ASSESSMENT OF THE OFF-GAS
FILTER BUILDING AT LASALLE
NUCLEAR STATION

by R. E. Shewmaker, P.E.
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Background:

At noon on March 30, 1982, I was provided with some preliminary information related to statements contained in a petition dated March 24, 1982 from Mr. Fahner, Esq. addressing the off-gas filter building roof by E. L. Jordan. I was alerted that it might be necessary to go to the LaSalle facility to view the structural components in question that same week and provide a written assessment by mid-week the following week.

At the direction of Mr. E. L. Jordan, mid-morning on March 31, 1982, I was instructed to assess in the field (1) whether the reinforced concrete roof of the off-gas filter building met the design requirements (that is, does the as-built condition conform to the drawings) and (2) whether the reinforced concrete roof of the off-gas building can meet its service requirements. The need for such an assessment was apparently the subject of a telephone conference call on March 29, 1982 regarding a petition filed by the Attorney General, State of Illinois requesting a Show Cause Proceeding or Other Relief related to this and other issues. This conference call was followed by a written request for assistance from IE by the RIII Regional Administrator (see Attachment 1).

Initial In-Office Effort (to determine requirements)

During the afternoon of March 30, 1982, I proceeded to review the pertinent portions of the LaSalle Final Safety Analysis Report (FSAR) to determine what the licensee had defined the structural safety requirements to be for the off-gas filter building.

Section 3.2, Classification of Structures, Components and Systems, was examined along with Table 3.2-1 which provides a detailed classification of various plant structures, equipment and components. As noted in the text of Section 3.2, plant structures, systems and components important to safety are designed to withstand the effects of a safe shutdown earthquake and remain functional. These are known as Category I and include all such items if they are required to ensure:

a. The integrity of the reactor coolant pressure boundary,

b. The capability to shut down the reactor and maintain it in a safe condition, or

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c. The capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures in excess of the guideline exposures of 10 CFR 100.

This revealed that all of the equipment housed in the off-gas filter building which is part of the off-gas system is classified as seismic Category II as well as the building itself. This means that the equipment and structure are not required to meet the requirements of 10 CFR 50, Appendix B, Quality Assurance Requirements. The quality group classifications for the various portions of the off-gas system are either C or D as indicated in Table 3.2-1 and defined in Regulatory Guide 1.26 and meet the various quality standards of the pertinent industry codes and standards (see Attachment 2).

The FSAR was then reviewed to determine what documented design requirements had been committed to by Commonwealth Edison for the design and construction of the off-gas filter building. The FSAR in Section 3.8.4 describes the criteria for the seismic Category I structures other than containment which in this case did not include the off-gas filter building. Commonwealth Edison provided for another level of safety-related structures in the design criteria known as "Non-Seismic Category I Safety Related Structures," but it also did not include the off-gas filter building. Therefore, no defined criteria existed in the licensee's application which is consistent with the fact that the building was not classified as safety related.

The Safety Evaluation Report (SER) for the LaSalle Nuclear Station was also examined to determine if the NRC staff had accepted the classification of structures, components and systems provided by the applicant. Section 3.2.1 indicates that with the exception of the classification of cooling loop of the spent fuel cooling and cleanup system all structures, components were correctly classified by Commonwealth Edison. In Section 11.2.2 which addresses gaseous wastes the NRC staff specifically stated that the off-gas system is located in the off-gas filter building which is a nonseismic Category I structure. The NRC staff further stated that the process off-gas system and the structure housing the system were acceptable (see Attachment 3).

I also had a discussion with an IE BWR systems engineer concerning the proper classification of "an off-gas filter building and the off-gas system." He indicated that the system was not used for accident prevention or mitigation and that the system would therefore most likely be classified as non-safety related.

On March 31, 1982, I discussed the proper classification of the off-gas system with an IE health physicist who reviewed the typical system's design and function as well as pointing out that many BWR's operate without such a system though newer plants are installing such treatment systems to conform to the ALARA guidelines of 10 CFR 50 Appendix I. His conclusion was that building failure should be of no real concern from a radiological viewpoint.

Also on March 31, 1982, during a meeting held with Commonwealth Edison at the request of the NRC for which a transcript was made, it was reiterated that the

NRC, specifically NRR, had considered the off-gas filter building as a "non-safety grade building" which contained no Category I safety related equipment. In addition, the NRC Region III office also stated that they had treated this as a Category II, or non-safety related building. The licensee stated, however, that they did apply the safety-related quality assurance program to the construction of the off-gas filter building (see Attachment 4).

In conclusion, all information available and assessments made indicated that the licensee's classification of the off-gas filter building was in fact correct in that it is not a Category I structure and that the structural requirements governing the design and construction would be those specified by the owner and his agents and would not necessarily incorporate any NRC requirements. With such a classification, the off-gas filter building would not be part of those structures that would be inspected by the NRC.

Field Effort (to determine as-built conditions):

On April 2, 1982 I visited the LaSalle Nuclear Station facility to obtain information and make first hand observations of the off-gas filter building roof. Three specific concerns were to be addressed during this field effort:

1. Facts related the off-gas filter building reinforced concrete slab roof thickness,

2. Facts related to the external loading of the roof by an electrical transformer, and

3. Facts related to the current condition of the reinforced concrete roof system such as holes, anchor bolts, embedments and cracking.

Roof Thickness

The as-designed roof slab thickness shown on the design drawings is 12" (ref. S&L Dwg. S-188, Rev. J). The top of the concrete was established by design at Elevation 726'-6".

Copies of the surveyors field notes for the surveys which the licensee had completed were obtained. These notes reflect three separate surveys with the first being a single point thickness established on March 10, 1982. This established a total thickness of 1'-2½" which included 1-3/4" to 2" of insulation, asphalt and gravel or a 12¼" or 12½" concrete roof slab. Two separate surveys were completed on March 29, 1982 by a four-man survey party using Level No. 2R728. W. Larson was the survey party chief. The party was made up of personnel of Walsh Construction Company and are classified as Technical Engineers and are union personnel. Their survey work was performed at the request of Mr. D. Shamblin, Construction Engineer, Commonwealth Edison. His directions were to establish the thickness of the roof slab between the integral roof beams. There are five (5) spans of roof slabs so the team selected three (3) points on approximately each of the spans' centerlines, making a total of fifteen (15) points on which to establish slab thickness. The approximate locations of the points were established from the column and beam centerlines for reference. The survey party conducted the field work without direct oversight by Commonwealth Edison representatives or quality assurance personnel. No independence from the construction company who built the roof existed.

From a previously established benchmark elevation on the off-gas filter building wall a series of vertical elevations were established by a surveyor's level on the outside of the roof and similarly for the ceiling inside the building at the fifteen (15) points. In the first case the level rod was held at each of the 15 locations on top of the builtup roofing gravel so that the thickness determined at each point reflected the thickness of the concrete roof slab plus the insulation, asphalt and gravel. The concrete roof slab thickness was then determined indirectly by subtracting the approximate design thickness of the insulation, asphalt and gravel which was taken as 2-3/4" to 2". In the second case a 6" steel spike was driven in the outside of the roof to puncture through the gravel, asphalt and insulation until the top of the concrete roof slab was struck. The top of this steel spike was then the point on which the level rod was held at each of the 15 locations on top of the roof. The thickness of the concrete roof slab was then obtained directly from the difference in elevations for the top and the bottom of the concrete roof slab.

From the first case the thickness at one (1) point was determined to be 11.68" assuming a 2" thick built up roof. In the second case the thickness at three (3) points was found to be 11.16", 11.52" and 11.64." I consider measurements of 11.88" as within the allowable measuring errors of ±0.01'. Four (4) measurements of 11.88" were obtained.

The reduction of field survey data has been checked to verify the determination of the thickness of the concrete roof slab based on the field data. No discrepancies were noted. No direct measurements of the concrete roof slab thickness were physically possible since no holes are open through the roof thickness. From the design drawings and field observation the six (6) penetrations through the roof are all sealed. They consist of three (3) roof drains, an HVAC vent/intake, an electrical conduit and an abandoned 12" diameter sleeve which is sealed closed.

Discussions with site personnel revealed that during drilling for concrete anchors there was an instance where drilling into the underside of a 24" thick reinforced concrete floor resulted in penetrating the trap of the floor drain for the 690'-0" floor level in the off-gas filter building. This allowed the water in the trap to flow down through the hole and the possibility of daylight being seen up through the drain via the hole. This occurred in the next floor level below the off-gas filter building's roof.

Based on my review of the facts my assessment is that the reinforced concrete slab portion of the off-gas filter building roof is nominally a 12" thick section with the average thickness, based on fifteen (15) measurements, being 1'-0½". The actual range of values for the fifteen (15) measurements was +1¼" and -13/16" indicating the tolerances are somewhat outside the generally accepted values of +½" and -¼" as provided in ACI 301, specifications for

Structural Concrete for Buildings, 1972, and the values of +3/8" and -½" as provided in the Proposed ACI Standard ACI 117, Tolerances for Concrete Construction and Materials, August 1980. These slight deviations of tolerance will have no significant effect on structural behavior.

External Loading of Electrical Transformer

Based on the information available at the site from Mr. D. Shamblin, Construction Engineer, Commonwealth Edison, there was a transformer placed on the roof of the off-gas filter building to provide electrical service for construction sometime probably in the last half of 1976. The concrete in the off-gas filter building was placed in November of 1975. The size of the base of the transformer was 4'-0" by 13'-2" and the assembly had a total weight of 6700 lbs. The transformer was removed sometime in 1981.

One end of the transformer was placed on the east wall (known as Ab) which is a 12" reinforced concrete wall with the long axis of the tranformer running in the east-west direction nearly aligned over the centerline of the roof beam just north of Column line 13. Based on my calculations this loading, conservatively assuming no loads are directly transmitted to the wall and that the roof slab and beam system must carry the load, results in a value of only about one-third (1/3) of the design live load (100 psf) existing over about 40% of the span of the beam. Therefore, the loading of the construction transformer placed as it was on the reinforced concrete roof of the off-gas building represented less than one-sixth (1/6) of the design live load on the supporting beam.

In addition to this assessment of actual loading versus design capability, I examined the underside of the reinforced concrete off-gas filter building roof in this area for indications of distress that could be caused by excessive loading or underdesign as a result of construction deficiencies. No evidence of load distress were found. Minor hairline cracks were visible but in no greater concentration than elsewhere on the structure.

Based on these facts my assessment is that the temporary construction loading of the electrical transformer was well within the design loads for the reinforced concrete roof of the off-gas filter building and that no structural distress was caused by the loads.

Current Roof Condition

In September of 1979, nearly four (4) years after the concrete had been placed for the roof of the off-gas filter building, the Quality Assurance group of Commonwealth Edison noted some surface cracking in the bottom surface of the off-gas filter building roof slab. The general area was noted as having a high density of expansion anchors and some concern was expressed as to whether the cracking was serious and whether it at all related to the anchors. The area in question was examined by the Walsh Construction Company Quality Assurance Supervisor and the General Superintendent as well as the Commonwealth Edison Company Structural Engineer. The decision was made to chip out two of the cracks over some several feet to determine the depth of cracking. After chipping the area was patched when the conclusion was reached that the cracks were surface type cracks and no further action would be required.

During the March 31, 1982 meeting mentioned previously, a representative of Commonwealth Edison indicated that the cracks did not exceed one-quarter (¼) inch depth. The cracking was also characterized as shrinkage cracking associated with the slab type construction (see Attachment 4, pp. 15 and 16).

On April 2, 1982, I examined the underside surfaces of the four (4) main roof beams and the five (5) roof slab areas for cracking, holes embedments, anchor bolts and patches. The area where the largest crack size was found consisted of the slab area adjacent to the two (2) patched areas which were repaired in 1979 as a result of the licensee's evaluation of cracking. From this observation I would conclude that the cracks investigated by Commonwealth Edison in 1979 were in fact the largest ones visible then also. I observed that at the end of the repaired area there had been no continuation or propagation of cracking since 1979 from the cracked and unrepaired area into the patch. I did observe a small (probably width of 0.005") crack which crossed the patch (generally at 90°) and continued about two feet on one side of the patch and about three feet on the other side of the patch. I attributed this to minor shrinkage that has occurred since 1979. Generally one can consider that 80-90% of the shrinkage takes place during the first year after placement and that this crack was a result of the later shrinkage.

The largest cracks I observed were on the order of 0.005" to 0.008" in width based on a wire feeler gauge I utilized. The maximum depth I was able to insert the probe was about 1/8". The cracks that were observed appeared to define no particular pattern with respect to embedded anchors, drilled-in anchors or the lines of distress that would develop as a result of excessive load or an understrength condition due to construction errors. Based on my observations I concluded that the roof does not show signs of distress as a result of cracking from any conditions related to external loads, drilling or construction errors. There are cracks, however, and these are to be expected in reinforced concrete construction. The shrinkage effects on the concrete in this particular roof framing system may be somewhat amplified due to differential shrinkage since the slab portions are relatively thin and can lose moisture fairly easy with the resulting shrinkage. The beam portions, on the other hand, are massive (3' x 4' in cross-section) and tend to have fewer losses and changes of moisture.

The embedments which were cast-in-place when the roof system concrete was placed consist of flat steel plates anchored by welded studs in the typical fashion. The condition of the concrete adjacent to these embedments showed some of the same minor cracks of from 0.005" to 0.008" in width. There appeared to be no consistency in the location of cracks to define a pattern that would relate to relatively heavily loaded anchors vs. lightly loaded anchors. In one instance an anchor judged visually to be relatively heavily loaded had no crack adjacent to the anchor, whereas an anchor plate with no load (unused) had some adjacent cracking. There was also no evidence to indicate that the unused anchor had ever been loaded.

The anchor bolts which were the drilled-in expansion type were used for attachments where the embedments could not serve as a result of there location or configuration. I observed several locations where drilling had apparently been started and was terminated as a result of apparently contacting reinforcing steel. Three specific anchors were examined in detail from the field observations back to the design layout and control of the design (anchors CC-13, CC-93 and CC-CP-7). All locations found where drilling was terminated due to contacting rebar were apparently patched as indicated by the licensee since no open holes were found. Several unused drilled-in anchors were observed and probably were left unused due to relocation of other anchors on a specific anchor plate with multiple anchor bolts.

It was stated by Mr. D. Shamblin of Commonwealth Edison that he knew of no core holes (cut all the way through) made in the roof slab. All through-slab penetrations were cast in place with sleeves or blocked out during concrete placement. I observed no indications of any core holes.

During the drilling operation in the off-gas filter building there were no cuts made through reinforcing steel. There were only hits or nicks made on the reinforcing steel as it was contacted. These hits were recorded when they occurred and they were illustrated on S&L Drawing, RHS-188, Rev. J. No observations could be made in the field but it is my opinion that these nicks will not have any significant effect on the off-gas filter building roof.

Conclusions

As a result of my review of the pertinent documents, discussions with cognizant individuals and my independent field observations and measurements I have concluded the following:

1. The off-gas filter building is a non-safety related bulding which contains equipment which has no function in preventing or mitigating accidents or accident conditions.

2. The reinforced concrete roof of the off-gas filter bulding has slight deviations of the thickness of the 12 inch thick slab as specified by the design drawings. The range of deviations of +1½" and -13/16" will have no significant effect on structural behavior.

3. The loading imposed by the temporary construction related transformer on the roof of the off-gas filter bulding did not exceed the design loads and did not cause structural distress.

4. The current condition of the roof of the off-gas filter building which includes existing cracks, embedments, anchor bolts and nicked reinforcing

steel is acceptable and there is every reason to expect that the roof system can fully carry the design live load of 100 psf while remaining in a serviceable condition in performing its intended function over its service life.

Attachments:
1. Request for Assistance
2. Section 3.2 and Table 3.2-1 of the SAR
3. Extracts from SER (NUREG 0519)
4. Extracts from Meeting Transcript (3/31/82)

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