32-2-0-0

Examination Guide CNSC-EG1, Rev. 0

Requirements and Guidelines for Written and Oral Certification Examinations for Shift Personnel at Nuclear Power Plants

July 2005

1216550

Appendices

Guidelines

1 Purpose and Scope

1.1 Purpose

The purposes of this Canadian Nuclear Safety Commission (CNSC) document are:

a) to specify a process acceptable to the CNSC that nuclear power plant (NPP) licensees should follow in planning, developing, conducting and marking written and oral certification examinations for persons seeking certification by the CNSC for the operating positions specified in their Power Reactor Operating Licences;

b) to specify requirements, criteria and guidelines endorsed by the CNSC that NPP licensees should comply with or follow to ensure that their written and oral certification examinations are administered in an equitable and consistent manner.

Collectively, those written and oral certification examinations may be referred to as knowledge-based certification examinations.

1.2 Scope

Persons seeking certification for the operating positions listed below must successfully complete the knowledge-based certification examinations administered by the licensee that are specified in the plant's Power Reactor Operating Licence:

Licensee	CNSC Generic Title	Licensees' Position Title
New Brunswick Power and Hydro-Québec	Reactor Operator (RO)	Control Room Operator (CRO)
	Shift Supervisor (SS)	Shift Supervisor (SS)
Ontario Power Generation and Bruce Power	Reactor Operator (RO)	Authorized Nuclear Operator (ANO)
	Unit 0 Operator (U0O)	Unit 0 Control Room Operator (U0 CRO)
	Shift Supervisor (SS)	Control Room Shift Supervisor (CRSS)
	Shift Supervisor (SS)	Shift Manager (SM)

These examinations are aimed at providing the CNSC with the assurance that, at the time of their certification, candidates for those positions have acquired the level of knowledge required to work competently in their assigned position at their plant. This document covers all the knowledge-based certification examinations applicable to those operating positions.

2 Definitions

The definitions below are of a restricted nature for the purpose of this document.

Approved Marking Guide - The document that contains the answers to examination questions approved by the Training Manager for marking the examination.

Authorized Marking Guide - The final version of the marking guide authorized by the Training Manager that is used for determining the results of an examination.

Barrier - A physical device, an administrative process or an individual's behaviour that significantly reduces the risk of compromising the security of a certification examination. Examples of acceptable barriers are:

- signed security agreements;
- a locked room with opaque windows accessible only to persons who have signed the appropriate security agreement;
- a locked file cabinet, desk or safe accessible only to persons who have signed the appropriate security agreement;
- password protected electronic files accessible only to persons who have signed the appropriate security agreement;
- direct control of examination material by a person who has signed the appropriate security agreement.

Conditional Pass Result - A pass result with attached conditions for remedial training which may be given to a candidate when the candidate obtains a pass score in the examination, but shows one or more significant knowledge deficiencies that could adversely impact on the safe operation of the plant.

Element - A stand alone component of the required answer. The number of elements in an answer is used to determine the number of marks assigned to a question.

Examination Team - The team which develops and marks an examination. In the case of an oral examination, the team also conducts the examination. The team is composed of the lead examiner and at least another qualified examiner.

Frozen Documentation - The set of licensee's administrative, operating and training documents that may be referenced when preparing an examination. This set should include all relevant documents available in the plant control room that may be referenced by incumbents of the position sought by the candidates in performing their duties. It should also include all relevant training material given to the candidates.

Generic Station System Knowledge Objectives (GSSKOs) - The *Generic Station System Knowledge Objectives for Control Room Operators*, dated June 1998, as amended from time to time, or a set of generic plant system knowledge objectives for ROs or for U0Os developed in accordance with a systematic approach to training and endorsed by the CNSC.

Lead Examiner (LE) - An examiner who coordinates the development, conduct and marking of an examination.

3 Responsibilities

The titles of the positions used in this document are generic. The responsibilities of those positions should be assigned by the licensee to individuals holding the equivalent position in its organisation.

3.1 Training Manager

The responsibilities of the Training Manager are:

a) To ensure that the requirements in this document are complied with and that the criteria and guidelines it contains are followed during all stages of the examination process.

b) To ensure that sufficient qualified personnel and resources are available to develop, conduct and mark all knowledge-based certification examinations.

c) To assign at least two qualified examiners to each examination and to designate one of them as lead examiner.

d) To approve the examinations and their marking guides prior to the conduct of the examinations.

e) To determine candidates whose examination will be marked a second time.

f) To authorize the marking guide and the examination result of each candidate.

g) To ensure that a copy of the examination and of its authorized marking guide is sent to the CNSC following each examination and that the CNSC is formally notified of the examination results of each candidate.

3.2 Lead Examiner

The responsibilities of the lead examiner are:

a) To inform all persons participating in the development of an examination of the requirements regarding examination security and to ensure that each person has signed a copy of the applicable security agreement.

b) To coordinate the development, conduct and marking of an examination, and to verify that the relevant criteria and guidelines for written or oral certification examinations are followed during those stages of the examination process.

c) To decide whether communications with licensee staff, that are not part of the examination team, on any matter relating to an examination are required and, if so, to determine how these communications are to take place.

3.3 Examination Team Members

The responsibilities of examination team members are:

a) To participate in the development and marking of an examination. In addition, for an oral examination, to participate in the conduct of the examination.

b) To operate the plant full scope simulator to obtain the data necessary to develop examination questions and answers, when required.

4 Administrative Requirements

4.1 Security of Certification Examinations

a) Licensees must document the physical, electronic and administrative measures and requirements, including those specifically designed for the simulator, which must be in place to minimize the risk of compromising the security of the examinations.

b) Access to the examinations and to examination material must be limited to persons with a need to know.

c) All examinations and examination material must be continuously controlled.

   i) At least one barrier against unauthorized access to examinations and examination material must be in place at all times.

   ii) All draft material, notes and other documents generated or consulted during any phase of the examination process must be handled in a way that prevents compromising the security of the examinations.

d) Before a person may participate in the development of an examination or in the conduct of an oral examination, the person must:

   i) have been informed of the physical, electronic and administrative measures and requirements, applicable to the person's role in the examination, established by the licensee to ensure the security of the examinations;

   ii) have been informed of the terms of the applicable *Security Agreement for Certification Examinations* shown in Appendix A.1, part A or part C, and of the consequences of violating its terms;

   iii) have signed a copy of the applicable agreement.

e) Prior to taking an oral examination, a candidate must:

   i) have been informed of the terms of the *Security Agreement for Certification Examinations* shown in Appendix A.1, part B, and of the consequences of violating its terms;

   ii) sign a copy of that agreement.

f) If any unauthorized access to information related to the content of an examination is suspected, the Training Manager must be informed and undertake an investigation. If the investigation shows that the security of the examination has been compromised, the examination must not be used.

4.2 Independence Between Training and Certification Examinations

a) Once an examiner has started working on the development of an examination or once a person has any information on the content of an examination, that individual can no longer train, or give training feedback to, the candidates scheduled to take that examination until all of them have completed the examination.

b) An examiner who has participated in the training of candidates scheduled to take an examination must not participate in the selection of the examination topics and in the preparation of the first draft of the examination questions in the areas covered by the training given by this examiner.

c) The Training Manager and the examiners participating in the examination process must not benefit from any performance incentive related to the success rate of candidates taking the certification examinations.

4.3 Qualifications of Examiners

a) Examiners developing and marking knowledge-based examinations and conducting oral examinations must have the applicable qualifications listed below.

i) For General Examinations:

(1) Have the knowledge in science fundamentals and equipment principles required by persons in the position for which the examination is intended.

(2) At least one examiner is sufficiently familiar with the operation of CANDU plants to ensure the examination questions are operationally focused.

ii) For plant-specific examinations:

(1) Examinations for RO and SS candidates, either:

(a) be currently certified or have been previously certified by the CNSC as RO or SS at any plant with at least one year of experience in the position, or

(b) have the knowledge that candidates are expected to have on the topics examined.

(2) Examinations for U0O candidates, either:

(a) be currently certified or have been previously certified by the CNSC as U0O or SS at any plant with at least one year of experience in the position, or

(b) have the knowledge that candidates are expected to have on the topics examined.

(3) If not currently or previously certified at the plant in the position for which the examination is intended, be fully familiar with the knowledge requirements of that position at that plant.

(4) At least one member of the examination team must:

(a) be currently or have been previously certified at the plant, or at a similar plant on the same site, in the position for which the examination is intended or as an SS; when not currently certified, the examiner must have the knowledge that candidates are expected to have on the design and operation of plant systems and on plant systems integrated operation;

(b) be capable of operating the plant full scope simulator to obtain the data necessary to develop examination questions and answers, when required.

iii) Be fully familiar with all criteria and guidelines applicable to the knowledge-based certification examinations at their plant.

b) In addition to meeting the applicable qualification requirements in a) above, the lead examiner must have participated as an examiner in the examination process for at least one written or oral certification examination.

Note: Qualified examiners may be assisted by other persons who do not have the applicable qualifications, such as subject matter experts.

4.4 Appeal of the Result of a Certification Examination

Licensees should have in place a documented process for handling appeals of the results of examinations by candidates.

4.5 Retention of Certification Examination Records

a) For each examination, licensees must retain the following records for a minimum of five years from the date of approval or signature:
   i) the approved examination, the authorized marking guide, the examination checklist and the invigilation form;
   ii) the names of the persons who developed the examination;
   iii) the name and signature of the person who approved the examination, with the date of signature;
   iv) the name and signature of the person who approved and who authorized the marking guide, with the date of signature;
   v) signed security agreements.

b) Licensees must retain the answer booklets of the candidates for written examinations and the recordings of the candidates for oral examinations for five years from the date of an examination.

c) Licensees must retain for each candidate a record of the examinations taken by the candidate, containing:
   i) the position sought of the candidate;
   ii) the titles and dates of the examinations;
   iii) the authorized marking guide of the candidate for each examination, with the results of the examination, and the names and signatures of the examiners who marked the examination;
   iv) the names and signatures of the persons who authorized the results of each examination, with date of signature;
   v) when the candidate must clear a conditional pass result:
      (1) the outline of the remedial training completed, with the name and signature of the person who approved the training;
      (2) the approved examination completed, with the names and signatures of the persons who developed and approved the examination and its marking guide, and the date of signature;
      (3) the authorized marking guide of the candidate, with the result of the examination and the names and signatures of the examiners who marked the examination;

(4) the name and signature of the person who authorized the result of the examination, with the date of signature;

vi) documentation of the outcome of any appeal of the result of an examination by the candidate.

d) As a minimum, the records specified in paragraph c) must be retained for the period prescribed in paragraph 14(5) of the Class I Nuclear Facilities Regulations.

5 Planning of Examinations

5.1 The Training Manager should establish guidelines for planning written and oral certification examinations at the plant that ensure that sufficient qualified personnel and resources are available to develop, conduct and mark these examinations, in accordance with the criteria and guidelines of this document.

5.2 The Training Manager should establish rules regarding frozen documentation, taking into consideration the following guidelines:

a) Documents should be frozen approximately six weeks before the date of an examination.

b) Frozen documents should not be replaced until the end of the examination process, except for those revisions of approved operating procedures made before the conduct of an examination that, according to plant management, have a significant impact on safe plant operation.

5.3 For each examination, the Training Manager should assign two or more qualified examiners to the examination team and designate one of them as lead examiner.

5.4 The Training Manager should communicate the tentative schedule of knowledge-based certification examinations for a given calendar year to the CNSC at least six months before the beginning of the year.

5.5 The Training Manager should promptly inform the CNSC of any change to this schedule.

5.6 Before the start of the development of an examination, the lead examiner should:

a) verify that all the information and the frozen documentation required to prepare the examination are available;

b) ensure that the members of the examination team are fully aware of their roles and responsibilities and of the rules they must abide by, as specified in Appendix A.2;

c) review with the members of the examination team the intent of the relevant security agreement shown in Appendix A.1, and the consequences of violating its terms;

d) ensure that each person signs or has signed a copy of the relevant agreement and collect the signed agreements for filing.

6 Development of Examinations

The lead examiner coordinates the activities of the examination team during the development of an examination. The examinations should be developed according to:

- subsection 6.1 for Station Specific Examinations for RO candidates
- subsection 6.2 for Supplementary Station Specific Examinations for SS candidates
- subsection 6.3 for General Examinations for RO candidates or for U0O candidates
- subsection 6.4 for Station Specific Examinations for U0O candidates

6.1 Station Specific Examinations for RO Candidates

6.1.1 The examination team should design the examination questions in accordance with the following instructions.

a) For each group of topics listed in Guideline G.1 A, select one or more specific topics for use in the examination. Allocate a tentative number of marks to each selected topic such that the total number of marks for the group is within the range indicated beside the group.

b) For each topic selected in a), select from Guideline G.1 B one or more knowledge groups to be used for designing the corresponding examination questions and, using an Examination Design Matrix (EDM) that outlines the topic groups vertically and the knowledge groups horizontally, distribute in the matrix the tentative number of marks for the topic among the knowledge area(s) selected. Ensure that the total marks allocated to the various knowledge groups are within the range indicated beside the group in Guideline G.1 B.

c) For each cell of the EDM where marks are indicated, prepare a first draft of the questions whose answers should be worth the marks indicated in the cell, according to the following guidelines:

   i) No more than 20% of the examination should be based on questions asked on the last two Station Specific Examinations at the plant.

   ii) To the maximum possible extent, prepare questions that measure integrated understanding or higher level knowledge required by ROs to perform their job competently.

   iii) When a cell is associated with GSSKOs or with radiation protection knowledge objectives, select the individual parts of the relevant objectives that will be used to formulate the questions on the corresponding topic, according to the following guidelines:

      (1) To the maximum possible extent, select GSSKOs according to Guideline G.1 D.

      (2) Avoid repeated use of the same objective in any knowledge group for different topics.

      (3) Objectives should not be used verbatim to formulate questions.

Ideas for questions can be found in the following documentation:

- plant and industry wide significant event reports
- operating manuals and operating memos
- design manuals and other technical basis documents
- plant's safety report
- licensee's and plant's administrative procedures and associated documentation related to plant operation and maintenance

d) Verify that each question on plant systems and procedures is within the scope of the applicable GSSKOs, or of the plant-specific knowledge objectives derived from them.

e) For any question for which specific data from the plant simulator are needed:

i) Obtain the simulation data required to allow completion of the formulation of the question.

ii) Identify the aspects of the data obtained that may be interesting to explore in the question and complete the formulation of the question.

6.1.2 The examination team should develop the examination in accordance with the following instructions.

a) Maintain a list of any significant deficiency found in plant and training documentation during the development of the examination. The lead examiner should promptly report to the Training Manager any deficiency found in the plant operating procedures which may impact on the safety of the plant.

b) Prepare the first draft of the marking guide as follows:

i) Identify, for each question, the reference documents required to prepare the answer and check that the revision number and date of issue of each document correspond to those of the frozen documentation.

ii) Prepare answers for all questions that:

(1) are in line with the intent of the questions;

(2) are complete and technically accurate;

(3) reflect the level of knowledge that candidates are expected to have on the topics examined;

(4) do not conflict with the information contained in the frozen documentation;

(5) are broken into elements used to determine the number of marks to be assigned to the question.

iii) Identify, for each question, the reference material to be given to the candidates. Ensure that no reference material is given when a question covers an area that the candidates have to know from memory.

iv) Compile a package containing the questions with their answers, a copy of the reference material used to prepare each answer and the knowledge objectives covered by each question.

c) Once the first draft of the marking guide is completed, review each question and answer in detail, as follows:
   i) Verify that the answer to the question reflects the level of knowledge that candidates are expected to have on the subject covered by that question.
   ii) Verify that the level of difficulty of the question is appropriate to discriminate between those candidates who have sufficient understanding of the subject covered by the question and those who do not.
   iii) Revise the question and its answer as required to ensure that the question is clear, technically accurate and contains all the information necessary to give the required answer, and that the answer:
      (1) contains only information specifically asked by the question;
      (2) is complete and technically accurate;
      (3) does not conflict with the information contained in the frozen documentation.

d) Group together the questions that are logically related, integrating them into a single question, according to the following guidelines:
   i) The parts and subparts of the question are arranged in a logical order, where applicable.
   ii) To the maximum possible extent, the answer to a part of the question is not completely dependent on the answer to a previous part.

e) Prepare a draft examination.

f) Verify that the identification codes of equipment and documents used in the questions are correct.

g) Verify that only the required reference material will be given to the candidates. Confirm that no reference material is given with any question that covers an area that the candidates have to know from memory.

h) Verify that the breakdown of each answer into elements is appropriate.

i) Determine the number of marks to be allocated to each question using the relevant table in Appendix A.3.

j) Make the final selection of the questions for the examination in accordance with the relevant guidelines for mark allocation.

6.1.3 The examination team should finalize the examination and its marking guide and have them reviewed and approved by the Training Manager, in accordance with the following instructions.

a) Finalize the examination using the following guidelines:
   i) The information on the cover page is similar to that shown in Appendix A.4.
   ii) Each page contains only one question.
   iii) The stems used in a question are placed immediately before the parts or subparts of the question to which they apply.
   iv) Whenever an acronym is used in a question, it is defined the first time it appears in that question.

v) The questions clearly identify any reference material given to the candidates and give appropriate instructions for its use.

vi) Any instruction or other information in a question quoted from licensee's or plant's documentation appears verbatim.

vii) In each question, the key words that indicate the degree of development required in the answer are typed in **bold and underlined** to help candidates to give a complete answer.

viii) The marks allocated to a question appear at the left of the question number. The number of marks is based on the total number of elements in the answers to all parts of the question.

ix) The estimated time to answer each part of a question and the number of elements in the answer appear to the left of the letter designating the question part.

x) The formatting of the questions is similar to that shown in Appendix A.5.

b) Finalize the marking guide using the following guidelines:

i) The information on the cover page is similar to that shown in Appendix A.6.

ii) Information that is an alternate way to present part of an element of an answer may be included within single brackets, immediately following the information it is equivalent to.

iii) Information in an answer element that is only given to assist the markers, but is not part of the required answer, is included within double brackets.

iv) The formatting of the answers in the marking guide is similar to that shown in Appendix A.7.

c) Complete an examination checklist similar to that shown in Appendix A.8 and confirm that the examination meets the criteria specified in this checklist.

d) Revise the EDM where necessary and forward it with the examination, its marking guide and the examination checklist to the Training Manager to obtain approval of the examination and of the marking guide.

No change shall be made to an approved examination and marking guide without the prior concurrence of the Training Manager.

e) Assemble the documents specified in the examination that will be given to the candidates. Group together the documents that relate to a particular question, indicating the number of the associated question.

Do not alter the content of approved procedures and flowsheets given as reference material.

f) Make arrangements for the preparation of a package containing all the material required for the conduct of the examination.

6.2 Supplementary Station Specific Examinations for SS Candidates

6.2.1 The examination team should design the examination questions in accordance with the following instructions.

a) For each of the topic groups listed in Guideline G.2, select one or more specific topics for use in the examination and allocate a tentative number of marks to each topic selected such that the total number of marks for the group is within the range indicated beside the group.

b) For each specific topic selected, prepare a first draft of the questions whose answers should be worth the tentative number of marks allocated to the topic, according to the following guidelines:

i) No more than 20% of the examination should be based on questions asked on the last two Supplementary Station Specific Examinations at the plant.

ii) To the maximum possible extent, prepare questions that measure integrated understanding or higher level knowledge required by SSs to perform their job competently.

iii) Select the individual parts of the relevant knowledge objectives for SSs endorsed by the CNSC that will be used to formulate the questions on the corresponding topic, according to the following guidelines:

(1) To the maximum possible extent, select objectives that require understanding or higher level knowledge.

(2) Objectives should not be used verbatim to formulate questions.

Ideas for questions can be found in the following documentation:

- plant and industry wide significant event reports
- operating manuals and operating memos
- design manuals and other technical basis documents
- plant's safety report
- licensee's and plant's administrative procedures and associated documentation related to plant operation and maintenance

c) Check that each question is within the scope of the knowledge objectives for SSs endorsed by the CNSC.

d) For any question for which specific data from the plant simulator are needed:

i) Obtain the simulation data required to allow completion of the formulation of the question.

ii) Identify the aspects of the data obtained that may be interesting to explore in the question and complete the formulation of the question.

6.2.2 Complete the development of the examination following the instructions given in paragraphs 6.1.2 and 6.1.3.

6.3 General Examinations for RO Candidates or for U0O Candidates

6.3.1 The examination team should design the examination questions in accordance with the following instructions.

a) For each of the topic groups listed in the relevant Guideline G.3 A, B or C, select one or more specific topics for use in the examination and allocate a tentative number of marks to each topic selected such that the total number of marks for the group is within the range indicated beside the group.

b) For each specific topic selected, prepare a first draft of the questions whose answers should be worth the tentative number of marks allocated to the topic, according to the following guidelines:

i) No more than 20% of the examination should be based on questions asked on the last two General Examinations at the plant.

ii) To the maximum possible extent, prepare questions that measure integrated understanding or higher level knowledge required by ROs or by U0Os to perform their job competently.

iii) Select the individual parts of the relevant knowledge objectives in science fundamentals and equipment principles endorsed by the CNSC that will be used to formulate the questions on the corresponding topic, according to the following guidelines:

(1) To the maximum possible extent, select objectives that require understanding or higher level knowledge.

(2) Objectives should not be used verbatim to formulate questions.

Ideas for questions can be found in the following documentation:

- plant and industry wide significant event reports
- operating manuals and operating memos
- design manuals and other technical basis documents
- plant's safety report

6.3.2 Verify that each question is operationally focused.

6.3.3 Complete the development of the examination following the instructions given in paragraphs 6.1.2 and 6.1.3.

6.4 Station Specific Examinations for U0O Candidates

6.4.1 The examination team should design the examination questions in accordance with the following instructions.

a) For each group of topics listed in Guideline G.4 A, select one or more specific topics for use in the examination. Allocate a tentative number of marks to each selected topic such that the total number of marks for the group is within the range indicated beside the group.

b) For each topic selected in a), select from Guideline G.4 B one or more knowledge groups to be used for designing the corresponding examination questions and, using an Examination Design Matrix (EDM) that outlines the topic groups vertically and the knowledge groups horizontally, distribute in the matrix the tentative number of marks for the topic among the knowledge area(s) selected. Ensure that the total marks allocated to the various knowledge groups are within the range indicated beside the group in Guideline G.4 B.

c) For each cell of the EDM where marks are indicated, prepare a first draft of the questions whose answers should be worth the marks indicated in the cell, according to the following guidelines:

i) No more than 20% of the examination should be based on questions asked on the last two Station Specific Examinations at the plant.

ii) To the maximum possible extent, prepare questions that measure integrated understanding or higher level knowledge required by U0Os to perform their job competently.

iii) When a cell is associated with GSSKOs or with radiation protection knowledge objectives, select the individual parts of the relevant objectives that will be used to formulate the questions on the corresponding topic, according to the following guidelines:

(1) To the maximum possible extent, select GSSKOs according to Guideline G.4 D.

(2) Avoid repeated use of the same objective in any knowledge group for different topics.

(3) Objectives should not be used verbatim to formulate questions.

Ideas for questions can be found in the following documentation:

- plant and industry wide significant event reports
- operating manuals and operating memos
- design manuals and other technical basis documents
- plant's safety report
- licensee's and plant's administrative procedures and associated documentation related to plant operation and maintenance

d) Verify that each question on plant systems and procedures is within the scope of the applicable GSSKOs, or of the plant-specific knowledge objectives derived from them.

e) For any question for which specific data from the plant simulator are needed:

i) Obtain the simulation data required to allow completion of the formulation of the question.

ii) Identify the aspects of the data obtained that may be interesting to explore in the question and complete the formulation of the question.

6.4.2 Complete the development of the examination following the instructions given in paragraphs 6.1.2 and 6.1.3.

7 Conduct of Examinations

Knowledge-based certification examinations are normally written examinations. Supplementary Station Specific Examinations for SS candidates may be conducted orally at those plants that have obtained CNSC concurrence to do so. Under exceptional circumstances, the Training Manager may request CNSC concurrence to conduct other certification examinations orally with one or more candidates. The request must be submitted to the CNSC with a justification.

Knowledge-based certifications examinations should be conducted according to:

- subsection 7.1 for written examinations
- subsection 7.2 for oral examinations

7.1 Written Examinations

Written certification examinations should be conducted in accordance with the following requirements and guidelines.

7.1.1 The licensee should provide a single location for writing an examination. This location should be such as to prevent contact between candidates and other plant personnel for the duration of the examination.

7.1.2 Candidates must not have access to any reference material other than the material given with the examination.

7.1.3 There must be an invigilator in each examination room at all times.

7.1.4 During the conduct of an examination, one member of the examination team should be available to address any request for clarification of examination questions made by the candidates.

7.1.5 Examinations must be invigilated in accordance with the instructions on the *Written Certification Examination Invigilation Form* shown in Appendix A.9. The data on the examination, and the names and identification numbers of the candidates should be entered in the form before the day of the examination.

7.1.6 Candidates should be seated one per table with sufficient spacing between them to ensure confidentiality of the examination. The spacing allowed should take into account the need to manipulate reference material.

7.1.7 The licensee should supply lined paper for the candidates' use. This paper should be distributed to the candidates by the invigilators a few minutes before the start of the examination and no notes may be made on this paper before the start of the examination.

7.1.8 During an examination, candidates can only have in their possession the examination paper with its attached reference material, the answer booklets and the following articles: pens, pencils, highlighters, erasers, a ruler, a magnifying glass and a non-programmable calculator.

7.1.9 No extension to the time allocated to write an examination shall be allowed.

7.2 Oral Examinations

7.2.1 Conditions and Requirements for Conducting Examinations Orally

Oral certification examinations should be conducted in accordance with the following requirements and guidelines.

7.2.1.1 The licensee should provide a room at the plant or at the plant training department that ensures confidentiality of the examination.

7.2.1.2 The licensee must provide a system capable of recording clearly the questions of the examiners and the answers of a candidate during the examination.

7.2.1.3 Candidates must not have access to any reference material other than the material given with the examination. If the examination is conducted in the control room at the plant simulator, candidates must not have access to any information on the control panels or to any documentation available in the control room that is not specified in the approved examination questions.

7.2.1.4 During an examination:

a) Candidates can only have in their possession the examination questions with their attached reference material, paper supplied by the examiners for the candidates' use and the following articles: pens, pencils, highlighters, erasers, a ruler, a magnifying glass and a non-programmable calculator.

b) The only persons allowed in the examination room are the candidate, the examiners, the Training Manager and a person who operates the recording system.

c) Candidates may voluntarily withdraw at any time. Such an action automatically results in a fail result.

7.2.1.5 No extension to the time allocated to take an examination shall be allowed.

7.2.2 Preparation for the Conduct of an Oral Examination

The lead examiner should prepare for the conduct of an oral examination in accordance with the instructions below.

7.2.2.1 Confirm that a suitable examination room and recording system will be available for the duration of the examination.

7.2.2.2 Confirm that all the examination material required to conduct the examination is available.

7.2.2.3 At a convenient time before the examination:

a) Brief the candidates and, if applicable, the operator of the recording system on the main characteristics of the examination and on the rules they must abide by. Appendix A.10 is provided to assist the lead examiner in this briefing.

b) Review with the candidates the intent of the security agreement shown in Appendix A.1, Part B and the consequences of violating its terms. If applicable, perform a similar review of the relevant security agreement in Appendix A.1 with the operator of the recording system.

c) Ensure that each person signs or has signed a copy of the relevant agreement and collect the signed agreements for filing.

7.2.3 Conduct of an Oral Examination

The examination team should conduct an oral examination in accordance with the instructions below.

7.2.3.1 Before allowing a candidate in the examination room, ensure that the recording system:

a) is ready for recording the questions of the examiners and the answers of the candidate;

b) is loaded with a tape or disc labelled with the name of the candidate and the examination title and date.

7.2.3.2 Let a candidate in the examination room.

7.2.3.3 Start the recording system or instruct the operator of the system to start it.

7.2.3.4 Briefly describe the examination, giving the total number of questions, and inform the candidate of the following facts:

a) In each question, the key words that indicate the degree of development required in the answer are typed in bold and underlined to help you to give a complete answer.

b) The marks allocated to each question appear at the left of the question number.

c) The estimated time to answer each part of a question and the number of elements in the answer appear to the left of the letter designating the question part.

d) When flowsheets, diagrams or procedures are provided for reference, the specific devices that are included in the answer must be identified by their complete identification code or by an equivalent oral description.

7.2.3.5 Give a copy of one examination question to the candidate and read it out. Give the candidate clarifications on the question, if required.

7.2.3.6 Allow the candidate sufficient time to formulate an answer and to make notes, if the candidate so desires.

7.2.3.7 Record the answers of the candidate on your copy of the marking guide, without interrupting the candidate. Note any significant misconception shown or error made by the candidate for follow-up.

7.2.3.8 If it appears that the candidate has missed or misunderstood one aspect of the question, rephrase the question, being careful not to give hints on the answer, to determine if the answer given accurately reflects the candidate's knowledge of the subject.

7.2.3.9 Ask the candidate additional questions, if necessary, to determine the extent of the knowledge deficiencies shown or to obtain clarification of a particular point made by the candidate.

a) If necessary, summarize the answers given by the candidate before asking these questions.

b) Record your areas of concerns and any significant misconception shown or error made by the candidate in your marking guide.

7.2.3.10 Repeat steps 7.2.3.5 to 7.2.3.9 for each question on the examination.

7.2.3.11 At the end of the examination, collect all material used by the candidate, instruct the candidate to leave the examination room and stop the recording.

7.2.3.12 Gather the labelled tape or disc. If applicable, remove the tabs on each tape to prevent accidental erasure of the recording.

7.2.3.13 Store the labelled tape or disc and the two marked-up marking guides securely.

7.2.3.14 Repeat steps 7.2.3.1 to 7.2.3.13 for each of the remaining candidates.

8 Marking of Examinations

Examinations should be marked as soon as practicable. The Training Manager should designate the examiners who will perform the first and the second marking. For an oral examination, the marking must be done by the examiners who conducted the examination.

The examinations are marked according to:

- subsection 8.1 for written examinations
- subsection 8.2 for oral examinations

8.1 Written Examinations

To ensure independence between the first and the second marking of a written examination, the second marker should not have access to the results of the first marking until the second marking has been completed.

8.1.1 First Marking

A first marker should grade the candidates' answers in accordance with the following instructions.

8.1.1.1 Use a new copy of the approved marking guide for each candidate. On the cover page, enter the name and employee number of the candidate and your name.

8.1.1.2 Grade the answer of all candidates to a given question before proceeding to grade the next question.

8.1.1.3 Grade an answer by checking in the candidate's marking guide the answer elements mentioned in the candidate's answer booklets.

8.1.1.4 Record in the candidate's marking guide, immediately following the answer to which they belong:

a) misconceptions or errors;

b) deficiencies in the answer which are not, or not sufficiently, accounted for by the marking guide;

c) any relevant information in the answer that is not included in the marking guide.

8.1.1.5 Once grading of a question is completed, record in an examination comments file:

a) any perceived difficulty encountered by a number of candidates with the question, as indicated by answers that are consistently incomplete or different from the answer in the marking guide;

b) any recommendation for changes to the answer in the approved marking guide that you consider necessary before the marking guide is authorized.

8.1.1.6 Once the first marking is completed:

a) Review the answers of each candidate to determine whether credit may be given for an answer element not mentioned explicitly in a candidate's answer to a question because you conclude from an answer to a related question that the candidate has this knowledge. Document your reasons for giving such credits in the candidate's marking guide.

b) Calculate the scores obtained by each candidate.

c) Determine the significance of misconceptions, errors and deficiencies recorded in each candidate's marking guide. Document your conclusions in the marking guide.

8.1.1.7 Assign a pass result if a candidate scores at least 60% in the examination, with at least 50% in each question, and no significant misconception, error or deficiency was detected.

8.1.1.8 Assign a fail result if a candidate scores less than 60% in the examination.

8.1.1.9 When a candidate does not meet the pass or fail criteria above:

a) Review the answers for which the candidate scored less than 50% as well as the misconceptions, errors and deficiencies recorded in the candidate's marking guide to determine the significance and extent of knowledge deficiencies shown by the candidate. Document your conclusions at the end of the candidate's marking guide.

b) Recommend a pass or fail result according to the following guidelines and justify your recommendation at the end of the candidate's marking guide:

i) Recommend a pass result if the knowledge deficiencies shown by the candidate are, in your judgement, not significant or extensive enough to warrant formal remedial training.

ii) Recommend a conditional pass result if the candidate has shown knowledge deficiencies that are, in your judgement, significant enough to warrant formal remedial training, but not extensive enough to warrant a fail result. The recommendation should include a list of the knowledge deficiencies that warrant remedial training. **Normally, candidates who score less than 50% on a number of questions that are worth more than 25% of the examination should not be considered for a conditional pass.**

iii) Recommend a fail result if the candidate has shown knowledge deficiencies that are, in your judgement, serious enough to warrant such a result.

8.1.1.10 Enter on the cover page of each candidate's marking guide the marks obtained by the candidate in percent and your recommended examination result.

8.1.1.11 Complete an Examination Result Form similar to that shown in Appendix A.11 for each candidate.

8.1.1.12 Identify the candidates who should undergo a second marking.

8.1.1.13 Sign the candidate's marking guides on the cover page.

8.1.1.14 Forward the marking guides, the Examination Result Forms and your examination comments file to the Training Manager for consideration.

8.1.2 Second Marking

8.1.2.1 The Training Manager should select candidates for a second marking according to the following criteria:

- Candidates with a score in the range from 57 to 63%
- Candidates for whom the first marker recommends a conditional pass
- Candidates who do not meet the fail criterion in paragraph 8.1.1.8, but for whom the first marker recommends a fail result
- Other candidates for whom the first marker recommends a second marking
- Other candidates at the discretion of the Training Manager

At least one of the candidates graded by each examiner performing the first marking must be selected for a second marking.

8.1.2.2 The second marker should grade the answer booklets of the selected candidates in accordance with the instructions for first marking given in paragraphs 8.1.1.1 through 8.1.1.14, except paragraph 8.1.1.12.

8.1.3 Reconciliation of the Results of the First and Second Markings

The examiners who have performed the first and the second marking should meet to discuss their results and to resolve any discrepancy between their two markings and recommendations. They should resolve those discrepancies in accordance with the following instructions.

8.1.3.1 Use a new copy of the approved marking guide for each candidate selected for second marking. On the cover page, enter the name and employee number of the candidate and your names.

8.1.3.2 Grade the complete examination of one candidate at a time.

8.1.3.3 Grade each answer by checking in the new copy of the candidate's marking guide the answer elements for which the markers gave credit in their respective marking guide. Whenever an answer element has been credited by only one of the markers:

a) Refer to the candidate's answer to determine whether credit is justified.

b) If the markers concur that credit is justified, check that element in the marking guide. In case of disagreement, record that element for subsequent discussion with the Training Manager.

8.1.3.4 Document in the new marking guide the misconceptions, errors, deficiencies and relevant additional information in the candidate's answers agreed upon by the markers. Record these in the candidate's marking guide, immediately following the answer to which they belong. Record any persisting disagreement for subsequent discussion with the Training Manager.

8.1.3.5 After completion of the above instructions for all candidates:

a) Review your respective examination comments file and make joint recommendations for changes to the approved marking guide that you consider necessary before the marking guide is authorized.

b) Add to the approved marking guide any comment that may help in preparing future examinations.

c) If you have recommendations for changes to the approved marking guide or if you have persisting disagreements, meet with the Training Manager to discuss them.

d) If the Training Manager decides that changes to the approved marking guide are warranted, make the required changes to the marking guide.

8.1.3.6 Once the Training Manager has authorized the marking guide, make any required change to the reconciled marking guide of the candidates and complete the grading and reconciliation.

8.1.3.7 For each candidate:

a) Calculate the scores obtained by the candidate.

b) Compare the recommendations made by each marker regarding the results of the candidates and formulate final recommendations with a documented justification. Document any persisting disagreement on the proposed result of a candidate at the end of the candidate's reconciled marking guide for subsequent discussion with the Training Manager.

8.1.3.8 If significant changes to the approved marking guide were authorized, assess the impact that these changes might have on the results of the candidates who were not selected for a second marking.

8.1.3.9 Meet with the Training Manager to discuss your recommendations on the candidates' results and, if applicable, the impact that authorized changes to the approved marking guide might have on the results of the candidates who were not selected for a second marking. Seek resolution of any persisting disagreement.

8.1.3.10 Complete any further work requested by the Training Manager to finalize your recommendations of examination results and revise the candidates' reconciled marking guides accordingly.

8.1.3.11 For each candidate impacted by the reconciliation process:

a) Enter on the cover page of the reconciled marking guide the marks obtained by the candidate in percent and your joint recommendation of examination result.

b) Sign the reconciled marking guides on the cover page.

c) Complete an Examination Result Form similar to that shown in Appendix A.11.

d) Forward the reconciled marking guides and the corresponding Examination Result Forms to the Training Manager for authorization.

8.1.3.12 Draft a report to notify the Training Manager of any significant deficiency in the plant's training program found during marking of the examination.

8.2 Oral Examinations

To ensure consistency of marking among candidates, the first marking should not begin until the examination has been conducted with all candidates.

8.2.1 First Marking

The first marker should grade the candidates' answers in accordance with the following instructions.

8.2.1.1 Obtain the data collected during the examination.

8.2.1.2 Use a new copy of the approved marking guide for each candidate to consolidate all the information collected during the examination. On the cover page, enter the name and employee number of the candidate and your name.

8.2.1.3 Grade the answer of all candidates to a given question before proceeding to grade the next question.

8.2.1.4 When grading an answer:

a) Check in the candidate's marking guide the answer elements for which both examiners gave credit in their respective marking guide.

b) Whenever an answer element has not been credited or been credited by one examiner only, refer to the recorded answer to determine whether the credit is warranted.

8.2.1.5 Record in the candidate's marking guide, immediately following the answer to which they belong:

a) misconceptions or errors;

b) deficiencies in the answer which are not, or not sufficiently, accounted for by the marking guide;

c) any relevant information in the answer that is not included in the marking guide.

Refer to the candidate's marking guides used during the examination and to the recorded answer to confirm that misconceptions and errors are accurately described.

8.2.1.6 Once grading of a question is completed, record in an examination comments file:

a) any perceived difficulty encountered by a number of candidates with the question, as indicated by answers that are consistently incomplete or different from the answer in the marking guide;

b) any recommendation for changes to the answer in the approved marking guide that you consider necessary before the marking guide is authorized.

8.2.1.7 Once the first marking is completed:

a) Calculate the scores obtained by each candidate.

b) Determine the significance of misconceptions, errors and deficiencies recorded in each candidate's marking guide. Document your conclusions in the marking guide.

c) Determine the result of each candidate as per the instruction in paragraphs 8.1.1.7 through 8.1.1.9.

d) Enter on the cover page of each candidate's marking guide the marks obtained by the candidate in percent and your recommended examination result.

e) Complete an Examination Result Form similar to that shown in Appendix A.11 for each candidate.

8.2.1.8 Identify the candidates who should undergo a second marking and document in the candidates' marking guides, immediately following the answer to which they apply, any specific item that should be reviewed by the second marker.

8.2.1.9 Sign the candidate's marking guides on the cover page.

8.2.1.10 Forward the consolidated marking guides, the Examination Result Forms and your examination comments file to the Training Manager for consideration.

8.2.2 Second Marking

The second marking is performed by the member of the examination team who has not performed the first marking. The Training Manager should select candidates for a second marking according to the following criteria:

- Candidates with a score in the range from 57 to 63%
- Candidates for whom the first marker recommends a conditional pass
- Candidates who do not meet the fail criterion in paragraph 8.1.1.8, but for whom the first marker recommends a fail result
- Other candidates for whom the first marker recommends a second marking
- Other candidates at the discretion of the Training Manager

At least one candidate must be selected for a second marking.

The second marker should grade the selected candidates in accordance with the following instructions.

8.2.2.1 Obtain the examination comments file produced during the first marking. Also obtain the consolidated marking guides and the Examination Result Forms of the selected candidates. Enter your name on the cover page of each consolidated marking guide.

8.2.2.2 Grade the complete examination of one candidate at a time.

8.2.2.3 For each candidate:

a) Review in the consolidated marking guide of the candidate those specific items identified by the first marker.

i) Refer, as required, to the recorded answer of the candidate and to the candidate's marking guide you used during the examination to make your assessment.

ii) Make the changes to the crediting of answer elements that you consider necessary. Highlight these changes for subsequent discussion with the first marker.

b) Review the areas of concern, misconceptions and relevant additional information in the candidate's answers documented by the first marker for accuracy and completeness.

c) Make the changes you consider necessary to the comments of the first marker in the consolidated marking guide of the candidate. Highlight these changes for subsequent discussion with the first marker.

d) Calculate the scores obtained by the candidate.

e) Determine the result of the candidate as per the instruction in paragraphs 8.1.1.7 through 8.1.1.9. When a candidate does not meet either of the pass or fail criteria in paragraphs 8.1.1.7 and 8.1.1.8, make the changes you consider necessary to the recommendation of the first marker documented at the end of the candidate's marking guide and highlight these changes for subsequent discussion with the first marker.

f) Enter your name on the candidate's Examination Result Form and make the changes you consider necessary to the form. Highlight these changes for subsequent discussion with the first marker and sign the result form.

g) Sign the revised consolidated marking guide of the candidate on the cover page.

8.2.2.4 At the completion of the second marking, review the examination comments file produced during first marking and make the changes that you consider necessary to the comments and recommendations of the first marker. Highlight these changes for subsequent discussion with the first marker.

8.2.2.5 Forward the revised consolidated marking guides, the corresponding Examination Result Forms and the revised examination comments file to the Training Manager for consideration.

8.2.3 Reconciliation of the Results of the First and Second Markings

The examiners who have performed the first and the second marking should meet to discuss their results and to resolve any discrepancy between their two markings and recommendations. They should resolve those discrepancies in accordance with the following instructions.

8.2.3.1 Review the complete examination of one candidate at a time.

8.2.3.2 For each candidate, discuss the changes to the crediting of answer elements and to the comments of the first marker highlighted by the second marker in the candidate's consolidated marking guide. Refer as required to the recorded answers of the candidate to reach a conclusion on the need for the changes.

a) Whenever the first marker agrees with a change proposed by the second marker, record the final position in the marking guide of the candidate.

b) Whenever the first marker disagrees with a change proposed, record the disagreement for subsequent discussion with the Training Manager.

8.2.3.3 After completion of the above instructions for all candidates:

a) Review the revised examination comments file and make joint recommendations for changes to the approved marking guide that you consider necessary before the marking guide is authorized.

b) Add to the approved marking guide any comment that may help in preparing future examinations.

c) If you have recommendations for changes to the approved marking guide or if you have persisting disagreements, meet with the Training Manager to discuss them.

d) If the Training Manager decides that changes to the approved marking guide are warranted, make the required changes to the marking guide.

8.2.3.4 Once the Training Manager has authorized the marking guide, make any required change to the reconciled marking guides and complete the grading and reconciliation.

8.2.3.5 For each candidate:

a) Calculate the scores obtained by the candidate.

b) Compare your recommendations regarding the results of the candidates and formulate final recommendations with a documented justification. Document any persisting disagreement on the proposed result of a candidate at the end of the candidate's reconciled marking guide for subsequent discussion with the Training Manager.

8.2.3.6 If significant changes to the approved marking guide were authorized, assess the impact that these changes might have on the results of the candidates who were not selected for a second marking.

8.2.3.7 Meet with the Training Manager to discuss your recommendations on the candidates' results and, if applicable, the impact that authorized changes to the approved marking guide might have on the results of the candidates who where not selected for a second marking. Seek resolution of any persisting disagreement.

8.2.3.8 Complete any further work requested by the Training Manager to finalize your recommendations of examination results and revise the candidates' reconciled marking guides accordingly.

8.2.3.9 For each candidate impacted by the reconciliation process:

a) Enter on the cover page of the reconciled marking guide the marks obtained by the candidate in percent and your joint recommendation of examination result.

b) Sign the reconciled marking guides on the cover page.

c) Finalise the Examination Result Form and sign the form.

d) Forward the reconciled marking guides and the corresponding Examination Result Forms to the Training Manager for authorization.

8.2.3.10 Draft a report to notify the Training Manager of any significant deficiency in the plant's training found during the conduct and the marking of the examination.

9 Examination Follow-up

After authorizing the results of an examination, the Training Manager must ensure that a copy of the examination and of its authorized marking guide is sent to the CNSC and that the CNSC is formally notified of the results of each candidate.

10 Clearance of a Conditional Pass Result

A candidate who has received a conditional pass result in an examination must complete appropriate training to correct the knowledge deficiencies revealed by the examination.

The licensee should follow the following process for clearing a conditional pass status in a knowledge-based examination.

10.1 Determine and document the extent of the candidate's knowledge deficiencies in each area where remedial training is required as specified in the examination result report.

10.2 Prepare, document and implement a remedial training program for the candidate to correct all knowledge weaknesses identified in paragraph 10.1. This training program should be approved by the Training Manager prior to its implementation.

10.3 Prepare an examination that meets the following criteria:

a) The examination is a written examination unless the certification examination for which the candidate received a conditional pass result was an oral examination.

b) The examination allows a meaningful sampling of the knowledge required by the candidate in each area where remedial training is required.

c) The examination includes, but is not limited to, the questions of the certification examination related to the areas where remedial training is required as specified in the candidate's examination result report.

d) The level of difficulty of each question is appropriate to determine whether the candidate has sufficient understanding of the subject covered by the question.

e) Each questions is clear, technically accurate and contains all the information necessary to give the required answer.

f) The questions clearly identify any reference material given to the candidate and give appropriate instructions for its use.

g) No reference material is given with any question that covers an area that the candidate has to know from memory.

h) The marking guide contains clear and detailed answers for all questions and sub-questions. Specifically, the answers:

   i) contain only information specifically requested by the questions;

   ii) are complete and technically accurate;

   iii) reflect the level of knowledge that the candidate is expected to have on the topics examined;

   iv) do not conflict with the information contained in the current training and plant's documentation;

   v) are broken into elements used to determine the number of marks assigned to the questions.

i) For each question, the marking guide references the corresponding knowledge objectives and the training or plant's documentation where the answer elements can be found.

j) The pass mark for the examination is 70%.

k) The examination is sufficient to clearly demonstrate that the candidate has achieved the required level of knowledge in each area covered by the remedial training program.

l) The examination and its marking guide are prepared by a qualified examiner, independently verified by a second qualified examiner and approved by the Training Manager.

10.4 At the completion of the remedial training, administer the examination to the candidate.

10.5 Mark the candidate's answers in accordance with the relevant instructions for first marking of an examination in subsections 8.1.1 or 8.2.1.

a) A pass result should be recommended to the Training Manager if the candidate scores at least 70% and the examiner is satisfied that no significant concern remains in the areas covered by the remedial training program.

b) A fail grade should be recommended if the candidate scores less than 70% or if the examiner concludes that significant concerns remain in the areas covered by the remedial training program.

10.6 If the candidate receives a fail result in the examination, the candidate must complete additional remedial training and another examination, based on an analysis of the cause of the failure, until no significant concern remains.

10.7 After endorsing a recommendation for a pass result, the Training Manager must ensure that the CNSC is formally notified of the examination result.

A.1 Security Agreements for Certification Examinations

Part A – Examiners and Examination Support Staff

Any person working on a regular basis in the development and conduct of certification examinations, either as an examiner or as examination support staff, must sign this agreement only once, when first being given those responsibilities.

Until I have been notified that the security of a certification examination is no longer an issue, I will not knowingly reveal any information related in any way to the content of the examination to any person other than:

- the examiners participating in the development and conduct of the examination
- any other person who has signed this security agreement or a security agreement for that examination

Discussions on a certification examination with any of these persons must take place in a secure environment to prevent compromising the security of the examination.

Once I have started working on the development of an examination or once I have any information on the content of the examination, I will no longer participate in the instruction of, or give training feedback to, the candidates scheduled to take that examination until all of them have completed the examination.

I am aware of the physical, electronic and administrative measures and requirements that are in place to prevent compromising the security of certification examinations.

I will immediately report to the lead examiner or to Training Manager any indication or suspicion that the security of an examination may have been compromised.

I understand that violation of the terms of this agreement may result in an examination being cancelled.

_____	_____	_____
Name	Signature	Date
_____	_____	_____
Name	Signature	Date
_____	_____	_____
Name	Signature	Date
_____	_____	_____
Name	Signature	Date

Part B: Candidates Taking an Oral or a Simulator-based Examination

This agreement must be signed by the candidates who are scheduled to take a given oral or simulator-based examination.

To the best of my knowledge, I have not received any information related in any way to the content of:

<Insert certification examination identifier>

that I am about to take.

Until I have been notified that this agreement has been rescinded, I will not knowingly reveal any information related in any way to the content of this certification examination to any person other than the examiners participating in the conduct of the examination. I understand that discussions on this examination with examiners must take place in a secure environment to prevent compromising the security of the examination.

I will immediately report to the lead examiner or to the Training Manager any indication or suspicion that the security of the examination may have been compromised.

I understand that violation of the terms of this agreement may result in the examination being cancelled.

_____	_____	_____
Name	Signature	Date
_____	_____	_____
Name	Signature	Date
_____	_____	_____
Name	Signature	Date
_____	_____	_____
Name	Signature	Date
_____	_____	_____
Name	Signature	Date
_____	_____	_____
Name	Signature	Date

Part C – Others

This agreement must be signed by any person who participates in the development and conduct of a given certification examination, other than persons employed on a regular basis as examiners and examination support staff, and other than the candidates scheduled to take the examination.

Until I have been notified that this agreement has been rescinded, I will not knowingly reveal any information related in any way to the content of:

<Insert certification examination identifier>

to any person other than:

- the examiners participating in the development and conduct of the examination;
- any other person whose name and signature appear below.

Discussions on this certification examination with any of these persons must take place in a secure environment to prevent compromising the security of the examination.

Once I have started working on the development of the examination or once I have any information on its content, I will no longer participate in the instruction of, or give training feedback to, the candidates scheduled to take that examination until all of them have completed the examination.

I am aware of the physical, electronic and administrative measures and requirements, applicable to my role in the examination, that are in place to prevent compromising the security of certification examinations.

I will immediately report to the lead examiner or to the Training Manager any indication or suspicion that the security of the examination may have been compromised.

I understand that violation of the terms of this agreement may result in the examination being cancelled.

Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date

A.2 Briefing of the Examination Team

The purpose of this briefing by the lead examiner is to review with the members of the examination team, before the development of the examination begins, their responsibilities and the rules they must abide by.

A) Responsibilities

a) To participate in the development and marking of the examination.

b) For an oral examination, to participate in the conduct of the examination.

c) To operate the plant full scope simulator to obtain the data necessary to develop examination questions and answers when required.

d) To record significant deficiencies in the plant's documentation found during the development of the examination.

e) To record significant deficiencies in the plant's training documentation and training program found during the examination process.

B) Rules of Conduct

a) Examination team members must control copies of all documents, personal notes and data related to the examination that may compromise its security. They must be careful not to leave examination material unsecured or unattended at any time, particularly when using copying machines in public areas.

b) Examination team members must prevent unauthorized access to the plant simulator when it is being used for the development of the examination and reset the simulator to a configuration which does not reveal the content of the examination before releasing the simulator for other uses.

A.3 Guidelines for Allocation of Marks and Time Versus Number of Answer Elements

General Examinations				Specific Examinations		
Elements	**Marks**	**Minutes**		**Elements**	**Marks**	**Minutes**
1	1	1		1	1	1
2	1	1		2	1	2
3	1	2		3	1	2
4	2	3		4	1	3
5	2	4		5	2	4
6	2	4		6	2	5
7	3	5		7	2	6
8	3	6		8	3	6
9	4	6		9	3	7
10	4	7		10	3	8
11	4	8		11	4	9
12	5	9		12	4	10
13	5	9		13	4	10
14	6	10		14	5	11
15	6	11		15	5	12
16	6	12		16	5	13
17	7	12		17	6	14
18	7	13		18	6	14
19	8	14		19	6	15
20	8	14		20	7	16
21	8	15		21	7	17
22	9	16		22	7	18
23	9	17		23	8	18
24	10	17		24	8	19
25	10	18		25	8	20
26	10	19		26	9	21
27	11	19		27	9	22
28	11	20		28	9	22
29	12	21		29	10	23
30	12	22		30	10	24
31	12	22		31	10	25
32	13	23		32	11	26
33	13	24		33	11	26
34	14	24		34	11	27
35	14	25		35	12	28
36	14	26		36	12	29
37	15	27		37	12	30
38	15	27		38	13	30
39	16	28		39	13	31
40	16	29		40	13	32

A.4 Examination Cover Page and Related Information

File:

Certification Examination

[Title of the Examination]
[Position]
[Station]
[Date]

Total: [number] marks
Time Limit: [number] hours
(Estimated required time: [number] hours)

Approved by: _____ _____
[Name] **Date**
Training Manager

Total Marks and Times for the Various Certification Examinations

Certification Examination	Total Marks	Time Limit	Estimated Required Time
General Examination			
• for RO Candidates	100	4h	3h
• for U0 Candidates	75	3h	2.25h
Station Specific Examination			
• for RO Candidates	100	5h	4h
• for U0 Candidates	75	4h	3h
Supplementary Station Specific Examination for SS Candidates			
• at Darlington	80	4.5h	3.2h
• at Bruce Plants	70	4h	2.8h
• at Other Plants	50	3h	2h

A.5 Examination Question Format

The format of an examination question is illustrated below by an example taken from a Station Specific Examination.

11 marks 3. Pages 15 to 43 of the following Operating Manual procedure are provided for your reference:

O.M. 1-09110-4.1 Moderator Pump up and Approach to Critical with Start-up Instrumentation Not in service.

a) See box 1.1 of section 4.1.1, page 18.

Explain why it is necessary to ensure that each of the following prerequisites has been met:

2 min. (3 elements) i) ensure moderator purification is valved out;

6 min. (8 elements) ii) ensure that heat transport and moderator systems meet the following specifications for isotopic:

- Heat Transport D_20 isotopic Spec is > 97.5% wt% D_20,
- Moderator D_20 isotopic Spec is >99.8% wt% D_20 and,
- Moderator D_20 isotopic is 0.5% above the HT isotopic.

6 min. (7 elements) b) i) See box 2.3.1, step 2 and the adjacent side bar on page 29.

Explain why indicated power decreases initially and then subsequently increases as moderator level is raised.

2 min. (3 elements) ii) See the third sidebar beside step 2.4.1 on page 35.

Explain why "it is more important that Average Zone Level (AZL) be consistent for each reading than it be 35% exactly".

QUESTION #3 CONTINUED ON NEXT PAGE...

8 min. (10 elements) iii) See box 2.4.1, step 2, on page 35.

Suppose that following a moderator level increase from 5 metres to 5.5 metres, average zone level (AZL) is at 65%.

Explain how AZL is reduced to and set at 35%. **Include** in your answer the response of the Reactor Regulating System (RRS).

2 min. (3 elements) c) The spreadsheet of DATA collected during an Approach to Critical with boron removal, identified by this question number, is provided for your reference.

Referring to the "Final RX power %" column, **state** the power level at which the reactor is considered to be critical.

Also, **explain why** the reactor is considered to be critical at this point.

A.6 Marking Guide Cover Page

File:

MARKING GUIDE

Plant: **Examination Date:**
Examination Title: **Marks:**
Candidate's Name: **Employee Number:**
Examination Result:

Examination Team Members: **[Names]**

Approved by: _____ _____
[Name] **Date**
Training Manager

Marked by: _____ _____
[Name], **[Name],**
First Marker **Second Marker**

Authorized by: _____ _____
[Name] **Date**
Training Manager

Notes:

1. Information that is an alternate way to present part of an element of an answer is included within single brackets, immediately following the information it is equivalent to.
2. Information in an answer element that is only given to assist the markers, but is not part of the required answer, is included within double brackets.
3. Information highlighted in redline and struck out was revised to determine the candidates' final result on the examination.

A.7 Format of a Marking Guide Answer

Q1 5 marks

a) 5 elements

i) The purpose of the unloader is to:

[ ] Protect a turbine-generator ((under adverse conditions)) by limiting its maximum load.

This is done:

[ ] by limiting the governor valve demand signal,
[ ] thereby, limiting the steam flow (limiting turbine load).

Ref.: TM 234-7, p. 4

ii) Unloading in a turbine generating system is initiated by:

[ ] low condenser vacuum (high condenser pressure), and
[ ] low boiler pressure.

Ref.: TM 234-7, p. 4

b) 8 elements

Unloading initiates a runback to prevent:

[ ] turbine load cycling that could occur as follows:

[ ] As a result of the unloading process, the unloading parameter (low condenser vacuum or boiler pressure) could return to an acceptable range, and
[ ] the load restriction imposed by the unloader would be removed.
[ ] This would allow the limit placed on the valve demand signal to be removed,
[ ] allowing the valves to return to the unchanged setpoint.
[ ] The turbine steam flow would increase,
[ ] causing the unloading parameter to again reach an unacceptable value
[ ] and the beginning of another unloading and loading cycle.

Ref.: TM 234-7, p. 4 and 5

A.8 Examination Checklist

Plant: _____ **File:** _____

Examination Title: _____

Examination Date: _____

This checklist is to be completed at the end of the examination development.

[ ] The examination follows the relevant guidelines for mark allocation and total marks.

[ ] No more than 20% of the examination is based on questions asked on the last two examinations of the same type at the plant.

[ ] The level of difficulty of each question is appropriate to discriminate between those candidates who have sufficient understanding of the subject covered by the question and those who do not.

[ ] Each question is clear, technically accurate and contains all the information necessary to give the required answer.

[ ] The parts and subparts of each question are arranged in a logical order, where applicable.

[ ] To the maximum possible extent, the answer to a part of a question is not completely dependent on the answer to a previous part.

[ ] To the maximum possible extent, questions measure integrated understanding or higher level knowledge required by persons in the position for which the examination is intended to perform their job competently.

[ ] The information on the cover page of the examination is similar to that shown in Appendix A.4.

[ ] Each page of the examination contains only one question.

[ ] The stems used in a question are placed immediately before the parts or subparts of the question to which they apply.

[ ] The identification codes of equipment and documents used in the questions are correct.

[ ] Any acronym used in a question is defined the first time it appears in that question.

[ ] The questions clearly identify any reference material given to the candidates and give appropriate instructions for its use.

[ ] No reference material is given for a question that covers an area that the candidates have to know from memory.

[ ] Any instruction or other information in a question quoted from licensee's or plant's documentation appears verbatim.

[ ] In each question, the key words that indicate the degree of development required in the answer are typed in **bold and underlined**.

[ ] The marks allocated to each question appear at the left of the question number.

[ ] The estimated time to answer each part of a question and the number of elements in the answer appear to the left of the letter designating the question part.

[ ] The formatting of the questions is similar to that shown in Appendix A.5.

[ ] The information on the cover page of the marking guide is similar to that shown in Appendix A.6.

[ ] Each answer contains only information specifically asked by the question.

[ ] Each answer is complete and technically accurate.

[ ] Each answer reflects the level of knowledge that candidates are expected to have on the subject covered by the question.

[ ] No answer conflicts with the information contained in the frozen documentation.

[ ] The breakdown of each answer into elements is appropriate.

[ ] Information that is an alternate way to present part of an element of an answer is included within single brackets, immediately following the information it is equivalent to.

[ ] Information in an answer element that is only given to assist the markers, but is not part of the required answer, is included within double brackets.

[ ] The formatting of the answers in the marking guide is similar to that shown in Appendix A.7.

Lead Examiner's Name: _____ _____
printed signature

Training Manager's Name: _____ _____
printed signature

A.9 Certification Examination Invigilation Form

Plant: _____
Examination Title: _____
Date: _____
Time Limit: _____
Starting Time: _____

Candidates' Names	Empl. #	Completion Time	Initials
1. _____	_____	_____	_____
2. _____	_____	_____	_____
3. _____	_____	_____	_____
4. _____	_____	_____	_____
5. _____	_____	_____	_____
6. _____	_____	_____	_____
7. _____	_____	_____	_____
8. _____	_____	_____	_____
9. _____	_____	_____	_____

Instructions for the Invigilators

1. Ensure that the candidates do not have access to any reference material other than the material that will be given to them with the examination.

2. Ensure suitable seating and spacing of the candidates.

3. Ensure that the persons writing the examination are those whose names appear on the above list.

4. Give the candidates a copy of the attached *Rules and Instructions for Candidates Writing Certification Examinations* and review these rules and instructions with them before the start of the examination.

5. Ensure that the candidates do not use unauthorized sources of information such as notes or textbooks.

6. Distribute the examination and the blank answer booklets.

7. Record the starting time of the test.

8. Ensure that the candidates do not obtain assistance during the examination.

9. In the event of a request for clarification of examination questions made by the candidates, contact a member of the examination team to obtain the required answer.

10. Request the candidates to record the time when they return their answer booklets and to initial this form beside their name.

11. Ensure that each answer booklet contains the candidate's full name, employee number, name of the plant, examination title and date of examination.

12. Collect all candidates' answer booklets immediately at the end of the examination.

13. Whenever a candidate does not submit any completed answer booklet, record this fact on this form.

14. Sign the declaration below.

15. Bring the answer booklets and this form to the lead examiner.

Notes:

_____
_____
_____
_____
_____

Declaration

I have invigilated this examination and I have complied with the above instructions.

Name: _____ Name: _____
printed printed

_____ _____
signature signature

Title: _____ Title: _____

Rules and Instructions for Candidates Writing Certification Examinations

1. Cheating during the examination will result in an automatic fail result being assigned to the persons involved.
2. Candidates may voluntarily withdraw at any time during the examination. Such an action automatically results in a fail result.
3. Candidates can only have in their possession the examination paper with its attached reference material, the answer booklets and the following articles: pens, pencils, highlighters, erasers, a ruler, a magnifying glass and a non-programmable calculator.
4. Rest room trips are allowed, but only one candidate at a time may leave. Communication with any person outside the examination room is prohibited.
5. Ensure that your full name, employee number, name of the plant, examination title and date of examination appear on the cover page of each of your answer booklets.
6. Read each question in its entirety before beginning to answer it. If any question is not clear to you, you may ask only the invigilators for clarification.
7. In each question, the key words that indicate the degree of development required in the answer are typed in bold and underlined to help you to give a complete answer.
8. The marks allocated to each question appear at the left of the question number.
9. The estimated time to answer each part of a question and the number of elements in the answer appear to the left of the letter designating the question part.
10. When flowsheets, diagrams or procedures are provided for reference, the specific devices that are included in the answer must be identified by their complete identification code or by an equivalent written description.
11. Leave sufficient space between answers or use separate booklets for different questions.
12. Use the left hand side of the booklets for rough calculations or drafting answers.
13. Use abbreviations and acronyms only if they are commonly used at the plant or after defining them.
14. When you have completed your examination:
    a) Hand in your answer booklets and all required additional material such as marked-up flowsheets, diagrams and procedures. No material will be accepted after you have left the examination room.
    b) Record the time when you return your answer booklets and initial the Certification Examination Invigilation Form beside your name.
    c) Leave the examination room and do not remain in its vicinity.
15. If you have questions on these rules and instructions, ask them before the examination begins.

A.10 Briefing of the Candidates and of the Recording Operator Before an Oral Examination

The purpose of this briefing by the lead examiner before the examination begins is to communicate to the candidates and, if applicable, to the operator of the recording system some general information regarding the examination and to review with them the rules they must abide by.

A) Introduction

The lead examiner covers the following points of general interest:

a) Introduction of the examination team members with a general description of their behaviour during the examination.

b) Overall duration and general characteristics of the examination.

c) General characteristics of the examination process, including the requirement to record the questions of the examiners and the answers of a candidate during the entire examination.

B) Rules of Conduct

a) The only persons allowed in the examination room during the examination are the candidate, the examiners, the Training Manager and, if applicable, the operator of the recording system.

b) Candidates and the operator of the recording system must remain in the examination room until given permission to leave by the lead examiner.

c) Candidates may voluntarily withdraw at any time during the conduct of the examination. Such an action automatically results in a fail result.

d) Candidates must not have access to any reference material other than the material given with the examination.

e) Candidates can only have in their possession the examination questions with their attached reference material, paper supplied by the examiners for the candidates' use and the following articles: pens, pencils, highlighters, erasers, a ruler, a magnifying glass and a non-programmable calculator.

f) Candidates and the operator of the recording system must hand over to the lead examiner all material related to the examination before leaving the examination room.

A.11 Examination Result Form

Candidate's Name: **Employee Number:**
Candidate's Position:
Plant:
Examination Title: **Examination Date:**

Examination Result:

Q#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
Max. Marks																	0.0
Scored Marks																	0.0
Score in %																	0.0

Justification of the Result:

Deficiencies Requiring Remedial Training:
(for a conditional pass only)

Examiners: _____ _____
[Name] **[Name]**

Authorized by: _____ _____
[Name] **Date**

G.1 A: Topic Groups For Station Specific Examinations for RO Candidates

The various topics that may be covered in the station specific examinations have been grouped as shown below to assist in their selection so that each examination contains a balanced mix of topics and that, over a number of examinations, all the knowledge that ROs are required to have on the topics covered is tested. The marks that should be allocated to questions in any topic group are indicated beside the group.

All groups **Marks: 100**

Group 1 **Special Safety Systems** **Marks: 8 ± 2**

a) SDS1 (SDSA at Pickering NGS A), including:
   i) absolute and conditional trip parameters with the reason for their existence, the type of events they protect against, primary and back-up parameters and power dependent trip set points
   ii) interlocks between SDS1 and the reactor regulating system
   iii) impairments
   iv) standard and non-standard operating procedures

b) SDS2 (SDSE at Pickering NGS A), including:
   i) absolute and conditional trip parameters with the reason for their existence, the type of events they protect against, primary and back-up parameters and power dependent trip set points
   ii) interlocks between SDS2 and the reactor regulating system
   iii) impairments
   iv) standard and non-standard operating procedures

c) Emergency core cooling system, including:
   i) related systems and subsystems
   ii) primary and conditioning initiating parameters, with the reasons for their existence
   iii) impairments
   iv) standard and non-standard operating procedures

d) Containment system, including:
   i) related subsystems
   ii) impairments
   iii) standard and non-standard operating procedures

Group 2 **Nuclear Safety** **Marks: 7 ± 2**

a) principles of nuclear safety, including:
   i) defence in depth considerations
   ii) principles of *Control, Cool and Contain* under normal and abnormal reactor operating conditions
   iii) requirements for establishing and maintaining a guaranteed shutdown state
   iv) roles of special safety systems, standby safety support systems and safety related process systems

v) means to achieve and maintain reliability of systems and equipment
vi) protection against common cause failures
vii) availability requirements and testing of safety related systems
viii) purpose, availability requirements and safety implications of different classes of electrical supplies
ix) plant licensing basis, safety analyses and safe operating envelope
x) plant operating licence and Operating Policies and Principles
xi) plant line-up and plant status control
xii) safety culture

b) heat sinks, including response to non-standard operating conditions during reactor unit outages
c) Critical Safety Parameters and their support parameters

Group 3 Emergency Procedures **Marks: 8 ± 2**

AIMs, APOPs, EOPs or equivalent procedures[1]

Group 4 Reactor Core Physics, Core Monitoring, Fuelling and Fuel Handling **Marks: 7 ± 2**

a) normal and abnormal reactivity configurations and flux shapes
b) Channel Power Peaking Factor (CPPF)
c) principles of reactor fuelling, fuelling limitations, fuel handling and storage, and irradiated fuel cooling
d) channel temperature monitoring
e) fully instrumented channels
f) channel power mapping, where applicable
g) flux mapping and ZOTPR, as applicable

Group 5 Reactor Regulating System **Marks: 8 ± 2**

a) RRS program routines
b) stepback routine (Pickering NGS A excepted)
c) adjuster rods
d) control absorber rods (Pickering NGS A excepted)
e) moderator liquid poison systems
f) liquid zone control system

Group 6 Reactor Systems **Marks: 7 ± 2**

a) primary heat transport system, including:
i) pressure and inventory control system
ii) heat transport pump gland seal cooling system
iii) heat transport pump trip system
b) shutdown cooling system (maintenance cooling system at Bruce plants)

---

[1] An incident addressed by an AIM, APOP or EOP at most NPPs may be addressed by a non-standard operating procedure at another plant. When this occurs, the latter procedure is considered as equivalent to an AIM, APOP or EOP for examination purpose.

c) main moderator system
d) moderator level and temperature control systems
e) end shield cooling system

Group 7 Miscellaneous Control Systems **Marks: 7 ± 2**

a) boiler pressure control
b) boiler level control
c) deaerator level control
d) turbine governor
e) general purpose control program or heat transport auxiliaries control program, as applicable

Group 8 Turbine, Steam and Feedwater Systems **Marks: 6 ± 2**

a) condensate systems, including condensate makeup and reject
b) boiler feedwater system
c) shutdown cooling system (at Bruce plants only)
d) boiler steam system, including:
   i) boiler safety valves
   ii) CSDVs and ASDVs (SRVs at Pickering plants)
   iii) main steam balance header
e) turbine steam system, including:
   i) ESVs, GVs, IVs, RVs
   ii) reheater stop valves, where applicable
f) turbine tripping system
g) unit power regulator control program, where applicable
h) turbine run-up and loading control system
i) turbine generator supervisory

Group 9 Main Generator and Power Systems **Marks: 6 ± 2**

a) main generator system
b) generator static excitation
c) station electrical equipment and distribution, including:
   i) electrical protection
   ii) emergency transfer schemes
   iii) emergency power system(s)
d) switchyard electrical equipment and distribution system
e) switchyard compressed air system
f) instrument air systems

Group 10 Reactor Auxiliary Systems **Marks: 6 ± 2**

a) moderator purification system
b) moderator cover gas system
c) HTS storage, transfer and recovery systems,
d) HT purification system
e) HT hydrogen addition system
f) annulus gas system
g) failed fuel detection system, where applicable
h) failed fuel location system, where applicable
i) emergency water supply systems (EWS, BMW)

Group 11 **Turbine, Generator & Boiler Auxiliary Systems** **Marks: 6 ± 2**

a) boiler blowdown
b) turbine gland steam system
c) turbine LP exhaust cooling system
d) condenser air extraction system
e) condenser circulating water system
f) generator hydrogen cooling system
g) generator stator cooling system
h) generator seal oil system
i) turbine-generator lubricating oil system
j) governor fluid supply system
k) extraction steam system
l) feedheater and separator drains system
m) condenser leak detection system

Group 12 **Overall unit operation** **Marks: 8 ± 2**

a) unit start-up procedures, including:
   i) heat transport system refill (Pickering plants excepted)
   ii) approaches to critical
   iii) heat transport system pressurization
   iv) unit heatup
   v) turbine-generator and auxiliaries start-up
   vi) unit loading
b) unit shutdown procedures, including:
   i) unit unloading
   ii) unit cooldown
   iii) heat transport system depressurization
   iv) heat transport system draining (Pickering plants excepted)
   v) turbine-generator and auxiliaries shutdown
   vi) establishment of guaranteed shutdown states
   vii) four unit shutdown at multi-unit plants
c) non-standard operating procedures, including:
   i) response to reactor trip
   ii) response to reactor setback
   iii) response to reactor stepback (Pickering NGS A excepted)
   iv) recovery from a reactor setback or stepback
   v) heat transport pump trip or manual shutdown
   vi) generation rejection and recovery
   vii) turbine trip and recovery
   viii) response to a main generator hydrogen leak or seal failure

Group 13 **Radiation Protection** **Marks: 10 ± 2**

a) emission control
b) radiation emergencies

Refer to Guideline G.1 C for the breakdown of marks in the group.

Group 14 **Miscellaneous** **Marks: 6 ± 1**

a) administrative procedures related to plant operation and maintenance
b) approved work practices
c) work protection
d) access control system
e) radiation monitoring systems
f) other systems not covered in other topic groups

G.1 B: Knowledge Groups for Station Specific Examinations for RO Candidates

The grouping below is intended to ensure that the sampling of topic groups in Guideline G.1 A covers adequately the different knowledge areas addressed by GSSKOs while also allowing sampling of the knowledge areas not explicitly covered by those GSSKOs. The marks that should be allocated to questions in any knowledge group are indicated beside the group. The information contained within brackets for groups A to G refers to the *Generic Station System Knowledge Objectives for Control Room Operators*, dated June 1998. Plants using a different set of generic system knowledge objectives for ROs may refer to the corresponding generic objectives in their set, once the resulting plant-specific learning objectives, developed in accordance with a systematic approach to training, are endorsed by the CNSC.

Group	Knowledge Area	Marks
Group A	System Design (GSSKOs - Part 1)	**9 ± 2**
Group B	Instrumentation and Control (GSSKOs - Part 2, excluding those covered in Group C below)	**13 ± 3**
Group C	Response of Control Loops and Logic Control Circuits (GSSKOs 2.2.3, 2.2.4, 2.2.5 and 2.3.7)	**14 ± 3**
Group D	Monitoring of System Parameters, Operating Procedures and Test Procedures, excluding Emergency Operating Procedures (GSSKOs 3.1, 3.3, 3.4 and 4.1)	**12 ± 3**
Group E	Operating Policies and Principles (GSSKOs 3.2.1 and 4.2) and System Limits and Constraints (GSSKO 3.2.2)	**8 ± 2**
Group F	System Impairments and Heat Sinks (GSSKOs 3.5 and 4.3)	**8 ± 2**
Group G	Emergency Operation (GSSKOs - Part 5)	**9 ± 3**
		73

Areas Not Specifically Addressed by the GSSKOs

Group H	Principles of Nuclear Safety and their application	**6 ± 1**
Group I	Reactor Core Physics, Core Monitoring, Fuelling and Fuel Handling	**7 ± 2**
Group J	Administrative aspects, such as administrative procedures related to plant operation and maintenance, work protection, and roles and responsibilities of operations personnel	**4 ± 1**
Group K	NPP radiation protection knowledge objectives endorsed by the CNSC (refer to Guideline G.1 C)	**10 ± 2**
		27

G.1 C: Radiation Protection Topics in Station Specific Examinations for RO Candidates

The various topics in radiation protection that may be covered, as part of topic group 13 in Guideline G.1 A, are related to the knowledge of those aspects of reactor unit operation, both normal and abnormal, that may result in the discharge of radioactivity to the environment, or that could affect the safety of plant personnel or of members of the public, including:

a) the knowledge required by ROs to deal with all aspects of routine and non-routine radioactive discharges from the plant;

b) the knowledge required by ROs to react to radiological incidents that, if not handled adequately, could result in a radiation emergency;

c) the knowledge of all aspects of radiation emergencies in which the ROs are involved.

Other questions on systems associated with radiation protection, such as the access control system and radiation monitoring systems, may be asked under topic group 14.

Part A: Radiation Protection Topic Subgroups and Knowledge Objectives for Point Lepreau Station Specific Examinations

This guideline specifies the marks that should be allocated to questions in each radiation protection topic subgroup and the knowledge objectives that may be used to formulate questions in each subgroup for station specific examinations for Point Lepreau RO candidates. These objectives may not be comprehensive and questions outside of these specific objectives may be asked if they fall within the bounds of those aspects of plant operation, both normal and abnormal, that may result in the discharge of radioactivity to the environment, or that could affect the safety of plant personnel or of members of the public.

Subgroup A Emission Control **Marks: 5 ± 1**

I. Basic Concepts

Explain what is meant by the following terms:

a) Derived Emission Limits for gaseous wastes

b) Derived Emission Limits for liquid wastes

c) Derived Emission Limits and the associated dose limits for Point Lepreau

d) Critical Group

II. Gaseous Effluents

(a) Ventilation and Vapour Recovery

1. Describe how the following systems control gaseous emissions:
   a) Reactor Building Ventilation System
   b) D_2O Vapour Recovery System
   c) Containment Isolation System
   d) Service Building Ventilation System
2. Explain the reason for the interlocks between the Containment Isolation System and the Reactor Building Ventilation System.
3. Describe how the exhaust filter train of the Reactor Building Ventilation System minimizes the release of airborne radioactivity.
4. Describe the pre-requisites that must be met before performing post-LOCA depressurization of the reactor building. Explain why each pre-requisite must be met.
5. Given the D_2O Vapour Recovery System post-LOCA depressurization procedure, explain why each step or group of steps is required. When specific instructions are stated for execution of a step, explain why it must be executed as specified.
6. Given the D_2O Vapour Recovery System procedure for depressurization following containment box-up, explain why each step or group of steps is required. When specific instructions are stated for execution of a step, explain why it must be executed as specified.
7. Describe the effect of low sampling flow on the containment isolation activity monitors, state the possible reasons for low flow and state the required operator actions in the event of such a low flow condition.
8. Explain the implications of incorrect operation of the containment isolation activity monitors. State the required actions if incorrect operation of these monitors is detected.
9. Describe the expected response of the containment isolation activity monitors to the following operations:
   a) Defuelling a defective bundle
   b) Degassing of the primary heat transport system
   c) Purge of the annulus gas system
   d) Purge of the liquid zone control system
   e) Purge of the moderator cover gas
10. Describe how the operation of the active exhaust filter train of the Service Building Ventilation System minimizes the release of airborne radioactivity.

(b) Gaseous effluent monitoring and sampling

1. List the main sources of gaseous radioactive wastes in the station.
2. Describe the significant radionuclide groups for gaseous effluents and their relative importance during normal operation.

3. Describe the general responsibilities of the SS, the CRO, the Health Physics Department and the Chemistry Department with respect to monitoring and control of gaseous effluents.
4. Explain the significance of isokinetic sampling, plate-out, heat tracing and stack flow as they relate to representative sampling of the contaminated exhaust stack.
5. Describe how the Gaseous Effluent Monitor (GEM) separates and detects the different radionuclides in the sample.
6. Describe how the Noble Gas Spectrometer measures noble gas releases.
7. Describe the typical response of the GEM and the Noble Gas Spectrometer to the following operations:
   a) Defuelling a defective bundle
   b) Degassing of the primary heat transport system
   c) Purge of the annulus gas system
   d) Purge of the liquid zone control system
   e) Purge of the moderator cover gas
8. List the general alarms and indications that are available locally, in the Control Room, in the Control Equipment Room and in the Secondary Control Area.
9. List the indications which may be used to confirm a release of radioactivity.
10. State the main actions required in the event of a GEM high activity alarm. Explain why each action is required.
11. Describe the process by which contaminated waste oil is approved for burning and how this release of radioactivity is added to gaseous effluent records.
12. Explain why laboratory analyses are performed by Health Physics to estimate gaseous releases from stack monitors and samplers.
13. Describe the actions required and the alternative monitoring methods available, if any, in the event of the following:
   a) Failure of a GEM channel that does not affect continuous sampling
   b) Failure of the GEM sampling pump
   c) Failure of the Noble Gas Spectrometer
   d) Failure of the C-14 sampler
14. Describe the effects of abnormal operation of the following on stack monitoring results:
   a) Spent Fuel Bay Ventilation
   b) Reactor Building Ventilation
   c) Vapour Recovery
   d) Upgrader Ventilation
   e) Central Contaminated Exhaust

15. Describe the actions required if air is to be exhausted from any active area not connected to the main exhaust stack. Explain why each action is required.
16. Describe the special monitoring required to measure releases from the turbine as a result of a boiler tube leak.
17. Describe how the stack monitors are used to help determine whether an ALERT or EMERGENCY condition exists.
18. State and explain the limitations of the GEM and Noble Gas Spectrometer during a large release.
19. Given current station operating conditions and an indication that stack releases are abnormally high:
    a) Diagnose the probable source using the stack monitor traces.
    b) State the actions required to confirm the diagnosis.
    c) State any subsequent action in the control room or the field to mitigate the release.

III- Liquid Effluent Monitoring and Sampling

1. List the main sources of liquid radioactive wastes in the station.
2. Describe the general responsibilities of the SS, the CRO, the Health Physics Department and the Chemistry Department with respect to monitoring and control of liquid effluents.
3. Describe the general operating steps for discharging the contents of a liquid waste tank, with specific attention to the analysis and control of releases.
4. Given a sample Liquid Effluent Pump-out Authorization, state whether the liquid effluent discharge may proceed and explain why.
5. For each condition stated on the Liquid Effluent Pump-out Authorization which requires Health Physics approval, explain why this approval is required.
6. Given an indication of high activity in liquid effluents and the required relevant information:
    a) Determine the reason for the indication.
    b) State the actions to prevent further releases.

Subgroup B Radiation Emergencies **Marks: 5 ± 1**

1. Describe the responsibilities and command structure of, and the resources available to, on-site groups.
2. Given a specific scenario, describe the roles and responsibilities of key off-site groups involved in Radiation Contingency Plans. Describe how the SS and the CRO interface with these groups.
3. Given a specific scenario, state any required contingency response, prioritize actions and initiate appropriate response.

4. Define a Radiation ALERT and a Radiation EMERGENCY in terms of the associated actions. Identify the procedure and list the parameters used for categorizing radiation events.
5. Given a specific event, categorize the event as an ALERT or EMERGENCY and state the priority actions to be taken before referring to the Contingency Procedures.
6. Describe how station staff (duty shift and Off-site Emergency Coordinator (OEC)) are organized in response to a Radiation EMERGENCY.
7. Describe the responsibilities of the SS and of the CRO during an on-site radiation contingency. Describe the role of the Response Team Leader.
8. Describe the responsibilities of the OEC Coordinator, OEC Assistant and OEC Liaison.
9. List the key facilities and equipment provided for radiation contingencies.
10. Describe the expected actions of station staff in a Radiation ALERT, Radiation EMERGENCY, and Station Evacuation.
11 List the key agencies involved in the Point Lepreau Off-Site Contingency Plan and state their responsibilities in a Radiation EMERGENCY.
12. a) List the groups under the direction of the New Brunswick Emergency Measures Organization (NBEMO) which will be present at the OEC and which may require information from the OEC Liaison.
    b) Describe the information and resources which must be provided to the groups in a) so that appropriate countermeasures may be applied to protect the public during a Radiation EMERGENCY.
13. Given any of the contingency procedures listed below which the candidate may be required to implement, explain the rationale for any step of the procedure:
    a) EP-29 OEC Coordinator Actions During an ALERT/EMERGENCY
    b) EP-30 OEC Assistant Actions During an ALERT/EMERGENCY
    c) EP-31 OEC Liaison Actions During an ALERT/EMERGENCY
    d) EP-32 Meteorological Data and Plume Prediction
14. Given a specific scenario, state the key actions required of a Response Team Leader as outlined in EP-25 Response Team Action During a Radiation Contingency.
15. Given data from the Meteorological Monitoring System, make an initial prediction of the direction, width and length of a radioactive plume resulting from a release.

Part B: Radiation Protection Topic Subgroups and Knowledge Objectives for Station Specific Examinations at Multi-unit Plants

This guideline specifies the marks that should be allocated to questions in each radiation protection topic subgroup and the knowledge objectives that may be used to formulate questions in each subgroup for station specific examinations for RO candidates at multi-unit plants. These objectives may not be comprehensive and questions outside of these specific objectives may be asked if they fall within the bounds of those aspects of plant operation, both normal and abnormal, that may result in the discharge of radioactivity to the environment, or that could affect the safety of plant personnel or of members of the public.

Subgroup A Emission Control **Marks: 5 ± 1**

I. Basic Concepts

Explain what is meant by the following terms:

a) Derived Emission Limits for gaseous effluents
b) Derived Emission Limits for liquid effluents
c) Derived Emission Limits and associated dose limits for the station
d) Critical group
e) Station Emission Target (SET).
f) Control Monitoring
g) Compliance Monitoring
h) Environmental Monitoring

II. Gaseous Effluents

(a) Airborne Emissions During Emergency Operations

1. State the purpose of the Emergency Filtered Air Discharge System (EFADS).
2. Given that a loss of coolant with fuel failures has occurred:
   a) State when the EFADS system will be poised for service.
   b) List the parameters that can be monitored when the EFADS is in service.
3. State who must be notified before placing the EFADS in service.

(b) Gaseous effluent monitoring and sampling

1. List the sources of airborne emissions.
2. State the categories of airborne emissions and describe how each category is monitored for.
3. State the components of the stack monitoring system.
4. State the actions required if the stack monitoring sampling system becomes unavailable.
5. Describe how ventilation flows are generally set up in the station radioactive areas.
6. State the purposes of the environmental monitoring program.
7. List the various measurements that are taken as part of the environmental monitoring program.

II. Liquid Effluent Monitoring and Sampling

1. List the main activities that would generate active liquid wastes.
2. State the primary route of a liquid emission to the public or the environment.
3. List the main sources of radioactive liquids that enter the Condenser Circulating Water (CCW) System.

4. State the categories of radionuclides monitored in the liquid emissions.
5. Define abnormal liquid emission and abnormal liquid emission limits.
6. State what back up monitoring of liquid emissions exists or must be put into operation if the normal monitoring fails.
7. State the documentation required for a normal and an abnormal release of active liquid wastes.
8. State what notifications are required for an abnormal release of active liquid wastes.
9. State the limitations on the accuracy of liquid effluent monitoring.
10. Describe the radioactive liquid monitoring system from the standpoint of control and compliance monitoring, including the monitoring points, types and frequency of monitoring.

Subgroup B: Radiation Emergencies **Marks: 4 ± 1**

1. List the potential sources of information regarding radiation hazards in the station available to the reactor operator.
2. List the possible radiation hazards that will exist after a LOCA with failed fuel.
3. List the systems or pieces of equipment that could present high radiation fields after a LOCA with fuel failures.
4. Given a work scenario and system conditions on a unit, evaluate a request for a work authorization from the radiation hazard perspective and determine if the work can be performed safely according to ALARA principles. Justify your conclusion.
5. List the categories of unusual radiological conditions.
6. State the responsibilities of the reactor operator in responding to an unusual radiological condition.
7. List the sources of radiological information available from the field that would aid in recognizing an unusual radiological condition.
8. Given a scenario involving an abnormal radiological condition, state the immediate actions required in the field and in the control room. Explain why each action is required.
9. Describe the primary role of the reactor operator in a radiation emergency.
10. Describe the general response of a reactor operator to an alarming Fixed Area Gamma Monitor (FAGM).

G.1 D: List of Recommended GSSKOs for Station Specific Examinations

The numbers below refer to the objectives in the *Generic Station System Knowledge Objectives for Control Room Operators*, dated June 1998. Plants using a different set of generic system knowledge objectives for ROs may refer to the corresponding generic objectives in their set, once the resulting plant-specific learning objectives, developed in accordance with a systematic approach to training, are endorsed by the CNSC.

To the maximum extent possible, the GSSKOs whose numbers are listed below should be selected to formulate examination questions since they represent higher level knowledge objectives. The numbers in bold correspond to the GSSKOs considered to be at the highest cognitive level. Other GSSKOs may also be used if the resulting examination question is sufficiently complex to discriminate between those candidates who have sufficient knowledge to perform their duties competently and those who do not.

PART 1: SYSTEM DESIGN
1.1.2 (i)
1.3.4
1.3.5 (i)

PART 2: INSTRUMENTATION AND CONTROL
2.1.1 (i)
2.1.1 (iii)
2.1.2
2.1.3
2.2.1.1
2.2.1.2
2.2.1.4
2.2.2
2.2.3
2.2.4
2.2.5
2.3.1
2.3.2
2.3.3 (i), except second bullet
2.3.3 (ii)
2.3.6
2.3.7
2.5.1 (ii)
2.5.2, except second bullet of (ii)
2.5.3
2.6.1
2.6.3

PART 3: OPERATIONAL ASPECTS
3.1.1 (vi)
3.2.1
3.2.2
3.3.1, except (vii)
3.3.2
3.4 (ii), (iii), (iv) and **(v)**
3.5

PART 4: OVERALL UNIT OPERATION
4.1.1, except (i)
4.1.2, except (i) and (vii)
4.1.3
4.2
4.3, except (v)

PART 5: EMERGENCY OPERATIONS
5.1 (i)
5.2.1
5.2.2, except (v)

G.2 Topic Groups for Supplementary Station Specific Examinations

The various topics that may be covered in the supplementary station specific examinations have been grouped as shown below to assist in their selection so that each examination contains a balanced mix of topics and that, over a number of examinations, all the knowledge that SSs are required to have in addition to that of an RO is tested. The marks that should be allocated to questions in any topic group are indicated beside the group.

Group	Topics Applicable to All Stations	Marks
1	**Accident assessment** a) Accident analysis assumptions b) Plant response under accident conditions c) Fuel cooling and heat sinks under accident conditions d) Fuel failures under accident conditions e) Consequences of impairments of safety related systems under accident conditions f) Technical bases for emergency operating procedures and abnormal incident manual procedures	**10 ± 3**
2	**Emergency Preparedness** a) Radiation emergencies, including: i) classification of event and categories of emergencies ii) radiation emergency response procedures iii) responsibilities of individual persons, teams and groups iv) situation assessment v) station and off-site protective measures vi) responsibilities of outside organizations vii) Consolidated Nuclear Emergency Plan viii) transportation emergencies (for Pickering A and Darlington) b) Conventional emergencies, including: i) conventional emergency response procedures ii) responsibilities of individual persons, teams and groups iii) situation assessment iv) protective actions v) responsibilities of outside organizations	**6 ± 2**

Group	Topics Applicable to All Stations	Marks
3	**Operating Licence, Acts and Regulations** a) Requirements in the station Power Reactor Operating Licence and in the Operating Policies and Principles, their supporting rationale, the provisions to ensure adherence to them and the potential consequences of operation outside of their stated limitations b) Situations during station operation and maintenance that may result in the violation of licence conditions c) Requirements that pertain to station operation and maintenance in the Federal and Provincial Acts and Regulations, and in associated standards and codes, with their supporting rationale	**7 ± 3**
4	**Technical** a) Neutron Overpower Protection (NOP), including: i) analysed reactivity mechanism configurations and flux shapes ii) reference, actual and critical channel powers iii) channel power peaking factor (CPPF) iv) NOP detector normalization v) NOP setpoint reduction for non-standard operating conditions b) Reactor regulation i) Normalization of RRS detectors ii) Normalization of zone thermal powers c) Reactor start-up after long and short shutdowns d) Operation with large and low excess reactivity e) Heat balance calculations f) Rationale for design requirements of systems g) System operating constraints and limits, their supporting rationale and the provisions to ensure adherence to them h) Derivation of system operating constraints from plant safety analyses i) Chemical control of systems during operation and maintenance, including: i) parameters and products controlled ii) chemicals, methods and equipment used to control them iii) consequences of their inadequate control iv) how and why each parameter or product controlled varies with specified changes in system or unit conditions v) specific actions to reduce or control each parameter or product j) Classification of impairments and corresponding operating strategies; consequences of impairments on the system and on unit operation k) Configuration of systems and equipment isolation required for specified maintenance activities on a system	**8 ± 2**

Group	Topics Applicable to All Stations	Marks
5	**Fuel Handling and Storage Systems** a) Refer to station-specific fuel handling objectives for SSs b) Configuration of equipment and systems, and procedures for other uses of fuelling machines, such as pressure tube surveillance, reactor face maintenance and channel flow checks	**7 ± 3**
6	**Radiological and Industrial Safety** a) Radiological safety i) High hazard work ii) Abnormal radiological conditions iii) Liquid radiation emissions iv) Radiation Protection Policies and Principles and Radiation Protection Requirements - Nuclear Facilities v) Radiological shipment vi) Responsibilities of the SS and of persons reporting to the SS with respect to radiation safety of station personnel b) Industrial safety i) Health and Safety Policy ii) Industrial safety program iii) Work protection procedures iv) Industrial hazards v) Responsibilities of the SS and of persons reporting to the SS with respect to conventional safety of station personnel	**6 ± 2**
7	**Administration** a) Permanent modifications b) Temporary modifications c) System configuration management d) Operating procedure changes e) Setpoint changes f) Testing requirements g) Reporting requirements h) Work control i) Site security and safeguards j) Environmental protection k) Responsibilities and authority of an SS and of other plant personnel who report to or interface with the SS l) Qualification requirements of plant personnel who report to the SS	**6 ± 2**
All Groups		**50**

Group	Unit 0 Systems at Bruce and Darlington	Marks
8	**Special Safety Systems, Safety Support Systems and Emergency Procedures** a) ECI and related subsystems b) Containment and related subsystems c) Emergency water supply system d) Emergency power system e) Powerhouse emergency venting system f) Safety System Monitoring Computer (SSMC) g) Unit 0 operator actions in AIMs and EOPs	**8 ± 3**
9	**Electrical Systems** a) Station electrical equipment and distribution, including: i) electrical protection ii) emergency transfer schemes iii) standby generators and auxiliaries b) Switchyard electrical equipment and distribution system c) Switchyard compressed air system	**6 ± 2**
10	**Other Systems** a) Common service water b) Environmental monitoring (CCW) c) Water treatment plant d) Condensate makeup e) Fire protection system f) Process air systems g) Ventilation systems h) D_2O management i) Access control system j) Off gas management system k) Active liquid waste systems l) Radiation monitoring systems m) Spent fuel bay cooling and purification systems n) Control computers (Common Unit)	**6 ± 2**
Unit 0 Groups		**20**

Group	Tritium Removal Facility (TRF) at Darlington	Marks
11	Refer to TRF objectives for SSs	**10**

G.3 A: Topic Groups for General Examinations for RO Candidates - New SAT-based Training

This guideline applies to plants that have implemented the new training program in science fundamentals and equipment principles for ROs developed in accordance with the principles of a systematic approach to training (SAT). The various topics that may be covered in the General Examinations have been grouped as shown below to assist in their selection so that each examination contains an appropriate mix of topics and that, over a number of examinations, all the knowledge that ROs are required to have on the topics covered is tested. The marks that should be allocated to questions in any topic group are indicated beside the group.

Total Marks: 100

A) Principles of Reactor Operation and Control

Group 1 Reactor Fundamentals **Marks: 7 ± 2**

a) Fission chain reaction, including:
   i) prompt and delayed neutrons and associated effects
   ii) neutron life cycle and the six factor formula
b) Moderator properties and moderation process
c) Neutron interactions with reactor core materials
d) Heat production in a reactor
e) Spatial dependence of the neutron flux in a reactor
f) Critical reactor operation, including:
   i) power response to positive and negative reactivity insertions
   ii) reactor period
   iii) prompt jump or drop
g) Subcritical reactor operation, including:
   i) sources of neutrons
   ii) power response to positive reactivity insertions
   iii) power doubling rule
h) Prompt criticality

Group 2 Reactivity Effects **Marks: 14 ± 2**

a) Reactivity effects arising from operation at high power, including:
   i) burn up of U-235
   ii) build up of fission products
   iii) production and removal of xenon and samarium
   iv) xenon and samarium transients
   v) build up and burn up of plutonium isotopes
   vi) plutonium transients
   vii) reactivity changes due to burn-up
b) Addition and removal of chemical neutron poisons in the moderator for reactivity control, including:
   i) poisons used under various operating conditions

ii) limits on poison concentrations
iii) methods of verification and control of poisons

c) Xenon oscillations and flux tilts, including:
   i) causes of xenon oscillations
   ii) means of controlling xenon oscillations

d) Effects of temperature changes on reactivity, including:
   i) temperature coefficients of reactivity
   ii) power coefficient and its effect on reactor regulation and protection
   iii) moderator temperature limit and consequences of operating above that limit

e) Effects of coolant voids on reactivity, including effect of core voiding on neutron flux detectors during a large LOCA

f) Moderator and heat transport coolant isotopic limits, including:
   i) reason for these limits
   ii) consequences of operating outside the limits
   iii) relationship between moderator and heat transport coolant isotopic limits

g) Reactivity changes after a reactor shutdown

Group 3 Reactor Control and Instrumentation **Marks: 14 ± 2**

a) Principles of bulk and zone power regulation, including reactivity mechanisms used and their principles of operation

b) Principles of reactor protection

c) Neutron flux measurements, including types of signals required for reactor regulation and protection

d) Neutron flux instrumentation, including:
   i) principles of operation of in-core and out-of-core start-up instrumentation
   ii) principles of operation of ion chambers
   iii) principles of operation of in-core detectors
   iv) factors affecting the accuracy of ion chamber and in-core detector flux measurements

e) Thermal power measurements for reactor regulation

f) Principles of operation of thermal power instrumentation, including factors affecting the accuracy of thermal power measurements at various power levels

g) Calibration of bulk and zone neutron flux measurements for reactor regulation and protection

h) Calibration of thermal power measurements for reactor regulation

i) Flux shapes, including:
   i) analysed and unanalysed flux shapes
   ii) flux flattening

iii) effects of fuelling on flux shape
iv) effects of configurations of reactivity mechanisms
v) channel power peaking factor (CPPF)
vi) reactor overpower protection at high power

j) Preferred reactor state for refuelling

k) Reactor power rundown after a trip

l) Approach to criticality, including:
i) use of special instrumentation for reactor regulation and protection
ii) methods of approach to criticality
iii) monitoring during an approach to criticality
iv) confirmation of criticality
v) precautions to be taken during an approach to criticality

B) Principles of Heat Transfer and Thermodynamics

Group 4 Reactor and Heat Transport System **Marks: 14 ± 2**

a) Principles of fuel cooling, including:
i) modes of fuel cooling
ii) heat transfer processes from the fuel to coolant
iii) factors affecting critical heat flux
iv) dryout in a fuel channel
v) coolant boiling

b) Fuel cooling by natural circulation, including:
i) principle of operation of thermosyphoning
ii) single-phase and two-phase thermosyphoning
iii) system parameters monitored during thermosyphoning
iv) system parameters controlled during thermosyphoning and consequences of inadequate control
v) cooling by intermittent buoyancy induced flow (IBIF)

c) Heat removal during small and large loss of coolant accidents, including:
i) need for reactor trip
ii) crash cooling
iii) HTS blowdown and refill by the emergency coolant injection system
iv) impact of dousing in containment

d) Reactor, channel power and fuel bundle operating limits

e) Fuel temperature profiles under various conditions

f) Coolant temperature and heat flux profiles along a fuel channel

g) Abnormal conditions that can lead to fuel overheating

h) Fuel damage, including:
i) contributing factors
ii) fuel sheath behaviour with temperature and irradiation
iii) sheath failure mechanisms

iv) methods of detection and location of fuel failures

i) Heat transport system (HTS) pressure control, including:
   i) principles of operation of the pressurizer
   ii) consequences of operating outside normal pressurizer level and temperature ranges
   iii) principles of operation of the bleed condenser
   iv) non-condensable gas build up in the bleed condenser

Group 5 Secondary Systems **Marks: 11 ± 2**

a) Principles of operation of the boilers, including:
   i) heat transfer processes from HTS coolant to the boiler water
   ii) relationship between boiler pressure and heat transfer
   iii) principles of boiler pressure control
   iv) boiler pressure changes during HTS warm-up and cool-down
   v) steady state and transient swell and shrink of boiler water
   vi) principles of boiler level control at various power levels
   vii) causes, operational concerns and consequences of abnormal boiler levels

b) Principles of operation of a multi-stage turbine, including:
   i) heat to work conversion process in the turbine
   ii) factors affecting turbine efficiency and integrity
   iii) control of turbine load
   iv) moisture separation and steam reheat
   v) turbine exhaust overheating

c) Principles of operation of the condenser, including:
   i) heat transfer processes in the condenser
   ii) factors affecting the pressure in the condenser
   iii) undesirable conditions in the condenser

d) Principles of operation of the feed heaters, including undesirable conditions in feed heaters

e) Principles of operation of the deaerator, including causes and consequences of deaerator pressure upsets

f) Factors that impact on secondary cycle efficiency

g) Precautions necessary when filling or draining a heat exchanger

h) Principles of operation of combustion turbines and undesirable operating conditions

C) Principles of CANDU Plant Equipment

Group 6 Mechanical Equipment **Marks: 12 ± 2**

a) Vibrations in turbine generators and other rotating machines, including:
   i) major causes and operating conditions that can affect them
   ii) operating conditions that may affect critical speeds

b) Equipment damage caused by excessive vibrations

c) Causes and prevention of cavitation in CANDU plants

d) Steam and water hammer in CANDU plants, including:
   i) causes
   ii) resulting equipment damage
   iii) operating practices to minimize the risk of their occurrence

e) Operation of centrifugal pumps, including:
   i) operational changes influencing operation of the pumps
   ii) pump cavitation and its consequences
   iii) operational changes that may cause pump cavitation
   iv) operating conditions that could lead to gas locking and vapour locking
   v) consequences of gas or vapour locking of a pump
   vi) major causes and consequences of pump run out
   vii) consequences of reverse rotation
   viii) pump problem diagnosis
   ix) pump start-up sequence and start-up precautions
   x) precautions during pump shutdown and isolation

f) Positive displacement pump start-up

g) Principles of operation and operational aspects of compressors and vacuum pumps

h) Consequences of excessive moisture in compressed air piping and receivers

i) Consequences and operational concerns associated with inadequate bearing lubrication, considering the various conditions that may result in inadequate lubrication

j) Consequences of abnormal operating conditions in mechanical and labyrinth seals

k) Operational concerns associated with valves, including consequences of impurities in hydraulic fluid and moisture in instrument air

Group 7 Electrical Equipment **Marks: 12 ± 2**

a) Principles of generator operation and control, including:
   i) generator synchronization
   ii) control of terminal voltage, frequency and load for various configurations of generators and loads
   iii) changes in generator parameters with changes in turbine steam flow and excitation current
   iv) factors affecting generator stability
   v) generator load rejection
   vi) automatic response to grid disturbances
   vii) heat production and removal in a generator
   viii) adverse generator operating conditions and consequences of exceeding operating limits

b) Principles of equipment protection, including:

i) bus protections
ii) transformer protections
iii) motor protections
iv) generator protections

c) Operating limitations of transformers, including consequences of exceeding operating limits

d) Operation of motors, including causes and consequences of abnormal operating conditions

e) Operation of station batteries, including associated operational concerns

f) Operation, isolation and deenergization of circuit breakers

g) Precautions when operating circuit breakers, MCC bus breakers and disconnect switches

h) Precautions when isolating voltage and current transformers

i) Ground faults on DC trip circuits

j) Consequences of excessive moisture and temperature on electrical equipment insulation

k) Means to achieve and maintain reliability of electrical power supplies, including:
i) purpose, availability requirements and safety implications of different classes of supply
ii) typical loads for each class of supply with the reasons for their selection
iii) normal and alternate sources of electrical supply
iv) switchyard ring bus

Group 8 Instrumentation and Control **Marks: 8 ± 2**

a) Basic principles of level, flow, temperature and pressure control loops, including:
i) principles of operation of detectors
ii) proportional control
iii) proportional control with integral action
iv) proportional control with derivative action
v) proportional control with integral and derivative actions
vi) feedforward control
vii) cascade and multi element controls
viii) valve actuators and positioners
ix) failure modes of control valves

b) Impact of operating environment and process conditions on:
i) pressure measurements
ii) level measurements
iii) flow measurements

c) Effect of failures and abnormal conditions of components on:
i) pressure measurements

ii) level measurements
iii) flow measurements
iv) temperature measurements

d) Principles of operation and failure modes of the following detectors and sensors:
i) position detectors
ii) speed sensors
iii) vibration sensors
iv) smoke and fire detectors
v) liquid detectors

Group 9 Materials and Chemistry **Marks: 8 ± 2**

a) Mechanical and thermal stresses in mechanical equipment, including:
i) causes and operating practices used to minimize stresses
ii) consequences of excessive stresses

b) Effects of radiation on plant materials and components, including problems caused by radiation damage

c) Problems affecting pressure tubes, including:
i) factors affecting creep in pressure tubes
ii) factors contributing to hydrogen embrittlement, delayed hydride cracking and blistering of pressure tubes
iii) operating practices used to minimize delayed hydride cracking of pressure tubes

d) Principles of operation of ion exchange (IX) columns, including:
i) control of pH and conductivity in plant systems by IX columns
ii) control of gadolinium and boron in the moderator
iii) detection of spent IX columns
iv) typical causes, symptoms and correction of IX column problems

e) Chemical control in plant systems, including:
i) causes of corrosion of plant components and ways of minimizing the various corrosion types
ii) effect of pH on corrosion of common plant materials
iii) typical causes of abnormal pH values in plant systems, methods used for control and consequences of operating outside the normal pH range in a given system
iv) typical causes of excessive dissolved oxygen in plant systems, methods used for control and consequences of operating with excessive dissolved oxygen in a given system
v) typical causes of abnormal conductivity values in plant systems, methods used for control and consequences of operating outside the normal range of conductivity values in a given system
vi) causes of scale and sludge formation in boilers, methods used to minimize scale and sludge formation and consequences of scale and sludge formation in boilers

vii) causes of CRUD formation in plant systems, methods used to control CRUD and operational concerns associated with CRUD in plant systems

f) Conditions favouring the reaction of zirconium with steam in a CANDU reactor and related operational consequences

g) Deuterium or hydrogen excursions in the moderator cover gas, the liquid zone control system and the heat transport system storage tank, including:
   i) reasons for controlling deuterium or hydrogen gas production
   ii) factors affecting production
   iii) related operational concerns
   iv) methods for deuterium or hydrogen reduction and control
   v) recombination unit operation

G.3 B: Topic Groups for General Examinations for RO Candidates - Traditional Training

This guideline applies to plants that have not yet implemented the new training program in science fundamentals and equipment principles for ROs developed in accordance with the principles of SAT. The various topics that may be covered in the General Examinations have been grouped as shown below to assist in their selection so that each examination contains an appropriate mix of topics and that, over a number of examinations, all the knowledge that ROs are required to have on the topics covered is tested. The marks that should be allocated to questions in any topic group are indicated beside the group.

Total Marks: 100

A) Principles of Reactor Operation and Control

Group 1 Reactor Fundamentals **Marks: 5 ± 2**

Fission chain reaction, including:

a) prompt and delayed neutrons and associated effects
b) neutron life cycle and application of the six factor formula
c) subcritical, critical and super critical reactors
d) subcritical reactor operation, including sources of neutrons
e) prompt criticality
f) changes in reactor power with time, including reactor period and prompt jump or drop
g) spatial dependence of the neutron flux in a reactor

Group 2 Reactivity Effects **Marks: 9 ± 2**

a) Reactivity effects arising from power operations, including:
   i) fission product poisons
   ii) build up of plutonium isotopes
   iii) reactivity changes due to burn-up
b) Xenon oscillations and flux tilts, and flux flattening, including:
   i) effects of fuelling on flux
   ii) effects of abnormal configurations of reactivity mechanisms
   iii) effects of power changes on plutonium and fission product poisons
   iv) effects of reactivity insertion on reactor power
   v) excess reactivity compensation, including Xenon simulation
   vi) effects of temperature and coolant voids on reactivity
   vii) use and methods of verification and control of chemical neutron poisons and adverse consequences of their use and control

Group 3 Reactor Control and Instrumentation **Marks: 12 ± 2**

a) Neutron flux measurements, including types of signals required for reactor regulation and protection

b) Principles of operation of in-core and out-of-core neutron flux instrumentation

c) Thermal power measurements and instrumentation for reactor regulation

d) Calibration of reactor power measurements for regulation and protection purposes

e) Principles of bulk and zone power regulation, including reactivity mechanisms used and their principles of operation

f) Principles of Liquid Zone Control level measurements

g) Principles of reactor protection, including neutron overpower protection

h) Effects of fuelling and of abnormal configurations of reactivity mechanisms on reactor regulation and protection

i) Guaranteed shutdown state

j) Approach to criticality (initial and following extended outages), including:
   i) use of special instrumentation
   ii) techniques of approach to criticality and the reasons for taking special precautions

B) Principles of Reactor Safety

Group 4 General Reactor Safety Principles **Marks: 5 ± 2**

a) Defence in depth considerations

b) Principles of *Control, Cool and Contain* under normal and abnormal reactor operating conditions

c) Means to achieve and maintain reliability of systems and equipment, including:
   i) routine testing
   ii) maintenance of reliable electrical supplies
   iii) purpose, availability requirements and safety implications of different classes of supply
   iv) typical loads for each class of supply with the reasons for their selection
   v) normal and alternate sources of electrical supply

Group 5 Special Safety Systems **Marks: 12 ± 2**

a) System reliability and reliability requirements, including:
   i) fail safe considerations
   ii) routine testing

b) Required shutdown system capabilities, including:
   i) absolute and conditional trip parameters with the reason for their existence, the type of events they protect against, primary and back-up parameters and power dependent trip set points
   ii) interlocks between shutdown systems and the reactor regulating system
   iii) requirements for establishing and maintaining a guaranteed shutdown state

c) Emergency core cooling system (ECCS) functions, required capabilities and operating considerations, including:
   i) primary and conditioning initiating parameters, with the reasons for their existence (in general terms)
   ii) blocking of the system before depressurization
   iii) heat transport system pump operation during a LOCA

d) Containment system types, functions and required capabilities, including:
   i) principles of operation of containment subsystems
   ii) containment of radioactivity during a LOCA

e) Concepts of impairments and their levels

Group 6 Fuel characteristics, behaviour and power limits **Marks: 8 ± 2**

a) Factors influencing fuel temperature, including:
   i) power excursions
   ii) flux distribution
   iii) coolant conditions

b) Reactor, fuel bundle and channel power operating limits, including:
   i) methods used to monitor power conditions
   ii) adverse consequences of fuel overrating and fuel overheating

c) Fuel failures, including:
   i) contributing factors
   ii) fuel sheath behaviour with temperature
   iii) sheath failure mechanisms
   iv) fission product migration in fuel and release from failed fuel bundles
   v) detection and location methods

d) Reactor refuelling, including:
   i) preferred reactor state for refuelling
   ii) consideration for selection of channels for fuelling
   iii) detection of channel blockage during refuelling

C) Principles of CANDU Plant Systems and Equipment

Group 7 Moderator System and Moderator Cover Gas **Marks: 7 ± 2**

a) Moderator isotopic limits, including:
   i) reason for these limits
   ii) adverse consequences of operating outside the limits
   iii) relationship with HTS isotopic limits

b) Adverse consequences of operating outside temperature limits and normal level range

c) Moderator chemical control, including:
   i) major objectives of chemical control
   ii) chemical parameters typically monitored and typical control methods employed
   iii) typical causes of abnormal values of chemical parameters
   iv) major short and long term operational concerns related to chemical control

d) Deuterium excursion in the moderator cover gas, including:
   i) reason for controlling deuterium gas production
   ii) factors affecting its production
   iii) related operational concerns
   iv) methods for deuterium reduction and control
   v) recombination unit operation

Group 8 Heat Transport System (HTS) and Annulus Gas System **Marks: 8 ± 2**

a) HTS pressure and inventory control, including:
   i) purpose and methods of pressure control and adverse consequences of operating outside normal pressure range
   ii) purpose and methods of inventory control and adverse consequences of operating outside normal pressurizer level range
   iii) response to changes in unit operating conditions and to unit upsets, including response to secondary side effects
   iv) overpressure protection requirements
   v) direct and indirect methods of pressure reduction

b) Boiler tube leaks, including:
   i) potential causes that may lead to boiler tube failures
   ii) operational concerns associated with boiler tube failures
   iii) indications of boiler tube failures
   iv) effect on unit operation
   v) prevention of boiler tube failures

c) HTS isotopic limits, including:
   i) reasons for these limits
   ii) adverse consequences of operating outside of these limits

d) HTS main circulating pumps, including:
   i) principles of operation of gland seals
   ii) operational problems, including cavitation and vapour locking

e) HTS chemical control, including:
   i) major objectives of chemical control
   ii) chemical parameters typically monitored and typical control methods employed
   iii) typical causes of abnormal values of chemical parameters
   iv) major short and long term operational concerns related to chemical control

f) Annulus Gas system, including its use in monitoring for HTS leakage and LOCA identification

Group 9 Boiler and Steam Systems **Marks: 8 ± 2**

a) Principles of boiler level control at various power levels, including:
   i) causes, operating concerns and adverse consequences of abnormal boiler level control
   ii) protective actions in response to abnormal boiler level conditions
   iii) steady state and transient swell and shrink of boiler water

b) Principles of boiler pressure control, including:
   i) causes of boiler pressure changes during normal and unit upset conditions
   ii) typical automatic response of the reactor control and boiler pressure control programs to boiler pressure upsets
   iii) operating concerns regarding SRVs and CSDVs during turbine trip or load rejection conditions

c) Boiler overpressure protection requirements, including:
   i) adverse consequences and operating concerns associated with incorrect setting or unavailability of boiler safety valves
   ii) testing of boiler safety valves

d) Causes of and general practices used to minimize the following operational problems in the boiler steam and water systems:
   i) carryover in boiler steam
   ii) thermal stresses
   iii) steam wetness at the turbine inlet
   iv) steam and water hammer
   v) steam line vibrations

e) Operational concerns regarding control of reheater drain levels

Group 10 Condenser, condensate and feedwater systems **Marks: 7 ± 2**

a) Adverse consequences and operating concerns caused by high pressure and excessive vacuum in the condenser

b) Typical causes of poor condenser vacuum

c) Functions and principles of operation of the condenser hotwell level control

d) Functions and principles of operation of the deaerator level control

e) Adverse consequences and operational concerns associated with condenser hotwell and deaerator level control

f) Deaerator pressure upsets, including:
   i) typical causes
   ii) adverse consequences and operational concerns

g) Major objectives of chemical control, including:
   i) chemical parameters typically monitored and typical control methods employed
   ii) typical causes of abnormal values of chemical parameters
   iii) major short and long term operational concerns related to chemical control

Group 11 Turbine-generator Operation and Control **Marks: 7 ± 2**

a) Principles of turbine generator control and protection, including:
   i) typical response to changes in unit condition
   ii) poison prevent operation
   iii) automatic response to unit upsets
   iv) generator hydrogen and cooling concerns
   v) turbine critical speed concerns
   vi) operational concerns associated with inadequate lubrication

b) typical turbine-generator parameter monitoring, including:
   i) reason(s) for their monitoring
   ii) causes that contribute to approaching parameter limits
   iii) consequence(s) of exceeding parameter limits
   iv) purpose and scheduling of turbine steam valve testing
   v) hazards of and general operating practices used to protect the turbine-generator from overspeed conditions, including effects of reheater tube leaks

D) Principles of Heat Transfer and Fluid Dynamics

Group 12 Thermodynamics, Thermohydraulics and Thermal Stresses **Marks: 12 ± 2**

a) Heat generation in and removal from the reactor fuel, structures, heat transport system (HTS) and moderator system, including:
   i) heat transport methods and heat sinks
   ii) modes of heat transfer from fuel to coolant
   iii) boiling heat transfer
   iv) reasons for and principles of cooling by natural circulation
   v) temperature distribution along a fuel channel
   vi) causes and consequences of fuel channel blockage

b) Heat removal during small and large LOCAs, including:
   i) crash cooling
   ii) HTS blowdown and refill from ECCS
   iii) moderator as the ultimate heat sink

c) Causes and prevention of steam and water hammer in any applicable system

d) Thermal stresses in any applicable system and mechanical equipment, including:
   i) causes and general practices used to minimize thermal stresses
   ii) adverse consequences and operating concerns caused by excessive thermal stresses

e) Causes and prevention of cavitation and vapour locking in any applicable system

G.3 C: Topic Groups for General Examinations for U0O Candidates

The various topics that may be covered in the General Examinations for U0O candidates have been grouped as shown below to assist in their selection so that each examination contains an appropriate mix of topics and that, over a number of examinations, all the knowledge that U0Os are required to have on the topics covered is tested. This guideline is based on the training program in science fundamentals and equipment principles for U0O candidates that has been developed in accordance with the principles of a systematic approach to training (SAT). The marks that should be allocated to questions in any topic group are indicated beside the group.

Total Marks: 75

A) Nuclear Theory and Principles of Reactor Operation

Group 1 Nuclear Theory and Reactor Fundamentals **Marks: 6 ± 1**

a) Radioactive decay processes

b) Induced nuclear reactions, including:
   i) scattering reactions
   ii) absorption reactions
   iii) photoneutrons

c) Nuclear processes important for CANDU operation, including:
   i) neutron thermalization
   ii) neutron detection reactions
   iii) parasitic absorption and activation

d) Fission chain reaction, including:
   i) prompt and delayed neutrons and associated effects
   ii) neutron life cycle

e) Moderator properties and moderation process

f) Neutron interactions with reactor core materials

g) Subcritical, critical and supercritical reactor operation

h) Build up of fission products

Group 2 Reactor Control and Major Features of CANDU Reactors **Marks: 7 ± 2**

a) Principles of bulk and zone power regulation, including:
   i) reactivity mechanisms used and their principles of operation
   ii) required neutron and thermal power measurements

b) Principles of operation of shutdown systems, including:
   i) shutdown mechanisms used
   ii) required shutdown system capabilities
   iii) requirements for establishing and maintaining a guaranteed shutdown state

c) Addition and removal of chemical neutron poisons in the moderator for reactivity control

d) Major components of CANDU reactors, including:
   i) reactor shielding
   ii) main moderator system and its auxiliaries
   iii) main heat transport system (HTS) and its auxiliaries
e) Heat production and removal in a CANDU reactor
f) Moderator and heat transport coolant isotopic

B) Principles of Heat Transfer and Thermodynamics

Group 3 Reactor and Heat Transport System **Marks: 10 ± 2**

a) Principles of fuel cooling, including:
   i) modes of fuel cooling
   ii) heat transfer processes from the fuel to coolant
   iii) importance of heat transport system pressure control
   iv) dryout in a fuel channel
   v) coolant boiling
b) Fuel cooling by natural circulation, including:
   i) principle of operation of thermosyphoning
   ii) single-phase and two-phase thermosyphoning
   iii) cooling by intermittent buoyancy induced flow (IBIF)
c) Heat removal during small and large loss of coolant accidents, including:
   i) need for reactor trip
   ii) crash cooling
   iii) HTS blowdown and refill by the emergency coolant injection system
   iv) impact of dousing in containment
   v) containment pressure changes during loss of coolant accidents
d) Reactor, channel power and fuel bundle operating limits
e) Abnormal conditions that can lead to fuel overheating
f) Fuel damage, including:
   i) contributing factors
   ii) fuel sheath behaviour with temperature and irradiation
   iii) sheath failure mechanisms

Group 4 Secondary Systems **Marks: 8 ± 2**

a) Principles of operation of the boilers, including:
   i) heat transfer processes from HTS coolant to the boiler water
   ii) relationship between boiler pressure and heat transfer
   iii) principles of boiler pressure control
   iv) boiler pressure changes during HTS warm-up and cool-down
b) Principles of operation of the condenser, including:
   i) heat transfer processes in the condenser
   ii) factors affecting the pressure in the condenser

c) Precautions necessary when filling or draining a heat exchanger

d) Factors that impact on the efficiency of heat exchangers

e) Principles of operation of combustion turbines, including:
   i) heat to work conversion process in the turbine
   ii) control of turbine load
   iii) undesirable operating conditions

C) Principles of CANDU Plant Equipment

Group 5 Mechanical Equipment **Marks: 12 ± 2**

a) Vibrations in standby generators and other rotating machines, including:
   i) major causes and operating conditions that can affect them
   ii) operating conditions that may affect critical speeds

b) Equipment damage caused by excessive vibrations

c) Causes and prevention of cavitation in CANDU plants

d) Steam and water hammer in CANDU plants, including:
   i) causes
   ii) resulting equipment damage
   iii) operating practices to minimize the risk of their occurrence

e) Operation of centrifugal pumps, including:
   i) operational changes influencing operation of the pumps
   ii) pump cavitation and its consequences
   iii) operational changes that may cause pump cavitation
   iv) operating conditions that could lead to gas locking and vapour locking
   v) consequences of gas or vapour locking of a pump
   vi) major causes and consequences of pump run out
   vii) consequences of reverse rotation
   viii) pump problem diagnosis
   ix) pump start-up sequence and start-up precautions
   x) precautions during pump shutdown and isolation

f) Positive displacement pump start-up

g) Principles of operation and operational aspects of compressors and vacuum pumps

h) Consequences of excessive moisture in compressed air piping and receivers

i) Consequences and operational concerns associated with inadequate bearing lubrication, considering the various conditions that may result in inadequate lubrication

j) Consequences of abnormal operating conditions in mechanical and labyrinth seals

k) Operational concerns associated with valves, including consequences of impurities in hydraulic fluid and moisture in instrument air

Group 6 Electrical Equipment **Marks: 16 ± 3**

a) Principles of generator operation and control, including:
   i) generator synchronization
   ii) control of terminal voltage, frequency and load for various configurations of generators and loads
   iii) changes in generator parameters with changes in turbine gas flow and excitation current
   iv) factors affecting generator stability
   v) generator load rejection
   vi) automatic response to grid disturbances
   vii) heat production and removal in a generator
   viii) adverse generator operating conditions and consequences of exceeding operating limits

b) Principles of equipment protection, including:
   i) bus protections
   ii) transformer protections
   iii) motor protections
   iv) generator protections

c) Operating limitations of transformers, including consequences of exceeding operating limits

d) Operation of motors, including causes and consequences of abnormal operating conditions

e) Operation of station batteries, including associated operational concerns

f) Operation, isolation and deenergization of circuit breakers

g) Precautions when operating circuit breakers, MCC bus breakers and disconnect switches

h) Precautions when isolating voltage and current transformers

i) Ground faults on DC trip circuits

j) Consequences of excessive moisture and temperature on electrical equipment insulation

k) Means to achieve and maintain reliability of electrical power supplies, including:
   i) purpose, availability requirements and safety implications of different classes of supply
   ii) typical loads for each class of supply with the reasons for their selection
   iii) normal and alternate sources of electrical supply
   iv) switchyard ring bus

Group 7 Instrumentation and Control **Marks: 8 ± 2**

a) Basic principles of level, flow, temperature and pressure control loops, including:
   i) principles of operation of detectors
   ii) proportional control

iii) proportional control with integral action
iv) proportional control with derivative action
v) proportional control with integral and derivative actions
vi) feedforward control
vii) valve actuators and positioners
viii) failure modes of control valves

b) Impact of operating environment and process conditions on:
i) pressure measurements
ii) level measurements
iii) flow measurements

c) Effect of failures and abnormal conditions of components on:
i) pressure measurements
ii) level measurements
iii) flow measurements
iv) temperature measurements

d) Principles of operation and failure modes of the following detectors and sensors:
i) position detectors
ii) speed sensors
iii) vibration sensors
iv) smoke and fire detectors
v) liquid detectors

Group 8 Materials and Chemistry **Marks: 8 ± 2**

a) Mechanical and thermal stresses in mechanical equipment, including:
i) causes and operating practices used to minimize stresses
ii) consequences of excessive stresses

b) Effects of radiation on plant materials and components, including problems caused by radiation damage

c) Principles of operation of ion exchange (IX) columns, including:
i) control of pH and conductivity in plant systems by IX columns
ii) detection of spent IX columns
iii) typical causes, symptoms and correction of IX column problems

d) Chemical control in plant systems, including:
i) causes of corrosion of plant components and ways of minimizing the various corrosion types
ii) effect of pH on corrosion of common plant materials
iii) typical causes of abnormal pH values in plant systems, methods used for control and consequences of operating outside the normal pH range in a given system
iv) typical causes of excessive dissolved oxygen in plant systems, methods used for control and consequences of operating with excessive dissolved oxygen in a given system
v) typical causes of abnormal conductivity values in plant systems, methods used for control and consequences of

operating outside the normal range of conductivity values in a given system

vi) causes of scale and sludge formation in boilers, methods used to minimize scale and sludge formation and consequences of scale and sludge formation in boilers

vii) causes of crud formation in plant systems and operational concerns associated with crud

e) Conditions favouring the reaction of zirconium with steam in a CANDU reactor and related operational consequences

f) Deuterium or hydrogen excursions in the moderator cover gas, including:

i) reasons for controlling deuterium or hydrogen gas production

ii) factors affecting production

iii) related operational concerns

G.4 A: Topic Groups For Station Specific Examinations for U0O Candidates

The various topics that may be covered in the station specific examinations have been grouped as shown below to assist in their selection so that each examination contains a balanced mix of topics and that, over a number of examinations, all the knowledge that U0Os are required to have on the topics covered is tested. The marks that should be allocated to questions in any topic group are indicated beside the group.

All groups **Marks: 75**

Group 1 **Special Safety Systems** **Marks: 12 ± 3**

a) emergency coolant injection system, including:
   i) related systems
   ii) impairments
   iii) standard and non-standard operating procedures
b) negative pressure containment system, including:
   i) related subsystems
   ii) impairments
   iii) standard and non-standard operating procedures
c) unit 0 safety system monitoring computer

Group 2 **Nuclear Safety** **Marks: 10 ± 2**

a) principles of nuclear safety, including:
   i) defence in depth considerations
   ii) principles of *Control, Cool and Contain* under normal and abnormal reactor operating conditions
   iii) requirements for establishing and maintaining a guaranteed shutdown state
   iv) roles of special safety systems, standby safety support systems and safety related process systems
   v) means to achieve and maintain reliability of systems and equipment
   vi) protection against common cause failures
   vii) availability requirements and testing of safety related systems
   viii) purpose, availability requirements and safety implications of different classes of electrical supplies
   ix) plant licensing basis, safety analyses and safe operating envelope
   x) plant operating licence and Operating Policies and Principles
   xi) plant line-up and plant status control
   xii) safety culture
b) heat sinks, including response to non-standard operating conditions during reactor unit outages
c) Critical Safety Parameters

Group 3 **Integrated Plant Operation and Emergency Procedures** **Marks: 10 ± 2**

a) Abnormal Incident Manual (AIM) procedures
b) interaction between unit 0 systems and those of the reactor units

c) integrated plant operating procedures, including:
   i) quiet mode operation
   ii) four unit shutdown
d) non-standard operating procedures, including:
   i) generation rejection
   ii) response to grid frequency disturbances
   iii) response to loss of grid
   iv) switchyard restoration after generation rejection (at Bruce plants)
   v) total loss of 250 VDC power in the switchyard (at Bruce plants)
   vi) response to a main generator hydrogen leak or seal failure
   vii) loss of common instrument air
e) secondary control area operation and impairments
f) emergency irradiated fuel cooling

Group 4 Switchyard and Electrical Distribution **Marks: 10 ± 2**

a) main power output system, including:
   i) electrical power transformation
   ii) switchyard electrical equipment (at Bruce plants)
   iii) switchyard compressed air system (at Bruce plants)
   iv) output system relay protection (at Bruce plants)
b) AC electrical distribution, including:
   i) 13.8 kV distribution system
   ii) 4.16 kV distribution system
   iii) 600 VAC Class III and Class IV distribution system
   iv) 600 VAC Class II system
   v) 120 VAC Class II system
c) DC electrical distribution, including:
   i) 250 VDC system
   ii) 125 VDC system (at Darlington)
   iii) 48 VDC system
   iv) 45 VDC instrumentation supplies system

Group 5 Emergency Electrical Supplies **Marks: 9 ± 2**

a) standby Class III power system, including:
   i) emergency transfer scheme
   ii) standby generators
   iii) impairments
b) emergency power system, including:
   i) emergency power generators
   ii) impairments
c) qualified power supply system (at Bruce NGS A)

Group 6 Water, Air, Ventilation and Fire Protection Systems **Marks: 9 ± 2**

a) condensate make-up system (at Bruce plants)
b) common service water system (at Bruce plants)
c) domestic water system, including site domestic water system (at Bruce plants)
d) emergency water system (at Bruce NGS B)

e) emergency boiler cooling system (at Bruce NGS A)
f) emergency and auxiliary service water systems (at Darlington)
g) frazil ice protection system
h) circulating water discharge control gate (at Darlington)
i) zebra mussel chlorination system
j) service air system
k) instrument air system
l) breathing air system
m) heating and ventilation systems
n) air conditioning systems
o) powerhouse emergency venting system
p) vapour recovery systems
q) fire protection water system
r) site fire protection water system (at Bruce NGS B)
s) transformer deluge and sprinkler system (at Bruce plants)
t) air foam fire protection system
u) smoke detection system
v) CO_2 fire protection system

Group 7 Radiation Protection Systems and Radiation Emergencies Marks: 9 ± 2

a) access control system, including:
   i) related knowledge requirements in the radiation protection training program for U0O candidates
   ii) airlocks and transfer chambers
b) fixed area gamma monitoring system
c) basic concepts related to the control of the discharge of radioactivity to the environment, including:
   i) Derived Emission Limits and associated dose limits for the station
   ii) critical group
   iii) Station Emission Target
   iv) control monitoring
   v) compliance monitoring
d) stack monitoring system, including:
   i) sources and categories of airborne emissions
   ii) emission pathways for airborne emissions
e) active liquid waste system, including:
   i) active liquid waste handling
   ii) active liquid waste treatment
   iii) liquid effluent monitor
   iv) knowledge requirements on radioactive liquid emissions and sources in the radiation protection training program for U0O candidates
f) off gas management system
g) environmental monitoring program
h) emergency filtered air discharge system
i) post accident radiation monitoring system

j) topics on radiological incidents and radiation emergencies specified in Guideline G.4 C

Group 8 Miscellaneous **Marks: 6 ± 1**

a) administrative procedures related to plant operation and maintenance
b) responsibilities of the U0Os, ROs and SSs
c) approved work practices
d) work protection
e) control and process computers
f) D_2O management (at Bruce plants), including:
   i) D_2O transfer and storage system
   ii) heavy water leak detection system
g) other systems not covered in other topic groups

G.4 B: Knowledge Groups for Station Specific Examinations for U0O Candidates

The grouping below is intended to ensure that the sampling of topic groups in Guideline G.4 A covers adequately the different knowledge areas addressed by GSSKOs while also allowing sampling of the knowledge areas not explicitly covered by those GSSKOs. The marks that should be allocated to questions in any knowledge group are indicated beside the group. The information contained within brackets for groups A to G refers to the *Generic Station System Knowledge Objectives for Control Room Operators*, dated June 1998. Plants using a different set of generic system knowledge objectives for U0Os may refer to the corresponding generic objectives in their set, once the resulting plant-specific learning objectives, developed in accordance with a systematic approach to training, are endorsed by the CNSC.

Group	Knowledge Area	Marks
Group A	System Design (GSSKOs - Part 1)	**10 ± 2**
Group B	Instrumentation and Control (GSSKOs - Part 2, excluding those covered in Group C below)	**7 ± 2**
Group C	Response of Control Loops and Logic Control Circuits (GSSKOs 2.2.3, 2.2.4, 2.2.5 and 2.3.7)	**10 ± 2**
Group D	Monitoring of System Parameters, Operating Procedures and Test Procedures, excluding Emergency Operating Procedures (GSSKOs 3.1, 3.3, 3.4 and 4.1)	**10 ± 2**
Group E	Operating Policies and Principles (GSSKOs 3.2.1 and 4.2) and System Limits and Constraints (GSSKO 3.2.2)	**8 ± 2**
Group F	System Impairments and Heat Sinks (GSSKOs 3.5 and 4.3)	**7 ± 2**
Group G	Emergency Operation (GSSKOs - Part 5)	**7 ± 2**
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Areas Not Specifically Addressed by the GSSKOs

Group H	Principles of Nuclear Safety and their application; Emergency Irradiated Fuel Cooling	**6 ± 1**
Group I	Administrative aspects, such as administrative procedures related to plant operation and maintenance, work protection, and roles and responsibilities of operations personnel	**6 ± 1**
Group J	Radiation protection topics not specifically addressed by the GSSKOs	**4 ± 1**
		16

G.4 C: Topics Related to Radiological Incidents and Radiation Emergencies in Station Specific Examinations for U0O Candidates

This guideline specifies knowledge objectives that may be used to formulate questions related to radiological incidents and radiation emergencies in station specific examinations for U0O candidates at multi-unit plants. These objectives may not be comprehensive and questions outside of these specific objectives may be asked if they address knowledge required by U0Os to react to radiological incidents and radiation emergencies in which they may be involved.

1. List the potential sources of information regarding radiation hazards in the station available to the unit 0 operator.
2. List the possible radiation hazards that will exist after a LOCA with failed fuel.
3. List the systems or pieces of equipment that could present high radiation fields after a LOCA with fuel failures.
4. Given a work scenario and system conditions on a unit, evaluate a request for a work authorization from the radiation hazard perspective and determine if the work can be performed safely according to ALARA principles. Justify your conclusion.
5. List the categories of unusual radiological conditions.
6. State the responsibilities of the unit 0 operator in responding to an unusual radiological condition.
7. List the sources of radiological information available from the field that would aid in recognizing an unusual radiological condition.
8. Given a scenario involving an abnormal radiological condition, state the immediate actions required in the field and in the control room. Explain why each action is required.
9. Describe the primary role of the unit 0 operator in a radiation emergency.

G.4 D: List of Recommended GSSKOs for Station Specific Examinations

The numbers below refer to the objectives in the *Generic Station System Knowledge Objectives for Control Room Operators*, dated June 1998. Plants using a different set of generic system knowledge objectives for U0Os may refer to the corresponding generic objectives in their set, once the resulting plant-specific learning objectives, developed in accordance with a systematic approach to training, are endorsed by the CNSC.

To the maximum extent possible, the GSSKOs whose numbers are listed below should be selected to formulate examination questions since they represent higher level knowledge objectives. The numbers in bold correspond to the GSSKOs considered to be at the highest cognitive level. Other GSSKOs may also be used if the resulting examination question is sufficiently complex to discriminate between those candidates who have sufficient knowledge to perform their duties competently and those who do not.

PART 1: SYSTEM DESIGN
1.1.2 (i)
1.3.4
1.3.5 (i)

PART 2: INSTRUMENTATION AND CONTROL
2.1.1 (i)
2.1.1 (iii)
2.1.2
2.1.3
2.2.1.1
2.2.1.2
2.2.1.4
2.2.2
2.2.3
2.2.4
2.2.5
2.3.1
2.3.2
2.3.3 (i), except second bullet
2.3.3 (ii)
2.3.6
2.3.7
2.5.1 (ii)
2.5.2, except second bullet of (ii)
2.5.3
2.6.1
2.6.3

PART 3: OPERATIONAL ASPECTS
3.1.1 (vi)
3.2.1
3.2.2
3.3.1, except (vii)
3.3.2
3.4 (ii), (iii), (iv) and **(v)**
3.5

PART 4: OVERALL UNIT OPERATION
4.1.1, except (i)
4.1.2, except (i) and (vii)
4.1.3
4.2
4.3, except (v)

PART 5: EMERGENCY OPERATIONS
5.1 (i)
5.2.1
5.2.2, except (v)