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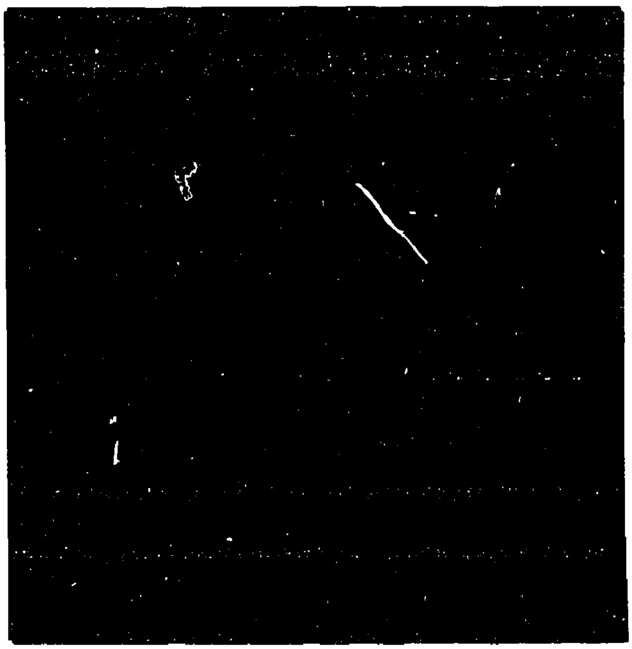

RAPPORT

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

Canada

INFO-0564

REPORT

AECB Staff Annual Assessment of the Point Lepreau Nuclear Generating Station for the Year 1994

Atomic Energy Control Board
Ottawa, Canada

June 1995

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

Canada

The Atomic Energy Control Board is the independent federal agency that controls all nuclear activities in Canada. Our mission is to ensure that the use of nuclear energy in Canada does not pose undue risk to health, safety, security and the environment.

A major use of nuclear energy in Canada is electricity production. We have an office at every nuclear generating station, and we monitor the stations on a day-to-day basis. Specialists in our Ottawa head office work with the on-site staff to accomplish our mission.

We assess every station's performance against legal requirements, including the conditions in the Operating Licence we issue. To do this, we review all aspects of a station's operation and management, and we inspect each station.

SUMMARY

This report is the Atomic Energy Control Board assessment of safety at Point Lepreau Generating Station for 1994. Our on-site Project Officers, and Ottawa based specialists monitored the station throughout the year.

The station operated safely during 1994. Performance of the special safety systems was very good, and NB Power made important progress improving the safety management of these systems.

NB Power staff failed to comply with the conditions of our Operating Licence seven times during 1994. This is an improvement from last year, but the number of compliance problems is still too high. NB Power introduced safety culture training for its staff last year. We are optimistic that this will help to improve compliance.

The station fully met our radiation safety requirements during the year. Releases of radioactive material to the environment are well below the limits we set. Radiation exposures to workers are being well controlled, and we believe that NB Power is maintaining these exposures 'As Low As Reasonably Achievable' for this reactor type.

NB Power appointed a new station manager, a new production manager and a new station health physicist last year. The management team is actively involved in the establishment of safety culture at the station. Although budgets are tight, we do not believe these limitations are affecting the safety management of the station.

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INTRODUCTION

Point Lepreau is a single reactor nuclear generating station of the *CANDU 600*MW design. It is located on the shore of the Bay of Fundy, near Saint John, New Brunswick.

This report is the Atomic Energy Control Board assessment of the safety of the operation of the Point Lepreau Nuclear Generating Station. It has been compiled by AECB staff at the Point Lepreau site, and in our head office in Ottawa. We have based our review on our own observations, and on information submitted to us by NB Power.

Throughout this report, we have included tables with more detailed information on specific topics. These tables also give a detailed breakdown of our assessment of NB Power's safety performance. Although we use similar terms to describe safety performance for each of the nuclear generating stations in Canada, many of them have different contexts. Readers should be aware that direct comparison between stations is difficult, and often not appropriate.

The nuclear industry uses many technical terms in its day-to-day activities. To help our readers, we have provided a glossary of the technical terms used in this report. We have also *italicised* glossary terms the first time they appear in the report.

At our head office in Ottawa, the public can consult documents relevant to the licensing of nuclear facilities. Our public library also contains an important collection of documents, available on request. Apart from the AECB Annual Report, we publish research reports, communiques, information bulletins, notices and pamphlets. Our address is: 280 Slater Street, Ottawa, Ontario. Written requests for information should be mailed to: Atomic Energy Control Board, Office of Public Information, P.O.Box 1046, Ottawa, Ontario K1P 5S9, Canada. We can also be reached by telephone at 613-995-5894 or 1-800-668-5284.

OPERATIONAL SAFETY

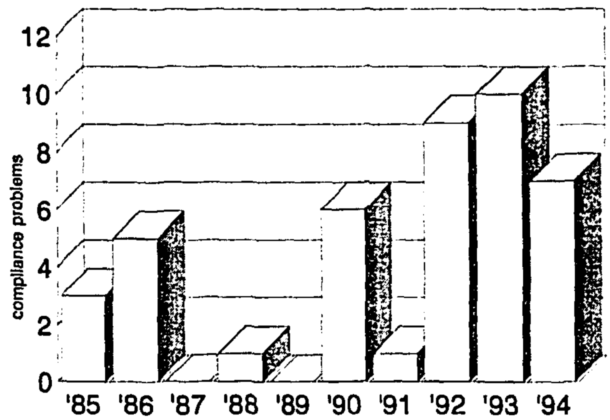
COMPLIANCE WITH THE ATOMIC ENERGY CONTROL REGULATIONS

We require NB Power to operate Point Lepreau Generating Station according to the legal requirements governing the nuclear industry. These requirements come from the *Atomic Energy Control Act* and regulations made under the Act. The regulations directly applying to Point Lepreau are the *Atomic Energy Control Regulations*, the *Physical Security Regulations*, the Transport Packaging of Radioactive Materials Regulations and the Cost Recovery Fees Regulations.

The Atomic Energy Control Regulations contain rules to ensure the safety of nuclear activities. NB Power met all the requirements of the Atomic Energy Control Regulations during the year, except for one problem. This compliance problem concerned the shipment off site of fuel packaging containing bags of low-level radioactive waste. This shipment did not comply with the Transport Packaging of Radioactive Materials Regulations, and consequently, the Atomic Energy Control Regulations. We are satisfied that this incident caused no risk to the public, and NB Power has taken action to prevent similar incidents in the future. We have included a more detailed description of the event later in this report.

COMPLIANCE WITH THE OPERATING LICENCE

The Operating Licence we issue to NB Power contains conditions that they must observe. In 1994, there were seven instances where NB Power did not comply with the conditions of this licence. This is an improvement, compared with the 10 non-compliances we observed last year. But, we believe that significant further improvement is necessary.



Of the seven events involving non-compliance, three affected safety or safety-related systems. The rest involved radiation control failures. We have included a description of these events in the appropriate sections of this report. None of these incidents was deliberate. However, NB Power staff could have avoided all these compliance problems with due care. On the positive side, NB Power is now delivering a safety awareness course to plant staff. We believe this training will be an important factor in avoiding such events in the future.

The accompanying figure shows the history of compliance problems at Point Lepreau. This information is difficult to interpret, since the willingness of NB Power staff to find and report safety problems is an indicator of an active and effective *safety culture.* There is also a considerable variation in the number of such events year to year. We will need to monitor the situation closely for several years before concluding that the required improvement has occurred.

COMPLIANCE WITH THE PHYSICAL SECURITY REGULATIONS

The *Physical Security Regulations* define the security measures that NB Power must maintain at Point Lepreau. During the past year NB Power continued to comply with the Physical Security Regulations.

In June 1994, we assessed NB Power's security arrangements at Point Lepreau. Our assessment found administrative and technical areas in their security operations requiring attention. NB Power's response to these issues has been very slow.

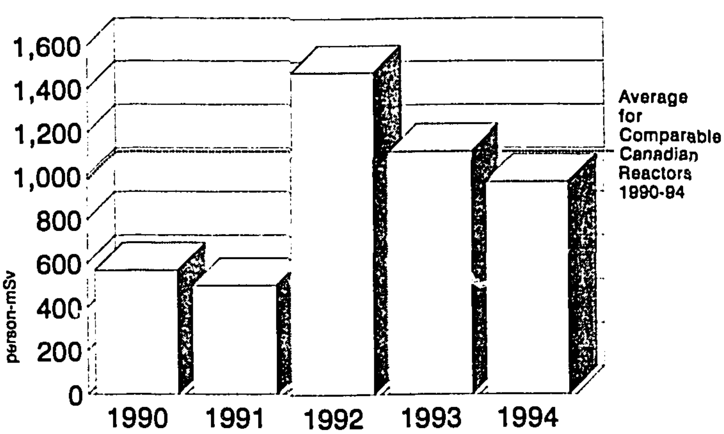
WORKER RADIATION SAFETY

During the year, radiation control in the station was satisfactory. No worker received a radiation *dose* greater than the legal limit of fifty *millisievert* (mSv). We believe that worker radiation exposures are *As Low As*

Worker Radiation Safety	1994	Assessment
Total whole body dose (person-mSv)	973	Acceptable
Number of exposures greater than legal limit	0	Acceptable

Reasonably Achievable for this type of reactor, and that NB Power is actively seeking ways to further control and minimise worker radiation exposure.

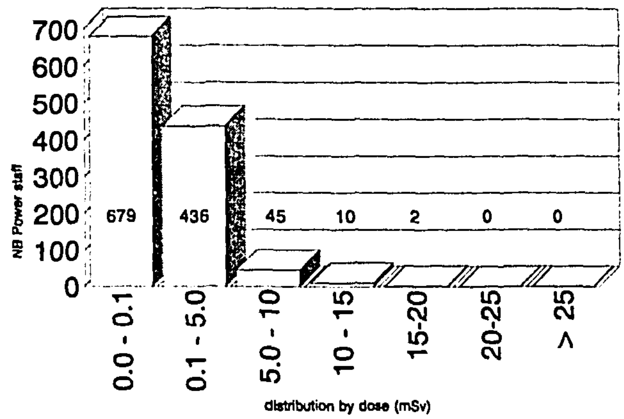
The highest exposure that any individual received at the station during 1994 was 15.7 mSv. The total *whole body radiation dose* that station workers received during 1994 was 972.5 person-mSv. *Tritium* caused about one quarter of this total dose. The figures in this section show the distribution of worker dose, and the history of worker exposure for the last five years.



The distribution of worker dose shows that NB Power's programs are effective in keeping exposures well below our annual limit of 50 mSv. The worker collective exposure varies from year to year, depending largely on the type of work required during the station's annual maintenance outage. Therefore, we find it difficult to draw conclusions from this data. However, the five year average of collective exposure for Point Lepreau is comparable with the five year average of the 9 similar Canadian reactors: Gentilly-2, Pickering A, and Pickering B.

NB Power has improved their dosimetry program by providing *Personal Alarming Dosimeters* to personnel involved in radiation work. The new meters improve dose accounting and control. Because they interface directly with dose records, a worker's dose status can be determined immediately. This allows better control of exposure, and permits dose information to be used to control access to a radiation area.

In 1994, NB Power started to plan the worker doses for work during the 1995 maintenance outage. As part of this planning NB Power has



set an overall goal for worker radiation exposure. They will review every activity planned to ensure that they have properly considered the expected exposures. NB Power has not yet committed to extending this approach to future outages, or routine radiation work. We believe radiation dose planning can be very important in minimizing personnel dose. We will be discussing this topic further with NB Power.

During the year, NB Power reported four radiation control incidents that represent non-compliances with the Operating Licence. In one incident, NB Power staff shipped six *pressure transmitters* off site to a testing laboratory. When the transmitters were returned to Point Lepreau, station staff rechecked them and found that they had trace *contamination* inside. A survey of the testing laboratory found minute traces of contamination which may have come from these transmitters. However, no one received any measurable radiation exposure as a result of this event.

The review of the event showed that NB Power staff had released the transmitters with an Unconditional Release Permit. This permit should guarantee that material leaving the station is free from contamination. Releasing the contaminated transmitters in this way did not comply with NB Power's own Radiation Protection Regulations. Our Operating Licence requires NB Power to comply with these Radiation Protection Regulations.

In December, NB Power returned a load of empty fuel packaging to the fuel supplier for recycling. The supplier found 10 radioactive waste bags in the boxes. Two of the bags contained radioactive material greater than permitted by the AECB Transport Packaging of Radioactive Material Regulations. The bags were all intact and had no external contamination. No member of the public received a radiation exposure from this event. Before the recycling program started, NB Power burned this type of packaging at the on-site dump. Therefore there was a possibility that a similar incident could have occurred in the past without being detected. Analysis of ash samples from the dump showed no evidence of radioactivity from the burning of radioactive waste. We have accepted NB Power's conclusion that it is very unlikely that they ever burned undetected radioactive waste inside packaging.

This incident, and the incident with the pressure transmitters, showed that there were deficiencies in NB Power's procedures for material leaving the station. Because station staff often limited radiation surveys to the outside of material or equipment, low-level activity inside could sometimes escape detection. NB Power now requires proper internal examination of material leaving the radiation area.

In November, a ventilation problem caused incorrect air movement between the *upgrader* and the service building. The station's *Operating Policies and Principles* require the ventilation systems to maintain air flow from zones with a low probability of contamination towards zones with a higher probability of contamination. Air flow reversal occurred because NB Power staff conducted maintenance on electrical equipment without realising that their electrical isolations would affect ventilation fan motors. The flow reversal lasted for about 11 hours. This event caused no measurable radiation dose to station staff.

During maintenance of a *moderator* pump, a maintainer wetted his hand with *heavy water* which had a high concentration of *tritium*. The maintainer received only a small dose (0.2 mSv) during this incident. The maintainer did not appreciate the hazards associated with this work, and did not follow the station's Radiation Protection Regulations.

PUBLIC RADIATION SAFETY

NB Power's control of radioactive material in effluents from the station was satisfactory during the year. The amounts of radioactive material released represented less than 0.05% of the 5 mSv annual limit we set for members of the public. The only radionuclide from the station found by the environmental monitoring program was trace amounts of tritium in the air.

In the following paragraphs we discuss radiation releases from the station in terms of the *Derived Emission Limit* or DEL. The Derived Emission Limit is a calculated annual limit that is specific to each reactor site. The DEL defines the amount of radioactive material release that could result in a radiation exposure of five millisieverts to a member of the public. The station operates to a target of one percent of these limits. NB Power reports liquid releases to us on a monthly basis, with the releases compared against a monthly limit which is one twelfth of the annual DEL. Similarly airborne releases are compared against a weekly limit.

Airborne Releases		1994	Assessment
Tritium	No. Weeks > 1% DEL	0	Acceptable
	Average %DEL	0.040	Acceptable
Noble gas	No. Weeks > 1%DEL	0	Acceptable
	Average %DEL	0.001	Acceptable
Iodine 131	No. Weeks > 1%DEL	0	Acceptable
	Average %DEL	0.001	Acceptable
Particulate	No. Weeks > 1%DEL	0	Acceptable
	Average %DEL	0	Acceptable

Liquid Releases		1994	
Tritium	No. Months > 1%DEL	0	Acceptable
	Average %DEL	0.001	Acceptable
Gross Beta/Gamma	No. Months > 1%DEL	0	Acceptable
	Average %DEL	0.006	Acceptable

For comparison, the annual natural background radiation measured in the Lepreau area averages about 0.7 mSv. Members of the public also receive radiation exposure from naturally occurring Potassium-40 in the body and from Radon. The total of these naturally occurring radiation exposures averages about 1.5 mSv per year.

Radioactive material in airborne effluents from the station averaged 0.04% of the DEL. This corresponds to an exposure to the public of 0.002 mSv. Most of the released gaseous activity is tritium. Radioactive material in liquid effluents from the station was 0.006% of the DEL in 1994. This corresponds to a radiation dose no greater than 0.0003 mSv to any member of the public. These figures do not include measurements for *Carbon-14*. NB Power has proposed a revised DEL for this isotope, which we have not yet accepted. We estimate that Carbon-14 contributed less than 0.0001 mSv to any member of the public. These figures are very similar to the levels of radioactive material released in 1993.

Public Exposure	1994	Assessment
Average boundary dose rate from plant emissions	0.002 mSv/Y	Acceptable
Average tritium in air at station boundary	3.0 Bq/m3	Acceptable

PERFORMANCE OF SAFETY SYSTEMS

In 1994, the *Special Safety Systems* performed very well. All four were well within the target we set for availability of special safety systems. NB Power staff failed to observe the requirements of the Operating Licence affecting the safety systems on three occasions, which is a significant improvement over last year.

NB Power continued to make good progress in improving its approach to special safety system operation and maintenance. They have significantly upgraded reliability analysis and its use, and they have improved maintenance scheduling. NB Power's review of allowable operating limits for the four special safety systems is continuing. This review is already making important contributions to station safety, and makes NB Power the industry leader in this area.

In our report last year, we said that there were too many *jumpers* on special safety systems. NB Power did reduce the number of jumpers in 1994. But we consider NB Power should reduce the number of safety system jumpers further.

We require each of the Special Safety Systems to be available at least 99.9% of the time. To meet our requirement, the time for which a special safety system does not fully meet its performance specifications must be limited to 8.8 hours a year. The total period of time during the year that a system does not fully meet its requirements is called the unavailability of the system.

Special Safety System Unavailability[1]	1994	Predicted Future	Assessment
SDS1	0 Hrs	2.5 Hrs	Acceptable
SDS2	0 Hrs	4.0 Hrs	Acceptable
Containment	72 Sec	52 Hrs	Acceptable
ECI	0 Hrs	17.5 Hrs	Acceptable

[1]Target unavailability is less than 8.8 Hours per year

Shutdown System One was fully available throughout the year. The *predicted future unavailability* of this system is 2.5 hours per year, which is well within our target. Shutdown System One operated three times during the annual outage. One of these was a planned manual trip during the annual full rod drop testing of the system. Two spurious trips also occurred. Since the reactor was in a *guaranteed shutdown state* at the time, these events did not affect safety.

Shutdown System Two was fully available throughout the year. The predicted future unavailability is 4.0 hours per year, which is also within our target. Shutdown System Two operated once during the year, as discussed in the 'Operations and Maintenance' section of this report.

In September, NB Power reported to us that they had discovered a design deficiency in Shutdown System Two. During an in-core *Loss of Coolant Accident*, parts of the injection system could become flooded with moderator water. This leads to a concern that *water hammer* might occur when the system must operate during such an accident. This possibility was not considered in the system design. NB Power very quickly installed additional piping supports to prevent this type of damage. We believe that NB Power's prompt and effective response to this discovery is noteworthy, and shows a responsible approach to safety.

In May, NB Power reported to us that they had misgivings regarding the net safety benefit of a particular step carried out in one of their routine testing procedures. This step involved closing the pressuriser isolating valves, which could impair both shutdown systems. After reviewing the situation with NB Power, we agreed to an alternative method of testing these valves.

The *Emergency Coolant Injection* system was fully available throughout the year. The predicted future unavailability is 17.5 hours per year, which is greater than our target of 8.8 hours per year. This is an improvement on last year's figure, and NB Power is working on further improvement. Given the good performance of this system over the past years, we are prepared to accept this situation while work continues.

In April, just before the annual shutdown, NB Power told us that operating the shutdown cooling pumps in their normal manner could impair the emergency coolant injection system. However, they wished to continue to use shutdown cooling in the normal way during the shutdown. They based this position on their belief that the emergency coolant injection system would continue to be effective. However, they were not able to produce a proper engineering assessment to support this view. We advised NB Power that we would consider operation in a condition where a special safety system was not clearly fully effective as a serious breach of the Operating Licence. NB Power changed the shutdown cooling operating procedures to ensure that emergency coolant injection system remained fully available.

In November, NB Power removed one of the two emergency coolant injection system pumps from service for maintenance. Before removing the pump from service they did not test the other pump. This failure to follow an approved work plan did not comply with Operating Policies and Principles. Both pumps were successfully test run after the maintenance, showing that safety had not been affected during the work.

In our annual report for 1993, we said that we were not satisfied with the poor performance of the *Containment System*. We also said that NB Power was not addressing the problems in the system with sufficient urgency. In 1994, NB Power expended considerable effort working on the containment system. They are to be commended for the significant improvement achieved in the performance of the containment system over the past year.

The Containment System was momentarily unavailable twice in 1994 for a total period of 72 seconds. The predicted future unavailability is 52 hours, which is substantially above our target. It reflects poor past reliability of containment isolation valves and some *airlock* components. NB Power is changing the containment isolation valve closing times, which will improve their reliability. They are also changing the design of airlock door shaft seals, and increasing test frequencies for some containment components. We expect these changes to result in acceptable availability for containment.

In March, performance of a test caused an impairment of the Containment System for 23 seconds. Investigation of this event showed that there were problems with the process NB Power used to prepare and review test procedures. This event was a failure to comply with Operating Policies and Principles. In December, during the execution of a work plan associated with maintenance of a containment valve, the *reactor building* pressure fell below minimum allowed level for about 30 seconds. The operator had not anticipated that the pressure would fall as quickly as it did, but took prompt corrective action during the event. We do not consider either of these events to have had any significant impact on safety.

NB Power completed a full pressure containment leak rate test in April 1994. The measured gross leak rate was 0.475% of contained volume per day, which is better than the target leak rate of 0.5% per day. The measured leak rate is slightly higher than that measured in the last test in 1990. NB Power believes this is because the 1994 test was shorter, allowing less time at pressure. Data obtained after a similar time in the 1990 test are quite comparable. As there also was no evidence of deterioration of the building, we considered the test to be acceptable.

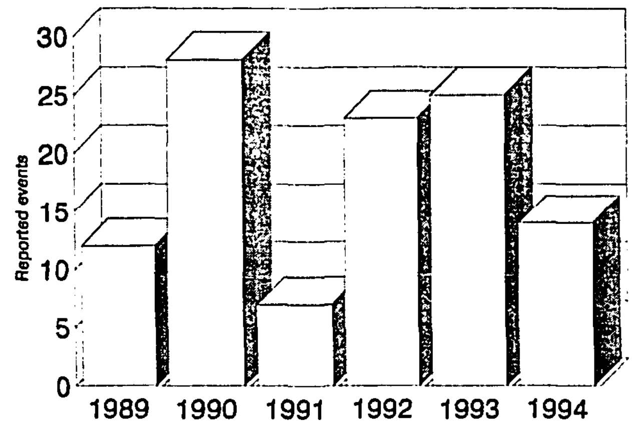
After the containment leak rate test, NB Power management formally requested a change in the frequency for containment full pressure testing. Currently we specify a three year test interval. NB Power would like to perform the next test in five years time. They claimed that the test represented an abnormal loading condition for the building. An abnormal loading could cause tension cracking of the concrete at the inner surfaces. Our review showed that the pressure test was in fact a normal loading condition, considered in the design. For such a normal loading condition, the reactor building design maintains compression in the concrete at the interior surface. This means that cracking should not occur during a full pressure test. We could therefore find no technical justification for changing our required pressure test interval. NB Power has now asked us to reconsider their request. One of the reasons for their request is a concern that pressure testing could represent a safety hazard to workers involved. We are considering this request carefully.

In one other safety-related event, NB Power carried out maintenance on one of the *standby generators* without following proper procedures to ensure the availability of the other standby generator. This was a failure to observe the requirements of Operating Policies and Principles. However, in this case, we consider it had minimal impact on safety.

EVENTS REPORTED TO THE AECB

NB Power reported 14 events to us in 1994. Event reporting was on time, and thorough. Half these events involved non-compliance with the conditions of the Station's

Events	1994	Assessment
Number of events reported to the AECB	14	Needs Improvement
Number of non-compliances with OP&P and licence conditions	7	Needs Improvement
Number of fires	0	Acceptable



Operating Licence. Personnel error was an important factor in all licence infractions. The number of reportable events was a significant reduction, compared with the 25 events NB Power reported to us in 1993. Each of the events is described in the appropriate sections of this report.

NB Power does not yet meet our expectations for the evaluation process used to assess human performance and the root causes of events. However, recent discussions with NB Power staff indicate that they may be prepared to explore more advanced techniques. We will be continuing our discussions with them, to ensure that they adopt a fully effective event evaluation process.

NB Power started training staff in safety culture in November of 1994. We believe that the reinforcement of safety awareness resulting from this course should be a key factor in minimising safety significant events at Point Lepreau. We have included more information on this new training course in the 'Station Management' section of this report.

OPERATIONS AND MAINTENANCE

The station operated well in 1994, attaining a *capacity factor* of 94%. The annual scheduled shutdown took place in April, and lasted nine days. The reactor was also shut down for ten days for repair of a tube leak in *boiler* 1. No *serious process failures* occurred and the reactor tripped once during operation. As part of our compliance inspection program, we frequently tour the station carrying out system and area inspections. We found no significant problems during these inspections in 1994.

Before the annual outage, NB Power conducted a detailed physical survey of the positions of the main steam lines at full power hot conditions. They repeated the survey during the shutdown when the steam lines were cold. The results showed that the thermal movement of the lines did not match the stress analysis code predictions. NB Power attributed the difference to errors in alignment during construction, or to load applied by improperly installed pipe-whip restraint cables. NB Power completed non-destructive testing on the most heavily stressed components, and revised the stress analysis based on the measurements obtained in the survey. The results confirmed that the lines were fit for continued service. NB Power also confirmed that the lines continued to meet their seismic qualification requirements.

During the annual outage, NB Power installed a permanent connection for the firewater supply line in the reactor building. In the past, they installed this connection at the beginning of an outage, and removed it before start-up. The change will improve NB Power's ability to respond to fires in the reactor building.

In January, during routine checks, one of the two main *control computers* stalled. Control of the reactor transferred to the other computer. When the operator returned control to the first computer after its repair, the *liquid zone control* system responded abnormally, and the computer initiated a *setback*. The operator immediately returned control of the reactor back to the standby computer, which stabilised reactor operation at 79% full power. The problem was caused by erratic behaviour of a liquid zone control system control valve, combined with a problem in the control computer program. In February, there was another plant upset, caused by the same valve. The control computer correctly responded to the problem by initiating a setback to 91.5% full power. NB Power repaired the control valve during the annual outage.

During reactor warm up after the annual outage, operators increased reactor power while the *heat transport system* pressure was close to the low pressure trip setpoint for Shutdown System Two. When power increased above the *conditioning* power level for this trip, Shutdown System Two fired. During the investigation of this event, NB Power found that the operators had not properly followed testing procedures for the heat transport low pressure trip. NB Power has told us they have taken action to impress upon staff the importance of following approved procedures.

In June, the plant was shut down for 10 days for the repair of a pinhole leak in a tube in boiler 1. (For reference, Point Lepreau has four boilers, each containing about 3,500 tubes). The tritium releases to the atmosphere from the leak were well below the allowable release limits. The resulting increased dose to the public during operation with the leak was negligible. Following inspections of the tubes in boilers 1 and 3, NB Power plugged seven other tubes which, although not leaking, did not meet the acceptance criteria for continued operation. The leak was similar to a previous leak experienced in 1992. There were similar other tube leaks in 1985 and 1987. These leaks are caused by corrosion pitting occurring in areas in the boilers where solid deposits have formed. NB Power intends to chemically clean the boilers in 1995 to complete removal of the deposits. They submitted their proposal for boiler chemical cleaning to us for approval in 1994.

NB Power has confirmed that Point Lepreau will be shutting down for a major outage in 1995, to carry out work on the pressure tubes. In a CANDU reactor, the hot pressure tubes are kept from contact with the cool *calandria* tubes by four spacers, called garter springs. In the Lepreau reactor, many of these spacers are not located properly, allowing contact to develop between a pressure tube and its calandria tube as the reactor ages.

Station Operation	1994	Assessment
Plant Capacity Factor	94.0%	
Number of non-spurious reactor trips	1	Acceptable
Number of serious process failures	0	Acceptable
Total outstanding call ups (year end)	870	See text
... on special safety systems only	107	See text
... on standby safety support systems	34	See text
Total number of jumpers in effect (year end)	507	Acceptable
... on special safety systems only	27	Needs Improvement
... on standby safety support systems	19	Acceptable

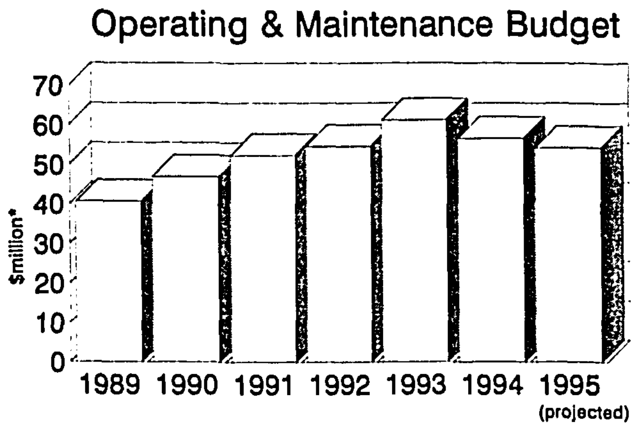
During the 1995 outage, NB Power will use the SLAR (Spacer Location And Relocation) tool to move the spacers. This should allow operation to near the 30-year design life of the reactor without concerns about pressure tube contact. In the meantime, we have received information from NB Power which confirms that the condition of the pressure tubes is acceptable for operation until the 1995 outage.

The table shows operating and maintenance statistics for the station in 1994. Our figures appear to show a marked increase in outstanding preventive maintenance work (*call ups*) when compared with last year. However, the apparent increase is mainly due to changes in the way NB Power's call up system works, and to the scheduling of work on safety systems. We will check this data in 1995 to make sure that no preventive maintenance backlog is developing.

STATION MANAGEMENT

We believe NB Power is managing the station safely. We were pleased to observe that management at the station were committed to reducing the number of compliance problems and reportable events. We also welcomed their active involvement in promoting safety culture among station staff.

During the year NB Power requested our approval for the appointment of a new station manager, production manager and station health physicist. We interviewed the production manager and health physicist candidates in Ottawa before issuing formal authorizations. We also authorized two new *shift supervisors.* NB Power now has a full complement of shift supervisors available for shift duty, easing the staffing problems we noted last year.



*Does not include taxes, insurance or computer services

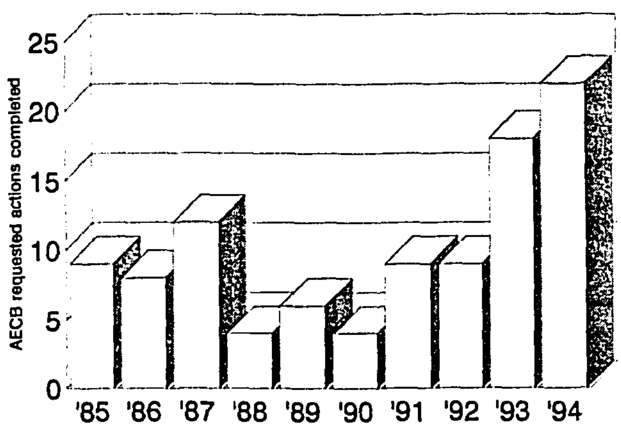
The accompanying figure shows the history of Point Lepreau's Operating and Maintenance budget over the past five years. Budget levels are stable, although they have declined slightly in the past three years. When cost inflation and the increasing demands of an aging reactor are considered, these figures imply a tightened budget in real terms. Nevertheless, we have seen no indication that the tight budget is affecting the safety performance of the station. We will continue to monitor NB Power's resource levels carefully.

In September, NB Power reported to us that information in a section of the current issue of the Operating Policies and Principles was incorrect. Investigation of this event revealed that a recent revision of a section of the document had not received adequate technical review. The information included in this section could have allowed staff to place equipment in a condition where it would not have met its safety requirements. NB Power detected the error before the information was used. This incident revealed a breakdown of the review and approval process used by management. NB Power will use a more formal process of technical and safety review for any future changes to Operating Policies and Principles.

In November 1994, NB Power started delivering a safety awareness course to plant staff. Senior management are actively participating in the delivery of this course. The course is designed to overcome any complacency which may have developed in the station as a result of Point Lepreau's excellent operating record. Our initial review of the course material and the response of participants indicates that the course should provide a very welcome boost to safety awareness.

NB Power continued to improve its response to our formal requests for action in 1994, completing a total of twenty of these *Action Items*. However, there are still some Action Items which they were not able to address at all in 1994, due to lack of resources. We have advised them that we cannot accept an open ended schedule, even for low priority items. We have asked them to set firm target dates for outstanding work. Due to the varying complexity of each Action Item, we do not measure station performance by the number of Action Items completed.

However, it is important to keep the number of outstanding Action Items low, to ensure that as few safety issues as possible remain unresolved.



TRAINING

Training activities continued satisfactorily in 1994. During the year, we conducted an evaluation of the effectiveness of the process by which University of New Brunswick provides training for the staff of the station. We found this to be a well managed and effective process well suited to the needs of the station.

NB Power presented four candidate Shift Supervisors for our new General Examination. The General examination is a combination of the previous Nuclear General and Conventional General examinations. All four candidates passed, and we authorized two new Shift Supervisors in 1994.

EMERGENCY EXERCISES AND DRILLS

NB Power staff showed adequate capability to respond to emergencies in 1994. The shift crews participated in 26 emergency drills that exercised NB Power's ability to handle radiation, fire, chemical, medical and security incidents. NB Power staff also participated in an exercise conducted by the New Brunswick Emergency Measures Organization which activated the Province's off-site emergency plan.

SAFETY ANALYSIS

NB Power continued to make satisfactory progress with safety analysis topics in 1994. In addition, they submitted an updated version of the station's Safety Report, as required by the Operating Licence.

We require licensees to analyze various hypothetical events to show that the plant meets our safety requirements. The following paragraphs deal with the more important analyses NB Power submitted in 1994.

Our discussions with NB Power concerning the protection of the plant against failures in the steam and feedwater systems pipes outside the reactor building were satisfactorily resolved in 1994. However, we are still reviewing some of the documentation that

NB Power submitted in support of the final agreed changes. NB Power has made the following changes:

- installation of pressure relief panels in the turbine hall.
- improved in-service inspection of piping.
- daily visual leak checks.
- strengthening of some walls and doors.
- training and placement of a special operator in the secondary control room to ensure adequate control and monitoring of the plant following a major steam line failure.

NB Power has also committed to continue to search for an on-line leak detection system. A detection system would give additional warning of a problem in the main steam lines, before it could develop into a major failure.

In the 'Safety System' performance section of this report, we discuss changes to the closing time of the containment isolation valves, to improve their reliability. The fast closing of these valves during testing was causing damage to the valve seats and the valve end stops. During the year, we received analyses from NB Power showing that the safety requirements for containment could still be met with slower valve operation. Following our review of these analyses, we gave approval to increase the closing time. Modifications to the valves started in 1994, and should be complete in early 1995.

In 1994, NB Power responded to our request for assessment of the effects on the fuel of the high flows which may occur during loss of coolant events. For some loss of coolant failure locations, the flow may reverse in affected *fuel channels*. The reversal of the flow may accelerate fuel bundles toward the inlet end of the channel, where they will create an impact load on various channel components. This effect will be particularly important when a fuel channel does not contain the normal number of fuel bundles, for example during fuelling. The analyses submitted by NB Power show that the consequences of this type of accident are within the required limits. We are reviewing these results.

In November, we received notification from NB Power that under large loss of coolant accident conditions the *divider plates* in the boilers may be damaged. This could release loose parts into the heat transport system during the accident. NB Power has not fully completed their review of this possibility, and are pursuing the detailed analysis urgently.

QUALITY ASSURANCE

During 1994, NB Power reorganised the station *Quality Assurance (QA)* department and made some changes in the Quality Assurance Program. We have not yet been able to assess the effect of these changes in the short time they have been in place. However, we believe that the program is operating satisfactorily.

The changes made in 1994 included transferring of some nuclear functions, previously carried out by NB Power Corporate QA, to the station QA program. The Quality Assurance department now reports directly to NB Power's General Manager Nuclear, which provides a welcome degree of independence from the station's management. NB Power has included these changes in a new revision of the station Operations Quality Assurance program documents. We are reviewing this revision.

We deferred our normal Quality Assurance audit for the station in 1994 to allow time for these changes to take effect. Our 1995 audits will allow us to assess the effectiveness of the new organisation.

SAFEGUARDS

During 1994, the station submitted all the required reports and cooperated fully in the planning and timely execution of all *safeguards* related work.

Canada has signed the *Treaty on the Non-Proliferation of Nuclear Weapons*. As required by this treaty, Canada has signed a safeguards agreement with the *International Atomic Energy Agency (IAEA)*. This agreement provides the IAEA with the right and the responsibility to verify that Canada is fulfilling its Non-Proliferation Treaty commitment not to use its peaceful nuclear program to make nuclear weapons or nuclear explosive devices.

We include a requirement for the application of IAEA safeguards in the Point Lepreau Operating Licence. To comply with this, the station must provide access and assistance to IAEA inspectors for verification purposes, and for the installation and maintenance of IAEA equipment. The station must also provide timely reports on the movement and location of all nuclear materials within the station.

CONCLUSIONS

New Brunswick Power operated Point Lepreau safely during 1994. We are encouraged by the effort that NB Power has made to address problem areas we noted in our reports for previous years.

The station fully met our radiation safety requirements during the year. Releases of radioactive material to the environment are well below the limits we set. Radiation exposures to workers are being well controlled, and we believe that NB Power is maintaining these exposures 'As Low As Reasonably Achievable' for this reactor type.

Safety systems performance in 1994 was very good. The work that NB Power has carried out on the containment system, and the on-going review of operating limits for the special safety systems, are very positive moves to enhance future safety performance. NB Power will need to continue to pay great attention to these very important systems, in particular the emergency coolant injection system and the containment. Predicted future availability figures for these systems are still causing us some concern.

NB Power's compliance with our Regulations and Operating Licence improved last year. However, the number of compliance problems is still too high. We believe that NB Power's emphasis on safety culture will be important in reducing these problems to an acceptable level. We continue to believe that NB Power's evaluation processes for root causes and human performance in events need upgrading. We will be continuing our discussions with NB Power in this topic area.

GLOSSARY

Action Item	A formal request to a reactor licensee made by the AECB.
Adjuster	Neutron absorbing rod, normally fully in the reactor core, which adjusts the distribution of power in the reactor.
Airlock	The means of access to and from the reactor building. There are two doors on each airlock, an inner door and an outer door. Automatic controls ensure that only one door is open at a time so that containment is always sealed.
Annunciation	An alarm window system in the main control room. The system alerts operators to unusual conditions in the reactor or its systems. The windows light up when measurements exceed pre-set limits. They will not clear until reset by the operator.
As Low As Reasonably Achievable (ALARA)	The principle, applied internationally, of keeping radiation doses 'as low as reasonably achievable', social and economic factors taken into account.
Atomic Energy Control Act	The federal act that established the AECB and allows it to regulate the nuclear industry in Canada.
Atomic Energy Control Regulations	Regulations made under the authority of the Atomic Energy Control Act.
Boiler	A heat exchanger that transfers heat from the heavy water reactor coolant to ordinary water. The ordinary water boils, producing steam to drive the turbine. The boiler tubes separate the reactor coolant from the rest of the power generating systems.
Boiler Make Up Water	A system to automatically inject Emergency Service Water to the boilers if the normal feedwater supply fails.

Call Up	Also known as scheduled preventive maintenance. A routine maintenance item or performance check completed at regular intervals.
Calandria	Cylindrical stainless steel tank which holds the moderator heavy water. Pressure tubes containing the fuel and the heavy water coolant pass through the calandria.
CANDU	A Canadian Designed reactor which is heavy water cooled and moderated. The name comes from Canada, Deuterium, Uranium.
Capacity Factor	The amount of electrical energy generated by the generating station, as a percentage of the amount of energy which would be generated if the station ran perfectly.
Carbon-14 (C-14)	A radioactive isotope of carbon produced in some reactor systems.
Collective Population Exposure	The total radiation exposure that the people living around a nuclear facility receive because of its operation. It is an estimate of the sum of all the radiation exposures to individual members of the public.
Conditioning	When the reactor is at low power, some of the measurements that indicate an unsafe condition to the shutdown systems are not needed. Trip conditioning prevents these measurements from tripping the reactor when it is below a specified power level.
Containment	The building surrounding the reactor. It is designed to contain the effects of any accident involving the reactor, isolating any hazard from the public. The containment has fast acting valves to automatically close ventilation openings in an emergency.
Contamination	The presence of radioactive material anywhere it is not wanted, particularly in places where its presence may be harmful.

Control Computer — One of two digital computers that control the reactor. The computer also provides annunciation and data display for the operators. A fault in the computer that is in control causes an automatic transfer to the second computer. If both computers fail, the controls rapidly reduce reactor power until it is shut down.

Control Room Operator — A Control Room Operator is responsible for operating the reactor controls. A control room operator needs authorization from the AECB before acting in this position.

Core — The heart of a reactor containing the fuel, the heavy water coolant and the heavy water moderator. It also includes various sensing and control devices.

Defence in Depth — An important and fundamental principle in the design and operation of a nuclear facility. Multiple barriers prevent unsafe conditions from developing, and separate people from hazards.

Derived Emission Limit (DEL) — A calculated amount of radioactive material that, if released from the station, would result in a radiation exposure of five millisievert to a member of the public in the worst possible case. Five millisievert is the maximum annual radiation exposure for members of the public allowed in the Atomic Energy Control Regulations. The calculation is done by examining the effect of the radioactivity on a theoretical person who lives full time at the station boundary, eats only locally harvested food, and drinks only water from the station discharges. This theoretical person is known as the 'critical individual'.

Divider Plate — Divider plates are situated in the bottom portion of the boilers to keep the heat transport system heavy water inlet and outlet areas separate

Dose — Generally, the quantity of radiation energy absorbed by the body.

Emergency Coolant Injection — An automatic system that rapidly injects cold water into the reactor's fuel channels if there is a problem with the normal heavy water coolant system. It also provides long term cooling for the fuel by recovering water from the reactor building floor.

Emergency Water System — A system that supplies cooling water to important reactor systems if normal service water supplies fail.

Feeder — There are 380 fuel channels in the reactor. The feeders are pipes that supply heavy water coolant to each channel, and return the hot coolant to the boilers.

Feedwater System — The system that returns and processes the condensed steam from the turbine as water to the boilers.

Flux Detector — A measuring device that, in the presence of neutron radiation, provides a signal indicating neutron flux.

Fuel Channel — A fuel channel consists of a pressure tube, which contains fuel, end fittings connecting it to the feeders supplying heavy water coolant, and closure plugs that can be removed by the fuelling machines for refuelling. Each pressure tube is located inside a calandria tube, which separates it from the cold moderator heavy water. Carbon dioxide gas between the pressure tube and the calandria tube provides insulation for the hot pressure tube.

Governor — The turbine governor valves control the flow of steam into the turbine. This controls the power that the turbine produces.

Gross Beta Gamma — A measurement of the total beta and gamma radioactivity in a sample.

Group 1 and Group 2 — Safety equipment at a reactor is divided into two groups. Each group generally carries out the same functions. For example, shutdown system one is in Group 1. All of its equipment is completely separate and independent from shutdown system two, which is in Group 2. Group 1 and Group 2 systems occupy widely separated areas in the station, so that a single action cannot disable both groups of safety equipment at the same time.

Guaranteed Shutdown State	A method for ensuring that the reactor is shutdown. It includes adding poison to the moderator, or draining the moderator from the reactor.
Heat Transport System	The closed cooling circuit that cools the reactor by carrying heat from the fuel bundles to the boilers. It does this by circulating heavy water at high pressure through the fuel channels and the boilers.
Heavy Water	Heavy water is a clear colourless liquid that looks and tastes just like ordinary water. It is about 10% heavier than ordinary - or 'light' - water. It occurs naturally in the environment. It consists of deuterium and oxygen (D2O), rather than the hydrogen and oxygen of ordinary water (H2O). A deuterium atom is a hydrogen atom with an extra neutron in its nucleus. CANDU reactors use heavy water as a moderator and as a coolant.
International Atomic Energy Agency (IAEA)	The International Atomic Energy Agency is a United Nations Agency. It provides a system of safeguards to make sure that states do not divert nuclear materials to non-peaceful activities. It also provides an international forum for nuclear safety.
Iodine 131 (I-131)	A radioactive isotope of iodine, produced in the fuel when the reactor is operating.
Jumper	A means of documenting and authorising temporary changes to equipment.
Liquid Zone Control System	The primary means for regulating reactor power level, and the spatial distribution of power in the core. Natural water is introduced in varying amounts into each of fourteen zone control units. The variation of neutron absorption by this natural water provides local control.
Loss of Coolant Accident (LOCA)	A failure in the reactor's heavy water coolant system that causes water to be lost faster than the normal heavy water supply can replace it. The emergency coolant injection system provides fuel cooling if this happens.

millisievert (mSv)	A measurement of radiation exposure. One Sievert is the same as 100 rem. One millisievert is one thousandth of a Sievert (0.001 Sv).
Moderator	The heavy water in the calandria that slows neutrons released by fission to energies at which they can produce additional fissions. Because the moderator surrounds the fuel channels, it also provides cooling and protection if a major accident were to cause a complete loss of cooling in the channels.
Neutron Flux	A measure of the fission power in the reactor.
Noble Gas	Noble gases are produced in the reactor fuel when the reactor is operating. They are radioactive, and decay to produce particulates, some of which are also radioactive.
Operating Policies and Principles	A licensee document, which we approve, that outlines the safe operating limits for the station. It also defines which staff have the authority to make decisions on safety matters.
Particulate	Any radioactive material that is in solid particle (e.g. like dust) form.
Personal Alarming Dosimeter (PAD)	An electronic dosimeter, which provides direct read outs of a wearer's exposure. It can interface directly with a dose records computer to allow automatic updating and control of the user's dose status. It can also be set to give an alarm if the wearer exceeds a specified exposure limit, or encounters an unexpected radiation field.
Physical Security Regulations	Regulations we issue stating the required security standards at nuclear facilities.
Pressure transmitter	An electronic device which measures fluid pressure in a system, and sends the measurement to an indicator, to a computer, or to a device which will trip the reactor.
Poison	A substance which absorbs neutrons, and hence removes them from the fission chain reaction.

Predicted Future Unavailability	A measure of how well a special safety system can be expected to perform in the future. A mathematical model of the system, and statistics of faults affecting the system are used to derive a theoretical prediction of the expected frequency of system failure.
Quality Assurance (QA)	A formal program of standards, procedures and checks controlling the quality of work on the station.
Reactor Building	A reinforced concrete building which serves as a support and an enclosure for the reactor and some of its associated equipment.
Safeguards	An international program of monitoring and inspection carried out by the staff of the International Atomic Energy Agency. Safeguards ensure that nuclear materials in the station are not diverted for non-peaceful uses.
Safety Culture	The safety culture of an organisation describes the values, attitudes, perceptions, competence, and behaviour of individuals, groups, and the organisation as a whole, which determine the style and effectiveness of health and safety management. Organisations with a positive safety culture are characterised by communications based on mutual trust, and by a shared perception of the importance of safety.
Safety Support Systems	Systems and features of a station used only to perform safety functions. Examples include the emergency water system and the standby generators.
Secondary Control Area	A second control room, separate from the main control room. Designed to withstand an earthquake, it contains controls for the Group 2 safety systems. Operators can safely shut down and cool the reactor from this area.
Secondary Systems	The collection of non-nuclear systems which pipe steam from the boilers to the turbine and return condensed water to the boilers.

Serious Process Failure	A serious process failure is defined as a failure in the plant's components or systems, which is sufficiently serious that one or more of the special safety systems must operate to prevent reactor damage.
Service Building	The building next to the reactor building. It contains auxiliary systems - for example heavy water management, maintenance facilities, and the main control room.
Setback	A controlled power reduction by the control computer in response to an abnormal plant condition. This power reduction function is in addition to, and quite separate from, the shutdown systems.
Shallow Dose	Radiation exposure that affects only the outer layers of body tissue.
Shift Supervisor	The technical expert who manages a shift, ensuring that the station meets all safety requirements. A shift supervisor requires AECB approval before acting in the position.
Shutdown System One	Shutdown system one works by dropping neutron absorbing rods into the reactor core if its instruments detect a potentially unsafe condition. It is completely separate and independent from shutdown system two.
Shutdown System Two	Shutdown system two automatically shuts down the reactor by injecting neutron absorbing chemical into the moderator if its sensors detect a potentially unsafe condition. It is completely separate and independent from shutdown system one.
Simulator	The simulator represents the plant's control room in the same way that a flight simulator represents the cockpit of an aircraft. It is used for training and testing staff.
Special Safety Systems	There are four special safety systems: Shutdown system one, shutdown system two, emergency coolant injection and containment. They are each independent systems that can shutdown the reactor, provide cooling, and contain any reactivity, if a problem occurs.

Spent Fuel Bay	A large pool of ordinary water, rather like a swimming pool, where used fuel is stored. The water cools the fuel, and provides shielding from radiation.
Standby Generators	Diesel generators that can provide electrical power if the station loses its normal supply.
Thermoluminescent Dosimeter (TLD)	A device that measures radiation exposure. Staff working in the station wear one to measure their personal exposure. They are also used to measure any radiation at the environmental monitoring sites around the station.
Treaty on the Non-Proliferation of Nuclear Weapons (NPT)	An international treaty that came into force in 1970, and to which Canada is a party. It is aimed at preventing the spread of nuclear weapons.
Tritium	A radioactive isotope of hydrogen produced in the reactor's heavy water during operation.
Upgrader	The upgrader processes heavy water to remove unwanted light water.
Water Hammer	A pressure disturbance caused by a sudden change of flow in a pipe. The 'bang' produced by rapidly shutting off a household tap is an example. In some cases, water hammer can be severe enough to damage equipment.
Whole Body Dose	The radiation exposure that affects all of the body tissue. Radiation that penetrates the body completely, or radioactive materials absorbed by the body, cause it.
Work Order	All work on the station is controlled. A work order is a document which is used to start a particular job.