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

March 8, 1979

Generic Technical Activity A-12

MEMORANDUM FOR: E. G. Case, Chairman, Task Action Steering Committee

FROM: V. Stello, Director, Division of Operating Reactors

SUBJECT: REVISED TASK ACTION PLAN FOR GENERIC TECHNICAL ACTIVITY A-12, "FRACTURE TOUGHNESS AND POTENTIAL FOR LAMELLAR TEARING OF STEAM GENERATOR AND REACTOR COOLANT PUMP SUPPORTS"

Attached for your use is the approved revised Task Action Plan (TAP) for Generic Technical Activity A-12. Activity A-12 is an "Unresolved Safety Issue" and revision of the TAP was required by Mr. Denton's directive dated January 23, 1979.

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Task A-12

FRACTURE TOUGHNESS AND POTENTIAL FOR LAMELLAR TEARING OF STEAM GENERATOR AND REACTOR COOLANT PUMP SUPPORTS

Lead NRR Organization:	Division of Operating Reactors (DOR)
Lead Supervisor:	Darrell G. Eisenhut, Deputy Director, DOR
Task Manager:	Dick Snaider, SEP/DOR
Applicability:	Pressurized Water Reactors
Projected Completion Date:	August 1979

1. Description of Problem

During the course of the licensing action for North Anna Power Station Unit Nos. 1 and 2 a number of questions were raised as to the potential for lamellar tearing[1/] and low fracture toughness of the steam generator and reactor coolant pump support materials for those facilities. Two different steel specifications (ASTM A36-70a and ASTM A572-70a) covered most of the material used for these supports. Toughness tests, not originally specified and not in the relevant ASTM specifications, were made on those heats for which excess material was available. The toughness of the A36 steel was found to be adequate, but the toughness of the A572 steel was relatively poor at an operating temperature of 80°F. In the case of the North Anna Unit Nos. 1 and 2, the applicant has agreed to raise the temperature of the ASTM A572 beams in the steam generator supports to a minimum temperature of 225°F prior to reactor coolant system pressurization to levels above 1000 psig. Auxiliary electrical heat will be supplied as necessary to supplement the heat derived from the reactor coolant loop to obtain the required operating temperature of the support materials.

Since similar materials and designs have been used on other nuclear plants, the concerns regarding the supports for the North Anna facilities may be applicable for other PWR plants. It was therefore considered necessary to reassess the fracture toughness of the steam generator and reactor coolant pump support materials for all operating PWR plants and those in CP and OL review. 2

Lamellar tearing may also be a problem in those support structures similar in design to North Anna. This possibility has been investigated on a generic basis. Although recently completed studies provided no conclusions regarding residual strength in a lamellar-torn joint, the staff is satisfied that continued operation of PWR facilities is safe in that there has been only one documented inservice failure attributed to lamellar tearing and this failure occurred on often-stressed truck brakes. 2

1/ Lamellar tearing is a cracking phenomenon which occurs beneath welds and is principally found in rolled steel plate fabrications. The tearing always lies within the parent plate, often outside the transformed (visible) heat-affected zone (HAZ) and is generally parallel to the weld fusion boundary. Lamellar tearing occurs at certain critical joints usually within large welded structures involving a high degree of stiffness and restraint. Restraint may be defined as a restriction of the movement of the various joint components that would normally occur as a result of expansion and contraction of weld metal and adjacent regions during welding ("Lamellar Tearing in Welded Steel Fabrication", The Welding Institute).

The scope of this program is limited to PWR steam generator and reactor coolant pump supports. Another program, ASYMMETRIC LOCA LOADS (A-2) will investigate vessel supports as part of its scope. As part of that effort, a review of the need for reviewing BWR vessel supports is being undertaken. | 2 | 2

2. Plan for Problem Resolution

A preliminary survey of operating PWR plants was made in May 1976 to determine the initial scope of this problem. Results indicated that five units have designs similar to North Anna and that 12 units use A36 materials. No plants which were surveyed used the A572 material.

The staff concluded that, depending on the heat treatment of the A36 material, a potential material toughness problem existed. In addition, it was determined that other materials used in the design of steam generator and pump supports have never been tested to determine toughness properties. Therefore, the potential "toughness problem" may exist for operating plants that did not use A36/A572. As noted above, the potential for lamellar tearing may also exist for certain support structures. | 2

Based on the above, the action plan for resolution of this concern for operating PWRs was as follows: | 2

A. Send a generic letter to all PWR licensees and selected OL applicants stating NRC concerns and requesting information on the design, materials, fabrication and inspection of the steam generator and reactor coolant pump supports for each plant. This was completed in late 1977. | 2 | 2

B. Based on information supplied by the licensees and with the aid of the consultant, categorize the support design and materials as far as practical and select typical designs for further study. This has been completed. The consultant's report is presently being prepared for transmittal. | 2

C. Complete preliminary review of typical designs and inform each applicable PWR licensee of the concerns on his particular support system. This implementation phase shall be accomplished with the aid of the consultant. | 2

D. Utilizing input from consultant, develop and issue specific guidance for resolution of the problems discovered. This will be a joint DSS/DOR task and will result in the issuance of a NUREG document and/or other appropriate document. Work on the NUREG document will begin after receipt of the consultant's final report. | 2

Subsequent case-by-case resolution (implementation) will involve requiring those applicants or licensees for whose facility(ies) a problem exists to either (1) demonstrate that safety margins are not lower than anticipated or (2) propose a solution to the problem in accordance with the criteria developed in step D above.

As noted in Section 1, no conclusion has been drawn regarding the severity of lamellar tearing and its affects at any of the PWRs reviewed. Although the staff has concluded that plants are safe to continue operation, the lamellar tearing issue will remain incomplete until the completion of ongoing university studies which are unrelated to this generic issue. Because of the long term nature of these studies, the lamellar tearing issue will be separated from the remainder of General Technical Activity A-12 but will be retained as a still-active technical issue. The priority assigned to this technical issue will be determined in the near future. 2

3. Basis for Continued Plant Operation and Licensing Pending Completion of Task

As indicated in Section 2, the staff anticipates that the result of this task will be the issuance of a NUREG document and Standard Review Plan revisions which will delineate guidance and requirements for the selection of materials and the construction of reactor coolant pump and steam generator support structures. The documents will also address preservice inspection requirements for plants in the operating license stage and inservice inspection requirements for operating reactors. 2

A preliminary survey of operating PWRs was performed in late 1976. Based on the results of this survey and the information received to date as part of this task, we have determined that additional investigation of certain facilities is prudent. Presently, there is no ASME Code requirement for inspection of the steam generator supports, although the establishment of such a requirement is being considered. The ASME Code requires visual inspection once every ten years for reactor coolant pump supports. As noted above, the staff will consider establishing additional guidance and requirements for inservice inspection of these supports as part of the implementation portion of this task, with the assistance of consultant nondestructive examination expertise. 2 2

The staff considers that continued operation of all PWRs is warranted during this completion and implementation phase, because support failure is not expected to occur except under the unlikely combination 2

of (1) an initiating event determined to be of very low probability (normal operating stresses are very low), (2) non-redundant and critical support member(s) of low-fracture toughness (many supports contain redundant members), (3) member operating temperature low enough that upper-shelf energy absorption (where fracture toughness properties are best) is not reached, and (4) a flaw of such large size that the stresses imparted during (1) above would be of such intensity that crack arrest would not occur and the member(s) would fail in a brittle manner.

As noted above (Section 2), the lamellar tearing issue will be continued as an open item until the various university studies are completed. However, and also as noted above (Section 1), the staff considers continued operation of PWRs during this study period to be acceptable, based on the fact that the consultant's review of approximately 400 related documents only revealed one instance of known failure, which occurred on often-stressed truck brakes. Again, applied stresses during normal operation are low and the probability of an initiating event is very low. Additionally, the staff considers lamellar tearing to be a lower order failure mechanism than others that are possible in heavy weldments, such as weld toe cracking. 2

Based on the foregoing, the staff has concluded that continued operation of operating reactors and licensing of plants in the operating license review stage will not present an undue risk to the health and safety of the public pending completion of the task. Further, based on the anticipated completion date for this task, the task results will be available well in advance of the operation of any plant currently under construction permit review.

4. NRR Technical Organizations Involved

A. Engineering Branch, Division of Operating Reactors. Has lead responsibility for review of data generated from licensee responses, control of and coordination with consultant organization, coordination with DSS in development and issuance of criteria, and control of implementation on facilities having possible material problems. 2

Manpower Estimates: .6 man-year FY 1979

B. Materials Engineering Branch, Division of Systems Safety. Review information received from operating units and problems identified during review. Coordinate with DOR in development and issuance of criteria.

Manpower Estimates: .2 man-year FY 1979 2

C. Task Manager, Division of Operating Reactors. Has overall responsibility for coordination of DOR and DSS technical tasks and for the development and issuance of criteria documents. Provides assistance as required during implementation.

Manpower Estimate: .3 man-year FY 1979 |2

5. Technical Assistance

Technical Assistance for the DOR program is required to provide continuing expertise in evaluating the potential for low fracture toughness of the support materials. The work will include: |2

A. Assisting in the formulation of information requests to, evaluation of responses from, and decisions regarding further action on, those plants to be identified in the forthcoming report as having materials of questionable fracture toughness.

B. Evaluating responses of those plants from which information was not received in time for full evaluation under the first phase of the program (six plants).

C. Providing assistance in formulation of questionnaires to, and in evaluation of responses from, PWRs recently licensed or soon to be licensed and on which complete review has not been accomplished. |2

D. Providing technical expertise in the area of non-destructive examination of the support structures, particularly in the assessment of ultrasonic testing efficacy. This task will also involve providing recommendations for changes to inservice inspection requirements to incorporate support inspection.

A consultant will be selected for the implementation work. We estimate costs to be $200,000 for FY 1979 and FY 1980.

6. Interactions With Outside Organizations

Individual licensees of PWR facilities and applicants for PWR licenses. All licensees of operating PWRs at program commencement were contacted to gather information. Those PWRs not already reviewed will be contacted as part of the implementation phase, as noted above. Some licensees will become more involved in this study due to the need for site visits and/or the discovery of material problems at their particular facility(ies). Further interaction will be a function of the results of our continuing review. |2 |2

7. Assistance Requirements With Other NRC Offices

The Office of Standards and Development intends to commence, in FY 1979, work on a program involving Fabrication and Examination of Component Supports. Although an effort is presently being made to incorporate specific guidance in the ASME Code, this new program may result in issuance of a Regulatory Guide.

8. Potential Problems

None.

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