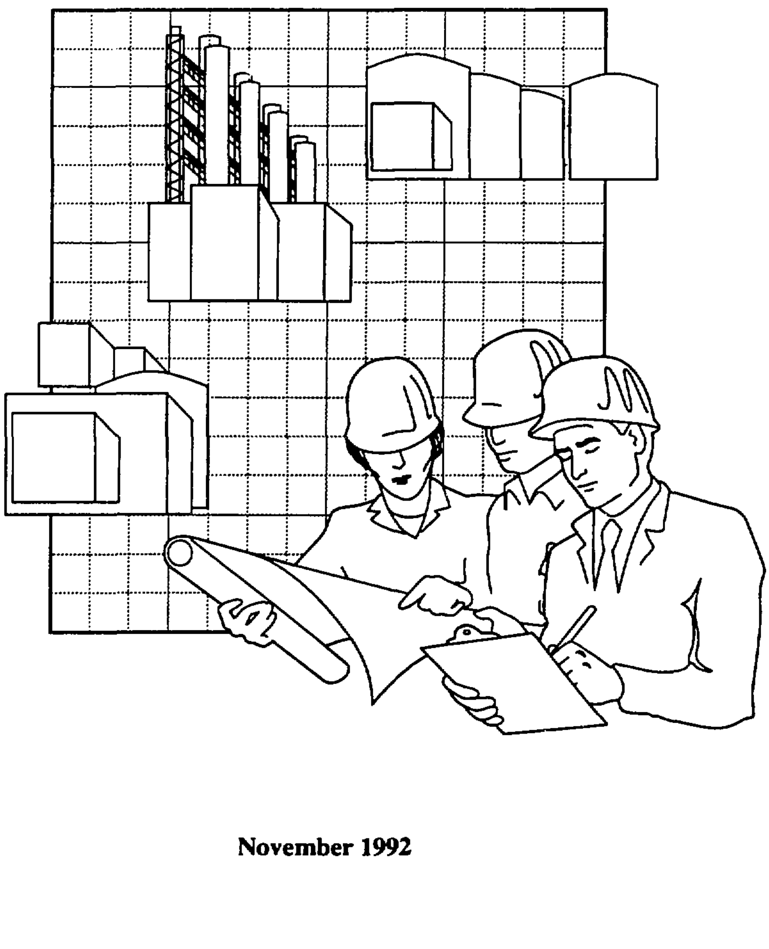
Atomic Energy Control Board
Commission de contrôle de l'énergie atomique

AECB Staff Annual Report of Bruce B NGS for the Year 1991



November 1992

Canada

THE ATOMIC ENERGY CONTROL BOARD

The Atomic Energy Control Board (AECB) is an independent federal agency that controls all nuclear activities in Canada. Our mission is to make sure nuclear energy is safe for Canadians.

The AECB exercises control through a regulatory system that encompasses all uses of nuclear energy and licenses only those that can meet the standards set out by this system. At all nuclear generating stations the AECB has resident staff who carefully monitor station operation and enforce licensing conditions.

At Bruce Nuclear Generating Station "B" (Bruce NGS B) this process requires that the on-site staff, in cooperation with AECB Head Office staff in Ottawa, monitors reactor operations, conducts audits and inspections, witnesses important activities and reviews station documents and reports from Ontario Hydro, the licensee.

SUMMARY

In this account of the Bruce NGS"B" station operation during the year 1991 AECB staff have pointed out the non-compliances with the operating licence which have been few in number and minor in degree of seriousness. There were no exposures of workers to radiation in excess of regulatory limits, but there were contraventions to the ALARA principle (as low as reasonable achievable). Releases of radioactive material to the environment have been well below the target levels. The performance of the four special safety systems has been good except for the containment system.

A review of the significant event reports and the causes of the events has revealed a lack of a system by which operations and maintenance work could be verified to have been carried out as intended. In operations and maintenance the backlog of work to be done to regularize temporary changes to equipment (removal of jumpers), to carry out preventative maintenance (call-ups), and to make repairs (deficiency reports) has increased from that of the previous year. On the other hand the station has reduced the number of temporary operating instructions (operating memos) to a half of what it was last year.

The fretting of steam generator tubes, reported last year, has not become worse. Nevertheless inspections continue and modifications to the tube supports are under way. Overall plant chemistry has been acceptable.

An Ontario Hydro assessment of the station found the station management's expectations for maintaining the margin of safety in the plant had not been properly communicated to all levels of station staff. The station is now attempting to correct this. Infractions of work protection procedures which were the subject of many significant events have led to changes in the procedures and resulted in a major training effort.

AECB staff believe that Ontario Hydro has continued to operate Bruce NGS"B" in a safe manner, but have pointed out areas where improvement is required to maintain safe operation.

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INTRODUCTION

The purpose of this report is to give an account of the Bruce NGS"B" station operation during the year 1991 in relation to its compliance with the reactor operating licence and the various regulations in force. As such the report is limited to the aspects of station operation that AECB staff consider significant from a safety point of view. AECB staff have produced it from their assessment of station reports, Ontario Hydro reports, and AECB staff compliance inspection reports.

AECB STAFF REVIEW OF OPERATIONAL SAFETY ASPECTS

COMPLIANCE WITH THE ATOMIC ENERGY CONTROL ACT AND ATOMIC ENERGY CONTROL REGULATIONS

There were no breaches of the Atomic Energy Control Act, the Atomic Energy Control Regulations, or the *Physical Security Regulations*.

Compliance inspections were conducted pursuant to the Physical Security Regulations. Security at this facility was found to be completely satisfactory. During the year, only one minor security incident occurred.

COMPLIANCE WITH THE OPERATING LICENCE

There were three types of non-compliance. The first was in contravention of a condition of the operating licence.

The control monitoring of the radioactive liquid waste discharge was found impaired by the presence of a filter upstream of the monitor that had been installed in November 1985 for the purpose of measuring suspended solids. A bypass to this filter had been installed but not used as required. The cause of this event was twofold: a lack of documentation to control the change to the system that occurred when the filter was installed, and a lack of surveillance of the system by technical staff. Corrective actions have been taken. All radioactive liquid waste is recirculated and sampled and the sample analysed before the waste is pumped out of the station. There was therefore no question here of releases having exceeded the limit.

The second and third types of non-compliance were in contravention of the licence document, Operating Policies and Principles. First, the limit on the unavailability of the containment system, as specified in the Operating Policies and Principles, was exceeded. The details of this are given below in the Performance of Safety Systems. Secondly, there were a number of significant events reported in which the moderator outlet temperature exceeded the limit set in the Operating Policies and Principles.

We do not consider these serious violations. The first two were isolated events the causes of which have been corrected. They should not recur. The third was a recurring event caused by a combination of fast power manoeuvres (e.g., trips and stepbacks) and inappropriate settings of the temperature control characteristics (control settings) that allowed momentary temperature increases to shoot over the limit. The control settings had been changed to solve another problem and brought on this problem. New control settings have since been applied that, it is believed, will avoid the original problem and prevent the overshoot of the moderator temperature. Results to date confirm this.

In this connection, there is a long standing problem. It is the confirmation of compliance with the Operating Policies and Principles. We require assurance from the station that a program is in place that will provide proper monitoring of all parameters that are subject to limits by the Operating Policies and Principles and that the instrumentation associated with these limits is maintained in a reliable state.

COMPLIANCE WITH ONTARIO BOILER AND PRESSURE VESSELS ACT

On maintenance being done to the liquid zone control system on unit 8, it was discovered that the two valves that each constitute an independent pressure relief path for a helium storage tank were both closed, the interlock system to ensure one of them is open being defeated. The cause was the deficient design of interlock that allowed strength of application to the valve handle to overcome it. The immediate remedy has been to place notices adjacent to the valves warning the operators that at all times one of the valves must be open. The long term remedy is to put in an effective interlock.

A mechanical maintainer observed that modifications that had been made to resin deuteration hoppers, which are pressure vessels detachable from the resin deuteration system, had sealed up the vents, thus cutting off the pressure relieving path to the system. The reason for this was to avoid leaks with the consequential hazards of high tritium uptakes to the operators that handle the hoppers. To remedy the situation each hopper is to be fitted with its own pressure relief system.

We consider these two infractions, though minor, would have been avoided if greater care had gone into the design of the systems.

WORKER RADIATION SAFETY

There were no exposures to radiation in excess of regulatory limits. However, there were contraventions of the ALARA principle (as low as reasonably achievable) and a contamination incident, as follows.

Modifications were made to the cobalt cooling system on units 7 and 8. There were unusual radiation occurrences in both these operations. On unit 7 two workers received excessive uptakes of tritium. Investigation revealed that incomplete isolation of a part of the system and inadequate protective clothing were the cause. On unit 8 the cobalt cooling system was put into operation while workers were rebuilding the shielding wall that surrounds the tank. This caused the radiation fields, which were low, to rise to high levels. This was immediately observed by the workers who promptly left the area. Thus significant exposures were avoided.

A worker contaminated the inside of the chest pocket of his coveralls and an area of the skin on his chest. The contamination was in the form of discrete particles, two in the pocket and one on the skin. Investigation determined that the exposure would have been less if appropriate contamination control procedures had been followed.

Our assessment of worker radiation safety is that it has been good, apart from the three incidents reported above. We consider that a major cause of the first contravention of ALARA lay in poor technical planning of the job.

PUBLIC RADIATION SAFETY

Bruce NGS"B" operates with very low levels of radioactivity release. The station remained well within its targets. Station performance is considered acceptable.

During normal operation some radioactive material leaves the plant by the ventilation systems and with the waste water. The AECB has set limits on the amounts of radioactive material released to the environment. The industry has set a target of one percent of the legal limit. Figure 1 shows the comparison of the limit and the target; it also shows background radiation in relation to these. The estimated radiation dose to a member of the public living near Bruce NGS"B" is shown in figure 2. The range in figure 2 has been expanded to give more detail. The full range in figure 2 is equal to one hundredth of the full range in figure 1. To make this clear the "Target" bar is shown in both figure 1 and figure 2.

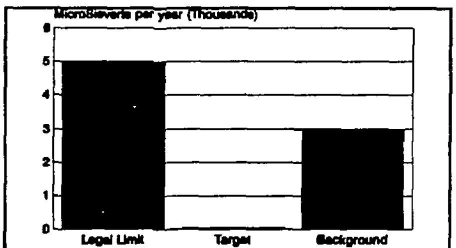

Figure 1: Limit, target and background radiation doses. The target is to be less than 50 microSieverts per year. (A microSievert is a unit of radiation dose.)

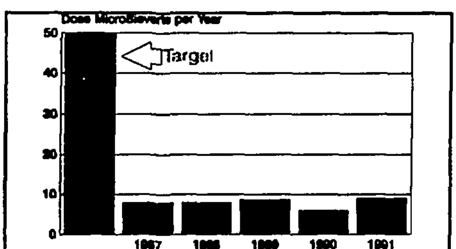

Figure 2: Estimated dose to a member of the public from the Bruce Nuclear Power Development. Target is 1 % DEL which is equal to 50 microSieverts/year

The target for Bruce NGS"B" is to keep radiation releases below 50 microsieverts per year. (Natural background is about 3000 microsieverts/year).

The radioactivity releases are divided into categories: four categories for releases to air and two categories for releases to water. The releases shown in figures 3 to 8 are given on a constant scale to compare against the target, which is one percent of the derived release limit.

Bruce NGS"B" met all its environmental targets. In fact it did better: in all the indices it is significantly below the target level. Environmental performance has been good. Tritium releases are a good indicator of performance. Tritium concentrations are increasing in the reactor water systems steadily whereas the tritium releases to the environment show no marked increase. See figures 3 and 5.

In February a heavy water spill occurred. There were reporting problems at the time, but the annual releases did not change much, and in fact airborne releases decreased. The trends for the last five years are included in the figures.

Releases to water are shown in figures 3 and 4.

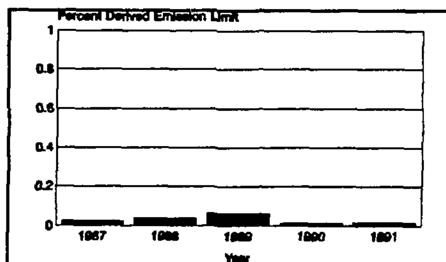

Figure 3: Bruce B tritium releases to Water Target is to be less than 1% of the DEL.

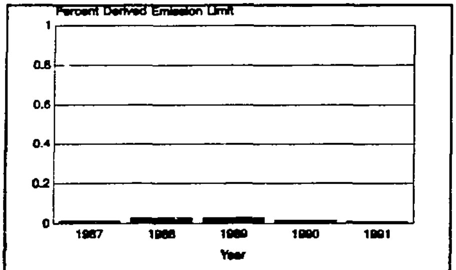

Figure 4: Bruce B beta/gamma releases to Water
Target is to be less than 1% of the DEL.

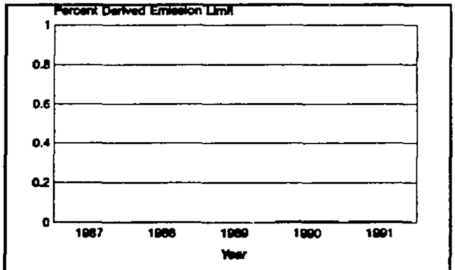

Figure 7: Bruce B radioiodine releases to Air
Target is to be less than 1% of the DEL.

Releases to air are shown in figures 5,6,7 and 8.

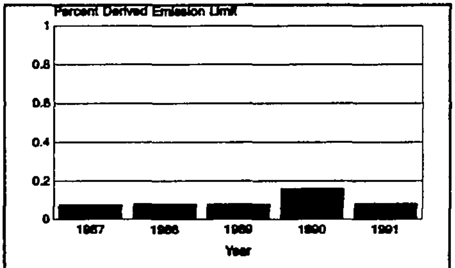

Figure 5: Bruce B tritium releases to Air
Target is to be less than 1% of the DEL.

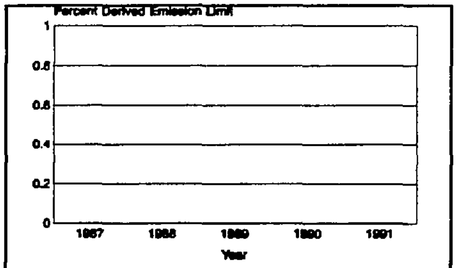

Figure 8: Bruce B particulate releases to Air
Target is to be less than 1% of the DEL.

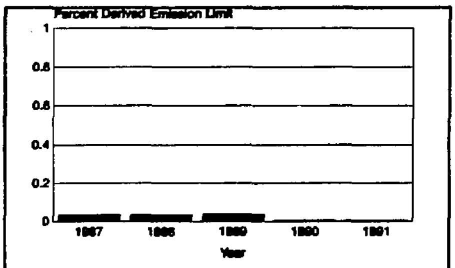

Figure 6: Bruce B noble gas releases to Air
Target is to be less than 1% of the DEL.

In addition to the monitoring of releases from the station Ontario Hydro take air, water, fruit, vegetable, milk and fish samples. They check radioactivity levels and then calculate the radiation dose people might realistically receive. The samples confirm radiation doses are well below the limits and targets. Bruce NGS"A", Bruce NGS"B" and the radioactive waste site all contribute to the releases. Bruce NGS"B" only contributes a part of the total.

Appendix B gives the actual numbers for the past 3 years. Trend data for the last 5 years are given in figure 2.

PERFORMANCE OF SAFETY SYSTEMS

The performance is measured by the unavailability of a system. This is the number of hours per year that the system is not able to operate as the design intended, and so is not able to meet the safety objective specified in the licensing submissions. There are two forms of unavailability that we consider: the actual past unavailability, which is the unavailability that occurred in the past year; and the predicted future unavailability that station staff calculate. In this calculation they use the test frequency and data on the frequency of failure of components collected from Bruce NGS"B" experience in the previous five years, together with knowledge of future preventative maintenance insofar as it will affect the availability of the system. The numbers for the actual past unavailability of the four special safety systems for each unit follow together with the predicted future unavailabilities.

Special Safety System Unavailabilities for 1991 (in hours per year).

SYSTEM	PREDICTED FUTURE UNAVAIL	ACTUAL PAST UNIT 5	ACTUAL PAST UNIT 6	ACTUAL PAST UNIT 7	ACTUAL PAST UNIT 8
Shutdown system 1	3.9	0	0	0	0
Shutdown system 2	8.6	0	0	0	0
Containment *	7.5	14.5	14.5	14.5	14.5
Emergency Coolant Injection	8.6	0.17	0.17	0.17	0.17

* Most causes of unavailability of this system result in an unavailability to the whole station. There was none confined to a unit in 1991.

Special Safety System Unavailabilities for 1990 (in hours per year)

SYSTEM	PREDICTED FUTURE UNAVAIL	ACTUAL PAST UNIT 5	ACTUAL PAST UNIT 6	ACTUAL PAST UNIT 7	ACTUAL PAST UNIT 8
Shutdown system 1	3.8	0	0	0	0
Shutdown system 2	8.3	0	0	0	0
Containment	7.2	11.5	151	1.6	1.6
Emergency Coolant Injection	7.8	0.17	0.17	0.17	0.17

The licence limit for the unavailability of the four special safety systems is 8.76 hours per year (10^{-3} years per year). This limit was exceeded by the containment system in 1991.

AECB staff consider that the unavailability of three of the special safety systems has been satisfactory. The emergency coolant injection system's unavailability arose from a spurious signal closing two motorized valves. The fourteen hours unavailability of the containment system was the result of design deficiencies in a modified door mechanism that had been fitted to an airlock for trial to attempt to preserve the life of the door seals. The mechanism has since been redesigned and is to be fitted to the airlock in 1992. Meanwhile warning notices have been placed at the airlock to point out the deficiency.

The predicted future unavailabilities of shutdown system 1 and emergency coolant injection system, which are near the target value, have arisen from the proneness of the mercury-wetted relays to fail, and from the conservative nature of the calculations of these unavailabilities. Ontario Hydro have done much research into the problem of the mercury-wetted relays. The immediate solution is to replace the relays with tin-doped mercury-wetted relays at every failure. For the long-term solution Ontario Hydro have set up a program of search for a suitable dry-contact relay to replace the mercury-wetted relay.

EVENTS REPORTED TO THE AECB

	1991	1990
Total No. SERs	145	115
Total No. Reportable SERs	31	35
No. SERs/Unit	36.25	28.75
No. Reportable SERs/Unit	7.75	8.75
Total No. Fires	3	3
Total No. Human Errors	36	48
No. Genuine Reactor Trips/Unit	0.75	1.0

Although the total number of significant events increased in 1991, the number of events which were reportable under the conditions of the licence decreased.

A large number of significant event reports involved infractions of work protection procedures. The station has taken steps to address this problem, as is discussed in the Training section of this report.

In most of the significant event reports which involved human error, a lack of verification is evident. Contributing factors to these events often included workers not checking their own work, or an apparent lack of field supervision. This is an issue we have raised with station management, and some progress is being made in correcting the problem. The new work protection procedures include a requirement to verify the field isolation of equipment. Throughout 1992, we will monitor significant event reports for progress in the area of verification.

In reporting significant events, station staff follow strict rules on whom the various types of events must be reported to, within what time limits, and what information must be included. At Bruce NGS"B", SERs are normally issued promptly, to the appropriate authorities, and with adequate information. In 1991, there were very few event reports which did not meet these standards. One involved a heavy water spill of heat transport water. The spill occurred outside the station, but within the plant boundaries. Incomplete reporting to the Ministry of the Environment, coupled with difficulties in containing the spill, contributed to initial confusion over what had actually happened. The importance of timely reporting of SER's was also stressed in an Ontario Hydro assessment of the station, conducted in 1991.

We consider the station's performance in this area to be acceptable.

OPERATIONS AND MAINTENANCE

Station Operation

One of the aims at all stations is to minimize temporary changes, both equipment configuration changes, and operating documentation changes.

Over the past three years at Bruce NGS"B", the number of temporary changes to equipment configuration, called Jumpers, has shown a slight, but steady increase. This trend is not a positive one, as it shows a growing backlog of work. This backlog indicates the increasing time lag between the time equipment is changed in the field, and the time that the change is incorporated into permanent station documents such as Operating Manuals, Training Manuals, and engineering drawings. Station management is aware of this trend, and had appointed a technical person to address the problem.

In 1991, the average number of temporary operating instructions, known as Operating Memos, dropped by one half. In comparison with the worsening trend of Jumpers, we feel that the station's efforts in reducing Operating Memos is very positive. Station management had indicated to us that the constraints imposed on them by the 1991 budget would make the reduction of temporary change documentation more difficult to achieve.

AECB staff's overall view is that Ontario Hydro staff continued to operate Bruce NGS"B" safely. Most operational problems were minor, and the causes were determined. Many work programs are in progress at the station, to correct the causes of operational difficulties, and to anticipate possible future problems. As with other nuclear power plants, some of the projects in progress reflect lessons learned from operational experiences at other stations.

	1991	1990
No. Operating Memos	38.25	75
No. Operating Memos extant >6 months	14.5	42.5
No. Systems (USI's) with >1 Operating Memo	2	7.5
No. Operating Memos with overdue review date	6.5	11.5
No. Jumpers	281.25	270.25

These numbers are a per-unit average, and represent the total number at the station divided by 4 (reactor units). Effective date is December 31, 1991.

Steam Generator Tubes

Previous AECB Annual Reports have described the fretting wear of steam generator tubes that has been found to affect all Bruce NGS"B" units. During 1991, Ontario Hydro repeated inspections in units 5 and 6. From these inspections it has been determined that the population of fretted tubes has not grown, nor has the maximum wear depth increased significantly. The maximum growth of wear scars deeper than 35% of wall thickness appears to have decreased to 5% per year. No tubes have been found to exceed the limits established by the acceptance criteria for wear depth, and no leaks have occurred because of fretting.

Last year's report referred to planned modifications to eliminate wear by improvements to steam generator tube supports. Ontario Hydro has now modified one steam generator in unit 5 and will install additional supports in another steam generator of unit 5 this Spring. These modifications will require careful monitoring by non-destructive eddy current methods to establish their effect on tube wear rates and to determine whether other steam generators should be modified. Installing the modifications results in the workforce receiving radiation doses and carries some technical risk also.

Plant Chemistry Control

We considered overall plant chemistry control to be acceptable during the year. This is based on reviews of plant chemistry we carried out and on reviews of the station's routine reports.

Bruce NGS"B" has set itself very stringent system chemical control targets. Typical control parameters are more restrictive than for other CANDU plants. Bruce NGS"B" met its targets 87% of the time. Bruce NGS"B" have reduced the number and severity of transients, improving their ability to recover and control them. An indication of the high priority placed on chemistry control is that significant event reports are required to be filed for certain out-of-specification chemistry conditions.

It is noted, that in spite of good control of steam generator chemistry, an increase in the primary coolant inlet header temperature has occurred. Reduction of heat transfer in the steam generators is a possible cause and could indicate fouling of the steam generator tubes. Cleaning of steam generators during plant life may be required to maintain normal operating margins. There are areas where the chemistry should be improved to prevent adverse effects in the future. This includes air ingress into the low pressure areas of the condensate system.

There has been good control of existing system chemistry, yet new requirements have not been identified and implemented in a timely manner. Oxygen addition to the annulus gas system has been an industry requirement for some time, yet the oxygen addition system had not been fully installed by the end of the year. Plans are in place to have the system in service in 1992.

A new chemistry information monitoring system is in service which improves the ability to trend data and improves data availability. There have been problems in setting up the system and there have been occasions when the information did not appear in the proper place. We expect the system will become more reliable with time as plant staff become more familiar with data input.

Chemistry laboratory instruments and field instruments had acceptable performance.

A large number of new chemistry technicians were hired recently. Experienced staff have been required to train them and this has resulted in fewer people available to do the required work.

Maintenance

The maintenance to prevent breakdown, which is governed by a system of call-ups, showed a worsening from that of the year 1990, as is shown in the statistics below. Of particular concern were the 145 call-ups on the four special safety systems that were outstanding at the end of 1991. The decline in maintenance was also manifested in the increase in the number of outstanding deficiency reports (reports that signal the need to repair a fault or supply a deficiency).

The 145 call-ups on the four special safety systems have since been completed. To prevent this sort of lapse recurring and to provide better control of call-ups in general a Preventive Maintenance Enhancement Program is being established. It is intended to have it in operation by the end of 1992.

To eliminate the bulk of the backlog of outstanding call-ups and deficiency reports the station recognises that it will require an extensive addition to the present staff of mechanical maintainers and control technicians.

	1991	1990
No. of Call-ups Outstanding at Year End	2436	1780
No. of Deficiency Reports Outstanding per Unit at Year End	2434	1887

We consider it very important that preventative maintenance be improved to ensure that the effects of the plant's ageing do not cause an increased risk to the public.

AECB Compliance Inspection

AECB staff conducted 19 system inspections in 1991. In three of these the system was found to be in an unsatisfactory state; the details follow.

Annulus Gas System. A test on a leakage detector had not been done since 1988 on three units and since 1990 on the other unit. Since 1988 the operating manual has required the test to be done every six months. Its being done every six months is an assumption made in the analysis of the unavailability of the system, which has established that the system can meet the target unavailability of 87.6 hours per year (10^{-2}). The importance of this system is its ability to detect a heat transport coolant leak in a pressure tube and enable the reactor to be shut down before a rupture of the pressure tube could occur.

Standby Generator System & Emergency Power System. Each of these safety systems displayed, according to call-up and deficiency report records, an unacceptable state of maintenance in outstanding preventative maintenance and repair.

AECB staff conducted inspections of all areas of the station (rounds). Housekeeping on the whole was found to be good. Exceptions to this were rubber areas and the auxiliary services building. The permanent rubber areas were kept in good condition, but the temporary ones were in poor condition; it was evident that station staff were not following the procedures for the setting-up and maintenance of these rubber areas. The auxiliary services building was found to be in a very poor state of housekeeping. Both these deficiencies have since been rectified.

STATION MANAGEMENT

Based on observations during 1991 AECB staff noted Bruce NGS"B" station management continued to improve the culture at the station to make it more open and safety conscious. Initiatives included:

- safety culture
- quality improvement process
- documentation
- resources

Safety Culture

Safety culture is that which cultivates an attitude that safety is the prime consideration in any activity. Ontario Hydro concluded that expectations for maintaining the margin of safety in the operation and maintenance of the plant have not been well defined and clearly communicated to appropriate levels of the station's organization. Steps have been taken to correct this at all levels of the station's organization.

On the other hand, there is a strong awareness amongst plant staff of the importance of safety. Safe operation requires operators to initiate deratings and shutdowns and to act conservatively when a potentially unsafe situation occurs. The following example illustrates this safety awareness. The transfer of a spent fuel bundle from the fuelling machine into the irradiated fuel bay failed. Instead of allowing the bundle to get hot, operators flooded the chamber to cool the bundle even though it resulted in heavy water being downgraded. Later, management showed support for the actions and were proud of the way people had handled the situation. This shows the type of management culture and support needed to promote the safety-first concept.

Quality Improvement Process

There is a major program throughout Ontario Hydro to improve quality and improve Ontario Hydro performance. The Quality Improvement Process (QIP) has many committees operating at all levels of the corporation.

Bruce NGS"B" committees have had varying degrees of success. Many of the committees have been very active, have improved morale in their area, and have created a sense of ownership with people feeling more in control of their job and feeling they have a say in what goes on. If QIP is to succeed, all station staff must support the improvement of quality and the use of a team approach.

All the QIP teams that AECB staff interviewed revealed that they saw management as being supportive and providing the teams with resources as needed.

Ontario Hydro has recently hired an outside firm. *Qual Tech*, to assist them in modifying the quality improvement program.

Documentation

Bruce NGS"B" plans to issue upgraded operating manuals to replace the current manuals. The five-year plan has completed its first year with 17% of the manuals issued and a further 4% being upgraded. The more important manuals dealing with emergency conditions, abnormal operation, and major nuclear systems are being completed first. Operators with experience in using manuals prepare the upgrades and bring their operating experience to bear in making the manual effective.

Resources

Some safety related work is not being done. This is seen in a number of areas, including backlog of work, preventive maintenance not completed, and the amount of time to update station operating documents.

It is not possible to state at this time if streamlining of work practices would improve the situation or if there is a need for larger numbers of people. An initiative to study the "wrench time" of mechanics which the station has undertaken and is about to issue a report on should help to point out some ways of improving the situation.

TRAINING

In 1991, Bruce NGS"B" continued its commitment to staff training. Two areas of training are addressed in this report: general staff training, and authorized staff training.

The reactor safety course, taught as part of the authorization training program, underwent a major revision in 1991. One reason for the revision was to place more emphasis on the defence-in-depth operating philosophy. We have received the revised training material, and believe that the changes are positive.

Changes to work protection procedures have resulted in a major training effort at the station. Prior to 1991, work protection procedures had been unique to each of the four operating facilities at the BNPD site. In 1991, the four sets of procedures were combined, and a single set of site work protection procedures issued. Station adherence to safe work protection practices and procedures has been an area where we have felt improvements could be made. An audit, carried out in the third quarter of 1991, confirmed our thoughts. Feedback from Ontario Hydro indicated that our audit observations would be addressed in the new site work protection procedures, and in the training.

Several emergency response documents were revised in 1991, and some training has been carried out. Revisions to the fire procedures included changes recommended by a QIP committee. Also, a new contaminated casualty plan was issued for the BNPD site. A subsequent revision of the site contaminated casualty procedure is planned for 1992. Other procedures which were revised in 1991, for implementation and training in 1992, include: medical emergencies, toxic gas emergencies, and radiation emergencies.

Ontario Hydro has an adequate number of authorized shift operating staff as shown in the table following.

	Shift Supervisor	Shift Operating Supervisor	Control Room Operator
Minimum Number Authorized Staff Required	5	5	25
Number Authorized Staff as of December '91	8	6	32

A training program for authorized staff, known as "authorization continuing training", is partially in place at the BNPD, but is not formally structured. Parts of this program which are in place include: computer simulator practice, periodic reviews of upgrades to station systems, significant event reports, and changes to station documentation.

The section of the continuing training program which is not yet in place involves more structured classroom training. This will include reviews of training material covered in the original authorization program, and will ensure all authorized staff maintain their level of knowledge in all areas of plant operation.

Periodic testing of authorized staff is another area that is under development. Station management informed us that current budget constraints may delay the implementation of the remaining portions of the continuing training program. We met with Ontario Hydro management to express our view that they continue their commitment to the funding of this training program.

Overall, we feel that the training provided to general station staff was acceptable. The training program for authorized staff underwent some improvement in 1991, but we feel that there is still room for further improvement.

EMERGENCY EXERCISES AND DRILLS

All 1991 planned emergency response exercises were completed.

Minor delays were encountered in accounting for station personnel, and completing the door-closing procedures within the allocated time. Ontario Hydro is investigating the use of an automated accounting system. Implementation is planned for 1992. Changes to the door-closing process are also being reviewed, to see if this can be streamlined.

A site contaminated casualty drill, in the fourth quarter of 1991, identified deficiencies in the emergency response agreement between Ontario Hydro and a local ambulance service. Negotiations are underway, to resolve the discrepancies.

Six security drills were conducted by the individual security shift crews. As is usual in such matters, a few problem areas surfaced and this enabled corrective action to be taken to ensure that suitable procedures were in place. Unfortunately, the planned major exercise that was to involve certain key elements of the facility's Operations, the Ontario Provincial Police, and the security force, was cancelled because of the inability of the police to release resources to this activity. Security related exercises and crew drills are considered excellent proactive activity leading to preparedness to deal effectively with emergency situations. AECB staff will continue to encourage and support such activity.

TYPES OF DRILLS	NUMBER OF DRILLS
Fire	85
Search & Rescue	65
Medical Emergency	13
Toxic Gas	18
Radiation Emergency	26
Security	6
1991 TOTAL	213

We consider the station's achievement of carrying out all the planned emergency drills in 1991 to be commendable.

SAFETY ANALYSIS

In-Core Loss-of-Coolant Accident

Ontario Hydro in updating the safety analysis for small loss-of-coolant accidents discovered that there was insufficient trip coverage for the case when the reactor was started up after a long shutdown. The moderator is then heavily poisoned and the process trip parameters would not be effective in a combined pressure tube and calandria tube failure (in-core loss-of-coolant accident) under certain combinations of reactor power, poison concentration, and the isotopic difference between the moderator and the heat transport coolant. There would be one effective trip only, the neutron overpower trip. The reason for this is that the core is more reactive than was previously considered to be the case when the original trip coverage was determined.

Ontario Hydro has taken certain steps to improve the trip coverage. Included in these is a procedural control to prevent the reactor from operating in the region of single-trip coverage, which has been declared impermissible. AECB staff have approved these in principle, since the installation of another trip would cause an undesirable increase in the complexity of the plant unwarranted for this very specific condition. To verify that the reactor is operated in the permissible region, a computer code called TRANSENT is used. AECB staff are at present reviewing this code to see that it is satisfactory.

Hydrogen Ignition System

Hydrogen igniters are required for a controlled combustion in the containment atmosphere of the hydrogen evolved in a loss-of-coolant accident. Ontario Hydro has argued that the hydrogen ignition system is required only for an event of very low probability, a loss-of-coolant together with a loss of emergency coolant injection, and therefore its unavailability need not be less than 87.6 hours per year (10^{-2}). AECB staff believe that since this system is part of containment, a special safety system, it should meet the unavailability criterion of 8.76 hours per year (10^{-3}).

As part of the safety report update Ontario Hydro is reanalysing more probable events, such as a large loss-of-coolant accident and a stagnation feeder break, to demonstrate that, on the basis of the amount of hydrogen generated, the hydrogen ignition system is not required for them. But the successful control of hydrogen combustion inside containment also depends on other factors, such as the hydrogen concentration distribution in the containment atmosphere established by the operation of the vault coolers, the required number of igniters, their location, etc. Hence AECB staff are of the opinion that in assessing the unavailability requirements for the hydrogen ignition system consideration must not be restricted to any one factor in isolation. We are urging Ontario Hydro to resolve this long-standing problem, in particular the issues specific to Bruce NGS"B".

QUALITY ASSURANCE

AECB staff have been of the opinion that the quality assurance section at Bruce NGS"B" is not given a sufficiently important role in monitoring the activities at the station on which hinge the safety of the plant. Throughout the year the section has been under strength, having only four of the complement of five persons, although it is to be brought up to strength in 1992. The activities subjected to internal audits have not been of the greatest importance from the safety point of view, with one exception. The exception was the monitoring and auditing of the preparation and fieldwork for the modification done to the steam generator tube supports on one of the steam generators of unit 5, and was done at the prompting of AECB staff. This task was done very well and its results showed that it was necessary.

Ontario Hydro is now reorganizing its quality assurance groups as a result of AECB staff's criticism of the state of quality assurance in Ontario Hydro nuclear generating stations. We expect an improvement to take place in 1992.

AECB staff conducted an audit of the Bruce NGS"B" Operations Quality Assurance Program in August 1991. As a result eight recommendations were made for improvements, including the increase in staff to full strength. No serious deficiencies or non-compliances were found.

CONCLUSIONS

AECB staff believe that Ontario Hydro has continued to operate the Bruce "B" nuclear generating station in a safe manner and has maintained the risk to the workers and public at an acceptably low level.

However, the Bruce NGS"B" plant is conservatively designed and is in the early years of its 40-year life. As such the impact on public risk of operator errors and less-than-satisfactory maintenance is not as serious now as it may be in years to come when the plant begins to age and safety margins become reduced. We therefore consider that Ontario Hydro should improve performance in the following areas:

- The safety culture of staff so that there is a complete understanding at all levels of the organization of nuclear safety principles in operational and maintenance activities.
- The reduction of the maintenance backlog and the establishment of an intensified maintenance program that will provide for effective management of the plant's life.
- The establishment of the necessary procedures to provide assurance that plant operation is in compliance with the Operating Policies and Principles.
- The institution of a true verification process to ascertain that actions that change the state of equipment have been carried out as intended.
- The adherence to the ALARA principle in all activities.

GLOSSARY

Adjuster Rods (AD)	Vertically operated neutron absorbing rods that normally are fully in the core. They adjust the neutron population (or flux) in a certain desirable manner.
Air Lock	The means of access to and from the reactor building, which is designed to maintain the containment integrity during personnel and equipment transfers.
Annulus Gas System (AGS)	A continuously circulating system of carbon dioxide gas in the space between the pressure tubes and calandria tubes for the purpose of thermally insulating the tubes from each other and the early detection of tube leaks.
As Low As Reasonably Achievable (ALARA)	The principle of keeping radiation doses 'as low as reasonably achievable', social and economic factors being taken into account.
Atomic Energy Control Board (AECB)	A federal departmental corporation established in 1946 by the *Atomic Energy Control Act* to control the development, application and use of nuclear energy in Canada and to participate on behalf of Canada in international measures of control. The AECB reports to Parliament through the Minister of Energy, Mines and Resources.
Authorized Staff	Persons that have been authorized to function in a specific capacity by the AECB in accordance with the provisions of the reactor operating licence.
Background Radiation	The radiation field caused by a distant source, e.g., natural radiation.
Bruce Nuclear Power Development (BNPD)	The Ontario Hydro property on which stand Bruce NGS"A", Bruce NGS"B", Bruce Heavy Water Plant, and various ancillary services.
Calandria	A cylindrical unpressurized stainless steel vessel which holds the moderator. Pressure tubes containing the fuel and coolant span the two end-plates of the calandria.

Call-up	A routine maintenance activity on a component which is carried out at regular intervals.
Canadian Deuterium-Uranium Reactor (CANDU)	Canadian designed reactor moderated and cooled by heavy water and fuelled with natural uranium. "CANDU" is derived from Canada, Deuterium, Uranium.
Cobalt Cooling System	Cobalt is the material of the adjuster rods. It becomes radioactive (cobalt 60) and so steadily increases in temperature. The cooling system prevents the temperature's reaching the ignition point of deuterium.
Condensate System	The system that retrieves water from the condenser attached to the turbine and passes it to the steam generator feed system.
Containment	The building surrounding the reactor which is designed to contain the effects of any accident involving the reactor. The containment is provided with fast acting valves to isolate any openings (e.g. ventilation) which operate if any radiation is detected.
Contamination	The deposition of radioactive material in any place where it is not desired, and particularly in any place where its presence may be harmful.
Deficiency Report (DR)	A document used to report a deficiency and start the process for its remedy.
Downgrade	Heavy water is downgraded when mixed with natural water.
Eddy Current Testing	A means of determining the existence of flaws in a tube of electrically conductive material by the relative motion of a magnetic flux and the tube.
Emergency Coolant Injection System (ECI)	A supply of cold water which can quickly be injected into the fuel channels of the reactor in the event that the normal source of cooling water is lost.
Fuel Bundle	A bundle of rods containing natural uranium fuel and formed into a full cylinder that fits snugly in the fuel channel.
Fuelling Machine (FM)	Equipment used to fuel the reactor. Two remotely controlled FMs work at opposite ends of the same fuel channel, with one machine inserting new fuel and the other removing irradiated fuel while the reactor continues to operate.

Heat Exchanger (HX) — Equipment that removes heat from a system and transfers it to another one.

Heat Transport Coolant — The liquid of the heat transport system, which is heavy water, that is made to flow through the fuel channels to the steam generators in order to transport the heat evolved in the reactor to the natural water of the steam generators.

Heavy Water (D_20) — A chemical compound made up of two parts deuterium (an isotope of hydrogen with one neutron in the nucleus) and one part oxygen. It is chemically and physically similar to water (H_20), but is about 10% natural heavier. Occurring in small concentrations in nature, it is made by separating it from natural water primarily for use as a moderator and coolant in CANDU reactors.

International Atomic Energy Agency (IAEA) — Established in 1957 under the auspices of the United Nations to provide a system for the safeguarding of peaceful nuclear energy applications against diversion of material for non-peaceful activities.

Irradiated Fuel Bay (IFB) — An area of the plant comprising a large pool of natural water where fuel that has been discharged from the reactor is cooled and shielded by the water.

Isotopic Difference — The difference between the greater concentration of heavy water in the moderator and the lesser concentration of heavy water in the heat transport coolant.

Jumper — A temporary modification to a piece of equipment in the station which is kept track of by a document called the jumper record and by a tag on the equipment.

Loss of Coolant Accident (LOCA) — An accident in which a failure in the heat transport system causes the heavy water coolant to be lost faster than it can be replaced by the normal heat transport coolant supply. The emergency coolant injection system is installed to permit fuel cooling if this happens.

Mercury Wetted Relay — A relay that uses mercury in the making of contacts in the switching process.

Microsievert - *(see sievert)*

Moderator — The heavy water in the calandria whose function is to slow down the neutrons released by fission to energies at which they are likely to produce additional fissions. Because the moderator heavy water surrounds the fuel channels, it also performs cooling and protection if a major accident were to cause a complete loss of cooling to the fuel channels.

Motorized Valve (MV)	A valve that is operated by or relies on an electric motor.
Nuclear Generating Station (NGS)	A facility comprised of a single or multi (usually four) reactor units that converts the fission energy released in the reactor to electrical energy.
Neutron Overpower Trip	A system that will activate reactor shutdown if a signal is received from in core detectors that neutron power in any of the regions monitored in the reactor exceeds a pre-established limit.
Operating Memo	A temporary instruction to operators on the operation of a specific system.
Operating Policies and Principles (OP&P)	A document required under the licence that outlines operating boundaries within which the station may be operated safely and efficiently, and which sets out authorities of the station staff.
Particulate	Any radioactive material which is in particle (e.g. dust) form.
Physical Security Regulations	Regulations promulgated in 1983 in pursuance of the Atomic Energy Control Act that prescribe the physical security standards to be complied with at certain nuclear facilities.
Poison	Any material in the reactor that readily absorbs neutrons unproductively and hence removes them from the fission chain reaction.
Pressure Tube (PT)	One of the tubes that pass through the calandria and contain twelve or thirteen fuel bundles and through which the pressurized heavy water coolant is pumped.
Pressurizer	A large steel vessel connected to the heat transport system and containing a cushion of steam above the heat transport coolant in it. It smooths out any rapid changes in pressure that can occur, and accommodates large changes in volume of the coolant that occur at start-up and cool-down.
Preventive Maintenance	Maintenance that is carried out at regular intervals of time to avoid breakdowns.
Quality Assurance (QA)	A formal program of standards, procedures and checks that controls the quality of work carried out in the station.

Quality Improvement Process (QIP)	A process instituted by Ontario Hydro to improve the performance of Nuclear Operations Branch.
Radiation Field	An area in the plant where there is a significant amount of ionizing radiation.
Reactor Regulating System (RRS)	*A system that combines the reactor's neutron flux* and thermal power measurements, reactivity control devices, and a set of computer programs to monitor and control total reactor power to satisfy station load demands, to monitor and control reactor flux shape, to monitor important station parameters, and to reduce power at an appropriate rate if any parameter is outside specific limits.
Resin Deuteration System	Resin is used in the purification of moderator and heat transport coolant. The purpose of the system is to minimize the downgrading of the moderator and heat transport coolant by causing heavy water molecules to displace the natural water (H_2O) molecules in the resin.
Rubber Area	A specially prepared area of floor in the plant where it is foreseen that there will be loose radioactive contamination. Its purpose is to contain the contamination and not to let it spread. It is so called because persons entering don rubber overshoes before stepping into the area, and remove them when leaving.
Shutdown System (SDS)	Consists of two independent systems, each capable of shutting down the reactor. The first shutdown system uses gravity-drop solid shut-off rods. The second injects pressurized liquid poison (gadolinium nitrate) into the moderator.
Shutdown System No. 1 (SDS1)	The primary method of quickly shutting down the reactor when certain parameters enter an unacceptable range, involving the release of spring assisted gravity-drop neutron absorber elements known as shutoff rods.
Shutdown System No. 2 (SDS2)	An alternate method of shutting down the reactor by rapidly injecting a neutron poison (gadolinium nitrate) into the moderator through horizontal tubes that enter one side of the reactor and terminate as nozzles in the moderator.
Sievert (milli, micro)	A measurement of radiation exposure. One sievert is the same as 100 rem; one millisievert is one thousandth of a sievert (0.001 Sv); one microsievert (1 μSv) is one millionth of a sievert (0.000001 Sv).
Significant Event Report (SER)	A formal report of an event occurring in the station that is abnormal according to certain criteria.
Standby Generators (SG)	Diesel or gas turbine powered generators that can provide electrical power to maintain reactor cooling if grid supply is lost.

Steam Generators	A heat exchanger that transfers heat from the heat transport coolant, passing through tubes, to natural water to form steam in its upper portion, which is delivered by piping to the turbine.
Stepback	An action taken by the reactor regulating system to reduce power immediately if any one of certain station parameters is out of specific limits.
Tin-Doped	An addition of a small quantity of tin to the mercury of a mercury-wetted relay to improve its performance.
Trip	A system that will activate reactor shutdown if any one of the safety related parameters falls outside a pre-established limit.
Trip Coverage	The measure of how well a specific potential accident of the reactor is guarded against by trips.
Trip Parameter	A characteristic quantity (e.g., temperature, pressure) of a system that is continuously measured and compared with a limiting value (trip setpoint). If it reaches the limit a signal is sent to activate a shutdown system.
Tritium	A radioactive isotope of hydrogen which is produced in the reactor's heavy water during operation.
Uptake	The amount of radioactivity ingested into the human body.
Vault Coolers	Large fans and heat exchangers placed in the bottom of the reactor vault to circulate cool air in the vault.
Work Protection	A set of rules and procedures that operators and maintenance workers must follow while work is performed on plant systems to ensure that the latter are protected from bodily harm.

Appendix A

Reportable Significant Event Reports

Significant Event Report Number	Description	Human Error
B91- 08	Conflicting Procedures for Emergency Water System (EWS)	No
B91- 11	Airlock Seal Failures	Yes
B91- 12	Level I Impairment of Emergency Coolant Injection System (ECIS)	No
B91- 13	Unit/Station Alert Due to D_20 Spill from a Tanker in the ASB	Yes
B91- 18	Relief Valves Not Calibrated During Outage	Yes
B91-19	Ancillary Service Building (ASB) Noble Gas Monitor Out of Service	No
B91-25	Damage to EWS Pipe Anchors	No
B91-32	Unplanned Outage on Unit 7	No
B91-33	SDS2 Level II Impairment Due to High Level in Injection Tanks	No
B91-40	Possible Type 2 Faults of SDS1 Neutron Overpower Parameter on Units 6 and 8	No
B91-43	Roadway Contamination - South Guardhouse	No
B91-56	Liquid Effluent Monitor (LEM) Impairment	No
B91-67	Unannunciated Breach of Containment of Airlock AL20 - Level 2 Impairment of Containment	No
B91-72	Cable Damage as a Result of Construction Earth Mover Penetrating Cable Trench	No
B91-77	Stack Monitor Downtime Over Allowed Limit	Yes
B91-79	Emergency Water System Pressure Switch Found Isolated	Yes
B91-90	Undocumented Jumper in Effect on the Unit 7 Boiler Feed Interunit Tie System	No
B91-96	Moderator Outlet Temperature Exceeded	No
B91-98	Stack Noble Gas Monitor Failure and Incorrect Response	Yes
B91-102	Use of Poison (Gadolinium Nitrate) Without Verification of Isotopic Concentration	Yes
B91-107	Moderator Outlet Temperature Exceeded OP&P Limit of 64°C	No

Appendix A

Reportable Significant Event Reports

Significant Event Report Number	Description	Human Error
B91-115	Unavailability of Stack Monitor	No
B91-118	Defeat of Overpressure Protection	No
B91-125	Herfurth Whole Body Monitors - Disabled	No
B91-127	Spurious Intercept Valve (IV) Fast Closing While This Action Was Inhibited	No
B91-128	Spurious Intercept Valve Closure/Moderator Outlet Temperature OP&P Limit	No
B91-132	Breach of Security - Lapse of Sponsorship Requirements	Yes
B91-139	Moderator Outlet Temperature Exceeds OP&P Limit of 64°C	No
B91-143	Breach of Containment Error During Quarterly Leak Rate Test	Yes
B91-145	Unapproved Test Air Connection When Conducting SST 2.4	Yes

Appendix B

Objective Measures of Station Performance
Bruce NGS 'B'

Item	Description	1989	1990	1991
1	Radiation Safety			
1.1	**Worker Radiation Safety**			
1.1.1	Total whole body (person Sieverts) radiation dose.	1.65	1.85	1.73
1.1.2	Total extremity (person Sieverts) dose.	1.28	2.94	3.44
1.1.4	Total neutron dose (person Sieverts)	0.003	0.001	0.005
1.1.5	Total tritium dose (person Sieverts)	0.39	0.30	0.20
1.1.6	Number of radiation exposures over the regulatory limit of 50 milli Sieverts per year.	0	0	0
1.1.7	Number of radiation related supervisor's investigations.	21	27	17
1.2	**Public Radiation Safety**			
1.2.1	Radiation Releases from Bruce B to air			
	Tritium-Percent of Derived Emission Limit(DEL), averaged over the year.	0.079	0.160	0.082
	Tritium-Number of Weeks during year where 1% DEL target exceeded.	0	0	0
	Noble Gases Percent of DEL, averaged over the year.	0.038	0.006	0.006
	Noble Gases Number of weeks during year where 1% DEL target exceeded.	0	0	0
	Iodine 131 percent of DEL, averaged over the year.	0.002	0.009	0.011
	Iodine 131 number of weeks during year where 1% DEL target exceeded.	0	0	0

Objective Measures of Station Performance
Bruce NGS 'B'

Item	Description	1989	1990	1991
1.2.1 (cont'd)	Particulates percent of DEL, averaged over the year.	0.003	0.003	0.003
	Particulates number of weeks during year where 1% DEL target exceeded.	0	0	0
1.2.2	**Radiation Releases from Bruce B to Lake Huron**			
	Tritium percent of DEL, averaged over the year.	0.063	0.015	0.017
	Tritium number of weeks during year where 1% DEL target exceeded	0	0	0
	Total beta-gamma percent of DEL, averaged over the year.	0.030	0.017	0.012
	Total beta- gamma number of weeks during year where 1% DEL target exceeded.	0	0	0
1.2.3	Total measured whole body radiation dose to an adult member of the public living near the Bruce Nuclear Power Development (BNPD) due to releases from BNPD. The target is to be less than 50 microsieverts per year whole body dose.	8.6	6.2	9.0
1.3	**Environmental Measurements of Radiation**			
1.3.1	Average radiation dose rate at the boundary of the site. (Values should be within the range of provincial reference sites (1991 average was 51 nanoGrey per year) and not show a significant increase from previous years.	37	45	45
1.3.2	Average tritium concentration in air at the site boundary. A significant increase would be considered unacceptable. The values are given as a percent of the internationally accepted allowable tritium in air concentration. (MPCa)	0.052	0.032	0.027

Appendix B

Objective Measures of Station Performance
Bruce NGS 'B'

Item	Description	1989	1990	1991
1.3.3	Average tritium concentration in precipitation as measured in the vicinity of the site. (Average of all measurement sites) Unit is a Becquerel per litre of rain. The international drinking water limit is 200,000 Becquerels per litre.	484	295	235
1.3.4	Average total beta activity in precipitation. Units are Becquerels per square metre in a month. Limits vary for different radioactive materials.	36	42	37
1.3.5	Average measured concentration of tritium in milk samples. Units are Becquerels per litre.	32	26	10
1.3.6	Average measured concentration of carbon 14 in milk samples. Units are Becquerels per litre averaged over the year.	236	274	307
1.3.7	Average iodine 131 concentration measured in milk samples. Units are Becquerels per litre averaged over the year.	0.12	0.15	0.21
1.3.8	Average tritium concentrations measured in drinking water over the year for both Port Elgin and Kincardine. The units are Becquerels per litre. The drinking water limit is 200,000 Becquerels per litre.	38	23	46
1.3.9	Average total beta concentrations measured in drinking water over the year for both Port Elgin and Kincardine. The units are Becquerels per litre. The drinking water limit varies depending on the radioactive material.	0.12	0.09	0.10
1.3.10	Total collective dose to the public to a radius of about 16 km was calculated. The units are person Sieverts.	0.07	0.17	0.17

Appendix B

Objective Measures of Station Performance
Bruce NGS 'B'

Item	Description	1989	1990	1991
2	<u>Station Operation</u>			
2.1	Number of genuine reactor trips per reactor during the year.	1.75	1	0.75
2.2	Number of serious process failures in the entire station during the year	0	0	0
2.3	**Performance of Safety Systems**			
2.3.1	Shutdown system number 1 unavailability measured as hours per year. The target is to have shutdown system one unavailable for less than 8 hours a year.	0	0	0
2.3.2	Shutdown system number 2 unavailability measured as hours per year. The target is to have shutdown system two unavailable for less than 8 hours a year.	0	0	0
2.3.3	Negative pressure containment unavailability measured as hours per year. The target is to have negative pressure containment unavailable for less than 8 hours a year.	0	41	15
2.3.4	Emergency coolant injection system unavailability measured as hours per year. The target is to have emergency coolant injection unavailable for less than 8 hours a year.	0.2	0.2	0.2
	Events Reported			
2.4	Number of reportable incidents per unit. This number takes the actual reportable incidents at the station and divides by four. Common services are then divided equally among the reactors.	4	8.75	7.75
2.5	Number of reported fires in the station on a per station basis.	6	3	3

Appendix B

Objective Measures of Station Performance
Bruce NGS 'B'

Item	Description	1989	1990	1991
2.6	Number of significant human errors reported on a per station basis.	11	48	36
3	<u>Station Maintenance</u>	0	0	0
3.1	Number of unplanned outages per unit during the year.	2.25	3.3.	0.6
3.2	Number of call-ups outstanding at year end averaged over the year on a per station basis.	2710	1780	2436
3.3	Deficiency reports outstanding on a per unit basis at the end of the year.	1311	1887	2434
4	<u>Station Management</u>			
4.1	**Documentation**			
4.1.1	Average number of Operating Memos in effect on a per unit basis at the end of year.	81	75	38
4.1.2	Number of Operating Memos in effect for greater than 6 months on a per unit basis.	33	43	15
4.1.3	Number of Systems with more than one Operating Memo in effect for more than six months.	9	8	2
4.1.4	Number of Operating Memos behind schedule for review on a per unit basis at the end of the year.	25	12	7
4.1.5	Total number of jumpers per unit at the end of the year.	261	270	281
4.1.6	Jumpers beyond review date, per unit at the end of the year.	Info not gathered.	250	227

Appendix B

Objective Measures of Station Performance
Bruce NGS 'B'

Item	Description	*1989*	*1990*	*1991*
4.2	**Training**			
4.2.1	Percent of planned drills completed	100	100	100
4.2.2	Percent of candidates passing AECB exams	82	82	83
4.3	**Security**			
4.3.1	Number of reportable security events for the station during the year.	3	3	1