U. S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-373/80-46

Docket No. 50-373 License No. CPPR-98

Licensee: Commonwealth Edison Company
P. O. Box 767
Chicago, IL 50590

Dates of Investigation: February 22, 26, 28; March 5, 7, 10, 24-25; May 12, 14, 19-22; June 20, 25; and July 8, 16, 1980

Investigation At: Nuclear Services Corp., Division of Quadrex Corp.
Campbell, CA

Investigators: P. V. Joukoff — 1/19/82
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Investigator, RV

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Reviewed By: RF Warnick — 1-29-82
R. F. Warnick, Director
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Staff, RIII

Investigation Summary:

Investigation on February 22, 26, 28; March 5, 7, 10, 24-25; May 12, 14, 19-22; June 20, 25; and July 8, 16, 1980 (Report No. 50-373/80-46)
Areas Investigated: Allegations that personnel in Nuclear Services Corp (NSC), Div. of Quadrex Corp., performing pipe stress analyses for LaSalle County Station Units 1 and 2, were not qualified and that proper analysis was not being performed by NSC or Sargent and Lundy; interviewed NSC management personnel, reviewed pertinent procedures and selective records. The investigation involved 110 investigation hours by four RV personnel. Additional inspection hours were expended by NRR and Region III personnel in subsequent reviews.

Results: It was determined that NSC was conducting educational and employment verifications of their engineering and technical personnel when contacted by the NRC investigators. Two of four persons identified by an alleger had been found by Quadrex to have falsified their educational qualifications. They were terminated following this discovery. No items of noncompliance were identified. Reviews of design procedures indicated they reflected technically appropriate engineering practice.

## REASON FOR INVESTIGATION

On February 22, 1980, a letter to the President of Nuclear Services Corp. (NSC), dated February 13, 1980, was provided to the NRC. Attempts were made to contact the writer, Individual A.

On March 5, 1980, Individual A was contacted by the NRC Region V office. He alleged deficiencies in the design work being performed by the firm of Nuclear Services Corporation, a division of Quadrex Corporation. Additional allegations were received from other individuals on March 24, May 19 and July 8, 1980. An NRC investigation was initiated to review these matters.

## SUMMARY OF FACTS

The four individuals who contacted the NRC Region V (RV) office provided a number of allegations regarding different aspects of the work performed by Quadrex, as follows; (paraphrased)

1. The company was not following NRC quality criteria (10 CFR 50, Appendix B).

2. Twenty-eight Engineering Change Notices had been sent to Sargent & Lundy without calculations having been performed.

3. The company had no procedures for the work performed; when procedures were developed, they were backdated.

4. S&L knew that the company was not performing adequately and took no action.

5. Audits of the company were announced, and not performed in-depth.

6. The company was advised during an audit that some people were not qualified for their positions.

7. Six engineers from India had unverified backgrounds.

8. Improper design criteria were utilized by Quadrex and S&L.

9. One individual's history was questionable.

10. Two employees had falsified background information on their resumes.

Investigation of allegations related to employee background falsification, scope of work, and general design criteria was performed during January 22, 1980 and July 16, 1980. It was found that the company had initiated a program to verify the educational and work experience backgrounds of their employees. Two employees were identified as having provided false information, and were subsequently terminated. Review of design calculations and criteria indicated that the company was following accepted engineering practices.

Reviews of the adequacy of design procedures by the office of Nuclear Reactor Regulation (NRR) Mechanical Engineering Branch, indicated that the procedures were technically appropriate and acceptable.

Further reviews of the adequacy of the Quadrex program were performed by Region III personnel during inspections at the LaSalle site and at the Quadrex office. These inspections took place between August 1980 and September 1981 and are documented in inspection reports already issued (see Paragraph 12).

The inspections resulted in several unresolved matters which were subsequently resolved to the Region III inspector's satisfaction. No items of noncompliance were identified relative to the work performed by Quadrex (one unresolved matter remains outstanding from the inspection conducted on September 22-23, 1981).

Region V personnel indicated that there have been no subsequent contacts from the individuals who provided allegations.

## DETAILS

1. Personnel Contacted

Nuclear Services Corporation (NSC) (A Division of Quadrex Corporation)

S. Naymark, President
*A. W. McCrae, Director of Projects
*J. Goldin, Corporate QA Engineer
*J. L. Wray, Director of Engineering
S. R. Holguin, Project Engineer
J. Thomas, Manager, Stress Analysis
S. Persinger, Executive Secretary
A. E. Corker, Manager, Product Services
G. Esswin, Stress Analysis Manager
H. Lee, Pipe Support Manager
G. Long, Stress Analyst
C. Oya, Stress Analyst
T. Gosh, Stress Analyst
M. Moldovan, Stress Analyst

*Denotes those present at the exit meeting on May 21, 1980.

The investigation also included contacts and discussions with other NSC personnel assigned to the LaSalle project.

2. Introduction

This investigation was conducted upon receipt of allegations from four different individuals who made allegations concerning the Nuclear Services Corporation (NSC) a Division of Quadrex Corporation at Campbell, California. The name Quadrex was used interchangeably with the name NSC by the allegers and is so used in this report. The allegations concerned Quadrex's safety related work on pipe stress analyses being performed for Sargent & Lundy (S&L), Architect-Engineer (AE) for Commonwealth Edison's LaSalle County Station, Units 1 and 2.

NSC offers engineering and technical services to the nuclear industry in project planning, design and analysis, construction and startup through operations and maintenance.

3. History of Quadrex's Involvement with the LaSalle Nuclear Project

a. Pipe Stress Analyses

In late 1979, S&L contracted with NSC to provide some of the pipe stress analysis work for the LaSalle Nuclear Project.

The original work was on non-safety related pipe hanger design for approximately 7800 hangers for the turbine building. This is known as the SAR-0302 project. They were 80% to 85% finished with the SAR-0302 work in early 1981.

As they completed SAR-0302, their people were assigned to the SAR-0303 project. The SAR-0303 project involves safety-related work in Unit 1 of the LaSalle Project and some safety-related systems in Unit 2. There are approximately 160 systems in this work, with with an average of 13 hangers in a system. The same design and procedures are used in SAR-0303 as were used in SAR-0302. The hangers for Unit 2 are to be similar to those in Unit 1. As part of their contract, they are reviewing as-built drawings for approval or changes.

Quadrex has developed their own Quality Assurance program that has been approved by Sargent & Lundy.

b. Fire Protection Work

Quadrex is doing an extensive updating of the existing fire protection system on the LaSalle Project. This is projected to be a three year program.

4. Allegations Against Nuclear Services Corporation and Sargent & Lundy

a. Individual A

On March 5, 1980, Individual A contacted NRC and made the following allegations:

(1) Quadrex was not adhering to the 18 criteria of 10 CFR Part 50, Appendix B on work being done for the LaSalle County Station.

(2) Quadrex is a dishonest company. An example of their dishonesty is when they sent 28 Engineering Change Notices (ECN) on pipe stress analyses to S&L in Chicago, Illinois without any calculations done on them.

(3) Quadrex performed work on safety-related components without any procedures. Then after doing the work wrote the procedures and backdated them. An unannounced audit by experts in the field of pipe stress analyses would have to be done in order to catch them at this violation of accepted NRC procedures.

(4) Individual A stated he believes S&L knew that Quadrex was not performing their pipe stress analyses properly and was participating in a "coverup." He could not name any specific employees in S&L involved in this alleged coverup. He said persons working for Quadrex that had knowledge of his allegations would not talk to NRC for fear of losing their jobs.

(5) Audits of Quadrex were announced by Commonwealth Edison (CECo) and S&L.

(6) Audits of Quadrex by CECo and S&L were not done in depth. Paperwork was examined as to form, but calculations were not checked for accuracy.

Individual A advised that on its face, the paperwork done by Quadrex, looks correct. He said unless you know design criteria, everything looks fine. He went on to say that meeting cost and schedule is Quadrex's whole existence. In his opinion, it was company policy to bypass correct procedures to get the job done. He advised that unless NRC investigators used a polygraph on members of management to show they are lying, NRC will never get the truth.

b. Individual B

On March 24, 1980, Individual B, an anonymous caller, contacted NRC and advised he had the following concerns regarding the calculations being done by Quadrex on safety-related piping systems for the LaSalle Nuclear Project:

(1) Recently an internal QA audit was done on the work for LaSalle by a team headed by Dr. Henry Thailer. He said Dr. Thailer is very respected in his field of engineering and is on an American Society for Mechanical Engineering (ASME) Code Committee. He advised that Dr. Thailer had been with NSC and quit to form his own engineering consulting company with two other men. When Dr. Thailer was with NSC he was head technical lead for pipe stress and pipe support design. During Dr. Thailer's recent audit he reviewed four or five pipe support designs for LaSalle for compliance with specified seismic criteria and found some calculations to be incorrect. According to Individual B, Dr. Thailer concluded that some of the people doing the calculations were not qualified and recommended they either receive additional training or new people be hired. Dr. Thailer reportedly told Sherm Naymark, President of Quadrex, about his concerns regarding using people not technically qualified to do safety-related work and recommended Naymark do something about it. With Dr. Thailer leaving the company, Individual B felt Quadrex would not do anything to correct the problem.

(2) A member of Quadrex's management working on the LaSalle project by the name of Sat Mahan has hired six employees from India without conducting any interviews or background verifications as to their education or prior employment.

Individual B advised he has worked in the nuclear engineering field for a period of years and the practice of firms hiring engineers who aren't qualified is not isolated to NSC. He said that, in general, the industry has never been required to put minimum requirements on the engineers they hire.

(3) In his opinion, NRC and General Electric criteria were not being followed by S&L in their analysis of the hydro dynamic load response spectra. He explained that the peak frequencies are significantly high, reaching 80 to 90 cycles per second. He advised S&L is using the computer program called PIPSYS for their calculations. He stated PIPSYS only takes the frequencies out to approximately 33 cycles per second and does not use mass point spacing for the cycle calculations. He said the NSC engineer responsible for these calculations objected to S&L's program and is taking NSC's calculations to approximately 130 cycles per second. In Individual B's opinion, S&L should develop a new computer program to include much higher frequencies and use the appropriate mass point spacing, depending on the size and type of pipe.

This anonymous caller never recontacted the NRC and was not identified during this investigation.

c. Individual C

On May 19, 1980, Individual C contacted the NRC. He advised NRC investigators he has been an engineer for over 30 years. He indicated that because he once gave information to another federal agency under the condition that they give him confidentiality, and then they violated this trust, he was reluctant to give the investigators specific information. He made the following comments concerning NSC:

(1) An individual who was fired from three jobs and who approved the Sacrificial Shield Wall at Washington Public Power Supply System Unit 2, now requiring extensive rework, is now a "boss" at Quadrex.

(2) NRC should check Quadrex's involvement in the fire protection system for LaSalle.

d. Individual D

On July 8, 1980, Individual D advised NRC investigators that he knew there were two people at Quadrex who had false resumes and who left Quadrex in late June 1980. Individual B gave the investigators the names of four other persons presently working for Quadrex that he had reason to believe had falsely claimed earning engineering degrees or completion of engineering courses.

5. Interview of Dr. Henry Thailer

On March 24, 1980, Dr. Henry Thailer advised that he participated in an internal audit for NSC's corporate Quality Assurance (QA) Department of NSC's pipe stress analysis work for the LaSalle Nuclear Project. This was done shortly before his departure from NSC. He said the work being done by NSC is in line with the re-evaluation

described in IE Bulletin 79-14, "Seismic Analyses for As-built Safety Related Piping Systems". He stated a portion of the project was just getting underway. He advised that S&L gave a portion of this work to NSC. He described the work as being 90% reconfirmatory analysis, and that analysis on safety-related work has not progressed far. To his knowledge no packages on safety-related work had been issued. He further advised he doesn't know of any major deficiencies in the analysis work being performed by NSC. He stated his findings were that some procedures should be changed and modified. He stated that the technical procedures were not of major concern in the findings of his audit. He said he did not recall directly talking to the president of Quadrex about the results of the audit.

On the same date Dr. Thailer recontacted the investigator and advised he had given a lot of thought to the matter of discussing NSC's audit and S&L work with the NRC. He said because he had signed an agreement with NSC that he would not give out proprietary information he was reluctant to furnish any further information. He advised that after being contacted by the investigator he called the president of Quadrex and told him of the NRC's investigation. He further advised the president stated he was willing to talk to NRC about the inquiry.

6. Investigation at Nuclear Services Corporation (NSC), Division of Quadrex Corporation - Campbell, CA

During the investigation at Quadrex on May 20-21, 1980, the following information was developed from interviews of the management staff and from selective examination of procedures and records relating to the LaSalle Nuclear Project:

a. NSC Personnel Records

On May 20, 1980, Mrs. Sally Persinger, Executive Secretary, advised she had been given the task of instituting a system to verify the education and employment for NSC employees assigned to the LaSalle project. This assignment began at the end of March 1980. Prior to this time they did not verify degrees and recent employment. Three forms were developed for making these inquiries. A release is obtained from each person whose education and employment history is being verified. At that time they were verifying educations through the highest degree obtained and employment histories through 1977. They were performing verifications for approximately 100 contract employees (employees hired directly by NSC). They expected to have these verifications completed by the end of June 1980.

Mrs. Persinger advised that an administrative procedure on the conduct of verifications of degrees and employment is in draft. She said when the procedure is finalized the verifications will be conducted by their personnel department.

At that time they had identified one employee who had falsified a degree in civil engineering, and he was terminated for this falsification. Verifications for degrees and employment in foreign countries were either taking a long time or no replies at all were being received. Inquiries to institutions in India and the Republic of China were not being answered.

On July 8, 1980, Individual D advised NRC investigators that he knew there were two people at Quadrex who had falsified resumes and had left Quadrex two weeks previous. Individual D said he knew these men had falsified resumes as he had checked the information and found they had claimed degrees and/or college courses they did not have.

Individual D gave the investigators the names of four other persons presently working for Quadrex whose backgrounds he had investigated and found falsifications in their resumes.

On July 16, 1980, an NRC investigator determined that two of the four men at Quadrex identified by Individual D had in fact falsified their educational history on their resumes and applications. The other two individuals' background had been checked by Quadrex and found to be correct.

The two individuals whose backgrounds were found to be correct had furnished different background information to Quadrex than they had to Individual D.

The two individuals whose resumes and applications contained false claims had been discovered by Quadrex's new background investigation program. The information concerning the falsifications had been given to the employees' immediate supervisors, but they had not taken any action at that time.

Subsequently, the investigator was advised by A. E. Corker, NSC Manager of Product Services, that the two employees who falsified their resumes and applications had been terminated. Corker also advised they were taking action "to close the loop" by making certain that all supervisors take appropriate action against subordinates who falsify their resumes/applications.

b. Personnel Records of Job Shoppers Employed by NSC

Some of the pipe stress analysis work has been jobbed out to Associated Technologies, Inc., (ATI), Clifton, New Jersey. The files of background verifications for ATI personnel are being maintained at NSC. ATI is not responsible for design or procedures.

ATI will follow the same design and procedures as required for SAR-0303, in the manual furnished by S&L to NSC.

Some of the work has also been jobbed out to Tutterrow Design Services, Los Gatos, California, which has approximately 14 people assigned to the LaSalle Project. The management of Tutterrow is doing the background investigations themselves and these are being audited by NSC. Tutterrow made a request to do their own background investigations as they have people on other sites.

c. PIPSYS

NSC presently uses S&L's PIPSYS computer program in their pipe stress calculations. S&L has the responsibility for the program and its accuracy. The use of PIPSYS is S&L's decision. Piping vibration of 75 cycles per second in corresponding to whatever the system mode shapes was programmed to be the cut off point. Above which, little or no significant activities is expected.

NSC has their own computer code program known as NEWPIPE. S&L did not want two sets of differing computer data in their files over the years. Therefore, NSC was required to use PIPSYS.

7. Audits Performed at NSC (Quadrex) for Work Performed On the LaSalle County Station, Units 1 and 2

During meetings with members of Quadrex management, it was determined that the company had been audited by S&L and CECo in March 1980 and an internal audit by Quadrex QA, was also performed that month.

a. Internal Audit of Quadrex No. 80-03

Quadrex, by letter dated May 30, 1980, made available to the investigators their internal audit report No. 80-03, captioned "Internal Audit of LaSalle Pipe Stress Analysis and Support Design (SAR-0303)." Internal audit report No. 80-03 showed the audit, requested by Quadrex's Director of Engineering, was conducted by a four member team from the Quadrex QA Department. The team leader was shown as Jack Weber, and Henry Thailer, supra, was shown as an auditor. The audit team was in the middle of their audit when Thailer left the company, and the report was completed after his departure.

This audit was conducted on March 3-7, 1980. This audit states that it "Examined the contractual commitments between S&L and Quadrex and the technical and quality aspects of the Quadrex work in compliance with these contractual commitments". This audit was also conducted to assure that "Appropriate checklists and planning documents were utilized to assure that the full scope of the Quadrex effort was adequately covered." This internal audit was performed before Quadrex began safety-related work on the LaSalle project. Dr. Thailer made the comment that there should be clarification on design input.

As a result of this audit there were some changes made. Procedures 2.2, Safety Related Piping Stress Analyses, and 2.3, Safety Related Pipe Support, were revised effective April 22, 1980 to respond to this audit.

According to Quadrex management, Dr. Thailer found errors which they call "code interpretations". They further advised that all of the items identified by Dr. Thailer as needing attention were reviewed by the company and addressed. They stated Dr. Thailer did not find anything Quadrex was doing that did not comply with S&L's directives.

The summary for this audit states:

"VI. SUMMARY

"In determining the status of the Project, it must be remembered that the project has grown considerably from the original concept. With the growth has been an increase in scope with new tasks being added and increasing schedular pressure.

"With due consideration for the rapid expansion of contract scope, a certain amount of laxity has occurred in the contractual documents between S&L and Quadrex.

"The number and quality of procedures, Work Instructions and project controls are by far the most advanced for the early stages of any large project undertaken by Quadrex. The present procedures, instructions and controls are just not sufficient for the magnitude of this project.

"The project is still in an early enough stage to correct all problems and assure a quality product. However, a high priority must be given to the development of the appropriate procedures, instruction and project controls. This priority must come from the upper management level, even at the sacrifice of some early production."

b. Audit of Quadrex by Sargent & Lundy and Commonwealth Edison conducted March 25-27, 1980

By letter dated June 23, 1980, the Commonwealth Edison Manager of Quality Assurance, made available to the investigators a copy of the Commonwealth Edison Company Audit of Nuclear Services Corporation dated March 26, 1980 and a copy of a June 9, 1980 follow-up surveillance report.

The audit report showed the audit was conducted on March 25-27, 1980 by the Commonwealth Edison Company Quality Assurance Department. Sargent & Lundy Quality Assurance was also a participant in the audit. The purpose of the audit was to determine if NSC

was properly implementing their quality program. The scope of the audit consisted of questions in the following areas:

Audit schedules and audit follow-up
Document Control
Qualifications of project personnel
Qualifications of audit team leaders
Indoctrination and training
Technical aspects of design
Design Review

The audit resulted in eight findings, three observations and three comments.

The Surveillance Report dated June 9, 1980 indicates the surveillance was conducted at Nuclear Services Corp. on June 9 and 10, 1980, to assess the implementation of corrective actions for findings and observations identified in the audit of March 25, 1980. During the course of this surveillance, it was determined that five findings required further corrective action and were still open.

c. Quadrex's Audit Program

Quadrex performs a continual audit of the work being performed for S&L on the LaSalle Nuclear Project. This QA audit is performed by H. Frankel, the Project Quality Assurance Engineer. Each day he reviews a different facet of the analysis. He reports directly to the Project Manager, A. Morshedi.

8. Supervision of Quadrex Employees Working on Pipe Stress Analyses for LaSalle Nuclear Project

Quadrex management advised that employees working on pipe stress analyses have their work checked by their supervisors during the first few weeks of their employment to make certain they can perform as required. They stated that where an employee has engineering experience, but does not have a degree, the supervisor is required to formally state that the employee can perform as required. They further advised that management is assuring that supervisors are checking their employee's work.

9. Exit Interview

An Exit Interview was conducted with members of Quadrex's management on May 21, 1980. Those persons in attendance are identified by an asterisk in Part 1, Persons Contacted, of this report.

The investigators advised that further evaluation of several matters would be conducted by the NRC during future inspections.

10. NRR Review of Design Procedures and Criteria

A review of statements by the several allegers indicated four allegations relative to design procedures and criteria:

1. Thermal expansion stress analysis were not to be performed when the design temperature was less than 150 degrees F.

2. Anchor displacement was not included in the analysis.

3. Branch lines were not included in the analysis of the main piping runs when the ratio of the moments of inertia was 7 to 1 or greater.

4. The computer program PIPSYS was to be used for all piping systems analysis even though the modal capacity of PIPSYS was not sufficient to handle higher frequency loads.

These allegations were reviewed by NRR and consultant personnel (Battele Memorial Institute). On September 15, 1980, a meeting was held at the offices of Sargent & Lundy to discuss the allegations and review piping analysis methods. Additional information was supplied by letters dated October 16, 1980, and October 21, 1980 (Exhibit I). This information was reviewed by Battelle personnel.

By letter dated October 22, 1980, Battelle advised NRR that its review indicated that Quadrex' procedures were technically acceptable (Exhibit II). These findings were documented via memos dated December 1, 1980 (Exhibit III), and December 17, 1980 (Exhibit IV).

11. RV Review of Quadrex Program

On March 20, 1981, RV personnel investigated allegations that Quadrex had sent ECN's to S&L without performing stress calculations, and that procedures were backdated to appear that they were being utilized earlier. Their findings are as follow:

On February 13, 1980, NSC transmitted 26 (not 28) ECN's to S&L. Of these, fifteen ECNs, which are stress analysis packages, were reviewed and all packages were found to contain appropriate calculations. Reviewed were ECNs FM 520 LS, 527 LS, 516 LS, 573 LS, 571 LS, 226 LS, 611 LS, 444 LS, 515 LS, 472 LS, 485 LS, 527 LS, 130 LS, 658 LS, and 570 LS.

The NSC procedures which deal with safety-related work are identified as SAR-P-2.6. The first edition of these procedures was issued on January 10, 1980, well before the first safety-related contract work was performed. The procedures have been subsequently revised due to normal procedure evolution.

Stress analysis methods, including piping system modeling, input data preparation, generation of final stress analysis reports, and checking of stress analysis calculations were reviewed. No items of noncompliance or deficiencies were identified.

12. Subsequent Reviews

Subsequent to the investigation effort documented in this report, Region III personnel conducted several inspections to review the design program for piping at the LaSalle station in general, and the work being performed by Quadrex as a part of the overall program. These inspections, conducted over the period August 8, 1980-September 23, 1981, are documented in Region III inspection reports as follows:

| Report | Dates of Inspection | |
|---|---|---|
| 50-373/80-32<br>50-373/80-20 | 8/6-8/80 | |
| 50-373/80-40<br>50-374/80-26 | 8/29, 9/2-5/80 | |
| 50-373/80-48<br>50-374/80-30 | 11/3-4, 5, 13-14/80 | (11/3-4 at Quadrex) |
| 50-373/81-02<br>50-374/81-02 | 1/12-14, 15, 19, 22-23/81 | |
| 50-373/81-07<br>50-374/81-12 | 3/30-31, 4/1-2/81 | |
| 50-373/81-33<br>50-374/81-17 | 9/21-22, 22-23/ 81 | (9/22-23 at Quadrex) |

These inspections resulted in several unresolved items which were subsequently resolved acceptably. One unresolved item still remains open from the inspection performed September 22-23, 1981 at Quadrex, a generic item relative to S&L's use of tack welds in design. No items of noncompliance were identified.

Attachments: Exhibits 1 through 4

Attachment
Part 1


SARGENT & LUNDY
ENGINEERS
FOUNDED BY FREDERICK SARGENT-1891
55 EAST MONROE STREET
CHICAGO, ILLINOIS 60603
TELEPHONE - 312-269-2000
CABLE ADDRESS - SARLUN-CHICAGO


October 16, 1980

Mr. E. Rodabaugh
Battelle Memorial Institute
505 King Avenue
Columbis, Ohio 43201

Dear Ev:

As requested during the September 13, 1980 meeting in Sargent & Lundy's offices I am providing copies of the response spectra used for designing small piping supported off major subsystems. As you will recall, you and Sam Moore raised several questions concerning the Sargent & Lundy design practice of generating response spectra for use in analyzing small piping which are not analyzed in an integral fashion with the main piping system they are attached to. We had indicated at that meeting that the Sargent & Lundy practice was to use a envelope response spectra of the main piping system for analysis of the smaller piping system. After reviewing this with our projects, it was determined that in several instances this was not the case. Because of that we have generated additional response spectra which were used for design of small piping systems in several instances.

As discussed with you or the phone I am attaching the results of a study performed on one sample piping system for the LaSalle County Nuclear Power Station to compare the response which would normally be used for design of branch piping connected to a main header with the actual response of that header. In order to make this comparison meaningful a time history analysis was performed on the sample system, (high pressure core spray subsystem), for both the safe shutdown earthquake and for the chugging load. Acceleration time histories were obtained from these analyses in the X, Y and Z directions at three locations on the sample piping system, (see circled locations on the attached isometric and analytical drawing). Two of these locations were locations where the branch piping were connected to the main system, but not coded with the main system, and the third location was a randomly selected node point in the system. Response spectra were generated from these time history acceleration histories and wided 20% on each side.

Black- spectra at main header the small would

Green - Main header spectra

These are shown in black on the 18 figures. The enveloped response spectra which would normally have been used for design of the main header is shown on the same figures in green. A review of the LaSalle project indicated that some of the branch lines were not designed for the envelope of the header, rather were designed for the envelope of all the support points on the branch line itself. Because of this the envelope response spectra using the branch line support locations is also shown in orange on the same figures, it should be noted that in most cases (75%) the branch line response spectra envelope bounds the header envelope. These locations and the associated response spectra are discussed in more detail in the following paragraph.

Orange - branch line spectra

A three inch branch line is connected to the main system at data point 45. The associated SSE response spectra are given in figures 1, 2, and 3; and the associated response spectra for the chugging load are given in figures 4, 5, and 6. It should be noted that just adjacent to data point 45 another small piping system is connected to the high pressure core spray system, however, because it is a small bore piping system (nominal diameter less than 2 inches) it would not normally be analyzed on the computer. The standard practice for piping systems in this category would be to analyze the small piping using simplified hand calculation procedures for an envelope of all the response spectra in the region the piping was in. In the case of the small bore piping system attached adjacent to data point 45 this would involve a response spectra which was an envelope of all of the response spectra inside the drywell. This envelope response spectra is larger than all of the response spectra shown for data point 45.

A two inch line is connected to the main piping system at data point 90. It's SSE response spectra given in figures 7, 8 and 9; and it's chugging load response spectra are given in figures 10, 11, and 12.

For discussion purposes only, another data point was picked on the main system at random at which no small piping systems were attached. This was done to illustrate the conservatism in the response spectra if a line had been attached at this point or was required to be attached at this point at some time in the future. The associated SSE and chugging response spectra are given in figures 13, 14, 15 and 16, 17, and 18.

Please note that because this data point does not have a small piping system attached to it, only the response spectra generated from the main system time history analysis is shown along with the envelope of the main system response spectra.

In general the response spectra comparisons illustrate the following:

1. The branch piping design spectra envelopes the header time history response spectra for all or the majority of frequency range interest. (This is the case for figures 1, 3, 4, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, and 18.)

2. For two figures (figures 2 and 8) the branch piping design response spectra did not bound or approximate the time history generated response spectra in the low frequencies areas i.e., below 8 hz. Since almost all safety related piping has a first period between 8 and 15 hz it was felt that this would be insignificant.

3. For one case (figure 1) the design response spectra was slightly lower than the time history generated response spectra in the piping frequency ranges i.e., between 10 and 20 hz approximately. This difference of approximately 0.25g's, was not considered significant.

4. For figures 5, 7 and 13 the design response spectra did not bound the time history generated response spectra in the high frequency range ( greater than 33 Hz approximately) It should be noted that in general piping responses are not governed by the high frequency loads, and also these piping systems would also have to be designed for the response spectra in the other directions at the same time as well as for the response spectra for the other loads such as chugging in the same direction. For example, in figure 5 the design response spectra is approximately 1.3g's less than the time history generated response spectra in the higher frequency ranges. However, this same piping system would have to be designed for the simultaneous application of the response spectra shown in figure 6 where the design response spectra exceeds time history response spectra by approximately 2g's in the same frequency range. A review of the other figures shows a similar comparison.

Mr. E. Rodabaugh
Battelle Memorial Institute



Because of the factors discussed above, it is felt that the design practice beiny followed on the LaSalle County project for design of branch piping not coded in with the main piping system, is reasonable and conservative engineering practice.

If you have any questions on the above please feel free to contact me or E. B. Branch at your earliest convenience.

Sincerely yours,

G. T. Kitz
Assistant Head
Engineering Mechanics Division

312-269-6781

GTK/rm
Copies:
S. Moore (Oak Ridge National Laboratories)
G. C. Kuhlman
R. J. Mazza
D. C. Haan
V. K. Verma
EMD File - 025838

SARGENT & LUNDY
ENGINEERS
FOUNDED BY FREDERICK SARGENT 1891
55 EAST MONROE STREET
CHICAGO, ILLINOIS 60603
TELEPHONE - 312-269-2000
CABLE ADDRESS - SARLUN CHICAGO

October 21, 1980

Mr. E. Rodabaugh
Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201

Dear Ed:

This letter is to confirm our telephone conversation of October 21, 1980 concerning the techniques employed by Sargent & Lundy when performing branch piping analysis on LaSalle County project. As I indicated to you we are using either of two techniques for determining the appropriate response spectrum for piping analysis, these are:

a) The envelope of the header response spectrum itself is enveloped with the response spectrum for all of the branch line support locations. This would consist of an envelope of the orange and green colored response spectrum transmitted to you in my letter of October 16, 1980.

b) In some situations the branch lines were designed for only the envelope of the support points on the branch lines itself. This would result in the branch line being designed to the response spectra shown in orange on the figures sent to you in my October 16 letter.

As discussed with you in our telephone conversation it is felt that both of these design procedures represent resonable and conservative engineering practices.

SARGENT & LUNDY
ENGINEERS
CHICAGO



If you have any questions on the above, please contact me at your earliest convenience.

Sincerely yours,

G. T. Kitz/by Vijay Verma

G. T. Kitz
Assistant Head
Engineering Mechanics
Division

GTK/sp
Copies:
S. Moore (Oak Ridge National Laboratories)
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Battelle
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 424-6424
Telex 24-5454

October 22, 1980

Mr. S.E. Moore
Oak Ridge National Laboratory
P.O. Box Y
Oak Ridge, Tennessee 37830

Dear Sam:

Meeting with Sargent & Lundy; Sept. 15, 1980
My Letter of Sept. 17, 1980

My letter of 9/17/80 included a draft of a "trip report" on the meeting with S & L regarding allegations against Quadrex. That letter includes Attachments 1 through 9. On 10/20/80 I received the S & L response to the missing aspect of item 3; it is enclosed herewith identified as Attachment 10. The completed draft "trip report" is enclosed herewith.

Yours very truly,

Everett

Everett C. Rodabaugh

cc: Dave Terao (NRC)

ECR/ss

Encl. Draft Trip Report (D. Terao Only)
Attachment 10 (D. Terao Only)

MEETING WITH SARGENT AND LUNDY
REGARDING PIPING ANALYSIS METHODS
USED BY QUADREX

September 15, 1980

The meeting was held to discuss the issues described in Attachment 1. The list of people at the meeting is shown in Attachment 2.

Sargent and Lundy (S & L), as part of S & L Specification J2952, provided to Quadrex an "Analysis Manual"; relevant portions of which are in Attachment 3. This manual is identified by Quadrex as SAR-0303 Analysis Manual, QUAD No. 7-80-006, and is a part of the Quadrex "Work Instruction for Use of LaSalle Project Master Lists of Documents, Forms, and Subsystems"; see Attachment 4. Attachment 5 contains the checklist used by Quadrex (Nuclear Services Corporation). These documents provide the factual basis with respect to items 1, 2, and 3 of Attachment 1. These are correct statements concerning the S & L instructions to Quadrex for this particular work.

The above cited documents do not give the "whys" of the S & L instructions. The meeting was mostly devoted to the "why" aspects. S & L's presentations and our evaluations of the technical aspects involved are described in the following.

## 1. Thermal Expansion Stress Analyses were not to be Performed when the Design Temperature is Less Than 150 F

Viewgraphs used in S & L's presentation on this subject are contained in Attachments 6 and 7. S & L maintains that thermal analysis of piping systems for operating temperatures up to 150 F is not indicative of actual conditions. We do not necessarily agree with all the details of the S & L presentation, and could add other aspects not included in the S & L presentation that would support their position. However, our overall evaluation is that the cut-off of thermal analysis at 150 F is technically appropriate.

2. Anchor Displacements were not to be Included in the Analyses

Viewgraphs used in S & L's presentation on this subject are contained in Attachment 8. The key aspect is that Quadrex work is outside the containment. As indicated by pages 4 through 8 of Attachment 8, the relative displacements outside containment are small. S & L's instructions are shown in pages 260 through 262 of the "Analysis Manual", included in Attachment 3. We agree that, for the specific work done by Quadrex on this contract, it is technically appropriate not to include anchor displacements of the magnitude shown on pages 4 through 8 of Attachment 8.

3. Branch Lines were not to be Included in the Analyses of Main Piping Runs when the Ratio of the Moments of Inertia is Seven to One or Greater

Viewgraphs used in S & L's presentation on this subject are contained in Attachment 9. In general, we agree that separation of branches with $I_R/I_B > 7$ ($I_R$ = moment of inertia of run pipe, $I_B$ = moment of inertia of branch pipe) is technically appropriate in the sense that the behavior of the branches will not significantly influence the behavior of the run pipe. However, we raised the question of what dynamic input is used for the branch sub-system. S & L stated that the same enveloping response spectrum that was used for the run pipe is used. While we thought this was probably conservative, we requested S & L to provide more detailed example analyses to examine this aspect. The S & L response to this request is contained in Attachment 10.

As indicated in Attachment 10, S & L practice is to use for dynamic evaluation of branch lines (that are analytically separated from the run pipe) either:

(a) Enveloping response spectra (NS, EW, Vertical) for all restraint points of the run pipe and branch pipe, or

(b) Enveloping response spectra (NS, EW, Vertical) for all restraint points of the branch pipe.

The contents of Attachment 10, while limited in scope, are deemed sufficient for the immediate scope of Attachment 1. Further investigation

of this aspect may be needed but, because it is deemed to be a generic type of problem (not limited to S & L Quadrex procedures) it should be treated as a generic problem.

While branch lines could be included with the main run piping in a dynamic evaluation, the result might be less significant than evaluating them separately. This is because of the possibility of having ill-conditioned matrices when a large, stiff pipe and a small, flexible pipe are both included in the model.

4. The Computer Program PIPSYS was to be Used for All Piping System Analyses Even Though the Modal Capacity of PIPSYS may not be Sufficient to Handle the Higher Frequency Loads, for Example, Those Resulting from Suppression Pool Dynamics

Pages 164, 165, and 166 of the "Analysis Manual" (see Attachment 3) address this question. Also see Attachment 5, page 6 of 17, item 4.5. Page 166 of the "Analysis Manual" specifies a high number of modes for the initial runs. While at the meeting, we checked the two available "Stress Reports" prepared by Quadrex (piping systems IR-6 and Unit-2,DO-5) and found that 30 modes were included; sufficient in both systems to get into the "zero period acceleration" region of the response spectrum used. This agrees with the instructions on page 165 of the "Analysis Manual". Our conclusion is that PIPSYS, as used by Quadrex, is sufficient to handle the higher frequency loads including those from suppression pool dynamics.

## SUMMARY

1. Thermal Expansion Stress Analysis Cutoff at 150 F

   This cutoff is deemed to be technically appropriate

2. Anchor Displacements

   For specific work done by Quadrex for LaSalle Units 1 and 2, not including anchor displacements is deemed to be technically appropriate.

3. Separation of Branch Lines from Main Piping Runs

   We deem the S & L response (Att. 10) is sufficient to address the specific allegation. Any further investigation of this aspect should be considered as a generic problem.

4. Modal Capacity of PIPSYS

   Available reports, showing 30 modes included, plus the instructions from S & L to Quadrex (see Att. 3, p. 164) are sufficient to indicate this allegation is incorrect.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

DEC 1 1980

MEMORANDUM FOR: E. Jordan, Acting Chief
Reactor Engineering Branch, I&E

FROM: R. J. Bosnak, Chief
Mechanical Engineering Branch, DE

SUBJECT: SARGENT & LUNDY DESIGN PROCUDURES AND CRITERIA

In the IE letter (Serial No. IE:RCI:80-04) from G. W. Reinmuth (RCI, I&E) to J. P. Knight (DE,NRR) dated June 12, 1980, lead responsibility was transferred to NRR regarding the review of four allegations lodged against Quadrex (formerly Nuclear Services Corporation) in their final as-built piping analysis for the LaSalle County Station, Units 1 and 2.

On September 15, 1980, a meeting was held at the Sargent & Lundy offices in Chicago to discuss the four allegations against Quadrex's work. Quadrex is under contract to Sargent & Lundy and uses the design criteria and procedures developed by Sargent & Lundy.

The allegations questioned four procedures specified in the SAR-0303 Analysis Manual, QUAD No. 7-80-006, which is part of Sargent & Lundy's Specification J2952 for the Quadrex work. The four procedures in question are as follows.

1. Thermal expansion stress analyses were not to be performed when the design temperature is less than 150°F.

2. Anchor displacement were not to be included in the analysis.

3. Branch lines were not to be included in the analyses of the main piping runs when the ratio of the moments of inertia is 7 to 1 or greater.

4. The computer program PIPSYS was to be used for all piping systems analyses even though the modal capacity of PIPSYS may not be sufficient to handle the higher frequency loads.

The above four issues were discussed with Sargent & Lundy and the NRC staff and its consultants from Oak Ridge National Laboratories. The findings of the staff and its consultants conclude that the above four procedures when implemented as stated in the Sargent & Lundy detailed procedures are technically appropriate and that the design procedures represent reasonable and conservative engineering practices that have been widely adopted throughout the industry.

R. J. Bosnak, Chief
Mechanical Engineering Branch
Division of Engineering

Contact:
D. Terao, DE:MEB, x29477

Dupe

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DEC 17 1980

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MEMORANDUM FOR: O. C. Shackleton, Region V

FROM: R. J. Kiessel, Reactor Engineering Branch, Division of Resident and Regional Reactor Inspection, IE

SUBJECT: SARGENT & LUNDY DESIGN PROCEDURES AND CRITERIA

The Mechanical Engineering Branch (MEB), Office of Nuclear Reactor Regulation, has completed its review of the four Sargent & Lundy design procedures identified in the allegations against Quadrex (formerly Nuclear Services Corporation).

The MEB has concluded that all four procedures are technically appropriate and that they present reasonable and conservative engineering practices. A copy of the December 1, 1980, memorandum from R. J. Bosnak to E. Jordan, which transmits the MEB findings, is enclosed.

I believe that this finding completes my participation in the investigation of Quadrex. Therefore, I plan no further action on this matter unless you request that something additional be done.

Richard J. Kiessel, Mechanical Engineer
Mechanical, Structural and
Metallurgical Section
Reactor Engineering Branch
Division of Resident and
Regional Reactor Inspection, IE

Enclosure: As stated

cc: I. T. Yin, RIII, w/enclosure

cc: w/memo only
J. H. Sniezek, IE
E. L. Jordan, IE
R. W. Woodruff, IE



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| OFFICE | IE:REB | IE:REB | | | | |
|---|---|---|---|---|---|---|
| SURNAME | RJKiessel:mkm | RWWoodruff | | | | |