United States Government **Department of Energy**

memorandum

Idaho Operations Office

Date: 9/25/07

Subject: Criticality Safety Support Group Response to Tasking 2007-07 (OS-QSD-07-126)

To: J. N. McKamy
DOE-HQ, NA-171/GTN

The CSSG has completed its action on Tasking 2007-07, "Review of the Technical Basis for IEZ at Y-12 (Y/DD-1242)." The statement of this task is:

> The CSSG is tasked to perform a technical review of the proposed approach to criticality accident alarm detection and placement at Y-12 with particular attention to whether such an approach is acceptable for the new Highly Enriched Uranium Materials Facility (HEUMF). Some specific potential applications at Y-12 of this new approach may be provided by the NNSA Y-12 Site Office (YSO) via the NCSP Manager under separate cover for the CSSG's consideration as part of this effort. The CSSG is requested to consider the acceptability of the proposal relative to DOE Order 420.1b nuclear criticality safety requirements including all ANSI/ANS-8 Standards invoked by the Order.

The attached review contains a summary statement giving the conclusions of the review, followed by a series of specific non-technical and technical comments from the two documents provided to the CSSG. These specific comments are not intended to be a complete set of all grammatical, syntax, logical or technical errors in the documents, but do provide a sufficiently large subset to convey the scope and intent of the CSSG review. Technical reviewers at the Y-12 National Security Complex can use these comments as a starting point to identify others in the documents.

The following summary conclusion of the review is taken from the attached document.

> These two documents are related in technical content and both suffer from two serious flaws: first, technical errors as well as basing conclusions on assumptions that are highly debatable are numerous; second, the logic, combined with grammar, syntax, and word usage errors, is so poor that confusion and an inability to definitively ascertain the intended meaning is prevalent throughout. These two documents are both revisions to the originals and it is the CSSG's judgment that further revisions will surely be less productive than withdrawal of the documents and development of a document that just follows the guidance in ANSI/ANS-8.23.

The attachment also contains several comments relative to the interpretation and compliance with ANSI/ANS-8.23 as evidenced in the subject documents. The reports are too flawed to support compliance with Parts (2), (3) and (4) of Section 4.2.1 of the Standard, and in summary do not demonstrate compliance with ANSI/ANS-8.23.

Based on the attached review, the CSSG cannot recommend approval of the subject document (Y/DD-1242) or the approach described therein for determination of the immediate evacuation zone (IEZ). The major concern is with the serious technical errors and misunderstandings of the source documents that could likely result in a reduction of personnel protection relative to the current program if they were to be implemented, and with lack of demonstrated compliance with ANSI/ANS-8.23.

Sincerely,

Adolf S. Garcia, Chair
Criticality Safety Support Group

cc:
CSSG, Jim Felty, DOE-HQ, NA-17/GTN

Attachment

CSSG RESPONSE TO NCSP TASKING 2007-07, REVIEW OF DOCUMENTS Y/DD-1242 AND Y/DD-1067

REFERENCES:

1. Technical Basis for an Immediate Evacuation Zone for Facilities Requiring CAAS Installation at the Y-12 National Security Complex, Y/DD-1242, Rev. 1, April 2007.
2. Technical Basis for the Highly Enriched Uranium Material Facility Immediate Evacuation Zone, Y/DD-1067, Rev. 1, February, 2007 (UCNI).

SUMMARY

The goal of these two related documents; namely, to define an immediate evacuation zone in general (Y/DD-1242) and then facility specific (Y/DD-1067), that is consistent with the ANSI/ANS-8.23 guidance, is certainly appropriate. In fact, other DOE fissile material handling sites have done just that over the years, even before ANS-8.23 was formally documented. Unfortunately these documents fall far short of that goal.

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Specific comments are included on the following pages. These comments are not intended to be a complete set of all grammatical, syntax, logical or technical errors in the documents, but do provide a sufficiently large subset to convey the scope and intent of the CSSG review.

SPECIFIC NON-TECHNICAL COMMENTS

Both documents exhibit spelling, grammar, syntax, word-choice and usage, and logic errors on essentially every page. Some examples are provided below, in which the quoted Y/DD text is in italics followed by the CSSG comments in parentheses, or, if there is no quoted text, then simply the CSSG comments.

Y/DD-1242

Page	Comment
X	(The acronyms CRAC and KEWB are incorrectly defined.)
3	*Historically, individuals located within three feet of an accident that received a lethal dose would not benefit from prompt protective action, since the dose delivered to them would be lethal.* (This statement is not only very poorly written, but it is also arguably technically incorrect.)
4	*...framework to determin areas...* (Obviously there was no spell-check.)
5	*Evaluates technically the radiation effects to an evacuating individual...* (Perhaps the author meant "Provides the methodology to evaluate the radiation effects..." or perhaps the author meant "radiation dose" instead of radiation effects?)
6	*The IEZ approach advanced here represents a new paradigm for Y-12, since the focus prior to adopting DOE 420.1B had been to first determine first, a distance that corresponded to a 12-rad-in air dose, where CAAS annunciation would be required, then relying on the fact that this distance extended up to 200 feet beyond a facility edge (the extreme accident location within a facility) around a facility, resulting in audible areas outside of buildings, requiring immediate evacuation for a de-facto IEZ.* (This much-too-lengthy sentence is extremely difficult to follow.)
10	*From Table 1: First pulse followed by limits of evacuation time away from IEZ* (meaning?)
11	*...as a criticality accidetn.* (Related to this misspelling, that a spell check would have caught, is the use of "criticality" incorrectly about half the time, and the use of "criticality accident" correctly the rest of the time, throughout both documents.)
11	*Recommendations are provided for implementing the Phase I IEZ including training the workforce may be provided.* (Very confusing)
12	*...installed CAAS station locate may extend...* (Location seems to be the intended word)
14	*DOE national laboratories have facilities where compartmental or smaller scale operations takes place and credible accident scenarios were restricted to isolated locations. These facilities are usually experimental with a reduced safety significance than large scale industrial facilities as at Los Alamos National Laboratory, Lawrence Livermore, or within heavily shielded areas, such as hot cells at Sandia National Laboratories and Oak Ridge National Laboratory or the Fuel Cycle Facility at Idaho National Laboratory (formerly Argonne-West).* (Not only are there numerous grammatical errors in these two sentences, but the words are confusing and possibly technically inaccurate.)

Y/DD-1067

Page	Comment
4	*The Y/DD-1242 analysis provided the Red Zone within the HEUMF facility.* (Meaning?)
5	*The HEUMF is designed as the modernized storage facility.* (Very poor word selection)
6	*This statement is evidenced by the fact that only one process criticality involving an unmoderated material outside a reactor facility has occurred since handling fissile material dated back to the 1940's.* (Very poor word choices, punctuation, and grammar)
10	*However, analysis of the evaluated conditions provided within the HEUMF PDs and CSEs may exclude credible accidents to a few areas of interest considered bounding.* (Perhaps the author meant "confine" or "limit" instead of "exclude"? and perhaps "provided" is not as accurate or revealing as others words that could have been chosen.)
12	*The Slide Rule provides a neutron half value thickness (HVT) for concrete close to the accident at 2.2 inches, and the photon half value thickness close to the accident as 4.3 inches. Therefore, net the half value thickness for an unmoderated accident would be 2.73 inches while the half value thickness for a moderated accident would be 3.78 inches respectively.* (Clarity could be greatly improved.)
14	*This considers the effects of the two limiting scenario at limiting distances and minimum shielding.* (Grammar, word choice, and clarity are far from professional quality.)
19	(All figures in Appendix A are illegible.)

SPECIFIC TECHNICAL COMMENTS

Y/DD-1242

Page	Comment
6-13	(Within Section 1.2 there are words in several locations that either imply or state that an IEZ is defined by a facility boundary. This is not consistent with the definition of an IEZ provided in ANS-8.23.)
11	*...and since radiation follows an inverse square in distance law...* (Not inside facilities or where ground scatter is present.)
26	*Section 2.2 RADIATION EFFECTS AND RISKS FROM ACUTE RADIATION EXPOSURE* (CSSG members are not acknowledged experts in these areas, but found the proposed allowable doses to be much larger than customary within the U.S. and there was no indication that this section had been at least vetted through the medical and radiation protection experts at Y-12.)
43	*In reality, a significant dose would be received from sky shine radiation and secondary photon production when neutrons scatter off steel and concrete structures.* (This statement is suspect without [a reference to] supporting analyses.)
43	*The credible accident scenario is derived from an event deemed beyond "double contingency" as noted in nuclear criticality evaluations (NCSEs).* (There is no such concept as "beyond double contingency". Either one has complied with the Double Contingency Principle and thus more than one unlikely, independent mishap must occur

before an accident is possible, or one has not complied with the DCP and only one unlikely mishap can result in an accident.)

45 *For process solutions or moderated accidents, the radiation effects from the possibility of recriticality events warrant evacuation at further distances as time progresses. The relatively small volume assumed to be associated with such an event would limit the moderated event to a single pulse.* (The first sentence is not correct; decisions to evacuate further are based on measured dose rates per ANS-8.23. The second sentence is stated as fact when there is no basis provided for the assertion.)

46 *...and the 1999 Russian critical facility accident at Arzamas (single pulse metal accident) resulted in one fatality.* (The accident occurred in 1997, had multiple pulses and remained critical for a week until physically shut down.)

47 *The evacuation model derived in Appendix B makes use of Barbry's correlation. The use of Nomura, Olsen, Tuck, and Barbry correlations is highly problematic and process dependent. Nakajima summarizes the appropriate use of these correlations for both the first pulse and any subsequent pulses depending on whether boiling has occurred in the solution.* (The author states that Barbry's correlation was used but then states that its use is problematic. No basis is provided or referenced to show that Barbry's correlation is problematic or process dependent. In fact, Barbry's correlation is empirically based and judged to be the most accurate available for the intention stated in his paper. One CSSG member who is familiar with Nakajima's paper and was present when it was presented at ICNC 2003 judges it to be deficient and of little value.)

48 *The first pulse power associated...was about 2.0 X 10+14 fissions /liter.* (fissions/liter is energy density not power. Also, the second and third critical volume entries in Table 4 are incorrect.)

49 (The text on page 48 and the caption of Fig. 6 would imply that just the entries in Table 4 are plotted in Fig. 6, but there are more data points in this figure than entries in Table 4, with no explanation of their origin.)

58 (While DOE-HDBK-3010 asserts that 1.0+17 is a conservative value for the fissions from an HEU metal criticality accident, it is inconsistent with Woodcock's value and with past Y-12 analyses that concluded that the large casting facilities warranted a neutron source when being used. It is also based solely on critical experiment accidents that occurred prior to the Arzamas accident that produced about 1.0+19 fissions. The author quotes from references CCG-439 and CCG-440 for justification for the 1.0+17 fission value. These have not been reviewed by the CSSG.)

59 *Thus it may be prudent to say a 10 liter criticality would bound these credible scenarios.* (The preceding text is unclear, but does not seem to support this conclusion.)

60 (The text discusses three bounding accidents: M1, M2, and M3. The ratio of the total fissions to first spike fissions varies by orders of magnitude for these three accidents with no explanation. As a general comment, there seems to be no justification for the assumed evacuation time to be 60 minutes. One would generally not accept such a long time.)

97 *An HEU moderated metal criticality accident will possess similar characteristics as an HEU solution accident for fissile densities greater than 0.5 kg/L and critical volume less than 10 L (H/X <20).* (It is not obvious that this assertion is valid.)

Page	Comment
3	*...would result in an accident lasting a very short duration. ...would be considered negligible. ...threshold radiation dose is greater than 25 mr/hr.* (These first two phrases are unsupported assertions and the third includes an undefined concept, "threshold radiation dose".)
6	*The energy produced by the critical configuration would be sufficient to disperse material and terminate the event. There is no credible constraining mechanism that would prevent the material from dispersing.* (Without providing a [justified] energy density for the assumed accident there is no support for the conclusion.)
7	***Moderated Metal Criticality**: A moderated metal criticality with a first pulse of 1x10+17 fissions, followed by any residual fission contribution from possible follow on pulses, however slight, would provide an additional 1x10+17 fissions during an evacuation interval of one hour for a total of 2x10+17 fissions.* (See bounding moderated accident M2 from Y/DD-1242, page 60, where a 1x10+17 fission first spike is followed by 1x10+18 fissions during the same 60 minute evacuation period. Barbry's correlation suggests that a factor of 10 to 20 increase in the total fissions will likely occur in the first ten minutes after the first spike if the reaction continues.)
7	***Unmoderated Metal Criticality**: ...1x10+17 fissions, self terminating instantly.* (This should be justified based on the Arzamas accident.)
8	*Because of the relatively small critical volume, the event would likely terminate by rapidly boiling off of the critical metal water mixture. This shutdown mechanism compares with most solution type criticality accidents.* [First, if the reviewers understand the (assumed) accident model, it is one comprised of HEU metal pieces in a water bath. If anything were to boil it would only be the water. Second, if the accident model is metal pieces in water then comparing this to a solution model is comparing apples to bananas. Third, to set the record straight, only one of the 21 solution (process) criticality accidents is known to have self-terminated by boiling off water.]
8	*Any subsequent pulses from this event would be much smaller in magnitude from the first pulse due to the presence of an excessive amount of neutrons produced from the fissions in the first pulse.* (Based on the CRAC and SILENE experiments it would seem that the reason for subsequent pulses being smaller is due to the smaller reactivity insertion rate associated with the migration of bubbles generated in the first spike.)
8	*Another possible shutdown mechanism could be from the continuous addition of sprinkler water that would eventually dilute the critical metal-water concentration.* (The scenario seems to be metal pieces in water. If that is the case then more sprinkler water will not change the concentration.)
8	*The subsequent pulses of that* (the Y-12) *accident, approximately 10% in magnitude of the first pulse, and occurring approximately at 10 second intervals, provided the majority of the dose contribution to evacuating individuals.* (This is certainly not true for those who received large or even moderate exposures from the first pulse.)
8	*This value was based on reactor and critical experiment mishaps which includes the presence of external sources.* (As stated before, DOE-HDBK-3010 has no strong

justification for 1.0+17, and evidence exists to the contrary. Also, the presence of external sources is questioned.)

9 *It can be shown...* (This is a strong assertion that must be shown.)

9 *In reality...* (The author applies fission values representative of a dilute solution accident to a moderated metal accident when the volumes would be orders of magnitude apart.)

16 Table 5 lists first-pulse dose rates (which are generally of no interest), but provides no discussion as to why they are provided nor for what time in the pulse they are representative.

COMMENTS RELATIVE TO ANSI/ANS-8.23

In Section 4.2 (Technical Staff Responsibilities), Subsection 4.2.1 (Planning), ANSI/ANS-8.23 requires that:

> The technical staff shall
>
> (1) identify potential criticality accident locations; - **that seems to be done in a general sense**
>
> (2) evaluate and characterize potential criticality accidents, including radiological dose prediction; - **that is really obfuscated with inaccuracies, questionable inferences (not a good lucid basis)**
>
> (3) determine the instrumentation and equipment requirements for emergency response activities; - **again, very obfuscated with inaccuracies, questionable inferences (not a good lucid basis)**
>
> (4) define the immediate evacuation zone around the potential criticality accident locations; - **again, very obfuscated with inaccuracies, questionable inferences (not a good lucid basis)**
>
> (5) participate in the planning, conduct, and evaluation of exercises and drills. - **not an issue with these reports.**

In short, the reports are too flawed to support (2), (3), and (4) of ANSI/ANS-8.23 and as a result do not demonstrate compliance with the Standard.