Minutes of the Canadian Nuclear Safety Commission (CNSC) Meeting held on January 21, 2021

January 21, 2021

Minutes of the Canadian Nuclear Safety Commission (CNSC) meeting held on January 21, 2021, 9:00 a.m. The meeting was webcast live via the CNSC website, and video archives are available on the CNSC's website. These minutes reflect both the public meeting itself and the Commission's deliberations as a result of the meeting.

Present:

R. Velshi, President
T. Berube
S. Demeter
M. Lacroix
S. McKinnon

M. Leblanc, Secretary
D. Saumure, Senior Counsel - Manager
S. Dimitrijevic, C. Moreau and W. Khan, Recording Secretaries

CNSC staff advisors were: A. Viktorov, H. Davis, H. Robertson, C. Carrier, M. Rickard, A. Levine, R. Jammal, K. Murthy, J. Burta, L. Forrest, M. de Vos, D. Miller, R. Jammal, S. Faille, C. Purvis, V. Tavasoli, B. Carroll, S. Langille, K. Heppel-Masys, P. Bourassa, N. Petseva, D. Reinholz and B. Ferguson

Other contributors were:

- Ontario Power Generation Inc.: A. Grace, R. Manley, J. Vecchiarelli and P. Fabian
- New Brunswick Power: N. Reicker and P. Thompson
- Bruce Power: H. Kleb
- Canadian Nuclear Laboratories: J. Griffin
- Global First Power: D. Train
- Natural Resources Canada: D. Cameron
- Atomic Energy Canada Limited: S. Quinn
- SaskPower: I. Harry
- Nuclear Waste Management Organization: D. Wilson
- Orano Canada Inc.: V. Laniece
- Province of Saskatchewan: L. Kaskiw
- University of British Columbia: J. Hankins

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e-Docs 6509193 (Word)
e-Docs 6511420 (PDF)

Constitution

1. With the notice of meeting Commission member document (CMD) 21-M1 having been properly given, the meeting was declared to be properly constituted.

2. Since the Commission meeting held on December 8-10, 2020, CMD 21-M2 to CMD 21-M11 were distributed to members. These documents are further detailed in Appendix A of these minutes.

Adoption of the Agenda

3. The agenda, CMD 21-M2, was adopted as presented.

Chair and Secretary

4. The President chaired the meeting of the Commission, assisted by M. Leblanc, Secretary and S. Dimitrijevic, C. Moreau, and W. Khan, Recording Secretaries.

Minutes of the CNSC Meeting Held on November 5, 2020

5. The Commission approved the minutes of the November 5, 2020 Commission meeting as presented in CMD 21-M3.

STATUS REPORT ON POWER REACTORS

6. With reference to CMD 21-M7, which includes the Status Report on Power Reactors, CNSC staff presented the following updates:

   - Bruce NGS Unit 2 was shut down for planned maintenance.
   - Darlington NGS Unit 2 was at 80% of full power (FP).
   - Pickering NGS Units 1 and 6 had returned to FP and Unit 8 was shut down for a planned maintenance outage.
   - One COVID-19 case was reported under REGDOC-3.1.1, Reporting Requirements for Nuclear Power Plants, Version 2.

7. CNSC staff provided details regarding a steam rupture disk on the secondary side which led to steam venting through the rupture disk to the atmosphere and a loud noise at Point Lepreau NGS. CNSC staff completed inspections and verified that there

were no injuries or releases to the environment and that NB Power had established a guaranteed shutdown state. The Commission sought more details on the cause of the event. An NB Power representative submitted that an assessment was currently underway.

8. Further on that topic, the Commission asked CNSC staff what it was doing to ensure that NB Power implements adequate corrective actions. CNSC staff reported that it continued to monitor the situation through attendance at decision-making meetings and discussions, verification by site inspectors to confirm that heat sinks are available, and ensuring that the required disk maintenance was proceeding in accordance with requirements.

9. With respect to the update on Darlington NGS, the Commission enquired as to whether the acceptance of the revised strategy sets a precedent for managing future issues with the fuelling machine. CNSC staff reported that OPG was granted acceptance to use only one ice plug, as opposed to two, for this particular instance and that this particular instance did not set a precedent for future decisions.

10. The Commission enquired as to whether there was a possibility that there could have been damage to the pressure tubes. CNSC staff responded that the reactor would not be restarted until CNSC staff have conducted the necessary inspections to confirm that the facility is safe and there is no damage to the equipment.

11. Asked for further information on the configuration of the CANDU fuel channel, an OPG representative submitted that the isolation within the fuel channel was formed by the use of special ice plugs designed to isolate the water flow.

12. The Commission asked whether the work on the Darlington reactor was being done remotely. An OPG representative submitted that the fuelling machine was controlled remotely while workers were present in the reactor vault working on the ice plug.

13. Asked whether such an event was frequent, an OPG representative submitted that such an event was the first of its kind.

EVENT INITIAL REPORT (EIR)

Orano Canada Inc., McClean Lake Operation: Elevated Hydrogen Level in Leach Tank

14. With reference to CMD 21-M11, CNSC staff presented information regarding the elevated hydrogen levels in one of the leach tanks at McClean Lake Operation, operated by Orano Canada Inc. (Orano). On December 15, 2020, members of the incoming shift observed that the hydrogen levels in one of the leach tanks were elevated. The event originated from an attempt by previous shift to troubleshoot an issue with one agitator that had been repeatedly tripping. The agitator and the secondary leach tank were bypassed, but the sweep air system for prevention of hydrogen accumulation was also bypassed, by mistake. The workers' action to rectify the problem and an automatic activation of the nitrogen purge system brought the leach tank into a safe state. During this event, no workers or members of the public were affected and there were no impacts to the environment.

15. The event was reported to the Saskatchewan Ministry of Labour Relations and Workplace Safety (LRWS) on December 17, 2020. The event was classified as a dangerous occurrence, and was reported under *Saskatchewan Occupational Health and Safety Regulations*.

16. The event was also reported to CNSC staff on December 17, 2020, an initial written notification was submitted on December 18, and a follow-up report on December 24, 2020 under subsection 29(2) of the *General Nuclear Safety and Control Regulations*. After reviewing the reports, CNSC staff was satisfied with the corrective actions and measures taken to prevent similar incidents in the future. CNSC staff did not anticipate additional reporting to the Commission regarding this event.

17. CNSC staff informed the Commission about a planned inspection of the human performance management program, which will be focused on training, and would include verification of the implemented corrective actions, and the changes and improvements proposed by Orano.

18. The Commission enquired about the accumulation of hydrogen in the ore and about testing procedures for changes in the slurry composition. Orano representative responded that research indicates that hydrogen is mostly captured in the clay surrounding the ore and, after a saturation period, hydrogen concentration does not increase any more. The slurry composition is tested by hydrogen analysers mounted on all of the seven leaching tanks.

19. The Commission sought clarification on whether the hydrogen was released only by the acid leaching process, or whether it could occur during other steps in ore processing, including operations in the Cigar Lake mine. The Orano representative stated that the hydrogen was released only under acid conditions of the leaching process when pH lowers below 5 (pH<5). This value is below the acidity of natural groundwater, so that the hydrogen release would not be of concern in the mine or during other operations involving the ore.

20. Asked about the status of works on the additional barrier to the digital control system, the Orano representative responded that the works were completed. The aim was to ensure that the sweep air valves remain lock-open during the operation and are under control of the operations general supervisor, so that operators or maintenance employees could not shut them off on their own. The works also involved appropriate training of the personnel.

21. The Commission asked representatives from the Saskatchewan Ministry of Labour Relations and Workplace Safety to comment on the adequacy of corrective measures that Orano had taken or was planning to take to address this issue. The Chief Mines Inspector for the Province of Saskatchewan responded that they had completed the investigation and issued a report to Orano. It was concluded that Orano had taken the appropriate actions.

22. The Commission asked about the worst case scenario and whether an event like this could cause a major explosion. The Orano representative responded that a hydrogen explosion could cause significant damage and severe injuries. Orano's leaching tanks are placed into a leaching vault, with limited access, surrounded by a very thick concrete wall. This wall provides protection against explosions, as well as against radiation.

23. The Commission was satisfied with the corrective actions, and that the event had no impacts on the environment, workers or members of the public.

University of British Columbia: Exposure above regulatory limit of a non-Nuclear Energy Worker

24. With reference to CMD 21-M10, CNSC staff presented information regarding the exposure of a person to a radiation dose in excess of the limits prescribed by the *Radiation Protection Regulations*. The event was reported to CNSC on November 9, 2020, by the Radiation Safety Officer (RSO) from the University of British Columbia (UBC). The licensee conducted an investigation and, on November 30, 2020, the RSO submitted a final report for this event. The person, who was deemed a non-Nuclear Energy Worker (non-NEW), was exposed to a radiation dose of 1.3mSv (millisieverts), i.e. 0.3mSv above the annual limit of 1.0mSv/y for a non-NEW. The typical annual doses for laboratory personnel over the last five years were below 0.2mSv. The reason that the licensee became tardily aware of the event was attributed to the delayed submission of dosimeters to the licensed dosimetry provider, due to the COVID-19 pandemic.

25. The investigation has also shown that the overexposed person had not followed the established safe work practices all the time, which had contributed to an elevated personal dose. The licensee had identified improvements that need to be implemented in order to ameliorate supervision and verification of worker adherence to the established protocols and safe laboratory practices.

26. CNSC staff reviewed the submitted reports, confirmed the accuracy of dose calculations and revealed that the dosimeter handling practices were not adequate. CNSC staff concluded that the cumulative exposure above the annual regulatory limit for a non-NEW could be attributed to the neglected laboratory safe work practices combined with a delay in returning the dosimeters to the licensed dosimetry provider. CNSC staff also concluded that there were no risk of radiation health effects at the level of exposure corresponding to the dose received by the person in question. Members of the public had not been affected and there were no environmental impacts from the event. CNSC staff did not anticipate additional reporting to the Commission regarding this event.

27. The Commission enquired if the person in question had been properly trained for the type of work it was performing. CNSC staff responded that, according to the report from the licensee, the person was trained initially upon joining the laboratory; however, the person had not followed the work practices that

were in place. UBC representative added that the person, a post-doctoral fellow, already had experience working with radiation, and had been trained and monitored initially to ensure that she had a complete understanding of the laboratory techniques. Against usual laboratory practice, the person had not used shielding during one particular step of radiation labelling reaction. The person had not provided any substantive reason for not following the established procedure. Asked if the person still had laboratory privileges, the UBC representative responded that the person was no longer with the university.

28. The Commission asked about the UBC laboratory action level with respect to quarterly dose, and about the date when the management become aware of the exceedance of that threshold. The UBC representative responded that the action level has been set at 0.75mSv, and that they had become aware only on November 9th that the received dose for the first quarter of 2020 had been 0.93mSv.

29. Asked to comment on inadequate dosimeter handling practices, and about actions taken, the UBC representative concurred that the investigation had exposed unacceptable handling of dosimeters, and stated that both the laboratory head and the supervisor had been categorically warned that the practice was not acceptable and has to be corrected.

30. Reflecting on late dosimeter submissions and delayed dosimetry services, the Commission asked CNSC staff whether a contingency plan had been put in place to ensure that dosimetry services were maintained despite the COVID-19 pandemic. CNSC staff responded that it had engaged with the licensed dosimetry services asking for a status update and their capacity to continue to offer services. These services have been declared to be essential and the dosimetry service provider has to maintain a minimum complement of staff. However, they had to introduce some modifications to the dosimeter wear periods for low-risk types of clients, such as this one in an academic institution. Instead of wearing the dosimeter for a three-month period, the dosimeter wear period was extended to approximately six months. As of July 2020, there were no reports of delays in reporting the doses to the National Dose Registry within 45 days. Some clients, however, complained about shipping delays through the mail service. The UBC representative added that, as of March 16, all laboratories, with the exception of those involved with *in vivo* experiments, had been suddenly shut down. One of the consequences was the delayed return of dosimetry data.

UPDATES ON ITEMS FROM PREVIOUS COMMISSION PROCEDINGS

Update from CNSC staff on CancerCare Manitoba

31. With reference to CMD 21-M8, CNSC staff presented an update regarding the exposure of a Cancer Care Manitoba (CCMB) worker in excess of the regulatory dose limit for the non-NEW, which was considered as EIR in the September 16, 2020 Commission meeting. During that meeting, the Commission expressed concerns regarding the dose estimation methodology and accuracy, and requested that CNSC staff provide additional details about dosimetry calculations.

32. In response to the Commission's request, CNSC staff submitted that its rationale in considering this matter had been based on the fact that the effective dose was low and that, despite the uncertainties in this case, there was no risk to the health of the worker. CNSC staff further provided details of its consideration related to the accuracy of the dose estimate and actions to correct dose records in Canada's National Dose Registry (NDR).

33. The Commission was satisfied with information submitted by the CNSC staff and had no further questions regarding this matter. Therefore, the Commission pronounced this action item closed. However, the Commission requested that CNSC staff prepare a technical presentation on the matter of dosimetry and dose calculations at a future public Commission meeting.

ACTION
21751
Closed

ACTION
By September 2021

Update from CNSC staff on Suncor Energy Inc.

34. With reference to CMD 21-M9, CNSC staff presented an update regarding the EIR report on a fire at Suncor's Tar Island location, which has been considered in the September 16, 2020 Commission meeting. Considering the EIR report, the Commission had asked a number of questions about the design of fixed gauges that had been involved in the fire. Following the discussion, CNSC staff undertook to provide additional information on the use of lead as a shielding material in the encapsulation of radioactive sources. In the submitted written update, CNSC staff provided responses to the questions related to the safety profile for fixed gauges, a risk assessment about environmental hazards that a gauge might be exposed to, and about lead used for shielding in fixed gauges.

35. The Commission was satisfied with the information provided and had no further question. The Commission pronounced this action item closed.

ACTION
21862
Closed

INFORMATION ITEMS

Update on CNSC Readiness for the Regulation of Small Modular Reactors and Advanced Reactor Projects

36. With reference to CMD 21-M5, CNSC staff presented its update on the CNSC readiness for the regulation of small modular reactors (SMRs) and advanced reactor projects. This report focussed on near-term reactor facility projects in Canada in relation to CNSC's regulatory framework readiness for SMRs.

37. The presentation also expanded on the following information related to SMRs:

- Pre-licensing engagements;
- International cooperation; and
- Engagement and consultation

38. CNSC staff explained that SMRs have similarities with many of the smaller reactors that were built in the past, but with modern advancements.

Discussion

39. The Commission emphasized challenges associated with engineering and design of such new and complex systems, and enquired about CNSC staff's readiness to perform the safety assessments for SMRs of different designs and to determine that all the potential failure modes and risks have been identified and accounted for. CNSC staff explained that Vendor Design Reviews allow CNSC staff to investigate vendors' safety analysis, covering the identification of hazards, the probabilistic safety assessment and the deterministic safety assessment. CNSC staff added that vendors had to identify uncertainties about their SMR design and how these issues will be dealt with. CNSC staff stated that it was qualified, and informed the Commission about its capability and capacity to perform these reviews. CNSC staff added that it also had the opportunity to reach out to external expertise.

40. CNSC staff reported that verification of SMR design could also be done through building demonstration SMR units to validate their safety through operational and maintenance experience. Demonstration SMRs would also assist in identifying vulnerabilities and improving the design before moving toward a fleet approach.

41. On whether CNSC staff has the legal authority, the resources and the capacity to licence next-generation reactor designs, CNSC staff explained that it started engaging with the different stakeholders almost 10 years ago and identified areas of potential challenges, such as the security regulations that were identified as being too prescriptive for some of the smaller facilities. CNSC staff added that there is a need for further discussions on the application of a graded approach.

42. The Commission enquired whether CNSC staff would be able to review and conduct inspection on SMRs assembled and sealed in a factory located outside of Canada. CNSC staff indicated that there are provisions in the licences to facilitate carrying out compliance activities, including conducting inspections at the factory sites, whether domestic or foreign.[1]

43. Asked whether SMRs using enriched uranium would affect CNSC's safety approach, CNSC staff explained that Canada had over 50 years of experience in operating the NRU and NRX reactors using either highly enriched uranium or low-enriched uranium. CNSC staff added that using enriched uranium is not seen as a safety concern, but that acquiring that material may be challenging. CNSC staff further added that it would conduct a comprehensive review of every application to verify that all regulatory requirements are addressed.

44. On the impact of a potentially wide spatial distribution of numerous SMR units deployed throughout Canada on CNSC staff's capacity to manage an increased workload, CNSC staff reported that, even though the potential number of applicants and their time frame is unknown, CNSC staff was constantly assessing its capacity and capability. CNSC staff added that it already has internal initiatives dealing with capability for nuclear safety and knowledge management.

[1] See REGDOC-1.1.2: *Licence Application Guide: Licence to Construct a Nuclear Power Plant*, section 8.3.1.

45. Industry representatives indicated that, in their view, the CNSC regulatory framework readiness is robust and offers flexibility for the eventual licensing of SMRs. Industry representatives also conveyed that they had a very high degree of confidence in Canada's overall readiness from the perspective of legislation and policy frameworks.

46. The Commission requested that CNSC staff prepare a presentation, in the context of a future Commission meeting, on the differences between prescriptive requirements versus performance-based requirements. **ACTION By December 2021**

47. The Commission expressed its appreciation to CNSC staff for this information session and looks forward to getting future updates as the SMR file progresses.

Status Update on Condition of Pressure Tubes in Operating CANDU Reactors in Canada

48. With reference to CMD 21-M4, CNSC staff presented an update on pressure tube fitness for service for the Canadian nuclear power plants (NPPs). The presentation was prepared in response to the Commission's request for information on the models used by the industry to predict fracture toughness and hydrogen concentration in CANDU reactor pressure tubes, and in recognition that this topic had received significant attention following the planned extension of the operating lives of several Canadian reactors.

49. In its presentation, CNSC staff illustrated how the development, implementation and improvements of these models contribute to the continuous safe operation of the Canadian NPPs and elaborated on the following topics:

- A description of CANDU fuel channels with a primary focus on the pressure tubes;
- The main degradation mechanisms of concern for pressure tube fitness for service;
- Important concepts for the evaluation of pressure tube fitness for service with emphasis on extended operation;
- Regulatory oversight activities and compliance verification criteria used to assess pressure tube fitness for service;
- A brief summary of the status of fitness for service evaluations for operating pressure tubes;

- A summary of CNSC staff's response to the Commission's request for information on the models developed to represent and predict behaviour of fuel channels under different conditions; and
- CNSC staff's observations regarding the impact of the BT-29 pressure tube test result on the current pressure tube fracture toughness model.

CNSC staff had earlier submitted to the Commission a briefing note with a description of the models used to make predictions for fracture toughness and the hydrogen uptake for pressure tubes.

50. CNSC staff stressed the importance of understanding the impact of hydrogen for evaluation of the fitness for service of pressure tubes and explained the ageing of pressure tubes through primary mechanisms that contribute to their degradation over time. These mechanisms include corrosion, dimensional changes and changes in material properties upon simultaneous exposure to high temperatures and pressure, and intense radiation fields. The most significant impact of the corrosion is the generation of deuterium represented by the hydrogen equivalent concentration[2] (Heq), which intensifies the potential for crack initiation and decrease pressure tube fracture toughness. The dimensional changes might cause a contact between a hotter pressure tube and a surrounding cooler calandria tube, in which case the hydrogen within the pressure tube would migrate to the point of contact. The increased local hydrogen concentration would contribute to the formation of a hydride blister, which could ultimately crack and cause a pressure tube failure.

51. CNSC staff further presented regulatory oversight related to pressure tube fitness for service. Presenting a safety case for pressure tube operation, CNSC staff discussed five levels of the defence-in-depth, as provided in CNSC REGDOC 2.5.2, *Design of Reactor Facilities: Nuclear Power Plants*, and emphasized the importance of Heq and fracture toughness models, since the Heq model is an example of a direct, and fracture toughness of an indirect, means of addressing CSA requirements (as given in CSA standards N285.4 and N285.8). CNSC staff used the presented consideration to address the issue of extended operation of CANDU reactors and provided a detailed information about the current status of pressure tubes in operating NGSs in Canada.

[2] The "hydrogen equivalent concentration" is a term used to represent an amount of hydrogen absorbed in a pressure tube, and is usually referred to as Heq. In this case, the initial hydrogen, H, and deuterium, D, concentrations are combined and Heq represents both of the hydrogen isotopes; 2Heq = 2[H] + [D].

52. With respect to hydrogen uptake, CNSC staff described measurements of hydrogen and deuterium concentrations, and the use of obtained Heq values to develop models that could be further used in various assessments required by CSA standards. There are generally two types of such models: empirical, which are applied to the body-of-tube part, and semi-mechanistic, applied to the rolled joint[3] areas of the pressure tube. CNSC staff pointed out the dependence of the fracture toughness on Heq, and discussed how the modelling of these two properties could be used to compare the estimated results to the values of compliance verification criteria, and to assess safety margins for pressure tube operation in the future.

53. With respect to fracture toughness, CNSC staff explained the change of fracture toughness as a function of increasing temperature, for a given Heq, and presented two models to describe it. The model called "cohesive zone model" (CZM) is applicable at low temperatures, where the material shows brittle fracture, and fracture toughness is the lowest and does not depend on temperature ("lower-shelf regime"). This model is also applicable at transition temperature regime, up to 250 ^{o}C during which the material behaviour changes from brittle to ductile and the fracture toughness increases with increasing temperature. Modelling of the behavior in this regime is important because pressure tube temperatures will be in the transition temperature regime during heat-up and cool-down of the tubes. The other model is applicable at temperatures above 250 ^{o}C, typical during power operation ("upper-shelf regime") where the fracture toughness is the highest.

54. CNSC staff discussed limits of applicability of the models, particularly the CZM, which has been incorporated in the 2019 update of the CSA N285.8 standard. This model has been restricted to the maximum Heq value of 120 ppm (parts per million)[4].

55. CNSC staff further discussed uncertainty related to CZM Revision 1 and explained the so-called B-29 fracture toughness test. The BT-29 test result represented a potential concern for safe operation because the front end region of pressure tubes could have lower fracture toughness than predicted by Revision 1 of the CZM. Consequently, an additional limitation of maximum Heq concentration of 80 ppm has been imposed on this model for the "front end" of pressure tubes. To address the obtained results, and to include the new understanding of the fracture toughness of the pressure tubes, a Revision 2 was

[3] Rolled joints are subjected to additional hydrogen uptake due to the end fitting.
[4] Revision 1 of the model.

intended for the CZM. The Revision 2 is expected to be proposed by the industry in 2021, and it would be subject to a detailed review by CNSC staff.

Discussion

56. The Commission enquired about the Heq limits in CZM Revision 2 and how close were the current testing results to the proposed values. CNSC staff responded that none of the tubes had approached or were approaching the 120 ppm limit of the current model. The only reactor that could be affected was Bruce Unit 3, due to the 80 ppm front end limit. Since the unit has been scheduled for a shutdown in the spring of 2021, until that time it was not considered to be a safety concern.

57. The Commission sought clarification regarding improvements of the "lower shelf" model, and asked whether this improved model would supersede the "upper-shelf" model in the licensing process. CNSC staff explained that the new revision of the CZM would replace the current "lower-shelf" and transition temperature model, but the "upper-shelf" model will remain, since it governs the fracture toughness behaviour at normal operating temperatures above 250^{o}C.

58. The Commission asked representatives from the industry whether this revision to the fracture toughness model was based exclusively on testing of Canadian pressure tubes. The OPG representative responded that, while revising the model, the samples for mechanical testing were collected mainly from ex-service pressure tube material from Bruce Power and OPG, and that only one foreign tube had been tested in the past.

59. Asked about the review of the revised model and approval procedure, CNSC staff stated that they were already reviewing the preliminary base document and that, upon submission of the final one, it would take three to four months to review the model. The submission of the revised model is expected by March 2021. Following the review, if the revised fracture toughness model is considered acceptable, CNSC staff would adopt it for licensing applications. The update of the CSA standard will follow after that. If the adopted new model goes beyond the current licensing basis, impacts the safety of operation, or reduces the safety margins, it would have to be considered and approved by the Commission.

60. The Commission enquired about potential implications for other regulators if this new model is accepted by the Canadian regulator. CNSC staff reiterated that after the review of the model for regulatory use in Canada, it would also be reviewed within the CSA Standards Committee and, if accepted, it would be adopted into the standard. Then any regulatory regime that would be using the CSA standard would be able to adopt it as well.

61. The Commission requested that CNSC staff inform the Commission on the progress of the review of the proposed model, and to bring to the Commission's attention if the model surpasses the current licensing basis, in which case the Commission's approval of the changes would be required. CNSC staff committed to update the Commission through the status update reports.

ACTION
by
September
2021

62. The Commission asked for the reasoning behind the 30:70 percentage ratio between inspected and uninspected pressure tubes. CNSC staff referred to the CSA N285.4 standard that sets minimum inspection requirements for pressure tube evaluations. These numbers are nominal, and could be altered. The information from the inspected tubes is used in the core assessment and evaluation of the remaining tube population. Depending on evaluation results, if the estimated risk is too high, a decision could be made to increase the number of inspected tubes. Therefore, the number of inspected tubes might be different for different reactor units.

63. The Commission enquired into other degradation mechanisms that could lead to pressure tube flaws. CNSC staff explained that some small flaws on the inside surface of the pressure tube, caused by debris trapped between the fuel bundles and the pressure tube, or by fretting between the fuel bundles and the pressure tube, could potentially initiate cracks. However, these degradation mechanisms are interrelated with the Heq concentration, which is the factor that determines whether or not these flaws could initiate cracks. If the Heq is not high, there would be no formation of brittle hydride blisters, and there would be no risk of tube failure.

64. The Commission sought clarification regarding seemingly incongruous trends in the fracture toughness and the deuterium concentration that both increase with temperature along the pressure tube. CNSC staff explained that, while corrosion originated increase of Heq would suggest decrease in fracture toughness, the direct temperature dependence of the fracture toughness shows a different trend. Consequently, for the

resulting behaviour of the material, both effects have to be taken into account.

65. Asked about correlation between the fracture toughness and the modulus of elasticity, i.e. strength of the pressure tube material, CNSC staff stated that the irradiation effects on the strength should be taken into account when this relationship is considered, and in general, these two material properties are inversely proportional.

66. The Commission sought more details regarding the materials used for annulus spacers between the calandria tube and the pressure tube, its thermal conductivity and potential impact in formation of brittle blisters that could compromise integrity of pressure tubes or calandria tubes. CNSC staff informed that the loose-fitting spacers are typically made up of a zirconium alloy, and the tight-fitting spacers are generally made of a nickel-based X750 alloy. Due to small contact areas with the tubes, these spacers are not significant in terms of causing localized cooling spots, and there were no evidence for their influence on the formation of blisters on the pressure tube or on the calandria tube. The OPG representative concurred with this explanation and supported it with the results of their own extensive testing.

67. The Commission expressed its appreciation for this presentation that provided valuable background information for this important topic that is frequently the subject of detailed discussion in Commission proceedings.

Technical Briefing on Non-Proliferation and Import/Export Controls Program in Canada

68. With reference to CMD 21-M6, CNSC staff presented its technical briefing on the Non-Proliferation and Import/Export Controls Program in Canada. The CNSC's Import and Export Controls Program has three main objective:

- Limiting the risk to the public, environment and global security;
- Implementing international measures to which Canada has agreed; and
- Implementing and supporting the key aspects of Canada's nuclear non-proliferation policy.

Discussion

69. Asked about how CNSC staff verifies and monitors appropriate use of an item after it has been exported, CNSC staff provided the following information:

- The Annual Inventory Reconciliation allows the CNSC to compare obligated material inventories in partner countries with how much obligated material had been exported to ensure it is being tracked in accordance with the Nuclear Cooperation Agreement. The International Atomic Energy Agency (IAEA) also conducts verification activities for all safeguards facilities; and
- CNSC staff can also conduct inspections, when needed, as part of some of the Nuclear Cooperation Agreements in place.

70. On the topic of dual-use products, the Commission asked how the determination was made as to whether a dual-use product was an export controlled product and if CNSC staff conducts outreach activities with industries. CNSC staff provided the following information:

- The CNSC relies on weapon states to provide information about what industrial items can be used for a weapons program;
- CNSC staff tries proactively to reach out to those industries for which the CNSC can foresee exports being conducted; and
- CNSC staff intends to, in the near future, conduct outreach activities with the Canadian Border Services Agency as they have a wider viewpoint of exports in Canada. The details of this collaborative effort are yet to be confirmed and will be provided to the Commission at a future Commission meeting.

71. Further on that topic, CNSC staff reported that there was a number of discussions between member countries before an item was added to the Nuclear Suppliers Group (NSG) list to ensure that a coordinated approach was implemented and incorporated into Canada's regulatory framework.

72. The Commission asked how the CNSC controls the export of software. CNSC staff responded that there would be different controls depending on the items and added that for computer numerical control (CNC) machine tool software, there were entries in the NSG list that identify what specific software are controlled and what specifications must be met.

73. The Commission asked for details regarding the 26 countries that the CNSC has administrative arrangements (AAs) with pursuant to Nuclear Cooperation Agreements, versus the 12 countries with whom the CNSC has distinct AAs pursuant to the IAEA Code of Conduct. CNSC staff responded that the number of AAs in place for nuclear items and technology with 26 countries is different than the 12 specific AAs for risk-significant sealed radioactive sources. The AAs for sealed sources are guidance documents and do not require being set up under the guise of nuclear cooperation agreements.

74. Asked about control of reprocessing of Canadian-spent fuel, CNSC staff confirmed that there was no reprocessing of Canadian-spent fuel in Canada.

75. With respect to the control of export of Colbalt-60, CNSC staff submitted that it is the exporter that is responsible for the safe packaging and transport to the end-user site and added that the control and responsibility would shift to the foreign regulator when imported into their country.

76. The Commission conveyed its appreciation to CNSC staff for its comprehensive presentation.

Closure of the Public Meeting

77. The public meeting closed at 3:58 p.m. The Commission convened a closed session to consider the matters raised in the context of the meeting.

Recording Secretary	April 13, 2021 Date
Dimitrijevic, Stevan Digitally signed by Dimitrijevic, Stevan DN: C=CA, O=GC, OU=CNSC-CCSN, CN="Dimitrijevic, Stevan" Reason: I am the author of this document Location: your signing location here Date: 2021-04-13 12:27:27 Foxit Reader Version: 9.7.1 Recording Secretary	April 13, 2021 Date
Recording Secretary	April 16, 2021 Date
Leblanc, Marc Digitally signed by Leblanc, Marc DN: C=CA, O=GC, OU=CNSC-CCSN, CN="Leblanc, Marc" Reason: I am the author of this document Location: your signing location here Date: 2021-04-13 08:55:02 Foxit Reader Version: 9.7.1 Secretary	April 13, 2021 Date

APPENDIX A

CMD	Date	e-Docs No.
21-M1	2020-12-11	6435624
Notice of Commission Meeting to be held on January 21, 2021		
21-M2	2021-01-12	6441807
Agenda of the Meeting of the Canadian Nuclear Safety Commission (CNSC) to be held remotely on January 21, 2021		
21-M3	2021-01-17	6445637
Approval of the Minutes of Commission Meeting held on November 5, 2020		
21-M7	2021-01-12	6460610
Status Report Status Report on Power Reactors Submission from CNSC Staff		
21-M5	2021-01-11	6460689
Information Items Update on CNSC Readiness for the Regulation of Small Modular Reactors and Advanced Reactor Projects Presentation from CNSC Staff		
21-M8	2020-11-27	6454120
Updates on items from previous Commission proceedings Update from CNSC staff on CancerCare Manitoba Presentation from CNSC Staff		
21-M9	2020-11-30	6454136
Updates on items from previous Commission proceedings Update from CNSC staff on Suncor Energy Inc Presentation from CNSC Staff		
21-M11	2021-01-12	6461773
Event Initial Reports Orano Canada Inc, McClean Lake Operation: Elevated Hydrogen Level in Leach Tank Submission from CNSC Staff		

21-M10	2020-12-02	6435850
Event Initial Reports University of British Columbia: Exposure above regulatory limit of a non-Nuclear Energy Worker Submission from CNSC Staff		
21-M4	2021-01-08	6459353
Information Item Status Update on Condition of Pressure Tubes in Operating CANDU Reactors in Canada Written submission from the Curve Lake First Nation Submission from CNSC Staff		
21-M6	2021-01-13	6462633
Information Item Non-Proliferation and Import/Export Controls Program Submission from CNSC Staff		