Comments on Draft Regulatory Document – Nuclear Criticality Safety (RD-327)

REVIEWER: AECL Criticality Safety Program **COUNTRY/ORGANIZATION: Canada, AECL**			
Comment No.	**Page/Para/Line No.**	**Proposed new text (if applicable)**	**Reason/Comment**
1	RD-327, GD-327 General		What is the relationship between RD-327, GD-327 and RD-364? Section 6 of RD-364 describes requirements for criticality evaluations for transport packages.
2	General		Definition of "Safe or Subcritical Limit" and "Upper Subcritical Limit" should be comparatively clarified. Administrative margins of sub-criticality for control parameters other than k-eff and mass should be defined in this regulation.
3	General structure	Some sections of the structure RD-327 should be rearranged, as follows: - The heading of Section 2.1.1 ("Nuclear Criticality Safety Practices") should be reworded such as "Categorization of Fissionable materials". Section 2.1.1.4 (Nuclear Criticality Safety Program) should be moved into Section 2.1.2 (Program Management Practices). - Section 2.2 (Single Parameter limits) should be presented in a separate section with as much detail as Sections 3 to 16. The heading of "Single-Parameter Limits for Fissile Nuclides" may be reworded as "Subcritical for Single Units of Fissile Nuclides".	
4	Preface and Page 1 Section 1.1	Add: "This document also includes requirements for alarms, as well as for shielding in areas to minimize the dose from a criticality accident."	This document goes beyond just prevention in that it also includes requirements for alarms, as well as for shielding in areas to minimize the dose from a criticality accident.

5	Preface and Section 1 Line 2	Fissionable Material – a material containing one or more fissionable nuclides. Fissionable – Capable of undergoing fission (the splitting of a nucleus) by any process, including spontaneous fission or following the capture of a neutron.	"Fissionable material" needs to be defined in the Glossary. Modify "Fissionable" in Glossary.
6	Page 1 Section 1.2	Delete the word "should" and the word "may".	RD-327 contains requirements and should not contain "should" and "shall" statement.
7	Page 1 Section 1.1		The term "facility" as defined in the NSCA is not always appropriate for AECL. It does not include all of AECL's nuclear criticality controlled areas.
8	Page 1 Section 1.3	"…relevant to this document are…"	An RD document is not a guide when it is incorporated into a licence.
9	Page 1 Section 1.3 Bullet 1 Line 4	"And (b)……."	"And (e)……."
10	Page 1 1.3 Line 1	Nuclear Safety Control Act	NSCA is referred to by acronym is not defined.
11	Page 3 Section 1.4	Add "Draft" to IAEA standard #3	Consistency within document. Reference #3 is a draft document. DS316 (#2) has now been replaced with NS-R-6.
12	Page 3 2.1.1	"Operations with fissionable materials shall follow the requirements. Recommendations should or may be followed in this document." Please make changes throughout the document as required.	This is a requirements document and therefore all terms used must reflect the expected mandatory nature. It is understood that these requirements only become mandatory when referred to in a licence. The reason is that recommendations should be treated as guidelines, and are not mandatory. All recommendations should be put in the accompanying GD-327 and treated as guidelines.
13	Page 3 2.1.1 & 2.1.1.1	Delete "and recommendations"	Recommendations are not mandatory and therefore cannot be preceded by the word "must"
14	Page 3 2.1.1.1	Suggest changing the term "exempted quantity of fissionable materials" to something else, e.g., "quantity of fissionable materials not requiring criticality analysis".	The use of the term "exempted quantity of fissionable materials" may cause some confusion with the definition of "exemption quantity" in the Nuclear Substances and Radiation Devices Regulations.

15	Page 4 2.1.1.3	The following note appears to be out of place: "Note that a facility containing a large quantity of fissionable materials may be subject to the *Nuclear Liability Act*."	This note would be more appropriate for Section 1.3 of RD-327, because it does not affect the requirements in Section 2.1.1.3.
16	Page 4 2.1.1.2/2a Last Sentence	"If combinations of only U-233 and U-235 are possible, then facility is safe with an exemption quantity of less than 500 g in total".	Provides further clarification.
17	Page 4 2.1.1.2 Bullet b.	Delete "in Section 10".	Not found in Section 10 of RD-327. Assumption is it references GD-327, Section 10. RD should <u>not</u> reference GD.
18	Page 4 2.1.1.2 Last Paragraph		"This regulatory document is <u>partially</u> applicable. Clarify what is partially applicable.
19	4/2.1.1.2 and 4/2.1.1.3	"Note that a facility containing a large quantity of fissionable materials may be subject to the <u>*Nuclear Liability Act*</u>*" [ref.]*.	What is the relevance of Nuclear Liability Act to Criticality Safety? A reference or information of the <u>*Nuclear Liability Act should be*</u> provided.
20	5/2.1.1.4 first sentence	"When specified" should be expanded.	Clarification needed on how and who will "specify".
21	Page 5 2.1.1.4		"Facilities involved in operations with small quantities of fissionable materials, as defined in Subsection 2.1.1.2, shall develop and maintain a <u>reduced-scope program</u> based on the applicable sections of this regulatory document, taking into account that the requirements of Subsection 2.1.2.2 are not applicable." Require details of "a reduced-scope program". Require details of a "full-scope program". Need a definition for "possible abnormal conditions" in comparison to credible (and incredible) abnormal conditions.

22	5/2.1.2.2 And Page 23 12.8		Needs to be revised. The requirement to demonstrate that our processes will remain sub-critical under all credible abnormal conditions greater than 10^{-6} per year will not be possible with an acceptable level of certainty for many of our processes. This is due to the fact that many of our processes are solid-based and not amenable to either active or passive engineering controls, but rely entirely on administrative controls for criticality safety. These administrative controls are subject to human errors, the probability of which cannot be determined with a high degree of accuracy. It is noted that the associated guidance document GD-327 does not provide any further recommendations on how to address this issue. It is also noted that the majority of the accidents given in Appendix A of GD-327 are applicable to solutions. The document needs to recognise, as shown by international experience, that the potential for criticality accidents is much greater in liquid based processes than in the processing of solid materials.
23	Page 5 2.1.2.2 Line 1		The location of the parenthesis is odd – why is 'event or event sequences' separate from 'that have a frequency of occurrence'?
24	Page 5 2.1.2.2		Why is an administrative margin of subcriticality of 5% in neutron multiplication factor required? (While the guidance on determination of subcritical limits in the standard ANSI/ANS 8.1 does not require this margin). "The applicable subcritical limits shall be as specified in Subsection 2.2 *Single- Parameter Limits for Fissile Nuclides*, or in Section 10:" → "The Single Parameter Limits as specified in Subsection 2.2 or in Section 10 may be applied as upper sub-critical limit". "Otherwise a minimum value for an administrative margin of subcriticality shall be 20% of the critical mass". Criticality can be controlled not only by mass but also other parameters such as concentration, linear density, geometry, etc. How can this regulation be applicable to the control parameters other than mass?

25	2.1.2.2		2. c and d) What is the role of the Double Contingency Principle (DCP) here? For these c) and d) requirements to be practical, the report by probabilistic/safety analyst(s)) should only show identified credible abnormal conditions, not criticality evaluation.
26	2.1.2.2		4. a) and b): These requirements do not look practical unless there is a report by probabilistic/safety analyst(s)) showing a list of credible abnormal conditions identified by combining accident sequences.
27	2.1.2.2		Need definitions for “not possible”, “unquestionably extremely unlikely”. What are the occurrence frequencies of these terms?
28	5/2.1.2.2		Guidance on when to implement RD-327 for existing operations with fissionable materials is required. Some clarity is required to address legacy situations where criticality safety evaluations may not exist or may not meet these requirements for existing operations with fissionable material.
29	Page 6 2.1.2.2 Last paragraph		Delivering a guarantee that sub-criticality can be assured for all credible abnormal conditions as defined in this document is not feasible and does not appear to be in industry best practice
30	Page 6 2.1.2.2		This is very much beyond the ANSI/ANS standard’s requirement. The ANSI standards do not use 10^{-6} per year. They use the double contingency principle. Such a low frequency is hard to demonstrate for a process that is performed manually. The frequency of 10^{-6} does not appear to be risk based. The consequences of a criticality accident are similar to the consequences of an automobile accident. Frequencies of much greater than 10^{-6} are accepted for automobile accidents. The use of such a low frequency for criticality accidents can lead to improper allocation of safety resources because it is not risk based.

			To put it in another perspective, the "core damage frequency" target of a new nuclear power plant is "10^{-5} per reactor year" (Reference: Appendix B of CNSC's document RD-152, "Guidance on the use of Deterministic and Probabilistic Criteria in Decision-making for Class I Nuclear Facilities"). 10^{-6} per year is not justifiable by a risk based argument and should be replaced by the use of the double contingency principle.
31	6/2.1.2.2 Bullet 2	Bullets that are identified as "c" and "d" should be "a" and "b"	Editing required.
32	Page 6 2d	For events with a probability , 10^{-6}	Why should there be a need to show the probability of occurrence if the analysis of the abnormal event shows that the USL is not exceeded?
33	7/2.1.2.2 Last paragraph		Clarify "realistic" in terms of criticality safety.
34	Page 6 2.1.2.2/1 b ii and Page 23 12.8	Include other critical parameters.	Need to include parameters other than mass. Mass is not the only parameter that can be controlled to ensure subcriticality.
35	6/2.1.2.2 (4a)		A basis for "10^{-7}/year" should be provided in the accompanying GD-327. It is unclear why "10^{-7}/year" has been chosen as the cut-off frequency for external events, when the cut-off frequency for credible abnormal conditions is 10^{-6}/year. External events should be considered as an initiator or common cause of some credible abnormal conditions.
36	7/2.1.2.6, 2nd para		Why is there no requirement for maintaining records on changes to the procedures? Why is there no requirement for change control for changes to procedures? Since nuclear criticality safety has a large component based on control of processes, configuration management on the procedures and change control of the procedures is as important as configuration

			management and change control of the physical facility configuration. Also, since a large part of the nuclear criticality safety analysis is based on analyzing deviations from processes, changes to procedures can negatively impact the criticality safety analysis.
37	8/2.1.3.1	Delete "The influence of variations on these parameters on the k-eff of the system shall be understood."	If single-parameter limits are used as allowed in Section 2.1.2.2, sub-section 1 b i, then there will be very little known about the effect of the controlled parameter on k-eff because k-eff will not be calculated.
38	9/2.1.3.3	The heading of "Geometry Control" should be changed to "Passive Engineered Control".	To make consistent with (active) administrative and (passive) engineered controls. These control definitions should also be included in this document.
39	9/2.1.3.5	Change text to "Neutron reflection shall be considered as a parameter for criticality control".	Consideration of neutron reflection is mandatory when doing nuclear criticality safety analysis. The derivation of an Upper Subcritical Limit can be negatively impacted by nearby neutron reflectors.
40	9/2.1.3.6	…interaction between <u>fuel</u> units.	"fuel unit" is term defined in Glossary.
41	9/2.1.4	Change to "Suitable calculational methods for determining the subcritical state of a system shall be selected and justified in accordance with an applicable quality assurance standard. The methods vary widely in basis and form, and each has its place in the broad spectrum of situations encountered in the nuclear criticality safety field. However, the general procedure to be followed in establishing validity is common to all. For an example of validation of a calculational method, refer to GD-327 *Guidance for Nuclear Criticality Safety* [1], Appendix C."	The text is not written in the form of a mandatory requirement. Selection and justification of the calculational methods is a mandatory requirement in accordance with an applicable quality assurance standard is an accepted practice.
42	9/2.1.4.1		What is the alternative requirement when a bias cannot be established? Guidance needed when no experimental data available.
43	10/2.1.4.3		A requirement to follow an accepted quality standard should be stated. There are accepted quality standards for computer

			program validation, e.g., CSA N286.7 and G-149. The corresponding guidelines in GD-327 should recommend following CSA N286.7.
44	10/2.2 1st sentence	The word “can” is used. It is not included in the section that describes “shall”, “should” or “may”. Either define it in Section 1.2, replace it or delete it.	As this is a requirements document, it should be clear what is required, as opposed to leaving it up to the person that must comply with the requirements to decide.
45	10/2.2 1st sentence		“Plutonium” is listed here, yet the sections of the Guide to which this sentence points specifies ^{239}Pu”. Is it only applicable to ^{239}Pu? Clarify description of what the reference covers.
46	10/2.2	Change to “When single parameter limits are used in place of the process analysis in Section 2.1.2.2, operations with fissile materials shall be performed safely by complying with any one of the limits given in GD-327 *Guidance for Nuclear Criticality Safety* [1], Subsections 2.4.1, 2.4.2, 2.4.3, and 2.4.4 for single units of ^{233}U, ^{235}U, and plutonium, provided the conditions under which the limit applies are maintained.”	This section needs to be written as a requirement to be used instead of Section 2.1.2.2
47	Page 11 3.1.1	There should be a requirement that “Radiological doses to Nuclear Energy Workers do not exceed the established limits for situations where inadvertent criticality does not occur.”	Guidance is needed on “excessive radiation dose to personnel”. It is unclear whether the CNSC intends to apply reference dose criteria to nuclear criticality safety. The NEW dose limits in the radiation Protection Regulations are not appropriate for the accident conditions. One can conceive of situations where assemblies of fissionable materials reach or slightly exceed a neutron multiplication factor of 0.990. In these situations, the radiation source term from subcritical multiplication can be as much as 10 times the radiation source term of the individual fissionable components. This would only be a radiation exposure hazard for the workers.
48	11/3.1.1 Paragraph 2	“The evaluation of the overall risk to personnel in a facility should weigh the risks to personnel from a criticality accident against the risks from false alarms. In	The second paragraph of Section 3.1.1 is too demanding, does not take all factors into consideration, and should be replaced with text to the

		some facilities, the hazards of responding to a criticality accident alarm, real or inadvertent, may outweigh the benefits of having a facility detection system and alarm in place. The evaluation should also take into consideration: (1) facilities where the criteria of Section 7 may apply and (2) large physical areas (e.g., nuclear material storage yards/areas where full coverage with fixed systems is not practical due to the size (and examine alternative safety equipment (portable instruments to be used where work actually takes place or personal, alarming dosimeters, etc)). A criticality alarm system shall be installed only when the evaluation clearly demonstrates the net benefit of the system. Process equipment used in areas from which immediate evacuation is required should be designed so that leaving the equipment will not introduce significant risk." [ANS 8.3, Sec 4.1.2]	left.
49	Page 11 3.1.2.1 Line 2	(containing **any** of these three nuclear substances)	There is a limit to be followed whether 1 or all 3 isotopes are present and that is not obvious from the original sentence. It seemed to indicate separate limits but only when all 3 are present. It only becomes obvious when reading Item d, which deals with the presence of all 3 together.
50	12/3.1.3/1		Don't understand what is meant by "or other protective actions. As far as international practice is concerned the only action on hearing criticality alarm is evacuation for those that are not already incapacitated by the event.
51	Page12 3.1.3/4	Delete sentence "A means for manual…….be provided."	There can be no circumstances under which manual actuation of a criticality alarm either in lieu of an automatic failure or for some other purpose is allowable. Criticality alarms must be sufficiently reliable, with a failure probability of less than 10^{-3} to be acceptable.

52	Page13 3.1.4 Paragraph 4	"…in which <u>licensed</u> activities involving the handling, processing and transfer of fissionable materials that are <u>required to</u> continue…systems."	The only licensed activities involving fissionable materials that can be permitted to continue during power outages without back up power to the criticality alarms are passive activities, such as storage. The handling, processing or transfer of fissionable material using portable instruments as criticality alarms shall not be permitted.
53	13/3.2.1	"…designed to have a probability of failure to alarm of less than 10^{-3}.	Need quantified requirement. Provide the technical definition of reliability in the Glossary
54	Pages 16 to 24 Sections 5.0 to 16.0		There are numerous references to sections of GD-327. On consulting it is noted that these sections contain mandatory requirements (shall statements). The mandatory requirement (shall) statements from GD-327 must be included in these sections of RD-327.
55	Page 16 Section 7.0		Please clarify what "these conditions" is referring to.
56	Page 18 Section 11	Rename title to " …Enriched reactor fuel …'	Nothing in the section depends on LWR characteristics. Documents should be technology neutral.
57	Page 18 Section 10.0 2nd paragraph		The words "shall" and "may" appear in the same statement, and a condition is included. Delete reference to "Section 2" and may is not consistent with requirements.
58	Page 18 12.1		The meaning of the statement 'includes cooperation among" is not clear.
59	18/12.1		Conformance with the criticality safety program relies on all employees following operating procedures. The meaning of the statement 'For each employee, the program relies upon conformance" is not clear.
60	12.1 1st paragraph		There is a switch in terms between "fissile" and "fissionable" and occasionally between "material" and "substance". Should be consistent use of terms as not all have the same meaning.

61	12.2 Paragraph 1 Line 2	"…for operations outside reactors for which"	Improves the English.
62	Page 19 12.3.1 **Paragraph 1**	Change to: "Operations management has overall responsibility for nuclear criticality safety and shall provide regular and systematic oversight.	Management has the responsibility and "continuing interest…" is very weak terminology
63	Page 19 12.3.1 **Last Sentence**	Suggest changing wording to "Management shall establish operating procedures and a process for the modification of said procedures.	
64	Page 20 12.3.2 Paragraph 1	Define: "Person who provides direction and guidance in the form of pre-job brief or who is present while a task is being performed to provide that direction and guidance".	The term "supervisor" needs defining in the Glossary.
65	12.3.2 Paragraph 5		It is not clear what the intent is here. The guidance document GD-327 simply reiterates the RD document and provides no further guidance. It is noted that the practice of simply repeating the requirements in the GD document is used frequently.
66	12.3.2 Paragraph 6	Each supervisor shall comply with good…"	This is ambiguous and it is not clear what the intent is here. Need to define what good safety practices are, what is unambiguous identification of fissile materials and good housekeeping.
67	12.3.3 Paragraph 1	"…shall provide and has responsibility for technical…"	Improves English.
68	12.3.3 Paragraph 7	"…shall participate…"	Mandatory requirement shall not be subject to a decision making process.
69	Page 21 12.4/3, 4 & 5	Replace with "Revision of operating procedures shall be carried out as needed and shall be reviewed and revised as necessary with a specified minimum frequency. All changes shall be subject to a change control process."	Ensures changes can be made as needed and that a rigorous process is followed and ad hoc changes are not made without proper review.
70	Page 22 12.7		What is the relationship between Section 12.7 of RD-327 and G-225, Emergency Planning at Class I Nuclear Facilities and Uranium Mines and Mills? G-225, Emergency Planning at Class I Nuclear Facilities and Uranium Mines and Mills, describes guidelines for emergency planning. It is unclear whether the licensees are required to follow both sets

			of guidance, and how will any conflicts between the two sets of guidance be resolved.
71	Page 22 12.7 Last Sentence		'Emergency procedures shall address re-entry procedures and the membership of response teams. What is meant by 'the membership of response teams'?
72	Page 23 13.0		This section is very short. The first sentence states the requirement. The second statement tells where guidance can be found. The guidance document contains shall statements. Are these shall statements requirements or guidance? The regulatory document should contain all the requirements and it should be clear that all statements in the guidance document that are not already requirements in the regulatory document are for guidance only.
73	Page 24 16.0		What about those areas that don't have Criticality Accident Alarm Systems but criticality safety may be a concern?
74	Page 25 Glossary		Contains some words that aren't in RD-327, assuming this is glossary for all NCS (RD-327 & GD-327)
75	Page 26 Glossary		The term: Fissile Nuclide. Suggest that you provide a list of all fissile nuclides.
76	Page 26 Glossary		Fissionable Material and Special Fissionable Material are terms commonly used. These terms must also be defined in this Glossary.
77	Page 27 Glossary	Delete "/or"	The term: "Light Water Reactor". Definition neds to be more restrictive as AECL does not consider ACR a light water reactor.
78	Page 28 Glossary		The term: Subcritical limit: The difference between sub-critical limit and upper sub-critical limit is not clear. How do these terms relate to Safety Limit, Safety System Setting and Limiting Condition for safe Operation (LCO) as applied to Nuclear Facilities.
79	Page 28 Glossary	Delete "A quantity proportional to"	The term "Reactivity"
80	Page 28	Replace with:	The meaning of the term Upper Subcritical Limit is not

	Glossary	The maximum allowed value of the calculated *k*-effective or single parameter value established to ensure that under both normal and credible abnormal conditions, including allowance for bias, uncertainty and a minimum margin of subcriticality, that systems assessed to be subcritical will actually be subcritical.	clear.
81	Page 28 Glossary	Delete	The Term: "Validated computational technique" This term is not used in the document.
Country/Organization: CANADA/ Ontario Power Generation			
1.	Section 2.1.2.2, item 1a) ii),		"A minimum value for an administrative margin of subcriticality, as presented in the formulas for calculation of subcriticality, is 5% in neutron multiplication factor." Is there a standard, reference, or source for the 5% neutron multiplication number?
2.	Section 2.1.2.6, Page 7/Para 2/ Line 2	"…*were constructed according to the design specifications*."	Missing word has been added.
3.	Section 2.1.3.2 Page 8/last para		Could the postulated undetected failures be considered as one condition in the implementation of the Double Contingency principle? Please clarify.
4.	Section 2.1.4.1, Page 10/Para 1		Could conservative assumptions be used in the calculational methods in this context as an alternative if there is lack of experimental data? Please clarify.
5.	Section 3.1.1, Page 11/bullet 1		Does this mean the argument cannot be based on fail-safe feature of the facility if any? Please Clarify.
6.	Section 3.1.2.1, Page 12/Para 2/ last line "…stipulation applied only to ^{233}U, ^{235}U, and ^{239}Pu."		How about the criteria for other materials? Is there a reference to be used?
7.	Page 6, item 1a-i	To the statement "The margin of subcriticality is calculated using formulas presented in GD-327…" add "or calculated	GD-327 is intended to provide guidance. Alternatives may exist, and hence GD-327 should not be referred to in a

		using other methodologies provided they are adequately justified"	prescriptive manner.
8.	Page 6, item 4a	The required frequency of 10^-7/year is inconsistent with other requirements in the document. It should read 10^-6/year or 10^-5/year per RD-337 definition of Design Basis Accidents. Same comment applies to Page 7 where reference is again made to 10^-7/year.	
9.	Page 10, line 1	Validation of a calculational method by comparing results with those of another calculational method should not be considered "unacceptable".	Such a validation method can be justified. For example, CSA N286.7, Section 9 Validation, includes the comparison of computer program results with the results of another validated computer program.
10.	Page 10, Section 2.2, first sentence	In a similar sense to comment 1, allow for compliance with other defensible limits (as an alternative to those in GD-327). This is a generic comment applicable throughout the draft RD-327 where reference is made to GD-327 in a prescriptive manner without allowing for justifiable alternatives.	GD-327 is intended to provide guidance. Alternatives may exist, and hence GD-327 should not be referred to in a prescriptive manner.
11.	General	Include a reference to ANSI 8 standard series in RD-327	It's very good that the terminology (double contingency, etc.) and important concepts have been taken from the ANSI 8 standard series. However, this document has no direct reference to these standards, unlike GD-327 which relies heavily on them.
12.	Reference Section 2.1.1.2 Page 4/ Para 2b Relates to definition of Small Quantity	New Text: "…mass limits specified in Section 10 of **GD-327."** Add the GD-327 at the end of the sentence.	Actually recommend inclusion of the limits here, rather than directing reader to GD-327, so that RD-327 does not depend on GD-327.
13.	Fundamental concept Section 2.1.2.2. Page 5/last para Process Analysis: "…it shall be determined that the entire process will be	a) Change 10^{-6} per year to 10^{-5} per year. This will also be consistent with US and international practice, as well as with the RD-310 definition of DBAs. b) The likelihood (frequency) of occurrence should be related somehow to the consequences of criticality accidents – not all of them are born equal. (if we adopt the US approach completely, then all criticality	1) The US NRC regulatory documents and the ANSI standards do not impose strict accident probability limits because of the difficulty in estimating these probabilities. Instead, the US regulators allow the licensees to define "unlikely, highly unlikely and credible". In a safety analysis context, the NRC document NUREG 1520 applies the term "highly unlikely" to accidents with frequency of occurrence lower than 10^{-5} per year (section 3.4 in the draft rev. 1, August 2009).

	subcritical under both normal and credible abnormal conditions (events or event sequences) that have frequency of occurrence equal to or **greater** than 10^{-6} per year [6, 7] (hereinafter "**credible abnormal** conditions").	accidents should be considered to have high consequence)	2) Regarding an accident in the spent fuel bay of a reactor using enriched fuel, section 4.3.4 in the doc NK054-REP-07730-00024 Rev 000 (*Malfunctions, Accidents And Malevolent Acts, Technical Support Document, New Nuclear – Darlington Environmental Assessment*) indicates that the consequences for the public are below 50 mSv at distances greater than 200 m (even without shielding). Also, the duration of such a criticality accident in the spent fuel bay is very short, therefore sheltering and evacuation are not required or possible (see below).
14.	Fundamental (and editorial) Section 2.1.2.2 (2.c.) Page 6/Para 2c. Deals with "…frequency of occurrence equal to or **greater** than 10^{-6} per year"	Change 10^{-6} per year to 10^{-5} per year. Correct numbering (Should be a. and b. rather than c. and d.	See above
15.	Novelty Section 2.1.2.2 (2.d.) Page 6/Para 2d "semi-quantitative methods"	N/A	Are these "semi-quantitative methods" subjective?
16.	Fundamental	Change to ensure consistency with the major comment above.	Should this be "10^{-6} per year" rather than "10^{-7} per year"?

	Section 2.1.2.2 (4.a, 4.b) Page 6/Para 4.a. and 4.b. Regarding "10^{-7} per year"		
17.	Editorial Section 4.0 Page 15/1st Para in Section 4 "... normal and credible abnormal conditions over the operating life of a **vessel**."	Suggest replacing "**vessel**" with "**facility**"	The term "vessel" is restrictive.
18.	Reference and Fundamental Section 7.0 Page 17/1st Para on page, starting with "Criteria for…"	Avoid dependence on GD-327, if feasible. We have to accept that a highly unlikely criticality accident may have high consequences for a few workers in immediate vicinity.	This section only talks about cases when shielding exists already, but refers to GD-327 section 7.3 which in fact imposes a very restrictive dose limit. We cannot expect the maximum dose to a worker following a criticality accident to stay below 50 mSv, which is the limit for one year of normal operation. See also NK054-REP-07730-00024 referenced above.
19.	Reference and Fundamental Section 8.0 Page 17/Para 2 and 4 in section. Relates to Nuclear Criticality	Avoid dependence on GD-327, if feasible. See above discussion above "credible" and frequency limit.	This section creates another dependence on GD-327 section 8 where "credible event" is again equated to an event (sequence) with frequency of occurrence equal to or greater than 10^{-6} per year
20.	General. Section 1.3, Page 2.	Add a statement from the *Nuclear Safety and Control Act* (*NSCA*) or other relevant regulation on storage and disposal of nuclear waste	A specific regulation on storage and disposal of nuclear waste is not provided in Section 1.3
21.	General Section 1.4 Page 2/Last Para	Define the acronym American National Standards (ANS) in paragraph 2 of Section 1.4	The acronym for American National Standards in not defined

22.	General Section 1.4 Page 3/After bullet 11	Include information from the following two standards in relevant sections of the document: • ANS-8.25, "Development of Nuclear Criticality Safety Related Postings" • ANSI/ANS-8.26: "Criticality Safety Engineer Training and Qualification Program"	The information from two relevant ANS standards is not included in RD-327.
23.	General Section 2.1.2.4 Page 7/Only Para in 2.1.2.4	Add the word 'signs' in Section 2.1.2.4: "Appropriate labelling, **signs**, and area posting …"	In addition to material labelling and area posting, we suggest including the word "signs"
24.	Editorial Section 2.1.1.1 Page 3, bullet 2	Existing Text: "…advanced moderators (more effective than water)" Clarify meaning – See comment.	There is nothing more effective in moderating neutrons than hydrogen. As such, heavy water (less absorptions than light water) is the most effective moderator. Maybe what is meant is reflectors from materials that promote (n,2n) reactions, like beryllium, for example.
25.	Editorial Section 2.1.2.1 Page 5/Para 1 /Line 6	Existing Text: "Nuclear criticality safety does not differ in any intrinsic way…." Suggested Text: "Nuclear criticality safety shall be treated at least with the same rigour as…" (or something to this effect)	I am not sure that the existing statement is true considering the potential consequences.
26.	Fundamental Concept Section 2.1.2.2 Page 5/Para 1	Existing Text: "…equal to or greater than 10^-6" Change 10^{-6} per year.	The cut off frequency for criticality safety should be consistent with other regulatory documents, like RD-310 for example. Why not 10^-05? In fact, consequence wise a LBLOCA, for example may be more severe than a criticality event in a small facility.
27.	Fundamental Section 2.1.2.2 Page 6/Bullet 4a	Existing Text: "An external event that leads to a criticality accident with frequency…10^-07…" Change to 10^-06.	This number is so small that it loses its relevance. What kind of external event that could happen once ten million years?!
28.	Concept Section 2.1.3.5 Page 9/Para 1 Line 5	Existing Text: "…wood, concrete, steel…" revise	How are these materials better reflectors? Maybe "lighter" materials, like aluminum, beryllium…
29.	Wording Section 2.1.4.2 Page 10/Para1/Line 1	Existing Text: "The uncertainty in the bias…" Suggested Text: "The **variation** in the bias…"	Industry uses the term "variation in the bias"
30.	Editorial	Existing Text: "…checks should be performed to confirm that	'Mathematical operations' in this context is vague.

	Section 2.1.4.3 Page 10/Para 1	mathematical operations…" Suggest using terms related to computer code verification, computer code models, computer code qualification	
31.	Wording Section 2.1.4.4 Page 10/Bullet 1	Existing Text: "...clarity and lack of ambiguity…" Eliminate one of them	Redundant terms
32.	Typo Section 10.0 Page 18/Title	Revise isotope format	Standard notation for isotopes, move the atomic number to the right (alignment)
33.	Editorial Section 12.3.1 Page 19/Para 1	Existing text: "Continuing interest in safety should be evident." Remove	If he/she fulfils the rest of responsibilities, his/her interest in safety should be evident.
34.	Editorial Section 12.4 Page 21/Para 1 /Line 3	Existing Text: "They should be free of extraneous material." Reword.	I am not sure what is meant here.
35.	General		This should be a standalone document, so any limits, restrictions, requirements should be part of this document. The reader should not be sent to the guide. Maybe an appendix should be considered.
36.	Section 1.2 Page 1/Para 2-4	Eliminate paragraphs 2 to 4	Paragraphs are a repetition of three paragraphs in the Preface
37.	Section 1.3 Page 1/Para 1	"The provisions of the ***Nuclear Safety and Control Act (NSCA)*** and the regulations…"	Define NSCA the first time that it is used.
38.	Section 11.0 Page 18/Para 2	"A **nuclear** criticality safety evaluation…"	Consistency of terminology (e.g. NCSE acronym appears in RD-327 and GD-327). Check document to ensure specification of 'nuclear' before 'criticality'
39.	Section 12.3.3 Page 20/Para 1	The NCS Staff shall: • Maintain familiarity with current… • Maintain familiarity with all… • Assist supervison…	Reformat section as a bulleted list. The content is ideal for a list given that each paragraph starts with 'The NCS Staff shall…'
Organization: Candesco			
1	p.3, section 2.1.1.1, point 2	"more effective than light water (H_2O)"	Clarification of the type of moderator intended to be used as the baseline. This comment also applies to section 2.1.1.2 point 2.c(.i), section 3.1.2.1 point 3. In fact, it

			would be help to include in the Glossary that "water" is used synonymously with "light water" unless otherwise indicated
2	p.6, section 2.1.2.2, point 1b(ii)		An administrative subcriticality margin of 20% of critical mass seems arbitrarily large.
3	p.6, section 2.1.2.2, point 2c (should be point 2a)	"All credible abnormal conditions (events or event sequences) potentially leading to criticality increase and having frequency of occurrence equal to or more than 10^{-6}/year are identified and assessed."	Focus of discussion should only be on credible abnormal conditions which lead to reactivity increases.
4	p.6, section 2.1.2.2, point 4a	"An external event that leads to a criticality accident with frequency of occurrence less than 10^{-6}/year ~~10^{-7}/year~~ "	Consistency with definition of credible abnormal events (frequency
5	p.9, section 2.1.4.1 para 2	"~~When no experimental data are available, establishment of the bias for a calculational method is not possible and the requirements of this Subsection cannot be satisfied.Validation of a calculational method by comparing the resultins with those of another calculational method, for example, is unacceptable~~."	This requirement is overly restrictive. Validation against another validated calculational method should be acceptable.
Organization: Bruce Power			
1	Sec 1.4		Since this document is a requirement on NCS, then all relevant sources of the requirements should be referenced in the RD. All ANSI documents should be listed in this section.
2	Sec 2.1.1		Clear definition of fissionable materials should be given. Sections 2.1.1.1, 2.1.1.2, and 2.1.1.3 are confusing with respect to the use of natural U. RD should make it clear that it doesn't apply to CANDU reactors operating with NU and heavy water.
3	Sec 2.1.1.1		Revise wording "advanced moderators (more effective that water)".
4	Sec 2.1.1		Remove "recommendation". Also apply this to the entire procedure.
5	Sec. 2.1.1.3		It should be made clear that this RD doesn't apply to CNADU reactors operating with NU and D2O
6	Sec. 2.1.1.4		"meet its legal requirements, when specified,, .." Not sure

			if this sentence is needed. It is clear that when a facility operate using enriched fuel that exceeds the exempted amount, CSE is needed to show the entire operation is safe.
7	Sec. 2.1.2.2		Need to give the basis of 10-6 (references 6 and 7) are not appropriate. A more appropriate value used in the Canadian industry is greater or equal 1.0-5 otherwise greater than 1.0-6 should be used. Industry consensus is needed on selecting the appropriate value.
8	Page 6		Items 3 and 4 are very restrictive and require industry consensus. Once agreement is reached on the appropriate value for credible then all accidents below that value should be acceptable. This RD should not apply more limiting restriction on criticality consequence than sever core accidents
8	Sec 2.1.3.6		Not sure the term “moderating” is appropriate
9	Sec. 2.1.2.8		Annual review is too cumbersome considering operator error is on the order of 10-1 or 10-2 for fully trained operators. 2-year review is more appropriate.
10	Sec. 2.1.3.2		It is not clear how DC principle is used in the RD when credible normal and abnormal accidents are defined based on 1.0-6.
11	Sec. 3.1.1		The requirement on the need for alarms should be based on 1.0-6 requirement nothing more. If the operator can demonstrate that all normal and credible abnormal events with likelihood of 1.0-6 are subcritical and meeting the requirement of 5% on subcriticality then there is no need to CAAS. Manual audible alarm is more appropriate to warn people not in the immediate vicinity to evacuate in case of a criticality event.
12	Sec 11		Not sure of the use “light water reactor fuel”. The term “enriched fuel” is more appropriate.
13	Page 19		3rd para from the bottom. Please delete. It is clear that it is the management responsibility to decide how to demonstrate the requirement on NCS. The use of “may” or “consultant” is not appropriate fort an RD.
14	Sec. 12.3.2		Supervisor is part of management and these requirements should be moved to 12.3.1.

15	Sec. 12.3.3		
16	Sec. 16		Can't find the requirements in this section. In the second para, "The provisions of this section may be considered…" not sure of the provisions and if it is a my be then it is not a requirement.