

SAFETY EVALUATION
LA SALLE COUNTY STATION, UNIT 1
DOCKET NO. 50-373

INTRODUCTION

License Condition 2.C(33)(b) of the La Salle County Station Unit 1 License No. NPF-11 states that:

Prior to exceeding 50% power operation, the licensee shall submit the results of an independent review acceptable to the NRC staff of the HVAC system, including design changes, fabrication and installation. The review shall encompass all safety-related HVAC systems and the effect of non-safety-related HVAC system failures on safety systems.

This license condition was prescribed as a consequence of allegations made against the Zack Company (Zack), the installer of the heating, ventilating, and air conditioning (HVAC) system at La Salle, by former employees. As a result of this license condition, two meetings were held with the Commonwealth Edison Company (CECo or licensee) and the intended independent reviewer, the C. F. Braun & Company (C. F. Braun) on August 11, 1982 and August 24, 1982. At the first meeting C. F. Braun presented its qualifications and preliminary indication of the scope of its program to perform this independent review. At the second meeting, a more detailed description of the program was provided with qualifications of personnel to be involved in the review. The NRC staff requested the licensee to document its selection of the independent HVAC review contractor and the HVAC review program description for review by the staff. By letters

DESIGNATED ORIGINAL

Certified By *K. L. Witt*

dated August 24 and 27, 1982, CECo responded, providing its selection of C. F. Braun as the independent reviewer, giving CECo's requirement to C. F. Braun for this review and forwarding C. F. Braun's Technical Program to CECo to perform this review. The NRC staff reviewed these submittals and, by letter dated September 8, 1982, notified CECo that the selection of C. F. Braun as the independent HVAC reviewer was acceptable to the NRC staff subject to the following comments relative to the Technical Program:

- . When comparing the Zack installation drawings to the Sargent & Lundy Company (S&L) design documents, C. F. Braun should verify that any differences have been properly corrected. A specific concern that should be investigated is that in those cases where Zack did not buy materials in accordance with the S&L specifications, it should be verified that the materials installed are of comparable quality.
- . When examining the CECo's disposition of non-conformance reports, C. F. Braun should determine on a selective basis that the technical justification is correct. If C. F. Braun's review determines safety concerns involving significant as-built design changes, then they should evaluate these changes against the design documents.
- . All observations that the C. F. Braun site review committee submits to CECo for disposition should be acknowledged in the C. F. Braun final report.

- . All observations that the C. F. Braun internal review committee determines are safety concerns should be discussed in the C. F. Braun final report.
- . In CECO's requirements, a request was made that the final report be simultaneously submitted to CECO and the NRC, however, in the C. F. Braun proposal, it was stated that the final report would be sent to CECO for distributing the unedited report to the NRC staff. We asked that the report be submitted simultaneously to CECO and NRC.
- . In CECO's requirements, a request was made that CECO be notified immediately when an item is sent to the second level review committee. In the C. F. Braun proposal, it is stated that the item first be sent to the second level review committee for disposition before notifying CECO. We asked that CECO be immediately notified for any item required for disposition by the second level review committee.

The NRC staff, based on its receipt and review of the final report, finds that CECO's contractor, C. F. Braun, satisfactorily accommodated the above concerns and requests.

CECO obtained the services of the C. F. Braun for this independent review.

As a result of this review, a final report dated October 27, 1982 by C. F. Braun entitled, "Independent HVAC Review Final Report," Project 6356-N, was submitted.

As stated in the report, the primary objective of the design review was to provide

verification and increased assurance that the HVAC installation by Zack was in accordance with the design of S&L, the architect/engineer for La Salle. However, because the S&L design was not in question for this effort, the scope of the independent program did not include a review of the S&L design.

Besides the C. F. Braun final report, the NRC staff had the benefit of a meeting on December 1, 1982 with Commonwealth Edison, C. F. Braun and Government Accountability Project (GAP) and two letters from GAP dated November 19, 1982 and November 30, 1982.

PROGRAM

The scope of the work for this investigation was to perform an independent review of the safety-related and seismic-supported non-safety-related HVAC systems at the La Salle County Station to determine if the HVAC system was installed in accordance with the design. This review included all seven La Salle Unit 1 safety-related HVAC systems including those common to Unit 2 and those non-safety-related HVAC systems which are seismically supported. There were three such non-safety-related systems. These non-safety-related systems are required to retain their structural integrity during a seismic event so as not to prevent the operation of any safety-related structures, systems, or components.

This review consisted of:

1. Material installed, by reviewing results of CECO and NRC conducted material tests;
2. Inspection of field and shop welding supports and ductwork including welding procedures and welder qualifications;

3. Operability of associated mechanical equipment by reviewing the leakage tests, the balance tests and preoperational tests;
4. Design changes as a result of site nonconformances, for their disposition and procedures followed in dispositioning;
5. Field testing by Zack Company, including construction testing performed by Zack Company and its subcontractors.

As indicated in the C. F. Braun final report, the selection of portions of the HVAC system to be given detailed inspection by C. F. Braun was made by the HVAC technical advisor, who, as noted from his qualifications and experience, is intimately familiar with nuclear safety aspects of HVAC systems. He first made a survey of the installed duct systems for the 10 systems involved. He then selected portions of those systems whose failure could jeopardize the operation of safety related equipment. This resulted in the 335 inspections discussed in the report. These inspections were performed by inspection personnel of C. F. Braun.

In its selective methodology, C. F. Braun selected a representative sample of HVAC items from all seven safety-related HVAC systems and from all three non-safety-related seismically supported systems using engineering judgement as discussed above instead of a random selection from a statistical standpoint. The staff agrees with using engineering judgement for selecting sample inspection because in reality for this evaluation, the safety consequences of failure are not randomly distributed but would be weighted with some locations having greater consequences than others. Also, the use of judgement rather than random sampling allows selecting of system portions more likely to fail than others. On this basis, it represents a more meaningful sample from a safety standpoint than selecting by purely statistical techniques.

In this final report, the following definitions were used to describe any perceived anomalies:

Discrepancies were defined as "departures of the actual installation from the specified design requirements as noted by inspection activities or engineering review."

Observations were defined as "confirmed discrepancies requiring CECO disposition and a verification of corrective action by the site review committee." Findings were defined as "observations which have been identified as potential safety concerns."

Indications of potential problems were first labeled as "discrepancies." These "discrepancies" were then reviewed by a C. F. Braun on-site review team to determine whether these first indications were confirmed discrepancies and thus should be labeled as "observations." Further, the "observations" were then reviewed by both the on-site and internal C. F. Braun review teams to determine if each observation was accurate and had the potential for a safety concern or a "finding." The C. F. Braun work was conducted by qualified senior technical personnel with broad experience in technical design in accordance with documented procedures and instruction.

RESULTS OF C. F. BRAUN PROGRAM

The C. F. Braun inspectors conducted inspections on 335 hangers, duct sections, and pieces of equipment. As discussed in the December 1, 1982 meeting, several thousand inspection points were performed in order to accomplish this inspection. From these inspections, discrepancies were found at 117 points. Of these, the site review committee eliminated 32, made 80 "observations", 3 "findings", and voided 2. Sargent & Lundy responded to the 80 observations and dispositioned 34 to the satisfaction of C. F. Braun as having no discrepancies. The other 46 observations required repairs, all of which were minor in nature and C. F. Braun concluded that these 46 items did not jeopardize the safety functionality of the system. Of these 46 items, 32 were Zack discrepancies, 9 were design drawing discrepancies, 4 were for weld coatings, and 1 was the result of a stud being removed after completion of Zack's work. Twenty-four (24) of the 83 observations and findings will result in Sargent & Lundy drawing revisions. Three inspections resulted in findings, these being QC-2-50, QC-2-88, and QC-2-89. Further discussions relative to these findings are discussed in the Mechanical Engineering section below.

In addition, C. F. Braun's analysis of the results on material tests conducted by the NRC and CECO verified that the material met the design requirements. C. F. Braun concluded that the quantity and variety of samples tested by the NRC and CECO encompassed the representation of material used to fabricate and erect the entire HVAC systems; and therefore, additional sampling was not required.

Additional C. F. Braun areas reviewed and conclusions reached were as follows:

1. Although a few welds were observed to be defective or undersized, C. F. Braun determined that the welding on the supports and ductwork is of good quality and no safety concerns exist on the HVAC systems.
2. All of the mechanical HVAC equipment examined by C. F. Braun was determined to be operable and in accordance with design requirements.
3. Inspection of non-conformance reports (NCR) by C. F. Braun indicated that design changes have been documented and approved by S&L.
4. Leak tests, balance tests and preoperational tests were found to be acceptable, even though in the balance tests some flows were lower than design but were found not to compromise the required functionality of the design.

Finally, while C. F. Braun recognized the allegations made about the Zack quality assurance; this investigation performed by C. F. Braun resulted in finding that the quality of the hardware and craftsmanship that went into actual installation was not adversely affected by the Zack quality assurance program. C. F. Braun concluded that the installed HVAC systems and associated supports were in conformance with the requirements of the S&L design.

ASSESSMENT BY THE NRC STAFF

The NRC staff review of the C. F. Braun report was broken into four areas: Quality Assurance, Mechanical Engineering, Materials Engineering and Functional Adequacy of HVAC Systems. These areas are addressed below.

Quality Assurance

The C. F. Braun review and followup work was performed in accordance with its topical report on quality assurance, Topical Report 21A, "Nuclear Quality Assurance Manual Volume I." This Topical Report was originally found acceptable (i.e., meeting the requirements of Appendix B to 10 CFR Part 50) by the NRC in July 1975 with Amendment 5a (C. F. Braun's latest submittal) by the NRC in July 1980. Although the entire C. F. Braun quality assurance program described in Topical Report 21A was not applicable to the independent HVAC review, the quality assurance controls under Appendix B Criteria I-Organization, II-Quality Assurance Program (including personnel training and qualification), V-Document Control, X-Inspection, XVI-Corrective Action, XVII-Quality Assurance Records, and XVIII-Audits did apply to this work.

C. F. Braun had a project quality assurance engineer at the site while the independent HVAC review was being performed. The quality assurance engineer was responsible for implementation of all quality assurance procedures on the program. Appendix B, "Project and Quality Assurance Instructions", of the C. F. Braun final report are instructions used by the C. F. Braun personnel to perform the independent HVAC review. The staff concludes from its review of Appendix B of this report that the instructions reasonably reflect the requirements of Appendix B to 10 CFR Part 50 for applicability to this work.

As part of C. F. Braun's quality assurance program, a qualified auditor from the C. F. Braun home office in California, who had no direct responsibility for implementing the program, audited the program while it was being implemented onsite. The report of the audit is included as Appendix K of the C. F. Braun final report. Based on our review of the audit report, we conclude that the audit scope and depth were appropriate. Appendix K indicates the audit resulted in several comments and recommendations. In Appendix K, the indicated responses from the onsite team to the home office auditor appear to acceptably close out any open item.

The staff concludes that the C. F. Braun's independent review of the HVAC systems was performed by qualified personnel in accordance with quality assurance controls adequate to provide credence to the results of the review.

Mechanical Engineering

As was stated above, the scope of work did not include a review of S&L design because the S&L design was not in question. From a mechanical design standpoint, the primary concern would be if significant differences were found between the design drawings and the installed "as-built" configuration. The final report indicated that if the C. F. Braun review resulted in safety concerns involving significant "as-built" versus design differences, then the "as-built" configurations would be evaluated against the S&L design documents.

The NRC staff reviewed the final report and noted that three findings (QC-2-50, QC-2-88, and QC-2-89) involved significant deviations from the design documents and required a review of the design documents to resolve the potential safety concerns. The staff recognizes that throughout the construction of a nuclear power plant numerous design changes, justifications for design anomalies, and changes in drawings will occur. The process of the field change requests and subsequent justifications was reviewed by C. F. Braun and found acceptable. Therefore, the staff focused its review on the adequacy of the resolution of the three findings.

In QC-2-50, the finding indicated that the installed HVAC duct hanger S-1382 on drawing M-1538-42 Rev. E was missing two vertical structural members that were shown on the design drawing. The discrepancy was resolved in a letter from D. C. Haan (S&L) to B. R. Shelton (CECo) dated October 5, 1982 which found that the drawing was in error but not the installation. S&L had previously performed a calculation per a field change request which was based on the support design without the two vertical members. The field change request was approved but because of a misinterpretation by the draftsman, the design drawing was not changed. The drawing was subsequently revised to properly indicate the installed configuration. The staff believes that from a design standpoint this finding has been properly resolved and does not affect the safety of the plant.

The two findings, QC-2-88 and QC-2-89 also involved a discrepancy between the installed condition and the design drawings for an HVAC support. The C. F. Braun site review team discovered two supports (S-2065 and S-2049) of structural tubing which were supposed to have a 4 x 4 x 1/4 TS member. These are steel tubes with 1/4 inch wall thickness and are used strictly for mechanical support - not pressure retention. However, the installed members for the two supports were

found to have a wall thickness of 3/16 inch. Thus, C. F. Braun considered this condition to be a generic problem, requiring the structural adequacy of all 4 x 4 TS members to be verified.

Sargent & Lundy responded to the finding and subsequently reviewed all La Salle HVAC hangers using 4 x 4 x 1/4 TS members. The maximum stress was recalculated using 4 x 4 x 3/16 TS for the 4 x 4 TS hanger with the largest loading. It was determined that the maximum stress was 14,267 psi which is less than the S&L design allowable stress value of 18,000 psi. For tubular steel sizes of 4 x 4, thicknesses greater than 1/4 inch are not specified for HVAC duct supports. C. F. Braun stated in the final report that they concurred with S&L's justification and, thus, the finding was considered resolved. The staff concludes that from a design standpoint, this finding has been properly resolved and does not affect the safety of the plant.

The staff also reviewed, on a sampling basis, the 117 observations identified in the report. We noted that many of the observations were related to weld deficiencies, missing duct attachment clips, and undersized support members. Commonwealth Edison's response to the observations indicated that many of these discrepancies had been previously evaluated in field change requests and in "as-built" configuration reviews. In some cases, actual repairs or drawing revisions were made to correct the discrepancy. Based on our sampling review of the observations and CECO's responses to the observations, the staff concludes that except for the three findings discussed above, the observations appear to be minor in nature from a design standpoint and do not result in significant safety concerns.

Materials Engineering

There have been questions raised that materials specified by S&L had not been properly procured by Zack. There were instances of materials ordered and furnished to commercial standards rather than to the ASTM Specifications required by S&L. However, it should be noted that the materials specified for ductwork and hangers are the same as those used in typical commercial and industrial application. The possible impact of these discrepancies in material control by Zack is not as severe as a similar loss of control would be in other systems because the specified materials used in the fabrication of the HVAC systems have such low strength requirements that even materials not purchased to a specification likely would be adequate. The maximum design allowable stress level is conservatively 18,000 psi as stated above. The actual strength level of the lowest grade of galvanized sheet metal and structural shapes available exceeds this maximum design allowable stress without exception. Additionally, the material strength of all welds tested exceeded this maximum design allowable stress level. Indeed, some of the specifications (e.g., ASTM-A 527 and A 575) have no mechanical property requirements. Some of the specifications (e.g., ASTM-A 575) that are called out by S&L are for "merchant quality" which is about as low grade material as is available by a specification.

Generally speaking, the yield strength of hot rolled mild steel is about 35,000 psi. Substitution of steel of lower carbon content (such as using ASTM-A 575 grades 1015 or 1010 for ASTM-A 36) will provide a material with a yield strength in the range of 30,000 to 35,000 psi. Data available from material tested by a Zack vendor show that the yield strength of Grade M 1008 is only as low as 34,000 psi. It would be rare indeed to obtain material with a yield strength of less than 30,000 psi. Similarly, the use of low carbon cold rolled bar for fastener materials for those specifications requiring higher carbon hot rolled material will still provide adequate properties.

To verify the grade of material installed by Zack, both CECO and the NRC staff conducted material tests. CECO's tests compared the carbon content with the allowables per the ASTM specifications. Of those found unacceptable on the first test, a second test was conducted by CECO and the material was found to be acceptable based on the retests. Otherwise, all samples were confirmed as being of the proper type of material.

The NRC staff initially had chemical analyses conducted on samples removed from ductwork, hangers, duct stiffeners, companion flanges and nuts and bolts. Subsequently, hardness tests were performed to obtain inferred tensile strength because the samples were not large enough to perform actual tensile strength tests. C. F. Braun requested results of the chemical analysis, and the staff submitted the requested information. At the time of this request, data from 48 samples were submitted to C. F. Braun. C. F. Braun concluded that the

quantity and variety of the samples tested provided a representative sample of the material used to fabricate and erect the entire HVAC system. The results of these tests were analyzed by C. F. Braun's structural engineer and the material specialist. The evaluation by C. F. Braun of these tests indicated that:

1. Several samples did not conform to the chemical requirements for heat analysis but were found acceptable.
2. Although the carbon content for the A 563 nut was questionable, (as it seemed unreasonably low for a carbon steel nut with a proof load strength of 97,000 psi), C. F. Braun found it acceptable.
3. Although samples analyzed for the NRC staff were found out of tolerance, ASTM specification A29, "General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought and Cold-Finished," contains the following statement, "4.3.1 Merchant quality carbon bar steel is not subject to rejection for product analysis unless misapplication of a heat is clearly indicated." Based on the above statement, these samples were considered to be acceptable.
4. All of the samples for which tensile strengths were obtained had tensile strengths that exceeded the minimum requirements.

C. F. Braun concluded that the materials utilized in the fabrication and installation of the La Salle HVAC system, are in general conformance with applicable codes and standards and that they satisfy the intent of the design documents.

Evidence presented indicates that steels of slightly different composition have been substituted for the materials specified by S&L in the HVAC design. However, it appears that this has been done at little or no sacrifice in strength. Because the classes of materials specified require relatively little in the way of control and inspection, there appears to be negligible loss in overall quality. Indeed, in many cases, the difference between the specified material and the ordered material is only a test report or certificate.

We note that C. F. Braun did not mention in their discussion the effect on stress corrosion behavior of the indicated high tensile strength for the A 307 bolt tabulated in Appendix L "Results of Sample Analysis Received from NRC 10/07/82." The low potential for stress corrosion failure for a bolt of this strength level was probably not considered by them to be a significant concern.*

Based on the staff's review of this final report, we conclude that C. F. Braun has satisfactorily evaluated the substitution of commercial material by Zack for those specified by S&L. Further, the evaluation of the material issue for the class of material involved is sufficient since most of the material is tough and ductile. We conclude that the high tensile strength measured on one A 307 bolt does not present a high potential for stress corrosion failure. We find that C. F. Braun exercised reasonable judgement in resolving potential safety concerns identified in their observations.

*The staff has evaluated the bolt hardness issue (see Inspection Report No.'s 50-373/82-51 and 50-374/82-18 for details) and considers that its significance is minor in nature and not a threat to the health and safety of the public when all facets of the issue are taken into account.

Functional Adequacy of HVAC System

We reviewed those portions of the C. F. Braun final report that deal specifically with reviews to verify the functional adequacy of the HVAC system. These reviews included inspections of leak rate, air balance and preoperating test results and component operability verifications. We also performed an audit review of the inspection reports as they pertain to observations/findings as defined in this report, relative to HVAC system function and component operability.

C. F. Braun's review of leak rate and air balance test results performed by Fluid Engineering Services, a subcontractor to Zack, against the S&L design documents concluded that leakage and air flow were within acceptable limits for the various HVAC subsystems with some exceptions. C. F. Braun concluded that the subcontractor utilized an acceptable means of determining leakage for the system duct sections based on an allowable design leakage of 1% of total system air flow. Leakage was found to be within engineering limits specified for each HVAC subsystem. In addition, during the performance of the secondary leak rate test of the reactor building by CECO startup personnel, it was determined that an acceptable leakage rate was obtained for the required supply and exhaust portions of the reactor building vent system as the standby gas treatment system was able to maintain a proper negative pressure within the secondary containment. The air balance test results identified flow rates which were not within design limits

for certain plant areas. These showed lower than design air flows for fans in the control room HVAC system, auxiliary electric equipment room HVAC system, and switchgear heat removal ventilation system. However, C. F. Braun's investigation of the nonconformance reports written against the low flow rates indicated satisfactory resolution, and system design changes had been provided by S&L for the affected systems which permitted acceptance of the flow without compromising the system's safety function. Air balance test results for the diesel generator ventilation system and cubicle coolers for the diesel generator building pump room, residual heat removal pump room, high pressure core spray pump room, and low pressure core spray pump room indicated that these systems operate as designed.

C. F. Braun's survey of the preoperational tests for the control room HVAC system and auxiliary electric equipment room HVAC system, performed by CECO to verify proper system operation in its various design modes, indicated that discrepancies had been identified but were properly handled by CECO. CECO established a procedure for identifying, tracking, and resolving deficiencies noted prior to releasing the systems for testing and adding those encountered during performance of the testing. Major deficiencies discovered were satisfactorily resolved by CECO QA and operating groups. Certain minor deficiencies were still unresolved but were deferred by CECO for future resolution, thus allowing the system to be released to operating control. These items do not affect the Zack scope of work. C. F. Braur determined that the preoperational tests verified that the systems would function satisfactorily subject to the CECO agreed upon qualifications. The preoperational testing of the refrigerant piping system was also reviewed and satisfactory results were confirmed by C. F. Braun.

C. F. Braun also inspected HVAC system components and verified acceptable equipment operation. C. F. Braun's inspections uncovered no observations/findings of a potential safety concern involving the functional capability of the HVAC system. Based on these inspections and the satisfactory conclusions from the review of the leak rate, air balance, and preoperational testing, C. F. Braun determined that no further HVAC system testing was necessary. We concur with this recommendation based on our review of the C. F. Braun final report.

CONCLUSIONS

Based on our review of the independent HVAC review final report, the NRC staff concludes that an extensive, independent, review was performed by C. F. Braun to verify that the HVAC installation was in accordance with the specified design documents. The staff also believes that C. F. Braun exercised reasonable judgement in resolving potential safety concerns identified in their findings. The staff further concludes that C. F. Braun has satisfied their commitments to evaluate significant "as-built" design changes that had the potential to result in safety concerns, against the design documents.

Finally, our review indicates that the independent review has provided reasonable assurance that the HVAC system is capable of performing its intended safety functions in accordance with the original design and is, therefore, acceptable. The staff concludes that the independent design review provides additional assurance that the "as-built" La Salle HVAC systems satisfy the specified design requirements, and consequently there is no justification for restricting the power level of the facility to less than full power.