UNITED STATES NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT

DIVISION OF INSPECTION PROGRAMS
REACTOR CONSTRUCTION PROGRAMS BRANCH

Report No.: 50-456/50-457/84-44, 84-40

Docket No.: 50-456, 50-457

Applicant: Commonwealth Edison Company

Facility Name: Braidwood

Inspection At: Braidwood, Illinois

Inspection Conducted: December 10-20, 1984 and January 7-18, 1985

Inspectors: P. Keshishian — 2/15/85
P. Keshishian, Sr. Reactor Construction Engineer, Team Leader — Date Signed

George B. Georgiev — 2/15/85
G. B. Georgiev, Sr. Reactor Construction Engineer — Date Signed

Kenneth R Hooks — 2/15/85
K. R. Hooks, Reactor Construction Engineer — Date Signed

for P. Keshishian — 2/15/85
W. Kropp, Reactor Inspection (Region III) — Date Signed

T. K. McLellan — 2/15/85
T. K. McLellan, Reactor Construction Engineer — Date Signed

J. Nemoto — 2/15/85
J. Nemoto, Reactor Construction Engineer — Date Signed

S. R. Stein — 2/15/85
S. R. Stein, Reactor Construction Engineer — Date Signed

Consultants: R. M. Compton, D. C. Ford, J. B. McCormack, O. P. Mallon, W. S. Marini, E. Y. Martindale, A. Miller, R. E. Serb and W. J. Sperko, Jr.

Approved By: R. Heishman — 2/15/85
Robert F. Heishman, Chief
Reactor Construction Programs Branch — Date Signed

TABLE OF CONTENTS

I. INSPECTION SCOPE AND OBJECTIVES

The objective of this inspection was to evaluate the adequacy of construction and project management controls at the Braidwood Station. This objective was accomplished through review of the construction program, evaluation of project construction controls, and review of selected portions of the Quality Assurance Program, with emphasis on the installed hardware in the field. In addition, the scope and significance of identified problems were determined.

Within the areas examined, the inspection consisted of a detailed examination of selected hardware subsequent to Quality Control inspections, a selective examination of procedures and representative records, and limited observation of in-process work. Interviews were conducted with site personnel from Management, Quality Assurance, Quality Control and various crafts.

For each of the areas inspected, the following was determined:

- Were project construction controls adequate to assure quality construction?
- Was the hardware or product fabricated or installed as designed?
- Were quality verifications performed during the work process with applicable hold points?
- Was there adequate documentation to determine the acceptability of installed hardware or product?
- Are systems turned over to the startup organization in operable condition and are they being properly maintained?

II. ELECTRICAL AND INSTRUMENTATION CONSTRUCTION

A. Objective

The primary objective of the appraisal of electrical and instrumentation construction was to determine whether safety-related components and systems were installed in accordance with regulatory requirements, Final Safety Analysis Report (FSAR) commitments, and approved vendor and construction specifications and drawings. Additional objectives were to determine whether procedures, instructions and drawings used to accomplish construction activities were adequate and whether quality related records accurately reflect the completed work.

B. Discussion

Within the broad categories of the electrical and instrumentation construction, attention was given to several specific areas. These included electrical cable, raceways, electrical equipment, instrumentation cable and instrumentation components. Additionally, a review was made of a select number of documents associated with design change control and nonconformance reporting.

A number of documents were generated by the applicant to record individual observations of the NRC Construction Appraisal Team (CAT) inspectors. Several are referenced directly in the discussions that follow and Table II-1 is a complete listing of the documents initiated as a result of the electrical and instrumentation inspection.

1. Electrical Raceway Installation

a. Inspection Scope

Eighty-five segments of installed Class 1E cable tray, with a total length of about 1,200 feet, were selected from various plant areas for detailed examination by the NRC CAT. These segments were inspected for compliance to requirements relative to routing, location, protection and physical loading. Additionally, 43 runs of installed Class 1E conduit, with an aggregate length of about 1,050 feet, were inspected for compliance to specified requirements such as routing, location, separation, bend radii, support spacing and associated fittings.

Forty-two raceway supports and 145 concrete expansion anchors were examined in detail for such items as location, material, anchor spacing, weld quality, bolt torque and installed configuration.

See Table II-2 for a listing of raceway support, cable tray and conduit inspection samples.

The following documents provided the basic acceptance criteria for the inspection:

Braidwood Station Units 1 and 2 Specification L-2790, "Electrical Installation Work"

L. K. Comstock and Company, Inc. (LKC) Quality Control Procedure 4.3.12 "Conduit and Cable Pan Hangers and Auxiliary Steel Installation," Rev. B, February 24, 1984

LKC Quality Control Inspection Procedure 4.8.1 "Inspection of Class 1E Safety-Related Conduit Installation/Wireway Installation," Rev. B, May 3, 1984

LKC Quality Control Inspection Procedure 4.8.5 "Inspection of Class 1E Safety-Related Cable Pan Installations," Rev. D, July 31, 1984

LKC Quality Control Inspection Procedure 4.8.6 "Inspection of Concrete Expansion Anchors," Rev. C, October 8, 1984

LKC Quality Control Inspection Procedure 4.8.12 "Inspection of Seismic Class I Supports/Hangers," July 29, 1982

LKC Quality Control Inspection Procedure 4.8.13 "Inspection of Class 1E Equipment/Junction Box Installation," Rev. E, August 9, 1984

b. Inspection Findings

In the area of electrical raceway, the NRC CAT inspectors observed that in general Class 1E raceway installations were in accordance with applicable design criteria. Important quality attributes such as material type, location, identification and installed configuration were found to be as shown on approved construction drawings. However, several construction deficiencies were identified and are discussed in the following sections.

(1) Raceway Separation

The Braidwood Station Final Safety Analysis Report (FSAR) section 8.3.1.4 "Physical Independence of Redundant Systems," and specifically section 8.3.1.4.2.2, provides the basic criteria for acceptable raceway installations at the Braidwood Station. This section describes requirements for physical arrangement of raceways in order to comply with the requirements of Regulatory Guide (RG) 1.75 for independence of redundant systems.

In general, these requirements specify that physical separation must be maintained between components of redundant divisions. NRC CAT inspectors noted that the separation distances specified in the FSAR accurately reflect those detailed in RG 1.75 and the Institute of Electrical and Electronic Engineers (IEEE) Standard 384-1974 which it endorses.

Separation criteria has also been established between safety and nonsafety-related raceway components. In this area the Braidwood Station FSAR specifies an exception to the standard separation distances of five feet vertical and three feet horizontal and reduces these distances to 12 inches vertical and three inches horizontal. NRC CAT inspectors used this reduced criteria as basis for the inspection of raceway installations.

The NRC CAT examination of the selected raceway sample disclosed numerous installations in which required spatial separation had not been maintained. Most of the identified deficiencies were observed between safety and nonsafety-related raceway components. Reference Table II-3 for a listing of raceway separation deficiencies.

These deficiencies were discussed with the licensee and Sargent and Lundy Engineers (S&L) personnel. The discussions disclosed that separation criteria has been designed into the raceway installation; thus in areas where less than the required separation exists, approved fire barriers such as cable tray covers would be shown on design drawings. NRC CAT inspectors selected seven of the identified deficiencies and reviewed the applicable design drawings with S&L engineering personnel to ascertain whether fire barriers had been specified for these installations. The results of this review indicates that in three of the seven examples identified, design details had not specified fire barriers.

Additionally, as a result of the numerous separation deficiencies observed, NRC CAT inspectors reviewed Quality Control inspection procedures to ascertain why many of these deficiencies had not been documented by inspection personnel. Several procedures were reviewed, two of which concern the installation of Class 1E cable trays. L.K. Comstock & Company, Inc. (LKC) Quality Control Procedure 4.3.5 "Cable Pan Installation" section 3.17.11 states, in part..."all cable pan shall be installed such that a minimum of (1") separation is maintained between the cable pan being installed and: (1) all conduits (including sealtite and all EMT conduit for lighting, communication, fire protection, etc.); (2) And all other cable trays." LKC Quality Control Procedure 4.8.5 "Inspection of Class 1E Safety-Related Cable Pan Installations," section 3.1.17 states..."Verify a minimum of 1" space separation is maintained between all tray to conduit and tray to tray. If the separation is unacceptable, the Quality Control inspector shall notify LKC Engineering via an ICR. LKC Engineering shall evaluate the separation per the requirements of Procedure 4.3.5."

NRC CAT inspectors noted that although the FSAR and design documents specify distances of 12 inches and three inches separation, the electrical contractor's procedures for controlling installation and inspection of raceway components specify only one inch of separation. Thus, installations which exhibited greater that one inch separation but less than that required by design documents would not be identified by craft or inspection personnel as deficiencies.

Additionally, site procedures do not require the inspection of nonsafety-related raceway components. As such, although the safety-related raceway may be installed in the proper location, an improperly located nonsafety-related raceway may cause an interface which results in an undetected violation of separation criteria.

NRC CAT inspectors also identified several installations which exhibited less than one inch of separation. Many of these deficiencies had not been identified by inspection personnel. As a result of this observation, the electrical contractor has issued several Inspection Correction Reports (ICRs) to document and correct these conditions.

Finally, with regard to electrical separation many of the types of deficiencies noted in both cable and raceway installations have previously been identified by Region III inspectors. The deficiencies identified by Regional personnel and NRC CAT inspectors are the result, in some areas, of a difference in interpretation of criteria between the applicant and NRC personnel. Consequently, additional evaluation will be required by the NRC Office of Nuclear Reactor Regulation (NRR). Further discussion of this issue is presented in Section II.B.2, below.

With regard to many of the deficiencies identified above, NRC CAT inspectors concluded that the licensee has not been effective in implementing a program to assure that separation deficiencies are identified and corrected.

(2) Electrical Conduit

Although generally conforming to requirements, several isolated installation deficiencies were noted in the NRC CAT inspection sample. In addition, three flexible conduits and a valve solenoid casing were found to be damaged due to construction activities in the area. The following is a list of those deficiencies and the ICRs written as a result of the NRC CAT findings.

Conduit No.	Finding	ICR No.
C1A16E7	missing O-ring	7549
C0A13B0	missing segregation code marker	7548
C0A13A8	missing segregation code marker	7548

C1A5108	flex. conduit beyond maximum length	--
C1R1205	construction damage	7546
C1R44B7	construction damage	7881
C1R1315	construction damage	7880
C1A1616	solenoid casing damage	7547

The NRC CAT examined eight conduits which were within the scope of the Braidwood Construction Assessment Program (BCAP) reinspection. These are identified on Table II-2, Raceway Inspection Sample. Although no significant deficiencies were identified by BCAP or the NRC CAT, the sample inspected was not of sufficient size from which to draw a meaningful conclusion regarding the effectiveness of the BCAP effort in this area.

(3) Raceway Supports

The examination of raceway supports was accomplished for both conduit and cable tray applications. In general, attributes such as location, material type and size, anchor spacing, welds (location, size and general quality), and installed configuration were found to be in accordance with design requirements. However, several discrepancies were noted within the sample of supports inspected.

Bolts of an indeterminate material were found by the NRC CAT inspectors on a number of supports. S&L's standard EB-115.0, Seismic Category I Electrical Equipment Fabrication and Erection Specifications, requires that bolts used with supports shall conform to ASTM-A-307 which requires a manufacturer's identification mark. Unmarked bolts were found by the NRC CAT on 10 of the 13 cable tray supports inspected whose design requires bolts as well as on a majority of the conduit supports. As a result of the NRC CAT findings Commonwealth Edison Company (CECo) issued NCR-692 regarding A-307 bolts for all plant systems. This issue is further addressed in Section VI, Material Traceability and Control, of this report.

Dimensional discrepancies were noted where lateral braces attach to cable tray supports for both of the braces inspected by the NRC CAT. The attachment location is identified on the detail drawings as dimension "T" and the value of T for a particular brace is provided on the hanger list drawings. However, the drawings do not provide an installation or inspection tolerance for the T dimension. Although the actual location of brace H543 for support H043 was only one inch from its design dimension, the actual value of T for brace H562 to support H062 was found to be 15 inches from design. The QC checklists for the two braces indicates acceptability to the drawing requirements. The dimensional discrepancy for brace

H562 was subsequently documented on ICR 7575 by the electrical contractor.

As the T dimension has not been translated into an adequate inspection attribute additional review by the licensee will be required to determine the extent of discrepant cable tray braces.

Another issue regarding the configuration inspection of cable tray supports involves inspection of supports for Class 1E cable tray. Prior to November 1, 1982, only 35 percent of seismic Category I (safety and nonsafety) cable tray supports were inspected for configuration. The CECo memorandum to LKC requiring 100 percent inspection of all safety-related supports after that date indicated that backfit inspections would be subsequently addressed. However, the NRC CAT inspectors found that the current LKC inspection procedure, 4.8.12, still only requires inspection of 35 percent of the supports and a backfit inspection program still is not documented. An internal CECo memorandum dated November 27, 1984, indicates that a System Control walkdown with S&L personnel will be used for, among other reasons, configuration inspection of those supports not originally inspected. The walkdown program therefore was not reviewed by the NRC CAT inspectors.

Two other discrepancies were noted with cable tray supports by the NRC CAT inspectors and are considered to be isolated cases. Support H070 was being used to support scaffolding and support H001 included a Unistrut spring nut which was rotated and not fully engaged. As a result of these NRC CAT findings, LKC issued ICRs 7576 and 7585 respectively to document these conditions.

In regard to conduit supports, a discrepancy was noted by the NRC CAT inspector with B-Line strut welds. The welds on B-Line strut members of a conduit support and a junction box support were found to be in violation of acceptance standards specified by the strut manufacturer in an attachment to previously issued CECo NCR-293. The disposition of this NCR was that all installed B-Line struts meet the manufacturer's standards. As a result of this NRC CAT finding, LKC issued NCR 3770 to document and correct the installed B-Line strut. The dispositioning of NCR-293 is further discussed in Section VIII, Corrective Action Systems, of this report.

The NRC CAT inspection sample of concrete expansion anchors (CEAs) previously inspected and accepted by the licensee revealed several discrepancies. Embedded length was determined by subtracting the measured extension from the length marked on the CEA bolt end. The discrepancies noted are as follows:

- Conduit support WS-4, Drawing 20E-1-3552A: anchors did not meet criteria for spacing and embedded length. ICR 7875 subsequently was written.

- Conduit support WS-5, Drawing 20E-1-3552A: anchors did not meet criteria for embedded length. ICR 7876 subsequently was written.

- Conduit support WS-505, Drawing 20E-1-3554A: anchors did not meet criteria for embedded length and thread engagement. ICR 7877 subsequently was written.

- Conduit support WS-503, Drawing 20E-1-3554A: anchors did not meet criteria for embedded length and thread engagement.

In addition to the above CEA discrepancies, the anchors for cable tray support H038, Drawing 20E-1-3043H, were found with the ends cut off rendering their embedded length indeterminate. These anchors had been installed by the previous contractor (E.C. Ernst) and inspected by LKC in 1981. The General Inspection Report indicated the CEA's condition but there is no evidence of any further action to correct the deficiency.

It is noted that prior to the NRC CAT inspection the licensee had identified a generic programmatic deficiency with respect to the inspection of CEAs and has notified NRC Region III of this deficiency in accordance with the requirements of 10 CFR 50.55(e).

c. Conclusions

The licensee's implementation of electrical separation criteria has not been consistant with the FSAR commitment to IEEE 384, and several items regarding the interpretation of separation criteria will require additional NRC review. In addition, the applicant's program has not been effective in identifying and correcting raceway separation deficiencies.

The majority of bolts used on raceway supports are of indeterminate material as they do not contain a manufacturer's mark as required by the ASTM standard.

The location dimensions for brace to cable tray support attachments inspected were found to be deficient as the dimensions are not toleranced on the detail drawings.

2. Electrical Cable Installation

a. Inspection Scope

The NRC CAT inspectors selected a sample of installed Class 1E cable runs that had been previously accepted by QC inspectors. The sample included high voltage, power, control and instrument cables. For each of these cable runs, physical inspection was made to ascertain compliance with applicable design criteria relative to size, type, location, routing, bend radii, protection, separation, identification and support.

Additionally, the NRC CAT inspectors selected approximately 182 cable ends for examination of terminations. These were inspected relative to the applicable design and installation documents for items such as lug size and type, proper terminal point configuration, correct identification of cable and conductors, proper crimping of lugs or connectors and absence of insulation or jacket damage. See Table II-4 for a listing of cable terminations examined.

The following high voltage and power cables totaling approximately 1,900 feet were selected from different systems, electrical trains, locations and were of various sizes:

Cable	Type
1SI001-P1E	3 conductor No. 2 AWG 5KV
1SI032-P1E	3 conductor No. 10 AWG 600V
1RH001-P1E	3 conductor No. 2 AWG 5KV
1RH019-P1E	3 conductor No. 10 AWG 600V
1SX039-P1E	3 conductor No. 10 AWG 600V
1DC021-P1E	3 conductor No. 10 AWG 600V
1DG075-P1E	3 conductor No. 10 AWG 600V

The following control cables totaling approximately 2,000 feet were selected from different systems, electrical trains, locations, and were of various sizes:

Cable	Type
1MS298-C1E	7 conductor No. 14 AWG 600V
1MS315-C1E	9 conductor No. 14 AWG 600V
1RC055-C2E	4 conductor No. 14 AWG 600V
1RC091-C1E	12 conductor No. 14 AWG 600V
1RC107-C2E	4 conductor No. 14 AWG 600V
1WO032-C2E	4 conductor No. 14 AWG 600V
1SI003-C1E	2 conductor No. 14 AWG 600V
1RH003-C1E	9 conductor No. 14 AWG 600V

The following instrument cables totaling approximately 750 feet were selected from different systems, electrical trains, and locations:

Cable	Type
1RC427-K3R	1 pair No. 16 AWG
1MS109-K1R	1 pair No. 16 AWG
1CS071-K1E	1 pair No. 16 AWG
1FW019-K2R	1 pair No. 16 AWG
1CS088-K2R	1 pair No. 16 AWG

The following documents provided the basic acceptance criteria for the inspections:

LKC Quality Control Inspection Procedure 4.8.8, "Cable Installation Inspection," Rev. B, September 14, 1984

LKC Quality Control Inspection Procedure 4.8.9, "Electrical Termination Inspection," Rev. E, July 9, 1984

LKC Work Instruction 4.3.9, "Cable Termination Installation," Rev. D, May 1, 1984

b. Inspection Findings

(1) Routing

In general, the routing of Class 1E cables through design designated raceway systems was found to be in accordance with specified criteria. However, a discrepancy was noted with the pull ticket for cable 1MS109-K1R. The ticket did not indicate the cable tray segment through which the cable was routed. This was considered an isolated case by the NRC CAT inspectors.

(2) Separation

The inspection of Class 1E cable installations revealed a number of instances in which cable of one electrical division did not maintain separation from cable or raceway of another electrical division. Deficiencies occurred primarily in installations where cable exited design designated raceway and were run free-air before entering electrical equipment or additional raceway segments. NRC CAT inspectors identified several examples in which a cable of one electrical division was in physical contact with raceway or cable of another division.

Additionally, NRC CAT inspectors identified nonsafety-related cables 1FW269-C1B, 1MS148-C1B, 1MS147-C1B and 1MS095-K1B which had been routed with Class 1E cables in safety-related cable trays and conduits.

NRC CAT inspectors observed that these installations were not in compliance with requirements detailed in section 8.3 of the Braidwood Station FSAR and the commitment to IEEE standard 384-1974, "Criteria for Separation of Class 1E Equipment and Circuits."

IEEE 384-1974 section 4.6.1 requires that... "Non-Class 1E circuits shall be separated from Class 1E circuits by the minimum separation requirements specified in Section 5.1.3, 5.1.4 or 5.6 or they become associated circuits." Additionally, section 4.5 specifies that... "associated circuits shall comply with one of the following:

(1) They shall be uniquely identified as such and shall remain with, or be separated the same as, those Class 1E circuits with which they are associated.

(2) They shall be in accordance with (1) above from the Class 1E equipment to and including an isolation device. Beyond the isolation device the circuit is not subject to the requirements of this document provided it does not again become associated with a Class 1E system.

(3) They shall be analyzed or tested to demonstrate that Class 1E circuits are not degraded below an acceptable level."

Finally, with reference to analysis, section 5.1.1.2 states... "In those areas where the damage potential is limited to failures or faults internal to the electrical equipment or circuits, the minimum separation distance can be established by analysis of the proposed cable installation. This analysis shall be based on tests performed to determine the flame retardant characteristics of the proposed cable installation considering features such as cable insulation and jacket materials, cable tray fill, and cable tray arrangement."

Discussions with licensee and engineering personnel concerning the cable separation deficiencies identified by the NRC CAT inspectors revealed that:

(1) Based on site design criteria these cable configurations were not considered by the licensee to be deficiencies.

(2) Although some non-Class 1E cables are routed with or share enclosures with Class 1E cables they are not designated as associated circuits.

(3) No analysis had been performed to demonstrate that these non-Class 1E circuits would not degrade Class 1E circuits.

As discussed in Section II.B.1.b.(1), above, several areas of site implemented separation criteria differ from the requirements specified in section 8.3 of the Braidwood FSAR and IEEE standard 384-1974. Relative to cable installations, differences exist in the following areas:

(1) Classification of non-Class 1E cables which are routed with, share enclosures with, or are installed in close proximity to Class 1E cables.

(2) Separation between cables installed free-air and cables or raceways of other electrical divisions.

(3) The use of cable jacket insulation as an approved fire barrier for Class 1E cables.

Some of these issues have previously been identified by Region III inspectors and have resulted in a number of meetings with the applicant, Sargent & Lundy Engineers and NRC Office of Nuclear Reactor Regulation. The results of these meetings and correspondence reviewed by the NRC CAT inspectors indicates that a number of items remain open relative to proper interpretation of cable separation criteria.

As a result the items documented by Region III and the additional concerns identified during the NRC CAT inspection will be discussed with NRR for appropriate action.

Cable separation deficiencies were also identified within many electrical equipment enclosures. However, in each instance identified by NRC CAT inspectors the electrical contractor had initiated a Cable Separation Conflict Report to document the condition.

Finally, as a result of comments made by NRC CAT inspectors S&L developed engineering analyses for several of the cable installation deficiencies discussed in this section. These analysis reports will be discussed with NRR for appropriate evaluation.

(3) <u>Cable Spacing</u>

Braidwood Station power cable installations have been designed in accordance with AIEE/IPCEA P-46-426, 1962 "Power Cable Ampacities - Volume I - Copper Conductors" and P-54-440, 1972 "Ampacities - Cables in Open Top Cable Trays." The power cables have been derated in accordance with the AIEE/IPCEA Standards such that cables sharing raceway may be in contact. As a result, cables in solid metal trays could be installed without maintained spacing. No deficiencies or concerns were identified in this area.

(4) <u>Cable Damage</u>

The NRC CAT inspectors observed the following cable installations which exhibited damage to the cable jacket or insulation:

° Cable 1CV548-C1E has a slice in its jacket which extends into the conductor of the cable. The location of this damage was near cable tray node 1513B below motor control center MCC-1AP21E. As a result of this observation, the electrical contractor has issued NCR-3713 to document and correct this condition.

- Cable 1VP029-C2E was found with a permanent indentation in its jacket and bent below the required minimum bend radius due to scaffold lumber against the coiled cable. LKC NCR-3704 was subsequently issued to document this condition.

- Cable 1CC174-C1E was found not meeting minimum bend radius requirements at the Kellums grip above riser 1R483. LKC QC issued NCR-3717 to document and correct this condition.

These three instances are considered by the NRC CAT inspectors to be isolated cases.

(5) Cable Identification

In general, the identification of Class 1E cable installations was found to be in accordance with applicable design criteria.

One example was identified in which a Class 1E cable had been inappropriately identified. Cable 1CD037 located in 4160V switchgear 1AP05E nad been labled with both safety (dark background) and nonsafety-related (light background) segregation codes. A possible explanation for this condition was that in attempting to identify the positive and negative phases of this cable craft personnel had inadvertently used labeling which represents a nonsafety-related systems designation. As a result of this observation, the electrical contractor has issued ICR 7868 to identify and correct this condition.

No other deficiencies were identified in this area.

(6) Tray Fill

The Braidwood Station FSAR section 8.3 sets forth requirements for limiting tray fill to the top of the side rails of the tray. During the inspection of Class 1E cable installations, NRC CAT inspectors observed several cable trays in which this requirement had not been met. However, in each instance identified, the electrical contractor had previously issued inspection reports to document and correct this condition.

(7) Terminations

Although the vast majority of the NRC CAT inspection sample was found to conform to design requirements, several isolated deficiencies were noted. These discrepancies were not considered to be technically or programmatically significant by the NRC CAT inspectors. However, a failure to meet an FSAR commitment regarding wire splices was also found by the NRC CAT.

The Braidwood Station FSAR commitment to IEEE Standard 420 prohibits the use of wire splices in Class 1E equipment. However, NRC CAT inspectors observed in-line butt splices in numerous electrical panels. As site procedures do not require the location of splices to be depicted on design documents, NRC CAT inspectors were unable to determine how extensively these splices have been utilized. Additionally, the licensee had previously issued NCR-598 to document hardware deficiencies in installed butt splices and reported this condition to NRC Region III in accordance with 10 CFR 50.55(e). The use of butt splices in Class 1E panels requires documentation in the FSAR as an exception to the IEEE standard.

The following are the isolated discrepancies noted by the NRC CAT inspector:

- ° Conductor insulation damage on the orange conductor of cable 1RH108-C1E in motor control center 1AP21E, cubicle F3. ICR-7610 was subsequently issued to document this condition.
- ° Several terminal screws were found loose in the Diesel Generator Control Panel 1A and in the Remote Shutdown Panel, section 1PL05J. ICR's 7646, 7644, and 7643 were subsequently issued to document these conditions.
- ° Internal motor lead T-9 was found damaged in motor operated valve 1CSQ01A. ICR-7867 was subsequently issued to document this condition.
- ° The red conductor of cable 1SI053-C1E, in motor operated valve 1SI8802A, was excessively bent and not meeting minimum bend radius criteria. ICR-7870 was subsequently issued to document this condition.

(8) Seepage of Oil From Okonite Cable

NRC CAT inspectors observed any oily substance seeping from jackets of numerous installed and terminated cables manufactured by the Okonite Company. This condition was observed in both Class 1E and non-Class 1E cables in various Class 1E equipment throughout the facility (motor control centers, main control boards, control panels, motor operated valves, etc.). Information obtained from NRC Region III, CECo, and S&L revealed the following:

- ° In a letter dated October 4, 1982, including an attached engineering report (No. 364), the Okonite Company informed CECo that, with reference to the identical condition identified at Byron Station, this seepage "will not affect the reliability or life of the cables."

- In a letter dated November 1, 1983 from Illinois Power Company (IPC) to NRC Region III (in accordance with 10 CFR 21), IPC stated that "...The effect of this oil on equipment connected to the cable is of concern. If oil that leaked from the divisional cable were to accumulate on essential components in Class 1E equipment, the possibility exists that misoperation of Class 1E equipment could occur."

- On January 10, 1984, Information Notice 84-1 was issued by the NRC Office of Inspection and Enforcement to all nuclear facilities. This Information Notice references the above letter from IPC and states the concern that "...Leakage of oil from the cable at terminations may create a fire hazard, and degrade other electrical equipment." In addition, this Information Notice suggests that "...Addressees review the information for applicability to their facilities."

The NRC CAT inspectors provided a copy of the above referenced IPC letter to licensee personnel and asked whether CECo or S&L has reviewed the question of the possible degradation of Class 1E equipment. The licensee indicated that no such review had been made.

Further attention is required by the licensee to assure that Class 1E equipment or components will not be adversely affected by the seepage from certain Okonite cable.

c. Conclusions

In general, cable installations including terminations have been accomplished in accordance with requirements. However, numerous separation deficiencies exist in areas where cable has been run free-air. In these areas further licensee attention is required to assure that deficiencies are identified and that subsequent corrective action or appropriate analysis is initiated.

Further attention will be required by the licensee to assure that Class 1E equipment and components are not adversely affected by the deficiencies identified in some Okonite manufactured cable.

3. Electrical Equipment Installation

a. Inspection Scope

Over 45 pieces of installed or partially installed electrical equipment and associated hardware items were inspected. Samples were based on system function and safety classification.

The following specific electrical components were inspected in detail:

(1) Motors

The installation of five motors and associated hardware was inspected for such items as location, anchoring, grounding, identification and protection. The motors inspected were:

Component Cooling Pump Motor	1CC01PA
Containment Spray Pump Motor	1CS01PA-M
Containment Spray Pump Motor	1CS01PB-M
Residual Heat Removal Pump Motor	1RH01PA
Safety Injection Pump Motor	1SI01PB

(2) Electrical Penetration Assemblies

The following containment penetration assemblies were inspected:

1LV09E - Instrumentation
1LV10E - Instrumentation
1NR03E - Nuclear Instrumentation
1SI01E - Essential Power
1SI02E - Essential Power
1SI04E - Essential Control Power

The location, type, mounting and identification of these penetrations were compared with the installation drawings and vendor manual.

(3) Circuit Breakers

Circuit breakers for the following Class 1E motors were examined to determine compliance with design and installation documents for size, type, system interface and maintenance.

Residual Heat Removal Pump 1A
Residual Heat Removal Pump 1B
Safety Injection Pump 1B

The use of circuit breakers with integral undervoltage trip attachments at Braidwood Station was also investigated.

(4) Switchgear and Motor Control Centers

The following switchgear and motor control centers were inspected:

Motor Control Center	1AP21E - MCC131X1
Motor Control Center	1AP25E - MCC131X2
Motor Control Center	1AP30E - MCC131X5
4160V Switchgear 141	1AP05E
4160V Switchgear 142	1AP06E

(5) Station Batteries and Racks

The 125V battery rooms including the installed batteries, battery racks and associated equipment were inspected. The location, mounting, maintenance and environmental control for installation of the batteries were compared with the applicable requirements and quality records.

125V DC Battery 111 - 1DC01EA, 1DC01EB
125V DC Battery 112 - 1DC02EA, 1DC02EB

(6) 125V DC System Equipment

The following equipment comprising portions of the 125V dc systems were inspected for compliance to design documents for such items as location, mounting (welds, concrete anchors and bolting) and proper configuration.

Battery Charger 111	1DC03E
Battery Charger 112	1DC04E
125V DC Fuse Panel 11	1DC10J
125V DC Fuse Panel 12	1DC11J
125V DC Distribution Panel 111	1DC05E

(7) Control Panels

A number of safety-related electrical control panels were inspected for compliance to requirements for items such as location, mounting and type. The panels inspected were:

Solid State Protection System Cabinet	1PA09J
Auxiliary Relay Cabinet	1PA24J
Auxiliary Relay Cabinet	1PA27J
Remote Shutdown Panel	1PL04J
Remote Shutdown Panel	1PL05J
Diesel Generator Control Panel	1PL07J
Diesel Generator Control Panel	1PL08J
Main Control Panel	1PM06J A1-A2
Main Control Panel	1PM05J B1-B2

(8) Motor Operated Valves

Five motor operators for valves were examined in detail.

1CS007B
1CS001A
1RH8701A
1SI8821A
1SI8802A

The following documents provided the basic acceptance criteria for the inspections:

Sargent & Lundy Engineers Electrical Specification

LKC Quality Control Procedure 4.3.17, "Electrical Penetration Installation, Termination and Maintenance," Rev. A, January 3, 1983

LKC Quality Control Inspection Procedure 4.8.6, "Concrete Expansion Anchors," Rev. C, October 8, 1984

LKC Quality Control Inspection Procedure 4.8.13, "Inspection of Class 1E Equipment/Junction Box Installation," Rev. E, August 9, 1984

LKC Quality Control Inspection Procedure 4.8.16, "Inspection of Revision to Installed Electrical Equipment," Rev. C, August 2, 1984

LKC Quality Control Inspection Procedure 4.8.17, "Inspection of Electrical Penetrations," Rev. D, March 5, 1984

b. Inspection Findings

(1) Motors

The inspection of the 4kV Class 1E motors revealed no major hardware deficiencies. The motors examined were of the size, type and configuration shown on design documents. Although the installation documents for most of the motors did not indicate torquing of the motor hold down bolts, Phillips, Getchow Company (PGCo) is in the process of performing an overall reverification program which includes retorquing all bolts with QC verification.

The maintenance activities for the motors were found by the NRC CAT inspectors to be fragmented among several organizations. The electrical contractor performs periodic surveillance for protection and space heater operation, CECo's Operational Assessment Department performed the periodic insulation resistance tests during storage, and the site Operating Department performs the periodic shaft rotation. This division of maintenance responsibilities was previously identified as a program weakness by the Institute for Nuclear Power Operations (INPO) which resulted in CECo NCR-689. The NCR requires project construction to develop a procedure to define responsibilities for preventive maintenance and to control the activities of CECo's contractors who must also provide maintenance procedures.

No deficiencies were found with the maintenance activities and records reviewed by the NRC CAT.

(2) Electrical Penetrations

The penetrations examined were found to be in accordance with the design documents. A review of the weekly penetration pressurization checks revealed that the QC inspector used a memo form to request that a penetration which had lost its pressure be repressurized. The electrical contractor indicated during discussions with the NRC CAT inspector that the weekly recording of pressure required by the inspection procedure, 4.8.17, was not considered an installation requirement. Therefore, it was their position that the procedural requirement to record deviations of installation requirements on an Inspection Correction Report was not applicable. However, no procedural guidance is provided for correction of a zero pressure situation.

When the NRC CAT inspector requested the leak rate test documentation for a penetration with consistently falling weekly pressure readings, the inspector was informed that the leak rate calculations for Unit I penetrations could not be produced. NCR-7918 was subsequently written to document and correct this situation.

Although not technically significant, these instances indicate a laxity in generating and maintaining quality related records.

(3) Circuit Breakers

The examination of the selected circuit breakers indicated that they had been purchased, installed and maintained in accordance with the applicable design documents. Important installation attributes such as proper alignment and main contact penetration were verified by physical inspection and review of construction test records. Maintenance records were also reviewed and indicate that lubrication and set point verification had been performed.

NRC CAT inspectors also evaluated licensee initiated actions and review of NRC Information Notice 83-18 "Failures of the Undervoltage Trip Function of Reactor Trip System Breakers" and NRC Generic Letter 83-28 "Required Actions Based on Generic Implications of Salem ATWS Events." NRC CAT inspectors noted that the Braidwood Station design will utilize Westinghouse type DS-416 breakers in the Reactor Trip System. The review of initial and supplemental actions to Generic Letter 83-28 indicates an ongoing effort by the licensee to resolve the maintenance and operational problems identified in the use of these breakers.

(4) Switchgear and Motor Control Centers

The installation of Class 1E 4160V switchgear 1AP05E and 1AP06E was found to be in accordance with design details and vendor requirements. Some examples of separation deficiencies were observed in cable and wiring installations within this equipment. However, in each instance identified, the electrical contractor's QC inspectors had previously identified and documented the condition.

(5) Station Batteries and Racks

During the inspection of the 125V dc battery rooms NRC CAT inspectors observed debris in the rooms and on the battery cells. Much of this debris appears to have been caused as a result of construction activity associated with the installation of adjoining block walls. As a result of this observation the debris was removed and the battery cells were cleaned by the licensee.

The 125V batteries were then examined in detail and found to be in good condition. Maintenance activities were reviewed and in general had been performed in accordance with requirements. Records demonstrating performance of intercell terminal resistance checks were not provided by the licensee. However, NRC CAT inspectors noted that the licensee plans to disassemble the 125V battery connections and that this maintenance activity would be performed when cell connections are re-established. In connection with this issue, the review of Station maintenance activities in general indicates that while some administrative responsibilities are not clearly defined, the maintenance program and its implementation were found to be comprehensive.

The inspection of the 125V battery racks disclosed that indeterminate bolting material had been used in the assembly process. This issue is discussed in detail in Section VI, Material Traceability and Corrective Action, of this report.

(6) 125V DC System

Inspection of components comprising the 125V dc system disclosed a deficiency in the installation of 125V dc fuse panel 1DC10J. Design details found on drawing 20E-0-3391-AR specify the use of concrete expansion anchors for installation of this equipment. The details show 5/8-inch anchors spaced 12 inches center to center. Physical inspection of this equipment disclosed that a number of the anchors installed exhibited less than the 12-inch spacing required. Additionally, several anchors were in violation of edge distance requirements detailed in site procedures and the electrical specification. As a result of this observation the electrical contractor has issued NCR-3782 to identify and resolve this condition.

Other 125V dc system components examined were found to be installed in accordance with applicable requirements.

(7) Control Panels

The various control panels examined were installed in accordance with applicable design documents, and no significant deficiencies were noted.

(8) Motor Operated Valves

The installation of the motor operated valves inspected conformed to the applicable requirements with only one deficiency noted by the NRC CAT inspectors. A crack was observed in the number 2 control rotor for valve 1RH8701A. ICR 7869 was subsequently issued to document this condition.

c. Conclusions

The installation of Class 1E equipment and associated hardware at Braidwood Station was generally found to be in accordance with the applicable design documents.

Current maintenance activities were found to be effectively implemented.

4. Instrumentation

a. Inspection Scope

Due to a recently instituted retrofit program pertaining to the installation of instrumentation components, few items were considered by the contractor to be complete during the NRC CAT inspection. NRC CAT inspectors did select nine supports, four instrument racks, seven instruments, and three instrument tubing runs for inspection. It should be noted that the three instrument tubing runs selected represented the entire amount of completed and QC inspected installations. See Table II-5 for a detailed listing of items inspected.

Additionally, approximately 200 feet of in-process instrument tubing was examined for general workmanship and conformance to industry standards.

The following documents provided the basic acceptance criteria for the inspection:

PGCo Construction Procedure PGCP-22, "Process Piping and Instrument Line Supports in Category I Buildings - Selected Supports," Rev. 12

PGCo Construction Procedure PGCP-30, "Installation of ASME III and Safety-Related Instruments and Instrument Lines," Rev. 7

b. Inspection Findings

Although the inspection sample was limited, only one installation deficiency was noted. The NRC CAT inspectors measured a dimension of 6¼-inches on tubing run OPC-W0020 which is depicted on Detail A on drawing OPC-W0020, Sh. 1, Rev. A as being 1-foot 6¼-inches. This installation had been inspected and accepted, and is considered complete by the contractor.

In addition, the NRC CAT inspectors observed a number of instances of damage caused by construction activity and scaffold erection. These include:

Instrument Line 1LT-0459 Near Rack 1PL50J
Instrument Line 1FW-91EB Near Rack 1PL56J
Electrical Wireway Section of Rack 1PL75J

c. Conclusions

The NRC CAT inspectors consider the quantity of completed instrumentation installations far too limited to draw a valid conclusion as to the quality of instrumentation construction.

However, it is evident that additional care needs to be exercised by personnel erecting scaffolding to insure that completed or partially completed installations are not damaged by subsequent activity in the area.

TABLE II-1

DOCUMENTS ISSUED AS A RESULT OF THE NRC CAT INSPECTION
ELECTRICAL AND INSTRUMENTATION

Document Number*	Subject	Document Number*	Subject
AIR 169	Supports	ICR 7617	Separation
NCR 0692	Bolting	ICR 7618	Separation
NCR 2262	Conduit	ICR 7619	Separation
NCR 2315	Support	ICR 7620	Separation
NCR 3202	Conduit	ICR 7621	Separation
NCR 3704	Cable	ICR 7622	Cable Tray
NCR 3713	Cable	ICR 7623	Cable Tray
NCR 3717	Cable	ICR 7624	Separation
NCR 3758	Equipment	ICR 7643	Cable
NCR 3770	Supports	ICR 7644	Cable
NCR 3783	Concrete Anchors	ICR 7645	Cable
ICR 1603	Cable Tray	ICR 7646	Cable
ICR 4591	Cable Tray	ICR 7647	Cable
ICR 6075	Cable	ICR 7678	Support
ICR 7546	Conduit	ICR 7679	Support
ICR 7547	Conduit	ICR 7680	Support
ICR 7548	Conduit	ICR 7681	Support
ICR 7549	Conduit	ICR 7811	Separation
ICR 7571	Conduit	ICR 7812	Separation
ICR 7575	Support	ICR 7813	Cable Tray
ICR 7576	Support	ICR 7816	Clearance
ICR 7585	Support	ICR 7817	Separation
ICR 7600	Separation	ICR 7867	Termination
ICR 7601	Separation	ICR 7868	Termination
ICR 7602/7603	Conduit	ICR 7869	Equipment
ICR 7607	Cable	ICR 7870	Termination
ICR 7608	Cable	ICR 7875	Concrete Anchors
ICR 7609	Conduit	ICR 7876	Concrete Anchors
ICR 7610	Cable	ICR 7877	Concrete Anchors
ICR 7611	Cable	ICR 7880	Conduit
ICR 7612	Cable	ICR 7881	Conduit
ICR 7615	Cable	ICR 7915	Equipment
ICR 7616	Cable	ICR 7918	Equipment

* AIR: As-built Information Report
ICR: Inspection Correction Report
NCR: Nonconformance Report

TABLE II-2

RACEWAY INSPECTION SAMPLE

Cable Tray:

2502E-P2E	2503E-P2E	21511L-P2E	1502F-P1E	1189MC-C1E
1555J-P2E	1554J-P2E	1573F-P1E	1R219-P1E	12006C-C1E
1553J-P2E	1552J-P2E	1517A-P1E	1516A-P1E	11900C-C1E
1551J-P2E	1703F-C2E	1513A-P1E	1511A-P1E	11951C-C1E
1915F-C2E	1914F-C2E	1510A-P1E	1514A-P1E	1R227-C1E
1912F-C2E	1911F-C2E	1514B-P1E	1515A-P1E	11894C-C1E
1910F-C2E	1909F-C2E	1515B-P1E	1516A-P1E	11898C-C1E
1908F-C2E	1R369-C2E	1516B-P1E	1613H-C2E	11952C-C1E
1R370-C2E	11461J-C2E	1612H-C2E	1610H-C2E	11885C-C1E
11460J-C2E	11459J-C2E	1599H-C2E	1609H-C2E	11912G-K1E
1814S-P1E	1813S-P1E	1R275-C2E	1R340-P2E	11910G-K1E
1812S-P1E	1811S-P1E	11530M-P2E	11519M-P2E	11907G-K1E
1809S-P1E	1807S-P1E	11518M-P2E	11517M-P2E	11905G-K1E
1977A-P1E	1978A-P1E	11516M-P2E	11487M-P2E	11911G-K1E
1980A-P1E	1981A-P1E	1R345-P2E	12121M-C1E	11908G-K1E
1982A-P1E	1983A-P1E	12137M-C1E	12138M-C1E	11906G-K1E
1991A-P1E	12141G-K1E	12062M-C1E	12034M-C1E	1R270-K1E

Cable Tray Supports:

Support No.	Drawing No.	Support No.	Drawing No.
13H20 (3 supports)	20E-0-3031	H042	20E-2-3244H
H001	20E-0-3052H	H046	20E-2-3244H
H025	20E-0-3052H	H048	20E-2-3244H
H033	20E-0-3063H	H062	20E-2-3244H
H025	20E-0-3063H	H562 (brace)	20E-2-3244H
H042	20E-0-3063H	H063	20E-2-3244H
H043	20E-0-3063H	H065	20E-2-3244H
H543 (brace)	20E-0-3063H	H070	20E-2-3244H
		H071	20E-2-3244H

Conduits:

Conduit No.	Length (Feet)	Conduit No.	Length (Feet)
*C1R1213	12	C0A13AB	6
C1R1315	35	C0A13B0	6
C1R1334	37	C0A5410	6
C1R1387	40	C0A7271	5
*C1R1494	20	C0A7269	6
C1R3441	13	C1A1616	30
C1R3443	76	C1A16E6	21
C1R4220	48	C1A16K1	10
C1R4235	25	C1A17K0	6
C1R4336	74	C1A4317	11
C1R4364	58	*C1A5105	45

TABLE II-2 (Continued)

RACEWAY INSPECTION SAMPLE

Conduit No.	Length (Feet)	Conduit No.	Length (Feet)
C1R4462	20	*C1A5108	18
C1R44B7	16	*C1A5133	27
C1R44C5	30	*C1A5166	18
C1R5109	32	C1A51B9	26
C1R54D1	20	C1A5329	5
C1R54D2	12	C1A5368	10
C1R54F2	26	*C1A6140	30
C1R54F3	26	*C1A6185	10
C1R7612	25	C1A61G0	20
C1R7614	25	C1A61G2	20
C1R7823	36		

Conduit Supports:

Support No.	Drawing No.	Location
FC-10	20E-1-3544A	Reactor Building
TCC-3	20E-0-3363A	Auxiliary Building
CC-20	20E-1-3342A	Auxiliary Building
CC-115	20E-1-3544A	Reactor Building
CC-CP-3	20E-1-3544A	Reactor Building
WH-4	20E-0-3362A	Auxiliary Building
CF-1	20E-0-3313A	Auxiliary Building
CF-3	20E-0-3313A	Auxiliary Building
WH-3	20E-0-3362A	Auxiliary Building
CC-171	20E-0-3362A	Auxiliary Building
WV-27	20E-0-3544A	Reactor Building
TS5-1	20E-1-3542A	Reactor Building
CP-500	20E-1-3322A	Auxiliary Building
TS3-2	20E-1-3343A	Auxiliary Building
CC-3	20E-1-3343A	Auxiliary Building
CC-74	20E-0-3313A	Auxiliary Building
CC-87	20E-0-3313A	Auxiliary Building
CC-30	20E-0-3363A	Auxiliary Building
CC-44	20E-0-3363A	Auxiliary Building
WV-8	20E-1-3532A	Reactor Building
CC-5	20E-1-3533A	Reactor Building
CC-5	20E-1-3533A	Reactor Building
FC-5	20E-1-3533A	Reactor Building
TS3-6	20E-1-3533A	Reactor Building
1JB201R	20E-1-3513	Reactor Building

TABLE II-2 (Continued)

RACEWAY INSPECTION SAMPLE

Concrete Expansion Anchors:

Anchor Diameter (inches)	Quantity Inspected	Quantity Torque Tested
1/4	56	54
3/8	44	0
1/2	26	16
5/8	19	13

* BCAP inspection sample

TABLE II-3

ELECTRICAL RACEWAY SEPARATION DEFICIENCIES

Raceway segments listed in the A columns do not maintain required separation as installed relative to raceway segments listed in the B columns.

A		B	A		B
COA3125-P1B		1900A-P2E	COA3117-C1B		1900A-P2E
COA3114-P1B		1899B-C2E	COA3220-P1B		1895A-P2E
1870P-C1B		1894J-K2E	1870N-P1B		1894B-C2E
1888J-K2E	*	1888Q-C1B	COA5242-P1B		11460J-C2E
COA5245-P1B		11459E-P2E	COA5286-P1B		11459E-P2E
CIA4279-P1B		1832E-C1E	CIA4257-P1B		1833E-C1E
CIA4258-P1B		1833E-C1E	18098-P1E		1809N-P1B
1930TS-P1E		1805P-C1B	COA5291-K2B		11317A-P1E
COA5191-C1E		COA5266-P2B	CIA7131-P1B		11519M-P2E
COA5191-C1E		COA5250-C2B	11584J-C2B	*	11519M-P2E
11591L-P2E		11621E-P1B	CIA6169-P1E	*	11564E-P1B
11520L-P2E		11547C-C1B	11547C-C1B		11583J-C2E
1613H-C2E	*	COA12F7-P2B	COA12F8-P2B		1613H-C2E
1514A-P1E		CIA0287-C2B	CIA0274-K2B	*	1516A-P1E
2702AA-C2E		COA3323-K1E	11430N-P2B		11448V-C2E
1778R-K1B		1797J-K3R	1785R-K1B		1797J-K3R
11583J-C2E		115447C-C1B	CIA51381-C1B		1982B-C1E
COA3170-P1B		1896A-P2E	1896A-P2E		1844N-P1B
COA3167-C1E		1896B-C2E	11906C-C1E		11905B-K1B
1713D-C1B	*	1696H-C1E	CIR5130-P2B	*	C390R-P2E
1397R-P2E		1397B-P2B	1398D-K2B		1398E-C2E
1427M-C1E		1358K-P1B	1800V-P1B		1799T-P1E
CIR4701-C1B		1380E-C2E	1309J-C1B		1380E-C2E
CIR4201-C2B		1JB303R-K3R	CIR4322-P2E		1343J-C1B
CIR44C5-C2E		1430J-C1B	CIR7806-K1R		1R104-P1B
CIR7820-K4R		1341P-P2B	CIR5406-K2R		1341P-P1B
1694A-P1E		1696G-C1B	1713D-C1B		1696H-C1E
1784U-C1E		1804P-C1B	1797U-C1E		1804P-C1B
1798U-C1E		1788R-K1B	CIR4220-K3R	*	lighting conduit

NOTE: The (*) designation indicates physical separation of less than one inch between the two raceway segments.

TABLE II-4

CABLE TERMINATION INSPECTION SAMPLE

Location	Drawing No.	Cable No.
MOV1SI8802A	20E-1-4884	1SI053, 1SI054
MOV1SI8821A	20E-1-4883C	1SI189, 1SI190
MOV1RH8701A	20E-1-4874	1RH027, 1RH028
MOV1CS001A	20E-1-4877A	1CS046, 1CS109
MOV1CS001B	20E-1-4875	1CS031, 1CS032
Sequencing and Actuation Cabinet 1PA14J	20E-1-4123C	1EF043, 1EF045, 1EF084, 1EF087, 1EF064, 1EF044, 1SX314, 1SX524, 1EF041, 1EF040, 1EF085, 1EF052, 1EF049, 1EF051, 1EF050, 1EF053, 1EF048, 1EF097, 1EF042
Process Instrumentation and Control Rack 1PA02J	20E-1-411B	1FW707, 1FW706, 1RC372, 1RC391, 1RC396, 1RC401, 1FW876, 1FW877, 1MS116, 1MS122, 1FW043, 1FW048, 1CS088, 1SI654. 1CC290, 1RC383, 1RC377, 1MS113, 1MS119, 1RC386, 1RC380, 1RY202, 1SI468, 1FW921, 1RC375, 1RC394, 1RC399, 1RC404, 1RY204, 1RC406, 1FW026
Diesel Generator Panel 1PL07J	20E-1-4093A	1DG027, 1DG155, 1DG018, 1DG200, 1DG022, 1DG115, 1DG165, 1DG034, 1DG169, 1DG083, 1DO062, 1DO064, 1DG157, 1DO073, 1DG071, 1DG070, 1DG173, 1DG082, 1DG168, 1DO058, 1DG117, 1DG111, 1DO002, 1DG094, 1DG119, 1DG118, 1DG206, 1DG207, 1SX294 1SX290, 1SX295, 1VD004
Main Control Board 1PM01J	20E-1-4044N	1AP139, 1AP050, 1AP075,
	20E-1-4044V	1DC085, 1AP120, 1AP119, 1AP137, 1AP053 1AP045, 1AP138, 1AP080
Remote Shutdown Panel 1PL04J	20E-1-4087K	1VC015, 1VC023, 1DC183, 1MS581, 1MS584, 1MS269, 1MS308, 1MS531 1MS288, 1MS278, 1MS285, 1MS272, 1MS275, 1MS519
	20E-1-4089G	1VP038, 1VP042, 1SX305, 1SX209, 1SX019, 1SX016, 1SX020, 1EF044, 1SX017, 1CV016, 1CV012, 1CV015, 1CV033, 1SX304, 1SX314, 1CC013, 1CC012, 1CC014, 1EF064, 1VP082, 1VP086, 1CC032, 1VP254, 1SX018, 1CV014, 1CC107, 1CC030
Motor Control Center 1AP21E	20E-1-4661B	1SX046, 1SX047, 1CV611, 1CV609, 1CV614, 1CV612, 1CS148, 1CS046, 1CS094, 1CS109, 1CS047
	20E-1-4661F	1SX218, 1SX217, 1RH109, 1RH017, 1RH016, 1RH108, 1RH068, 1RH069, 1RH067

TABLE II-4 (Continued)

CABLE TERMINATION INSPECTION SAMPLE

Location	Drawing No.	Cable No.
Motor Control Center 1AP28E	20E-1-46487B	1AF039
	20E-1-4687D	1CC146, 1CC041, 1CC043, 1SI201, 1SI203
	20E-1-4687E	1VX036, 1VX038
	20E-1-4687F	1SI493, 1SI193, 1SI194, 1SI195
	20E-1-4687K	1VA162, 1WO078, 1WO080
	20E-1-4687M	1SI173, 1SI172, 1SI175

TABLE II-5

INSTRUMENTATION INSPECTION SAMPLE

Instruments:

OPC-W0020
1FT-AF016
1LS-D0036
1PT-934
1PT-935
1PT-936
1PT-937

Tubing Runs:

OPC-W0020	34 feet
1FT-AF016	15 feet
1LS-D0036	6 feet

Instrument Racks:

1PL50J
1PL56J
1PL71J
1PL75J

Instrument Supports:

H1012A-1
OPC-W0020-H220-1
OPC-W0020-H102A-2
OPC-W0020-H135B-3
OPC-W0020-H135B-4
1PT-935-H234A-1
1PT-936-H234A-1
1PT-937-H234A-1
1PT-934-H234-1

III. MECHANICAL CONSTRUCTION

A. Objective

The objective of the appraisal of mechanical construction was to determine if installed and Quality Control (QC) accepted mechanical items conformed to engineering design, regulatory requirements and licensee commitments.

B. Discussion

The specific areas of mechanical construction evaluated were piping, pipe supports/restraints, concrete expansion anchors, mechanical equipment, and heating, ventilating and air conditioning (HVAC) systems. To accomplish the above objective, a field inspection of a sample of QC accepted hardware was performed in each area. In addition, certain programs, procedures and documentation were reviewed as required to support or clarify hardware inspection findings.

1. Piping

a. Inspection Scope

Piping depicted on the sixteen Phillips, Getschow Co. (PGCo) isometric drawings listed in Table III-1 was inspected by the NRC CAT. Approximately 350 feet of 2 inch diameter and smaller piping and approximately 700 feet of greater than 2 inch piping which had previously been accepted by PGCo QC was inspected. The inspection sample included piping located in both the auxiliary and containment buildings. Pipe sizes ranged from 3/4 to 10 inches and pipe classifications were ASME 1, 2, and 3. Attributes inspected included configuration (i.e., component orientation and dimensions), component locations and types, and valve operator orientations. Additional features such as support locations and types, maintenance of In-Service Inspection (ISI) clearance criteria and site construction practices were observed.

As is identified in Table III-1, four of the piping isometrics included in the NRC CAT inspection sample had previously been inspected by Commonwealth Edison Company's (CECo) Braidwood Construction Assessment Program (BCAP) personnel. This small coincident sample permitted only a limited review of the BCAP program.

The following documents provided the acceptance criteria and background information for the NRC CAT inspection:

- PGCo Construction Procedure, PGCP-40, Rev. 3, "Verification, Preparation and Transmittal of As-constructed Drawings."
- PGCo Quality Control Procedure (QCP), QCP-B21, Rev. 9, "Installation of ASME Section III and Safety-Related Process Piping Systems-2 Inch and Smaller."

- PGCo, QCP-B28, Rev. 4, "Fabrication and Installation of ASME III and Safety-Related Large Bore Process Piping Systems."

- Sargent & Lundy (S&L) Drawing M-919, Rev. P, Component Support Installation Guidelines and Tolerances," Sheet 6.

- S&L Drawing M-99 Rev. D, "Component Support Installation Guidelines and Tolerances," Sheet 6.

- S&L, "List of Lines That Will Undergo In-Service Inspection of Welds," review dated February 7, 1984 and approved by J. S. Mattingly.

b. Inspection Findings

NRC CAT inspection observations associated with specific piping isometric drawings are listed in Table III-1.

Procedure PGCP-40 requires measurement and recording of linear dimensions within one-eight inch by QC inspectors. Two design dimensions on Drawing 1A-SX-57 differed considerably from measurements by the NRC CAT inspector. Also, on Drawing 1A-AF-8, one difference between design and measured dimensions was detected. Numerical detail regarding these differences is included in Table III-1. NCRs regarding each of these dimensions were written by PGCo. Although not insignificant, these differences appear to be isolated instances not indicative of the overall QC effort.

For the coincident NRC CAT and BCAP piping inspection samples, two differences in findings were detected. Both conditions are on piping included on Drawing 1A-AF-8. In one case, the BCAP inspection did not detect the 3-inch dimensional difference noted by the NRC CAT. In the other case, the BCAP reported a 10-inch dimensional difference from the floor at elevation 383' 0" to the top of the riser which penetrates that floor. The NRC CAT inspection verified the original dimension to be correct within 0.5 inches.

In 1983, the NRC identified a concern with possible piping clearance violations. The site has taken several actions to address this concern including revision of the piping "as-constructed" inspection procedures, an assessment of other contractor specifications and procedures and issuance of ECNs in September 1984 to provide installation criteria guidelines to other contractors. However, at the time of the NRC CAT inspection at Braidwood, most quality control and engineering procedures still did not include specific provisions for maintenance or verification of clearances between piping and other components/structures, including pipe to sleeve clearances. During the inspection, NRC CAT members observed many instances of less than 3-inch pipe-to-pipe and pipe-to-structure clearances. Site personnel noted that upcoming revisions to procedures would include provisions for minimum clearances. Currently a final walkdown of piping installation is planned which would identify clearance violations for resolution by analysis or rework. However, a draft copy of this procedure reviewed by the NRC CAT only required noting of direct contact with pipes in the hot position.

Although thermal clearance checks during final walkdown programs are necessary, the NRC CAT notes that experience at other sites has demonstrated that system or area walkdown inspections have not proven to be reliable methods to resolve potentially unacceptable interferences. The NRC CAT considers that additional actions are needed on this matter.

Several instances of generally poor construction practices were observed during the inspection. A large temporary platform was found to be supported at one point by 1½ inch diameter, Class 1, RC piping (line 1RC22AC). Pipe design would obviously not account for a load of the magnitude possible in this case. The platform was subsequently removed from the pipe and a calculation was performed by S&L which concluded that allowable stresses had not been exceeded. Another scaffold was noted tied to Class 2 line 1CS05AB. Other examples of inadequate mechanical equipment maintenance or protection were observed by the NRC CAT. In one instance, metal grating was found to be installed in such a manner as to bear against the hanger rod for the constant support spring hanger of support 1CV06009C. Other examples included grating stored against installed pipe and a snubber was left unattached at its rear bracket and hanging loose from the pipe it was apparently intended to restrain.

In addition, several installed lines (2CV-218, 2A-RF-4) were observed to be uncapped (open to the atmosphere) by NRC CAT inspectors.

A relatively large air operator is installed on valve 1SI8880 located on 2-inch piping depicted on Drawing PG-2539A-29. The operator displaces significantly in response to very slight loading and is not restrained or otherwise protected from accidental loading by construction personnel or equipment. Several similar situations of large operators mounted on small bore piping were observed. Examples of such unrestrained, unprotected operators are those of valves 1SI8877B, 1RC8036C and 1CV8141C. Three of the four valves have permanent supports designed, however, temporary supports should have been provided, as there is a concern that an inadvertent bump of the operator could result in significant loading at the valve and adjacent piping.

Drawing 1A-AF-8, Revision C incorrectly listed a Field Change Order, (FCO) 1AF-1213, as having been incorporated. This FCO modified the first horizontal piping run downstream of pump 1AF01PA-1A. Discrepancies between the design drawing and the piping configuration resulting from this FCO include an overall dimensional difference for the affected run of approximately 6 inches and several location differences for components within that pipe run.

Three pipe supports were observed during inspection of small bore pipe line number 1RC22AC depicted on Drawing PG-2542C-17. It was determined during discussions with PGCo QC personnel that each of these supports had been accepted by QC in their then current locations. The subject pipe line is included on the S&L line list referenced by PGCo QC for identification of pipe subject to ISI. As such, included welds are subject to the 3 inch clearance required per M-999. One of these supports, 1RC18030R, was located such that the support structure covered a pipe socket weld and in addition the support member intended to provide pipe-to-support contact was located 0.25 inches from the toe of the same weld. As a result of the NRC CAT observation, this restraint was relocated away from the weld in question. Plate used to shim another of these supports, 1RC18032X, overlapped the toe of an adjacent socket weld. The third support, 1RD18031G, was located 1.25 inches from an adjacent socket weld. During discussion with PGCo QC it was determined that QC personnel believed that socket welds do not require ISI. Because socket welds require only a visual/surface ISI (vs. volumetric) it is possible that the 3 inch clearance criteria can be reduced for these welds. PGCo QC has issued a request for clarification of the criteria to S&L. Regardless, an inadequate QC inspection was performed on these supports/restraints.

c. Conclusions

Piping was found to generally conform to design documents. However, sufficient discrepant conditions were found to warrant additional management attention to QC design verification activities.

Communication between design, construction and QC organizations regarding criteria, such as necessary clarification of ISI clearance requirements, should be closely monitored by CECo.

The need for increased licensee surveillance of contractor construction practice is apparent. The platform mounted on nuclear safety-related pipe and numerous instances of uncapped pipe and unprotected valve operators illustrate a greater incidence of poor construction practice than normally observed by the NRC CAT.

The NRC CAT is concerned that reliance on a final walkdown of mechanical installations to identify pipe clearance violations is overly optimistic and could result in extensive inspection, analysis and rework very late in the construction schedule.

2. Pipe Supports/Restraints

a. Inspection Scope

Thirty-one ASME Class A, B and C and five Class D pipe supports/restraints were selected for detailed inspection. These supports/restraints represented a variety of types, sizes, systems and location. All had been inspected and accepted by the mechanical contractor, Phillips, Getschow Co. (PGCo). Six of the ASME supports/restraints had been inspected during the BCAP activities. These supports/restraints were inspected for configuration, clearances, member size, location, damage, weld size and proper fasteners.

In addition, approximately 100 other supports/restraints were observed at random in the field for obvious deficiencies such as loose or missing fasteners, improper clearances or angularity, damage, etc.

Documentation packages consisting of Weld Data Travelers, Hanger Checklist Travelers and Stores Requests for nine ASME supports/restraints were also examined for completeness, accuracy and conformance to procedural requirements.

See Table III-2 for a listing of the pipe support/restraint inspection samples.

Acceptance criteria for these inspections were contained in the following documents:

- PGCo Quality Control Procedure (QCP)-B23, Rev. 8, "Installation and Inspection of Component Supports."
- PGCo QCP-B23A, Rev. 0, "Supplemental Procedure for Handling and Installation of Component Support Speciality Items."
- PGCo Work Instruction PGWI-6, Rev. 1, "Implementation of Advanced Hanger ECN (AECN) Field Actions."
- Sargent & Lundy Engineers (S&L) Drawing M-919, Rev. P, "Component Support Installation Guidelines and Tolerances."
- S&L Drawing M-999, Rev. D, "Component Support Installation Guidelines and Tolerances." (Superseded M-919 on August 13, 1984).
- Applicable design drawings and change documents.

b. Inspection Findings

At the time of this inspection, approximately 80 percent of the approximately 13,160 ASME and Class D large bore supports/ restraints had been QC accepted. Approximately 42 percent of the approximately 16,300 ASME and Class D small bore supports/ restraints had been QC accepted.

The NRC CAT inspectors observed a large number of installation deficiencies on QC accepted supports/restraints. See Table III-3 for a listing of inspection observations. On the 36 supports/ restraints in the primary sample, approximately 17 observation on 12 supports/restraints indicated conditions outside of allowable tolerances had been accepted by PGCo Production and QC personnel.

These conditions included improper or undersized welds (4), wrong material installed (4), attachment locations out of tolerance (5) and excessive snubber to rear bracket angularity. In addition, one Class D support that had been "inspected" by Production personnel was found to have a smaller than specified strut installed. For Class D supports/restraints, (non-safety systems but installed in seismic buildings and thus near safety-related pipe/components) only attachment welds and concrete expansion anchor installations are inspected by QC. The remainder of the support features are "inspected" by Production personnel.

Based on the observations of installed hardware, the NRC CAT inspectors considered that QC inspectors did not always have clear inspection/acceptance criteria. Several instances were noted where no visible clearance could be seen between piping and member of box restraints, potentially causing an axial restraint where one had not been designed. The M-999 drawing allowed a tolerance of minus 1/16 inch where a 1/16 inch gap was specified for box restraints and U-bolts, thus a bound condition could be accepted per the tolerance drawing. In another instance, the M-999 drawing specified in the General Notes that locknuts or jamnuts are required for threaded fasteners (as required by ASME Code), but then indicates that vendor's catalogues will be the governing document for minimum requirements. Vendor's catalogues do not usually reflect any lock/jam nuts or reflect compliance with specific ASME requirements. In another instance, Revision B to M-999 defines a "riser" for different pipe diameters with a plus or minus tolerance where only a minimum length should have been specified. See Section IV of this report for a discussion of acceptance criteria regarding skewed tee welds.

One large bore box restraint was noted to have a gap between the lower support member and pipe, thus not supporting the pipe for "dead weight" loading and passing the loading to adjacent pipe supports. The NRC CAT inspectors were informed that this would be an inspection item in the system walkdown procedure (PGCP-48), but a draft of this procedure reviewed by the inspectors did not address this item.

Hardware inspections and the review of documentation packages indicated several cases where engineering reviews (and in some cases QC inspection effort) had been inadequate. Several examples are as follows:

(1) On 1C503029V, field engineers reported by Field Change Request (FCR) that the clip angles that had been installed were larger than specified on drawing Revision "E". In fact the correct material had been installed per Revision E and accepted by QC. However, in response to the FCR, Revision F was subsequently issued to reflect larger clip angles. PGCo QC erroneously updated the inspection checklist traveler, apparently without field verification, to reflect that the support was installed per the FCR. Thus when inspected by the NRC CAT this support did not conform to the latest design documents.

(2) For Class D support 1W002009X, work and QC acceptance was apparently performed to drawing Revision "C" and Field Problem Report (FPR) C-289 that allowed deleting two beam stiffeners. However, ECN 12140, issued to incorporate the FPR, still showed the stiffeners installed. Revision D to the drawing also shows stiffeners installed. These stiffeners are not installed.

(3) For restraint 1CS045002S, angle iron beam stiffeners have been removed by Field Change Orders (FCO's), but the latest support drawing revision ("D", issued 10/84) did not reflect removal of stiffeners and showed a one inch thick cover plate on the wrong side of beam. This installed and QC accepted support does not conform to the latest design documents.

(4) For 1AB16018R, Advanced Engineering Change Notice (AECN) 15114 was issued in March 1984 to change the attachment location on a beam weld that had been incorrectly installed and accepted 5-3/8 inches beyond allowed tolerances in February 1984. No NCR was written to document the out of tolerance condition as required by site procedures.

See Section VII for a further discussion of design change control activities.

Three QC accepted supports/restraints had been disassembled without the required authority or documentation to assure that necessary reinspection were performed. Numerous instances of loose or missing fasteners were also observed. These examples indicate a need for greater attention to the problem of altering completed and accepted hardware.

Of the six supports/restraints that had undergone a previous inspection by the BCAP program, two were found to be installed as designed by both the NRC CAT and BCAP and one had deficiencies that were identified by both the NRC CAT and BCAP. Three of the supports/restraints were found to be installed with discrepant conditions not identified by the BCAP inspection. On 1SX06028R, BCAP did not note that the attachment to existing steel was approximately three inches out of tolerance. In addition, the BCAP inspection did not note that an undersize pipe clamp and load bolt had been installed on this support. The BCAP inspector did note on a material listing that the clamp was marked N3H rather than the 3HN marking indicated in the drawing Bill of Materials. It is doubtful if a review of this discrepancy in marking of the catalogue number would have revealed that a wrong size clamp had been installed. On 1CS04002S, beam stiffeners shown on the latest design drawing were not installed and a cover plate not shown on the drawing was installed. The BCAP inspector did note, in the remarks column of the inspection report, that he was unable to identify if the stiffener was installed. This may have been identified as a problem during the BCAP engineering review of the inspection report. On 1CS03029S, the BCAP inspection did not note that the attachment location along the supplementary steel was out of tolerance by 2 1/2 inches and that four clip angles were smaller in size than specified on the drawing.

Another condition noted during the hardware inspection was a large number of supports/restraints in contact or close proximity to pipe or other structures. Of special concern were several instances of snubbers binding against other structures (see Table III-3). See Section III.B.1 of the report for a further discussion of clearance violations.

The licensee stated that a number of future inspection/review programs are planned or being drafted that possibly could identify the problems noted by the NRC CAT inspectors. However, the reliance on system or area walkdowns performed at the end of the construction program to identify construction deficiencies is no substitute for thorough and timely first line inspections.

c. Conclusions

The number and type of discrepancies identified in installed ASME and Class D hardware indicates the QC/Production inspection programs have not been effective in assuring that installed hardware conforms to design requirements.

Existence and clarity of inspection/acceptance criteria, drafting/ document control/engineering review activities, general construction practices and timely development/implementation of clearance criteria are all issues requiring additional review and attention.

Late construction walkdown programs should only be relied on as an extra level of quality verification and not a substitute for thorough and timely first line inspection efforts. The acceptability of previously accepted support/restraint work must be evaluated and final walkdowns addressing clearances and other features not previously verified must be extensive, thorough and closely managed.

3. Concrete Expansion Anchors for Pipe Supports/Restraints

a. Inspection Scope

Forty-eight concrete expansion anchors on 13 pipe supports/ restraints were inspected for proper diameter, length (by UT and code stamping), spacing, edge distance, damage, washers and residual torque (an indication of anchor preload). The anchors inspected were selected on a variety of systems at random during a plant walkdown and ranged in diameter from 1/4 inch to 1 inch. Table III-4 provide a listing of the anchors inspected. Anchors were torqued to the 15 day-3 month test torque specified in site procedures (approximately 50-60 percent of installation torques). Acceptance criteria for these field inspections were contained in the following documents:

- Form BY/BR/CEA, Rev. 21, "Standard Specification for Concrete Expansion Anchor Work."
- PGCo. Construction Procedure PGCP-10, Rev. 16, "Installation of Wedge and Sleeve Type Concrete Expansion Anchors."
- Detail drawings for pipe supports/restraints.

b. Inspection Findings

The concrete expansion anchor program at Braidwood has recently undergone extensive review and various procedures were revised to provide a more complete QC inspection role and to make the various programs more consistent. The intent is to issue a generic site procedure so that all contractors will be installing and inspecting anchors identically.

Only 4 of the 48 anchors turned prior to reaching the test torque and all reached torque in less than one quarter turn of the nut. Even considering that the test torques were relatively low, no installation deficiency is indicated. All other characteristics examined were either within tolerance or had been previously identified and evaluated.

c. Conclusion

The concrete expansion anchors installed in pipe supports/restraints that were inspected by the NRC CAT were installed in accordance with design and procedural requirements.

4. Mechanical Equipment

a. Inspection Scope

The following four items of mechanical equipment were inspected for proper orientation, support configuration and foundation bolting.

- Letdown Reheat Heat Exchanger, 1CV05A
- Moderating Heat Exchanger, 1BR01A
- Letdown Chiller Heat Exchanger, 1BR03A
- Recycle Evaporator, 0AB01DA

Installation documentation for this listed equipment was also examined.

Acceptance criteria was provided by vendor technical manuals and drawings and site structural drawings.

b. Inspection Findings

In general, the mechanical equipment examined was installed in accordance with vendor and A/E requirements. A problem was noted with apparently inadequate clearances for expansion on the sliding end of the Moderating Heat Exchanger. Also, review of documentation indicated that all fasteners may have been torqued down at installation (in 1981-1982) including the sliding ends of heat exchangers. PGCo procedure QCP B22 is not completely clear on the requirements and acceptance criteria for these characteristics. However, both of these concerns had been previously identified and were being evaluated by S&L on a generic basis. Installed and accepted equipment will require reinspection and untorquing and retorquing as appropriate.

c. Conclusions

No apparent unidentified deficient installations were observed on mechanical equipment. The acceptability and installation status of mechanical equipment on site is indeterminate at this time pending licensee resolution of questions concerning foundation bolt torquing and adequate expansion clearance on heat exchangers.

5. Heating Ventilating and Air Conditioning (HVAC)

a. Inspection Scope

Fourteen HVAC Category I supports/restraints, one duct section, and one in-line fan were inspected. The sample included five HVAC supports/restraints and one duct section inspected by BCAP. See Table III-5 for listing and observations of the HVAC hardware inspected by the NRC CAT. HVAC supports were examined in the auxiliary, reactor, diesel generator, and control buildings. Features examined were location, configuration, member connection details and support to duct connection details. The seismically supported duct runs were not completely erected and/or QC accepted, limiting the NRC CAT inspection sample. Safety-related equipment installed by Pullman Sheet Metal Works Incorporated (PSM) had a "stop work order" in effect addressing installation and inspection per NCR BR-254. Only approximately 10 percent of the safety-related equipment had been QC inspected. QC inspectors and BCAP personnel were interviewed regarding their knowledge of requirements and their responsibilities.

The following documents provided the acceptance criteria for the inspection of HVAC hardware installations.

- Sargent and Lundy Engineers (S&L) Specification L-2782 for HVAC Work
- S&L Drawing M-1261, "Safety-Related HVAC Hanger Details," Sheets 1 thru 40
- S&L "Safety-Related HVAC Hanger List"
- Pullman Sheet Metal Works Inc. (PSM) Procedure B10.3F, Rev. 6, "Installation Inspection Procedure"
- Commonwealth Edison Company (CECo), NCR No. 349, "Nonconformance Report for Construction and Test", Ref: Weld Detail on S&L DWG M-1261-1
- PSM "Duct Brochure", Rev. F
- CECo NCR No. 460 Rev. 0 and Rev. 1, Ref: Safety-Related HVAC Hangers, Braces, Aux. Steel and All Safety-Related Details and Connections

- PSM NCR BR 254, Ref: "stop-work-order" Addressing Installation and Inspection of HVAC Equipment

- Applicable Duct Support/Restraint and Layout Drawings

b. Inspection Findings

Approximately 25 percent of the Category I supports had been QC accepted by PSM and approximately 65 percent of BCAP's HVAC support reinspection program was completed. In addition to the equipment "stop-work-order" currently in force, problems were identified in 1982 and 1983 requiring extensive program changes, reinspection, reanalysis and rework for duct welding, duct fabrication and support/restraint installation deficiencies. Although numerous minor dimensional discrepancies were observed by the NRC CAT, no major installation deficiencies involving location, geometry and member size were identified. In the area of welding and connection details of the HVAC supports the NRC CAT identified missing welds, undersize welds and at the support to duct connection "blow holes" in the duct sheet metal were identified. See Section IV of the report for further discussion of HVAC welding findings. The NRC CAT inspection findings of the five BCAP HVAC support/restraint samples and duct section #4430 were similar to BCAP's findings.

The NRC CAT inspected one sample of safety-related equipment, an in-line fan (1V08CA) and its support (#3763) as the remaining seven equipment samples were partly or not installed. No deficiencies were noted on the in-line fan. However, for the fan support the following observations were made (1) bolt detail for fan to support attachment not shown or referenced on fan support drawing #M-1315 Rev. H, i.e., bolts welded to frame steel with no weld symbol, (2) two of four diagnal braces were not detailed on fan support drawing, nor noted in the PSM QC inspection report.

Nonconformance Report BR-254 and the "stop-work-order" (BR-84-221) concerning the lack of adequate installation and inspection criteria and documentation for HVAC equipment were reviewed. The NCR disposition indicates that corrective action will be directed at a review, statusing and necessary reinspection of installed equipment for vendor requirements only. The NRC CAT notes that a thorough evaluation and/or reinspection of previously accepted items for all attributes appears warranted. This conclusion is based on the problem description in the stop-work-order, the extensive construction and inspection problems in other HVAC hardware (duct and supports) and the observations made by the NRC CAT.

The NRC CAT inspectors found the QC inspectors and BCAP personnel to be knowledgeable of requirements and their responsibilities in the area of HVAC.

c. Conclusions

HVAC safety-related support/restraints generally conformed to design and procedural requirements. Conclusions cannot be made on HVAC duct runs and safety-related equipment because of the limited sample available and indeterminant hardware status. Additional evaluation of the corrective action regarding the HVAC equipment stop-work-order is necessary.

TABLE III-1

PIPING INSPECTION SAMPLE

Small Bore Pipe (2 Inch Diameter or Less)

Isometric (Note 1)	Diameter (Inches)	Class	No. of Support Locations Checked	Notes	Observations
2539A-29, Rev. C	3/4, 1, 2	B, C	6	-	Large unstable valve operator is not supported or otherwise protected
2539A-31, Rev. A	3/4	B	7	-	
2539C-82, Rev. C	3/4	B	2	2	
2541A-4, Rev. C	2	C	3	-	
2541A-7, Rev. C	2	C	5	-	
2542C-17, Rev. B	1 1/2	A	3	3	3 Support to weld ISI clearance violations Platform mounted on pipe elbow
2545A-100, Rev. B	1 1/2	C	0	4	
2546C-15, Rev. D	3/4	A, B	0	-	
2546C-16, Rev. C	3/4	A	0	-	
2549A-75, Rev. A	2	C	0	4	

TABLE III-1 (Continued)

PIPING INSPECTION SAMPLE

Large Bore Pipe (Greater Than 2 Inch Diameter)

Isometric (Note 1)	Diameter (Inches)	Class	No. of Support Locations Checked	Notes	Observations
1A-AF-8, Rev. C	6	C	9	2	FCO 1AF-1213 incorrectly listed as incorporated 3'5¼" design dimension measures 3'2"
1A-AF-33, Rev. A	3	C	1	-	Continuation isometric sheet numbers are switched for 2 branch connections
1A-CV-3, Rev. B	8, 6, 4	B	10	3	
1A-CV-3A, Rev. A	8	B	8	2	
1C-SI-8, Rev. 0	6, 10	A, B	0	2, 3	
1A-SX-57, Rev. 0	3, 4, 6	C	14	-	3'2" design dimension measures 3'6" 2'5" 1/8" design dimension measures 3'11"

Notes

1. Letter designations 'A' and 'C' of isometric drawing numbers identify pipe location as auxiliary and containment buildings respectively.
2. This isometric is included in BCAP piping inspection scope.
3. This isometric includes piping subject to ISI.
4. QC inspection including "as-contructed" dimensional checking for this piping is in accordance with QC Procedure B21.

TABLE III-2

PIPE SUPPORT/RESTRAINT INSPECTION SAMPLES

S/R Number	Class	Size (Inches)	Type	Location	QC Inspection Date
1AB07001R	C	4	Strut	Auxiliary	09/84
1AB11019R	C	3	Box	Auxiliary	10/84
1AB12003G	C	4	Box	Auxiliary	11/84
1AB16018R	C	3	Strut	Auxiliary	03/84
1AB21035X	C	4	Box	Auxiliary	11/84
1SX03005R	C	20	Rod	Auxiliary	03/84
1SX06001R	B	16	Strut	Auxiliary	05/83
1SX07008R	B	14	Strut	Reactor	04/84
1SX09038S	B	10	Snubber	Reactor	07/84
1CC03067R	C	14	Box	Auxiliary	02/84
1CC03074V	C	12	Spring	Auxiliary	05/83
1CC04001X	C	6	Strut	Auxiliary	04/83
1CC10008V	C	4	Spring	Auxiliary	04/83
1CC13037R	C	16	Strut	Auxiliary	04/83
1RC01004V	A	8	Spring	Reactor	01/85
1RC10032S	A	3	Snubber	Reactor	08/84
1RC11093R	A	3	Box	Reactor	11/84
1RC10034S*	A	3	Snubber	Reactor	05/84
1RC01007S	A	8	Snubber	Reactor	01/84
1SI01025S	C	8	Snubber	Reactor	04/84
1SI03046S	A	6	Strut	Reactor	05/84
1SI01032S	B	10	Snubber	Reactor	07/84

TABLE III-2 (Continued)

PIPE SUPPORT/RESTRAINT INSPECTION SAMPLES

S/R Number	Class	Size (Inches)	Type	Location	QC Inspection Date
1SI0403G	B	10	Strut	Auxiliary	09/84
1SI14027A	B	3/4	Anchor	Reactor	11/84
1RH02007S	A	12	Snubber	Reactor	--
1RH02029R	B	12	Strut	Reactor	05/84
1SX07007X*	B	4	Strut	Reactor	03/83
1CS03029V*	B	6	Spring	Auxiliary	11/82
1CC20012S	B	4	Snubber	Reactor	05/84
1SX06028R*	C	10	Strut	Reactor	05/83
1CS04002S*	B	10	Snubber	Reactor	02/84
1W001025S	D	10	Strut	Reactor	07/83
1W002009X	D	8	Rigid	Reactor	03/83
1FC99004X	D	4	Strut	Reactor	08/83
1CC39051X	D	4	Strut	Reactor	02/84
1W001001R	D	10	Rod	Reactor	01/83

*Supports/Restraints that had also been inspected by BCAP program.

Document Packages Reviewed

1AB16018R	1RC10034S
1SX06001R	1SX03005R
1SI01025S	1SI03046S
1AB21035G	1RC10032S
1SX07008R	

TABLE III-3

PIPE SUPPORT/RESTRAINT INSPECTION OBSERVATIONS

Primary Sample

Support/Restraint	Observation (PGCo NCR Issued)
1AB07001R	Adjacent pipe cut and removed-program did not require reinspection of previously accepted S/R for location or angularity.
1AB12003G	Missing locknut. Attachment welds not full penetration as specified (NCR 2947).
1SX03005R	Undersized pipe clamp installed (NCR 2964). One inch clearance to ten inch SX pipe.
1SX06001R	Attachment location exceeds tolerance by 1/2". Orientation dimensions reversed (NCR 3151). 3/4 inch clearance to electrical conduits.
1SX09038S	Underfilled flare bevel weld and missing return welds where specified (NCR 2976).
1CC03074V	Beam attachment location on embed exceeds tolerance (NCR 3308).
1RC01004V	3/4 inch beam attachment installed, 1/2 inch specified-not allowed by M-999 (NCR 3310).
1RC10032S	Snubber disconnected without authorization/documentation (NCR 2909).
1RC01007S	Snubber to end bracket angularity of 7 degrees exceeds vendor specified maximum of 5 degrees.
1RH02029R	Location on embed exceeds tolerance by 5/16 inch. Mislocated welds result in less than design weld length (NCR 3053).
1CS03029V	Location along supplementary steel exceeds tolerance by 2½ inch. Undersized clip angles installed.

TABLE III-3 (Continued)

PIPE SUPPORT/RESTRAINT INSPECTION OBSERVATIONS

Primary Sample

Support/Restraint	Observation (PGCo NCR Issued)
1CC20012S	Damaged snubber extension piece paddle.
1SX06028R	Disassembled without authorization/ documentation. Attachment location to beam exceeds tolerance by 3 inches. Unspread cotter pins. Undersized pipe clamp and load pin installed (NCR 3385)
1CS04002S	Loose fasteners. Drafting/engineering error.
1WO02009X	Stiffeners shown on drawing not installed.
1CC39051X	Undersized strut installed.
1AB21035X	Zero clearance to strut 1SX17034X.
1CC04001X	3/4 inch clearance to strut 1CC04036R.
	Adjacent Sample
1SX09001R	Drawing specified return welds missing.
1AB21008X	Box guide with no visible pipe to support clearance (NCR 3313).
1FW04018X	Verticle restraint with no visible pipe to support clearance (NCR 3391).
1CS03084X	Gap (0.090 inch) under 8 inch pipe on weight box support.
1RC10032S	Disassembled without authorization/ documentation (NCR 2909).
1SX03004X	Loose pipe clamp fasteners.
1AB11020X	Load pin cotter severed and pin almost disengaged.
1AB11090X	Loose strut locknut.
1RC01006S	Snubber tube in contact with whip restraint.

TABLE III-3 (Continued)

PIPE SUPPORT/RESTRAINT INSPECTION OBSERVATIONS

Primary Sample

Support/Restraint	Observation (PGCo NCR Issued)
1CV02004S	Snubber binding against wall.
2FW06014S	Snubber binding on structural steel.

TABLE III-4

CONCRETE EXPANSION ANCHOR INSPECTION SAMPLE

Pipe Support Drawing	Number-Diameter (Inches) of Anchors Inspected
1W034009X	4-3/4
1W034007X	4-3/4
1WOF49005T	1-1 3-3/4
2FP03049X	5-1/4
2FP03009X	4-1/2
1BR1001X	3-1
1BR10029X	4-1/2
1BR3101R	4-3/4
1BR31009X	4-1/2
1WX65B006T	4-1
1WE06B040T	4-1/2
1W037006A	4-1

TABLE III-5

HVAC INSPECTION SAMPLES AND OBSERVATIONS

Supports/Restraints

S&L Restraint Mark Number	BCAP Selection Number	Building	Observations
S-2169 M-1323-7	CSR-I-H-03-43	Auxiliary	Missing welds on lower stiffener plate to vertical member; material reduction on top of horizontal member greater than 1/16"; auxiliary steel inaccessible - not inspected.
S-2164 M-1323-7	CSR-I-H-03-42	Auxiliary	Auxiliary steel inaccessible - not inspected.
S-160 M-1310-2	CSR-I-H-03-06	Auxiliary	Diagonal brace edge distance 5/32". 3/16" minimum required.
S-2008 M-1274-2	CSR-I-H-03-053	Reactor Containment	Duct dented, and water inside duct run.
S-3281 M-1326-5	CSR-I-H-03-52	Control	Overlap dimension of support leg to auxiliary is 2" vs. 2½" overlap required.
S-1309 M-1283-	CSR-I-H-03-022	Diesel Generator	No findings on support frame, auxiliary steel not inspected. (Support had not yet been inspected by BCAP)
S-42 M-1309-6	N/A	Auxiliary	Undersize welds on frame vertical member to attachment plate at four places.
S-043 M-1309-6	N/A	Auxiliary	None
S-1041 M-1313-01	N/A	Auxiliary	None
S-196 M-1310-04	N/A	Auxiliary	3/8" actual edge distance of horizontal member of vertical member vs. 1/4" edge distance allowed.

TABLE III-5 (Continued)

HVAC INSPECTION SAMPLES AND OBSERVATIONS

Supports/Restraints

S&L Restraint Mark Number	BCAP Selection Number	Building	Observations
S-010 M-1309-5	N/A	Auxiliary	Two 'blow holes' in bottom of duct sheet metal at support to duct attachment, warped and dented duct, missing welds vertical members to top horizontal member.
S-3282 M-1326-5	N/A	Control	Support vertical legs incorrectly numbered on FEM 241A and FCR 12187, upper diagnal attachment to wrong leg, duct to leg No. 1 (dimen.) out of tolerance, dimension of 1½" between bottom of diagonal member to horizontal member exceeds maximum required dimension of 1", gusset plate and weld undersize more than 10%.
S-90 M-1309-9	N/A	Auxiliary	None
S-135 M-1310-2	N/A	Auxiliary	Temporary pipe support for 3/4" pipe attached to duct support, 2" end weld at duct to support attachment is 1 1/8" from corner rather than 1/2" maximum allowed.

TABLE III-5 (Continued)

HVAC INSPECTION SAMPLES AND OBSERVATIONS

HVAC Duct Sections and Safety-Related Equipment

S&L Duct Section Number	BCAP Selection Number	Building	Observations
4430 M-1323-2	CSR-I-H-01-046	Control	None

S&L Safety-Related Equipment Number	BCAP Selection Number	Building	Observations
1VA08CA & (Fan Suport #3763)	N/A	Auxiliary	For fan: None For fan support: detail for fan to support attachment not shown or referenced on drawing, i.e., bolts welded to frame - no weld symbol, two of four diagonal braces not detailed on drawing nor noted in PSM QC inspection report.

IV. WELDING AND NONDESTRUCTIVE EXAMINATION (NDE)

A. Objective

The objective of the appraisal of welding and nondestructive examination (NDE) was to determine if Quality Control (QC) accepted work related to welding and NDE activities was controlled and performed in accordance with design requirements, Safety Analysis Report (SAR) commitments, and applicable codes and specifications.

An additional objective was to determine if personnel involved in welding and NDE activities were trained and qualified in accordance with established performance standards and applicable code requirements.

B. Discussion

To accomplish the above objectives, welds and welding details for piping, pipe supports/restraints, field and shop fabricated tanks, structural steel installations, heating, ventilation and air conditioning (HVAC) installations, electrical supports, and instrumentation and control tubing were inspected. The inspected welds were selected to provide a representative sample of the applicant's contractor welding activities in terms of welding processes used, materials welded and existing weld-joint configurations. Considerations such as physical location, difficulty of welding and limited accessibility were also used in sample selection.

NDE activities were appraised through the review of radiographs for both field and vendor fabricated welds, the review of NDE procedures and personnel qualifications, the inspection of the calibration status of NDE equipment and the witnessing of in-process NDE activities. The NRC Construction Appraisal Team (CAT) inspectors reviewed samples of radiographic film in final storage in the vault at the licensee's facility. In addition, a sample of film which was stored at the Westinghouse storage facility was also brought to the site for review.

During the inspection of welds on pipe supports/restraints, the NRC CAT identified welds which did not have the weld size specified by the Architect Engineer, Sargent & Lundy (S&L). Undersized welds were found on both skewed and non-skewed connections on pipe supports. S&L has evaluated most of the undersized welds and determined that the welds are adequate for the intended application. Undersized weld reinforcements were also found in nozzle to shell joints (ASME Code Category D joints) on tanks and heat exchangers. A detailed discussion concerning these welds is included later in this section.

The licensee has undertaken a program of inspections and reviews intended to perform an overall assessment of the Braidwood Station. The Braidwood Construction Assessment Program (BCAP) was set up to include inspections of welds in all of the major areas of plant construction such as electrical, piping, instrumentation, HVAC and structural steel construction. During the time of the NRC CAT inspection, the BCAP had completed only the HVAC weld inspection. The NRC CAT inspectors inspected three HVAC supports which were inspected previously by the BCAP team in order to assess the adequacy of their inspection. In essence, the BCAP observations were identical with the NRC CAT findings which tends to indicate that the BCAP was effective in identifying weld deficiencies in the HVAC area.

In the area of NDE, the review of the licensee's Quality Assurance procedure SQI #20 revealed that the project reviews 10 percent of the radiographs transmitted to Quality Assurance from on and off-site vendors and contractors. However, the QA review is not intended as an independent interpretation of radiographs and is confined to a paper review of the associated NDE documentation. The team believes that this apparent lack of independent interpretation of radiographs prior to their storage in the vault may have contributed to the licensee's inability to identify questionable or deficient radiographs. During the review of radiographs supplied by various vendors and contractors, the NRC CAT found radiographs which showed that some welds did not have the required weld quality. A detailed discussion concerning these welds and their associated deficiencies are provided later in this section.

The welding and NDE activities were examined in order to ascertain compliance with the governing construction codes and specifications. This effort involved the review and inspection of the following contractors:

Field Fabrication

1. Sargent & Lundy Engineers: Architect Engineer.

2. Phillips, Getschow Company (PGCo): piping installation and piping supports/restriants, instrumentation installation and instrumentation supports, fire protection fabrication and installation.

3. Chicago Bridge and Iron Company (CB&I): containment liner and containment penetration fabrication and installation, tank fabricator.

4. Pittsburgh-Des Moines Corporation (PDM): reactor pool and spent fuel pool liner fabrication and installation, tank fabricator.

5. L.K. Comstock and Co., Incorporated (LKC): electrical installations and electrical supports

6. Pullman Sheet Metal Works, Inc. (PSM): heating ventilation and air conditioning (HVAC).

7. Gust K. Newberg Construction Company (GKN): structural steel installation

8. American Bridge Company (AB): structural steel erectors and suppliers.

9. Napoleon Steel Contractors, Incorporated: structural steel installation

10. Mid-City Steel Company: structural steel installation

11. Nuclear Installation Services Company (NISCO): reactor internals installation.

Shop Fabrication

1. Southwest Fabricating & Welding Company, Inc.: shop fabricated piping spools.
2. Harnischfeger Corporation: crane manufacturer
3. Westinghouse Electric Corporation: nuclear steam supply system
4. Anchor/Darling Valve Company: valve manufacturer
5. Graver Company: tank fabricator
6. Carrier Corporation: chillers and coolers manufacturer
7. Gulf & Western Corporation: containment spray eductors supplier
8. Cooper Energy Services: tank fabricator
9. Control Components, Incorporated: valve manufacturer
10. Dresser Industries, Incorporated: valve manufacturer
11. Unitech Division of Ecodyne: radwaste evaporators suppliers
12. Atwood and Morrill Co., Incorporated: valve manufacturer
13. L A/Water Treatment Corporation: feedwater heater manufacturer
14. W.K.M.: valve manufacturer
15. Yuba Heat Transfer Corporation: high pressure heater manufacturer
16. Aerojet-General Corporation: volume reduction system supplier
17. McQuay-Perfex: steam generator blowdown condenser fabricator
18. ITT Grinnell Corporation: pipe hangers supplier
19. Cleaver Brooks: heating boilers manufacturer
20. TRW Missions: valve manufacturer
21. Teledyne Brown Engineering: NSSS support steel supplier
22. Borg-Warner Fluid Controls: valve manufacturer
23. Continental Boiler Works: tank fabricator, miscellaneous stack and platework supplier
24. Rockwell International: hydrogen recombiner manufacturer

25. Greer Hydraulics: pulsation dampeners supplier

26. W.J. Woolley Company: containment vessel hatches fabricator and supplier

27. Jamesbury Corporation: valve manufacturer

28. Atlas Industrial Manufacturing Company: heat exchanger manufacturer

29. Bingham-Willamette: pump manufacturer

30. Joseph Oat Corporation: heat exchanger manufacturer

31. Lamco Industries, Incorporated: tank fabricator

The results of the inspection activities involving each of these areas and contractors are documented as follows:

1. <u>Pipe and Pipe Support Fabrication</u>

a. <u>Inspection Scope</u>

(1) <u>Welding Activities</u>

The NRC CAT inspectors reviewed activities relating to fabrication contracts in the areas of piping system welds, support/restraint welds, welding procedures, welder qualifications, NDE procedures, personnel qualifications, and the review of radiographic film for shop and field fabricated welds. Field welding involving pipe fabrication was performed by Philips, Getschow Company (PGCo). Southwest Fabricating and Welding supplied the shop fabricated piping spools.

The NRC CAT inspected 44 pipe supports/restraints involving approximately 700 welds in order to verify conformance of welding to drawing requirements and confirm the visual acceptability of the welds. See Table IV-1 for a listing of supports subjected to detailed inspection. Additionally, another 18 supports/restraints involving 350 welds were also visually inspected to verify the quality of the completed welds. The welds on the Unit 1 pressurizer lower ring girder and upper guides were also included in this inspection. See Table IV-2 for a listing of supports inspected.

The NRC CAT inspection of piping welds consisted of visual inspection during walkdown of piping systems and inspection of pipe welds located near the supports/restraints being inspected. Approximately 47 piping spools involving 1400 ASME Class 1, 2 and 3 welds were inspected. Twenty of those piping spools were subjected to detailed inspection which included the review of pertinent QC documentation while the remaining 27 spools were only visually inspected. Both field and shop welds were inspected in order to assure compliance with the requirements of the ASME Code. Some of the surfaces of the inspected welds were blended for inservice inspection. See Tables IV-3 and IV-4 for listings of piping spools inspected. In addition, 50 welding filler metal test reports, 19 welder qualification test records and 5 welding procedures were reviewed for compliance with applicable specifications, procedures and the ASME Code requirements.

(2) Nondestructive Examination Activities

The NRC CAT inspection of NDE activities for the pipe fabrication area included the review of 104 shop and 86 field fabricated welds which involved 2326 film. The field welds were fabricated by PGCo and the shop fabricated pipe spools were supplied by Southwest Fabricating and Welding. In addition 6 NDE procedures and 7 NDE personnel qualification records were reviewed in order to verify compliance with the governing codes and specifications. Five NDE technicians were observed while performing in-process inspections and were evaluated for their ability to follow the applicable inspection procedures. Ten pieces of NDE equipment were inspected for calibration and one quality assurance NDE procedure was reviewed for adequacy.

b. Inspection Findings

(1) Welding Activities

In general, the inspected pipe and pipe supports/retraints welding activities were found to comply with the governing codes and specifications. However, discrepancies were identified involving undersized welds in both skewed and non-skewed welded connections. Fifty-two of 1050 structural welds inspected, involving 62 pipe supports/restraints, were found to be deficient with respect to the specified acceptance criteria. Thirty-three of the welds were undersized, three welds were short on length, eleven flair and full penetration welds were underfilled, one support had an extra load-bearing plate welded and 4 welds were completely missing. See Table IV-1 for details. As a result of this finding the licensee issued NCRs and most of the welds were determined to be adequate for the intended application.

Eight of the 1400 pipe welds inspected were found to deviate from the specified acceptance criteria. As a result of these findings, the licensee issued NCRs and the welds will be evaluated and dispositioned by S&L. The welds, and their associated deficiencies are listed as follows:

1) PG-25-52C, FW 2 had excessively convex bead shape (NCR 3009).

2) RH-7-5 had weave width which exceeded that permitted by applicable WPS (NCR 3271).

3) 1-SI-RPP-1-FW1 and 1-SI-RPP-2-FW1 exhibited excess crown height, surface porosity, lack of fusion, poor bead shape and arc strikes (NCR 2935).

4) Containment Sump A in Unit 1 exhibited arc strikes (NCR 3257).

5) RH-12-11 (12" Schedule 40 pipe) had been ground heavily in an area that would not normally be ground. PGCo could not show that this work was authorized or controlled, speculating that it was repair of an arc strike. A subsequent thickness check showed the area to be under minimum wall thickness (NCR 3309).

6) A small diameter drain line under one Fuel Pool Cooling Heat Exchanger was observed to have been bent, probably due to being walked on. Subsequent reinspection showed that it had been straightened. PGCo could not show that the repair had been authorized or controlled. Monitor Report 6308 was written, resulting in Letter B-B-693 requiring training sessions for all construction personnel regarding the need to have appropriate controls prior to performing work.

7) The end preparation on 1-DO-46 was found to be out of conformance with fit-up requirements after fit-up inspection (NCR 3100)

Two of the 50 welding filler metal test reports reviewed were found to be deficient with respect to the applicable requirements. One test report was found to be incomplete, in that the lateral expansion values for impact testing was not reported (NCR 3390). In addition, the purchasing specification for E7018 welding electrodes was found to not meet the requirements of ASME Section III for impact testing. NCR 3389 was generated to correct the specific purchasing specification.

(2) Nondestructive Examination Activities

In general, the inspected NDE activities were found to comply with the applicable codes and specifications. However, during the review of the radiographic film several irregularities were identified which involved the following 12 welds:

° Field Welds SI-7-FW5B and FW-1-9-W100

The radiographs for these welds were found to have film densities above 4.0. When a high intensity viewer was used, the weld quality was found to be acceptable.

° Field welds AF-13-FW6 and ISI-RPP-2-FW1

These two welds were identified as having unacceptable weld quality. Weld AF-13-FW6 had porosity in excess of code and weld ISI-RPP-2-FW1 had incomplete fusion. As a result of this finding, the licensee issued NCR 214 and NCR 215 and the welds are scheduled to be repaired.

- Field Welds AF13-FW17 and FW51-FW11

  Those two welds were identified as having questionable indications. After the welds were reradiographed, these indications were determined to be film artifacts and the weld quality was determined to be acceptable.

- Field Weld RH-7-FW1

  The reader sheet for this weld indicated that the weld was rejected by the original interpreter. The review of existing film could not establish whether the present status of the weld was acceptable or rejectable. The weld was reradiographed and the final radiographs revealed that a proper repair had been accomplished. The weld quality was determined to be acceptable.

- Shop welds SX-36-1-SW3 and SX-36-1-SW4

  These two welds had two identical radiographs. Both welds were reradiographed to determine which weld had been radiographed two times with different weld identification. The final radiographs indicated that the weld quality for the two welds were acceptable.

- Shop Weld FW-2-6-W4

  This weld had incomplete coverage between stations 22 and 25. A linear indication could not be evaluated because the penetrameter was placed in the area of interest at stations 7 to 9. Several areas had lead numbers placed in the weld area which also prevented the proper interpretation of the area of interest. The weld was reradiographed and the weld quality was found to be acceptable.

- Shop Weld RH-12-7-W4

  The original radiograph for this weld showed a questionable linear indication in one of the weld areas. The weld was reradiographed and liquid penetrant examined after which the indication was determined to be an acceptable surface condition.

- Shop Weld SI-43-1-W4

  The original radiographs for this weld showed an unacceptable linear indication. Subsequent reradiographs and visual examination revealed a sharp valley on the internal weld surfaces. The indication was photographed and the pictures were used to aid the radiographic interpretation process. The quality of the weld was determined to be acceptable.

The review of the project quality assurance procedures SQI #20 revealed that the project does not perform independent interpretation of radiographs prior to their storage in the vault. The procedure requires 10 percent review of NDE documentation and is not intended to review radiographs.

c. Conclusions

1. Welding Activities

In general, the inspected welding activities were found to comply with the requirements of the applicable codes and specifications. However, the NRC CAT found structural welds on pipe supports/restraints which did not meet the weld specifications. Most of these supports were evaluated by the Architect Engineer and determined to be adequate for the intended application. The project had also instituted the BCAP program which is intended to assess the welding workmanship. Our review of BCAP inspections in the HVAC area tend to indicate that the program is effective in identifying weld deficiencies. Nevertheless, the NRC CAT identified undersized welds which showed that the original weld inspection of the supports was not effective in the identification of weld deficiencies. This indicates a program weakness in this area.

2. Nondestructive Examination

In general, the inspected NDE activities were found to comply with the requirements of the governing codes and specifications. However, the NRC CAT found welds which did not have the required weld quality. The review of the licensee's quality assurance procedure SQI #20 revealed that the project reviewed 10 percent of the radiographs transmitted to quality assurance for final storage in the vault. The review was not intended to be an independent interpretation of radiographs and was confined to the review of NDE documentation. The NRC CAT believes that this lack of independent interpretation of radiographs has contributed to the licensee's inability to identify deficient radiographs.

2. Reactor Internals Installation

a. Inspection Scope

Approximately 25 tack welds on the upper and lower reactor internals locking caps were inspected. In addition, the welds on the upper internals tubing clamps and the welds on the energy absorbers for the lower internals were also inspected. The documentation packages for three welds were reviewed to determine compliance with the applicable code requirements. One welding procedure and 7 welder qualification test records were also reviewed for adequacy. The reactor internals installation was performed by NISCO.

b. Inspection Findings and Conclusions

No problems were identified in the area of inspected welding activities. Activities were found to meet the specified acceptance criteria.

3. Electrical Installation and Electrical Supports

a. Inspection Scope

The NRC CAT inspected approximately 100 field and 50 shop welds in the area of electrical installation. Three welding procedures and the qualification test records for 10 welders were reviewed. Two studs were torque tested to verify the adequacy of the stud welding procedure. In addition, the personnel qualification test records for two welding inspectors were also reviewed and two inspectors were observed and evaluated for their ability to follow the visual inspection procedures. The welding activities in the electrical area were performed by LKC.

b. Inspection Findings

Five of the 150 inspected welds were found to be deficient with respect to the specified acceptance criteria. One weld was undersized and four welds had longer lengths across the beam flange than those specified by the Architect Engineer. As a result of this finding, the licensee issued NCR's and the welds were evaluated by S&L. The welds were accepted "as is" and determined to be adequate for the intended application.

c. Conclusions

No significant problems were identified in the area of inspected welding activities. With the exception of the minor finding previously discussed, the inspected welding activities were found to comply with the applicable construction codes and specifications.

4. Instrumentation Tubing Installation and Instrumentation Supports

a. Inspection Scope

Approximately 170 welds involving 25 instrumentation supports, 5 panels, and 60 tubing welds were visually inspected to ascertain compliance with the specified acceptance criteria. Three welding procedures and qualification test records for six welders were reviewed. NDE procedures and qualification records for three NDE inspectors were also reviewed. Two visual welding inspectors and one liquid penetrant inspector were observed and evaluated for their ability to follow the applicable inspection procedures. The welding in the instrumentation area was performed by PGCo.

b. Inspection Findings

During the time of this inspection, instrumentation construction activities were suspended by the applicant as a part of an effort to evaluate and correct deficiencies that existed in this area. The NRC CAT inspected the sample of welds to determine whether a major problem existed in the areas of welding and NDE. No significant problems were identified in these areas. However, instrumentation racks were found to have welds which did not have the specified weld size. In addition, the welds on two skewed instrumentation supports were found to be undersized. As a result of these findings, the licensee issued NCRs and these items will be addressed during the restart of the instrumentation construction activities.

c. Conclusions

No significant problems were identified in the area of inspected welding and NDE activities. With the exception of the items previously discussed, activities were found to comply with the applicable construction codes and specifications.

5. Heating, Ventilating and Air Conditioning, Installation and Supports

a. Inspection Scope

Approximately 140 welds involving 23 supports were inspected for compliance with the specified acceptance criteria. Six welding procedures and the qualification test records for 10 welders were reviewed. In addition, four personnel qualification test records were also reviewed and two welding inspectors were observed and evaluated for their ability to follow the visual inspection procedures. The vendor welds on four duct pieces and two air blowers were also included in this inspection. Three BCAP inspected supports involving 30 welds and two BCAP duct pieces were also inspected in order to assess the effectiveness of the BCAP inspections. The welding in the HVAC area was performed by Pullman Sheet Metal Inc.

b. Inspection Findings

Four of the inspected 140 welds were found to be undersized. As a result of this finding, the licensee issued NCRs and the welds were evaluated by S&L. The welds were accepted "as is" and determined to be adequate for the intended application.

The three supports which were previously inspected by BCAP were also found to contain undersized welds. In addition, a burn through the duct was observed in the brazed joints between the duct and the duct companion flanges. The BCAP inspectors had made the same findings in their report which was submitted to the project prior to this inspection.

c. Conclusions

In general, the inspected welding activities were found to comply with the requirements specified by the Architect Engineer. However, undersized welds were found in HVAC supports which indicated that the initial welding inspection was not effective in identifying undersized welds and showed a program weakness. The BCAP welding inspection performed in the HVAC area was found to be effective in identifying welding deficiencies.

6. Structural Steel Fabrication and Erection

a. Inspection Scope

Approximately 160 welds comprising 50 field and 110 shop welds were visually inspected in order to ascertain compliance with the specified acceptance criteria.

Two welding procedures and the qualification test records for eight welders were reviewed. Visual inspection procedures and the qualification test records for two inspectors were also reviewed. Two welding inspectors were observed and evaluated for their ability to follow the visual inspection procedures. The original structural steel contract was performed by American Bridge Company, Napoleon Steel Contractors, Inc. (NSCI) and Mid-City Steel Company. The modification to the structural steel fabrication was performed by G.K. Newberg Company.

b. Inspection Findings

No problems were identified in the area of inspected welding activities involving the modification of structural steel. However, several shop welds involving clip to beam web connection welds were found to be deficient. Specifically, the design drawings required fillet welds all around while the connection was seal welded in some areas. These welds were fabricated by American Bridge Company, which supplied the structural steel for the project.

One connection fabricated by NSCI was found to be welded while the drawings required a bolted connection. No Field Change Request (FCR) was found to document this change.

Two welds fabricated by Mid-City were found to deviate from the construction drawings. The drawings required that the fillet welds be completed with returns around the clip while these two welds did not have returns around the clip.

As a result of these findings, the licensee issued NCRs and the welds were evaluated by S&L. The welds were accepted "as is" and determined to be adequate for the intended applications.

c. Conclusions

In general, no significant problems were identified in the area of inspected welding activities. With the exception of the deficient welds previously discussed, activities were found to comply with the applicable construction codes and specifications. The deficient welds were determined to be adequate for the intended application by the Architect-Engineer.

7. Fuel Storage Pool and Refueling Cavity Liner Fabrication

a. Inspection Scope

The NRC CAT inspected approximately 100 feet of welded seam on the Fuel Storage Pool and the Refueling Pool Liner. Two welder qualification test records and one welding procedure were reviewed for compliance with the applicable codes and specifications. In addition, five plug welds and one cross plate welded seam located inside the refueling cavity were liquid penetrant examined. Two NDE technicians were observed while performing these liquid penetrant inspections and were evaluated for their abilities to follow the applicable inspection procedures. The Fuel Storage Pool and Refueling Cavity Liner Fabrication was completed by PDM.

b. Inspection Findings and Conclusions

No problems were identified in the areas of inspected welding and NDE activities. Activities were found to comply with the applicable construction codes and specifications.

8. Fire Protection System Fabrication and Installation

a. Inspection Scope

Approximately 80 welds involving 12 pipe supports and 25 pipe welds were visually inspected. One welding procedure and the qualification test records for five welders were also reviewed for adequacy. The fire protection installation was completed by PGCo.

b. Inspection Findings and Conclusions

No problems were identified in the area of inspected welding and NDE activities. Activities were found to comply with the governing construction codes and specifications.

9. Containment Liner and Containment Penetration Installation

a. Inspection Scope

The NRC CAT visually inspected approximately 60 feet of liner seam, the welds on five patch plates, the attachment weld for one equipment hatch, one construction opening and the attachment welds for two mechanical and two electrical penetrations. In addition, one welding procedure and three welder qualification test records were also reviewed for adequacy. In the area of NDE, the NRC CAT reviewed 117 feet of liner seam which involved 289 films. One magnetic particle inspection procedure was also reviewed as a part of this inspection. The containment liner and penetrations were installed by CB&I.

b. Inspection Findings and Conclusions

No problems were identified in the area of inspected welding and NDE activities. Activities were found to comply with the governing construction codes and specifications.

10. Vendors and Shop Fabricators Other Than Those Previously Addressed

a. Inspection Scope

The NRC CAT visually inspected 14 vendor supplied tanks and heat exchangers. See Table IV-5 for inspected vendor supplied equipment. In addition to the welds inspected and listed in Table IV-5, the NRC CAT inspectors reviewed radiographs related to work performed by 32 vendors which have supplied various equipment and hardware to the Braidwood project. A total of 750 feet of welded seam involving 1069 radiographs and 79 welds involving 364 film were reviewed. The radiographs for 23 valves involving 471 film, and the radiographs for 96 spot welds involving 186 film were also reviewed for compliance with the governing codes and specifications. See Table IV-6 for detailed listing of vendors reviewed.

b. Inspection Findings

During the inspection of tanks and heat exchangers supplied by the vendors listed in Table IV-5, the NRC CAT found that the size of the nozzle and manway weld reinforcement did not meet the requirements stated in the vendor drawings. In addition, the welds on some of the inspected supports were also found to be undersized. A total of 14 tanks and heat exchangers were found to deviate from the required drawing sizes. As a result of these findings, the licensee issued NCRs and this item will be reviewed and dispositioned by S&L. See Table IV-5 for details.

In the area of NDE, the NRC CAT inspectors identified several irregularities related to radiographs supplied by six vendors. As a result of these findings, the licensee has issued NCRs and the welds will be evaluated and repaired as needed. The welds and their associated irregularities are identified as follows:

- Two welds fabricated by CB&I (reference A1 and A2 Report 282A, Index Box 94) were found to have linear indications.
- One weld fabricated by Aerojet General identified as PX6030, piece 2 weld 2 was found to have linear indication.
- One weld fabricated by Harnischfeger Corporation showed excessive internal slag or surface pitting.

- One seam weld fabricated by PDM identified as seam 57 in the Refueling Water Tank was found to have a crack in area 3 to 4.

- Film supplied by Cleaver Brooks did not meet the low density requirements of the Code. However, adequate density was available to interpret the area of interest and the weld quality was found to be acceptable.

- Film supplied by Greer Hydraulics did not meet the low density requirements of the Code. However, sufficient density was available to interpret the weld and the weld quality was found to be acceptable.

c. Conclusions

In general, the inspected welding and NDE activities were found to comply with the requirements of the governing codes and specifications. However, several tanks and heat exchangers were found to deviate from the requirements stated in the applicable drawings and specifications. In addition, the radiographs for some welds were found to be deficient with respect to the specified weld quality.

TABLE IV-1

PIPE SUPPORTS/RESTRAINTS SUBJECTED TO DETAILED INSPECTION

1W025006	1AB12003G (2)	1SX68017R
1FW01236S	1SI06027S (1)	2WXF26001T
1CV54009R (3)	1CV02003S	1CV02001C (4)
1RH02054S	1RH0201R (5)	1RH02008S
1REF40003G (6)	1SI01030S	1SI04016S (21)
1CV52016G (7)	1FW04009V	1FW02009X (8)
1RC13069S	1RC12073X	1FW05002R
1SX08037G (9)	1WR-FWR-22	1RH2059S
1RE04008X	1CV03003S	1SI16020X (10)
1RH02026R	1SI13002G (11)	1CV37038 (12)
1RH02073X	1CV02006V (13)	1CV02004S
1SI19023G	1RF26003T	1RY29031T
1W001021X (14)	1FIS-447-H140-1 (15)	1RH0281S
1RC100325 (16)	1SX09038S (17)	1SI06035S (18)
1AB18019G (19)	1CS06032X (20)	

NOTES:

(1) Four flare bevel welds undersized. Pipe attachment weld undersized. NCR 2941

(2) Two full penetration groove welds did not have full penetration; 2 fillet welds were short for more than 10% of the weld length. NCR 2947 and 3394

(3) Skewed fillet welds undersized for full length. NCR 3156.

(4) Two non-skewed fillet welds undersized NCR 2975.

(5) Weld undersized due to overgrinding.

(6) Support has extra load-bearing plate which was not specified on the drawing. FPR-G2690

TABLE IV-1 (Continued)

PIPE SUPPORTS/RESTRAINTS SUBJECTED TO DETAILED INSPECTION

(7) Skewed fillet welds undersized. NCR 2977.

(8) Skewed fillet welds undersized. NCR 2978.

(9) Skewed fillet welds undersized; four groove welds did not have full penetration. NCR 2965

(10) Skewed fillet welds undersized. NCR 3008.

(11) Tube steel to embedment weld was short in length. NCR 3155

(12) Two welds missing; two skewed fillet welds undersized. NCRs 3055 and 3387.

(13) Two skewed fillet welds undersized. Flare bevel weld was not welded flush. NCR 3011.

(14) Two skewed fillet welds undersized. NCR 3261.

(15) Four skewed fillet welds undersized. Three non-skewed fillet welds undersized

(16) Two flare bevel welds were not filled. NCR 2976.

(17) Two flare bevel welds were not filled. NCR 2941.

(18) Two welds were missing; incorrect welding symbol used; two fillet welds undersized. NCR 3393.

(19) Two skewed welds undersized. NCR 3261 (generic).

(20) Two skewed welds undersized. NCR 3261 (generic).

(21) Skewed welds undersized. NCR 3261 (generic).

TABLE IV-2

PIPE SUPPORTS WHICH WERE SUBJECT TO VISUAL INSPECTION ONLY

1CC40AA	1CV02002S	1FDF10001T
1FC99008X	1CV52016G	1CV52026R
1SI19025X	1FC01005X	1CC13037R
1RH02058S	1CV42081G (1)	2RH01Ca
1RY09080S	1SI06124X	1CS06032X
1RH01001V	1SI06091S	1FW04018X

Unit 1 Pressurizer Lower Ring Girder and Upper Guides (2)

NOTES:

(1) Pipe bent due to interference by temporary support.

(2) Arc strikes (found).

TABLE IV-3

PIPE WHICH WAS SUBJECTED TO VISUAL INSPECTION ONLY

ITEM	DESCRIPTION	PIPE SIZE(in.)	DESCRIPTION
1-CC-13-W-1	Component Cooling	18	Carbon Steel
1-CS-16-11	Containment Spray	10	Stainless Steel
1-CS-16-2	Containment Spray	10	Stainless Steel
1CV-34	Chemical Volume Control	4, 6, 2	Stainless Steel
1-CV-41	Chemical Volume Control	3	Stainless Steel
1-CV-41-1	Chemical Volume Control	12, 1	Stainless Steel
1-CV-A3B	Chemical Volume Control	2	Stainless Steel
1-DO-46	Diesel Oil	4	Carbon Steel
1-FC-1-5	Fuel Pool Cooling	18	Stainless Steel
1-FC-2-2	Fuel Pool Cooling	12	Stainless Steel
1-FC-8-1	Fuel Pool Cooling	16	Stainless Steel
1-FC-8-2	Fuel Pool Cooling	10	Stainless Steel
1-FC-8-5	Fuel Pool Cooling	16	Stainless Steel
1-FW-03DA	Feedwater	16	Carbon Steel
1-FW-13-7	Feedwater	16	Carbon Steel
1-FW-16-7	Feedwater	16	Carbon Steel
1-RC-0-12	Reactor Coolant	36	Stainless Steel
1-RC-7-2	Reactor Coolant	4	Stainless Steel
1-RE-4-5	Containment Equipment Drain	4	Stainless Steel
1-RF-02AA	Containment Floor Drain	2	Stainless Steel
1-RH-01AA	Residual Heat Removal	12	Stainless Steel
1-RH-2-5	Residual Heat Removal	6	Carbon Steel
1-RH-7-5	Residual Heat Removal	16	Stainless Steel
1-RH-19-6	Residual Heat Removal	6	Stainless Steel

TABLE IV-3 (Continued)

PIPE WHICH WAS SUBJECTED TO VISUAL INSPECTION ONLY

ITEM	DESCRIPTION	PIPE SIZE(in.)	DESCRIPTION
1-SI-03AB	Safety Injection	4	Stainless Steel
1-SI-10-1	Safety Injection	8	Stainless Steel
1-SI-10-6	Safety Injection	10	Stainless Steel

TABLE IV-4

PORTIONS OF PIPING SYSTEMS WHICH WERE SUBJECTED TO DETAILED INSPECTION

ITEM	DESCRIPTION	PIPE SIZE (in.)	MATERIAL
1-FW-15-01	Feedwater	16	Carbon Steel
1-FW-15-03	Feedwater	16	Carbon Steel
1-FW-15-04	Feedwater	16	Carbon Steel
1-FW-15-05	Feedwater	16	Carbon Steel
1-FW-15-06	Feedwater	16	Carbon Steel
1-MS-16-1	Main Steam	32	Carbon Steel
1-MS-16-2	Main Steam	32	Carbon Steel
1-MS-16-3	Main Steam	32	Carbon Steel
1-MS-16-4	Main Steam	32	Carbon Steel
1-MS-16-5	Main Steam	32	Carbon Steel
1-MS-16-6	Main Steam	28	Carbon Steel
1-MS-16-7	Main Steam	28	Carbon Steel
1-MS-16-8	Main Steam	8	Carbon Steel
1-MS-16-8A	Main Steam	8	Carbon Steel
1-OG-33-2	Off Gas	3	Carbon Steel
1-OG-33-4	Off Gas	3	Carbon Steel
1-OG-33-5	Off Gas	3	Carbon Steel
1-OG-33-6	Off Gas	3	Carbon Steel
1-OG-33-7	Off Gas	3	Carbon Steel
1-OG-33-8	Off Gas	3	Carbon Steel

TABLE IV-5

VENDOR SUPPLIED TANKS AND HEAT EXCHANGERS
WHICH WERE VISUALLY INSPECTED

ITEM	MANUFACTURER
Two Spent Fuel Heat Exchangers 2FC01A/1FC01A (1)	Atlas Industrial Manufacturing
Component Cooling Surge Tank 2CC01T (2)	Westinghouse Electric
Two Boric Acid Storage Tanks 1AB03T/2AB03T (3)	CB&I
Two Recycle Holdup Tanks 0AB01TA/0AB01TB (4)	CB&I
Letdown Reheat Heat Exchanger 1CV05A (5)	Atlas Industrial Manufacturing
Diesel Fuel Oil Day Tanks 1D010T (6)	Graver
Volume Control Tank 1CV01T (7)	Lamco Industries
Mixed Bed Demineralizer Tank 2CV01DA (8)	Lamco Industries
RHR Heat Exchanger 1RH02AA (9)	Joseph Oat
Spray Additive Tank 2CS01T (10)	Graver
Horizontal Letdown Heat Exchanger 1CV04AB (11)	Joseph Oat

NOTES:

(1) One coupling had undersized fillet weld.

(2) Support welds undersized; manway fillet welds undersized; two 4" nozzles have undersized fillets between nozzle and reinforcing pad.

(3) Tank support welds still covered with welding flux; manway fillet welds undersized; nozzle welds undersized. NCR 694.

(4) Manway fillet welds undersized; nozzle welds undersized; stiffening ring welds missing. NCR 694.

(5) Three nozzle fillet welds undersized.

(6) Support fillet welds on one saddle undersized.

(7) Manway nozzle configurations different than those shown on the design drawings.

(8) Nozzle to reinforcing pad fillet weld undersized. Four support fillet welds undersized.

(9) Three 3/4" half-couplings had undersized fillet welds.

TABLE IV-5 (Continued)

VENDOR SUPPLIED TANKS AND HEAT EXCHANGERS WHICH WERE VISUALLY INSPECTED

(10) Three nozzle to reinforcing pad welds undersized.

(11) Two 3/4" nozzle fillet welds undersized.

TABLE IV-6

VENDOR RADIOGRAPHS REVIEWED

Contractor	Welds	Valve Pumps	Spot Welds	Feet of Welds	Film	Notes
Chicago Bridge and Iron			82		164	(1)
Yuba Heat Transfer	50				252	
Aerojet-General	3				28	(1)
Westinghouse Electric				70	118	
W.K.M.				40	34	
Harnischfeger				40	72	(1)
Anchor/Darling		5			192	
Graver				60	86	
PDM				80	162	(2)
Carrier				12	17	
Gulf & Western				100	116	
American Bridge	21				68	
Cooper Bessemer				20	14	
Control Components				30	41	
Dresser Industries		2			36	
Unitech Div. of Ecodyne			8		16	
Atwood and Morrill		1			12	
L.A. Water Treatment			6		6	
McQuay-Perfex	5				16	
ITT-Grinnell				8	8	
Pall Trinity				40	54	
Cleaver Brooks				50	54	(3)
TRW Mission		3			18	

TABLE IV-6 (Continued)

VENDOR RADIOGRAPHS REVIEWED

Contractor	Welds	Valve Pumps	Spot Welds	Feet of Welds	Film	Notes
Teledyne Brown Engineering		2			28	
Borg-Warner		4			98	
Continental Boiler Works				20	22	
Rockwell International				30	43	
Greer Hydraulics				30	64	(3)
W.J. Wooley				20	30	
Jamesbury		3			27	
Bingham-Willamette		3			60	
Atlas Industrial Manufacturing				100	132	

NOTES:

(1) Linear indications found

(2) Crack found in area 3-4, seam 57 of the Refueling Water Tank

(3) Film density not within the ranges required by the code.

V. CIVIL AND STRUCTURAL CONSTRUCTION

A. Objective

The objective of the appraisal of civil and structural construction was to determine by evaluation of completed work and by review of documentation whether work, inspection, and test activities relative to civil and structural construction areas were accomplished in accordance with regulatory requirements, Safety Analysis Report (SAR) commitments, and project specifications, drawings and procedures.

B. Discussion

The specific areas of civil and structural construction evaluated were: concrete, reinforcing steel configuration, cadwelds, structural steel installation and bolting, masonry walls, and the concrete expansion anchor bolt qualification report.

For concrete, reinforcing steel configuration, structural steel installation and bolting, and masonry walls, a physical or hardware inspection and a Quality Control (QC) documentation and field procedures review were conducted. For cadwelds and the concrete expansion anchor bolt qualification report a review of QC documentation and field procedures was performed.

1. Concrete Activities

a. Inspection Scope

The reinforced concrete activities reviewed by the NRC Construction Appraisal Team (CAT) inspectors included four construction openings. These areas were reviewed for conformance of rebar placement with the design drawings (see Table V-1) and specifications. General concrete quality was also examined from surrounding areas for conformance to site specification requirements. Records associated with the concrete placements were also reviewed. These included the concrete placement reports, concrete placement checklists and the field inspection reports for reinforcing steel.

Using the cadweld splice performance records, adequacy of the production and sister splices testing frequency was reviewed. In Table V-2 the numbers of the cadweld splices reviewed are listed along with the production and sister splices taken for those cadwelds. The inspection sample size of the tensile tests covered 1200 cadwelds. Documentation and requirements for cadwelder qualification and requalification procedures were reviewed. The qualifications of five cadwelders were checked to see if they met visual and tensile test requirements.

The requirements and acceptance criteria for concrete activities and rebar placement are included in the following specifications and procedures:

- CECo Specification F/L-2722 "General Structures Work"
- CECo Braidwood Station Units 1 and 2 Quality Control Procedure Section 11, Rev. 14 "Concrete and Grout Placement"
- 10.02.01 Cadweld Splicing Qualifications Horizontal (Expired)
- 17.01 "Cadweld Splice Performance Record NS-7"
- 17.02 "Cadweld Splice Procedure Inspection NS-8"
- Form BY/BR/MCS, Rev. 7 "Quality Control Procedures Napoleon Steel Contractors, Inc. Procedure #3 - Cadweld Splicing"

b. Inspection Findings

In the four concrete areas inspected, three areas were identified where the rebar was not placed in accordance with design drawings. Two areas were in the Reactor Auxiliary Building where the reinforcing shown on the design drawings was not placed in the temporary construction openings at elevation 401 in the 15 and 21 line walls between column line U and column line V. For both faces of the east ends of the construction openings in the walls on lines 15 and 21, the drawings specified eleven #7 bars. However, only ten #7 rebars were found in the north faces of the 15 and 21 line wall openings. For the south faces of the 15 and 21 line wall openings, there were twelve #7 and nine #7 rebars, respectively. Although the construction openings had not been filled, the proper number of rebars should have been placed when the concrete was placed for the 15 and 21 line walls.

Followup discussions with responsible engineers and examination of inspection criteria disclosed that the construction openings had not been signed off for placement of concrete. The reinforcement arrangement will have to be inspected and approved by craft, field engineers, and construction inspectors prior to placement of concrete. The licensee stated that the reinforcing steel will be added prior to placement of the concrete.

The third area was a construction opening located at the east end of the Unit 2 Containment Building at elevation 426'-0". Reinforcement was not placed around the construction opening as shown on the design drawings. On the drawing three layers of eight-#11 rebars were required. However, only three layers of seven-#11 were found. Also, some of the rebar spacings on all four sides of the construction opening were out of tolerance. The licensee has written a Nonconformance Report (NCR) to evaluate these discrepancies. A preliminary explanation by the licensee for the missing eighth #11 rebar in the three layers of rebar was that the eighth rebar could be embedded in the surrounding concrete placement.

Procedures required that for the first 498 cadwelds 5 production and 12 sister splices be taken, if only one cadweld operator or crew had performed all of them. Records showed that only 5 production and 11 sister splices were taken. In addition, it appears that 5 cadweld operators were involved for the first 498 cadwelds. Since it could not be shown that any of the 5 cadweld operators had worked together as a unit, 2 additional test samples were missing for each extra cadwelder performing more than 100 cadwelds in that sample. This discrepancy was also found in the next 702 cadwelds inspected. Had a single cadwelding unit performed all 702 cadwelds, the procedures required a total of 21 production and sister splices. However, only 18 were tested. Also, it appeared that a few new cadweld operators had performed some of those cadwelds. For each new operator performing more than 100 cadwelds in those additional cadwelds, 2 more tensile test samples were required.

This deficiency was brought to the attention of QC personnel. Their subsequent investigation determined that the problem was generic. Following this, an NCR was issued and a resolution to disposition the NCR was being prepared.

No problems were identified with the qualification of the five cadwelders reviewed. However, during the review of cadwelder qualification documentation, no requalification documents were found. Appropriate QC personnel were questioned and they confirmed that there was no requalification documentation. The reason stated was that no cadwelder required requalification since no two consecutive tensile tests had failed for any cadwelder.

c. Conclusions

The concrete quality was found to be acceptable. Three areas were identified where the reinforcing had not been placed in accordance with the design drawings. To resolve these concerns, NCRs were either issued or being prepared.

Despite the generic problem with the deficient frequency of cadweld production and sister splices taken, the results of those which were tested did not indicate a concern for the quality of cadwelds installed. Cadwelder qualification and documentation procedures appeared adequate. No concerns were found with cadwelder requalification, since it appeared no cadwelder required it.

2. Structural Steel Installation

a. Inspection Scope

Installed and QC accepted structural steel was inspected for member size, configuration and conformance of bolted connections to the design drawings (see Table V-3) and specifications. Structural steel bolts were tested using a calibrated torque wrench to determine whether the bolts were properly tightened. The inspection sample was selected randomly from structural steel assemblages installed in the Reactor Containment Building Units 1 and 2 and the Reactor Auxiliary Building.

Structural steel installations inspected included 38 members and 30 connections for proper sizes, dimensions and configuration, and 316 high strength bolts for minimum inspection torque. Table V-4 gives the distribution of the various members and connections inspected in the three buildings. For the distribution of high strength bolts torqued see Table V-5.

The bolts tested included 7/8 inch diameter A325 bolts and 1 and 1-1/8 inch diameter A490 bolts. Test torques were obtained using a Skidmore Wilhelm tension tester in which bolt tension torque value requirements were measured and compared against job inspection torques. Values obtained were in general agreement to those used by construction inspectors.

The requirements and acceptance criteria for structural steel installation and inspection are included in the following specifications and procedures:

- CECo Specification F/L-2722 "General Structures Work"
- CECo Specification L-2735 "Structural Steel"
- S&L (Form 1700-T) "Standard Specification for Fabrication of Structural Steel"

b. Inspection Findings

No discrepancies were identified between the installed 38 structural steel members and 30 connections and the design drawings. Part of the inspection sample covered steel beams in the Reactor Containment Building Units 1 and 2 that were subject to a major modification program at the site to account for loads identified at another nuclear power plant, Commonwealth Edison Company's (CECo) Byron Station, which was similar in design. No problems were found with the QC procedures which controlled proper modification of the beams that were part of the 38 inspected beams.

With the high strength bolt torque sample, 19 bolts were found to have been torqued significantly below agreed upon minimum inspection torque values. Of the 19, 5 had zero installation torque and were in the Unit 1 Containment Building. No significant concentration of overall bolt torque failure was found in any single building. In Unit 1 for the 1-1/8 inch diameter A490 bolts, 2 out of 5 bolts failed. This was the only case that experienced a high percentage rate of failure. However, the sample size was small.

c. Conclusion

In general, structural steel installation activities (member size, configuration and connections) were found to be in conformance with the design drawings. The 14 bolts found to have low torque values were probably isolated cases. This includes the two that failed in the Unit 1 Containment Building for 1-1/8 inch diameter A490 bolts. The licensee indicated that NCRs will be written for the five bolts that were found to be loose and that new high strength bolts will be installed.

3. Masonry Walls

a. Inspection Scope

Masonry wall construction attributes inspected included controlling procedures, specifications, and installed block walls. For the installed block walls, the inspection concentrated on exterior and interior column fixes and removed portions of masonry walls exposing rebar. All masonry work reviewed was in the Reactor Auxiliary Building.

The requirements and acceptance criteria used for review of masonry construction and inspection were:

- CECo Specification F/L-2722 "General Structures Work"
- Quality Control Procedure Section 32 Storage and Installation of Masonry Material Form 32-3 "Interrupted and Repair of Masonry Work Checklist"

b. Inspection Findings

Examination of completed work showed that masonry wall installations in general conformed with design drawings and specifications. Portions of the masonry walls had been removed around embedded structural steel columns in order to expose the steel for a separate CECo QA inspection. The purpose was to verify that the embedded structural steel conformed to design drawings and specifications. In some areas where the masonry walls had been removed, embedded rebars had become exposed. Some of those rebars had been doweled into the remaining portion of the masonry walls. A few instances were noticed in which the exposed doweled rebars had become loose and may have no longer been able to meet anchorage requirements. The QC procedures covering the repair of the masonry walls did not require inspection of this attribute.

c. Conclusions

In general masonry wall activities were found to be acceptable. The licensee should revise existing procedures for repair work on masonry walls to ensure that the doweled rebars are adequately anchored.

4. Concrete Expansion Anchor Bolts

a. Inspection Scope

The qualification test report for the wedge type concrete expansion anchors used at the Braidwood site was reviewed for technical adequacy, conformance to the project specifications and demonstration of satisfactory anchor performance.

The following qualification test report was reviewed:

- Byron/Braidwood Structural Project Design Criteria DC-ST-03-BY/BR Table 38.1

The requirements and acceptance criteria for wedge type concrete expansion bolts was contained in the following document:

- Form BY/BR/CEA "BY/BR Standard Specification for Concrete Expansion Anchor Work Byron Units 1 and 2 and Braidwood Units 1 and 2"

b. Inspection Findings

The qualification test report was found to be consistent with the specifications and procedures for installation and inspection.

c. Conclusions

The concrete expansion bolt qualification test program was found to be acceptable.

Table V-1

DRAWINGS USED FOR CONCRETE CONSTRUCTION REVIEW

Drawing No.	Title
Inryco-A-302, Rev. 2	Containment Building 5'-0" Deep Slab at El. 426'-0" Slab Bottom Steel Reinforcement
Inryco-A-303, Rev. 2	Containment Building 5'-0" Deep Slab at El. 426'-C" Slab Top Steel Reinforcement
Inryco-C-91, Rev. 3	Auxiliary Building Walls on Lines 15 and 21 from El. 383'-0" to 481'-0"
Inryco-C-104, Rev. 3	Auxiliary Building Tunnel Floor El. 375'-6" Tunnel Floor El. 394'-6" Lines Q to Q.8 and 15 to 21
Inryco-C-123, Rev. 10	Auxiliary Building Wall on Line 15, Q to W Wall on Line 21, Q to W El. 401'-0" to El. 426'-0"
Inryco-D-23, Rev. 5	Fuel Handling Building Wall Along Line W (Column Lines 15 to 21) El. 426'-0" to El. 485'-0"

Table V-2

CADWELD TENSILE TESTING FREQUENCY INSPECTION SAMPLE

Cadweld Splice No.	Production Splice No.	Sister Splice No.
1 thru 498	5, 49, 198, 362, 444	43S, 74S, 94S, 133S, 166S, 230S, 269S, 300S, 332S, 392S, 498S
529 thru 774	636SP*	530S, 545S, 607S, 652S, 678S
785 thru 815	801SP	807S
842 thru 895	none	859S
911 thru 945	none	none
965 thru 1005	none	996S
1024 thru 1049	none	none
1062 thru 1078	none	none
1105 thru 1164	none	none
1190 thru 1262	1190SP, 1191SP, 1235SP, 1237SP, 1259SP	
1278 thru 1305	none	none
1333 thru 1346	none	none
1369 thru 1445	1385SP	1398S, 1417S

*SP designates a sister splice in lieu of a production splice.

Table V-3

DRAWINGS USED FOR STRUCTURAL STEEL INSTALLATION REVIEW

Drawing No.	Title
S&L-S-914, Rev. AJ	Cont. Bldg. Floor Framing Plan El. 412'-0" Areas 2 & 3
S&L-S-927, Rev. T	Cont. Bldg. Column Schedule
S&L-S-1010, Rev. BA	Cont. Bldg. Floor Framing Plan El. 426'-0" Areas 5 & 8
S&L-S-1287, Rev. V	Aux. Bldg. Floor Framing Plan El. 409'-6" Area 6
S&L-S-1290, Rev. BE	Aux. Bldg. Floor Framing Plan El. 414'-0" Area 7
S&L-S-1293, Rev. CC	Aux. Bldg. Mezz. Floor Framing Plan El. 426'-0" Area 2
S&L-S-1294, Rev. BP	Aux. Bldg. Mezz. Floor Framing Plan El. 426' Area 3
S&L-S-1297, Rev. BD	Aux. Bldg. Mezz. Floor Framing Plan El. 426'-0" Area 6
S&L-S-1354, Rev. AA	Aux. Bldg. Cover Plate Schedule
S&L-S-2108, Rev. D	Cont. Bldg. Framing Modif. Plan El. 412'-0" Areas 2 and 3
S&L-S-2127, Rev. AP	Cont. Bldg. Framing Modif. Sched. for El. 412'-0"
S&L-S-2128, Rev. AD	Cont. Bldg. Framing Modif. Sched. for El. 412'-0"
S&L-S-2135, Rev. AD	Typical Modification Details
S&L-S-2180, Rev. AP	Aux. Bldg. Framing Modif. Sched. for El. 375'-6"; 376'-0"; 391'-6"; 392'-0"; 394'-6"; 401'-0"; 409'-6"; 414'-0"; 415'-0"; 417'-0"
S&L-S-2181, Rev. AP	Aux. Bldg. Framing Modif. Sched. for El. 426'-0"
S&L-S-2213, Rev. F	Cont. Bldg. Framing Modif. Plan for El. 426'-0" Areas 5 and 8
S&L-S-2227, Rev. Z	Cont. Bldg. Framing Modif. Sched. for El. 426'-0"
S&L-S-2305, Rev. C	Framing Modification Sections and Details
S&L-S-2335, Rev. E	Framing Modification Sections and Details
S&L-S-2345, Rev. E	Framing Modification Sections and Details
S&L-S-2365, Rev. B	Framing Modification Sections and Details
S&L-S-2403, Rev. B	Framing Modification Sections and Details
S&L-S-2407, Rev. D	Framing Modification Sections and Details
S&L-S-2423, Rev. D	Framing Modification Sections and Details

Table V-4

STRUCTURAL STEEL INSTALLATION SAMPLE

Location	Number of Beams	Number of Braces	Number of Columns	Number of Connections*	Comments
Containment Building Unit 1	10	1	None	10	No deficiencies identified.
Containment Building Unit 2	8	1	5	13	No deficiencies identified.
Auxiliary Building	9	1	3	7	No deficiencies identified.
Total	27	3	8	30	

*This sample is separate from the high strength bolt torque sample.

Table V-5

HIGH STRENGTH BOLT TORQUE SAMPLE

Location	A325 7/8 in. dia.		A490 1 in. dia.		A490 1-1/8 in. dia.	
	Accepted[1/]	Not Accepted	Accepted	Not Accepted	Accepted	Not Accepted
Containment Building Unit 1	67	9	16	None	3	2
Containment Building Unit 2	31	0	79	3	14	2
Auxiliary Building	79	2	None	None	8	1
Total[2/]	177	11	95	3	25	5

1/ "Accepted" designates the number of bolts that reached minimum acceptable bolt torque values. "Not Accepted" designates the number of bolts which did not reach minimum torque values. Minimum acceptable bolt torque values used for the inspection of 7/8 in., 1 in. and 1-1/8 in. diameter high strength bolts were 400 ft-lbs, 900 ft-lbs and 1200 ft-lbs, respectively.

2/ The range of torque values of bolts found below the minimum acceptable torque values in ft-lbs were:

7/8 in. dia.	1 in. dia.	1-1/8 in. dia.
0 to 325 (5 had zero torque)	750 to 850	200 to 700

VI. MATERIAL TRACEABILITY AND CONTROL

A. Objective

This portion of the inspection was to verify, through selected samples, the adequacy of the traceability and control of material and equipment. The inspection was also to verify the adequacy of the licensee's program relative to these activities.

B. Discussion

The method utilized to determine the adequacy of the licensee's traceability program included selecting samples of installed material and equipment for examination. Material delivered (such as protective coating materials) but not yet installed, were sampled from storage areas. Some samples of installed material that were not accessible were selected from records. A total of 267 samples were examined to varying extents. Table VI-1, "Summary of Samples", indicates the major contractors involved and the types of activities and samples examined.

Various procedures from active on-site contractors were reviewed. The procedures reviewed included the following:

Phillips-Getschow

- Quality Control Procedure (QCP) B21, Rev. 9, "Installation of ASME Section III and Safety Related Process Piping Systems - 2 Inches and Smaller"
- QCP B4, Rev. 5, "Material Control"
- QCP B28, Rev. 4, "Fabrication and Installation of ASME Section III and Safety Related Large Bore Process Pipe"
- Phillips-Getschow Construction Procedure (PGCP) 15, Rev. 4, "Bolted Connections"
- PGCP 46, Rev. 0, "Mechanical Joint Review/Retro-Fit Program"

Gust K. Newberg

- Section 9, Rev. 10, "Receipt, Storage and Issuance of Safety-Related Materials"
- Section 7, Rev. 3, "Receipt and Storage-Reinforcing Steel"
- Section 16, Rev. 4, "Storage of Cadweld Materials"

L. K. Comstock

- Procedure 4.3.8, Rev. D, "Cable Installation"
- Procedure 4.3.10, Rev. F, "Storage,Issue and Control of Welding Material"

° Procedure 4.10.2, Rev. B, "Receiving and Storage"

Installed material and equipment was inspected to verify that markings on various samples, such as equipment (mechanical, electrical and instrumentation), pipe hangers/supports and weld joints, were traceable to associated documentation. Samples were also selected from items in warehouses and on-site fabrication shops. Table VI-2, "Sample Breakdown by Contractors", identifies the number and type of samples applicable to each contractor. Table VI-3, "Weld Filler Material Compliance", contains a list of weld filler material samples.

The following sections describe the inspection results:

1. Material Traceability

a. Inspection Scope

The 267 samples selected were examined for traceability to drawings, specifications, procurement records, Certified Material Test Reports (CMTRs), Certificates of Compliance, heat numbers or other required documentation.

b. Inspection Findings

Procedures for material traceability and control of material at the site were determined to be in place. At present, the site mechanical contractor is implementing a Material Traceability Verification (MTV) program for large bore piping installed prior to November 1982 and small bore piping installed prior to July 1983. It had previously been determined that the site mechanical contractor did not have adequate procedural controls to ensure piping traceability prior to these dates. This generic programmatic deficiency, with respect to piping traceability, has been identified to NRC Region III in accordance with the requirements of 10 CFR 50.55(e). The MTV program is to determine that: 1) the correct piping material was installed and 2) the material is traceable to certified material test reports. This program was almost complete and was to be evaluated under the Braidwood Construction Assessment Program. The piping/tubing samples selected during this inspection had been verified for traceability by the site mechanical contractor's quality control under the MTV program.

The site mechanical contractor has developed a program for reviewing, verifying and tracking mechanical joints. This is a retro-fit program which was developed as a result of an internal audit finding issued by the site mechanical contractor. Fasteners for two mechanical joints sampled during the inspection were determined to be the wrong grade of material. However, the existing documentation identified these as temporary mechanical joints. The mechanical joint retro-fit program, if properly implemented, should ensure correct fasteners are installed for mechanical joints.

Twenty samples of weld filler material listed in Table VI-3 were examined for traceability and compliance with the applicable code and were found to be acceptable. Nine weld rod holding ovens in the Phillips-Getschow weld rod issue stations were examined and found to meet requirements.

The site contractors use a combination of computerized and manual records to help control the identification and status of material and equipment. The following observations were identified:

(1) As a result of the NRC CAT inspector investigating the qualification of switchboard wire, over 10,500 feet of General Electric switchboard wire not qualified to IEEE 383-1974, was identified as being received at Braidwood. Programmatic controls did not exist to prevent this wire from being utilized in an application requiring IEEE 383 qualification. As a result, Commonwealth Edison issued NCR 707 to identify this item.

(2) Sargent & Lundy Standard EB 115.0 required the use of ASTM A307 bolting material for Class IE seismic cable tray hangers. Hangers in the lower cable spreading room were examined and found to have fasteners installed that did not comply with ASTM A307. Also, the generic qualification document issued by Gould Inc. for Braidwood's Class 1E storage batteries specified ASTM A307 bolts for the battery racks. The battery racks were inspected and found to have bolting material that did not meet the requirements of ASTM A307. Commonwealth Edison issued NCR 692 to identify these items.

(3) A certified material test report for a loop 4 jet deflector embed was reviewed and noted not to be in compliance with Sargent & Lundy Drawing S-1089. This drawing required the material for the embed to be ASTM A588 Grade B. The embed installed was fabricated with ASTM 588 Grade A material.

(4) The anchor assemblies for the diesel generators consisted of studs which were required to meet ASTM A293 Grade B7. The installed studs were not marked with the material grade as required by ASTM 193.

2. Conclusions

Except for the observations noted above, the material traceability program presently in place appears to be adequate. However, it should be noted that there has been past problems identified pertaining to traceability. Specifically, in the area of large and small bore piping. The licensee has established a program to determine acceptability of installed piping in regards to traceability which is still in process.

TABLE VI-1

SUMMARY OF SAMPLES

Contractors	Activities	No. of Samples
Phillips-Getschow (PG)	Piping & Supports	135
Newberg (GKN)	Civil/Structural	22
Napoleon (Nap)	Civil/Post Tensioning	52
Comstock (LKC)	Electrical Construction	20
Midway (Md)	Coatings	6
Teledyne (Tel)	NSSS Supports	13
Chicago Bridge & Iron (CB&I)	Containment Liner	16
American Bridge (AB)	Structural Steel	3
	TOTAL	267

TABLE VI-2

SAMPLE BREAKDOWN BY CONTRACTORS

	PG	GKN	Nap	LKC	Mid	Tel	CB&I	AB
Equipment	8	-	-	-	-	-	-	-
Pipe/Tubing	30	-	-	-	-	1	-	-
Steel-Struc.	5	2	-	-	-	-	-	3
Steel-Plate/ Sheet	3	3	-	-	-	5	3	-
Hanger/Supports	9	-	-	11	-	-	-	-
Embedment	-	4	-	-	-	-	3	-
Weld Filler Material	14	-	3	3	-	-	-	-
Weld Joints	44	-	-	-	-	4	10	-
Elec. Cables (Reels)	-	-	-	-	-	-	-	-
Fasteners	22	7	-	6	-	3	-	-
Cadweld Sleeves/ Powder	-	-	9	-	-	-	-	-
Coatings	-	-	-	-	6	-	-	-
Rebar	-	6	40	-	-	-	-	-
TOTALS	135	22	52	20	6	13	16	3

TABLE VI-3

WELD FILLER MATERIAL COMPLIANCE

Material Designation	Heat No. Material I.D.	Compliance Comments
E7018 3/32	22272	Acceptable
E7018 1/8	49556	Acceptable
E308 3/32	507761	Acceptable
E308 1/8	08022	Acceptable
E316 3/32	08203	Acceptable
E316 1/8	1F102M02	Acceptable
E309 3/32	50737-1	Acceptable
E309 1/8	616280	Acceptable
E316 3/32	21810	Acceptable
E7018 1/8	48840	Acceptable
E7018 3/32	33255	Acceptable
E309 3/32	626218	Acceptable
E7018 1/8	33807	Acceptable
E3092 1/8	11846-1	Acceptable
E7018 5/32	411H4691	Acceptable
E7018 1/8	23553	Acceptable
E7018 1/8	33228	Acceptable
E7018 1/8	33004	Acceptable
E7018 3/32	33255	Acceptable

VII. DESIGN CHANGE CONTROL

A. Objective

The primary objective of the appraisal of design change control was to determine whether design change activities were conducted in compliance with regulatory requirements, Safety Analysis Report (SAR) commitments and approved licensee, engineer, constructor and vendor procedures. An additional objective was to determine that the changes to structures and hardware prescribed in a sample of design change documents were accurately completed.

B. Discussion

10 CFR 50, Appendix B, Criterion III "Design Control" and Criterion VI "Document Control" establish the overall regulatory requirements for design change control. These requirements are elaborated in Regulatory Guide (RG) 1.64 Rev. 2, June 1976, "Quality Assurance Requirements for the Design of Nuclear Power Plants" which endorses American National Standards Institute (ANSI) Standard N45.2.11-1974 "Quality Assurance Requirements for the Design of Nuclear Power Plants." The licensee's commitment to comply with RG 1.64 is stated in Chapter 17 of the Byron/Braidwood Stations Final Safety Analysis Report (FSAR).

The areas of design change control evaluated by the NRC Construction Appraisal Team (CAT) inspectors were control of changes to design documents and control of design changes. In each of these areas, interviews were conducted with personnel responsible for the control of activities, procedures were reviewed, and a sample of the controlled documents was reviewed. In addition, a sample of the completed structures and hardware which had been inspected and accepted by on-site contractor quality control personnel was inspected by the NRC CAT inspectors. These evaluations were performed on an interdiscipline basis.

1. Control of Design Documents

The specific aspects of the control of design documents inspected were the availability to the users of the latest approved design documents and design change documents and the methods of assuring that approved changes not yet incorporated into design documents are provided to the users prior to work being performed.

a. Inspection Scope

(1) The following procedures related to distribution and control of design documents and design change documents were reviewed:

- Commonwealth Edison Company (CECo) Quality Requirement (QR) 3.0, "Design Control," Rev. 15, August 15, 1984
- CECo QR 6.0, "Document Control," Rev. 9, August 15, 1984
- CECo Quality Procedure (QP) 6-1, "Distribution of Design Documents," Rev. 7, October 10, 1983

- CECo QP 6-2, "Procedure for Station Construction Department Design Document Control," Rev. 3, May 12, 1983

- CECo Braidwood Nuclear Station Project Procedure PCD-03, "Field Change Request," Rev. 0, June 15, 1984

- Sargent & Lundy Engineers (S&L) General Quality Assurance Procedure (GQ) 3.07, "Sargent & Lundy Drawings," Rev. 6, October 21, 1981

- S&L GQ-3.13, "Engineering Change Notices," Rev. 6, October 21, 1981

- S&L GQ-6.01, "Project Distribution List and Project File Indexes," Rev. 5, October 21, 1981

- S&L Project Instruction for Byron/Braidwood (PI-BB) 29, "Distribution and Control of Design Documents for S&L Field Personnel at the Byron/Braidwood Stations"

- L. K. Comstock & Company, Inc. (LKC) Procedure 4.2.1, "Document Control," Rev. F, October 12, 1984

- Gust K. Newberg Construction Co. (GKN) Quality Assurance Manual (QAM) Section IV, "Document Control," Rev. 4, October 3, 1984

- GKN Quality Control Procedure (QCP) Section 3, "Drawing Control," Rev. 6, October 25, 1984

- GKN QCP Section 4, "Specification Control," Rev. 4, October 4, 1984

- Phillips, Getschow Co. (PGCo) QCP B-29, "Document Control," Rev. 2, October 31, 1984

- Pullman Sheet Metal Works Inc. (PSM) Quality Assurance Program (QAP) Section B6.1.F, "Document Control," Rev. 2, September 9, 1983

- PSM QAP Section B3.2.F, "Drafting," Rev. 0, July 22, 1984

(2) CECo and contractor Quality Assurance (QA) audit and surveillance reports concerning design document control were reviewed for findings, trends and corrective actions.

(3) CECo, S&L and contractor document control, engineering, construction and QA personnel were interviewed concerning distribution, control and use of design documents and design change documents.

b. Inspection Findings

(1) S&L design documents and Engineering Change Notices (ECNs) are distributed by S&L to CECo, contractor and S&L organizations and personnel in accordance with PI-BB-29 and the S&L distribution lists. Field Change Requests (FCRs), which are CECo design change documents, are distributed by the CECo Project Construction Department (PCD) to S&L, contractor and CECo organizations and personnel.

(2) CECO, S&L and the contractors each control the redistribution and use of design documents and design change documents within their organizations in accordance with their separate and different document control procedures. In general, receipt of design documents and design change documents is recorded on control cards or log sheets, the latest revisions of design documents and design change documents are issued to the (satellite) document control stations and the superseded revisions destroyed or stamped. Five of the six document control systems reviewed by the NRC CAT inspectors control the use of approved, unincorporated design change documents by annotating the design change identification numbers on all controlled copies of the affected design documents. GKN has recently revised their procedure to identify unincorporated design changes on a separate list, a copy of which is maintained at each GKN document control station.

(3) The CECo PCD document control station is the "master" against which other document control station records are evaluated. Typically, possible contractor discrepancies concerning the latest approved and issued revision of a design document and the correct annotated design change documents are resolved by comparison to the design documents and document receipt logs in the CECo PCD document control station. The document control list(s), ECN status list and FCR status list are also used but the data is not current since they are issued monthly and the input data cutoff can be several weeks prior to the lists issue dates.

(4) The most prevalent and sustained deficiency identified in the QA audits and surveillances of the various document control systems is incorrect annotating of design change documents. The majority of these deficiencies are ECNs and FCRs listed on design documents after the changes have been incorporated. The more serious deficiency is failure to list unincorporated design changes on the design documents (possible lost information). Substantial efforts (corrective actions) to eliminate this type of deficiency have been made in each of the various document control programs.

(5) The NRC CAT review of the S&L Distribution Lists identified the following discrepancies:

a. The Mechanical Department Distribution List, Rev. 19, and the Structural Department Distribution List, Rev. 24, do not have the total number of pages on each page. GQ-6.01 states, in paragrapn 3.A.1, "All pages of the Project Distribution List shall contain the project number, revision number, page number and the total number of pages." S&L is now revising the procedure to permit putting "final" on the last page in each list, which is consistent with their current practice.

b. The Structural Department Distribution List, Rev. 24, and the Electrical Department Distribution List, Rev. 19, do not identify the controlled copies. GQ-6.01 states, in paragraph 3.A.1, that the lists "...will identify the recipients of S&L drawings who are responsible for maintaining controlled sets of drawings." S&L QA informed the NRC CAT inspector that all design documents distributed in accordance with these lists are "controlled" copies.

(6) The NRC CAT inspectors reviewed about 150 S&L design documents at 3 LKC document control stations (Numbers 10, 19 and 28) for legibility, LKC date stamp, and other stamping (i.e., "For Reference Only" and "For QC Use Only"). The revision numbers and ECNs/FCRs annotated were recorded for about 60 design documents and checked against the LKC Document Master Cards.

No incorrect design document revisions were identified. At Station Number 28 (Quality Control) drawing 20E-2-3503, Rev. D was not stamped "For QC Use Only" in accordance with LKC Procedure 4.2.1 paragraph 6.2, and FCR-L-13419 was not annotated on S&L drawing 20E-0-3091H01, Rev. E, although it was listed on the Document Master Card. In addition, several cases were identified where ECNs/FCRs were still annotated on design documents when the Document Master Cards showed them incorporated (i.e., ECN-22123 on drawing 20E-0-3393, Rev. AF).

(7) About 50 design documents were reviewed for legibility and stamping (i.e., "Controlled") at PGCo document control station Number 1 (Engineering Files), and the revision numbers and ECNs/FCRs annotated were recorded and checked against the Document Distribution Cards, hand-updated S&L ECN Status Report and PGCo FCR log. All design documents were in accordance with the Document Distribution Cards, ECN Status Report and FCR log except where new design documents and design change documents had been received within about five working days. PGCo procedure QCP B-29 does not contain any time limit for replacing superseded design documents or annotating ECNs/FCRs on design documents.

(8) About 30 of the design documents reviewed for revision number and ECN/FCR annotation were cross-checked against design documents in the CECo PCD document control station. Discrepancies were noted on about fifteen, mainly in the ECNs/FCRs annotated on the design documents. Investigation showed that most discrepancies were due to different time lags in replacing

design documents and adding or deleting ECNs/FCRs on design documents.

Two ECNs, 23416 and 23486, were not annotated on CECo PCD's controlled copy of drawing 20E-0-3237E, Rev. A, due to a misunderstanding of a note on the ECNs. Several ECNs/FCRs which had been incorporated were listed on design drawings (i.e., FCR L-14744 was listed on drawings M-820, Sheet 1, Rev. P; M-823, Sheet 2, Rev. H; M-823, Sheet 7, Rev. H).

(9) Distribution of controlled copies of approved design documents and design change documents within contractor organizations is based on some form of receipt acknowledgement (i.e., positive control). However, distribution of design and design change documents by S&L and CECo to contractors does not involve receipt acknowledgement. It is thus possible that a contractor may not receive certain documents and will not know that the documents have not been received. Although the contractors can check the project document status lists (see paragraph 1.b(3) above) cross checking against these listings is not generally a contractor procedural requirement, although it appears to be a requirement of CECo QP 6-1.

As an example, ECNs 22696, 23544, 23587 and 23620 had not been received by L. K. Comstock as of December 18, 1984; these ECNs had, however, already been annotated on S&L drawings 20E-0-3393T, Rev. H and 20E-0-3-393G, Rev. S by CECo PCD. CECo QA Surveillance Report 3450, March 16, 1984, identified nonreceipt of the latest revision of an S&L drawing by PGCo.

(10) In general, the number of ECNs/FCRs not incorporated into design documents is small, particularly on electrical drawings for which responsibility (and the mylar originals) has been transferred to the S&L Braidwood site organization. As an example, S&L drawing 20E-0-3388 was revised and reissued on January 6, March 7, March 23, September 12 and October 10, 1984 and Rev. G, dated October 10, 1984 had no approved, unincorporated ECNs/FCRs at the time of the NRC CAT inspection.

c. Conclusions

For the sample inspected, the control of design documents is generally adequate. However, deficiencies in annotating ECNs/FCRs on design documents have been previously identified by CECo and contractor QA audits and surveillances and by NRC Regional and Resident Inspectors, and are still present in two of the three document control systems inspected by the NRC CAT.

2. Control of Design Changes

The specific aspects of the control of changes to design inspected by the NRC CAT were the change control systems for ECNs and FCRs, and implementation and verification of the changes.

a. Inspection Scope

(1) The following procedures relating to the control of design changes were reviewed:

- CECo QR 3.0, "Design Control," Rev. 15, August 15, 1984
- CECo QP 3-1, "Design Control," Rev. 5, October 5, 1984
- CECo QP 3-2, "Design Change Control," Rev. 13, October 5, 1984
- CECo PCD-02, "Engineering Change Notices," Rev. 0, May 24, 1984
- CECo PCD-03, "Field Change Request," Rev. 0, June 15, 1984
- S&L GQ 3.07, "Sargent & Lundy Drawings," Rev. 6, October 21, 1981
- S&L GQ 3.08, "Design Calculations," Rev. 4, March 5, 1979
- S&L GQ 3.13, "Engineering Change Notices," Rev. 6, October 21, 1981
- S&L PI-BB-13, "Procedure for Processing Commonwealth Edison Comapny Field Change Requests (FCRs)," Rev. 12, September 27, 1984
- S&L PI-BB-18, "Procedure for Handling Commonwealth Edison Company Field Change Requests Transmitting "As-Built" Information," Rev. 1, May 7, 1984
- S&L PI-BB-23, "Byron/Braidwood Electrical Field Personnel," Rev. 7, October 25, 1983
- S&L PI-BB-25, "Activities of the On-Site Structural Design Group," Rev. 0, August 29, 1983
- S&L PI-BB-28, "Activities of the Byron/Braidwood Station Mechanical Engineering, Piping Design, Support Design and Analysis Field Personnel," Rev. 3, August 4, 1983
- LKC Procedure 4.2.3, "Field Problem Reporting Procedure," Rev. A, April 27, 1983
- LKC Procedure 4.2.4, "As-Built Information Reporting Procedure," Rev. B, August 20, 1984
- GKN QAM Section III, "Design Control," Rev. 4, October 3, 1984

- GKN QCP 33, "Design Change Control," Rev. 5, October 25, 1984

- PGCo Construction Procedure (PGCP) 1.1, "Control of Engineering Change Notices (ECN), Field Change Notices (FCN), Field Change Requests (FCR) and Field Problem Reports (FPR)," Rev. 9, May 31, 1984

- PSM Procedure B3.1.F, "Design Control," Rev. 4, December 2, 1983

(2) CECo and contractor QA audit and surveillance reports concerning design changes were reviewed for findings, trends and corrective actions.

(3) Interviews were conducted with personnel from CECo, S&L, LKC, GKN, PGCo and PSM concerning initiation (origination), review, approval and implementation of design changes.

b. Inspection Findings

(1) S&L has approximately 500 people in their Braidwood site organization, of whom about 400 are assigned in engineering and design groups. The majority of the engineering and design personnel are engaged in resolving field problems by clarifying design documents and making design changes.

The contractors do no engineering or design; however, GKN, PGCo and PSM prepare supplementary drawings/sketches from the S&L approved design drawings for use as aids in fabrication and construction. Generally, such aids are prepared by the contractor field engineers and both contractor engineering an QC personnel review them for conformance with the S&L approve drawings. QC inspections of structures and hardware are to be made only from S&L approved design drawings. CECO and contractor QA audits and surveillances have identified discrepancies between these aids and the design drawings, but the discrepancies appear to be isolated programmatic failures.

(2) Design changes are accomplished through design change documents such as FCRs, ECNs, Field Change Notices (FCNS) and through revision of design documents without an intermediate design change document. FCRs are a CECo design change document generally originated in the field by CECo or contractor personnel and approved by both CECo and S&L. ECNs are an S&L design change document originated in the field or S&L's Chicago office and approved by S&L. FCNs are a Westinghouse Electric Corporation (the Nuclear Steam Supply System vendor) change document originated and approved by off-site Westinghouse personnel.

Roughly 40,000 FCRs/ECNs have been issued for the Braidwood Project. An average of about 200 FCRs and 300 ECNs have been issued each month since June 1984, and the present trend is decreasing.

(3) Problems, conflicts and items requiring clarification identified by the contractors in the approved design documents are forwarded to S&L for resolution. When resolution requires a design change, an FCR, ECN or drawing revision is prepared and issued to the contractor. LKC and PGCo use Field Problem Reports (FPRs), GKN uses Framing Modification Field Problem Reports, and PSM uses Field Engineering Memoranda (FEMs). These contractor documents are generally not controlled or considered QA documents.

(4) Approximately 600 ECNs and FCRs were selected and reviewed for procedural compliance, adequacy of problem description and resolution (design change).

A number of minor procedural deficiencies and inconsistencies were identified:

- The FCR form differentiates between "major" and "minor" changes; the definitions are provided in CECo QP 3-2, Attachment A. However, review of in-process and completed FCRs and discussion with CECo, S&L and contractor personnel indicated that considerable variations exist in practice in determining what constitutes "major" and "minor" changes.

  In the sample of FCRs inspected by the NRC CAT, it appears that structural FCRs were "Minor" even when resulting from NCRs. HVAC FCRs were generally "major" even though an NCR was not involved. Some piping FCRs were "Major", although the stated reason for the change request is "S&L Drawing Clarification." Examples are:

  FCR L-15823, November 16, 1984
  FCR L-158830, October 9, 1984
  FCR L-14065, May 4, 1984
  FCR L-16152, November 29, 1984
  FCR L-16039, October 19, 1984
  FCR L-16344, December 7, 1984

  S&L's procedure PI-BB-13 does not differentiate between "major" and "minor" changes, and discussions with S&L personnel indicated that this designation is not considered in their processing of F ?s.

- Changes were made to FCRs (Part C and Part D) with "whiteout" or by lining through previous information and adding new information without dating and initialing the changed items. Examples are:

L-14665, June 22, 1984
L-14893, July 20, 1984
L-30651, March 24, 1983
L-30686, March 30, 1983

Although the CECo procedures reviewed do not prohibit "whiteout" or require that all corrections on FCRs be initiated and dated, S&L PI-BB-13, paragraph 4.8, states "Any changes or corrections made ... are to be circled and initialed. The person circling and initialing ... shall sign and date under Part C ...". Failure to do so can result in concerns about when changes were made (prior to or after approval) and by whom they were made.

° FCRs and ECNs are not stand alone documents. In general, the descriptions of the design changes and the reasons for the design changes on FCRs are terse almost to the point of inadequacy, and extensive use is made of references to other documents, often superseded FCRs. FPRs and FEMs are referenced in the margins of FCRs, if at all, and the references are not required by procedure. Examples are:

FCR L-13026, February 21, 1984
FCR L-16174, November 9, 1984
FCR L-20604, March 17, 1984
ECN 7909, June 1984
ECN D-00040, November 5, 1984

° The "Request Class" blocks for "Limited Construction" or "Plant Modification" and "Major" or "Minor" change were not checked on a number of FCRs. Examples are;

L-12041, December 14, 1983
L-13026, February 21, 1984
L-13062, February 23, 1984
L-14830, July 5, 1984

This appears to be inconsistent with the requirements of Attachment B to CECo QP 3-2.

(3) Several of the ECNs/FCRs reviewed in detail had the "Reason for Change Request" phrased so that it appeared an NCR should have been written, but none was identified. Subsequent investigation by CECo QA determined that FCR L-16,127 dated November 15, 1984, described a discrepancy that should have been identified on an NCR. PSM has now iss[illegible] NCR BR-332 on this item. Other apprently isolated cases [illegible]adequate attention to the reason for issuance of a d[illegible]gn change are described in Section III.B.2.b.

CECo Site QA issued a memorandum on January 2, 1985 (BRD #14,354) directing that all new FCRs be routed through CECo

Site QA for review prior to filing. It is possible that this review will identify discrepancies such as whiteout, missing initials and dates on lined through changes, unchecked items and missing references to NCRs.

(4) FCRs/ECNs for which the work had been completed and accepted by contractor QC were selected for verification. Prior to inspection of the physical changes, the base design drawings, applicable change notices and backup calculations and QC inspection reports were reviewed by the NRC CAT inspectors. The physical changes associated with the following FCRs/ECNs were then inspected to verify that the changes were implemented as described.

- FCR L-14830, July 5, 1984 - The change required addition of a vertical member to an HVAC duct hanger and the acceptance of two existing, non-standard weld connections. The FCR resulted, at least in part, from NCR 460, January 31, 1983. Action on this change was acceptable.

- FCR L-30651, March 24, 1983 and ECN 10202 (supersedes FCR L-30651) - The changes required modification of a pipe support and welded pipe attachment due to an uninstalled beam connection plate and an interference. Action on this change was acceptable.

- FCR L-11032, August 23, 1983 - The change required coping the top of a column to avoid interference from two pipes. The actual copes and reinforcement plate were inaccessible due to application of fire protection material; however, interferences which would have existed between the beam, an electrical conduit and a copper pipe, if the copes had not been made, were identified.

- FCR 14890, July 20, 1984 - The change required addition of a wingplate and concrete expansion anchor (CEA) to the baseplate of a blockwall column. The change resulted from a baseplate CEA which did not meet minimum embedment criteria, per NCR 213-799, June 12, 1984. Action on this change was acceptable.

- ECN 7944, June 26, 1984 - This change required a new connection detail for an electrical tray support brace. The physical installation was in accordance with the intent of the ECN. A discrepancy in the associated paperwork (incorrect orientation/numbering) was identified by LKC on NCR 3139, August 24, 1984.

(5) The calculations for about 20 ECNs/FCRs were reviewed for conformance with applicable requirements (particularly S&L GQ 3.08). All the calculations were for changes to previously approved designs, and thus were in effect partial revisions to previous calculations. They consisted of both

hand and computer calculations, involving mostly structural attachments, core drilling and pipe supports/restraints. Examples are:

FCR 14890, July 20, 1984
FCR L-30651, August 24, 1983
ECN 23843, December 7, 1984

The calculations in the sample inspected were prepared, checked and reviewed in conformance with procedural requirements. They had been reviewed and approved prior to the approval date on the related ECNs/FCRs. Due apparently to varying standards between the S&L technical disciplines, page numbers, revision numbers, references to ECNs/FCRs and locations of signatures and dates were inconsistent, but adequate. No calculational errors were observed in the sample inspected.

(6) The NRC CAT inspectors identified cracked and spalled diesel generator exhaust silencer foundations on both Unit 1 diesel generator installations, which appeared to be due to inadequate provisions for thermal expansion of the silencers. Discussions with CECo personnel showed that the cracked foundations had been identified on CECo NCR 618, April 19, 1984. The NCR states "Original design did not allow for adequate thermal expansion." The deficiencies will be corrected in accordance with ECN 22326, August 17, 1984 which requires modifying/repairing the pedestals and anchor bolts, and ECN 22578, August 30, 1984, which requires modifying the slots on the exhaust silencer saddle plates for both longitudinal and lateral movement and adding plate washers. The ECNs apply to Braidwood Units No. 1 and 2.

Subsequent discussions with S&L indicated that the pedestal spalling appeared to be caused by both lateral and longitudinal forces, the plate slots were partially flame cut and not ground smooth, and loose grout was found in the slots after the pedestal failures.

The NRC CAT inspectors had observed that the bolted connections between the embedded plates in the pedestals and the sliding end silencer saddle plates appeared to be too tight to permit movement for thermal expansion. If these connections were excessively tight at the time of the diesel generator tests, or the rough slots and grout interferred with thermal movements, the cracking could be attributed to incorrect installation as well as inadequate design.

ECN 22886, September 14, 1984 which was written to resolve NCR 213-582 on the Letdown Heat Exchanger, also requires modifying the bolt slots on the sliding supports. Braidwood QA Surveillance Report 3305, January 9, 1984 states "... the foundation details as documented on drawing M-1221 sheet 2, Revision 5 were found to differ from those as installed." It appears that CECo should consider the possibility of a generic problem in either or both design of supports for and installation of equipment requiring sliding connections for thermal expansion (see Section III.B.4.b for additional details).

(7) A pipe support was identified by the NRC CAT inspectors which had been installed and inspected in accordance with ECN 19783, October 25, 1984, written against support drawing 1RC01004V, Rev. D, although Rev. E. of the support drawing had been issued September 13, 1984. Rev. E of the drawing changed some physical items on the support, including the spring can size.

Subsequent investigation by S&L identified the following additional six previously unidentified supports for which ECNs had been issued against superseded revisions of pipe support drawings.

- 1OG14005G
- 1AB22007R
- 1AB22034X
- 1OG14006X
- 1CV57001G
- 1RC04004V

These discrepancies were stated by S&L to have occurred as a result of S&L Chicago modifying support designs due to analysis at the same time that the S&L site organization was modifying the supports to resolve field problems.

The discrepancies might have been identified and resolved when the final revision of the support drawing, incorporating all design changes, was issued prior to the final PGCo walkdowns. S&L Braidwood Field Instruction (BRFI) 4 is being modified to prevent reocurrence of this problem.

Discussions with PGCo personnel indicated that it is not uncommon for them to receive ECNs written against superseded support drawings. Such problems may be identified by PGCo to S&L by a FPR (i.e., FPR G-2137, August 24, 1984).

c. Conclusions

For the sample inspected, the control of the design change process is adequate. Management attention is needed to preclude future design changes being made to superseded design documents.

VIII. CORRECTIVE ACTION SYSTEMS

A. Objective

This portion of the NRC CAT inspection was to verify through selected samples, whether measures were established and implemented to assure that nonconformances and other conditions adverse to quality were promptly identified and corrected.

B. Discussions

The method utilized to determine the adequacy of the applicant's corrective action program included selecting samples of documents for review. Some of the documents reviewed were:

- Trend Analyses
- Audits and Surveillances
- Stop Work Orders
- Nonconformances
- Corrective Action Reports

Table VIII-1 "Corrective Action Samples", identifies the documents randomly selected for review for each major site contractor.

The following procedures of active on-site contractors were the criteria to which these documents were evaluated:

Phillips, Getschow Co.

- Quality Assurance Manual, Section 15, Rev. 0, September 27, 1984, "Control of Nonconforming Items, Material or Activities"
- Quality Assurance Manual, Section 16, Rev. 0, September 27, 1984, "Audits"
- Quality Assurance Procedure (QAP)-12, Rev. 6, "Control of Nonconformance Reports"
- QAP-12.1, Rev. 6, "Internal Audits"
- QAP-12.2, Rev. 0, "Corrective Action Request"
- QAP-110, Rev. 1, "Reporting of Defects and Noncompliance"
- Quality Control Procedure (QCP)-B27, Rev. 3, "Quality Control Monitoring"
- Phillips, Getschow Construction Procedure (PGCP)-1, Rev. 14, "Control of Field Change Orders"

L. K. Comstock & Company, Inc.

° Procedure 1.0.1, Rev. August 31, 1983, "Quality Assurance and Control Program"

° Procedure 4.11.1, Rev. F, "Nonconforming Items"

° Procedure 4.11.2, Rev. C, "Corrective Action"

° Procedure 4.11.3, Rev. A, "Stop Work"

° Procedure 4.13.2, Rev. A, "System Completion/Turnover

° Procedure 4.14.1, Rev. A, "Internal Audit Program"

Pullman Sheet Metal Works Inc.

° Procedure B16.1F, Rev. 3, "Non-Conformance/Corrective Action"

Pittsburgh Testing Laboratory

° Instruction Sheet,IS-BRD-22-UC, Rev. 2, "Unit Concept Instruction"

° QC-CRN-1, Rev. 4, "Control and Reporting of Non-Conformances"

Gust K. Newberg Construction Co.

° Quality Control Procedure, Section 15, Rev. 2, "Nonconformance Reports"

Commonwealth Edison Company

° Procedure PM-02, Rev. 0, "Stop/Start Work Authority"

° Quality Procedure 18-1, Rev. 17, "Quality Program Audits"

° Quality Requirement 18.0, Rev. 19, "Audits"

° Quality Requirement 16.0, Rev. 16, "Corrective Action"

The results of the review of these procedures were discussed with the licensee's personnel. The samples selected of various corrective action documents were selected to ensure specific measures had been implemented for the control of corrective actions. Also, samples of specific nonconformances requiring actual correction of material/equipment were identified and inspected to verify that corrections had been made or were in progress. A total of 229 corrective action documents were examined and 20 material/equipment samples were inspected for verification of actual corrective actions.

1. Corrective Action Measures

a. Inspection Scope

The 229 corrective action document samples selected were examined for adequate corrective action, action to preclude recurrence, and verification of the effectiveness of the corrective action. Procedures for identifying and resolving conditions adverse to quality were reviewed for compliance to applicable codes and standards.

b. Inspection Findings

The review of the procedures for implementing the corrective action system resulted in identifying the following procedural problems:

(1) The Phillip, Getschow Co. (PGCo) audit procedure did not require that the corrective action for audit findings be verified for effectiveness nor did it address the scheduling of supplemental audits. It was also noted that the PGCo procedure for trending nonconformance reports did not require verification of the corrective action taken as a result of an adverse trend.

(2) The L.K. Comstock audit procedure did not require the audit report to address the effectiveness of the elements audited and did not require verification of the effectiveness of correction action to audit findings.

The elements of the applicant's audit program which included audit reports, schedules and follow-up to audit findings, were reviewed and determined to be comprehensive. These audits are identifying not only lack of implementation, but also programmatic problems.

The examination of samples listed on Table VIII-I revealed the following concerns regarding corrective action:

(1) Two nonconformance reports (NCR), issued by the electrical contractor, had improper corrective action:

(a) NCR 39, issued in April 1979, identified weld deficiencies in electrical struts and hanger assemblies. The supporting documentation attached to the NCR identified that 90 percent of the welds associated with this NCR were unacceptable in accordance with AWS D1.1-1975. The corrective action block on the NCR was marked "N/A" and contained a statement identifying the welds as acceptable. There was no documentation supporting the conclusion stated in the corrective action block on the NCR. As a result, L. K. Comstock has issued a NCR to reopen and resolve the deficiencies noted on NCR 39.

(b) NCR 293, issued in May 1981, identified questionable welds on back to back B-line strut and spaced back to back strut. The corrective action stated on the NCR consisted of reworking the welds on the back to back strut and returning the spaced back to back strut to the vendor. Inspection of installed spaced back to back strut by L. K. Comstock and NRC CAT inspectors identified numerous weld deficiencies. Based on these weld deficiencies noted in the installed strut, it is apparent that the corrective action stated on NCR 293 was ineffective.

(2) L. K. Comstock voided approximately 2.5 percent of the NCRs issued from October 1976 through December 1982 and approximately 5 percent of the Inspection Correction Reports issued from May 1977 through July 1981. Ten of the voided documents were selected to determine if a documented justification existed. None of the ten sampled had a documented justification. In addition, four NCRs were voided by Phillips, Getschow Co. without a documented justification.

(3) It appears nonconformances issued prior to 1983 and dispositioned "USE-AS-IS" or "Repair" were not routinely submitted to Sargent & Lundy for their review. An example is Gust K. Newberg NCR 469 which identified laminations in the embed for a jet deflector. The embeds were repaired, but there is no objective evidence that Sargent & Lundy reviewed the repair.

2. Conclusions

The applicant's corrective action program is generally acceptable except for those concerns noted above.

TABLE VIII-1

CORRECTIVE ACTION SAMPLES

ITEMS	QUANTITY EXAMINED				
	CECo	PGCo	LKC	Others	Total
Trend Reports	4	3	4	2	13
Site Audits	7	5	6	-	18
Corporate Audits	1	2	3	-	6
Inspection Reports	-	15	20	15	50
Surveillance Reports	12	-	-	-	12
Nonconformance Reports	10	18	11	20	59
9006	-	10	-	-	10
Inspection Correction Reports	-	-	18	-	18
Material Receiving Reports	-	9	17	-	26
Material/Equipment Samples for Field Verification of Corrective Action	2	3	4	3	12
Conditional Releases	-	5	-	-	5
TOTAL	36	70	83	40	229

CECo = Commonwealth Edison
PGCo = Phillips Getschow
LKC = L. K. Comstock
Other = Gust K. Newberg, Pullman Sheet Metal and Pittsburgh Testing Laboratory

IX. PROJECT MANAGEMENT

A. Objective

The objective of the appraisal of the licensee's project management organization and construction controls was to determine if the project management organization was properly controlling the total project, maintaining quality control of construction and test activities to assure that construction activities were accomplished in accordance with regulatory requirements, codes, standards, specifications and licensee commitments.

B. Discussion

To accomplish the appraisal of the project management organization approximately 25 members of the Braidwood Station project management organization were interviewed and project organization charts and managerial position descriptions were reviewed. The interviews and reviews were conducted to determine the project organization's prior nuclear construction experience, Commonwealth Edison Company (CECo) management involvement in the project, adequacy of management reports and intercommunications, management awareness of industry problems, control of site contractors, and management and supervisory support of Quality Assurance and Quality Control activities.

1. Project Organization

a. Inspection Scope

To review the project management organization and implementing procedures to determine that they are effective in monitoring and controlling the construction, startup, and quality activities to assure a quality end product in conformance with regulatory requirements.

b. Inspection Findings

Commonwealth Edison Company (CECo) is performing the function of project manager and construction manager of the Braidwood Station. They have utilized this type of approach in the past for the construction of their nuclear units. There are approximately ten contractors performing discrete work at the site under the direction of the CECo Project Construction Superintendent. Sargent and Lundy (S&L) is the Architect Engineer for Braidwood and has a staff of approximately 450 engineers at the site performing field engineering and stress analysis. The activities of S&L Engineers at the site is directed and coordinated by the CECo Project Field Engineer.

CECo has structured their Braidwood organization essentially along project lines. The CECo Manager of Projects is responsible for the activities and personnel required to design, engineer, construct, test and startup the plant. CECo, as the licensee, represented by the Manager of Projects and the Assistant Manager of Projects acknowledge that they hold full responsibility for the design and construction of the project and for compliance with the applicable regulatory requirements. The Chairman of the Board of Directors of CECo has vested in the Manager of Projects the responsibility for construction of the plant. The Manager of Projects is located in CECo headquarters, however, he allocates a significant portion of his time to the Braidwood project including time on site. Located at the site is his direct representative, the Assistant Manager of Projects, who is responsible for the daily direction and control of site activities.

Reporting to the Assistant Manager of Projects are the Construction Superintendent, Startup Superintendent, Licensing and Compliance Superintendent and the Station Superintendent.

The ten site contractor organizations are directed and coordinated in their activities by three discipline supervisors who work directly for the CECo Project Construction Superintendent.

The CECo site QA organization is under the direction of the Assistant Manager of QA who reports off-site to the headquarters QA Manager who in turn reports directly to the Chairman of the Board of Directors of CECo. This reporting relationship provides the independence of the QA organization from the pressures of cost and schedule.

The Assistant Manager of Projects has an organization of approximately 160 individuals directly engaged in the direction and control of site construction and engineering activities.

Some observations made from management interviews, review of correspondence and reports are:

- The project management organization as a group have had significant prior nuclear construction experience.

- The staffing of the project management organization appears adequate to control site activities.

- The project management organization appears to be functioning adequately to direct and control site activities.

- Functional responsibilities that have been assigned to management personnel were in agreement with the organization charts and position descriptions and are understood by the personnel interviewed.

- A cooperative relationship appears to exist among management in the various functional areas of the project.

- The relationship between CECo project management and site contractor's management is defined clearly and is understood by both parties.

- The CECo Project Training Supervisor to date has not exercised sufficient monitoring and coordination of site contractor training activities as determined from interviews with site contractor training coordinators.

(1) Management Involvement at Braidwood

By interviews, review of documents and procedures the NRC CAT inspector was able to determine that CECo management at all levels was actively involved in the construction of the project and participating in the resolution of site problems. This was demonstrated by the following actions of CECo:

- The Chairman of the Board of Directors of CECo inspects the site on an approximately monthly basis and receives first hand reports on critical project areas from the respective managers.
- The Chairman of the Board of Directors of CECo on an approximately monthly basis meets with CECo executives and Sargent and Lundy executives for the status of Braidwood engineering effort and resolution of problem areas.
- The Manager of Projects spends a significant portion of his time at the Braidwood site following construction activities.
- The Manager of Projects periodically makes a presentation to the CECo Board of Directors reporting the status of construction at the Braidwood site.
- The Assistant Manager of Projects is assigned full time to the Braidwood site and is actively involved in site construction and quality problems and in their resolution.
- The Assistant Manager of Projects holds a monthly meeting with key Sargent and Lundy, CECo and Westinghouse managers to determine the status and resolution of construction problems and quality issues in the areas of engineering, construction, production, startup and operations.
- CECO is the construction manager for the Braidwood Station and under the direction of the Project Construction Superintendent and a staff of approximately 60 engineers directs, coordinates and monitors the construction activities of the site contractors.
- CECo is directly responsible for the pre-operational and startup testing of the unit and under the direction of the Startup Superintendent and approximately 100 engineers and technicians they are conducting the necessary pre-operational and startup tests.

- CECo has a project field engineering group on site under the direction of a manager who directs a staff of approximately 17 CECo engineers and a Sargent and Lundy engineering group of approximately 450 engineers.
- The Manager of Projects reports directly to the Chairman of the Board of Directors of CECo and there is frequent communication between them relative to site construction status and problems.

(2) Management Reports and Intercommunications

The NRC CAT inspector through interviews, report reviews, procedure reviews and observation determined whether construction reports and intercommunications of the CECo project management and contractor organizations were sufficiently detailed to reflect the status of activities and problems of the project. The reports listed below are those that are prepared and distributed to various levels of management:

- A monthly Project Scheduling and Control report is prepared by the Manager of Projects and distributed to CECo officers.

- The CECo Board of Directors make an annual inspection of the Braidwood Station and receive a comprehensive report of project activities that is distributed to the Chairman and all CECo officers.

- The Assistant Manager of Projects issues a quarterly report to members of site management that essentially establishes construction and quality goals for the coming quarter.

- The CECo Director of Nuclear Licensing issues a Monthly Activities Report that identifies inspection and enforcement highlights, NRC IE Bulletins, Notices and Circulars received during the month and graphs NRC noncompliances versus NRC inspection hours at the Braidwood Station.

- The CECo Supervisor of Licensing and Compliance prepares and distributes a semi-monthly open item list that tracks NRC inspection findings.

- The site contractors transmit periodic production and quality issues reports to the CECo Project Construction Superintendent and the Quality Assurance Manager.

- An NRC open items list prepared by the Byron Station is transmitted approximately twice a month to the Braidwood Station Supervisor of Project Licensing and Compliance. The Byron and Braidwood units are replicate units so that a review of the Byron open items can significantly reduce similar problems at the Braidwood Station.

- The site contractor's quality assurance managers and the CECo Quality Assurance Manager meet approximately semi-monthly to review and discuss quality issues, problem areas and on-going quality programs. Minutes of these meetings are prepared and distributed.
- The CECo Quality Assurance Manager prepares and distributes a weekly Open Item Progress Report to site management that identifies NRC violations, audit findings, nonconformances, contractors inspection deficiencies and CECo field change requests. This tracking is done to expedite the closing of these items within an appropriate time frame.
- The Assistant Manager of Projects prepares and distributes to the Manager of Projects and other members of management a monthly Regulatory and Quality Issues Status report that identifies and trends NRC Reports, audit findings, nonconformances, inspection deficiencies, and field change requests.
- The CECO Quality Assurance Manager issues a monthly activities report to the Corporate QA Manager.
- The CECo Quality Assurance Manager prepares and distributes a monthly 60 day open audit item status report to the Assistant Manager of Projects. The purpose of this report is to focus attention on the necessity for prompt closure of open audit findings.
- The Corporate Manager of Quality Assurance prepares and forwards to the Chairman of the Board of Directors of CECo an annual report of site quality assurance activities.

(3) <u>Management Awareness of Industry Construction Problems</u>

Through interviews, discussions, and review of documentation the NRC CAT inspector evaluated if Project Management was aware and participated in the resolution of nuclear industry construction problems. The inspector determined that the following associations, reports and methods were utilized to stay abreast of industry wide problems:

- CECo is a participating member of the Westinghouse Pressurized Water Reactor and Steam Generator Owners Group. Various engineers in the CECo organization are committee and subcommittee members who are actively engaged in the resolution of problems associated with pressurized water reactors and steam generators.

- CECo is a participating member of the Edison Electric Institute and has engineers as members of committees that actively deal with the resolution of problems and interchange information relative to technical areas associated with nuclear power plants. Currently, CECo has membership on the Nuclear Operations Committee, Fire Protection Committee, Quality Assurance Committee and Metallurgy and Piping Committee among other committee participation.

- CECo supports research efforts of the Electric Power Research Institute and has individuals assigned to the various committees and task forces of certain of the ongoing activities associated with nuclear power plants.

- CECo is a member of the Institute for Nuclear Power Operations (INPO), participates in their various programs and provides on-loan employees to participate in INPO activities. Through various INPO audits, reports and information interchange they become cognizant of nuclear construction and equipment problems.

- CECo s a member of the Quality Assurance Committee of the Nuclear Construction Utilities Group that meet periodically to interchange information and resolve problems relative to quality issues at nuclear power plant construction sites.

- CECO receives periodic Westinghouse Nuclear Service Division Technical Bulletins reporting on problems with equipment provided by Westinghouse.

- CECO receives, analyzes, and institutes corrective action where required for NRC IE bulletins, circulars and information notices.

- CECo, within the last six months, has instituted a Lessons Learned Task Force that identifies generic problems at the Byron Station and applies them to the Braidwood Station so as to avoid as much as possible similar problems occurring at Braidwood. Byron and Braidwood are replicate units so that many identified problems at Byron can be avoided or minimized at Braidwood because Byron is in a later construction stage. There is also a Startup Task Force and Fire Protection Task Force that takes problems identified at Byron in these areas and determines applicability and corrective action required at the Braidwood Station.

(4) Control of Site Contractors

CECo has the responsibility for construction management at the Braidwood site. The Project Construction Superintendent has a staff of supervisors and engineers in each discipline that coordinate and direct the activities of the site contractors.

At the present time there are ten contractors at the site performing safety-related work. These contractors are working under their own CECo approved construction procedures and Quality Assurance Programs. Each of the contractors have their individual QA/QC organizations which conduct surveillances, inspections and audits of their respective work. The CECo construction department also conducts surveillances of contractors work performance. In addition, CECo QA conducts surveillances and audits of the contractor activities.

There is reporting to CECo Quality Assurance the Pittsburgh Testing Laboratory (PTL) that acts as an independent test agency for QA. This test agency overinspects a percentage of the work conducted by the contractors to give an additional level of assurance as to work quality. The PTL organization is also assigned certain core activities by CECo in the area of nondestructive examinations, concrete testing, structural steel bolting and testing of concrete expansion anchors.

Sargent and Lundy has an engineering force of approximately 450 engineers on site under the direction of the CECo Project Field Engineering Manager. The work of these engineers is audited by the CECo headquarters Quality Assurance organization and the site QA organization.

The following observations were made of CECo's control of site contractors:

° The QA/QC organizations of the site contractors were essentially fully staffed in budgeted positions and further their staffings were periodically reviewed to determine adequacy as construction progresses. Table IX-1 lists the licensee and contractors QA/QC organizations.

° At the present time there are approximately 2500 crafts performing work at the site. There are approximately 360 employees of the CECo and the contractors engaged in quality assurance activities. There appears to be a satisfactory ratio of QC inspectors to craftsmen.

° The site contractor QA/QC managers indicated they have access to upper management and freedom to express their concerns and implement corrective action if necessary.

° The CECo and contractor site QA/QC organizations appear to be independent from the pressures of construction cost and schedule.

- Trending information generated by the site contractors is reviewed by the CECo Quality Assurance organization and the contractors QA organization.

- The CECo site QA superintendent holds semi-monthly meetings with the site contractors QA/QC supervisors to discuss and resolve quality issues. Meeting minutes of the November 27, 1984 meeting were reviewed and items discussed included inspector recertification, hold/witness points and the reinspection program.

- The CECo Quality Assurance organization requires the principal contractors to conduct trend analyses of all deficiency reports and submit an analyses of trends in a quarterly report. Included in the report, when necessary, are actions to be taken for any identified adverse trends. Four recent reports of the principal contractors were reviewed and it was determined that some of the contractors were submitting data for quarterly periods but not including data for prior quarterly periods so that meaningful trend information could be determined. Further it was determined that some contractors were not trending deficiencies determined from the PTL overview inspections and that one contractor, G.K. Newberg, was not trending first level QC inspection deficiencies. Another contractor, Pullman Sheet Metal, trends weld rejects as a percentage of Correction Notices rather than a percentage of welds inspected. Further it treats weld rejects in such a broad context that it is not possible to make a meaningful trend analysis.

- The Commonwealth Edison QA audit schedule for 1984 was examined by the NRC CAT inspector and it was determined to contain a schedule of approximately 75 audits to be implemented over the course of the year. These scheduled audits covered all the applicable criterion for specific contractors. It was determined the schedule included all the applicable site contractors. Random audits were selected for review and they were determined to have been implemented in accordance with specific check lists relative to the specific area being inspected. The reviewed reports were found to have been issued in a time frame as required by procedure. The response to audit findings, corrective action and follow-up confirmation was reviewed for a sample of audits and was evaluated to be acceptable. CECO was found to be performing audits in agreement with their audit procedure.

- Contractor craft training was reviewed with the training coordinators of the four principal contractors. It appeared that with some of the contractors the training was primarily for new hire orientation and indoctrination and for construction procedure revision. There appeared to be a lack of training schedules and programs to improve craft workmanship.

- The control of measurement and test equipment for the site contractors Phillips Getschow, G. K. Newberg, L. K. Comstock and Pittsburg Testing Laboratories was reviewed. Procedures, calibration certifications, out of tolerance reports, corrective actions and the physical equipment was reviewed. In L.K. Comstock's crib no. 4 in the Auxiliary Building, two portable weld rod carriers were identified with calibration stickers indicating they were beyond their calibration due date. In the G.K. Newberg fabrication shop, three portable weld rod carriers were located that did not have any identifying calibration stickers nor hold tags. A log entry for one of the carriers indicated it had been taken out of service.

  A CECO QA audit in 1984 had previously identified a number of deficiencies in both L.K. Comstock and G.K. Newberg control of measurement and test equipment programs and both contractors were in the process of taking corrective action.

- Craft performance and effective contractor first level quality control inspections need improvement. As documented in Section III of this report, numerous pipe support/restraint deficiencies were identified by the NRC CAT inspectors that indicated poor craft performance and inadequate contractor quality control inspections. In Section IV of this report, the CAT inspectors identified numerous deficient welds in the areas of electrical supports, instrumentation supports and structural steel that had not have been identified by first level contractor quality control inspectors.

- Table IX-1 lists CECO and site contractors and the work each is performing. In addition, the table indicates the number of craft workers, the size of the QA/QC staff, the existence of QA/QC organizational independence, the presence of QA/QC supervisory position descriptions and if there is periodic review of the contractor's QA program.

(5) <u>Management and Supervisory Support of QA/QC</u>

The NRC CAT inspector conducted interviews and discussions with CECo and contractor QA/QC management, engineers, auditors and inspectors to determine if CECO is committed to the support of quality assurance efforts to build a quality plant. The following observations were made:

- CECo has initiated and is implementing a Quality First program to resolve employee concerns relative to plant construction. It is planned to have a "hot line" program in effect so employees can readily communicate their concerns. The programs appears that it will be effective in resolving employee concerns but at the time of the inspection the inspector could not find a policy statement by senior CECo management that they encourage employees to support the program. In addition to the policy statement, the program should include CECo and Sargent and Lundy headquarters personnel working on the project and a procedural requirement that quality concerns be investigated by an organization independent of the area of concern.

- The staffing of CECo and contractor's QA/QC organizations appears to be adequate for their existing responsibilities.

- CECO and contractor QA management personnel are actively involved in site construction activities and in the chain of pertinent communication channels for construction.

- The CECo QA personnel are experienced and qualified personnel indicating management commitment to the overall QA program.

- The QA managers of CECo and the contractors do have access to senior management when the need arises.

- CECo and contractor QA managers are of the opinion that they do have senior management support, when justified in their disagreements with construction personnel.

- Within the past six months CECo has created and filled a new position, Assistant Manager of Quality Assurance, to strengthen the QA organization.

- CECo is utilizing the PTL organization to conduct a series of over inspections of installed QC inspected installations and equipment to give an added measure of confidence for quality construction.

c. Conclusions

The CECo overall project management effort is evaluated to be satisfactory to complete the project in conformance with quality requirements. The senior management of CECo has integrated a qualified, competent team that work in unison to reach a common objective. The management structure and accountabilities are essentially in agreement with the organization charts and position descriptions.

CECo management involvement at Braidwood is comprehensive and the reports and intercommunications amongst the various site organizations appears satisfactory.

CECo and project management have made a determined effort to stay informed about industry construction and equipment problems and are well represented in various industry and utility groups attempting to resolve such problems.

At all levels of project management and contractor management interviewed there appeared to be management support and the recognition for the need of a strong and comprehensive Quality Assurance/Quality Control effort to assure quality construction. A senior management notice endorsing the Quality First Program was not evident to the NRC CAT inspector. At the latter portion of the inspection a draft policy statement was in the CECo review process.

The area of project management that requires additional attention and improvement is the control of site contractors. Improvement is necessary in the area of contractor deficiency trending and craft and quality control inspector training. In addition, improvement is required in some of the contractors control of measurement and test equipment.

TABLE IX-I

LICENSEE AND SITE CONTRACTORS

Organization	Services Performed	Craft Workers	QA/QC Staff	QA/QC Org. Ind.	QA/QC Supv. Pos. Des.	Periodic Review of QAP
CECo	Licensee	N/A	64	Yes	Yes	Yes
CB&I	Tank Repairs	5	1	Yes	Yes	Yes
L.K. Comstock	Electrical	465	84	Yes	Yes	Yes
P. Getschow	Piping	1169	158	Yes	Yes	Yes
Midway	Coatings	31	3	Yes	Yes	Yes
G. K. Newberg	Concrete	560	17	Yes	Yes	Yes
Nuclear Installation Services	NSS	3	2	Yes	Yes	Yes
Pittsburgh Testing Laboratory	Testing	+94	2	Yes	Yes	YEs
Pullman Sheet Metal	HVAC	198	28	Yes	Yes	Yes
V.S. Wallgren	Masonry	46	*	*	*	*
Westinghouse	Technical Services	6	#	Yes	Yes	YEs

* - V.S. Wallgren - Working under G. K. Newberg QA Program

- Audited by Westinghouse - Pittsburgh

+ - Testers

ATTACHMENT A

A. PERSONS CONTACTED

The following list identifies applicants representatives and NRC personnel present at the exit meeting, applicants discipline coordinators for each area, and individuals contacted during the inspection.

1. Exit Meeting

Licensee

P. L. Barnes
D. A. Boone
R. L. Byers
D. L. Cecchett
A. J. D'Antonio
J. D. Deress
R. J. Farr
D. L. Farrar
E. E. Fitzpatrick
J. W. Gieseker
M. A. Gorski
C. Gray
G. L. Groth
J. F. Gudak
T. F. Hallaren
J. Hawkinson
D. L. Jones
N. N. Kaushal
L. M. Kline
R. D. Kyrouac
R. C. Lemke
T. Maiman
D. M. Mathew
C. A. Mennecke
J. J. O'Connor
G. M. Orlov
R. M. Preston
T. E. Quaka
C. W. Schroeder
B. Shelton
W. J. Shewsi
T. W. Simpkin
D. H. Smith
N. P. Smith
R. E. Spence
E. D. Swartz
H. L. Vener
M. Wallace

Contractors

T. Brooks
J. Carlsen
W. L. Chase
D. Craven
I. Dewald
W. H. Donaldson
R. Donica
S. Forbes
K. J. Fus
D. A. Gallagher
G. Gorski
D. Grant
J. A. Hite
G. Jones
J. Klena
L. J. Koch
K. Kostal
P. P. Lantermo
R. Lauer
R. Lawler
R. Leigh
D. L. Leone
D. M. Mathew
G. Minor
T. D. Morrow
J. M. Murphy
C. Novak
T. O'Connor
A. Rodds
F. Rolan
R. Seltmann
D. Stegemuller
J. Stewart
R. Voss

NRC and Consultants

R. M. Compton
D. C. Ford
W. Forney
G. B. Georgiev
E. G. Greenman
R. F. Heishman
K. R. Hooks
P. Keshishian
W. J. Kropp
O. Mallon
W. S. Marini
E. Y. Martindale
L. McGregor
T. K. McLellan
J. I. Nemoto
R. D. Schulz
R. E. Serb
W. J. Sperko
S. R. Stein
R. F. Warnick

2. <u>Applicant's Coordinators</u>

Area	Name
Project Licensing & Compliance Supt. and CECo CAT Coordinator Supplies & Support Services	Chuck Schroeder Gary Watts
Project Construction Superintendent	Dan Shamblin
Structural Area (CECo)	Clif Gray
GKN	Rick Domica
Midway	Rich Leigh
VSW	Al Stein
Mechanical Area (CECo)	Mike Gorski
PGCo	Jim Murphy
NISCO	Clay Novak
HVAC Area (CECo)	Ken Kroft
PSM	Dave Grant
Electrical Area (CECo)	Larry Tapella
LKC	Bob Seltman
Housekeeping and Preventive Maintenance Area	Dave Boone
Administrative Services Area	Jim Brylka
Site Q.A. Superintendent	Tom Quaka
Welding/Radiographs	Tony D'Antonio
Pittsburg Testing Lab	Fred Forrest
ANSI 45.2.6	Dick Spence
Project Field Engineering	Warren Vahle
Sargent & Lundy	Ken Kostal
Project Operating	Joe Jasnosz
Project Start-up	Hank Zimmerman
Project BCAP	Howard Vener
Quality First	Ray Preston

3. Braidwood and Licensee Corporate Personnel Interviews

P. Bertain
J. Carlsen
D. Craven
I. Dewald
J. Dominique
R. Donica
R. Farr
E. E. Fitzpatrick
S. Forbes
F. Forest
D. Gallagher
D. Grant
C. Gray
G. E. Groth
T. Halloren
L. Kline
P. Lantermo
C. Mennecke
D. Niebaum
J. J. O'Connor
T. O'Connor
R. Preston
T. Quaka
C. Reynolds
F. Rolan
C. Schroeder
R. Schoults
R. Seltmann
W. Shewski
N. Smith
W. Szuberal
C. Tomashek
N. Tomis
V. Trickle
W. E. Vahle
M. Wallace
E. Wendorf
R. Wolfer

In addition to the above personnel, numercus other inspectors, engineers and supervisory personnel were also contacted.

B. Documents Reviewed

The types of documents listed below were reviewed by the inspection team members to the extent necessary to satisfy the inspection objectives stated in Section I of this report. References to specific procedures, specifications, and drawings are contained within the body of the report.

1. Final Safety Analysis Report
2. Quality assurance manuals
3. Quality assurance procedures
4. Quality control inspection procedures
5. Administrative procedures
6. General electrical construction installation procedures
7. General electrical installation specifications
8. General piping installation procedures
9. General piping specifications
10. General mechanical installation specifications
11. General concrete specifications
12. As-built drawings
13. NDE procedures
14. Personnel qualification records
15. Material traceability procedures
16. Procedures for processing design changes
17. Procedures for processing field change requests
18. Procedures for controlling as-built drawings
19. Procedures for processing nonconformances

ATTACHMENT B

GLOSSARY OF ABBREVIATIONS

AECN	Advanced Engineering Change Notice
AIEE	American Institute of Electrical Engineers
AIR	As-built Information Report
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Material
AWG	American Wire Gage
BCAP	Braidwood Construction Appraisal Program
CAT	Construction Appraisal Team
CEA	Concrete Expansion Anchor
CB&I	Chicago Bridge and Iron Company
CECo	Commonwealth Edison Company
CMTRs	Certified Material Test Reports
CSCR	Cable Separation Conflict Report
ECN	Engineering Change Notice
FCN	Field Change Notice
FCO	Field Change Order
FCR	Field Change Request
FPR	Field Problem Report
FSAR	Final Safety Analysis Report
GKN	Gust K. Newberg Construction Company
GQ	General Quality Assurance Procedure
HVAC	Heating, Ventilating and Air Conditioning
ICR	Inspection Correction Report
IE	Office of Inspection and Enforcement
IEEE	Institute of Electrical and Electronic Engineers
INPO	Institute of Nuclear Power Operations
IPCEA	Insulated Power Cable Engineers Association
ISI	In-Service Inspection
LKC	L. K. Comstock & Company, Inc.
MCC	Motor Control Center
MTV	Material Traceability Verification
NCR	Nonconformance Report
NDE	Nondestructive Examination
NISCO	Nuclear Installation and Services Company
NRC	Nuclear Regulatory Commission
NRR	Office of Nuclear Reactor Regulation
NSCI	Napoleon Steel Contractors, Inc.
NSSS	Nuclear Steam Supply System
PCD	Project Construction Department
PGCo	Phillips, Getschow Company
PGCP	Phillips, Getschow Construction Procedure
PSM	Pullman Sheet Metal Works, Inc.
PTL	Pittsburg Testing Laboratory
QA	Quality Assurance

QAM	Quality Assurance Manual
QAP	Quality Assurance Procedure
QC	Quality Control
QCP	Quality Control Procedure
QP	Quality Procedure
QR	Quality Requirements
RG	Regulatory Guide
SAR	Safety Analysis Report
S&L	Sargent and Lundy Engineers