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

Appendix 2
to Attachment 1
A2-1

JUL 30 1982

MEMORANDUM FOR: R. J. Bosnak, Chief, MEB, DE

THRU: HLB H. L. Brammer, Section Leader, MEB, DE

FROM: D. Terao, MEB, DE

SUBJECT: TRIP REPORT FOR REVIEW OF LASALLE HVAC SYSTEM DESIGN

HVAC Meeting at Region III

On July 26, 1982, the applicant for the LaSalle County Station 1 & 2 (Commonwealth Edison Company) and its architect-engineer (Sargent & Lundy) met with the NRC staff at the Region III offices in Glen Ellyn, Illinois to discuss the safety implications of the allegations concerning deficiencies in the quality assurance of the Zack Company and, specifically, the effect on the HVAC system ductwork and support design. The major questions and concerns focused on by the staff were:

1) How were the specifications developed for the HVAC system (ductwork and supports)?
2) What is the significance of using materials which cannot be determined to conform to their specifications?
3) What is the Sargent & Lundy role in resolving non-conformance reports (NCR)?

Sargent & Lundy (S&L) stated that the safety-related ducting for HVAC systems are composed of galvanized sheet material required to meet the specifications of ASTM A526 (14 gauge and heavier) or ASTM A527 (16 gauge and lighter). S&L further stated that there are no national codes nor standards pertaining to the overall design, fabrication, or installation of HVAC systems. There is only an ANSI-N509 standard which pertains to air cleaning systems and it requires the use of A526 and A527 material for galvanized steel ducts and the use of A36 material for structural shapes. The S&L design specification (J2590) is in agreement with the ANSI material requirements.

The S&L design specification (J2590) required the results of all chemical analyses and mechanical tests as required by the material specification. The NCR's centered around the lack of documentations [certified material test reports (CMTR) and certification of conformance (C of C)]. For galvanized sheet metal (A526 and A527), the ASTM specification only requires a chemical test and does not require mechanical strength tests. S&L stated that the ducting was designed to a maximum allowable stress value of 18 ksi and that there was a large design margin available.

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Similarly, for the structural stiffeners and supports, the S&L design specification required the use of ASTM A575 Grade M-1020 and ASTM A-36, respectively. A 575 (M-1020) only requires a chemical test not a mechanical test. A-36 requires both a chemical and a mechanicaL test. S&L stated that the support members were conservatively designed with a large design margin and that, generally, the weld was the weakest point in the support design (not the structural member). That is, the weld would fail before the structural member.

Sargent & Lundy further stated that the materials required by the S&L specification were not high-strength low alloy steel materials but were from the family of steels normally classified as "carbon steel". Within that family, there was no lesser quality material that could have been substituted with significantly lesser strength properties.

The staff caucassed for a few minutes and had two major concerns that required further action. The staff wanted to determine how much design margin existed in the HVAC system supports and ducting. The staff decided to audit the S&L calculations for the HVAC system design the next day. Secondly, the staff had a concern regarding the strength of ASTM A575 material used for stiffeners. Because A575 material is available with different carbon content and in some cases, Grades M-1010 and M-1015 with lesser carbon content were used instead of M-1020, the staff wanted to know the differences in mechanical strength for the different grades of A575 material. The applicant (and S&L) agreed to provide this information.

HVAC Meeting at Sargent & Lundy

On July 27, 1982, I met with the architect-engineer (Sargent & Lundy) for the LaSalle 1 & 2 plant at their offices in Chicago, Illinois. The purpose of the visit was to review the design calculations for the LaSalle 1 & 2 HVAC System as agreed upon at the previous day's meetings held at the Region III offices. The list of attendees is included as Attachment A.

In the morning, we discussed the design methodology used by Sargent & Lundy (Component Qualification Division) to reassess the HVAC ducting and supports. The reassessment of the HVAC supports was performed to qualify the supports to the LaSalle hydrodynamic loads. The supports were requalified using the load and frequency controlled design method as presented in Attachment B. The supports which remained in the rigid range (beyond the peaks in the response spectra) were qualified to an allowable maximum stress of 12,000 psi (1/3 Sy). For the critical supports which could be affected by the dynamic response spectra peaks, an allowable maximum stress value of 22,000 psi (0.6 Sy for ASTM-A36) was used. I reviewed the HVAC calculation[1,2] for qualifying the typical support details and the critical supports (non-rigid). I randomly selected three calculations to determine whether the methodology was appropriate. The calculations appeared to be acceptable.

In general, it appears that the HVAC supports have a large design margin as stated by S&L previously. In performing the reassessment for hydrodynamic loads, S&L found supports in which the allowable stress was exceeded, however, the support was reinforced as needed and requalified.

We also discussed the design procedures used by S&L in reassessing the ducting sheet metal. S&L evaluated all duct sizes and determined the optimum span for the spacing of seismic supports. In order for the ducting to remain in the rigid range and within the 18,000 psi stress allowable, S&L used a maximum allowable span of 14 feet. The 14 feet maximum span was selected to encompass all duct sizes in order to maintain a rigid body assumption for the ducting. The methodology appears to be reasonable and acceptable.

Sargent & Lundy provided me with the previously requested material strength values for the various grades of A575 material. The yield stresses were obtained from Northwestern Steel and Wire Company. The values are as follows:

ASTM A575	Minimum ~~Maximum~~ Yield Strength
Grade M1008	34.0 ksi
M1010	35.7 ksi
M1015	36.1 ksi
M1020	37.2 ksi

Thus, it appears that the lowest grade (M1008) could be approximately 10% weaker than the S&L design specification requirement (M1020).

We also discussed the design and material differences between the safety related HVAC system and the HVAC system that are not safety-related. S&L stated that the materials used for galvanized ductwork is the same regardless of its safety class. The design is identical with respect to

[1] "Analysis of HVAC Seismic Hangers in Auxiliary Building - LaSalle County Station - 1, Supplement to Phase I and Phase II dated 7/23/80. (EMD-024713)

[2] Same title as above (Phase II) dated 7/25/81. (EMD-020798)

stiffener spacing and support spacing (except in the service building where the seismic support spacing was not required). The only major design differences appears to be in the ducting flange joint connection. The use of a slip joint rather than a companion angle was allowed for the HVAC system that are not safety-related.

Sargent & Lundy stated that, in the bolting requirements, Zack had requested to use "Huck" bolts rather than the A307 bolts required by the S&L specification. The use of Huck bolts (AISI C-1035 Carbon Steel) would result in a more efficient installation of the bolts. S&L accepted the Huck bolts because the bolts exhibited the same (or better) properties than A307 bolts. For example, a ¼ inch A307 bolt had a tensile strength of 1900 lbs. while a ¼ inch Huck bolt had a 3000 lbs. tensile strength.

In summary, the overall design methodology used for the requalification of the HVAC ducting and supports appears to result in a conservative design, thus providing an adequate design margin. However, the actual margin to failure is dependent on the mechanical strength of material. The possible tolerances in the expected property values for material where the ASTM specification does not require mechanical testing will be addressed separately by MTEB.

D. Terao

D. Terao
Mechanical Engineering Branch
Division of Engineering

cc: R. Vollmer, DE
J. Knight, DE
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R. Lanksbury, RIII
C. Sellers, DE

LASALLE COUNTY
HVAC SYSTEMS

- DEFINITIONS
- HVAC SYSTEMS
- AREAS SERVED/FUNCTION
- ZACK COMPANY SCOPE
- SYSTEM DIAGRAMS
- MATERIAL REQUIREMENTS
- MATERIAL PROPERTIES
- MATERIAL FURNISHED
- DISPOSITION OF CECO NCR'S #556, 557, 558, 566 & 594

DEFINITIONS

A. Nuclear Safety-Related Function

Any function necessary to assure:

1. The integrity of the reactor coolant pressure boundary or primary coolant boundary,

2. The capability to shutdown the reactor and maintain it in a safe shutdown condition, or

3. The capability to prevent or mitigate the consequences of conditions of design which could result in potential off-site exposures that are a significant fraction of Title 10, Code of Federal Regulations, Part 100, "Reactor Site Criteria."

B. Safety-Related HVAC Systems (Engineered Safety Feature Systems)

Those heating, ventilating, air conditioning, or air cleaning systems which provide necessary support to enable nuclear safety-related functions to be performed. Specific objectives are to:

1. Provide suitable environment for plant personnel so they may perform required nuclear safety-related functions.

2. Provide a suitable environment for nuclear safety-related plant equipment so it may perform required nuclear safety functions.

3. Control, limit, or prevent the release or transfer of airborne radiological contaminants and intake of hazardous chemicals that could affect nuclear safety functions.

C. Non-Safety Related-Seismic

Those HVAC Systems or portions of HVAC or air cleaning systems which, although not requirred to function, are required to retain their structural integrity (i.e. remain in place during and after an SSE) so as not to prevent the operation of other nuclear safety related systems.

D. Non-Safety-Related - (Non-Seismic) HVAC Systems

Those systems or portions of HVAC or air cleaning systems whose operation or structural integrity is not required to support nuclear safety-related functions.

E. Commercial Grade Quality

Merchant or common grade materials, components, or appurtenances that are customarily used in industrial and commercial HVAC applications and which are readily available, catalog-type ("off-the-shelf") items. No special manufacturing processes are required, over and above, the normal industry practice, to enhance the items' characteristics.

F. Special Quality

Material, components, or appurtenances that are special order, custom made as required when end use, method of fabrication or subsequent processing treatment requires quality characteristics not availble in merchant or commercial grade quality (e.g., high strength, low alloy, quencher or special killed steels).

LASALLE COUNTY
HVAC SYSTEMS

SAFETY RELATED/SEISMIC

- Control Room HVAC (VC)
- Auxiliary Electric Equipment Room HVAC (VE)
- Diesel Generator Facilities Ventilation (VD)
- Switchgear Heat Removal Ventilation (VX)
- Emergency Core Cooling System (ECCS) Equipment Area Cooling (VY)
- Standby Gas Treatment System (SGTS) (VG)
- Limited Portions of Reactor Building Ventilation and Primary Containment Purge

NON-SAFETY RELATED/SEISMIC

- Primary Containment (Drywell) Ventilation (VP)
- Primary Containment Purge, Portions (VQ)
- Reactor Building Ventilation System (VR)

NON-SAFETY RELATED/NON-SEISMIC

- Auxiliary Building Office HVAC (VA)
- River and Lake Screen House Ventilation (VH)
- Machine Shop Ventilation (VJ)
- Auxiliary Building Laboratory HVAC (VL)
- Off-Gas Building HVAC (VO)
- Service Building HVAC (VS)
- Turbine Building Ventilation (VT)
- Radwaste Ventilation (VW)

LASALLE COUNTY

HVAC SYSTEMS

Safety Related HVAC Systems	Areas Served	Function
1. Control Room HVAC		
A Train and B Train	Unit 1 & 2 Control Room Main Security Center Storage Room	Provide Habitable zone for radiological and haz chemical protection. Provide temperature control for personnel comfort and equipment operation. Maintain positive pressure.
2. Auxiliary Electric Equipment Room HVAC		
A Train and B Train	Unit 1 Auxiliary EE Room Unit 2 Auxiliary EE Room Computer Room Computer Storage	Provide habitable zone for radiological and haz chemical protection for remote plant shutdown. Provide temperature control for personnel comfort and equipment operation. Maintain positive pressure.
3. Diesel Generator Facilities Ventilation		
Unit 1 Diesel Gen. Room Vent	Unit 1 Diesel Gen. & Diesel Oil Rooms	Provide temperature control for D-G, HPCS switchgear and pumps rooms when equipment operates. Provide ventilation of diesel oil and day tank rooms.
Standby Diesel Gen. Room Vent	Standby Diesel Gen. & Diesel Oil Rooms	
Unit 1 HPCS D-G Room Vent	Unit 1 HPCS Diesel Gen. & Diesel Oil Rooms	
Unit 1 HPCS SWGR/Pump Rm Vent	Unit 1 HPCS SWGR & Pump Rms.	
Unit 2 Diesel Gen. Room Vent	Unit 2 Diesel Gen. & Diesel Oil Rooms	
Unit 2 HPCS D-G Room Vent	Unit 2 HPCS Diesel Gen. & Diesel Oil Rooms	
Unit 2 HPCS SWGR/Pump Rm Vent	Unit 2 HPCS SWGR & Pump Rms	

Attachment 2

Safety Related HVAC Systems	Areas Served	Function
4. Switchgear Heat Removal		
Unit 1 Reactor Protection System MG Set Room Vent	Unit 1 Reactor Protection Sys. MG Set Rm & 48V Battery Room & Cable Spreading Room	Provide ventilation for temperature control for equipment operability
Unit 1 Ess Swgr Div I Vent	Unit 1 Ess Div I Swgr Room & 125 V Battery Room	Provide ventilation for battery rooms.
Unit 1 Ess Swgr Div II Vent	Unit 1 Ess Div II Swgr Room & 125V Battery Room	
Unit 2 Rx Protection System MG Set Room Vent	Unit 2 Rx Protection System MG Set Rm & 48V Battery Room & Cable Spreading Room	
Unit 2 Ess Swgr Div I Vent	Unit 2 Ess Div I Swgr & 125V Battery Room	
Unit 2 Ess Swgr Div II Vent	Unit 2 Ess Div II Swgr & 125V Battery Room	
5. ECCS Equipment Area Cooling		
Unit 1 RHR Pump 1A Cubicle Cooler	Unit 1 RHR Pump 1A Cubicle	Provide Temperature control for ECCS pump operability.
Unit 1 HPCS Pump Cubicle Cooler	Unit 1 HPCS Pump Cubicle	
Unit 1 RHR Pump 1B and 1C Cubicle Cooler	Unit 1 RHR 1B & 1C Pump Cubicle	
Unit 1 LPCS & RCIC Pumps Cubicle Cooler	Unit 1 LPCS & RCIC Pump Cubicle	
Unit 1 RHR Sw Pump A & B Cubicle Cooler	Unit 1 RHR Sw Pump A & B Cubicle	
Unit 1 RHR Sw Pump C & D Cubicle Cooler	Unit 1 RHR Sw Pump C & D Cubicle	
Unit 2 - Same as Above.	Unit 2 - Same as Above.	
6. Standby Gas Treatment		
Unit 1 & 2 SGTS Trains	Unit 1 Reactor Building Unit 1 Drywell & Suppression Pool Chamber Unit 2 Reactor Building Unit 2 Drywell & Suppression Pool Chamber	Maintain negative pressure in reactor building and drywell. Remove radioactive iodine from post accident reactor building effluent.

Attachment 2

Safety Related HVAC Systems	Areas Served	Function
7. Reactor Building Vent		
Unit 1 & 2 Reactor Building Supply and Exhaust Isolation	Unit 1 Reactor Building Unit 2 Reactor Building	Isolate supply and exhaust ducts for Reactor Building Vent System post accident.
8. Primary Containment Purge		
Unit 1 & 2 Containment Isolation	Unit 1 & 2 Primary and Secondary Containment	Isolate Primary and Secondary containment supply and exhaust pipes post accident.

Attachment 2

Attachment 2

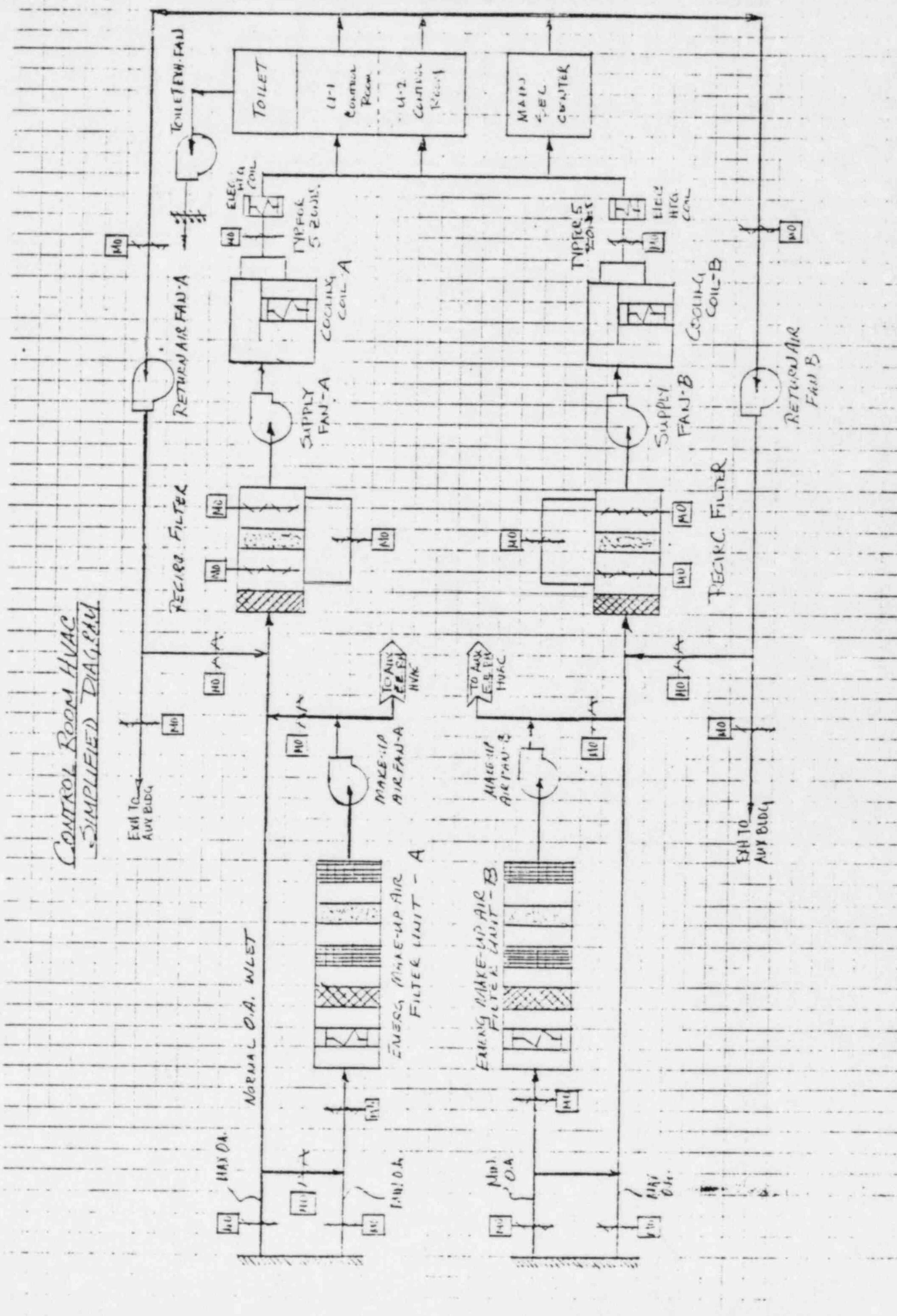
SAFETY RELATED HVAC SYSTEM

AND EQUIPMENT CHECKLIST

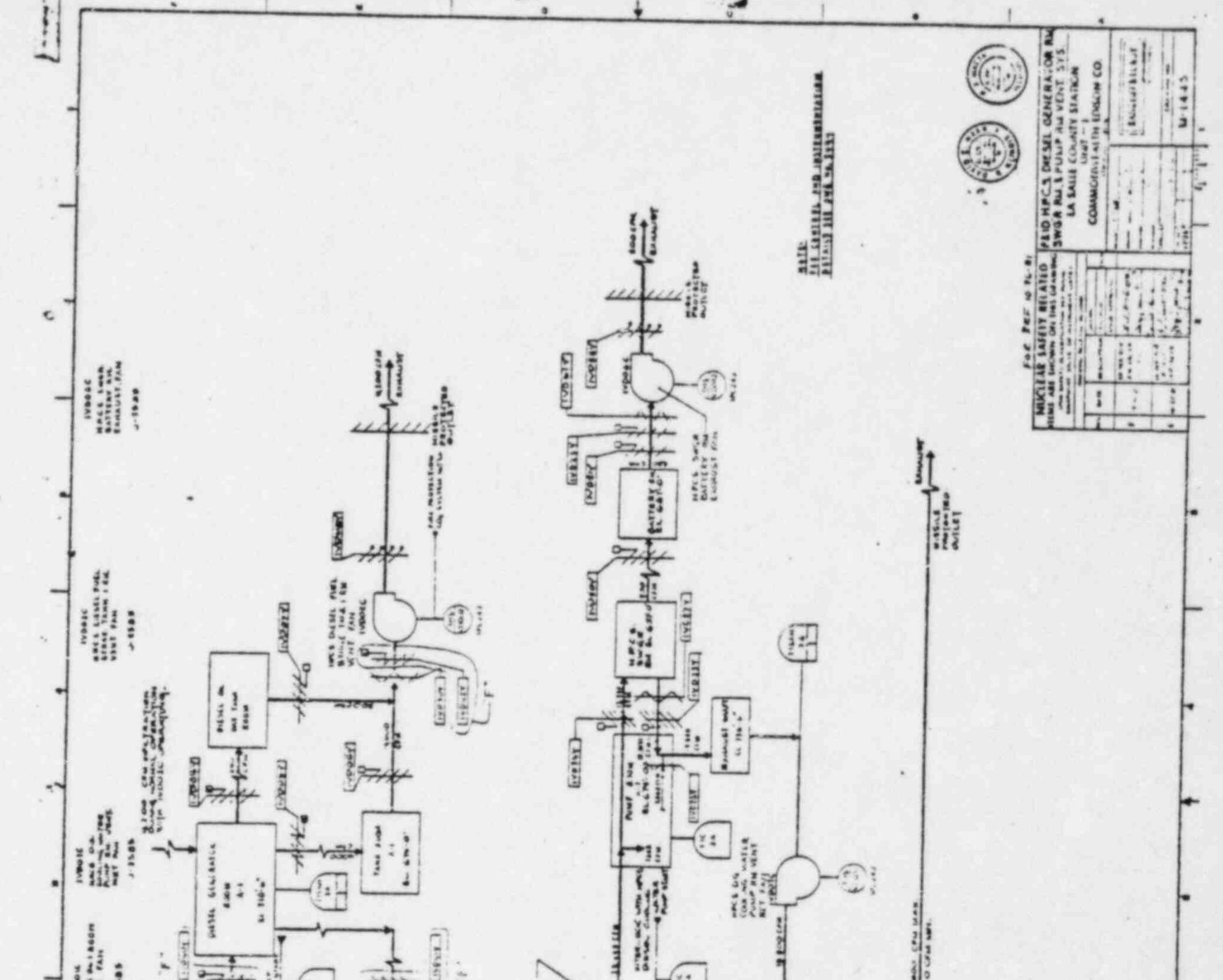
LASALLE COUNTY NUCLEAR GENERATING STATION

SCOPE OF HVAC WORK	Items Identified On Safety Related HVAC Systems					
	System Acronym					
	VC	VD	VE	VG	VX	VY
Furnished By Zack, Installed By Zack						
Ductwork	X	X	X	*	X	X
Supports	X	X	X	-	X	X
Welding	X	X	X	-	X	X
Refrigerant Piping	X	-	X	-	-	-
Purchased By Zack, Installed By Zack						
Fasteners	X	X	X	*	X	X
Sealants	X	X	X	*	X	X
Flexible Connections	X	X	X	X	X	X
Access Doors	X	X	X	-	X	X
Refrigerant Specialties	X	-	X	-	-	-
Fire Dampers	X	X	X	-	X	X
Gravity Shutters	X	X	-	-	X	-
Balancing Dampers	X	X	X	-	X	X
Grilles, Registers and Diffusers	X	X	X	-	X	X
Airflow Measuring Stations	X	-	X	X	X	X
Silencers	X	-	X	-	X	-
Filters	-	X	-	-	X	-
Purchased By CECo, Installed By Zack						
Heat Exchange Coils and Cabinets	X	-	X	-	-	X
Atmospheric Clean-Up Filter Units	X	-	X	X	-	-
Vaneaxial Fans	X	X	X	-	X	X
Centrifugal Fans	X	X	-	-	X	X
Air Cooled Condensing Units	X	-	X	-	-	-
Isolation Dampers	X	X	X	-	X	X
Check Dampers	X	-	-	-	-	-

*Limited Scope i.e. Less 5 Feet Of Ductwork.


CONTROL ROOM HVAC
SIMPLIFIED DIAGRAM
TOILET
U-1 CONTROL ROOM
U-2 CONTROL ROOM
MAIN ELEC CENTER
TOILET EXH. FAN
RETURN AIR FAN-A
SUPPLY FAN-A
COOLING COIL-A
ELEC HTG COIL
TYP FOR 5 ZONES
RECIRC FILTER
SUPPLY FAN-B
COOLING COIL-B
RETURN AIR FAN B
EXH TO AUX BLDG
TO AUX E.S. EH HVAC
MAKE-UP AIR FAN-A
MAKE-UP AIR FAN-B
EMERG MAKE-UP AIR FILTER UNIT - A
EMERG MAKE-UP AIR FILTER UNIT - B
NORMAL O.A. INLET
MAX O.A.
MIN O.A.
MO

Attachment 2



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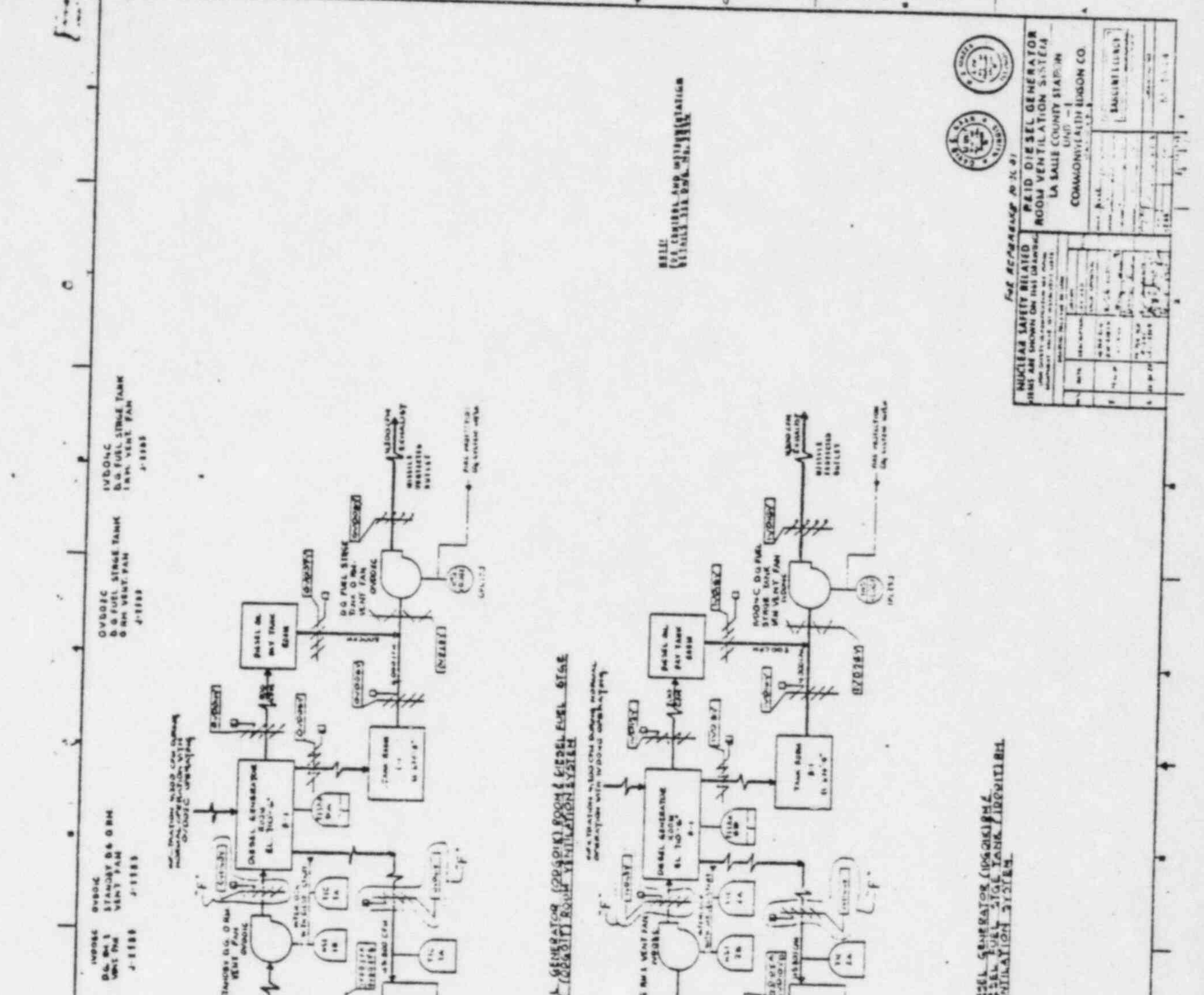

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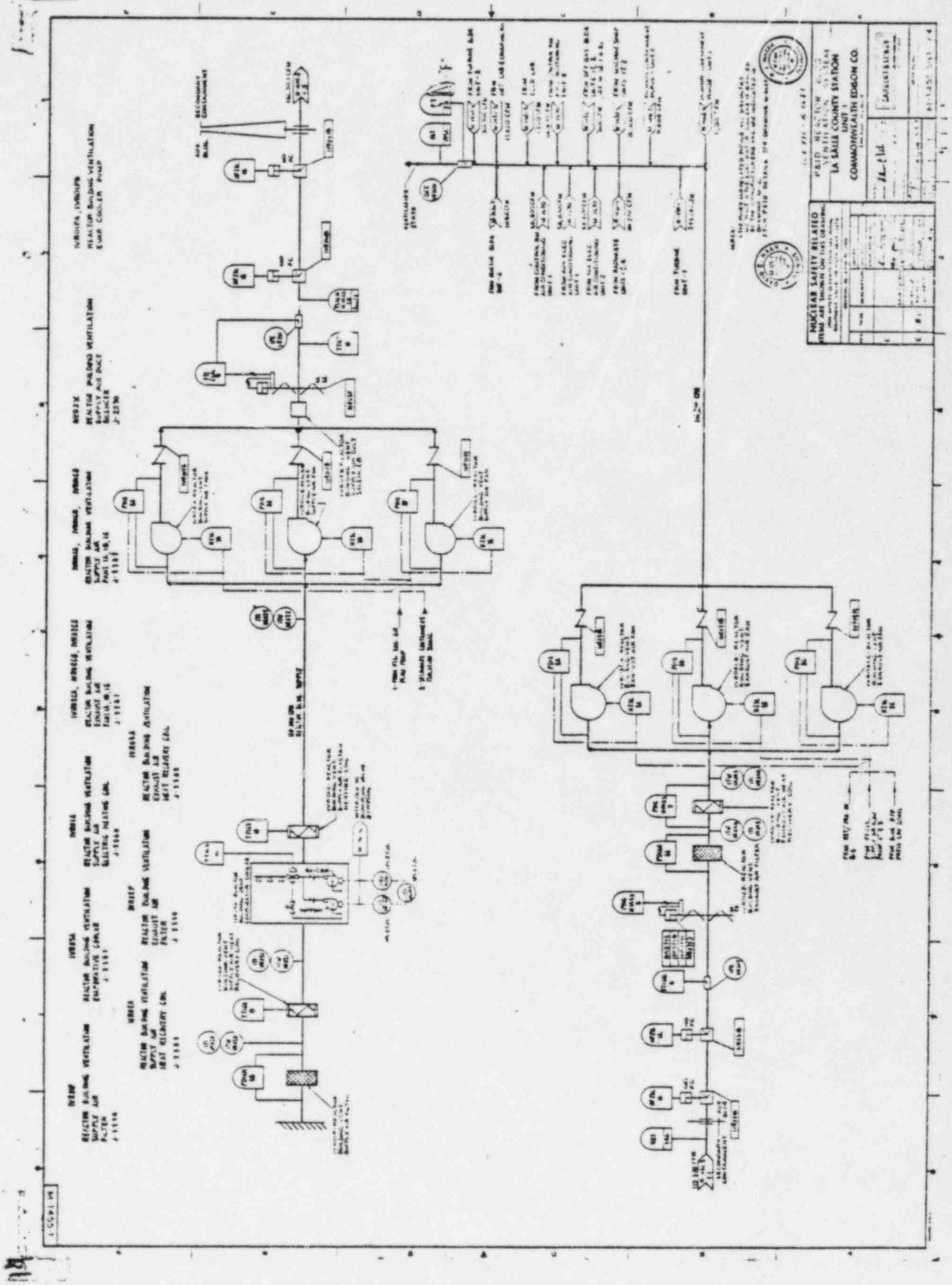

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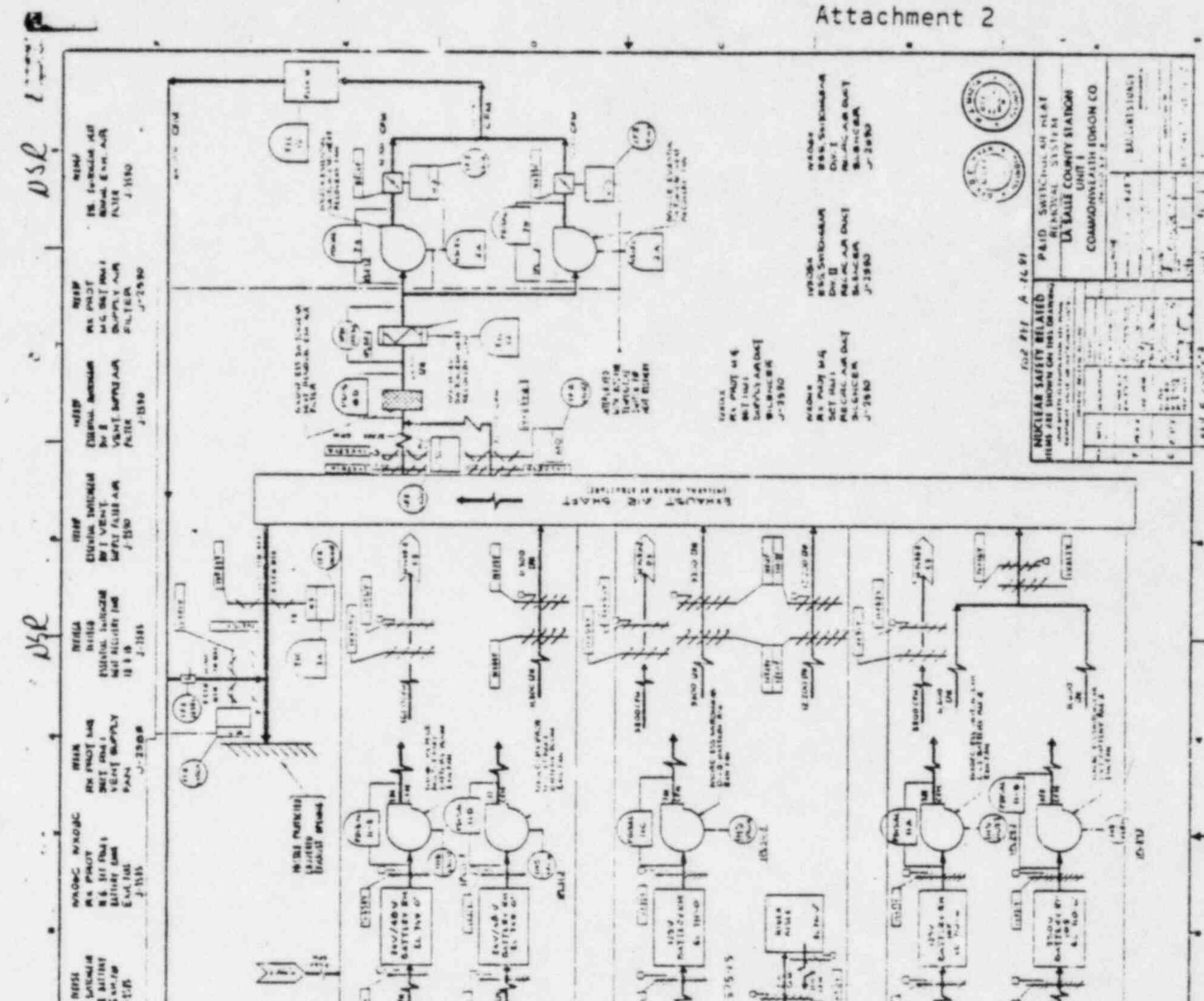

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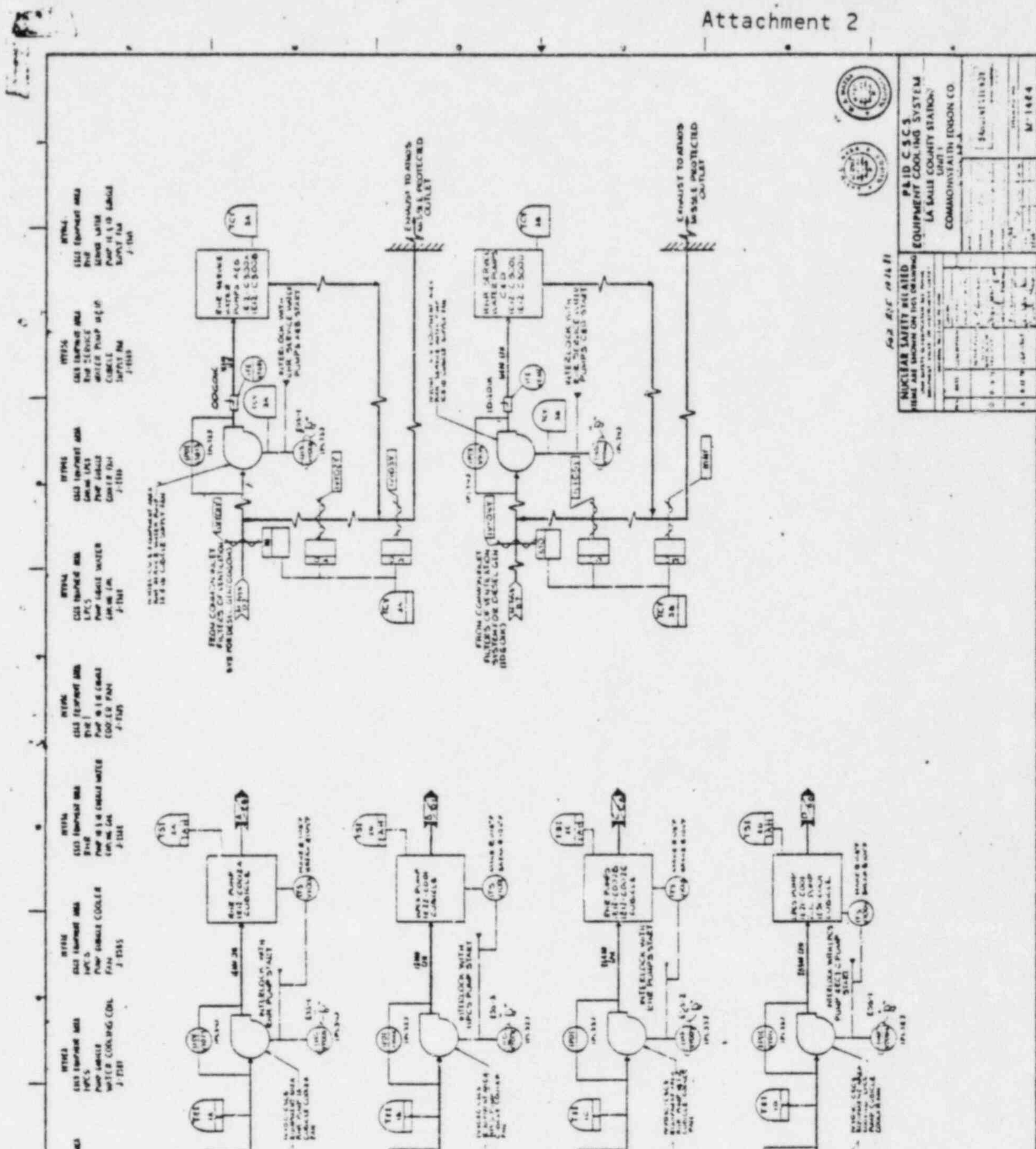

LaSalle County Nuclear Station

Material Requirements for HVAC Ductwork Systems

The LaSalle County HVAC Work Specification J-2590 requires that the HVAC ducts be made of galvanized sheet metal conforming to the requirements of ASTM A-527 for up to 16 gauge thickness and ASTM A-526 for 14 gauge and over. The companion flange angles and stiffening angles are specified as ASTM A-36 (ASTM A-575 for angles less than 2-1/2" x 2-1/2" x 1/4"). Hanger supports are specified as ASTM A-36. The specification further states the required thickness and angle iron stiffening and flange joints to be used for both seismic (safety-related and non-safety-related) and non-seimsic (non-safety-related) applications. The physical design drawings indicate the size of hanger angles.

The material used for this application is no different from that used in any industrial or commercial application. Nuclear power plant galvanized ducts, angles and hangers do not have any additional requirements placed on the manufacturing of this material. The galvanized ducts, angles and hanger steel must simply conform to the specified ASTM standard.

It is also important to point out that there are no national codes which specifically govern the design, fabrication, or installation of HVAC systems such as there are for power plant piping, which is covered by ASME Boiler and Pressure Vessel Codes. In fact, the only national standard which covers duct systems is ANSI N509 "Nuclear Power Plant Air Cleaning Units and Components" which states requirements for air cleaning ducts only. This standard, written initially in 1976 and extensively revised in 1980, states that galvanized sheet material for air cleaning ducts shall conform to ASTM A-527/A-526. No specific material documentation is required.

The federal regulation which addresses the requirements for documentation is 10CFR50, Appendix B, Section VII, Control of Purchased Material, Equipment, and Services. It states that "documentary evidence that material and equpment conform to the procurement requirements shall be available at the nuclear power plant site prior to installation or use of such material and equipment. This documentary evidence shall be sufficient to identify the specific requirements, such as codes, standards, or specifications met by the purchased material and equipment."

Since there are no national codes or standards which specify the documentation required, the documentation requirements are the responsibility of the Purchaser (and his A-E) to define. As a minimum, evidence which indicates the material conforms to the specified material is all that is required. For this application which uses standardized, commercial-grade material, a certificate of conformance would be acceptable.

LaSalle County HVAC Work Specification J-2590 however included standardized QA articles (prepared mainly for ASME B&PV code systems). These require the following:

> Two (2) copies of all appropriate documentation, as hereinafter specified, or as required by applicable code, standard, and criteria shall be submitted. . . A list of the minimum required documentation with references where they are defined is as follows:
>
> a. Certified Material Test Report, which shall include the actual results of all chemical analyses and mechanical tests required by the material specifications and actual results of all other tests required by material specification.
>
> b. Welding Material Test Report.
>
> c. Radiographic Certification.
>
> d. Repair Weld Certification.
>
> e. Eddy Current Test Report.
>
> f. Hydrostatic Testing and/or Pneumatic Testing Report.
>
> g. Leak Test Report.
>
> h. Heat Treatment (Time and Temperature Charts).
>
> i. Material Identification and Marking (Traceability).
>
> j. Filler Metal Traceability on Pressure Retaining Welds.
>
> k. Welder Qualification Report.
>
> l. Nondestructive Testing Personnel Qualification Report.
>
> m. Code Data Report, including nameplate date and rubbing.

After award, a meeting was held with The Zack Company, Commonwealth Edison Company and Sargent & Lundy to clarify the QA requirements. Item a above was clarified to only apply to duct sheets, angles and supports. Typical welding rod material certificates were also requested for noncode weld rod, which is in accordance with AWS 5.01. For the remainder of the work, certificates of conformance were required.

Nonconformances concerning the galvanized sheet steel and angle iron were submitted by The Zack Company to Commonwealth Edison Company in late 1981 and early 1982. These nonconformances were for documentation deficiencies (i.e., documentation which did not meet specification requirements) and not material deficiencies. These nonconformances were evaluated to determine if there was sufficient documentation available to verify if specified materials or materials equivalent to or exceeding specified materials were provided.

Other documents such as steel company invoices and Zack purchase orders which indicate for example ASTM A-527 or lock forming quality (LFQ) galvanized steel[1], provide adequate assurance that the specified materials were provided. Since these materials are identical to those materials routinely used in industrial and commercial applications, and the steel manufacturers have been producing this material to a nationally recognized standard for many, many years, the history of this standardized product indicates a satisfactory performance and quality.

In addition, these materials have low carbon content, less than 0.3% by the ASTM specifications and it is well known that low carbon steel metal exhibits yield stresses of a minimum of 35,000 psi[2]. The seismic safety-related duct system assumes an allowable stress of 18,000 psi maximum with many ducts seeing less than that. Thus, considerable margin exists in the system design with the normal production quality ASTM material. A comparison of the commercially available materials that could possibly be used for ducts, stiffeners and angles confirms that the majority of the materials have yield stresses in excess of 30,000 psi. The worse possible case (ASTM A663, Standard Specification for <u>Merchant Quality</u> Hot-Rolled Carbon Steel Bars subject to Mechanical Property Requirements) exhibits a minimum yield of 22,500 psi. This is still above the 18,000 psi design value. Thus, even if the worse possible steel was used, the yield stress would not be exceeded. (Refer to the attached discussion on "Material Specification and Mechanical Properties for Galvanized Sheet Steel and Stiffener, Hanger, and Support Steel" for additional information).

It should also be pointed out that none of the nonconformances submitted involve the sheet metal gauge or angle size and thickness. Zack documents (fabrication tickets and duct construction details) indicate the sheet metal gauge. This is checked during shop inspection.

All of these factors were involved in our review of the material documentation nonconformances to the specification requirements and allowed us to accept the alternate documentary evidence.

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[1]ASTM A-527 is referred to as lock forming quality (LFQ) in its title. ASTM A-526 is referred to as commercial quality (CQ). These terms are acceptable alternates for the ASTM designation.

[2]T.B. Jefferson, <u>Metals and How to Weld Them</u>, (The Welding Encyclopedia), Second Edition.

Material Specification and Mechanical Properties

for Galvanized Sheet Steel,

and Stiffener, Hanger, and Support Steel

We have reviewed the properties of the available materials for sheet steel, stiffeners, hangers, and supports and compared them to properties of the material specified in Specification J-2590, HVAC Work. The enclosed table, Material Specification and Mechanical Properties, lists the possible sheet and angle materials and corresponding mechanical properties. The minimum yield strength for all tabulated sheet steel materials is 3~~4~~3,000 psi and for angle materials is 22,500 psi. The seismic analysis of the ductwork and support systems utilized a design yield strength of 18,000 psi. Therefore, materials routinely purchased by The Zack Company would satisfy the design requirements of Specification J-2590.

Stiffener, hanger, and support angles used by The Zack Company have typically been purchased from Northwestern Steel and Wire Company. Angles of a size 3" x 3" x 1/4" and larger are normally produced to ASTM Specification A36 which has a minimum yield strength of 36,000 psi. Angles 2-1/2" x 2-1/2" x 1/4" and smaller are normally produced to ASTM A36 or ASTM 575. ASTM 575 does not require physical property tests as part of its specification. However, based upon our discussions with Northwestern, their typical Mechanical properties for the grade of steel specified (M1020), the lowest grade available (M1008), and two intermediate grades (M1010 and M1015) range from 34 ksi to 37.2 ksi minimum yield strength as shown on the attached tabulation.

Another possible substitution to the above materials is ASTM A663, Standard Specification for Merchant Quality Hot-Rolled Carbon Steel Bars subject to Mechanical Property Requirements although this is not a normal product for ductwork. Grades 45, 50, and 55 represent the worse possible cases with a minimum yield strength of 22,500 psi, and as stated above, exceed our design minimums.

Galvanized sheet steel used by The Zack Company has typically been purchased from Inland Steel Company and other similar reputable companies. Galvanized sheet steel, unless specifically identified otherwise, is normally produced to ASTM Specifications A526 or A527. These specifications do not require physical property tests as part of their specifications. However, Inland Steel Company periodically obtains mechanical property data on these materials as part of their quality control program. The mechanical properties listed in the attached table are representative of the values obtained from this testing program. Other possible types of galvanized sheet steel are also shown on the attached tabulation. These represent the minimum mechanical properties available for sheet steel, and as stated above, exceed our design minimums.

One other alternative to purchasing galvanized sheet steel manufactured to ASTM A526/527 would be to purchase uncoated sheet steel from the steel mill and then have it galvanized elsewhere. Procurement in this manner would not change the characteristics of the sheet steel as the uncoated material would have been produced at ASTM A366, Standard Specification for Steel, Carbon, Cold-Rolled Sheet, Commercial Quality or ASTM A569, Standard Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality. These specifications have the same chemical composition as materials produced to ASTM A526 or A527 and therefore, are equivalent. Other forms of galvanized sheet, e.g., "Paintgrip", "Electrogalvanized", are different coating variations to the same base metals and carry the same ASTM designation for the base metal.

Since the specified materials are very common to the HVAC industry, material substitution is not very probable. However, this should eliminate any concern with respect to the hypothetical question of what is the worse that could happen if the wrong material was furnished.

MATERIAL SPECIFICATION AND MECHANICAL PROPERTIES

FOR GALVANIZED SHEET STEEL AND STIFFENER HANGER, AND SUPPORT STEEL

MATERIAL	SIZE	MATERIAL SPECIFICATION	SPECIFICATION TITLE	MECHANICAL PROPERTIES	
				MINIMUM YIELD STRENGTH PSI	MINIMUM TENSILE STRENGTH PSI
Sheet	16 Gauge - Lighter	ASTM 527 (1)	Standard Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality	38,000 (4)	52,000 (4)
	14 Gauge - Heavier	ASTM 526 (1)	Standard Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process, Commerical Quality	40,000 (4)	53,000 (4)
		ASTM A446 Grade A	Standard Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality	33,000 (2)	45,000 (2)
		Grade B		37,000 (2)	52,000 (2)
		Grade C		40,000 (2)	55,000 (2)
		Grade D		50,000 (2)	65,000 (2)
		Grade E		80,000 (2)	82,000 (2)
		Grade F		50,000 (2)	70,000 (2)
		ASTM A742	Standard Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process, Polymeric Pre-Coated For Sewer and Drainage Pipe	33,000 (2)	45,000 (2)
		ASTM A444	Standard Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process for Culverts and Underdrains	33,000 (2)	45,000 (2)
		ASTM A528	Standard Specification for Sheet Steel, Zinc Coated (Galvanized) by the Hot-Dip Process, Drawing Quality	34,000 (5)	52,000 (5)
		ASTM A642	Standard Specification for Sheet Steel, Zinc Coated (Galvanized) by the Hot-Dip Process, Drawing Quality, Special Killed	34,000 (5)	52,000 (5)
		ASTM A361	Standard Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process for Roofing and Siding	33,000 (6)	52,000 (6)
		ASTM 525	Standard Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process, General Requirements	38,000 (7)	52,000 (7)

( ) Refers to note numbers.

Attachment 2

MATERIAL SPECIFICATION AND MECHANICAL PROPERTIES (cont.)

FOR GALVANIZED SHEET STEEL AND STIFFENER HANGER, AND SUPPORT STEEL

MATERIAL	SIZE	MATERIAL SPECIFICATION	SPECIFICATION TITLE	MECHANICAL PROPERTIES	
				MINIMUM YIELD STRENGTH PSI	MINIMUM TENSILE STRENGTH PSI
Stiffeners, Hangers, and Supports	3"x3"x1/4" and Larger	ASTM A36 (1)	Standard Specification for Structural Steel	36,000 (2)	58,000 (2)
	2-½"x2-½"x¼" and smaller (Formed Angle)	ASTM A575 Grade M-1020 (1)	Standard Specification for Merchant Quality Hot-Rolled Carbon Steel Bars	37,200 (3)	57,500 (3)
		Grade M-1008		34,000 (3)	52,000 (3)
		Grade M-1010		35,700 (3)	54,500 (3)
		Grade M-1015		36,100 (3)	55,000 (3)
		ASTM A663 Grade 45	Standard Specification for Merchant Quality Hot-Rolled Carbon Steel Bars Subject to Mechanical Property	22,500 (2)	45,000 (2)
		Grade 50		25,000 (2)	50,000 (2)
		Grade 55		27,500 (2)	55,000 (2)
		Grade 60		30,000 (2)	60,000 (2)
		Grade 65		32,500 (2)	65,000 (2)
		Grade 70		35,000 (2)	70,000 (2)
		Grade 75		37,500 (2)	75,000 (2)
		Grade 80		40,000 (2)	80,000 (2)

( ) Refers to note numbers.

Notes:

1. Materials specified in J-2590.
2. Properties from appropriate ASTM specification.
3. Properties obtained as minimum produced value from Northwestern Steel and Wire Company.
4. Properties obtained as routine periodic testing for quality control from Inland Steel Company.
5. Material has a chemical composition that is similar to ASTM A575, Grade 1008.
6. Material not chemically controlled, data estimated by Inland Steel Company.
7. Material has a chemical composition that is similar to ASTM 527.

Attachment 2

MATERIAL SPECIFICATION AND MECHANICAL PROPERTIES FOR FASTENERS USED IN HVAC SYSTEMS

FASTENER MATERIAL	MATERIAL SPECIFICATION	SPECIFICATION TITLE	MINIMUM TENSILE STRENGTH, PSI	COMMENTS
Bolts:	ASTM A307 (1)	Standard Specification for Carbon Steel Externally Threaded Standard Fasteners	60,000 (2)	
	ASTM A325	Standard Specification for High-Strength Bolts for Structural Steel Joints	120,000 (2)	
	ASTM A354	Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners	125,000 (2)	
	ASTM A449	Standard Specification for Quenched and Tempered Steel Bolts and Studs	120,000 (2)	
	ASTM A490	Standard Specification for Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints	150,000 (2)	
	ANSI B18.2.1	American National Standard Square and Hex Bolts and Screws Inch Series	60,000 (3)	Refers to ASTM A307
Nuts:	ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts	~~52~~ 68,000 (2)	Proof Stress, PSI
	ASTM A194	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service	120,000 (2)	Proof Stress, PSI
	ANSI B18.2.2	American National Standard Square and Hex Nuts	52,000 (3)	Refers to ASTM A563
Rivets:	ASTM A152 (1)	Standard Specification for Wrought-Iron Rivets and Rivet Rounds		Discontinued
	MIL-R-24243	Military Specification, General Specification for Rivets, Blind, Non-Structural Retained Mandrel	Minimum Tensile Load-475 lbs (2)	3/16" diameter rivets
Screws:	ASTM A548 (1)	Standard Specification for Steel Wire, Carbon, Cold-Heading Quality, for Tabbing or Sheetmetal Screws		
Washers:	ASTM F436	Standard Specification for Hardened Steel Washers	38-45 HRC (2)	(HRC) Hardness Rockwell C
	ANSI B27.1 (ANSI B18.21.1)	American National Standard Lock Washers	45-51 HRC (2)	Redesignated as ANSI B18.21.1 1972
	ANSI B27.2 (ANSI B18.22.1)	American Standard Plain Washer	23-35 HRC (3)	Redesignated as ANSI B18.22.1 1965 (R1975) Refer to ASTM A325
Studs:	ASTM A193	Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service	75,000 (2) 110,000 (2)	Class 1 Class 2
	ASTM A354	Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners.	125,000 (2)	
	ASTM A441	Standard Specification for High-Strength Low Alloy Structural Manganese Vanadium Steel	70,000 (2)	3/4" diameter and under

Notes:

1. Materials specified in J-2590.
2. Properties from subject material specification.
3. Properties from referenced ASTM specification.

HVAC MATERIALS AND EQUIPMENT FURNISHED

BY THE ZACK COMPANY FOR THE

LASALLE COUNTY NUCLEAR GENERATING STATION

Material/Equipment Categories

- Fasteners
- Miscellaneous Steel Products
- Sealants and Gaskets
- Ductwork, Stiffeners, Hangers
- Weld Rod Filler Material
- Ductwork Accessories
- Coatings/Paints
- Refrigeration Equipment
- Purchased Equipment
- General Notes

HVAC MATERIALS AND EQUIPMENT FURNISHED
BY THE ZACK COMPANY FOR THE
LASALLE COUNTY NUCLEAR GENERATING STATION

Material/ Equipment Designation	Specified Materials/ Equipment	Furnished Materials/ Equipment	Safety-Related (SR) or Non-Safety-Related (NSR) (See Note 1)	Quality Commercial (C) Or Special (S)	Documents Available (Objective Evidence)
FASTENERS					
• Bolts	ASTM A307	ASTM A307 ANSI B18.2.1	SR	C	Field Test Data
• Nuts	None specified ASTM A307 references ASTM A563	ASTM A194, A563 ANSI B18.2.2	SR	C	Field Test Data
• Huck Fasteners	None specified	MIL-P-24369B	SR	C	Reliable Supplier
• Rivets	ASTM A152	IFI-110, 114 MIL-R-24243	SR	C	See Note 7
• Screws	ASTM A548	ANSI B16.6.4 IFI-113	SR	C	See Note 8
• Plain Washers	None specified	ASTM F436 ANSI B27.2	SR	C	See Note 9
• Concrete Expansion Anchors	Phillips "Red Head" et al.	Phillips "Red Head", HILTI	SR	C	Reliable Supplier
• Structural Bolts	ASTM A325	ASTM A325, A354, A449, A490	SR	S	Visual Inspection

Attachment 2

HVAC MATERIALS AND EQUIPMENT FURNISHED
BY THE ZACK COMPANY FOR THE
LASALLE COUNTY NUCLEAR GENERATING STATION

Material/ Equipment Designation	Specified Materials/ Equipment	Furnished Materials/ Equipment	Safety-Related (SR) or Non-Safety-Related (NSR) (See Note 1)	Quality Commercial (C) Or Special (S)	Documents Available (Objective Evidence)
• Captive Screw Assemblies	None specified	ASTM A307	NSR	C	Not applicable
• Lock Washers	None specified	ANSI B27.1	SR	C	See Note 9
• Beveled Washers	None specified	ANSI B27.4	SR	C	See Note 9
• Lock Nuts	None specified	IFI-100, 101, 107	SR	C	See Note 10
• Studs	None specified	ASTM A193, A354 A449	SR	C	Visual Inspection
• Drive Nails	None specified	GSA FF-S-325 #3.2.5.2	NSR	C	Not Applicable

Attachment 2

HVAC MATERIALS AND EQUIPMENT FURNISHED

BY THE ZACK COMPANY FOR THE

LASALLE COUNTY NUCLEAR GENERATING STATION

Material/ Equipment Designation	Specified Materials/ Equipment	Furnished Materials/ Equipment	Safety-Related (SR) or Non-Safety-Related (NSR) (See Note 1)	Quality Commercial (C) Or Special (S)	Documents Available (Objective Evidence)
MISCELLANEOUS STEEL PRODUCTS					
• Tie Rods	1/2"Ø Galvanized Tubing	Republic Elecreunite E.M.T. WW-C-563-A	SR	C	Reliable Supplier
• Band Steel	None specified	ASTM A36	SR	C	Field Test Data
• Bar Stock	None specified	ASTM A36	SR	C	Field Test Data
• Shims	ASTM A36	ASTM A36	SR	C	Reliable Supplier
• Gusset Plates	ASTM A36	ASTM A36	SR	C	Field Test Data
• Expansion Anchor Plates	ASTM A36	ASTM A36	SR	C	Field Test Data
• Hanger Clip Strips	ASTM A526	ASTM A526	SR	C	Reliable Supplier
• Threaded Rod	None specified	ASTM A307, A193	NSR	C	Not Applicable
• Wire Cloth	None specified	RRW-360A	NSR	C	Not Applicable
• Channel	None specified	ASTM A36	SR	C	Field Test Data
• Tube Steel	None specified	ASTM A500, A501	SR	C	Field Test Data

HVAC MATERIALS AND EQUIPMENT FURNISHED
BY THE ZACK COMPANY FOR THE
LASALLE COUNTY NUCLEAR GENERATING STATION

Material/ Equipment Designation	Specified Materials/ Equipment	Furnished Materials/ Equipment	Safety-Related (SR) or Non-Safety-Related (NSR) (See Note 1)	Quality Commercial (C) Or Special (S)	Documents Available (Objective Evidence)
• Structural Beams Used as Auxiliary Steel	ASTM A-36	ASTM A36	SR	C	Field Test Data

Attachment 2

HVAC MATERIALS AND EQUIPMENT FURNISHED

BY THE ZACK COMPANY FOR THE

LASALLE COUNTY NUCLEAR GENERATING STATION

Material/ Equipment Designation	Specified Materials/ Equipment	Furnished Materials/ Equipment	Safety-Related (SR) or Non-Safety-Related (NSR) (See Note 1)	Quality Commercial (C) Or Special (S)	Documents Available (Objective Evidence)
SEALANTS AND GASKETS					
• Duct Sealant	GE SCS #1200 DOW #732 RTV et al.	GE SCS #1200 DOW #732-BL11 JM "DUXSEAL"	SR	C	Reliable Supplier
• External Sealant	None specified	Hardcast FT-20 Standard Tape (DT)	SR	C	Reliable Supplier
• Gaskets	Weatherban #1202	Weatherban #1202T	SR	C	Reliable Supplier

HVAC MATERIALS AND EQUIPMENT FURNISHED
BY THE ZACK COMPANY FOR THE
LASALLE COUNTY NUCLEAR GENERATING STATION

Material/ Equipment Designation	Specified Materials/ Equipment	Furnished Materials/ Equipment	Safety-Related (SR) or Non-Safety-Related (NSR) (See Note 1)	Quality Commercial (C) Or Special (S)	Documents Available (Objective Evidence)
DUCTWORK STIFFENERS HANGERS					
• Galvanized Ductwork	ASTM A526, A527	ASTM A526, A527	SR	C	Field Test Data
• Stainless Steel Ductwork	Type 316	Type 316	NSR	C	Not Applicable
• Stiffeners	ASTM A575 Grade M1020	ASTM A36 ASTM A575 Grade 1020 Grade 1015 Grade 1010	SR	C	Field Test Data
• Hangers	ASTM A36	ASTM A36	SR	C	Field Test Data

Attachment 2

HVAC MATERIALS AND EQUIPMENT FURNISHED

BY THE ZACK COMPANY FOR THE

LASALLE COUNTY NUCLEAR GENERATING STATION

Material/ Equipment Designation	Specified Materials/ Equipment	Furnished Materials/ Equipment	Safety-Related (SR) or Non-Safety-Related (NSR) (See Note 1)	Quality Commercial (C) Or Special (S)	Documents Available (Objective Evidence)
WELD ROD FILLER MATERIAL					
• Welding Ductwork, Stiffeners, Supports	Per Welding Procedures	AWS E60-11 AWS E70-18 AWS E70S	SR	S	Field Test Data See Note 11
• Ductwork Brazing	Per Welding Procedures	RCU-SiA	SR	S	Field Test Data See Note 11
• Copper Pipe and Fittings	AWS 5.8 BAg-1	AWS 5.8 BAg-1	SR	S	Reliable Supplier

HVAC MATERIALS AND EQUIPMENT FURNISHED

BY THE ZACK COMPANY FOR THE

LASALLE COUNTY NUCLEAR GENERATING STATION

Material/ Equipment Designation	Specified Materials/ Equipment	Furnished Materials/ Equipment	Safety-Related (SR) or Non-Safety-Related (NSR) (See Note 1)	Quality Commercial (C) Or Special (S)	Documents Available (Objective Evidence)
DUCTWORK ACCESSORIES					
• Vanes	ASTM A526, A527	ASTM A526, A527	SR	C	Reliable Supplier
• Flexible Connection (<50 HP, 2500 FPM)	Ventglas, et al.	Ventglas	SR	C	Reliable Supplier
• Flexible Connection (>50 HP, 2500 FPM)	Goodyear E-59241-0348	Goodyear E-59241-0348	SR	C	Reliable Supplier
• Factory Insulated Ducts	Wiremold 57K, et al.	Porter	NSR	C	Not Applicable
• Flexible Metal Ducts	Flexaust Co. Bendway, et al.	Flexaust Co. Bendway	NSR	C	Not Applicable
• Access Doors	Air Balance et al.	Air Balance, Zack	SR	C	See Note 12
• Insulation	Certain-Teed Read	Certain-Teed Read	NSR	C	Not Applicable

HVAC MATERIALS AND EQUIPMENT FURNISHED

BY THE ZACK COMPANY FOR THE

LASALLE COUNTY NUCLEAR GENERATING STATION

Material/ Equipment Designation	Specified Materials/ Equipment	Furnished Materials/ Equipment	Safety-Related (SR) or Non-Safety-Related (NSR) (See Note 1)	Quality Commercial (C) Or Special (S)	Documents Available (Objective Evidence)
COATINGS/PAINTS					
• Galvanized Touch-up	Galvanox Type I by Subox	Galvanox, ZRC	NSR	C	Not Applicable

HVAC MATERIALS AND EQUIPMENT FURNISHED

BY THE ZACK COMPANY FOR THE

LASALLE COUNTY NUCLEAR GENERATING STATION

Material/ Equipment Designation	Specified Materials/ Equipment	Furnished Materials/ Equipment	Safety-Related (SR) or Non-Safety-Related (NSR) (See Note 1)	Quality Commercial (C) Or Special (S)	Documents Available (Objective Evidence)
REFRIGERATION EQUIPMENT					
• Piping	ASTM B88 Type K Hard	ASTM B88 Type K Hard	SR	C	See Note 13
• Specialties	Henry, Superior, et al.	Henry, Superior	SR	C	Reliable Supplier
• Fittings	ANSI B16.22		SR	C	See Note 13
• Expansion Valves	ALCO, Sporlan	Sporlan	SR	C	Reliable Supplier
• Liquid Solenoids	ALCO, Sporlan	Sporlan	SR	C	Reliable Supplier
• Hot Gas Bypass Valves	ALCO	Flo-Con	SR	C	Reliable Supplier
• Insulation	Armstrong, et al.	Armstrong	NSR	C	Not Applicable
• Refrigerant	R22	R22	SR	C	See Note 14

Attachment 2

HVAC MATERIALS AND EQUIPMENT FURNISHED

BY THE ZACK COMPANY FOR THE

LASALLE COUNTY NUCLEAR GENERATING STATION

Material/ Equipment Designation	Specified Materials/ Equipment	Furnished Materials/ Equipment	Safety-Related (SR) or Non-Safety-Related (NSR) (See Note 1)	Quality Commercial (C) Or Special (S)	Documents Available (Objective Evidence)
PURCHASED EQUIPMENT					
• Fire Dampers	Advanced Air, et al.	Advanced Air, Ruskin	154 SR 207 NSR	C	Reliable Supplier
• Gravity Shutters	Performance Specification	American Warming	23 SR 138 NSR	C	Reliable Supplier
• Balancing Dampers	Performance Specification	American Warming	53 SR 347 NSR	C	Reliable Supplier
• Grilles, Registers, Diffusers	Titus, et al.	Titus	252 SR 1347 NSR	C	Reliable Supplier
• Airflow Measuring Stations	Air Monitor, et al.	Air Monitor	50 SR 168 NSR	C	Reliable Supplier
• Silencers	IAC, et al.	IAC	23 SR 52 NSR	C	Reliable Supplier
• Terminal Control Units	Titus, et al.	Titus	70 NSR	C	Not Applicable
• Dust Collector	AAF	AAF	1 NSR	C	Not Applicable
• Filters	Farr, et al.	Farr	11 SR 28 NSR	C	Reliable Supplier

Attachment 2

HVAC MATERIALS AND EQUIPMENT FURNISHED

BY THE ZACK COMPANY FOR THE

LASALLE COUNTY NUCLEAR GENERATING STATION

Material/ Equipment Designation	Specified Materials/ Equipment	Furnished Materials/ Equipment	Safety-Related (SR) or Non-Safety-Related (NSR) (See Note 1)	Quality Commercial (C) Or Special (S)	Documents Available (Objective Evidence)
• Humidification Steam Generator	Armstrong	Armstrong	1 NSR	C	Not Applicable
• Humidifiers	Armstrong	Armstrong	20 NSR	C	Not Applicable
• Miscellaneous Fans	Greenheck, et al.	Greenheck, et al.	43 NSR	C	Not Applicable
• Electric Heating Coils	Bransh	Bransh	2 NSR	C	Not Applicable
• Packaged Air Conditioning Units	Trane, et al.	Trane	6 NSR	C	Not Applicable
• Air Handling Unit	Carrier	Carrier	1 NSR	C	Not Applicable
• Condensing Unit	Carrier	Carrier	3 NSR	C	Not Applicable
• Water-Cooled Condensing Units	Carrier	Carrier	1 NSR	C	Not Applicable
• D-X Cooling Coils	Carrier	Carrier	2 NSR	C	Not Applicable

Attachment 2

HVAC MATERIALS AND EQUIPMENT FURNISHED

BY THE ZACK COMPANY FOR THE

LASALLE COUNTY NUCLEAR GENERATING STATION

General Notes

1. Under safety classification, listing of an item as SR or NSR represents use in safety-related or non-safety-related HVAC systems. For purchased equipment, numerical representations are quantities of equipment in their respective safety category.

2. Where materials were provided by Zack, even though they were not specified, they represent normal commercial practice of providing all necessary hardware required for successful execution of the project. For those miscellaneous materials, not covered in the specification, Zack Company did submit correspondence covering these materials for review.

3. Reliable Supplier - Manufacturer has been producing this standard item for many years. Operational history of this standard item indicates that its significant characteristics perform satisfactorily.

4. Field Test Data - Actual physical data has been verified by in situ material testing.

5. Visual Inspection - Materials can be readily identified by visual observation of a known physical characteristic.

6. Not Applicable - Items were used in non-safety-related HVAC systems and therefore objective evidence is not required.

7. Rivets in safety-related systems were used in the attachment of the hanger support clips. The use of rivets for the application was bared on test results utilizing commercially available rivets ("Pop Rivets"). The strength of the rivet is a function of the rivet diameter. Therefore, it is sufficient to perform a visual inspection to determine rivet diameter.

8. Screws in safety-related systems were used in the attachment of grilles, registers and diffuers (GRD) to the HVAC ductwork system. These GRD's are the end points of the HVAC system and are provided to introduce air into a space to obtain a desired indoor environment. The individual spaces are provided with a number of GRD's. The screws that were used are commercial grade sheet metal screws. No further objective evidence is warranted.

HVAC MATERIALS AND EQUIPMENT FURNISHED

BY THE ZACK COMPANY FOR THE

LASALLE COUNTY NUCLEAR GENERATING STATION

General Notes

9. Washers used in safety-related HVAC systems can be categorized as plain, bevel and lock type. Plain washers are used primarily to minimize embedding and to aid in torquing the nut/bolt assembly. Bevel washers are normally provided with concrete expansion anchors and are used to aid in torquing the expansion anchor assembly. Lock washers are used to provide greater bolt tension per unit of applied torque or to provide protection against looseness resulting from vibration. The washers that were used are commercial grade devices with no special requirements dictated by their application. No further objective evidence is warranted.

10. Lock nuts in safety-related systems were used in lieu of a bolt and lock washer connection. These lock nuts are commercial grade devices with no special requirements dictated by their application. No further objective evidence is warranted.

11. Welding rods are used in the attachment of stiffener angles to the ductwork, the assembly of the supporting system or the longitudinal welding of 16 gauge and heavier ductwork. They were controlled by a weld rod quality control procedure. The welding applications were controlled by specific welding quality control procedures. Assurance has been maintained that the proper welding rod was used for the appropriate fabrication assembly. No further objective evidence is warranted.

12. Access doors have been provided in safety-related ductwork to aid in maintenance and inspection of duct mounted accessories such as dampers and airflow measuring stations. These devices are mounted in the ductwork system and are provided with latching mechanisms to maintain closure. These devices have been procured from reliable suppliers or have been fabricated by Zack. They are constructed of the same materials as the ductwork for which they were installed. The use of these doors poses no safety concern. No further objective evidence is warranted.

13. Refrigerant piping and fittings have been subject to pressure tests in excess of system design pressures during construction testing of system. No further objective evidence is warranted.

14. Refrigerant used within the safety-related air conditioning systems was confirmed by resulting temperature conditions identified during pre-operational testing of the respective system. The use of other refrigerants would have resulted in temperature extremes outside of the actual tested values. No further objective evidence is warranted.

The 10CRF50.55e submitted by The Zack Company (Zack) was dispositioned as follows:

1) Those Zack NCR's which appeared to be albe to be resolved by Zack were returned to Zack for further review.

2) Those which Zack could not resolve were included in Commonwealth Edison Company (CECo) NCR's 556, 557, 558, 566 and 594 and were submitted to CECo Engineering and subsequently to our consulting engineer (S&L) for their recommended corrective action. The Zack NCR's can be categorized as follows:

   - Material specifications for angles, shapes, plates and fasteners are different than those identified in the project specification.
   - Documentation provided for angles, shapes, sheets, coils and welding rod filter material is incomplete.
   - Materials provided were used in non-safety related applications.
   - Miscellaneous discrepancies.

In the course of reviewing these NCR's the following was considered prior to final disposition:

- Material specifications that differed from those identified in the project specification were reviewed to establish the chemical and/or mechanical property variances.
- Documentation that was deemed incomplete was reviewed to determine if sufficient information was provided

to establish the material specification. This was done by reviewing other evidence, such as purchase orders and documentation, provided by Zack.

- Materials were reviewed to determine their applicability to safety-related systems by identifing material unique to non-safety-related systems, Zack provided documentation and discussions with construction engineers.

Once all technical information relating to the NCR has been reviewed, the resolved NCR is dispositioned in accordance with established procedures.

C F BRAUN & CO Engineering and Construction Subsidiary of Santa Fe International Corporation

August 25, 1982

B R Shelton, Project Engineering Manager
Commonwealth Edison Company
Station Nuclear Engineering Dept
35 FNW
P O Box 767
Chicago, Illinois 60690

Dear Mr Shelton

TECHNICAL PROPOSAL - REVISION 1
INDEPENDENT HVAC REVIEW
LA SALLE COUNTY PROJECT
ADVANCE PURCHASE ORDER 805023
BRAUN PROJECT 6356-N

C F Braun & Co is pleased to submit this revised technical proposal for the HVAC independent review as discussed with Commonwealth Edison personnel and during the NRC public hearing. This proposal supersedes our August 20 submittal.

The scope of work, in general, is to verify that the HVAC installation by Zack & Co is in accordance with the Sargent & Lundy design documents.

This technical proposal includes the scope of work, a work plan to accomplish independent review, an organization chart and resumes of personnel assigned to the project.

The commercial aspects of this proposal were in a separate mailing to Mr R E Van Derway, dated August 20.

We are pleased to have the opportunity to provide our services on this interesting project. If you have any questions, give me a call.

Sincerely yours

George R Boddeker
Power Project Management

GRB BG

COMMONWEALTH EDISON COMPANY

LASALLE COUNTY STATION

CHICAGO, ILLINOIS

TECHNICAL PROPOSAL

PROJECT 6356-N

C F BRAUN & CO

ALHAMBRA, CALIFORNIA

AUGUST 25, 1982

CONTENTS

Attachment 3

SCOPE OF WORK

The scope of work for this project is to perform an independent review of the safety-related, and seismic supported non-safety related HVAC systems at the Commonwealth Edison Company (CECO) LaSalle Nuclear Plant.

The review will include all seven LaSalle unit one safety-related HVAC systems listed below.

- Control Room HVAC System (System Identification Code VC)
- Auxiliary Electric Equipment Room HVAC System (VE)
- Diesel-Generator Room Ventilation System (VD)
- CSCS Equipment Area Cooling System (VY)
- Switch Gear Rooms Ventilation Systems (VX), except for the recirculation duct in the Auxiliary Building HVAC Equipment Room.
- Portions of the Reactor Building Ventilation System (VR) - The following parts of the reactor building ventilation system are safety-related.
  - Supply air duct between and including the secondary containment isolation dampers and the duct penetration of the secondary containment boundary.
  - Exhuast air duct between and including secondary containment isolation dampers, and the duct penetration of the secondary containment boundary.
  - Exhaust air duct between and including secondary containment isolation dampers, and the duct penetration of the secondary containment boundary.
- Those portions of the Standby Gas Treatment System SGTS (VG) installed by the Zack Co.

The review will also include the supports for all three non-safety related but seismically supported systems listed below:

- Primary Containment Ventilation System (VP)
- Primary Containment Purge System (VQ)
- Reactor Building Ventilating System (VR)

Attachment 3

SCOPE OF WORK Continued

The primary objective of this independent review is to provide verification that the HVAC installation by the Zack Co is in accordance with the Sargent and Lundy design. The scope of work will include, but not be limited to, a review of -

Material installed

Field and shop welding on supports and ductwork

Operability of associated mechanical equipment

Significant design changes

Field testing by Zack Co up to, and including, any construction testing performed by Zack Co or their subcontractors.

During this review Braun will be responsible for identifying any additional testing or changes necessary to assure that the HVAC systems fulfill their safety function. Braun will also review the adequacy and results of additional tests as performed by others.

All observations made during the review shall be documented and submitted to a Braun site review team composed of senior technical personnel with broad experience in technical management. This review team will determine if the observation is accurate and has the potential for a safety concern. If the team determines that the observation is accurate, but is not a safety concern, it shall be submitted to CECO for disposition.

If the observation is considered a potential safety concern, it shall be submitted to a second level internal review committee. The internal review committee, located in the home office, will review the finding expeditiously and if the finding is not a safety concern, they shall indicate in writing why not and return the finding for appropriate disposition. If it is determined to be a safety concern, they shall indicate in writing why and return the finding to the Braun project manager. He will notify CECO of this safety related finding.

A final report documenting this review shall be sent to CECO which will, in turn, concurrently distribute the reports, unedited, to the NRC staff, S&L, and internally within CECO. Prior review or editorial control of the written report by any of these parties will not be made.

SCOPE OF WORK Continued

All inspection, review activities, quality assurance, project procedures, to be performed by C F Braun & Co during this independent review of the HVAC systems will be conducted in accordance with written, approved procedures. These procedures will contain all the necessary forms to document the Braun activities with regard to this review. Those procedures will include but not necessarily be limited to the following Braun activities:

a) Document Control

b) Quality Control Inspection

c) Interface between the Braun Site and the Braun Office Internal Review Committee

d) Quality Control Inspection

e) Training and Qualification of Inspectors to the Requirements of ANSI-N 45.2.6 - 1978 (Regulatory Guide 1.58)

f) Quality Assurance Audits

g) Qualification of Quality Assurance Program Audit Personnel to the Requirements of ANSI-N 45.2.23 - 1978

h) Processing of Observations/Findings Report

During the review it is understood that CECO will make available all documents requested by Braun that are needed to perform this review.

As part of this work Braun will provide for CECO approval the Braun Quality Assurance Manual and QA Topical Report, and Braun's Security Screening Procedure. We will also have all personnel involved in this review execute the required CECO forms that show freedom of substantial interest in CECO or Zack Co.

It is our intent to provide adequate support of this review effort so that the report of our findings will be submitted by Braun to CECO and the NRC simultaneously. The target date for this submittal is September 15, 1982 or subsequent date as directed by CECO.

Attachment 3

WORK PLAN

This section of the proposal describes the work plan for Braun's independent review of the HVAC installation of the Zack Co at CECO LaSalle Nuclear plant. Braun sent a team of knowledgeable individuals (Vice President of Power, Manager of Nuclear Projects, and Review Team Project Manager) to Chicago in order to describe the Braun organization, present their experience and qualifications and highlight their availability. This was accomplished for the benefit of CECO and S&L as well as in a separate meeting with the NRC Region III office.

In order to accomplish the review task, Braun will form a project team at the LaSalle site consisting of project manager, HVAC technical advisor, QA engineer, welding/material engineer, QC supervisor, and other personnel to work under the supervision of these individuals. Certain key people will be sent to LaSalle in order to develop QA instructions, detail work procedures and other activities which are required prior to commencement of productive work.

The HVAC technical advisor will compare the S&L design documents to the Zack Co shop drawings to verify that Zack has correctly interpreted the design documents. Zack's procedures for procurement and processing of HVAC material will be reviewed by the QA and welding/material engineers to evaluate their conformance to appropriate S&L design documents and ANSI standards.

The welding/material engineer will also review the weld procedure qualifications and welder qualifications associated with the ductwork fabrication practices. Any information or testing generated by CECO or Conam will be used to assist in this evaluation. Zack's fabrication procedures will be compared to SMACNA standards and ANSI 509 requirements, as appropriate, in addition to that required by the design documents.

The HVAC technical advisor will survey all of the installed duct systems as defined on page 1-1 of the SCOPE OF WORK. Based on this survey he will select portions of the system whose failure may jeopardize the operation of safety-related equipment for detailed inspection. The portions selected will include concealed and insulated ductwork. If discrepancies are found in the selected portions, then additional portions of ductwork will be selected for further inspection. Braun is prepared to inspect 100 percent of the system if deemed necessary.

The leak rate and balancing test for the Control Room HVAC System (VC), CSCS Equipment Area Cooling System (VY) and portions of the Reactor Building Ventilation System (VR) will be reviewed in detail to verify system conformance to the design documents. Spot checks will be made of the Auxiliary Electric Equipment Room HVAC System (VE), Diesel Generator Room Ventilation System (VD) and Switch Gear Rooms Ventilation Systems (VX) to ascertain that they have been tested to the same quality as that of the systems reviewed in detail. In addition, the HVAC technical advisor will survey the system operating tests performed by CECO to verify that the results confirm the adequacy of the balancing/leak rate tests.

WORK PLAN Continued

A review of the HVAC refrigerant system, subcontracted by Zack, will also be accomplished. Preliminary information indicates that there have been no nonconformances generated against these systems.

In addition to this step-by-step review of the Zack installation, Braun will review all CECO and Zack NCRs and FCRs generated against the installed system. Each document will be categorized by type for example, weld problem; material certification lacking; location/ dimensional/interference discrepancy; fabrication problem; etc. The frequency of occurrence and importance of each category will be assessed. Twenty percent of those types determined to be critical to safety will be inspected in detail to verify that the specified disposition has been correctly implemented. If discrepancies are found, then the remaining NCRs of this type will be reviewed.

The HVAC technical advisor will randomly select other parts of the system to be inspected for similar types of nonconformances. The inspections will result in a determination of whether or not similar types of nonconformances may have existed on these random sections but were not reported.

Project instructions and quality assurance procedures will be written to provide direction and guidance in accomplishing the work plan. Appropriate forms will be provided to document the observations and findings made during the course of the work.

All available inspection reports will be reviewed to determine if the inspector's observations may lead to a potential finding. Such reports will be evaluated by a site review committee consisting of project manager, QA engineer, and HVAC technical advisor or material/ welding engineer, depending on the expertise required. The site review committee will determine if the observation is accurate and has the potential for a safety concern.

If the site review determines that the observation is accurate, but is not a safety concern, it will be properly documented and submitted to CECO for appropriate disposition. Dispositioning may involve field correction, additional analysis, or both.

If the finding is considered a potential safety concern, it will be forwarded to an internal review committee within Braun for their concurrence. This committee will be chaired by Braun's chief nuclear engineer and will include senior technical personnel in the appropriate field of expertise for the finding being evaluated. If this committee determines that the finding is a safety concern, the project manager will immediately notify CECO. CECO will properly document and disposition such finding (including taking proper action in accordance with the technical specifications), and notify the NRC.

Attachment 3

PROJECT ORGANIZATION

This section of the proposal describes the organization and people Braun will use for this project. First, we describe our Project Organization, including an organization chart. Then, we enclose resumes for the candidates for all positions on the chart.

We plan to use a task force approach, with home office personnel being assigned to the project and located at the LaSalle County Station. The internal review committee will be located in Alhambra. Other specialists may be added to the task force as required.

An organization chart for the project follows. Responsibilities for the positions shown on the chart are defined below.

PROJECT MANAGER The Project Manager has the prime responsibility for execution of the project. He is responsible to CECO and to Braun management for the overall success of the project. His principal areas of concern are the planning, scheduling, and performance of the work. He issues the project instructions, procedures and schedules for the execution of the work, and keeps them current. He is your principal contact on these matters, and reports on all elements of progress to you. The project manager has the organizational freedom to call on all resources of the company to support the project in areas required. He reports to the Manager of Nuclear Projects of the Power Division.

QUALITY ASSURANCE ENGINEER The Project Quality Assurance Engineer is responsible for all project QA activities. Those activities include the writing of all quality assurance procedures necessary to perform an independent review of the ten designated HVAC systems at CECO's LaSalle Nuclear Station. The PQAE will obtain the necessary approvals for these procedures. He will establish a document control system and provide for the collection, maintenance and storage of all QA records generated during this Independent Review, in accordance with the Requirements of ANSI-N 45.2.9. The PQAE will review and sign-off on all observation/finding reports prior to their being sent to the Management Review Committee in Alhambra. He will assure himself that all personnel participating in this review are qualified to perform the task to which they have been assigned. He will assure that these qualifications are properly documented in accordance with ANSI-N 45.2.6 and ANSI-N 45.2.23. The PQAE will then provide for the monitoring, surveillance and auditing of all activities, both Project and Inspection. All audits will be performed to pre-planned check list and will be distributed to both Braun's Management and Commonwealth Edison Management simultaneously. All audits will be performed in accordance with the C F Braun & Co's Nuclear Quality Assurance Manual and will be documented on the forms contained therein.

PROJECT ORGANIZATION Continued

QUALITY CONTROL SUPERVISOR The Quality Control Supervisor will interface with the HVAC Engineer on matters relating to the inspection of the HVAC hangers and ducting.

All requests for duct and hanger inspection made by the HVAC Engineer will be presented to the QC Supervisor who will assign the work to an inspector. The QC Supervisor will make contact with site construction personnel making arrangements for scaffolding around the work area, removal of paint, insulation or other materials that may interfere with the inspection. Additional items such as drawings, FCRs, NCRs, or surface inspection materials will also be supplied by the QC Supervisor when required to assist in the inspection.

The inspection reports will be returned to the QC Supervisor for his review. He will complete additional forms if reportable findings are determined during inspection and distribute these forms to the HVAC Engineer and Project Manager for review.

The QC Supervisor will assist in duct and hanger inspection when required and work with the Braun Material/Welding Engineer to resolve questions regarding weld quality and material identification.

HVAC TECHNICAL ADVISOR The HVAC Technical Advisor will determine which HVAC system or part of an HVAC system will be inspected. He will work with the QC Supervisor to assign the Quality Control inspection assignments for the HVAC ductwork and ductwork supports.

The NCR and FCR will be reviewed to determine if the ductwork, as called out in the NCR or FCR should be inspected.

The HVAC Technical Advisor is responsible for verifying that the HVAC systems have been installed in accordance with the design drawings and that the systems fulfill their safety functions. He provides guidance to the QC Supervisor and materials/welding advisor as to the extent and nature of their reviews. The advisor will survey the installed HVAC systems and select those portions requiring detail inspections.

He is also responsible for reviewing the applicable tests performed by the HVAC contractor plus a survey of the associated HVAC preoperational tests performed by CECO. Another area of his review will be the installation of the refrigerant system. He will also assist in a review of any applicable nonconformances and field change requests as well as participating in the site review committee in his area of expertise.

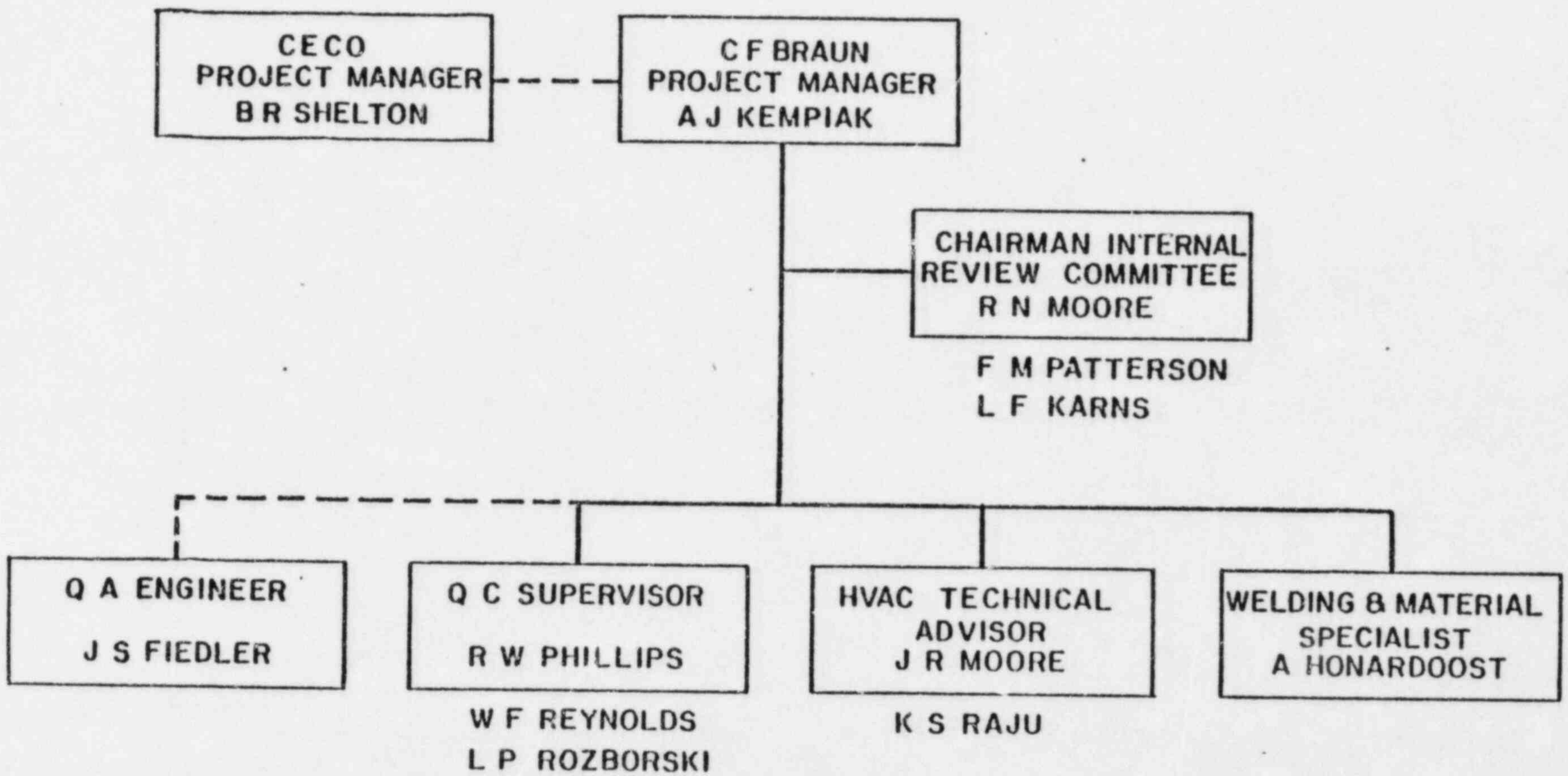
PROJECT ORGANIZATION Continued Attachment 3

WELDING AND MATERIAL SPECIALIST The Welding and Material Specialist is responsible for the review of all welding procedures which were used by the contractor. He will review all welder qualifications of the contractors' personnel who performed that welding. He will assist in the evaluation and determination of the integrity of the welding which has been completed by the contractor. Should any material sampling (chemicals) or weld tensiles be required he would assist in the sampling and test evaluations as necessary.

This Welding and Material Specialist will be utilized extensively as a consultant whenever any problem involving Metallurgy arises. Additionally, he will be utilized in the review of nonconformances and field change requests involving welding of duct hanger support and duct joints.

Attachment 3

PROJECT ORGANIZATION



COMMONWEALTH EDISON COMPANY,
PROJECT 6356-N, AUGUST 25, 1982

RESUMES Attachment 3

KEY PERSONNEL

The following are the key personnel we propose for this project. Their resumes are included on succeeding pages.

PROJECT ENGINEER

A J KEMPIAK Andy Kempiak has over 17 years experience in power and related fields, including the past 15 with Braun. His primary areas of expertise include mechanical systems and HVAC engineering.

His current assignment is as Engineering Manager for the 1220 MWe TVA power plant project. Here he directs four project engineers responsible for building design coordination, customer interface, supplier review, and coordination with field forces. Prior to this, he served as Project Engineer for field coordination activities, involving monthly meetings with owner and field engineering staff.

Andy was leader of a group of up to 15 engineers and designers responsible for mechanical system and the HVAC design and layout activities on the TVA project. Systems designed included waste processing, service, cooling, and heated water, and chilled water systems. He was responsible for the design of all chilled water systems on the TVA project, and wrote procurement specifications for major chiller packages. Other systems he designed and specified equipment for include gas filtration and fire protection.

Within Braun's building mechanical group, he was responsible for various types of HVAC and utilities systems. As group leader on the Lawrence Livermore project, he prepared P&I flow diagrams, design and procurement specifications, HVAC and piping drawings, and preoperational test specifications for all utility systems. He was also responsible for HVAC system design and checkout on several Rocky Flats Weapons Facility projects. He designed complex ductwork systems, sized fans and other equipment, and worked as a field engineer on a plant expansion program.

On the USAF Satellite Test Center and Power Plant project, he was responsible for all HVAC design. This included the design of supply and exhaust air systems for gas turbine units and heat recovery boilers, and the design of the air-conditioning system for the plant, including chillers, HVAC units, and associated equipment.

Mr Kempiak has a BSME degree from the University of Illinois, and is a registered professional mechanical engineer in California.

Attachment 3

QUALITY ASSURANCE ENGINEER

J S FIEDLER Jim has over 30 years experience in nuclear engineering and construction, the past 12 years as the Project Quality Assurance Engineer on various nuclear power plants throughout the United States. They include the Duane Arnold facility at Palo, Iowa, a 550 MW BWR unit for Iowa Electric Light and Power Company, the Greenwood Energy Center consisting of one fossil plant (800 MW) and a four-unit nuclear plant, PWR units (1250 MW each) for the Detroit Edison Company, the St Lucie nuclear unit 1, an 800 MW PWR for Florida Power and Light, the Waterford III nuclear unit, a 900 MW PWR for Louisiana Power and Light.

Since joining Braun in 1977 he has been assigned as the Project Quality Assurance Engineer on the Baily nuclear project, a 600 MW BWR unit for Northern Indiana Public Service Company and is currently assigned as the Project Quality Assurance Engineer on the GE/TVA STRIDE projects.

Prior to specializing in quality assurance, Jim was a design and operations engineer at the University of California's Lawrence Radiation Laboratories at Berkeley, California and was the site representative for the Universities' Research Association during construction of the Fermi-National Accelerator Laboratory at Batavia, Illinois.

Before his university association he spent eight years as a design engineer with Westinghouse Electric Company, Bettis Facility in Pittsburgh, Pennsylvania, during the early development of the US Navy nuclear program.

Mr Fiedler has a BA from Waynesburg College, and a BSME from the University of West Virginia. He is a registered professional engineer in Pennsylvania.

QUALITY CONTROL SUPERVISOR

Attachment 3

R W PHILLIPS   Bob has 28 years experience in Source Quality Control, eight years with Braun. His latest assignments with Braun include Source Inspection Coordinator on four projects. He was in charge of implementing the Positive Material Identification Program, currently in use. This included the operation of the analysis equipment required in the PMI program.

Bob's other duties have involved conducting training and certification of personnel in liquid penetrant, magnetic particle, radiographic and ultrasonic examination as a certified NDE Level III Examiner. Also inspection of pressure vessels, heat exchangers, piping, furnace equipment, pumps, storage tanks and structurals.

Prior to working at Braun, while at Richardson X-Ray Company, Bob directed operation of a commercial nondestructive inspection laboratory. While at Boeing, Bob performed plant surveys and supplier audits in NDE and electrodeposited plating facilities. He conducted inspection on components for aerospace use. At Richardson X-Ray Company, he was the quality control manager for a nondestructive inspection facility. At Ferro-Spec Laboratories, he managed a commercial nondestructive inspection laboratory. And, at Aerojet General he also performed source inspection and wrote manufacturing procedures in quality engineering.

Mr Phillips attended Mt San Antonio College. He is a member of the American Society of Nondestructive Testing.

Attachment 3

MECHANICAL ENGINEER

J R MOORE Jack has 31 years experience in the mechanical engineering field, the past 14 at Braun. He is presently a principal engineer in the Mechanical Engineering Department. His primary areas of expertise are in HVAC, fire protection, and plumbing and piping systems.

He is presently the leader of the HVAC group on the TVA STRIDE project. In this role he is responsible for all group functions, including heating and cooling calculations, design and specification of equipment, ductwork arrangement and sizing, and determination of environmental conditions in normal operation and accident conditions.

His other nuclear projects include field and home office assignments on the Rocky Flats Part V Expansion and Plutonium Recovery projects. Here he designed sophisticated three-zone HVAC systems for use in areas where protection of operating personnel from very hazardous plutonium substances was vital. He also was active in the fire protection area on these projects. Finally, he prepared design criteria, specifications, and estimates for the General Electric LMFBR project.

Jack's other assignments at Braun have included US Air Force facilities, a tetraethyl lead plant, an x-ray telescope, and a foam latex plant.

Prior to joining Braun, he was with Ralph M Parsons, where he worked primarily on Minuteman missile projects in the environmental and HVAC areas. With J H Pomeroy and Co, he designed air conditioning systems, plumbing, process piping, and fire protection, for a Polaris missile manufacturing facility and Vandenburg AFB. His other experience includes industrial drying systems and liquid carbon dioxide fire protection systems.

Mr Moore holds a BSME degree from Chicago Technical College.

METALLURGICAL ENGINEER

A HONARDOOST Abbas Honardoost has over 15 years experience, primarily in the power field. He selects critical metallic and nonmetallic materials used for equipment in Braun-engineered process plants. Reviews job specifications for agreement of all materials selection and fabrication with Braun standards, customer standards, and the various applicable codes. Provides materials and welding consultation on various assigned projects. Provides technical assistance on metallurgical matters to Sales, Engineering, Power, Construction, and others. Performs complex metallurgical research assignments on projects relating to fabrication, mechanical properties, or corrosion of metals and alloys. He has been with Braun for one year.

Prior to joining Braun, Abbas served as a Senior Quality Engineer with Gilbert Commonwealth. Here his primary duties involved preparation of welding and non-destructive testing procedures for both in-house and subcontractor applications on a number of power projects. In this role he worked with various members of the project team on problem areas which arose in equipment fabrication shops, field construction, and during plant operation. Included in his assignments was an audit of welding procedures in the HVAC and piping systems in a nuclear power plant.

Abbas also worked with Burns & Roe as a Senior Metallurgical Engineer. Here he worked closely with subcontractors on welding and heat treatment procedures in compliance with ASME, ASTM, ANSI, AWS, and NRC requirements. He was a site engineer on the WPPSS No 2 project, resolving problems in corrosion, failure analysis, and welding of piping and HVAC systems. This assignment included review of field procedures and performand qualification of welders.

As a Corrosion Engineer at Ebasco Services, he was responsible for all phases of corrosion prevention on nuclear and fossil power plants, refineries, and chemical and petrochemical facilities. This work included the development of laboratory testing programs for protective coatings, and the design and supervision of cathodic protection systems.

Prior to joining Ebasco Services, Abbas was corrosion and inspection engineer with the National Iranian Oil Company and a materials engineer with W R Grace.

Mr Honardoost received his BSChE from the University of Delaware, and his MS in Metallurgy from the Stevens Institute of Technology. He has been accredited as a corrosion specialist by the NACE, and is an AWS Certified Welding Inspector.

Attachment 3

QA/QC COORDINATOR

W F REYNOLDS   Bill has over 30 years experience in management planning, estimating, design, procurement writing, procedure and specification, quality assurance, quality control field erection, and startup of new and expansion facilities embracing all fields of chemical plants, nuclear generating stations, conventional generating stations, and allied industrial complexes.

Quality Assurance Manager of a multi-billion dollar Saudi Arabian Project including development of the "Pioneer" Camp, establishing jobsite perimeters, initial development of a quality program for the management services contractor, and establishment of bid analysis procedures in accordance with acceptable Saudi Arabian government criteria.

Corporate Quality Assurance Audit Team Leader for various Middle East projects. Development of audit checklists, preparation/notification to all responsible parties of audit dates and subjects, pre and post audit conferences culminating with the issuance of formal audit reports.

Field Quality Control Supervisor for one of the largest management services contracts including interviewing, staffing and supervision of quality control (QC) engineers, laboratory technicians, Saudi national engineering students and QC inspectors. Published a Field Quality Control Manual for the industrial complex, assigned QC personnel to various phases of construction, testing, contracts, procurement, and implementation of all disciplines within the "Kingdom" of Saudi Arabia.

Instrumentation Superintendent during construction/start-up of a 1.7 MGPD diesel unit including field design of sensing and loading lines along with providing written and verbal instructions to international instrument crews. The jobsite was the Saudi Naval Base in Jeddah, Saudi Arabia, and the assignment included start-up of package boilers, checking out system controls by use of the logic diagrams, and actual pressure testing of the tubing/multitube "bundles".

Start-up Engineer for two 960 MW nuclear power plants (BWR Mark III), including development of safeguard systems, punchlists, and progress reports.

Mr Reynolds is 56 years old, and holds a PE degree from Marietta College. He is also certified to ANSI 45.2.6.

SOURCE QUALITY CONTROL INSPECTOR

L P ROZBORSKI Larry has 33 years engineering and shop experience, 7 years of source inspection with Braun. He has been assigned to inspection of compressors, turbines, pressure vessels, towers, heat exchangers, storage tanks, furnace equipment, and other petrochem process equipment.

Larry's other duties have involved design engineering, shop layout and supervision. He is certified as a Level 2, to SNT-TC-1A in radiography, magnetic particle liquid penetrant and ultrasonic examinations. He is familiar with API, ASME, and TEMA Codes. He is certified senior engineering technician by the Institute for the Certification of Engineering Technicians.

Prior to working at Braun, while at Bos-Hatten, Inc, Larry was responsible for all inspection procedures and QC for ASME shop certification. He wrote welding procedures and maintained qualifications of welders to ASME standards. He held positions of shop superintendent and manager of engineering.

Larry also worked for American Standard as metallurgical lab technician, senior draftsman where he was responsible for all radiography, nondestructive examinations and welder qualifications. And, for Worthington Corporation as a design draftsman.

Mr Rozborski attended Erie Community College, evening extension courses and various seminars conducted by technical societies. He is a registered Professional Engineer in Quality Engineering in California. He is a member of the American Society of Mechanical Engineers, the American Welding Society and the American Society for Nondestructive Testing.

Attachment 3

SENIOR MECHANICAL ENGINEER - HVAC

K S RAJU K S Raju has over 22 years experience in the power engineering field, both nuclear and fossil. His primary areas of interest have been in the design and specification of gas turbines, waste heat steam systems, and refrigeration systems. He has been with Braun since December 15, 1980, performing engineering design on various HVAC systems for TVA's Hartsville nuclear power station.

While at Burns and Roe, he was the lead mechanical engineer for a pair of gas turbine/waste heat boiler cogeneration units for the City of Santa Clara. The generators produce 8 MWe each, and the boilers each produce 40,000 pounds per hour of 150 psig steam. The combustors are natural gas-fired, with fuel oil as backup. He sized and wrote specifications for the gas turbines, steam generators, deaerators, feedwater treatment equipment, pumps, gas compressors, and instrumentation. He did piping flexibility analysis, and wrote preoperational and start-up procedures. He also engineered the entire steam and condensate distribution system between the city and steam customer, a paper products plant.

In another project, he was the lead mechanical engineer on five 330 MWe combined cycle power plants for Jersey Central Power and Light Company, the Gilbert Station Units 4 through 8. On this assignment, he was responsible for engineering the power cycle piping, cooling water systems, steam and compressed air system, water treatment systems, fire protection, and HVAC. He also wrote installation specifications, and provided engineering assitance during construction and start-up.

While with Ebasco Services Inc, as a senior mechanical engineer he performed a wide variety of functions on two nuclear, two coal-fired, and ten hydroelectric power plants. He was responsible for HVAC, refrigeration, steam, cooling water, and condensate systems, and took a lead role in scheduling and manpower planning for these projects.

Mr Raju is 48 years old, and holds BS and MS degrees in Mechanical Engineering from Michigan Technological University. He is a member of the ASME.

Attachment 3

CHIEF NUCLEAR ENGINEER

R N MOORE Roger Moore has 29 years experience in the nuclear field, including 8 years with Braun. He is presently Braun's Chief Nuclear Engineer, and his expertise and experience are primarily in the areas of nuclear engineering, safety, and licensing.

In his present assignment, he is responsible for all nuclear and environmental aspects of Braun's nuclear power work. On the TVA STRIDE project, he provides design reviews in areas of nuclear safety, health physics, and shielding. He is also responsible for coordination with and reporting to the NRC on all matters of nuclear safety.

His other projects at Braun have included Braun SAR, in which he participated in the design effort, and led the work to produce the PSAR and eventually secure the preliminary design approval from NRC. He also prepares license and permit applications to state and federal authorities on environmental and nuclear matters, responds to questions from regulatory agencies, and gives expert testimony at public hearings.

Prior to joining Braun, Roger was Director of Nuclear Services at Gulf States Utilities. Here he directed the environmental and nuclear efforts on two Louisiana power plants. He coordinated the work of a number of environmental consultants, and published the first Environmental Report based upon the new NRC format.

He was Superintendent of Engineering, Nuclear Division, for Todd Shipyards, where he led the engineering of the retrofit of a modernized design into the nuclear portion of the NS SAVANNAH. He also designed environmental control equipment and did control rod drive analysis for the LOFT project. He was also Manager of Training for nuclear matters at Babcock & Wilcox, where he qualified nuclear ship crews and coordinated various research programs.

Mr Moore has a BA in chemistry from the University of Colorado, and a business management certificate from UCLA. He is a registered nuclear engineer in California.

Attachment 3

SYSTEMS SECTION HEAD
MECHANICAL ENGINEERING DEPARTMENT

F M PATTERSON Pat has 30 years of engineering experience, all at Braun. He is leader of the Systems Section of the Power Division which is composed of the following groups - Mechanical, HVAC and Instrument & Controls. He is responsible for all engineering in the section which includes the complete design of nuclear and fossil power plant systems. This involves preparation of P&I flow diagrams, logic diagrams, hydraulic and thermal calculations, systems, equipment and pre-op specifications, and equipment evaluation and selection. Involved is the complete design including mechanical equipment room layouts, HVAC ductwork drawings, and fabrication specifications. Mr Patterson is responsible for administering the three groups in his Section and providing technical guidance and review of the work.

Pat's other duties have involved the analysis of heat transfer and fluid flow problems of all types. Also process design of such apparatus as heat exchangers, condensers and feedwater heaters.

Mr Patterson has been in the Power Division since 1973. During this time he was responsible for mechanical and HVAC systems in the Reactor Island for TVA's Hartsville and Phipps Bend Nuclear Power stations. He also directed the activities on several other power projects.

Before his assignment to the Power Division, Pat was a Principal Engineer in the Engineering Division. Prior to that he was leader of the HVAC Group at Braun.

Mr Patterson has a BSME from the University of California at Berkeley and MSME and Engineer in ME degrees from the University of Southern California. He is a member of the IEEE Working Group for Unique Identification of Power Plant Systems and Components. He is a registered professional mechanical engineer in California.

Attachment 3

PROJECT QUALITY CONTROL MANAGER

L F KARNS   Lee Karns has 39 years of experience including 31 years with Braun.

He is currently head of the Site Quality Control Section of the Quality Engineering Department. In this capacity, he is responsible for coordination of field jobsite inspection activities at various jobsites throughout the world. He maintains liaison with jobsite inspectors and home office engineering. He is responsible for preparing Construction Inspection Plans for construction projects, review of drawings and specifications, and establishment of inspection procedures and checklists to be used at the jobsite. He coordinates with customer representatives in the preparation of the site inspection requirements. He is responsible for the field piping pressure test programs and the preparation of the piping test diagrams that are used at the jobsites.

For 18 years he was Chief Field Inspector. He was responsible for all jobsite construction inspection and quality control activities for field projects ranging to $150 million throughout the world. He was responsible for all site inspection activities for projects in The Netherlands, Trinidad, Australia, and the Philippines. He participated in source inspection activities in Europe and other foreign countries during his overseas assignments. He is familiar with foreign codes and foreign work methods. At the jobsite, he was responsible for soil inspection, concrete control, concrete inspection, welding inspection including procedure and performance qualification, Code pressure vessel fabrication and assembly inspection, inspection of piping fabrication and erection, piping system pressure testing, site metallurgy, inspection of complex materials handling systems, and boiler and furnace inspection. He is particularly qualified in the various techniques of nondestructive examination and code requirements. At the site, he has been responsible for supervising a team of inspection personnel that numbers up to 20 people.

Prior to joining Braun, he was a source inspector for 8 years in various metal manufacturing facilities serving the petroleum industry. He also supervised shop forces in the manufacture of pressure vessels and the fabrication of structural steel.

Mr Karns is 61 years of age. He received his education in Mechanical Engineering at Purdue and Newark College of Engineering.

Attachment 3

EXPERIENCE

TVA STRIDE Braun has been involved in the design of HVAC systems for a 1220 MWe BWR for GE/TVA. The systems have been completely designed, procurement specifications written, and ductwork drawings issued. The majority of the HVAC equipment has been purchased and Braun has provided the review of supplier drawings and the resolution of supplier nonconformances and problems.

Some of the HVAC systems designed by Braun include control room system, standby gas treatment, diesel generator ventilation and other systems similar to those installed at the LaSalle plant.

During the course of our efforts we have sent the HVAC engineer to the construction site to assist in interpreting the design drawings. Some of the problems discussed with construction personnel include methods of supporting and attaching ductwork materials used in fabrication of ductwork and the fabrication procedures.

ROCKY FLATS WEAPONS FACILITY Braun was involved in two major projects for this AEC nuclear weapons facility located near Denver, Colorado. From 1967 to 1970, Braun designed the HVAC systems for a plutonium fabrication/machining operation; office/cafeteria complete; beryllium fabrication facility and the modification and/or extension of the HVAC systems for over 50 of the existing buildings at Rocky Flats. The first project involved the design of HVAC system to control and confine the spread of contamination. The systems controlled the pressure and air leakage between areas of high potential for contamination and those of low potential. Process supply and exhaust systems were designed to maintain an ambient temperature of 70° F and a moisture content of 0.6 grains. The room conditioning systems were of similar design with space conditions of 70° F and 6 grains, an extremely dry condition. The systems were fabricated from carbon steel, galvanized and stainless steel materials.

The second project consists of the design of HVAC systems for a plutonium recovery and waste treatment facility and was accomplished from 1970 to 1981. The processes within this facility consisted of wet chemical operations.

In addition to the systems described above, Braun also designed a large nitrogen recirculating system for a plutonium storage vault, process scrubber exhausts and water spray and removal systems to collect firewater water sprayed on HEPA exhaust filters to prevent criticality conditions.

During this 14 year period, Braun retained a full crew of construction engineers and inspectors to oversee the contractors' operations. In addition, Braun wrote detail system operating procedures, participated in field startup tests and evaluated test results.

The majority of the systems are in operation at this time.

EXPERIENCE Continued

Attachment 3

LLL This was a plutonium research laboratory for the LLL in northern California. Many of the systems are similar to those designed for RF but the criteria was based upon the AEC "Minimum criteria for Plutonium handling facility." Braun assisted in the development of this criteria, which required more stringent design based upon safety and seismic concerns addressed in the document.

Braun also reviewed the supplier drawings for this project.

SUNNYVALE ADP and POWER HOUSE These facilities housed the ADP equipment for the US satellite tracking program. The cooling load for this facility varied greatly due to irregular need for satellite tracking. Braun designed a unique variable air volume system utilizing diverting dampers to satisfy this highly variable load. The power house consisted of 11 turbine generators with waste heat boilers and steam absorption refrigerant units which were ventilated with axial fans.

OFFICES FACILITY, HOSPITALS, ETC Up to five years ago Braun had a subsidiary, Kilpatrick & Co, which performed HVAC mechanical contractors and sheetmetal fabrication and erection for large commercial complexes in the Los Angeles area. The facilities were located on the Braun campus in Alhambra and were readily available to the design engineers. They were consulted in past matters detailing with sheetmetal fabrication and installation.

In addition, all A/E services for the Braun facilities at Alhambra and Murray Hill are accomplished with in-house personnel. Over the past years Braun has designed and constructed four, seven to nine story, office buildings in addition to other new and modification work.

Braun acts as their own construction managers for each of these facilities.

PHARMACEUTICAL AND FOOD PROCESSING FACILITIES Braun has designed systems to satisfy FDA requirements for the ventilation of pharmaceutical and food processing facilities. These systems utilize galvanized and stainless ductwork, appropriately caulked and sealed, to confine these potential hazard materials.

RESULTS OF SAMPLE ANALYSIS

Sample Number	ASTM* Material Type	System Removed From	System Component	Weight % C	Weight % S	Weight % P	Weight % Mn	Tensile Strength, KSI Calculated Min.	Tensile Strength, KSI ASTM Min.
1	A36	VE	Hanger	0.19	0.035	0.008	0.68	-	58
2	A527	VC	Duct	0.07	0.027	0.005	0.38	N/A	N/A
3	A36	VC	Hanger	0.15	0.038	0.006	0.69	65	58
4	A575	VC	Stiffner	0.18	0.030	0.009	0.49	N/A	N/A
5	A36	VE	Hanger	0.23	0.038	0.012	0.68	-	58
6	A36	VE	Hanger	0.21	0.026	0.006	0.68	-	58
7	A527	VE	Duct	0.07	0.031	0.006	0.35	N/A	N/A
8	A575	VE	Stiffner	0.16	0.036	0.018	0.56	N/A	N/A
9	A36	VC	Hanger	0.18	0.029	0.006	0.75	69	58
10	A36	VC	Hanger	0.21	0.032 0.033	0.001	0.86	-	58
11	A36	VC	Hanger	0.20	0.041	0.027	0.58	-	58
12	A527	VX	Duct	0.06	0.019 0.018	0.005	0.41	N/A	N/A
13	A36	VX	Hanger	0.18	0.035	0.012	0.62	-	58
14	A36	VX	Hanger	0.16	0.036	0.006	0.68	65	58
15	A36	VX	Hanger	0.18	0.035	0.008	0.54	-	58
16	A36	VE	Hanger	0.19	0.046	0.023	0.73	65	58
17	A36	VX	Hanger	0.19	0.032	0.005	0.61	-	58
18	A575	VX	Companion Flange	0.22	0.051 0.052	0.017	0.58	N/A	N/A
19	A575	VD	Hanger	0.20	0.025	0.007	0.50	N/A	N/A

*All ASTM A575 Samples are specified to be Grade M1020, except sample 41 which was M1015.

RESULTS OF SAMPLE ANALYSIS

Sample Number	ASTM* Material Type	System Removed From	System Component	Weight % C	Weight % S	Weight % P	Weight % Mn	Tensile Strength, KSI Calculated Min.	Tensile Strength, KSI ASTM Min.
20	A527	VD	Duct	0.05	0.025 0.024	0.008	0.35	N/A	N/A
21	A575	VD	Companion Flange	0.23	0.026	0.005	0.52	N/A	N/A
22	A36	VD	Hanger	0.19	0.038	0.008	0.60	-	58
23	A36	VD	Hanger	0.19	0.036	0.009	0.68	64	58
24	A575	VD	Stiffner	0.20 0.19	0.026	0.008	0.61	N/A	N/A
25	A36	VY	Hanger	0.20	0.042	0.009	0.64	-	58
26	A575	VY	Stiffner	0.23	0.031	0.008	0.61	N/A	N/A
27	A36	VY	Hanger	0.17 0.18	0.037	0.007	0.56	-	58
28	A575	VY	Stiffner	0.21	0.029	0.008	0.58	N/A	N/A
29	A36	VY	Hanger	0.15	0.048	0.035 0.035	0.72	-	58
30	A36	VY	Hanger	0.21	0.030	0.009	0.72	-	58
31	A527	VD	Duct	0.08	0.02	0.006	0.42	N/A	N/A
32	A527	VD	Duct	0.05	0.02	0.009	0.30	N/A	N/A
33	A527	VD	Duct	0.06	0.02	0.006	0.43	N/A	N/A
34	A527	VY	Duct	[illegible]	0.03	0.007	0.28	N/A	N/A
35	A527	VY	Duct	[illegible]	0.02	0.007	0.28	N/A	N/A
36	A36	VY	Hanger	0.17 0.18	0.04	0.006	0.71	66	58

*All ASTM A575 Samples are specified to be Grade M1020, except sample 41 which was M1015.

RESULTS OF SAMPLE ANALYSIS

Sample Number	ASTM* Material Type	System Removed From	System Component	Weight % C	Weight % S	Weight % P	Weight % Mn	Tensile Strength, KSI Calculated Min.	Tensile Strength, KSI ASTM Min.
37	A527	VX	Duct	0.08	0.03	0.008	0.32	N/A	N/A
38	A307	VX	Bolt	-	0.03	0.011	0.69	145	60
39	A563	VX	Nut	0.05	-	0.009	0.39	97**	68**
40	A575	VX	Hanger	0.21	0.03	0.013	0.65 0.62	N/A	N/A
41	A575	VX	Stiffner	0.16	0.03	0.010	0.42	N/A	N/A
42	A575	VC	Hanger	0.19	0.04	0.018	0.44	N/A	N/A
43	A575	VC	Stiffner	0.19	0.04	0.012	0.32	N/A	N/A
44	A575	VC	Companion Flange	0.13 0.12	0.03	0.016	0.45	N/A	N/A
45	A527	VC	Duct	0.04	0.05 0.04	0.009	0.32	N/A	N/A
46	A527	VC	Companion Flange	0.14	0.04 0.03	0.016	0.42	N/A	N/A
47	A527	VE	Duct	0.09	0.02	0.005	0.40	N/A	N/A
48	A527	VC	Duct	0.07	0.03	0.011	0.33	N/A	N/A
49	A575	VC	Companion Flange	0.14	0.03	0.017	0.45	N/A	N/A
50	A575	VC	Companion Flange	0.13	0.03	0.017	0.46	N/A	N/A
51	A307	VX	Bolt	-	0.02	0.021	-	77	60
52	A563	VX	Nut	0.08	0.03	0.016	0.37	88**	68**

*All ASTM A575 samples are specified to be Grade M1020, except sample 41 which was M1015.

**Proof load stress.

RESULTS OF SAMPLE ANALYSIS

Sample Number	ASTM* Material Type	System Removed From	System Component	Weight % C	S	P	MN	Tensile Strength, KSI Calculated Min.	ASTM Min.
53	A307	VX	Bolt	-	0.02	0.014	-	102	60
54	A563	VX	Nut	0.09	0.02	0.009	0.50	87**	68**
55	A307	VR	Bolt	-	0.02	0.031	-	86	60
56	A563	VR	Nut	0.11	0.01	0.026	0.34	107**	68**

*All ASTM A575 Samples are specified to be Grade M1020, except sample 41 which was M1015.

**Proof load stress.

SARGENT & LUNDY
ENGINEERS
CHICAGO

Attachment 5

NRC REGION III

QUESTIONS ON HVAC SYSTEMS

Question 1: The NRC tested 4 bolts which were 3/8 inch A307 Grade A. The ASTM hardness requirement is between 121 and 241 Brinell. One of the 4 bolts tested had a hardness of 287 Brinell. The chemical analysis was OK. The NRC's lab could not conduct elongation or tensile tests on a 3/8 inch bolt. What does the 287 Brinell hardness mean?

S&L Response: With increasing hardness yield and fracture strength increases and ductility decreases. Increased hardness is advantageous from a strength point of view.

Increased hardness also decreases ductility of the bolt material. However, as no impact loads are expected on HVAC ductwork, this decreased ductility does not affect the safety of the bolts.

Hence, increased hardness is beneficial.

Attached is a list of stresses on the bolts, obtained by conservative analysis of typical HVAC ductwork containing components (dampers, registers, grills, etc.).

Summary of findings for A307 bolts used in HVAC Duct. Companion flange analysis.

Note: 1) The analysis was conservatively based on highest duct and duct component weights.

2) Analysis was based on 3/8 inch bolts.

3) Yield stress for A307 is minimum 36000 psi.

Building - Reactor 1 and 2 Service Level: Emergency

Duct Size (W X H inches)	Calculated Stress (ksi)	Duct Size (W X H inches)	Calculated Stress (ksi)
10 X 6	8.0	30 X 14	7.544
10 X 6	10.0	30 X 20	8.323
12 X 8	9.6	32 X 20	4.633
12 X 10	10.7	36 X 30	9.92
12 X 12	9.6	40 X 20	9.102
14 X 10	10.6	40 X 36	7.995
16 X 16	10.33	42 X 18	7.831
18 X 8	9.76	42 X 36	5.95
18 X 12	9.35	48 X 16	9.76
18 X 14	8.94	48 X 32	5.002
18 X 18	9.92	60 X 40	2.624
24 X 24	10.05	72 X 60	5.084
24 X 18	8.98	96 X 40	6.44
24 X 20	7.18		
26 x 12	8.16		
26 X 14	9.184		
26 X 20	9.963		
28 X 14	9.512		
28 X 20	9.061		

Building - Auxiliary

Service Level: Emvergency

Duct Size (W X H inches)	Calculated Stress (ksi)
10 X 6	10.414
18 X 8	10.91 -
20 X 6	6.81
12 X 16	10.54
12 X 20	10.91
12 X 30	10.62
14 X 40	6.57
18 X 44	9.31
20 X 16	8.57
12 X 36	9.594
36 X 18	8.41
26 X 20	10.62
24 X 54	8.57
48 X 36	8.82
30 X 28	7.75
30 X 38	9.23
22 X 18	7.71
28 X 70	9.512
72 X 72	5.54
40 Ø	9.8
70 Ø	9.23

Building - Containment

Service Level: Emergency

Duct Size (W X H inches)	Calculated Stress (ksi)
12 X 24	8.16
32 X 10	8.1
30 X 32	8.364
18 Ø	9.27

ENCLOSURE 4