

Sandia National Laboratories

Albuquerque, New Mexico 87185

October 26, 1981

James F. Costello  
U.S. Nuclear Regulatory Commission  
Mail Stop NL 5650  
Washington, DC

Dear Dr. Costello:

Attached is a summary of the advisory panel meeting on September 17-18, 1981. Please send me any changes or corrections which you would like to have incorporated. After I receive your input, we will distribute the summary and our latest cost figures to the panel members.

As I told you in a telephone conversation, we had a meeting at Sandia with Lowell Greimann of Ames on September 29, 1981. Although his work is of interest to our program, I do not see any significant overlap. Greimann's analytical work is based upon a very conservative failure criteria. The criteria is based upon the half-elastic slope of the pressure-displacement curve; that is, the failure point is the point where the pressure-displacement curve intersects a line originating from the origin with a slope equal to one-half the elastic slope of the curve. For an ideal elasto-plastic system, this criteria corresponds to limiting strain to twice the elastic strain. Similar criteria have been utilized by others in comparing experimental work on pressure vessels to limit analysis calculations. For materials with high ductility and strain hardening, the experiments show significant capacity past the theoretical limit pressure.

Greimann is using the ANSYS code. It became clear from our conversations that this code has severe limitations for large strain analyses. An axisymmetric shell element with nonlinear capabilities is not available in the version used by Greimann. In my recent conversations with personnel at Failure Analysis Associates they also have indicated that ANSYS is well suited primarily for elastic and small strain nonlinear analyses. They use MARC for large strain problems and believe that it is the only commercially available general purpose code for very large strain problems.

Greimann was quick to admit that many of his analyses have a great deal of uncertainty. He believes that tests such as

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these prepared in our program are very important to predicting, with confidence, the containment capacity.

Sincerely yours,

*T. E. Blejwas*

T. E. Blejwas  
Systems Safety Technology  
Division 4442

TEB:ds

Copy to

4442 W. A. Von Rieseemann  
4442 W. A. Sebrell  
4442 File (1047.011)

File  
Sandia Laboratories

Albuquerque, New Mexico  
Livermore, California

date January 5, 1982

to Containment Advisory Panel

*Thomas E. Blejwas*

from Thomas E. Blejwas

subject Summary of the Meeting on September 17-18, 1981

Enclosed is a summary of our last meeting on the Safety Margins of Containments Program. Also enclosed is a summary of the program dated November 23, 1981 which includes a projected budget. The data in the summary are still our best estimates except for the dates in Table 3 which we now view as optimistic. We would appreciate any comments or corrections which you may have.

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USNRC J. F. Costello  
4442 W. A. Von Riesemann  
4442 W. A. Sebrell

Meeting of the Advisory Panel  
Safety Margins of Containments  
Marriott O'Hare Hotel, Chicago, Illinois  
September 17-18, 1981

The following advisory panel members were present:

Thomas J. Ahl  
Wilfred E. Baker  
George E. Howard  
Mete A. Sozen  
Joseph J. Ucciferro  
Richard N. White  
John D. Stevenson (Sept. 18)

James F. Costello from the NRC was present.

Personnel from Sandia National Laboratories included:

Walter A. Von Riesenmann  
Thomas E. Blejwas  
Albert W. Dennis  
Wayne A. Sebrell  
Ronald L. Woodfin

The major activities were as follows.

1. Motivation for the meeting was provided by Costello and Von Riesenmann. The funds available from the NRC are insufficient for conducting the program which was presented by Sandia at the June panel meeting. Elements for compromise and/or omission must be considered.
2. The status of work on containment programs around the world was reviewed by Von Riesenmann. A tentative decision to hold a workshop on containment structures in about six months was reached.
3. A discussion of difficulties in measuring leakage in containment buildings and models was headed by Woodfin. He presented data which suggests that accurately measuring leakage as a function of pressure in our small models would be extremely expensive and might mean that static pressurization testing of a single model would require weeks or months to complete. He will document his findings in a future report.
4. A presentation of preliminary analytical results was made by Blejwas. These results, which were made using the MARC code, indicate that, although computational problems exist and additional modifications and refinements in methodology may be required, the analysis of containment structures and components to high strain levels is not unreasonable. However, comparisons with experimental results are required. The results also suggest that the behavior of penetrations requires considerable further study.

5. Von Rieseemann presented alternate approaches to the program. The four major alternatives were.

- a) full-scale testing of existing containment structures for leakage data;
- b) full-scale testing of components for leakage data;
- c) extensive analysis with supporting experiments, such that the selection of experiments would be decided as the program progressed; and
- d) the use of small prototypical structures upon which analytical work would be based.

6. A modified experimental program as envisioned by Sandia personnel was presented by Von Rieseemann. The program follows the approach in 5d. In the first experimental part of this program, steel prototypical structures at two sizes will be tested by internal pressurization. Three sets of experimental models at the smaller size (about 1/30 of the height and radius of actual steel containments) will be tested. The three sets are a) clean shell, b) ring-stiffened shell, and c) ring-stiffened shell with major penetrations. A single model of the larger size (about 1/10 full-size radius) will be tested next. It will be similar to c) above but with more penetrations. The models in these experiments will not replicate full-size structures. Where practical, conventional construction practices will be utilized. No attempt to model leakage paths such as through gaskets and seals will be made.

Internal pressurization of concrete prototypical structures (not prestressed) will follow the steel experiments. Pressurization tests of prestressed concrete structures will not be conducted if sufficient data can be obtained from British and Canadian experiments. Also, pending further analytical investigation, dynamic pressurization tests will be postponed or deleted. Seismic investigation, both analytical and experimental, will be postponed.

Although alternatives were discussed, general agreement on this approach was reached.

7. Costello expressed great concern over the omission in the Sandia proposal of data on leak rate versus pressure. The discussion of leakage continued intermittently through the remainder of the meeting. The panel generally supported Sozen's suggestion that Sandia conduct the experiments as they see best and draw whatever conclusions about leakage that they can. The possibility of hydrostatic testing was not eliminated. Costello requested that Woodfin provide him with cost figures for detecting/measuring leakage to various levels of accuracy. Several people expressed the view that detailed leakage data would not serve a useful purpose.

8. Von Rieseemann summarized the first day's discussions. He saw overall agreement on the program plan proposed by Sandia. He observed specific agreement on

- a) delaying the dynamic pressurization and seismic tests,
- b) accepting either pneumatic or hydraulic testing,
- c) replicating tests,
- d) using prototypical models.

9. Details of the models were discussed. Although several panel members expressed a desire for the large model to be a replica of the small detailed model, changing the R/T ratio was reluctantly accepted by the group because of construction constraints. The design of the large scale model will require further study.

It was agreed that the concrete basemat will not be modelled to be representative of actual containments. Basemat behavior will be included in tests of concrete containments.

A crane girder will not be included in the test structures.

10. The topic of leakage was again discussed. The panel agreed that the tests as proposed are properly oriented towards structural behavior rather than towards leakage. Costello expressed the desire to know if leak rate in the models was a step function or a ramp function with respect to pressure. The panel generally agreed with Ucciferro that Sandia should concentrate upon defining deformation patterns. Plant-specific leakage problems should be estimated by others. Leakage during the experiments should be detected, but Sandia should not spend large resources to accurately measure leakage.

11. Costello asked the panel members to look at the cost data provided by Sandia and to comment to him on whether or not the costs seem reasonable. The cost figures will be included with the summary of the meeting.

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