inspection Conducted January 2 through February 23, 1985
(Report STN 50-482/85-13)

Areas Inspected: Routine, announced, inspection of licensee's corrective action on AWS structural steel welding.

The inspection involved 63 inspector-hours onsite, and 64 inspector-hours offsite by one NRC inspector.

Results: Within the one area inspected, no violations or deviations were identified.

DETAILS

1. Persons Contacted

Principal Licensee Employees

*P. Dyson, Field Engineering Supervisor
*J. Fletcher, Supervisor, Quality Control
*R. Grant, Director, Quality
*H. Chernoff, Licensing

Bechtel Power Corporation

C. M. Herbst, Assistant Project Engineer

The NRC inspector also interviewed other licensee and Bechtel personnel.

*Denotes those attending the exit interview.

2. Licensee Action on Previous Inspection Findings

(Closed) Violation (482/8422-01) This item dealt with an inspection program for safety-related structural steel field welds not being adequately executed to assure conformance to requirements, nor were adequate records kept to document the quality of the welds.

KG&E's corrective action commitments included a 100 percent visual reinspection of all accessible structurally significant safety-related structural steel field welds. Accessible is defined as those joints which are not embedded in concrete. The structurally significant welded joints were identified and defined by Bechtel as being those field welded joints which support or potentially support safety-related equipment and building components. Reinspection was to be performed by AWS (American Welding Society) certified welding inspectors (CWIs), who were also certified as Quality Inspectors by Daniel International Corporation (DIC), the constructor. Inspection criteria to be used were procedurally defined and any supplemental training required would be completed prior to initiation of the reinspection activity. Adequate technical justification was to be provided by Bechtel to validate the result of visual examination (VT) of painted welds. The reinspection results were to be documented in inspection data sheets which were to delineate the design requirements with respect to joint geometry and individual weld characteristics. The CWIs were instructed to record the inspected as-built condition of all accessible welds, with signature and date of inspection. All identified deficiencies were to be documented in nonconformance reports (NCRs) which, together with the inspection data sheets, were to be provided to Bechtel so that a case-by-case evaluation of each structurally significant joint could be performed. The evaluations were to determine whether each welded

joint's as-built condition met design allowable stresses at maximum loading condition, or represented a significant deficiency as defined by 10 CFR Part 50.55(e), or rework/repair was required.

KG&E's final report addressing the violation, dated January 21, 1985, includes Revision 1 to Bechtel's "Final Report on the Evaluation of AWS Field Welding on Structural and Miscellaneous Steel at the Wolf Creek Generating Station," dated January 19, 1985.

Bechtel's report identified 2670 structurally significant and safety-related field welded joints which required reinspection. The joint inspectability data shows:

2403 joints were completely inspected
165 joints were partially inaccessible
102 joints were totally inaccessible

The results of the CWIs inspection efforts showed that of the 2403 joints that were completely inspected, they accepted 1305 joints and rejected 1098 joints for various material and weld deviations. The report further shows that of the 2670 total joints, 82 joints required rework/repair due to defective conditions which caused the design allowable stresses to be exceeded in the as-built condition, and 81 additional joints were identified as requiring rework/repair due to KG&E's commitment to install missing material and missing and underlength welds (unless prohibited by field conditions) even though the design allowable stresses had not been exceeded. It was determined that field conditions did preclude the rework of 14 of the 81 joints, therefore, Bechtel dispositioned the applicable NCRs as "Use-As-Is."

In order to assess the adequacy and implementation of KG&E's committed corrective actions, the NRC Region IV inspector accompanied CWIs on several occasions to observe and verify their inspection activities and to assure that the results of the inspections were being accurately recorded. In addition, the NRC Region IV inspector conducted independent inspections on selected joints with subsequent comparison to the CWIs inspection data sheets. There were no discernible differences in inspection results obtained by the NRC Region IV inspector and the CWIs during either the accompanied or independent inspection activities. This created a very high level of confidence in the data being documented by the CWIs during the reinspection program.

The NRC Region IV inspector reviewed inspection data sheets and applicable NCRs for approximately 1750 welded joints, including 149 data sheets and 34 NCRs associated with the joints that were repaired. In addition, and subsequent to the completion of the reinspection effort, the NRC Region IV inspector performed an inspection on 42 of the 149 repaired joints, with acceptable results. It was noted that magnetic particle examination (MT)

was also performed on 24 of the 149 repaired joints with acceptable results.

Of potential concern was the reconciliation of the as-built conditions to the design drawings. This was resolved by Bechtel in that they are identifying all NCRs applicable to field welded/structural steel joints on Drawing No. C-1045. Note 46 in Revision 1 to Drawing No. C-1003, "Civil-Structural Steel and Concrete General Notes," states in part, ". . . See the shop detail drawings and appropriate nonconformance reports identified on Drawing C-1045 for connection details."

With respect to the 102 joints identified as being totally inaccessible due to their being embedded in concrete, 62 were acceptable as is because evaluation showed that the concrete was capable of supporting the design load, thus eliminating any concerns with respect to defective welds. It was also noted that 165 joints were partially inaccessible; however, sufficient inspection data was available on 139 of the joints to allow an evaluation to be performed. This leaves a total of 66 joints out of 2670 which could not be evaluated. The basis by which Bechtel accepted these joints was through statistical analysis, and is considered proper logic. If the 2604 fully evaluated joints are considered a sample of the 2670 total population of joints, then the sample size represents such a large percentage of the total population that statistics associated with the sample may be applied to the total population with virtually 100 percent confidence. This implies that if a percentage of inspected joints were determined to exceed design allowable stresses, then statistically this percentage may be applied to the total population.

Of the 2604 joints which were evaluated, 82 joints (3.14%) were identified in which the design allowable stresses were exceeded. Analysis has shown that those joints would not have failed under the design loading conditions. However, 60 of the 82 joints were polar crane radial stops in which the same welds were missing in each joint and the design allowable stresses were exceeded. In addition, six pressurizer support joints had the same welds missing in each joint, three of which exceeded the design allowable stresses. Thus, a total of 19 joints in the remaining population of 2541 joints (0.75%), exceeded the design allowable stresses. It should be pointed out that the cause of the missing identical welds in the 60 polar crane radial stops and the 6 pressurizer supports is attributable to the failure of the detail drawings to provide a clear understanding of the weld details. This is considered an isolated condition and was substantiated by the NRC Region IV inspector's review of the applicable structural steel detail drawings delineating the welded joint configurations.

The 0.75% statistically applied to the group of 66 joints which could not be evaluated, results in less than 1 joint in which the design allowable stresses could be expected to be exceeded. It would also be expected that

none of these joints would fail under the design loading conditions as a result of defective welds.

Incorporated into the KG&E report is Bechtel's engineering position for VT, in accordance with AWS D1.1, of painted welds. In summary, their position states that "fillet welds which have been coated with up to 4 mils of primer and, in some cases, up to an additional 10 mils of topcoat can be visually inspected to the AWS D1.1 acceptance criteria. Those attributes which cannot be fully evaluated are of little concern on the structural steel at WCGS." Those attributes identified as being capable of being fully evaluated to the design requirements and AWS D1.1 acceptance criteria are: weld presence and location; weld length; weld size; weld profile; fusion; overlap; cross-section of weld craters; coarse undercut, and large porosity. The attributes identified as being more difficult to inspect, or not being visible at all, include: tight weld cracks; fine porosity, and tight undercut. A discussion followed in which these attributes were identified as being largely dependent on the metallurgical characteristics of the base metal, welding filler materials, and the ability of the welders. With respect to the metallurgical characteristics of the base metal (ASTM A-36) and the welding filler material (Type E7018 electrodes), compatibility results in sound, crack and porosity-free welds provided certain precautions are taken. The precautions are included in the approved welding procedure specifications used for structural steel welding. A DIC and Bechtel review substantiated that DIC welders involved with structural steel welding were satisfactorily qualified in accordance with AWS requirements.

It should be noted that paragraph 3.10.1, in Section 3 of AWS D1.1-75, states in part, ". . . Welded joints shall not be painted until after the work has been completed and accepted . . . ."

With the exception of one attribute, i.e., lack of fusion, the logic of the Bechtel engineering position regarding inspection through paint appeared sound. The NRC Region IV office requested technical assistance from the Office of Nuclear Reactor Regulation (NRR) in order to arrive at a technically acceptable position.

Specifically, NRR was requested to:

a. Review the process by which Bechtel identified the structurally significant safety-related field welded joints.

b. Review calculations, evaluations, and dispositions as they relate to identified deficient welds.

c. Review the adequacy of Bechtel's position regarding the acceptance of inaccessible welded connections embedded in concrete.

d. Review the adequacy of Bechtel's engineering position with respect to VT of painted welds.

NRR staff visited Bechtel's Gaithersburg, Maryland, offices on November 6, 13, and 27, 1984, to acquire and review information pertaining to the above items. The NRR staff evaluation concluded that:

a. There is little likelihood of any structurally significant safety-related field welded joint not being identified for reinspection.

b. Bechtel's approach of individually calculating stress levels to determine the structural adequacy of the identified as-built conditions is acceptable.

c. There is no deficiency in Bechtel's approach with respect to inaccessible welded joints embedded in concrete, in that the use of statistical analysis and acceptable alternative load path evaluation is proper.

d. With respect to VT of painted welds, the defects which could significantly affect structural integrity, i.e., lack of fusion, undersize and underlength welds, heavy undercut, and missing welds, are all visually detectable and measurable through coatings, except for lack of fusion. NRR further stated that reinspection of welds with coatings for these types of defects, other than lack of fusion, would be acceptable. It was recommended that alternate methods for detection of lack of fusion be addressed.

As a result of NRR's recommendation, the NRC Region IV office requested NRC Region I assistance in performing an independent nondestructive examination (NDE) program at the WCGS. The particular NDE disciplines to be utilized were MT and VT. The NRC Region IV specifically recognized that fine lack of fusion, tight cracks or porosity, might be masked by coatings and that the use of MT might be of significant assistance in helping to determine its existence. One of the goals of the MT was to help establish the validity of the VT of painted welds. The results of the NRC Region I inspection are documented in NRC Inspection Report 50-482/85-12; however, a summary of those results are presented here.

NRC Region I staff, in conjunction with NRC contract NDE personnel, conducted an inspection at the WCGS on February 6-9, 1985, in order to:

(a) determine whether MT can be relied upon to detect rejectable indications through painted coatings;

(b) determine whether VT of coated welds is reliable for detecting critical structural weld flaws; and

(c) perform a sample inspection to verify the adequacy of the previous licensee reinspection.

Four structural carbon steel weld samples were fabricated with known flaws such as tight cracks and porosity in the welds. The samples were 3/4" X 6" X 8" in dimension. These were examined by VT and MT, and then photographed before painting. The samples were then coated with Carboline CZ-11 Primer and the coating thickness measured. The VT and MT examinations were repeated through the coating and the results photographed. The samples were then coated with Carboline 191 HB epoxy, representative of field conditions, and the examinations performed again and photographed. The types of indications noted within these test blocks represented the types of indications that would be encountered with structural welding. The team also indicated that the tight indications in the test blocks were difficult to visually detect and if all the welds were in the as-welded condition, a small percentage of the indications would have been detected visually. Indications wider than the samples would be detected by visual inspection.

The results of these tests proved that meaningful MT can be performed through paint coatings.

The NRC inspectors randomly selected safety-related structural welds in the essential service water system pumphouse (ESWS) and reactor building. The welds were subjected to VT and MT with either the primer or the epoxy coatings applied. The coatings were then removed and the welds were reexamined by VT and MT.

In the ESWS, welds on 6 clip angles were visually examined with Carboline CZ-11 primer coat applied. The dry film thickness for the primer ranged from 1.0 to 3.0 mils. After the primer was removed, the welds were reinspected by VT and MT using the NRC-approved procedure NDE-6, Revision 0, and addendum WC-1-6-1.

The examinations disclosed that three of the clip angle welds were undersized; P-7, P-8, and P-10. Review of KG&E records showed that these welds had been identified as being undersize and were recorded on a nonconformance report. Otherwise, no other deficiencies were noted.

Similar examinations were conducted in the reactor building wherein five structural steel weld joints were VT'd and MT'd for AWS D1.1 acceptability and overall workmanship. The welds had Carboline 191 HB epoxy coating on them. The welds were found to be acceptable.

A sample of 55 welded connnections were selected in the reactor building for VT with primer and epoxy coatings applied. The samples were selected from different elevations in order to provide a sample that had been welded by different welders and at different times. The VT was performed to design requirements and AWS D1.1 acceptance criteria. Five of the

joints had their coatings removed and were reinspected by VT and MT. No indications were found on the welds with coatings or on those that had the coatings removed.

It was concluded that certain characteristics involved in VT can be evaluated effectively on coated welds. There were no characteristics identified during this inspection that could affect the integrity of the welded joints inspected.

A statistical sample of welded structural joints was selected from the reactor building for reinspection and evaluation to provide a level of confidence as to the quality of existing welded joints. The selected sample consisted of 53 welded joints that were inspected for size, surface condition and overall workmanship, then MT'd for discontinuities. On those welded joints selected, all primer and epoxy coating was removed prior to inspection. The inspection was performed and evaluations made in accordance with the design requirements and AWS D1.1 acceptance criteria. No rejectable welds were identified.

The NRC Region I staff concluded that the above VT and MT examinations provided adequate assurance that welds can be MT'd through the coatings and that the previous reinspections give reasonable confidence that the inspection program was capable of identifying detrimental structural weld flaws.

Based on the NRR technical review, the Region I NDE effort, the independent Region IV inspections, the Region IV witnessing of the KG&E reinspection activities, and the Region IV evaluation of the KG&E reinspection results, it is determined that the corrective actions have been implemented and are complete; therefore, this item is closed.

3. KG&E Significant Construction Deficiency No. 53564-K152, Structural Welding (Closed)

As a result of the activities described above, this item is closed.

4. Exit Interview

Exit interviews were held periodically with licensee management personnel during the course of this inspection. Those attending the final Region IV meeting on January 22, 1985, are denoted in paragraph 1. Other personnel attended the Region I meeting on February 9, 1985. At these meetings, the scope and findings of the inspection were presented.