UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
COMMONWEALTH EDISON COMPANY	)	Docket Nos. 50-454
	)	50-455
(Byron Station, Units 1 and 2)	)	

TESTIMONY OF LOUIS FRANK ON DAARE/SAFE
CONTENTION 9C AND LEAGUE CONTENTION 22

Frank Summary

This testimony contains the broad Staff position on steam generator tube integrity issues raised i. DAARE/SAFE contention 9(c) and League contention 22. It makes the following principle points:

1. Tube degradation problems at Westinghouse steam generators have included the following: (a) wastage and thinning corrosion,(b) pitting, (c) denting, (d) intergranular attack, (e) stress corrosion cracking, (f) wear caused by flow induced vibration, and (g) wear and/or impact damage as a result of foreign objects or loose parts.

2. Measures which have or will be taken to ensure tube integrity encompass minimization of the potential for degradation and surveillance requirements to ensure that acceptable levels of tube integrity are maintained.

3. Measures which have been taken to minimize the potential for degradation due to corrosion include improved design features, use of all volatile treatment (AVT) secondary water chemistry, and an improved program to monitor and control second water chemistry.

4. With regard to surveillance, the Byron steam generator tubes will be subjected to periodic inservice inspections in accordance with Regulatory Guide 1.83 and standard technical specifications for Westinghouse pressurized water reactors. Operational limits on allowable primary to secondary leakage will provided added assurance of adequate tube integrity.

5. The primary method for inspecting steam generator tubes is eddy current testing. Steam generator inspections typically involve inspection of a representative sample of tubes. The technical specifications require additional tube samples to be inspected depending on the number of degraded and defective tubes found.

6. The technical specification limit on allowable primary to secondary leakage is intended to assure that a tube leaking at a rate equal to or less than the limit will retain adequate integrity against rupture under normal operating and postulated accident conditions.

7. Early operating experience and lead operating PWR facilities which employ Westinghouse model D steam generators indicate that tubes in the

preheater region may be subject to excessive wear due to flow induced tube vibrations when these facilities are operated at power levels in excess of 70% full power (Model D4/D5). Measures which can be taken to minimize the potential for excessive tube vibrations are discussed in the separate testimony of Jai Raj Rajan.

8. The potential for damaging the tubes as a result of foreign objects and loose parts being present in the steam generators can be minimized by appropriate surveillance. The Applicant is required to implement Regulatory Guide 1.131 which provides, in part, for loose parts monitoring systems to be mounted on the lower plenum of each steam generator.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
COMMONWEALTH EDISON COMPANY	)	Docket Nos. 50-454
	)	50-455
(Byron Station, Units 1 and 2)	)	

TESTIMONY OF LOUIS FRANK
REGARDING DAARE/SAFE CONTENTION 9(c) AND LEAGUE CONTENTION 22

Q1. Please state your name and affiliation.

A1. My name is Louis Frank. I am a Senior Materials Engineer in the Materials Engineering Branch, Division of Engineering, NRC Office of Nuclear Reactor Regulation. A statement of my professional qualifications is attached.

Q2. What is the purpose of this testimony?

A2. The purpose of this testimony is to address the staff position with regard to DAARE/SAFE Contention 9(c) and League Contention 22 dealing with steam generator tube integrity.

Q3. Do you adopt the SER section on steam generator tube integrity as part of your testimony?

A3. Yes. I have reviewed the Staff evaluation of Unresolved Safety Issue (USI) A-3, "Westinghouse Steam Generator Tube Integrity", provided in Section C.5(A-3) of the Byron Safety Evaluation Report (SER) (NUREG-0876) issued in February, 1982 and concur in and adopt that evaluation as a part of my direct testimony.

Q4. What are the degradation mechanisms which have affected Westinghouse steam generator tubing to date?

A4. Tube degradation problems at Westinghouse steam generators have included the following:

(1) wastage and thinning corrosion;

(2) pitting;

(3) denting;

(4) intergranular attack (IGA);

(5) stress corrosion cracking;

(6) wear caused by flow induced vibration; and

(7) wear and/or impact damage as a result of foreign objects or loose parts.

Q5. What measures will be taken to assure tube integrity?

A5. Measures which have or will be taken to ensure tube integrity fall into two general categories: (1) measures to minimize the potential for degradation and (2) surveillance requirements to ensure that acceptable levels of tube integrity are maintained.

Measures which have been taken to minimize the potential for degradation due to corrosion (items 1-5 in answer 4 above) include (1) improved design features, (2) use of AVT secondary water chemistry, and (3) an improved program to monitor and control secondary water chemistry. These measures are discussed more fully in the separate testimony of Conrad C. McCracken.

Early operating experience at lead operating PWR facilities which employ Westinghouse Model D steam generators (similar to the types to be

used at Byron) indicate that tubes in the preheater region may be subject to excessive wear due to flow-induced tube vibrations when these facilities are operated at power levels in excess of 70% full power (Model D4/D5). Measures which can be taken to minimize the potential for excessive tube vibrations are discussed in the separate testimony of Jai Raj Rajan.

The potential for damaging the tubes as a result of foreign objects and loose parts being present in the steam generators can be minimized by appropriate surveillance. Examples of available surveillance methods include visual inspections with the aid of fiber optics and/or video camera devices, and loose parts (acoustic) monitoring of the steam generator during operation. Byron is being required to implement Regulatory Guide 1.131 which provides in part for loose parts monitoring systems to be mounted on the lower plenum of each steam generator. This is expected to reduce the potential for foreign objects or loose parts remaining in the steam generators for long periods of time and potentially causing damage to tubes as in the Ginna event. Additional surveillance requirements (generic) have been developed in draft form and are currently undergoing internal Staff review as a result of the Staff's evaluation of the R.E. Ginna tube rupture event in January 1982.

The above measures are expected to reduce the potential for the types of problems which have been experienced to date. However, the Staff believes that some degree of degradation is likely to occur at the Byron units during their lifetime. Given the potential for degradation, surveillance requirements are essential to ensure adequate tube integrity is maintained against rupture and excessive leakage during the full range of normal operating and postulated accident conditions. The Byron steam generator tubes will be subject to periodic inservice inspections in accordance with Regulatory Guide 1.83, "Inservice Inspection Requirements of Pressurized Water Reactor Steam Generator Tubes," Revision 1, and NUREG-0452, Revision 2, "Standard Technical Specifications for Westinghouse Pressurized Water Reactors" (STS). Operational limits on allowable primary to secondary leakage will provide added assurance of adequate tube integrity.

Q6. What are the key elements of the required inservice inspections?

A6. The Standard Technical Specifications (STS) require that inservice inspections be performed every 12 to 24 months, depending on the condition of the steam generators. In cases where the degradation processes have been highly active, the Staff has required that the inspections be performed at more frequent intervals, consistent with the rate at which the degradation is occuring. The standard method for inspecting the steam generator tubes is eddy current testing (ECT). Steam generator inspections typically involve inspections of a representative sample (i.e., percentage) of tubes. The minimum inspection sample required by the STS is 3% of

the steam generator tubes. The STS requires additional tube samples to be inspected depending on the number of degraded and defective tubes found. In this context, degraded tubes are those exhibiting ECT indications of wall penetration exceeding 20% but which are less than the plugging limit. Defective tubes are those which exceed the plugging limit. The total number of tubes to be inspected during a given inservice inspection will range between 3% and 100% of the total number of steam generator tubes.

The tube sampling requirements for inservice inspections have been established on the basis of operating experience and judgment with the goal of minimizing the potential for tube ruptures and excessive leakage during normal and postulated accident conditions while also minimizing personnel exposures incurred while performing the inspections. These sampling requirements are being reevaluated as part of an integrated Staff program relating to the Unresolved Safety Issue concerning steam generator tube integrity which includes work performed under Task Action Plan (TAP) A-3. Based upon the current status, we anticipate that this generic program may result in additional criteria for determining the necessary additional sampling if degraded or pluggable indications are found during the initial 3% sample. These requirements may include criteria that additional sampling following the initial 3% sample be developed on a statistical basis consistent with the tolerable number of tube failures during normal operating and postulated accident conditions as determined by systems analysis.

Q7. What is the basis for the plugging limits which are used to determine whether a tube shall be removed from service?

A7. The plugging limits are based upon the minimum remaining wall thickness of tubing which is required to maintain acceptable structural margins against a tube rupture over the full range of normal operating and postulated accident conditions. The plugging limits incorporate allowances for eddy current measurement error and for additional incremental corrosion between inspections.

Q8. Describe the effectiveness of eddy current testing in monitoring tube integrity.

A8. Eddy current testing (ECT) has proven to be a generally reliable technique for purposes of monitoring tube integrity as substantiated by operating experience. The industry has encountered some difficulty in detecting and quantifying very small volume flaws such as intergranular attack, stress corrosion cracking, and fatigue cracks. The industry has made considerable progress in improving its detection capabilities in this regard including the development of multiple frequency techniques and new ECT probe designs. There is much ongoing effort by the nuclear industry and through NRC-sponsored programs in this area and improved techniques are incorporated as they are proven viable. Regarding present ECT capabilities, the Staff believes that small flaws of structural significance (in terms of length and depth of penetration) are generally detectable. Where flaws have gone undetected and resulted in leaks, the leaks have generally been small and of little consequence. The restrictive leakage rate

limits in the plant technical specifications provide assurance that the unit will be shutdown in a timely manner for appropriate corrective action.

Q9. How do primary to secondary leak rate limits contribute to the assurance of tube integrity?

A9. The limit on allowable primary to secondary leakage is intended to assure that a tube leaking at a rate equal to or less than the limit will retain adequate integrity against rupture under normal operating and postulated accident conditions. Experience has shown leakage events to provide an important indication of the existence of new degradation phenomena, that degradation is developing at an unanticipated rate, and/or the need for licensing action or remedial pressures to provide added assurance of tube integrity.

Q10. What is the Staff position regarding interim operation pending resolution of the Unresolved Safety Issue regarding steam generator tube integrity.

A10. This Unresolved Safety Issue is not considered to be of sufficient concern to delay licensing of new PWR facilities. Operating experience has demonstrated that current regulatory requirements have been generally successful in maintaining acceptable structural margins against tube ruptures. Where new or unanticipated degradation problems have occurred, these problems have been revealed either during routine inservice inspection or as a result of leaks and appropriate action has been taken at that time. In some cases, the action has included additional inspection requirements or operational limitations imposed by the Staff. In addition, the

plant operators have been able in many instances to take remedial measures to reduce the potential for further problems. Leaks when they have occurred have generally been small. Although there have been four instances of tube ruptures involving leakage (between 80 and 700 gallons per minute), these single tube ruptures have been within the design basis for the plants and there were no significant offsite releases. Two of these rupture occurrences have been corrosion related (Point Beach 1 in 1975 and Surry 2 in 1976). The conditions which led to these ruptures are not expected to occur at the Byron units. The use of AVT secondary water chemistry and improved monitoring and control of secondary water chemistry is expected to reduce the potential for the conditions which led to these corrosion related ruptures. In the case of the Surry rupture, severe denting has been determined to be a necessary precondition for the failure. The Staff would expect severe denting to be identified during inservice inspection in time to permit appropriate corrective action. The two other rupture events (Prairie Island 1 in 1979 and R.E. Ginna in 1982) are attributable to damage caused by foreign objects and loose parts. Byron is being required to install a loose parts monitoring system on the lower plenum of each steam generator which is expected to reduce the potential for similar tube ruptures.

Ongoing Staff studies as part of the Unresolved Safety Issue may result in additional requirements relating to inservice inspections of the steam generators to provide added assurance of

tube integrity. Pending the conclusion of these studies, the Staff has concluded that the current surveillance requirements will provide reasonable assurance that operation of the Byron steam generators will not adversely affect public health and safety. Added assurance of safe operation is provided by measures which have been taken at Byron to reduce the potential for many of the types of degradation which have been observed at operating plants to date.

LOUIS FRANK
DIVISION OF ENGINEERING
OFFICE OF NUCLEAR REACTOR REGULATION
PROFESSIONAL QUALIFICATIONS

My name is Louis Frank, I am a Senior Materials Engineer in the Inservice Inspection Section, Materials Engineering Branch, Division of Engineering, Office of Nuclear Reactor Regulation, of the United States Nuclear Regulatory Commission. In my present position, I am responsible for performing technical reviews and evaluations of PWR steam generator tube surveillance and repair programs for NTOL and operating plants.

I hold a Bachelor of Science Degree in Metallurgical Engineering and a Master of Science Degree in Metallurgy from the University of Kentucky and New York University, respectively. I am also a Registered Professional Engineer in the State of Maryland.

I have a total of thirty-one years of professional experience of which thirty years has been in the nuclear field. I was employed as a materials research engineer at General Telephone & Telegraph's Atomic Energy Labs in Bayside, N.Y. starting in 1952. From 1955 thru 1963 I was a supervisory engineer in nuclear materials research and development at the Martin Co's. nuclear division. From 1963 thru 1973 I was with two consulting firms engaged in nuclear safety studies.

Since joining the NRC in June 1973 I have been involved in corrosion and steam generator issues. In the Office of Standards I prepared regulatory guides on steam generator inspection and plugging. In the Office of Research I managed programs involving eddy-current inspection, particularly developing advanced techniques for conducting eddy-current inspections.