UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

August 6, 1968

R. E. Hollingsworth
General Manager

THRU: for G. M. Kavanagh, AGMR

E. V. McGarvey

APPARENT DEFICIENCIES IN IMPLEMENTATION OF ASME BOILER AND PRESSURE VESSEL CODE, SECTION III "NUCLEAR VESSELS"

This is in reference to your memorandum of June 20, 1968, to Mr. Price and Dr. Kavanagh suggesting that REG and AGMR staffs jointly review the reliance being placed on ASME code certification of equipment for reactor plants to determine whether there should be revisions in requirements for AEC-owned plants or commercial nuclear plants. The suggestion was provoked by VADM Rickover's memorandum of June 10, 1968, which described circumstances arising from KAPL's procurement of a reactor vessel to Section III, Nuclear Vessels, ASME Boiler and Pressure Vessel Code.*

As you know, an RDT/ORNL/REG/ACRS ad hoc joint group has been working since January 1967 to coordinate RDT and REG standards programs and identify the additional or modified requirements necessary to upgrade the ASME Code and other existing standards for both Commission and commercial reactor plants. A number of modified and additional requirements representing proven practices beyond the ASME Code have been identified and incorporated into appropriate RDT Standards, which have been promulgated for application to RDT projects, and into the Tentative Regulatory Supplementary Criteria for ASME Code-Constructed Nuclear Pressure Vessels, which was published in August 1967 for comment and guidance to licensees. Bearing on the issues in the KAPL vessel case and the indicated deficiencies in the ASME Code, the RDT Standards and Regulatory Criteria contain requirements beyond the Code for ultrasonic examination of welds and for vessel owner's responsibility for inspection.

It should be noted that the RDT and REG standards efforts have been partially instrumental in inducing industry code committees to upgrade their codes and standards. For example, since the Regulatory Criteria for nuclear vessels were published, approximately 25% of the Criteria have already been adopted by the ASME Code, and the Code Committee has indicated they are studying others for inclusion. However, last March in their written comments on these criteria, the Code Committee had dismissed the two criteria relating to ultrasonic examination and owner's responsibility for inspection as being unnecessary, and the latter as possibly detrimental. In a meeting July 9, 1968, at KAPL regarding the KAPL inquiry to ASME, Messrs. Guy and Williams, the current and past Chairmen of the ASME Code Committee

*Circulated as AEC 943/44.

expressed essentially this same opinion in maintaining that the Code as written was adequate. Yet, in a meeting July 11, 1968, at Germantown with representatives from Naval Reactors, RDT, and Regulatory, Messrs. Guy and Williams stated after considerable discussion that the Code Committee was working hard to get ultrasonic requirements specified and that purchasers must recognize the limited scope of the Code inspection and conduct additional inspections over and above the Code inspections for their own protection.

Although the ASME has not yet ruled on the KAPL inquiry, it appears that the letters, discussions, and reexaminations stimulated by this case will help avert an adverse ruling by ASME and further weakening of the Code. Moreover, this case has helped provide a better basis for further discussions with the Code Committee in connection with current efforts to revise the Regulatory criteria for nuclear vessels f[illegible]ication as regulatory requirements, for effecting further needed improvements in the ASME Code, and for obtaining a more willing industry acceptance of these upgraded requirements.

We are continuing our efforts to induce the ASME Code Committee to take actions responsive to recognized deficiencies in the Code and will take their actions into account in our on-going joint RDT-REG staff efforts to define requirements necessary to upgrade existing standards for both Commission and commercial reactor plants. We will keep you advised of significant developments in this matter.

Milton Shaw

Milton Shaw, Director, Division of
Reactor Development and Technology

C 9

September 24, 1968

SECRETARIAT

AEC-R 69/15

ON CLOSING THE VERIFICATION GAP

Note by the Secretary

The Deputy Director of Regulation has requested that his attached speech, presented at the ASME Quality Assurance Seminar on June 26, 1968, be circulated for the information of the Commission.

W. B. McCool

Secretary

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X - S.P-4-7 Reg Speeches

ON CLOSING THE VERIFICATION GAP*

ASME QUALITY ASSURANCE SEMINAR
QUALIFICATION OF ENGINEERING
SPECIALISTS
June 26, 1968

Clifford K. Beck
Deputy Director of Regulation
U.S. Atomic Energy Commission

The Necessity for Reliability:

No one, to my knowledge, has questioned the necessity for an extraordinary level of reliability in the performance of nuclear power plants. But, just to show that there is an ample justification for this necessity, I will enumerate three compelling reasons for it:

1. The cost of repair, if parts do not function properly, is unusually high. Repair costs, already high enough, increase many fold when radiation and radioactive contamination are present. Such measures as remote handling, shielding and protective clothing are tedious and time-consuming.

2. Plants are so large that power outages create a serious system and region impact. For many systems the capacity of a nuclear plant is so large that the remainder of the system could not absorb the load demands in case the nuclear plant should fail.

According to present projections, the lifetime of the plants we are building now -- the 30 odd plants which are now in process in our staff, and the plants we are talking in this seminar about inspecting, will extend far beyond the time when nuclear plants will supply more than half of the total electricity in this country. Reliability in performance long before that time would have become a matter of national urgency.

3. Safety requires reliability of performance. We have deliberately developed a coherent system of protective safeguards to insure that safety is achieved in the operation of nuclear plants. But this system will not function properly unless the structures, components and systems function properly. Hence, the importance we attach to quality assurance.

The Approach and Divisions of Safety Protection in Nuclear Plants:

To convey to you the importance we in the Commission attach to the adequacy of safety protection in nuclear plants, let me indicate a little further the basis of approach.

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* A speech given from rough notes to representatives of industry organizations interested in improving the inspections of boiler and pressure vessels as required by the ASME Boiler and Pressure Vessel Code. Subsequently converted into a manuscript in response to requests received.

First, it must be recalled that the essential hazard of real concern is that fission product accumulated in the reactor core might by accident escape into inhabited areas. To prevent this, a policy best described as "defense in depth" is applied. The idea of "defense in depth" is to provide, not just one element of safety defense at a given point, but a second, or even a third element to give protection in case the first one should fail to function.

To illustrate: (a) Before construction can begin on a nuclear facility, the Commission must determine that no undue hazard is likely to arise from the proposed facility. To do this, a complete review of the plans, the possible inadequacies in design, potential hazards that might occur and the protective measures provided against these possible hazards, ... is made by the Commission's regulatory staff. An independent review is then made by the expert, statutory Advisory Committee on Reactor Safeguards (ACRS). Finally, the safety issues are then considered by a 3-member Safety and Licensing Board in a public hearing where the viewpoints of the applicant, the review bodies and any intervenors are made known. The Commission relies on these several reviews in helping to reach its position on the requested authorization. (b) As another example, for fission products to escape into the environment, the facility is so devised (in the usual water-type reactors) that four separate and successive barriers must be transgressed: (1) fission products are "born" within the solid, dense, highly impermeable, high melting point, ceramic (uranium oxide) fuel matrix in the individual fuel elements; (2) each fuel element is encased in sealed metallic tubes; (3) the fuel bundles are enclosed within the high-pressure primary steam-water recirculating system, and finally (4) a high pressure, low-leakage containment building encloses the entire plant. Accidental escape through these several barriers is highly unlikely.

<u>"Defense in Depth" in Engineering Design:</u>

In the regulatory reviews of reactor design, great stress is placed on sound engineering design of the basic plant systems, good quality in materials and workmanship, ample margins of safety in crucial components, extensive testing of systems to insure that safe operation can be confidently expected. Nevertheless, in anticipation that failures may still occur, a system of "accident prevention" safeguards is provided to prevent anticipated perturbations from escalating into serious accidents: emergency power, backup cooling, alternate shutdown mechanisms - an extensive list of such safety measures. Finally, just in case a serious accident should occur, a series of "consequences-limiting" safeguards are provided to prevent the escape of fission products, the most notable of which is the containment envelope mentioned above.

It is clear, of course, that such redundancy of elements is provided to increase the assurance that protection will still be provided even though one or more elements fail to perform. In the final analysis, however, unless the various parts have a high degree of reliability, the entire combination of safeguards could fail to function. Hence, basic reliance must still rest ultimately on the integrity of the hardware components. Good designs for these

components, and reliable elements, such as valves, pumps, joints, welds, tubes, bolts, pipes, etc., are essential to safety.

The Necessity for Appropriate Standards and Codes of Good Construction Practice:

Recognition of this fact has been one important element in bringing the Commission to its present high priority of attention on the development of criteria, standards and codes. Extensive efforts have been, and still are being, devoted to this matter. These efforts are directed along several distinct lines:

1. The Commission has made clear, through the precedents of requirements in individual licensing cases and through the publication of safety design criteria, the general concepts of safety protection and the general level of safety standards required in nuclear facilities.

2. Initiative has been exercised in encouraging in every possible way the professional societies and the national standards organization, USASI, to expand and expedite their efforts to develop urgently needed standards in nuclear field through their voluntary collaborative procedures. To do just this, in fact, is the policy which the Commission follows. Members of the AEC staff serve on the Nuclear Standards Board and on perhaps a hundred standard-writing committees or subcommittees of USASI or the sponsoring professional societies. To the extent these efforts result in articulation of acceptable standards, it makes the Commission's task that much easier.

3. The AEC undertakes, where necessary, the development of specific code-level specifications in lieu of or as an interim measure pending the development of industry standards on items important to safety. In addition, it is also necessary for the AEC to specify additional requirements on certain systems, over and above the normal code requirements for those systems.

Collaboration with ASME Vessel Committee - An Example:

These principles reflecting the AEC approach to codes and standards are illustrated by the working relations which have existed with ASME Committee on Boilers and Pressure Vessels. Some two years ago, in a meeting between AEC staff and representatives of the ASME Code Committee, I had the opportunity to define some areas of urgent need of interest to both the AEC and the code committee. These problems included:

1. A need to upgrade the requirements of the code for vessels intended for nuclear applications, to reflect the best practices then available for construction of such vessels.

2. A need to extend the design principles and quality requirements of the code to other components of the primary system; the pumps, valves, piping, etc.

3. A need for an appropriate code of good practice on how to join the individual components into an overall high-quality system.

The Committee was invited to address itself to these challenges. The members responded with vigor and enthusiasm. I have admiration and almost astonishment at how much really difficult technical and equally difficult policy matters the Committee has been able to accomplish since that time. The pressure vessel code has been substantially upgraded; plans for qualifying manufacturers, requirements for quality assurance and further specification of inspection requirements have been included; a new code on piping is now in existence; a code on pumps and valves is nearly completed; and even further work is in progress. Frank Williams, who has been the moving power behind this meeting here today has also been the guiding genius for these significant advances in code technology. I am sure he amply deserves the rewards of retirement which he now contemplates, but I definitely view with mixed feelings the implications of this with respect to further progress in ASME code development. He is a man that cannot be spared, and I hope he will remember that in planning his retirement schedules.

Further, on ASME-AEC relationships, during the time the advances discussed above were being made, a large number of reactor applications were filed and it became apparent that the AEC would have to give guidance to applicants on an interim basis on primary system requirements over and beyond those of codes then current, while the revised codes were being developed. An ad hoc committee, within AEC, was established and supplementary criteria, beyond ASME code requirements were developed. The code committees, concurrently hard at work, were kept fully informed. After these supplementary criteria were developed for interim guidance of prospective licensees, they were supplied to the code committee for inclusion in the code or whatever other disposition they wished to make. Many of these requirements have been adopted into the revised code and others are being considered.

<u>The Goal of the Commission:</u>

The basic role of the Commission, and the goal toward which we strive in these areas, is to have codes and standards for construction and operation, established insofar as possible by industry, and monitored by industry through an in-house surveillance system to assure that the established codes of practice are in fact observed. The function of the Commission can then be fulfilled by spot-check auditing - verification to ascertain that the system is working.

It was to move toward achievement of this situation that I proposed last spring that the N-45 USASI Committee under the dedicated leadership of Murray Joslin undertake the establishment of an industry code which would establish the pattern for such a system to apply during the construction of nuclear facilities.

Specifically, this committee, now working with good momentum, is striving to provide a framework of principles and concepts by which (1) a solid and clearly defined line of responsibility for accomplishment of requirements and standards will run from one group to another throughout the whole combination of construction organizations at each project; (2) codes are defined for field manipulation on components to be carried out at the same quality level as that required in the original construction of the components... that is, field installation must not degrade the quality of components; (3) good housekeeping is regularly observed in receipt of material, verification of material quality, storage, handling, cleaning, records, labeling, etc.; (4) an effective system of in-house surveillance, auditing and inspection will assure that specifications and agreed-on practices are in fact carried out.

Closing the Verification Gap:

It is this last item that really closes the gap in any quality assurance program. That is precisely the role that you people play under the requirements of the ASME Code for boiler and pressure vessels. It is a most vital and necessary function.

In the creation of any item, component, system or facility, there are several functions that must be recognized and performed in the successive stages of development, if the furnished article is to have reasonable assurance of the quality intended.

For a major item there is, first, the identification of functions or performance goals that the item will satisfy, accompanied by design concepts and principles, and possibly preliminary design. This corresponds approximately to the construction permit stage for a nuclear reactor.

Then there is the responsibility for translation of these agreed on design concepts into detail designs, specifications, blueprints and purchase orders wherein material characteristics and all important requirements are clearly specified. The codes to be followed and the inspection, tests or other procedures to be observed to insure desired quality are also specified.

Then follows the actual manufacture of the materials and/or fabrication of components in vendors shops, followed by delivery to the user.

Finally, the item is installed, assembled with other items and constructed into a system as appropriat and readied for use. During this period there must be clear specifications and requirements as to the methods of installation, the techniques to be used, the tests to be performed, etc.

Now, through each of these four steps there are several principles that should apply:

1. There must be a direct responsibility resting on some person or group for performing the task at each stage.

2. The responsibility for the task to be performed must be clearly assigned and the important specifications and requirements to be observed or satisfied during the performance of the task must be identified.

3. The quality of the finished product depends on (a) whether the proper specifications and requirements were established, and (b) whether the specification requirements were faithfully observed. On these two issues: Are the specifications adequate? and - Were the specifications followed? ---- depend the integrity, reliability and capability of the finished product.

Now - "two heads are better than one" is not just a conversational witticism, is an absolutely essential principle that must permeate any construction program where there needs to be a high degree of assurance that 'specifications are adequate' and 'specifications are observed', which is what we mean by quality assurance.

In each of the four stages mentioned above, the line organization "action group" must bear the responsibility for doing the job --- and the ultimate outcome depends on how well they do it. But, somehow, in addition, there must be someone looking over their shoulder, double-checking their work, and concurring with the way it is done... or calling a halt until they can concur. The basic function of the auditing, double-checking group is to verify that the "action group" is proceeding or has proceeded according to specifications. At the earlier stage it is to see that detail designs and purchase specifications developed by the "action group" are actually in accord with the approved design concepts and performance goals. At the later stage, it is to verify that materials received and construction carried out are in accord with the construction specifications.

This auditing group contributes nothing tangible if the "action group" performs according to specifications; though it shares the responsibility equally with the constructor, if the latter does not follow specifications and the product is defective. On the other hand, the value of the auditing group is really exceedingly high, although its contribution may at times appear to be largely intangible. It keeps line organizations honest. Just the presence of the auditing group alone, aside from the testing, probing, measuring that it does, assures that the constructor will take extra care to observe the requirements.

Therefore, you people repr nt a vital element in the quality assurance chain; you close the verification gap -- on you rest the responsibility for certifying that the designers intention were carried over into the hardware of the finished product. Quality cannot be inspected into a plant, but without inspectors there can be no real assurance that quality is there.