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AECB STAFF ANNUAL REPORT ON PICKERING NGS FOR THE YEAR 1989

Canada

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1. INTRODUCTION

The operation of Pickering NGS-A Units 1-4 and Pickering NGS-B Units 5-8 is *monitored to ensure compliance with licensing requirements by the AECB* Pickering project office staff in cooperation with AECB staff in Ottawa.

This report presents AECB staff's review of major licensing issues and of the operational performance of Pickering NGS during 1989. The report is limited to those aspects that AECB staff considers to have particular safety significance. More detailed information on performance is contained in Ontario Hydro's 1989 Quarterly Technical Reports for Pickering NGS-A and Pickering NGS-B.

2. STATION OPERATION - PICKERING NGS-A AND -B

During 1989, the following capacity factors were achieved:

Unit 1:	71%	Unit 5:	75%
Unit 2:	74%	Unit 6:	87%
Unit 3:	38%	Unit 7:	75%
Unit 4:	50%	Unit 8:	95%

For Pickering NGS-A, the station net capacity factor for 1989 was 58% compared to the overall lifetime capacity factor of 69%

For Pickering NGS-B, the station net capacity factor for 1989 was 83% compared to the overall lifetime capacity factor of 85%.

Unit 3 was shut down on June 3, 1989, for a 23-month planned outage for the replacement of pressure tubes (retube) and rehabilitation work similar to that which was completed in 1987 and 1988 for Unit 1 and Unit 2.

In Unit 4, retube is scheduled to begin in 1991, although the majority of rehabilitation work has been completed during an outage which extended into 1989. Rehabilitation work included, among other things, installation of a high pressure emergency core cooling system, conversion of ten adjusters to shut-off rods, and installation of a new rupture panel system in containment.

Unit 4 was restarted in April, 1989, following recommissioning of the modified systems, and after the requisite pressure tube inspection data was obtained indicating pressure tube fitness for service for at least one more year. An inspection and maintenance program to demonstrate fitness for continued service for a further one-year period up to the beginning of retube in 1991 was submitted in April, 1990.

A program for demonstrating the concept of dry storage of spent fuel above ground is continuing at Pickering NGS. A second concrete integrated container (CIC) loaded with 384 bundles of spent fuel that has been cooled for six years was moved to outdoor storage in November, 1989, adjacent to the first CIC. Both CIC's are being monitored for radiation levels, surface contamination and real integrity for the duration of the test period ending in 1990, after which time the fuel will be returned to the Auxiliary Irradiated Fuel Bay.

Pickering NGS is expecting zebra mussel infestation to begin in the summer of 1990. The zebra mussel is a small mollusc (adults reach a length of 1-3 cm) native to the Black, Caspian, and Azov Seas, that was discovered in Lake Erie in 1988. The mussel raises immediate concerns for raw water systems because it can obstruct the flow of water through pipes, hoses, screens, and condensers when it occurs in substantial numbers. Biofouling attributed to this mussel was observed at several power plants, water treatment plants, and processing and industrial facilities along Lake Erie in 1989. At one power plant, densities as high as 700,000 per square metre were observed in the intake canal. At a Monroe, Michigan, water treatment plant, flow in a 30-inch pipe was reduced by 20% in just a few months. At present, chlorination of the water at the inlet appears to be the most effective and practical method of mussel control. Pickering NGS is currently developing a mussel abatement program for its various raw water systems. Chlorination will be used as the control method in the short term.

3. AECB STAFF REVIEW OF OPERATION SAFETY ASPECTS

3.1 Operation Common to Pickering NGS-A and Pickering NGS-B

3.1.1 Station Compliance with Operating Licences

During 1989, there were 15 violations of the operating licences, of which 11 were violations of the Operating Policies and Principles (OP&Ps) and one was a violation of the Ontario Hydro Radiation Protection Regulations. In addition, there were 3 violations of the Atomic Energy Control (AEC) Regulations. These are listed in Appendix D.

The number of violations has increased compared to 1988. In last year's annual report, the AECB staff concluded that the number of violations indicated that working level staff had an inadequate understanding of the conditions and requirements of the licences and regulations. In addition, Ontario Hydro did not appear to have a program in place to monitor compliance with the licences and regulations. During 1989, Ontario Hydro instituted a staff training program on licensing and regulatory requirements, and a review of all numerical licensing limits in order to verify that, for each such limit, there was a specific means of ensuring compliance. By year end, the staff training had been completed, but a number of actions pertaining to numerical licensing limits remained outstanding. These are scheduled to be completed by December, 1990.

Despite these training and compliance monitoring program, the number of violations kept increasing in 1989. However, early indications in 1990 show a decreasing trend in the frequency of violations. AECB staff will continue to monitor closely performance in this area and will ensure that current efforts are maintained and, if necessary, augmented.

3.1.2 Quarterly Reports

Ontario Hydro submits technical reports on a quarterly basis, which together summarize station operation for the year. During 1989, these were submitted in a timely manner. The reports have been reviewed by the AECB staff and, in general, were found to reflect accurately station operation for 1989. AECB staff comments on specific topics are given in the following sections of this report.

3.1.3 Radiation Protection

On August 9, 1989, three workers were exposed to radiation doses in excess of the regulatory limits while removing an irradiated cobalt adjuster from Unit 1. The overexposures occurred because the workers used an unshielded adapter, intended for use only in rehearsals with non-radioactive components, in place of the proper shielded adapter. The unshielded adapter had not been clearly identified, prior to the job, as being unsuitable for use on the reactor.

Two of the workers received gonad doses (127 and 92 mSv) in excess of the annual limit of 50 mSv. One of these workers also exceeded the annual limits on doses to bone, bone marrow and skin, and the quarterly limits for doses to the hands, lungs and other organs. The third worker received a skin dose 740 mSv) which exceeds of the annual dose limit of 300 mSv; he also received a dose which exceeded the quarterly limit for doses to the feet.

As a result of these overexposures, charges were laid against Ontario Hydro under the Atomic Energy Control Act. These charges are still before the court.

Total whole body doses for all workers at Pickering NGS for 1989 was 8.89 Sv, compared to the previous year's total of 7.46 Sv.

The whole body dose distribution for 1989 may be summarized as follows:

Dose (Annual whole body dose limit = 50 mSv)	Number of Individuals		
	Pickering NGS-A*	Pickering NGS-B	Total
No dose assigned	1052	56	1108
<5 mSv	815	354	1169
5 to 10 mSv	271	57	328
10 to 15 mSv	151	8	159
15 to 20 mSv	61	3	64
20 to 25 mSv	6	0	6
25 to 50 mSv	0	0	0
>50 mSv	1**	0	1

* Doses for those working on both stations are reported under Pickering NGS-A

** The table covers only individuals whose dosimetry year ended in 1989, therefore only one of the overexposures is included.

3.1.4 Station Effluents and Environmental Monitoring

3.1.4.1 Effluent Release

No major events leading to large unplanned emissions of radioactive material occurred during 1989.

On one occasion during 1989, airborne tritium releases exceeded 1% of the weekly emission limit. This was due to a spill of moderator water in the Unit 4 moderator room on January 16, resulting in a release of 1.2% of the limit for the week. Except for this, the gaseous emissions via monitored pathways for tritium, iodine-131, particulates, noble gases and carbon-14 were all less than 1% of the Derived Emission Limits (DEL) for each group.

The liquid emissions for tritium and for gross beta-gamma were also less than 1% of the DEL's.

Each year, a number of significant event reports (SERs) arise as a result of breakdowns in compliance effluent monitoring. In most cases, Ontario Hydro is able to estimate emissions for the duration of the interruption. However, it is possible that an unexpected release of radioactive material could occur while compliance equipment is either failed or out of calibration. The magnitude of such a release would be difficult to estimate. In view of this, and given Condition A.A.7 of the Pickering NGS-A and -B operating licences which stipulate that the rate of release of prescribed substances shall be monitored, Ontario Hydro was asked to clarify how compliance with this licence condition is assured, and what would be considered a reportable event for compliance monitoring. AECB staff will review this matter further once a reply has been received.

At Pickering NGS-A, the reliability of both liquid and gaseous effluent compliance monitoring improved markedly in 1989. At Pickering NGS-B, the reliability of liquid effluent compliance monitoring also improved over the previous year. Table 2 on page 24 lists the number of compliance monitoring interruptions which occurred during 1988 and 1989. Although compliance monitoring reliability has increased, AECB staff believes that further improvement is both practical and necessary.

3.1.4.2 Environmental Monitoring

Environmental surveillance data in the vicinity of Pickering NGS are collected routinely by Ontario Hydro and analyzed to determine the levels of radioactive materials in the environment due to the operation of the station, and to assess the radiation dose to the public from such operation.

During 1989 tritium was detected in concentrations statistically greater than background in air, precipitation, drinking water, milk and local produce. Carbon-14 was also detected above background levels in food, vegetation and in milk from the surrounding area.

The resulting dose to a member of the critical group, a 6-month old infant, was assessed to be 43.5 uSv (micro sieverts), which is less than 1% of the regulatory limit. The population dose from all emissions was assessed to be about 2.1 person-Sv. The individual doses are listed on page A2. For 1989 they were slightly lower than for 1988, but the population dose was higher. The increase in the population dose is primarily due to refinements in the methodology used in the dose calculation.

AECB staff considers the results of the environmental monitoring program to be acceptable.

3.1.5 Audits and Appraisals

An audit of the Pickering NGS operations quality assurance (QA) program was carried out by AECB staff in March, 1989. It covered the use of temporary instructions, surveillance testing, system surveillance, equipment calibration, material control, work control, and the implementation of corrective measures resulting from significant event reports (SER's).

In general, procedure compliance was found to be good. However, a number of specific points, both positive and negative, were identified. One quality observation directive, three quality observation action notices and one recommendation were issued.

To date, corrective action being taken by Ontario Hydro in response to this audit has been satisfactory.

In October, 1989, AECB staff conducted an appraisal of the radiation protection planning and preparation for the rehabilitation and retubing of Unit 3. The scope of the appraisal included such topics as the radiation protection training of workers and of work planners, the radiation protection aspects of the work planning process, the roles and responsibilities of the key individuals in the construction and operations groups, and the documentation describing these topics and their interrelationships. The appraisal team concluded that, in general, the radiation protection planning and preparation for the rehabilitation and retubing of Unit 3 is well organized and competently executed. Both strengths and weaknesses were identified and were made known to Ontario Hydro staff.

The completion of outstanding actions from health physics appraisals of previous years, however, continues at a rate which AECB staff considers unacceptably slow. Measures taken by Ontario Hydro to correct this shortcoming were discussed at the annual review meeting in April, 1990.

An audit of radioisotope licence compliance at Pickering NGS was carried out in May and June, 1989. Some items of non-compliance with radioisotope licence conditions and with the Atomic Energy Control Regulations, specifically with Sections 20 and 22, were observed. AECB staff considers the corrective actions being implemented by Ontario Hydro to date in response to these findings to be acceptable.

3.1.6 Training

The success rate achieved on the AECB general examinations for both plants was 33 out of 34 candidates. For the specific examinations at Pickering NGS-A and Pickering NGS-B, the results were 14 successful candidates out of 17 and 8 out of 8 respectively. This is a slight decrease in performance for the A station.

Job Task Analysis (JTA) data for the Pickering NGS-A operator position was updated by the Eastern Nuclear Training Centre to meet the plant's rehabilitated status and current operating procedures. Integration of the final product into the training program remains to be done.

JTA results for the Pickering NGS-B shift supervisor position are currently being applied to the development of shift supervisor general training material (eg: reactor safety and nuclear theory).

The simulator-based initial 'dry-runs' of the continuing training program were suspended as a need for methodology changes became evident. The original approach was designed to measure the performance of individuals, whereas a need to measure both team and individual performance became apparent. Appropriate modifications are underway.

Emphasis towards integrating JTA results into training programs, and completing the development of the continuing training programs for authorized staff is expected.

3.1.7 Emergency Exercises and Drills

3.1.7.1 Radiation Emergency Practices

Each shift crew from Pickering NGS-A and Pickering NGS-B completed their two scheduled radiation emergency practices.

3.1.7.2 Seismic Emergency Practices

Only one shift crew from Pickering NGS-B held a seismic emergency practice. Two practices per shift crew are scheduled. Apparently an oversight in the transfer of information to the new computerized work management system resulted in the practices being missed.

3.1.7.3 Station Radiation Emergency Exercise

The annual station emergency exercise was delayed until early in 1990, as approved by the AECB. AECB staff acting as observers during the exercise found that the overall response was satisfactory, but noted that some improvements should be made in the area of communications between work groups and the Pickering Emergency Response Centre (located at the station). *At the time of writing, AECB staff is still waiting for Ontario Hydro's* report on the results of the exercise.

3.1.7.4 Radiation Emergency Procedures

During 1989, the Pickering Radiation Emergency Procedures were significantly improved through an extensive revision. AECB interim approval for implementation of the revision was given pending the outcome of a station radiation emergency exercise in which the new procedures would be practiced.

Such an exercise was held in January, 1990 (see previous section). Final AECB approval is in abeyance pending the results of the January exercise and the completion of other actions to improve further the procedures.

3.1.8 Security

There were three reportable security events during 1989. There are no outstanding actions arising from any of these reports.

Construction work on a replacement perimeter fence is in progress. Some delays have been experienced due to construction difficulties. Adjustments have been made to the work program to minimize the impact on the overall schedule.

The Security Unit conducted a total of 24 exercises in 1989, including a large scale exercise carried out in conjunction with Durham Regional Police.

3.1.9 Station Maintenance

Last year AECB staff reported on the large backlog of maintenance of fuel handling system components which resulted in frequent unavailability of fuelling capability on the reactors. During 1989, improvements have been observed as a result of stabilization of the maintenance work-force, utilization of a new high pressure water jet decontamination system and use of a new type seal on the fuelling machine rams. In spite of these improvements, breakdown maintenance continues to dominate with not enough attention being given to planned maintenance. Ontario Hydro is working toward alleviation of this situation.

In 1989, the Pickering NGS-B units still suffered from lack of refuelling to the extent that the reactors were operated frequently with adjusters withdrawn. The main cause appears to be unavailability of qualified fuel handling operators to carry out fuel handling operations. This situation is prevalent at Pickering NGS-B, but not at Pickering NGS-A. Ontario Hydro is currently assessing the situation and possible corrective actions.

Pickering NGS has in place a system surveillance program designed to satisfy several objectives, two of which are:

- to ensure the station is operated and maintained in a manner which is consistent with the operating licences, Operating Policies and Principles, and associated safety documents.

- to ensure the system performance is routinely monitored and where necessary tested in a systematic fashion such that trends toward degradation of performance and documentation are identified early and corrective actions are taken.

AECB staff views system surveillance as an important aspect of station operation to give added assurance of station compliance with the conditions of the operating licences.

Surveillance of systems by the Technical Section has gradually deteriorated to the point where it is clearly less than adequate to meet the stated objectives. The main reasons given for this are the high work load arising from Engineering Change Notices (design changes to be implemented at the plant), and the lack of qualified system engineers.

It is the view of AECB staff that the continuing backlog of maintenance work, the excessive emphasis on breakdown rather than preventive maintenance and the lack of adequate surveillance cannot be tolerated for an extended period of time. Ontario Hydro is working on increasing the number and upgrading the skill level of its maintenance staff. In addition, improvements in the engineering support for maintenance work is expected to lead to improved quality and more effective preventive maintenance. Several initiatives to improve maintenance efficiency and effectiveness are being studied.

Ontario Hydro is also adding staff to the Technical Section and anticipates some improvement in surveillance before the end of 1990. AECB staff will continue to monitor the situation closely.

3.1.10 Station Management

The AECB approved two acting management appointments to accommodate the assignment of the station manager to the Main Bargaining Committee for the renegotiation of the Ontario Hydro contract with the Ontario Hydro Employees Union, CUPE Local 1000. The temporary assignments became effective November 1, 1989 for a 5 month term.

During 1989, the number of infractions of the operating licences and the AEC Regulations doubled compared to 1988. AECB staff considers that the continuation of this situation is unacceptable and that appropriate corrective actions must be taken to reduce the frequency of infractions. Station management has initiated a number of actions to improve compliance as discussed under Section 3.1.1. 1990 operation to date shows a decreasing trend in the frequency of violations.

A number of reportable events during 1989 were the direct result of failure to follow procedures. A particularly notable example was the isolation of a boiler safety valve (see Appendix C, SER A-89-182). In the view of AECB staff, failure to follow procedures is a serious matter as plant safety is highly dependent on procedural compliance. At the annual review meeting

(April, 1990), station management confirmed that this issue will be addressed through various facets of the Ontario Hydro Quality Improvement Program (submitted to the AECB in March, 1990). AECB staff will be monitoring progress closely.

Housekeeping has been an area of continued deficiency in 1989 (see Section 3.1.11). This matter has been discussed with station management on several occasions, and although some actions have been taken, the focus of these is not clear and overall progress has been slow. AECB staff considers that the current situation is unacceptable and that a program of actions with specific targets for improvement is required. At the annual review meeting, Ontario Hydro presented a comprehensive housekeeping improvement plan which addresses all significant problem areas. A performance program is included to monitor progress. AECB staff is pleased to see the introduction of such a plan and will check progress on a routine basis.

3.1.11 AECB Staff Inspections

Field inspections have revealed no improvement from the previous year, when a large number of deficiencies had been observed, especially in the following areas:

- Housekeeping
- Identification of hazards, conventional and radiation
- Storage of equipment

Some incidents causing safety system unavailability and which could be linked to improper housekeeping, have been reported (Refer to SER A-89-136 and SER A-89-186 in Appendix C). In addition, two lost-time accidents occurred during the year which have been linked to conventional hazards caused by improper housekeeping. Equipment leakage and station cleanliness continue to be problem areas.

A lack of properly designed facilities has resulted in the temporary storage of equipment and material in less-than-adequate areas. Examples are the storage of radioactive waste oil in temporary facilities, and heavy water drums located in many areas of the plant unsuitable for this purpose. The use of such temporary storage and the frequent movement of items that it entails also result in difficulty ensuring compliance with the AEC Regulations dealing with the posting of radiation hazards.

AECB staff believes that a major clean-up effort to improve the housekeeping, and a cleanliness program is necessary (see also Section 3.1.10 above).

3.2 Pickering NGS-A

3.2.1 Process Systems

There were no serious process failures in 1989. (A serious process failure is a failure of a process system or procedure which, in the absence of Special Safety System action, could lead to significant fuel failures in the reactor or a significant release of radioactive material from the station).

Two potentially serious process system failures, classified as Type B process system faults (see Table 1) occurred during the year. These failures involved cracked primary heat transport system feedlines in both Unit 1 and Unit 4, and are discussed further under SER A-89-33 and -175 in Appendix C.

3.2.2 Chemistry Control

During 1989, overall chemical control performance at Pickering NGS-A was below target. Chemical control performance is determined from a combination of process equipment performance, laboratory performance, and chemical control performance for systems as measured by the percentage of sample results within specification. Laboratory performance and system chemical control were consistently below target.

Laboratory performance suffered from a staffing shortage throughout the year. New staff is being hired and trained.

Difficulties with the feedwater system and the water treatment plant resulted in below target system chemical control. The poor performance index for the feedwater system was largely due to high oxygen levels in the condensate water attributed to in-leakage of air at the turbine condensers. A systematic "leak search and seal" program has been implemented. A project to upgrade the performance of the water treatment plant is also under way.

It is clear that these and other improvements are required to restore acceptably good overall chemical control performance at Pickering NGS-A.

3.2.3 Performance of Special Safety Systems

Events which caused unavailability of the containment and emergency core cooling systems occurred in 1989. These and other reportable events are discussed in Appendix C. The actual past and predicted future unavailabilities are summarized in Appendix A.

The process used for predicting future unavailability of the Special Safety Systems is, in the view of AECB staff, not rigorous enough. As a result, the accuracy of the prediction of future unavailability is uncertain.

Ontario Hydro is currently producing new models as part of the risk assessment for Pickering "A". Pickering "B" risk assessment is scheduled for later.

Other aspects of special safety system performance are discussed in the following:

3.2.3.1 Shutdown System (SDS)

No unavailability was recorded for the Pickering NGS-A shutdown systems for 1989.

The shutdown system in Unit 3 was taken out of service in August after the fuel had been removed in preparation for retube and rehabilitation. At year end, the unit remained in the defuelled guaranteed shutdown state with the shutdown system out of service.

3.2.3.2 Containment System

The target unavailability for this system is 3 x 10-3 years/year. Containment unavailability for each unit for 1989 was 2.32 x 10-3 years/year.

Many components of the containment system are shared between both Pickering "A" and Pickering "B". Although the actual unavailability was less than the allowable target for Pickering "A", it nevertheless exceeded 1 x 10-3 which is the target for Pickering "B". AECB staff therefore considers that the availability of the system should be improved.

AECB staff comments on the predicted future unavailability of the containment system are discussed in Section 3.3.3.2.

Reactor building leakage rate measurements were carried out in Unit 3 in September, 1989. The measurements were made at 13.8 kPa(g) and 27.6 kPa(g), and at the design pressure of 41.4 kPa(g). The leakage rates were below the operational target of 1% of contained mass per hour in all cases. The safety analysis assumes leakage rates of 2.7% contained mass per hour.

With Unit 3 in the defuelled guaranteed shutdown state, a bulkhead to separate Unit 3 from the pressure relief duct and the negative pressure containment system was installed. Upon bulkhead installation, AECB staff approved the relaxation of the Unit 3 containment system on several occasions to permit the transfer of large equipment into the reactor building, requiring both inner and outer equipment airlock doors to be open at the same time. At year end, the bulkhead remained in place and the reactor building remained isolated from the negative pressure containment system.

3.2.3.3 Emergency Core Cooling System (ECCS)

The ECCS exceeded its target unavailability of 3 x 10-3 in Units 1 and 2 (Unavailabilities for 1989 were: Unit 1 - 23.7 x 10-3, Unit 2 - 182.9 x 10-3, Unit 3 - 0, Unit 4 - 0.42 x 10-3). Contributors to the unsatisfactory performance in Unit 1 included unavailability of moderator sump pumps on one occasion, and on another, existence of an opening in the fuelling machine service room recovery sump screen large enough to allow debris to enter and block the emergency coolant injection recovery system. The poor performance in Unit 2 was due to the existence of an opening between the moderator purification room and the moderator room. The size of this opening (100 cm2) was such that leakage of primary heat transport system and ECCS water could exceed the capacity of the moderator room sump pumps, thereby jeopardizing the operation of the moderator pumps (which are required for ECCS recovery operation).

Remedial measures have been taken by Ontario Hydro to prevent recurrence of similar events.

In Unit 3, ECCS was taken out of service and remained so at year end, as the unit was in a defuelled guaranteed shutdown state for retube and rehabilitation.

3.2.4 Reportable Significant Events

A list of events reported pursuant to the Pickering NGS-A operating licence is given in Appendix C.

3.2.5 Measures of Station Performance

As an indication of the quality of overall station operation, measures of the performance of Pickering NGS-A, as evaluated by AECB staff, are attached in Appendix A. The data contained in this appendix were taken from Ontario Hydro reports and records.

Several factors indicated a need for improvement. These were: occupational dose exceeding regulatory limits, availability of containment and of ECCS, the total number of reportable events, the number of operating memos, jumper records, call-ups, and deficiency reports in effect at year end, and the number of AECB action items outstanding at year end.

3.3 Pickering NGS-B

3.3.1 Process Systems

There were no serious process system failures in 1989.

There was one potentially serious process system failure (Type B) during the year. The event is described in Section 3 of Appendix C, under SER B-89-80.

3.3.2 Chemistry Control

Ontario Hydro Quarterly Technical Reports in 1989 indicate a slight improvement in the overall chemical control performance at Pickering NGS-B over the previous year, but still slightly below target. It should be noted that station targets for both Pickering NGS-A and -B were set at levels less demanding than the Ontario Hydro Nuclear Generation Division standard in the area of system chemical control performance as measured by the percentage of sample results within specification.

Problems continued with chemical control in the following areas; dissolved oxygen content in the condensate, silica and sodium content in the demineralized water from the water treatment plant, and dissolved deuterium level in the heat transport system coolant.

Efforts in these areas have included the purchase of condenser leak search equipment in 1989, and the development of an inspection program aimed at finding and reducing air ingress to the condensers. Another initiative was to purchase a highly efficient resin to improve the quality of demineralized water; it was still awaiting installation at year end. A plan to change the primary heat transport hydrogen supply to a bulk supply, in order to provide a more stable supply pressure, was not finalized by the end of the year. This modification will assist in controlling the dissolved deuterium/hydrogen levels in the heat transport system.

Progress in achieving improved chemical control in problem areas has been slow in 1989, although appropriate corrective actions appear to be in hand. AECB staff will continue to monitor progress in this area.

3.3.3 Performance of Special Safety Systems

Several events occurred in 1989 which caused unavailability of special safety systems. A complete list of these events is included in Appendix C. The actual past and predicted future unavailabilities are summarized in Appendix B. Specific aspects of special safety system performance are discussed in the following.

3.3.3.1 Shutdown Systems

Except for the SDS2 in Unit 8, the shutdown systems in all units met their availability targets of 10-3 years/year in 1989.

The actual unavailability for Unit 8 SDS2 was 17.32 x 10-3. The majority of the Unit 8 SDS2 unavailability arose from the simultaneous failure of two mercury wetted relays. See Appendix C SER B-89-150/151 for further details. See also Section 4.3.2.

The predicted future unavailability of SDS1 is 1.87 x 10-3 and this continues to exceed the target of 1X10-3. A major contributing cause is the fact that the shutoff rod multiplying relays cannot be fully tested while the reactor is operating. Ontario Hydro is modifying the system to correct this deficiency. This modification is expected to be completed on all units in 1990.

3.3.3.2 Containment System

Containment unavailability for each unit for 1989 was 2.3 x 10-3. The vacuum building isolation subsystem continues to make an unacceptably large contribution to the predicted future unavailability of the containment system. This is due to lack of redundancy in the vacuum pump isolation valves. It is the opinion of the AECB staff that duplicate isolation valves should be provided on both the main volume and upper chamber vacuum pumps. To date, Ontario Hydro has committed duplicate valves on the main volume pumps but not on the upper chamber pumps. Discussions with Ontario Hydro on this matter are continuing.

3.3.3.3 Emergency Core Cooling System (ECCS)

There were no availability periods recorded for the ECCS in 1989. The predicted future unavailability meets the target of 10-3.

3.3.4 Reportable Significant Events

A list of events reported pursuant to the Pickering NGS-B operating licence is given in Appendix C.

3.3.5 Measures of Station Performance

As an indication of the quality of overall station operation, measures of the performance of Pickering NGS-B, as evaluated by AECB staff, are attached in Appendix B. The data contained in this appendix were taken from Ontario Hydro reports and records.

Improvement is necessary in the areas of plant control, special safety system availability, operating memos, jumper records and call-ups and the number of AECB action items outstanding at year end.

4. SIGNIFICANT LICENSING MATTERS AND ACTIVITIES

4.1 Common to Pickering NGS-A and Pickering NGS-B

4.1.1 Steam Line Failures Outside Reactor Building

Steam and feedwater system failures in the powerhouse would result in harsh environmental conditions which could adversely affect reactor shutdown, containment and heat sink capabilities. In July, 1984, Ontario Hydro was asked to carry out reviews on Pickering NGS-A and -B. The study was carried out in two phases. The phase I study focused on localized failures where the release of steam and water could affect equipment located close to the failure but would not affect equipment remote from the failure. The phase II study is a review of the consequences arising from the main steam line failures in the powerhouse. The major recommendations for Pickering NGS-A are as follows:

1. Provide structural reinforcement to ensure the integrity of the south wall of the powerhouse.

2. Install emergency steam venting system in the powerhouse.

3. House and ventilate essential class I and II electrical equipment.

4. Install an interstation electrical transfer bus to supply Pickering NGS-A 600V class II buses from Pickering NGS-B. (With this arrangement, the Pickering NGS-A class I batteries will be capable of supplying power to the 250 volt DC control circuits for a prolonged period.)

5. Provide a water supply from Pickering NGS-B to the Pickering NGS-A boilers so that the boilers may be relied upon as the long term heat sink.

6. Install piping restraints for steam piping located above the control equipment rooms to protect the control equipment rooms and the control room air conditioning penthouse enclosures from pipe whip effects resulting from failure of the steam piping.

7. Reroute the Units 1, 3 and 4 120V and 48V Bus B cabling and the Unit 4 TPS (third power supply) cabling from the switchgear in the turbine auxiliary bay to the control equipment rooms so that these cablings will be immune to main steam piping failures.

8. Provide additional control room protection and ventilation so that the control room will remain habitable following a main steam piping failure above the control equipment room.

Upon review of the Pickering NGS-B design, Ontario Hydro concluded that recommendations 1, 2, 3, 6, and 8 also apply, in whole or in part, to this station.

The in-service date for the Pickering NGS-A powerhouse environmental modifications remains unchanged, which is 1991 for Units 1,2 and 3. Unit 4 is scheduled to enter into a 19-month retube outage in March, 1991, and the modification for this unit will be completed during the long outage. The in-service date for the Pickering NGS-B modifications has been advanced by 6 months to July, 1993, which is a significant achievement in view of the design complexities. As an interim measure to provide added assurance of piping integrity during the implementation of the protective modifications, Ontario Hydro have been inspecting a number of welds on the main steam and feedwater piping. So far, inspections have been completed on Units 2,5,6 and 7 and no service-induced defects were found in the welds. Minor slag indications were found in some welds but these were not considered detrimental to weld integrity. Unit 3 and 8 inspections are being carried out at this time while the Units 1 and 4 inspections are scheduled to be done during the May, 1990, outage.

An audit of the Pickering NGS-A steamline restraint system design and stress analysis was conducted by AECB staff and resulted in two actions on Ontario Hydro. One was to further assess the acceptability of the chosen welding specifications and the other one was to re-evaluate the adequacy of the restraint design against the effect of higher boiler steam pressure at reactor powers below 100% full power. AECB staff was otherwise satisfied that the restraint design and stress analysis were well done. A second audit has been initiated on the computer software application in the powerhouse venting system.

In response to an AECB staff suggestion, Ontario Hydro has arranged technical reviews on the four major modifications, i.e. emergency venting, inter-station transfer bus, emergency boiler water supply and main steam line pipe restraints, as well as a general overview. These technical reviews will further assure the design adequacy of the modifications.

AECB staff considers that the progress of the powerhouse environmental protection modifications is acceptable. AECB staff will continue its review and audit of selected topics and will continue to monitor progress via periodic meetings with Ontario Hydro.

4.1.2 Filtered Air Discharge System

The filtered air discharge system (FADS) is designed to allow filtered venting of containment following a loss of coolant accident (LOCA) with fuel failures. This would maintain the pressure inside containment sub-atmospheric to minimize the risk of unfiltered release of radioactive material. However, it is important that the filter effectiveness be verified prior to initiating any releases to the environment and that the magnitude of the releases be known. In order to permit this, Ontario Hydro has installed a recirculation line which allows air to be recirculated through the filters and returned to the containment system. Sampling and analysis of the recirculating flow would verify filter effectiveness and indicate the rate of release of radioactive material.

Additional changes will allow the system to draw from the vacuum building, rather than the pressure relief duct. This has the advantage that it should further reduce public doses, since the concentration of radioactive materials would be less in the vacuum building and since it would allow intermittent venting during periods when the atmospheric dispersion conditions are most favorable. (These changes were completed during the vacuum building outage in May, 1990).

4.1.3 Post-LOCA Radiation Monitoring

An Ontario Hydro review, submitted in 1988, identified a number of deficiencies in station equipment and procedures for monitoring radioactive releases, and controlling the spread of radioactive contamination within the plant, following a loss of coolant accident (LOCA). The most significant finding was that equipment and procedures for the transportation and analysis of samples from the filtered air discharge system (FADS) stack monitoring system were inadequate. Ontario Hydro has proposed construction of a portable, seismically qualified laboratory to analyze these samples. The proposed laboratory would normally be located close to the FADS stack monitoring room to minimize the transportation required for sample analysis. However, in the event that this area was uninhabitable because of high radiation or for any other reason, the laboratory could be relocated. The target date for placing the proposed laboratory in service is December, 1991.

4.1.4 Fire Fighting Capability Assessment

In response to one of the recommendations of AECB report INFO-0234, "The Accident at Chernobyl and Its Implications for the Safety of CANDU Reactors", Ontario Hydro submitted a report entitled "Assessment of Fire Fighting Capability of Ontario Hydro's Nuclear Generating Stations", which identifies 12 recommendations applicable to Pickering NGS. Of these two have been completed, and ten are in progress. It is the view of AECB staff that some of the recommendations of the report have not been adequately transformed into action plans. Much work remains to be done at the site.

AECB staff is currently reviewing the Ontario Hydro report to ensure the issue of fire fighting in the presence of radiation hazards is adequately addressed for Pickering NGS. AECB staff will continue to monitor progress in the completion of outstanding actions.

4.1.5 Emergency Operating Procedures (EOPs)

Ontario Hydro has been collaborating with Hydro-Québec and NB Power in a program to improve the emergency operating procedures at Canadian power reactor facilities. An Inter-Utility Task Group has produced a set of standards for EOPs. In order to gain more experience in the application of these standards, Ontario Hydro established a trial group at Pickering to develop a sample set of procedures for Pickering NGS-B. This trial is now complete and a program for reviewing and upgrading station procedures has been proposed. This program will include production of new symptom-based procedures for events which may not be correctly diagnosed or for which the use of the present event-based procedures proves inadequate. These new procedures are expected to be complete by the end of 1990. The proposal also includes a systematic review of all of the existing procedures which will produce more user-friendly procedures, better documentation of technical bases and supporting rationale, and more systematic verification and validation of the procedures. This review is expected to be complete by the end of 1994.

4.2 Pickering NGS-A

4.2.1 Loss of Coolant Accident (LOCA) and Failure to Shutdown

Following the accident at Chernobyl in 1986, AECB staff conducted a study of the event to ascertain the implications for the safety of CANDU nuclear reactors. One of the recommendations of this study called for a re-examination of the safety of the Pickering NGS-A reactors for dual failures involving the failure to shutdown. In response, Ontario Hydro submitted a reanalysis of the consequences of a large loss of coolant accident (LOCA) and failure to shut down. AECB staff review indicated a number of significant shortcomings in the analysis and AECB staff judged that the issue could not be resolved solely by further analytical effort. Ontario Hydro was advised to investigate design improvements to the existing shutdown capability and inform AECB staff of the results. In January 1990

Ontario Hydro submitted a formal proposal for enhancing the shutdown capability. The option chosen provides two shutdown systems which are not fully independent and which do not give two shutdown system coverage for large LOCA. Nevertheless, Ontario Hydro considers this proposal is acceptable largely on the grounds that to install a fully independent second shutdown system capable of protecting against a large LOCA would be prohibitively complex and expensive, and that the reliability improvements to the existing capability ensure an acceptable risk to the public by reducing the probability of the most likely dual failures; loss of regulation plus failure to shut down or small loss of coolant accidents plus failure to shut down.

AECB staff has reviewed Ontario Hydro's submission and found that the investigation into potential alternatives is not as rigorous as expected. Further information is being requested in support of the proposal. The results of the AECB staff review will be reported separately to the Board.

4.2.2 Rupture Panel System (RPS)

The Board, in 1986, mandated modifications to the Pickering NGS containment system. These modifications would increase the time prior to containment venting and reduce the containment venting rate after a postulated LOCA in any one of the units in Pickering NGS-A or Pickering NGS-B.

To satisfy these requirements, Ontario Hydro committed itself to installing a new RPS in each of Units 1 to 4 which will isolate these units from the Pressure Relief Duct (PRD). The concept requires that the existing bulkheads between Units 1 to 4 and the PRD be modified to provide a mounting surface for a set of rupture panels, two bypass butterfly valves, and a personnel access door.

As reported in last year's annual staff report, the new RPS was installed in Units 2 and 4. Installation in Unit 1 is to be completed in the fall of 1990. Unit 3 is currently in its 23-month rehabilitation/retube outage and the RPS will be installed and available for service prior to the unit re-start in May, 1991. Performance of the RPS has been satisfactory and there has been no visual indication of panel deterioration.

4.2.3 Nitrogen-16 (N-16) Compensation for Neutron Overpower Trip

The Pickering NGS-A overpower trip design uses the N-16 gamma field from the heat transport system to correct ion chamber flux readings to compensate for the effects of moderator boron concentration, fuelling, flux tilts and the configuration of reactivity devices.

Deficiencies in the performance and reliability of the original system led to a decision to redesign the system.

The redesigned system was operational in Unit 3 prior to its rehabilitation/retube outage in June, 1989 and plans were underway to install the system in the other Pickering NGS-A units. However, a new requirement was raised by the recently completed loss of moderator inventory accident analysis where bottom to top flux tilt was predicted to occur. This has resulted in tighter operating limits on the N-16 compensation system and the possibility that operation may prove to be impracticable. The current plan is to activate one channel in each of Units 1,2 and 4 in order to obtain some operating experience. (The previous Unit 3 operating experience was not truly representative because it was operating with a different adjuster configuration). A decision will then be made on placing the system in service. AECB staff will continue to monitor the progress of this work.

4.2.4 Unit 1 Fuel Failures

On November 22, 1988, during recovery from a reactor trip on Unit 1, reactor power was increased substantially above the level specified in the Operating Policies and Principles (OP&Ps) for the configuration of the reactor reactivity devices at the time. Shortly thereafter, a number of fuel elements failed. The failed elements were removed from the reactor.

The status of the investigation and subsequent actions is summarized below.

4.2.4.1 Fuel Failures

A number of fuel elements in the high powered region of the Unit 1 core have been examined. The results confirm that the fuel failures were caused by excessive bundle overpower (the step change in bundle power from the previous steady state value) when reactor power was increased from 65% to 87% of full power. Given the reactor core conditions at the time, reactor power should have been held at 65%. However, the extent of fuel failures was greater than expected for such a transient. Ontario Hydro is continuing its investigation to determine the cause of the observed behaviour. At present, Ontario Hydro is of the opinion that fuel fabrication parameters are contributing factors.

4.2.4.2 Protection Against Loss of Regulation Accidents

Although the November 22, 1988 incident was not a loss of regulation accident, the rate of power increase did fall within the range covered by such accidents. Since the analyses supporting operating licence applications indicate that loss of regulation would not lead to fuel damage, the fact that fuel failures occurred during this incident is of some importance. AECB staff has questioned Ontario Hydro's view that the current level of reactor protection is adequate. Ontario Hydro is treating the subject as a generic issue and will respond by June, 1990.

4.2.4.3 Continued Operation with Failed Fuel

AECB staff questioned whether the analysis supporting operating licence applications takes into account reactor operation with failed fuel and elevated Iodine-131 levels in the core. It appears that such operation could result in levels of Iodine-131 in the PHT system during an accident transient which exceed the values assumed in the analysis. Ontario Hydro has undertaken a generic study of this issue and will inform the AECB of the outcome by August, 1990.

4.2.4.4 Acceptability of Current Operating and Licence Limits

Ontario Hydro contends that current limits are acceptable provided that bundle overpowers are kept below 24%. AECB staff is of the opinion that the current limits are acceptable for a limited time pending further information. The completion of AECB staff's investigation depends on the supply of such information from OH. A submission is expected by the end of June, 1990.

4.2.4.5 Assurance of Compliance With Operating Licence Conditions and Operating Policies and Principles (OP&Ps)

Ontario Hydro instituted a number of actions during 1989 to improve performance in this area and give added assurance of compliance. Two main initiatives were involved:

i) A training program in OP&Ps involving the initial training of technical unit staff and the refresher training of authorized shift personnel. This was completed by the end of 1989.

ii) A review of all numerical limits in the operating licence and OP&Ps in order to verify that, for each such limit, there was a specific means of ensuring compliance. All aspects of this work will be completed by the end of 1990.

4.2.4.6 Human Factors Assessment

A human factors assessment report on the Unit 1 fuel failure incident was submitted and found to discuss only a narrow range of the relevant factors, and to provide neither explanation nor justification of the identified causes of the misoperation. AECB staff did not request that the report be rewritten as it is not possible to reconstruct event details on the basis of testimony from site personnel one year after the incident. However, Ontario Hydro advised the AECB that a structured program for human factors assessment has been implemented at all stations. AECB staff will monitor the conduct and reporting of assessments conducted under this program.

4.2.5 Calandria Vault Corrosion

On December 13, 1989, Ontario Hydro reported that inspections of Units 2 and 4 calandria vaults revealed extensive corrosion of carbon steel components, such as the support beams and tie rods for the ion chambers, the brackets holding the ring thermal shield segments, the biological shield cooling system, and the dump tank legs. On the basis of visual examinations, it is believed that all components are still fully functional. The main concern is with continuing corrosion which could eventually lead to structural failure.

Ontario Hydro has determined that the corrosion is due to the effect of nitric acid thought to be formed by atmospheric nitrogen combining with airborne moisture in the presence of high radiation fields within the vault.

Therefore, in addition to surface corrosion, stress corrosion cracking is also of concern. The moisture can come from leaks in the piping or from spills in the boiler room, since the calandria vault is not sealed.

Ontario Hydro's short term action plans include drying the calandria vault atmosphere and completing the inspection of all ion chamber supports in all Pickering NGS-A units.

Longer term action plans include, among others, installation of an additional stainless steel support beam for the ion chambers, installation of high capacity driers for the control of moisture in the calandria vault, development of improved inspection tools, development of remote handling equipment for replacing components in the vault, and isolation of all end shield ring piping to reduce the likelihood of further leaks.

AECB staff will continue to monitor the progress of this work.

4.2.6 Emergency Core Cooling System (ECCS) Long Term Reliability

The recovery portion of the emergency core cooling system is the credited long term heat sink following a loss of coolant accident. It is, therefore, required to operate reliably for some period of time after the accident and this long-term running reliability of the system must be assessed and demonstrated to be satisfactory.

Ontario Hydro has initiated a two-phase assessment to demonstrate the long term running reliability of the Pickering NGS-A ECCS. The first phase of the assessment will identify and assess the failures affecting ECCS capability in the long term while the second phase will assess the consequences of loss of ECCS at different times during its long term operation. The first phase of the assessment is targeted for submission in September, 1990.

4.3 Pickering NGS-B

4.3.1 Cobalt Adjusters

Ontario Hydro's safety analysis states that uncontrolled draining of the moderator water in the calandria could cause a release of dissolved deuterium from the water. As the water level drops in the calandria, the adjuster rods which are cooled by the moderator water, become uncovered and heat up.

Ontario Hydro has submitted a revised safety analysis of the consequences of uncontrolled draining of the moderator. The analysis concluded that the peak temperature reached on the surface of an uncovered adjuster rod is insufficient to ignite any deuterium released into the moderator cover gas during the event. Because of uncertainties in the analysis, this conclusion has not been accepted by the AECB staff. However, Ontario Hydro has responded to AECB staff questions on the analysis and this additional information is currently under review.

Since the question had not been resolved by the April, 1989, deadline, the cobalt adjusters were removed from Unit 5 and replaced with stainless steel adjusters. Units 6, 7 and 8 still contain cobalt adjusters. As an interim measure, pending resolution of the analytical question, Ontario Hydro has implemented special controls and monitoring on the dissolved deuterium in the moderator water of these units.

4.3.2 Mercury-Wetted Relays

Mercury wetted relay (MWR) failures continued to be a problem at Pickering NGS-B in 1989. Table 3 on page 24 summarizes the experience with unsafe failures of MWRs in the four Special Safety Systems.

MWRs are widely used in safety and safety-related systems in all operating Canadian nuclear power reactors. As a result of numerous MWR failures at Pickering NGS-B and other stations, AECB staff issued a gene ic request to all licences to address the following:

i) Provide evidence that the predicted unavailability of each safety and safety-support system remains consistent with the values credited in support of applications, taking into account recent operating experience, OR

   Provide a program for replacement of the MWRs with components whose reliability is consistent with the unavailability requirements of the systems.

ii) Undertake a program of surveillance of MWRs or their replacements to verify that their performance is, and continues to be consistent with the design and safety nalysis assumptions.

At Pickering NGS-B the status is as follows:

i) SDS1 - All original MWRs are being replaced with a different type of MWR. This work was completed on Unit 7 in 1988, and Units 5 and 6 in 1989. For Unit 8, replacement is scheduled for 1990.

ii) SDS2 - To date, original MWRs have been replaced only as failures occur. However, a program is being undertaken to replace all relays whose failure could have a significant impact on the reliability of the system. This is expected to be complete before the end of 1990.

iii) Other systems - Original MWRs are being replaced as failures occur.

iv) A surveillance program to monitor relay performance is in place. To date, no failures of the replacement type of MWR have been observed.

In addition, Ontario Hydro has implemented a program to find an acceptable alternative dry-contact relay. A program to assess the reliability performance of MWRs and their impact on the predicted future unavailability of special safety systems is also being undertaken.

5. CONCLUSION

The assessment of the AECB staff on the basis of 1989 operation is that station operation must be improved. The main contributors to this conclusion are:

- A doubling of the number of infractions of the operating s and the AEC Regulations in 1989 compared to 1988 (see section 3.1.1).

- The exposure of three workers to radiation doses in excess of the regulatory limits (see section 3.1.3).

- Inadequate procedural compliance (see section 3.1.10).

- Unacceptable level of housekeeping (see section 3.1.10).

AECB staff considers that performance in the following areas also requires improvement:

- Response to AECB Health Physics Appraisals (see section 3.1.5).

- Surveillance of systems by the Technical Section (see section 3.1.9).

- Chemical control performance (see sections 3.2.2 and 3.3.2).

- Response to outstanding AECB action items (see sections 3.2.5 and 3.3.5).

- Availability of special safety systems (see sections 3.2.3 and 3.3.3).

- Operating memos, jumper records, call-ups and deficiency reports in effect (see sections 3.2.5 and 3.3.5).

- Fire fighting capability (see section 4.1.5).

Ontario Hydro has initiated a number of programs which are expected to result in improvements in the above areas. These include:

- Ontario Hydro In-Service Station Quality Improvement Plan (submitted to the AECB in March, 1990).

- The program to improve and give assurance of compliance with the AEC Regulations, the operating licences and the Operating Policies and Principles.

- The Housekeeping and Material Condition Improvement Plan.

- The action plan undertaken following the radiation overexposures.

It is the opinion of AECB staff that these programs are necessary and appropriate and, given adequate resources and management support, should result in a noticeable improvement in station performance in 1990.

TABLE 1

Definitions of Fault Types and Levels of Impairment

Process System Faults

Type A: A fault which would, in the absence of special safety system action, cause significant fuel failures.

Type B: A fault which would not, in the absence of special safety system action, cause significant fuel failures, but which would do so if some unpredictable factors were different, such as,

i) reactor conditions being different, or
ii) the occurrence of a common mode fault which could have failed all redundant components of a system.

Safety System Faults

Type 0: A fault which totally incapacitates the system such that it cannot provide any protection under any conditions.

Type 1: A fault which significantly reduces system effectiveness such that it would be of little or no benefit if the worse possible process system failure occurred.

Type 2: A fault which reduces the effectiveness of the system such that it fails to meet the design intent. However, the system still operates, and would be of significant benefit if a process system failure occurred.

Special Safety System Levels of Impairment

Level 1: The system is ineffective to the degree that, given the worst process upset with which it is intended to cope, it would not provide adequate protection.

Level 2: The system is reduced in effectiveness to the degree that, given the worst process upset with which it is intended to cope, it would provide some but not complete protection. However, the system does provide adequate protection for less severe process upsets.

Each of the aforementioned faults and impairments are required to be formally reported to the AECB.

TABLE 2

Number of Compliance Monitoring Interruptions in 1988 and 1989

	Pickering NGS-A 1988	1989	Pickering NGS-B 1988	1989	Common Location 1988	1989
Liquid	10	4	10	2	0	3
Gaseous	24	5	2	5	5	2

TABLE 3

Failures of Mercury-Wetted Relays in Pickering NGS-B Special Safety Systems

	1983	1984	1985	1986	1987	1988	1989	Total
SDS1	1	0	0	0	0	7	3	11
SDS2	0	0	0	0	2	8	12	22
Containment	2	2	1	2	11	5	5	28
ECCS	0	1	0	0	0	0	0	1
Totals	3	3	1	2	13	20	20	62

APPENDIX A

MEASURES OF STATION PERFORMANCE - PICKERING NGS-A, 1989

	1989	1988	AECB Staff Comments: (A = Acceptable; NI = Needs Improvement)
A. Radiation Control			
Occupational dose*			
Total whole body dose (person-Sv)	7.49	6.21	A
Total extremity dose (person-Sv)	16.37	10.71	A
Total neutron dose (person-Sv)	0.040	0.042	A
No. of exposures > regulatory limits	3	0	NI
No. of whole body exposures > 20 mSv	6	6	A

* Doses for those working on both stations are reported under Pickering "A"

Releases from the Station

	1989	1988	AECB Staff Comments
No. of times the 1% DEL target was exceeded:			
Airborne tritium	1	0	A
Airborne noble gases	0	0	A
Airborne iodine-131	0	0	A
Airborne particulates	0	0	A
Airborne carbon-14	0	0	A
Waterborne tritium	0	0	A
Waterborne gross beta activity	0	0	A
Average %DEL for the year:			
Airborne tritium	0.47	0.39	A
Airborne noble gases	0.33	0.22	A
Airborne iodine-131	0.03	0.02	A
Airborne particulates	0.01	0.01	A
Airborne carbon-14	0.17	0.45	A
Waterborne tritium	0.10	0.10	A
Waterborne gross beta activity	0.14	0.07	A

MEASURES OF STATION PERFORMANCE - PICKERING NGS-A, 1989

	1989	1988	AECB Staff Comments: (A = Acceptable; NI = Needs Improvement)
Public dose (Pickering 'A' and Pickering 'B')			
Estimated dose to critical group (uSv):			
- infant	43.5	47	A
- adult	34.7	41	A
Estimated population dose (person Sv)	2.1	1.5	A
Environmental Measurements (Pickering 'A' and Pickering 'B')			
Average boundary dose rate external gamma (nGy/hour)	42	45	
Average boundary tritium in air (Bq/m3)	22	28	This represents 0.14% Maximum Permissible Concentration (MPC) for tritium in air for the public
Average boundary tritium concentration in precipitation (Bq/L) (average of all measurement sites)	2060	2940	This represents 0.98% MPCw for tritium in public drinking water.
Average boundary gross beta in precipitation and dry deposition (Bq/m2/month) (average of all measurement sites)	21	14.8	
Average tritium in milk (Bq/L) (highest of 2 sites, sampled monthly)	54	61	This represents 0.03% MPC for tritium in milk.
Average C-14 in milk (Bq/kg of carbon)	445	411	This represents 0.35% MPC for carbon in milk.
Average I-131 in milk (Bq/L)	<0.16	0.14	This represents <1% MPC for iodine in milk.
Average tritium in drinking water (kBq/L) (highest of 4 sites, sampled weekly)	23	72	This represents 0.01% MPC for tritium in public drinking water.
Average gross beta in drinking water (Bq/L)	0.13	0.12	

MEASURES OF STATION PERFORMANCE - PICKERING NGS-A, 1989

B. Plant Control		1989	1988	AECB Staff Comments: (A = Acceptable; NI = Needs Improvement) (NA = Not Available)
No. of reportable events		33	15	NI
No. of reportable events where human error was a significant contributing factor		16	NA	NI
No. of serious process failures		0	0	A
No. of non-spurious reactor trips		3	7	
Percentage of safety system tests completed				
Shutdown system (SDS)		100%	100%	A
ECCS		100%	100%	A
Containment		100%	100%	A
Special safety system unavailability (x10-3):				
Actual past unavailability:				
SDS	Unit 1	0	0.4	A
	Unit 2	0	0	A
	Unit 3	0	0	A
	Unit 4	0	0	A
Containment	Unit 1	2.32	0	NI
	Unit 2	2.32	0	NI
	Unit 3	2.32	0	NI
	Unit 4	2.32	0	NI
ECCS	Unit 1	23.7	8.2	NI
	Unit 2	182.9	542.0	NI See note below.
	Unit 3	0	0	A
	Unit 4	0.42	37.8	A

NOTE Number different than that reported last year. It was raised as a result of the moderator room hole discussed in Appendix C, as SER A-89-38.

		1989	1988	AECB Staff Comments: (A = Acceptable NI = Needs Improvement) NA = Not Available
Predicted future unavailability: ($x10^{-3}$)				
SDS	Unit 1	1.59	2.8	A
	Unit 2	1.59	2.8	A
	Unit 3	1.59	1.7	A
	Unit 4	1.59	2.8	A
Containment (each unit)		3.07	5.15	NI
ECCS	Unit 1	3.5	3.5	NI
	Unit 2	3.5	3.5	NI
	Unit 3	3.5	11.3	NI
	Unit 4	3.5	3.5	NI

C. Plant Maintenance and Administration

Documentation

Operating Memos:

	1989	1988	
No. in effect at year end	93	104	NI
No. in effect for > 6 months	21	37	NI

Jumper Records:

	1989	1988	
No. of operational jumpers in effect (at year end)	510	499	NI

Call-ups (outstanding at year end)

	1989	1988	
Special Safety Systems	39	NA	NI
Standby Safety Support Systems	124	NA	NI

MEASURES OF STATION PERFORMANCE - PICKERING NGS-A, 1989

	1989	1988	AECB Staff Comments: (A= Acceptable NI = Needs Improvement) NA = Not Available
C. Plant Maintenance and Administration			
No. of Deficiency Reports (at year end)			
Special Safety Systems	1912	NA	NI Note: These are for both Pickering NGS-A and -B
Standby Safety Support Systems	824	NA	NI
Others	15,329	NA	NI
D. Licensing			
AECB Action Items:			
No. of Items outstanding at year end	48	42	NI
No. of Items opened during the year	19	20	-
No. of Items closed during the year	13	18	-
Quality Assurance Audits:			
No. of AECB audits	1	1	
No. of Directives issued	1	0	A
No. of Action Notices issued	3	5	A
Health Physics (HP) Appraisals:			
No. of AECB HP Appraisals during year	1	1	
No. of Recommendations	13	5	A

MEASURES OF STATION PERFORMANCE - PICKERING NGS-B, 1989

	1989	1988	AECB Staff Comments (A = Acceptable; NI = Needs Improvement)
A. Radiation Control			
Occupational dose			
Total whole body dose (person-Sv)	1.40	1.25	A
Total extremity dose (person-Sv)	2.04	1.63	A
Total neutron dose (person-Sv)	0.006	0.026	A
No. of exposures > regulatory limits	0	0	A
No. of whole body exposures > 20 mSv	0	0	A
Releases from the Station			
No. of times the 1% DEL target was exceeded:			
Airborne tritium	0	0	A
Airborne noble gases	0	0	A
Airborne iodine-131	0	0	A
Airborne particulates	0	0	A
Waterborne tritium	0	0	A
Waterborne gross beta activity	0	0	A
Average %DEL for the year:			
Airborne tritium	0.10	0.07	A
Airborne noble gases	0.21	0.21	A
Airborne iodine-131	0.002	0.001	A
Airborne particulates	0.001	0.001	A
Waterborne tritium	0.01	0.17	A
Waterborne gross beta activity	0.04	0.18	A

Public dose and environmental measurements are included under "MEASURES OF STATION PERFORMANCE PICKERING NGS-A, 1989" in Appendix A.

MEASURES OF STATION PERFORMANCE - PICKERING NGS-B, 1989

		1989	1988	AECB Staff Comments (A = Acceptable; NI = Needs Improvement)
Special safety system unavailability (x10-3):				
Actual past unavailability:				
SDS1	Unit 5	0	0	A
	Unit 6	0	0.86	A
	Unit 7	0	0	A
	Unit 8	0	0	A
SDS2	Unit 5	0	0	A
	Unit 6	0	0.86	A
	Unit 7	0	0	A
	Unit 8	17.32	0.002	NI
Containment	Unit 5	2.3	0	NI
	Unit 6	2.3	0	NI
	Unit 7	2.3	0.001	NI
	Unit 8	2.3	0	NI
ECCS	Unit 5	0	8.2	A
	Unit 6	0	82.2	A
	Unit 7	0	82.2	A
	Unit 8	0	123.3	A
Predicted future unavailability:				
SDS1		1.87	1.20	NI
SDS2		0.07	0.45	A
Containment		3.11	4.23	NI
ECCS		0.75	1.31	A

MEASURES OF STATION PERFORMANCE - PICKERING NGS-B, 1989

B. Plant Control	1989	1988	AECB Staff Comments (A = Acceptable; NI = Needs Improvement) (NA = Not Available)
No. of reportable events	28	15	NI
No. of reportable events where human error was a significant contributing factor	13	NA	NI
No. of serious process failures	0	0	A
No. of non-spurious reactor trips	5	2	
Percentage of safety system tests completed		100%	A
SDS1	100%		A
SDS2	100%		A
ECCS	<100%		NI One ECI test (E-22) missed on Unit 5
Containment	100%		A in November

MEASURES OF STATION PERFORMANCE - PICKERING NGS-B, 1989

	1989	1988	AECB Staff Comments (A = Acceptable; NI = Needs Improvement) NA= Not Available
C. Plant Maintenance and Administration			
Documentation			
Operating Memos:			
No. in effect at year end	55	48	NI Efforts to reduce the number of
No. in effect for > 6 months	15	31	NI Operating Memos and Jumper Records are in progress, but further improvements are required.
Jumper Records:			
Number of operational jumpers in effect	382	373	NI
Call-ups (outstanding at year end)			
Special Safety Systems	44	NA	NI
Standby Safety Support Systems	73	NA	NI
D. Licensing			
AECB Action Items:			
No. of Items outstanding at year end	50	51	NI
No. of Items opened during the year	9	5	-
No. of Items closed during the year	10	17	-
Quality Assurance Audits:			
No. of AECB audits	1	1	
No. of Directives issued	1	0	A
No. of Action Notices issued	3	5	A
Health Physics (HP) Appraisals:			
No. of AECB HP Appraisals during year	-	1	
No. of Recommendations	-	5	-

APPENDIX C

REPORTABLE EVENTS

The following reportable events occurred in 1989:

1. Events Affecting Pickering NGS-A and Pickering NGS-B

Reference	Description
SER A-89-36	On February 28, 1989, during routine testing of an instrumented pressure relief valve, IPRV-1, beetle alarms were received indicating the presence of water in the U-tubes for Pressure Relief Valves (PRV)-2 to 6. This indicated a possible blockage (depending on the quantity of water involved) of 6 of the 12 PRVs including all 3 IPRVs. However, it was not until noon on March 1, that it was determined that there was 12 feet of water in the U-tubes. At that time, a Level 2 impairment of containment was declared. The water was drained from the U-tubes by 02:30 on March 2, and all beetle alarms had cleared.
SER A-89-55	On March 9, 1989, Carbon-14 samples from Unit 2 stack monitors were shipped from the chemical laboratory through stores to the Ontario Hydro research lab in Toronto. The samples were sent without the required documents for a radioactive shipment.
SER A-89-76	On May 17, 1989, a bomb threat was received by the Canadian Nuclear Association. The threat wasn't specifically directed at any particular Canadian nuclear facility. A public address announcement was made to warn station personnel of the threat. A search was carried out by designated station staff. The bomb threat notification was cancelled after the deadline had passed.
SER A-89-79	On May 22, 1989, two persons attempted to enter the Protected Area in an unauthorized manner. This was detected by the Security systems, and both persons were detained and released into police custody.
SER B-89-55	On June 20, 1989, a complete loss of Site Electrical System (SES) redundancy occurred at the station for a period of approximately 64 hours. This was initiated by the forced outage of a unit and a combination of other unit outages. SES power is required to support safety system operation, in particular the High Pressure Emergency Cooling Injection (HPECI) pumps. One of the units was made available to supply SES power and improve SES redundancy.

Letter, Dewar to Schwarz 1989 08 14	As a result of a review by Ontario Hydro to ensure compliance with the OP&Ps, it was reported on August 8, 1990, that the majority of PRV/IPRV test results failed to meet the OP&P limits due to the test tolerances exceeding the limits assumed in the safety analysis. This situation has existed since Pickering NGS-A commissioning. AECB staff requested an assessment of the impact of operating outside the limits imposed by OP&Ps and safety analysis limits. Ontario Hydro concluded that such operation does not impact significantly on containment integrity and on radiological consequences to the public.
Letter, Dewar to Schwarz 1989 09 26	On September 14, 1989, blank flanges were found installed downstream of pressure relief disks on a high activity ion exchange train. These blanks had been installed temporarily in 1987 and were not removed when the operating instruction was cancelled.
SER A-89-156	On November 2, 1989, while construction personnel were working in the pressure relief duct (PRD) weather enclosure, the drain line on the air receiver which supplies instrument air to the PRD airlock seals was inadvertently damaged. As a result, all PRD airlock seals deflated. This event was classified as a Level 1 impairment of the containment system which lasted for slightly more than one hour.
SER A-89-166	On November 10, 1989, it was discovered and reported that the moderator heavy water upgrader area (Sulzer A/B) was not equipped with compliance monitors to measure for tritium and beta/gamma activity in its liquid effluents. This condition had been present since start-up of Pickering NGS-A. It was corrected immediately by instituting grab samples on a regular basis until a sampler could be placed in service toward the end of November. Samples taken to date indicate low releases to the environment. Experience gained over the coming year will permit a more accurate determination of the probable releases in the past.
SER A-89-180	On December 7, 1989, radioactive contaminated components were found in Zone 1 near the badge rack on the bridge separating the Administration Building from the Service Wing. An investigation confirmed that the contaminated components did not affect the dose recorded on the badges.
Letter, Schuelke to Schwarz 1989 12 13	On December 12, 1989, the station operated with less than the minimum shift complement in the Control Maintenance unit specified under the Operating Licence for Pickering NGS-B. This condition lasted for approximately 1.5 hours.

SER A-89-187	On December 22, 1989, freezing of Emergency Coolant Injection (ECI) storage tank instrument lines resulted in a Level 1 impairment of the High Pressure ECI. The frozen instrumentation lines were thawed, and the system returned to its normal state. The period of level 1 impairment was 3.5 hours.
SER A-89-181	On December 9, 1989, the AECB notified Ontario Hydro of a bomb threat which applied to all CANDU stations. The Pickering NGS-A shift supervisor was informed and vigilance was increased.
Letter, Schuelke to Schwarz 1990 01 05	On December 29, 1989, an explosion threat was received by Ontario Hydro security staff by telephone. Metropolitan Toronto Police later advised that the call was to be disregarded.

2. Events Affecting Pickering NGS-A Only

Reference	Description
SER A-89-33	On February 17, 1989, Unit 1 was shut down to repair a primary heat transport system leak. A crack was found in the feedline at the boiler room penetration into the east fuelling machine vault. The pipe was repaired and the penetration modified to prevent recurrence.
SER A-89-38	On March 8, 1989, a hole was discovered in the wall connecting the moderator and purification rooms of Unit 2. Following a LOCA, the pumps used for ECCS recovery could have been impaired by the water entering the pump room through this hole. This was identified as a Level 1 impairment of the ECCS, which had been present since the unit re-start following its extended maintenance outage (a period of 15 months).
SER A-89-44	On February 27, 1989, during a condenser retubing on Unit 4, the unexpected failure of two bolts while fastening the main flange covers of the outlet condenser waterboxes led to the discovery that incorrect replacement bolts had been ordered, and that incorrect bolts had been used on Units 1 and 2 previously. The correct replacement bolts were ordered and operating procedures were issued to minimize the probability of situations occurring which could lead to bolt failures on running units. Bolt replacement was completed in two weeks.
SER A-89-65	On April 29, 1989, the Unit 2 moderator system temperature limit in the OP&Ps was exceeded by one degree when a control valve on a moderator heat exchanger failed in a partially closed position. The reactor was setback to curb this increase in temperature. This high temperature condition lasted for approximately 5 minutes.
SER A-89-68	On May 2, 1989, the end shield cooling system on Unit 4 suffered a partial loss of inventory following the failure of an expansion joint. High end shield temperatures resulted, but it was later determined that stress limits had not been exeeded. The unit was setback, and tripped in response to the event. Personnel working near the site of the failure were wetted by spraying water. After an investigation by the Health Physics section, it was determined that no additional dose needed to be assigned to the workers. Inventory was restored within two hours.

SER A-89-72	On May 15, 1989, the isotopic differential between the Unit 4 moderator and heat transport systems fell below 0.25%. Interunit transfers were initiated to return the isotopic differential above 0.25%, as required by the OP&Ps.
SER A-89-95	On July 8, 1989, the Unit 4 moderator system temperature limit specified in the OP&Ps was exceeded by one degree when a control valve on a moderator heat exchanger failed in a partially closed position. The reactor was setback to curb the increase in temperature. The high temperature condition lasted for approximately seven minutes.
SER A-89-104	On August 9, 1989, three workers were exposed to radiation doses in excess of the regulatory limits. See Section 3.1.3 further details.
SER A-89-113	On July 27, 1989, high levels of activity were discovered on waste being removed from a Unit 3 rubber area. An investigation revealed that the source of the activity was debris from autoclave work in the boiler room. The waste was disposed of in an acceptable manner. No unexplained doses were received by the workers involved. The boiler room was inspected and the floor cleaned.
SER A-89-128	On September 3, 1989, a potential impairment of the ECCS recovery flowpath was discovered on Unit 2, as the west moderator room door was found to be improperly closed. This condition appears to have existed for 15 months (since start-up of the unit in June, 1988). The mispositioned bottom seal plate was raised to the required closed position. The event was treated as a Level 2 impairment of the ECCS.
SER A-89-131	On September 20, 1989, the reactor in Unit 1 tripped from full power on high PHT system pressure. This event was initiated by the accidental opening of a class 2 power supply breaker. This caused a loss of power to boiler level indication which in turn caused a turbine governor valve trip. The resultant power mismatch caused the PHT system pressure to increase to its trip setpoint.
SER A-89-136	On October 4, 1989, an inspection of the Unit 4 reactor building at the 254 elevation revealed several housekeeping concerns, including unsecured D2O drums, air hoses, scraps of paper and gloves on the floor. This area and other areas on the ECCS recovery flowpath for that unit were cleaned up. AECB staff requested that this event be reported formally, due to the level of impairment initially assigned to this event (Level 2) by operating staff.

SER A-89-138	On August 3, 1989, routine testing of a moderator room sump pump on Unit 1 revealed that the pump was seized. A few days earlier, the other sump pump had been taken out of service for repair. Since both pumps were potentially unavailable, a Level 1 impairment of ECCS was declared for a period of 24 hours, the period of unavailability of the second pump. Unit 1 was in a shutdown state for its annual maintenance outage at the time.
SER A-89-154	On November 2, 1989, a fuse failure on Unit 4 resulted in the automatic closure of the calandria outlet valves. This in turn resulted in a reduction of moderator flow below the specified minimum for the operating conditions. This flow reduction, which lasted for two minutes, represented an impairment of the moderator in its availability to act as a heat sink.
SER A-89-175	On October 12, 1989, Unit 4 was shut down because of a leak of about 39 kg/hour from the PHT system. The source of the leak was found to be a crack in a feedline at the boiler room/fuelling machine vault seal plate penetration. The failed section of pipe was replaced.
Letter, Schuelke to Schwarz 1989 11 06	On November 6, 1989, Ontario Hydro notified the AECB of a failure to meet the committed date for the Unit 2 inaugural pressure tube inspection. The inspection was late by three months.
SER A-89-182	On December 9, 1989, during a routine field inspection of Unit 2, the isolating valve of a boiler safety valve was found closed. At the time, reactor power was in excess of the OP&P allowable power limit with one boiler safety valve unavailable. The period of such operation was approximately 76 hours. Follow-up reports were produced, including a human factors analysis.
Letter, Schuelke to Schwarz 1989 12 13	On December 13, 1989, Ontario Hydro reported that inspections of Units 2 and 4 calandria vaults revealed extensive corrosion of carbon steel components, such as the support beams and tierods for the ion chambers, the brackets holding the ring thermal shield segments, the bioshield system piping and the dump tank legs. This situation is described in more detail under Section 4.2.5.
SER A-89-186	On December 27, 1989, field inspection of a Unit 1 ECCS recovery sump revealed the presence of debris obstructing the recovery line downstream of the sump screen cover. The debris, consisting of a lead blanket and a plastic end fitting cap, was removed. The actions taken were consistent with a Level 1 impairment. Duration of this fault is under review.

3. Events Affecting Pickering NGS-B Only

Reference	Description
SER B-89-16	On March 24, 1989, Unit 6 was shut down because of a leak of about 70 kg/h from the primary heat transport system. The source of the leak was identified to be a crack in the feedline at the wall penetration between the boiler room and the fuelling machine vault. This line had failed previously at the same location. Follow-up investigation determined that the failure was due to high cycle fatigue, originating at a stress concentration area. The failed section of pipe was replaced and the penetration design was changed from a seal plate to a guide sleeve to prevent recurrence. Similar locations on all Pickering NGS-B units were inspected, and the revised penetration design installed during subsequent pl planned outages.
SER B-89-28	On April 23, 1989, Unit 8 SDS2 became unavailable for 75 seconds due to flooding in the poison injection helium header. The high levels occurred during a backflushing procedure of the poison injection lines. The procedure was initiated because the interface between moderator and gadolinium had moved down the injection path, as indicated by a conductivity alarm. The cause of the mis-operation was identified, and the procedure corrected. This event constituted a Level 2 impairment of SDS2.
SER B-89-38	On May 16, 1989, the supply of fuel oil for the Pickering NGS-B standby generators was found to be less than the minimum inventory specified in the OP&Ps. Emergency fuel orders were placed and the inventory was increased to above the minimum requirement within 24 hours of the discovery of the shortfall.
SER B-89-49	On June 16, 1989, during routine operation of an airlock (5-21130-AL5), the inner door failed to close fully prior to the opening of the outer door. The fault was attributed to a failure of the door interlock logic which was subsequently repaired. This was regarded as a Level 1 impairment of containment which lasted 30 seconds.
SER B-89-50	On June 19, 1989, Unit 7 was operating at full power when a failure of two instrument lines occurred, causing a leakage of approximately 750 kg/h from the moderator system. The unit was shut down in an orderly manner. Repairs to the lines were effected.

Letter, Dewar to Schwarz 1989 06 16	After the event on Unit 6 (SER B-89-16 above), an inspection of Unit 5 was conducted, during its annual planned outage. It revealed a crack, which did not penetrate the pipe wall, in the PHT system feedline south loop. This is the same location where a through wall crack occurred on Unit 6. The inspection also revealed a possible crack in the line to the north loop of the PHT system. Sections of both lines were replaced. This included the same modification as performed on Unit 6.
SER B-89-74	On July 30, 1989, on both Units 7 and 8 moderator cover gas pressures were reduced, while moderator temperatures were increased, in an attempt to reduce the quantity of dissolved deuterium gas in the moderator system of each unit. A violation of OP&Ps occurred when the limits specified for moderator temperature were exceeded. Conditions were brought back within limits in 28 hours.
SER B-89-80	On July 28, 1989, during an investigation of a problem with the power supply to some ECCS loads, a 120 V ac fuse supplying the in-core flux detectors for the reactor regulating system was inadvertently removed. This resulted in the reactor regulating system initially increasing reactor power. A completed reactor trip occurred on neutron power high. This loss of regulation on Unit 5 was considered a Type B process system failure. Further investigation has identified the need for several design and operational improvements, including the need for a fuse pulling policy and some control program modifications.
SER B-89-82	On August 7, 1989, during a routine control room panel inspection on Unit 5, the moderator cover gas pressure was found to be below the minimum specified in the OP&Ps. The violation was immediately corrected by increasing the cover gas pressure.
SER B-89-89	On August 16, 1989, a breach of containment lasting about 5 minutes occurred at Unit 7 airlock 1. The inner equipment door was opened while the outer door seals were deflated. The event was attributed to human error during manual operation of the equipment airlock and was a Level 1 impairment of containment.
SER B-89-131	On October 1, 1989, during routine operation of an airlock (6-21130-AL6) on Unit 6, the inner door failed to close fully prior to opening the outer door. The fault was due to a failure of the door interlock logic, which was subsequently repaired. This constituted a Level 1 impairment of containment which lasted for 30 seconds. This event is similar to SER B-89-49, described above.

SER B-89-130 On September 20, 1989, on Unit 6, while the reactor was shutdown for its annual maintenance, incorrect isolation was discovered on a valve for the Guaranteed Shutdown State (GSS). A motorized valve, required to be blocked in the closed position, was found blocked in the open position.

SER B-89-150/151 On October 23, 1989, Channel G of the Reactor Building High Differential Pressure trip of Unit 8 SDS2 failed to trip under test. The defective relay causing the failure was replaced, and the channel was retested successfully. Shortly thereafter, Channel H of the same trip parameter on SDS2 also failed to trip under test. A second defective relay was replaced and the channel tested successfully. This event was classed as a Level 1 impairment of SDS2 as two channels of a trip parameter were unavailable at the same time. The duration of the Level 1 impairment was estimated to be 154 hours.

SER B-89-161 On October 27, 1989, Unit 7 was shut down for a planned maintenance outage and placed in a non-standard Guaranteed Shutdown State (GSS). This permitted shutting down the moderator pumps to allow for the installation of an energy dissipator on the moderator calandria inlet line. The moderator was heavily poisoned during the outage, as SDS2 had fired. Moderator samples taken just prior to returning the pumps to service revealed that the moderator poison was below the level present before shutting down the pumps. Although the poison concentration did not drop below the level required for the GSS, no decrease in concentration was expected. Investigation to determine the cause is in progress.

APPENDIX D

Violations of Licences and Regulations

Reference	Description
For more details on the following descriptions, please refer to Appendix C.	
Letter, Schwarz to Dewar 1989 03 15	On March 15, 1989, field inspections revealed several non-compliances with Section 22 of the AEC Regulations dealing with the posting of radiation warning signs and the display of information on drums containing radioactive material.
SER A-89-65	On April 29, 1989, the Unit 2 moderator system temperature limit given in Appendix A.32.2 of the OP&Ps was exceeded by one degree, when a control valve on a moderator heat exchanger failed in a partially closed position.
SER A-89-72	On May 15, 1989, the isotopic differential between Unit 4 moderator and heat transport systems was less than 0.25%, the limit given in Appendix A.30.1 of the OP&Ps.
SER B-89-38	On May 16, 1989, the supply of fuel oil available for the Pickering B standby generators was found to be less than the minimum specified in Statement 54.1 of the OP&Ps.
Letter, Nurmsoo to Dewar 1989 06 30	An audit of radioisotope license compliance at Pickering NGS was carried out in May and June 1989. Some items of non compliance with the AEC Regulations, Section 20 and 22, were reported.
SER A-89-95	On July 8, 1989, Unit 4 moderator system temperature limit given in Appendix A.32.2 of the OP&Ps was exceeded by one degree when a control valve on a moderator heat exchanger failed in a partially closed position.
SER B-89-74	On July 30, 1989, on both Units 7 and 8, the moderator temperature was increased above the limit necessary to be in compliance with Statement 32.3 of the OP&Ps during an attempt to reduce the quantity of dissolved deuterium gas in the moderator system of each unit.
SER B-89-82	On August 7, 1989, on Unit 5 during a routine control room panel inspection, the moderator cover gas pressure was found to be below the minimum specified in the OP&Ps, Statement 32.3.

Letter, Dewar to Schwarz 1989 08 01	On August 8, 1989, it was found that the majority of PRV/IPRV test results failed to meet the limits given in Appendix A 21.2.2 of the OP&Ps due to incorrect test tolerances.
SER A-89-104	On August 9, 1989, three workers were exposed to radiation doses in excess of the limits specified in the AEC Regulations. See Section 3.1.3 further details.
SER B-89-130	On September 6, 1989, on Unit 6, while the reactor was shutdown for its annual maintenance, inadequate isolation was discovered for a Guaranteed Shutdown State (GSS). A motorized valve, required by a GSS condition to be blocked in the closed position, was found blocked in the open position. This event was a violation of OP&Ps Statement 63.18 regarding adequate isolation for a GSS.
Letter, Dewar to Schwarz, 1989 09 20	On September 14, 1989, blank flanges were found downstream of pressure relief disks in violation of OP&Ps Statement 02.3 on overpressure protection.
SER A-89-154	On November 2, 1989, a fuse failure on Unit 4 resulted in the automatic closure of the calandria outlet valves which resulted in a reduction of moderator flow below the specified minimum for the operating conditions specified in OP&Ps Statement 32.2.
Letter, Schuelke to Schwarz 89 11 06	On November 6, 1989, it was reported that the inaugural inspection of Unit 2 pressure tubes (required after the large scale fuel channel replacement) was late by three months from the committed time. This was a violation of Condition A.A.12 of the Pickering NGS-A Operating Licence.
SER A-89-166	On November 10, 1989, it was discovered that the moderator heavy water upgrader area, Sulzer A/B, was not equipped with compliance monitors to measure for tritium and beta/gamma activity in its liquid effluents. This constituted a violation of Condition A.A.7 of the operating licence.
SER A-89-180	On December 7, 1989, contaminated components were found in Zone 1, near the badge rack on the bridge separating the Administration Building from the Service Wing. This was a violation of section 4.1.1 of the Ontario Hydro Radiation Protection Regulations, Part I. An investigation confirmed that the presence of the radioactive components did not contribute to the dose recorded on the badges.
SER A-89-182	On December 9, 1989, the isolating valve of a boiler safety valve was found closed on Unit 2. This was a violation of Statement 36.1 of the OP&Ps for the conditions under which the reactor was operating at the time.

Letter, Schuelke to Schwarz 1989 12 13	On December 12, 1989, the station operated with less than the minimum shift complement in the Control Maintenance unit specified in a procedure referenced in Condition A.A.3 of the operating licence.