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Guidelines for Preparing and Reviewing Licensing Applications for the Production of Radioisotopes

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General Comment

See attached file(s)

Attachments

Nureg1537 - ISG Comments by B&W

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Babcock & Wilcox Comments to Draft Interim Staff Guidance Augmenting NUREG-1537, Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors

Docket : NRC-2011-0135

Introduction

Babcock & Wilcox appreciates the progress made by NRC on developing this draft guidance for licensing a medical isotope facility. B&W believes this guidance document will significantly enhance the processes of preparing and reviewing the application(s).

We also appreciate the opportunity to provide comments that follow. These comments are divided into 3 sections. The first section contains major comments that B&W believes are extremely important to address. The second and third sections contain specific comments on Parts 1 and 2 for NRC's consideration.

Major Comments (Applies to both Parts 1 & 2)

1. Two-Step license application content

   Licensing of these type facilities under 10CFR 50 requires both a construction permit and an operating license. While it is possible to submit these at the same time, it is more likely that licensees will use a two step licensing process. In this case, neither NUREG-1537 nor the augmenting guidance provides differentiation between the expected content of the construction application and the operating application. During the meeting between B&W and NRC in 2010 (ML100501028) B&W presented a high level description of the content of a construction application versus an operating application. While this description was brief and very high level it begins to describe the expectation. B&W believes it will be extremely important to provide some level of guidance for both the applicant and the reviewers regarding the content of the construction application and the operating application. Absent guidance there is high potential for misalignment between NRC and the licensee that could result in protracting the licensing process.

   Suggestion/Recommendation: Include a section in each chapter of the ISG (both Parts 1 and 2) that provides a general discussion of the content of a construction application versus an operating application.

2. Applicability of 10CFR70

   There are a number of places in the ISG where the requirements of 10CFR70 are either cited or implied to be directly applicable to the production facility. While the concepts of 10CFR70 regarding criticality safety, chemical safety and worker protection may be appropriate for consideration and inclusion, they should be done within the context of 10CFR50 for the production facility. Statements such as "per the requirements of 10CFR70" do not seem appropriate. A statement directing the applicant and reviewer to 10CFR70 for insight as to what has previously been found acceptable may be more appropriate and may avoid confusion regarding the true regulatory requirement for the production facility being rooted in 10CFR50.

   Similarly, the use of the term IROFS (defined in 10CFR70) applied to the production facility seems inappropriate for a facility licensed under 10CFR50. B&W believes introducing the term IROFS to the facility will not only complicate the licensing process but will ultimately be confusing to the facility operations staff who will be working in the context of both a utilization and production facility.

   Note that there are a number of specific comments listed below related to this topic.

   Suggestion/Recommendation: Review the ISG in its entirety for the use of 10CFR70 and terms such as IROFS to assure they are used as guidance or reference and do not state or imply that they are regulatory requirements for a facility licensed under 10CFR50.

3. Small number of citations for Section 4a2

   Section 4a2 is one of most important sections regarding AHR PSAR and FSAR development. This section is roughly 13 pages worth of guidance but cites only 3 external references. While the references cited are useful, there are many other documents available to the NRC that will allow them to edit the ISG, assess AHRs, and judge the adequacy of future designs. In particular, B&W encourages the NRC to consider the following documents:

   1. *Status Report on the Water Boiler Reactor* by M.E. Bunker (1963)

2. *Experimental Studies on the Kinetic Behavior of Water Boiler Type Reactors* by M.E. Remley, J.W. Flora, D.L. Hetrick, et. al. (1958)
3. *Hazards Summary Report for the Walter Reed Army Medical Center Nuclear Research Reactor* by H.H. Cappel, R.S. Hart, and J.O. Henrie (1959)
4. *Reactor Excursion Behavior* by W.E. Nyer, G.O. Bright, and R.J. McWhorter (1964)
5. *Aqueous Homogeneous Type Research Reactors* by W.E. Parkins, R.F. Wilson, W.N. McElroy, et. al. (1958)
6. *Inter-code Comparison Exercises for Criticality Excursion Analysis* by Y. Miyoshi, Y. Yamane, K. Okubo, et. al. (2009)

While this list is by no means comprehensive, the above documents will be useful references for the NRC in future work with AHRs. If requested, B&W can provide additional references.

4. Void "collapse"

The term "collapse" is used throughout the ISG. However, "collapse" does not accurately reflect AHR phenomenology. There are indeed situations in which the voiding characteristics of the reactor change. These events can be initiated from various sources including changes in power and over pressurization. The term "collapse" implies a more catastrophic phenomenon than what has been observed in AHRs. While unusual gas evolution behavior has been observed in some AHRs (namely SHEBA), those observations were the exception and still resulted in bounded oscillatory behavior. Water boilers like SUPO, KEWB, SILENE, TRACY, and the Atomics International L-Series have all operated without observations of void "collapse." The differences in observation can most likely be attributed to the fuel base (Uranyl Floride for SHEBA, Uranyl Nitrate or Uranyl Sulphate for the others). A much more common mechanism for positive reactivity contribution relates to void compressibility. This mechanism is discussed at length in "Transient Criticality in Fissile Solutions—Compressibility Effects" (C.C. Pain, C.R.E. de Oliveira, A.J.H. Goddard, et. al. Nuclear Science and Engineering: 138, 78-95 (2001)).

Suggestion/Recommendation: Emphasize changes in void state instead of individual phenomena. Then, the NRC should have the applicant identify the most likely cause for changes in void state and, perhaps most importantly, quantify the reactivity effect for those changes in void state. Analyses should focus on the AHRs' power evolution as a function of time-dependent voiding changes.

5. Power density as an instability issue

A major issue cited throughout the ISG is the contribution of power density to AHR instability. This linkage between power density and instability is problematic for several reasons.

Firstly, the definition of "stability" must be clarified. Safety and stability are not mutually inclusive. A system may be characterized as stable but respond in an unsafe manner. Conversely, an unstable system can respond in a safe manner. The response is largely dependent on the design of the system.

For example: a hypothetical AHR may be stable when $3 of reactivity is inserted. In this sense, stability means a finite insertion results in a finite, bounded response. However, if the vessel wall is too thin, the vessel may rupture resulting in failure. This would be an unsafe response to a theoretically stable system.

Conversely, a hypothetical AHR may be unstable when an amount of reactivity is inserted causes unfavorably large variations in power and pressure. However, if the vessel wall is thick enough to withstand the subsequent pressure oscillations, no failure will occur. In this example, although the system was unstable, a safe response occurred due to engineered features. Thus, the NRC must carefully consider the applicants definitions of both stability and safety.

Secondly, a linkage between power density and AHR instability has not been proven experimentally or analytically. If power density was the sole source of instabilities it is unlikely that AHRs would have such well behaved transient performance. Transients that caused high powers (order of MW) would have likely resulted in instabilities (as the power density would have been on the order of MW/l). In fact, unusual time-dependent behavior observed in AHRs at higher steady-state powers (order of kW/l) can mostly likely be attributed to the design of the system, not physics inherent in AHRs.

For example, at SUPO's power level was chosen to be 25 kW. This limit was chosen based off of three observations (Bunker, 1963):

1. Large pressure fluctuations. The source of the pressure fluctuations was linked to recombiner performance.
2. "Transients [that are] either too large or too rapid to be completely cancelled by operation of the automatic control system." Linked to either or both recombiner performance and "sporadic local boiling ... in the spaces between cooling-coils loops".
3. Melting of the reflector's boron-loaded paraffin.

From these observations, we can say while power density is a good indicator of system behavior, there is no clear indication that higher power densities resulted in unstable behavior in SUPO. However, we can say there is a direct link between certain design features of SUPO and undesirable system behavior. From these observations, it is not hard to project that a system with a larger recombiner, optimized cooling coil geometry and better reflector design could operate in a safe and stable manner at higher power densities.

Specific analytical calculations have also been performed to investigate AHR instabilities. While the studies are proprietary, results have indicated that it is not appropriate to generically associate power density with instabilities. It is one thing to observe instability onset at certain power levels, it is another thing entirely to be able to identify the parameter or phenomenological source of the instability. It should be noted that analytical results have indicated that other system parameters are worthy of more consideration than just power density.

Suggestion/Recommendation: The NRC should have the applicant define "stability" for the system they are trying to license. As other design features and parameters will influence system behavior, the NRC should assess the system's "stability" and "safety" without specifically focusing on power density.

6. <u>No boiling</u>

There may not be technical justification to disallow fuel solution phase change. In fact, boiling was identified as a stabilizing phenomenon that enhanced the safety characteristics of both SUPO and KEWB. For example, in SUPO "[d]uring the boiling mode of operation, the power is almost continuously varying, but the magnitude of the fluctuations is only 10-15% (Bunker, 1963)." From KEWB experimentation it was found "as the core temperature approaches the boiling point of the solution, the [temperature] coefficient increases rapidly and reaches a value of -0.032 %ΔK/°C" from -0.027 %ΔK/°C. KEWB experimenters also noted that boiling served as an "additional shutdown mechanism in the homogeneous solution reactor (Remley, 1958)."

Additional boiling experimentation was undertaken by the French with CRAC and SILENE. In the first documented cited in Section 4a2 of the ISG, an appendix by Barbry shows three possible scenarios for long term AHR transient response. The final scenario includes phase change. For times less than 100 minutes, the boiling behavior of the AHR is well characterized and categorically stable. Barbry shows that boiling must be sustained for long periods of time before concentration changes begin to alter reactivity.

Proprietary analytical work has yielded results in line with the experimental results cited above. However, even without quantitative analyses, enough historical evidence exists to conclude that boiling is a phenomenon that can occur safely in an AHR.

The bigger concern with boiling relates to the reliable operation of the reactor. Sustained phase change is likely to make operations more complex and less reliable. Thus, an AHR will most likely operate near but below the saturation temperature during steady state operations. There may be some operational transients that result in boiling but these are unlikely to jeopardize reactor stability or safety.

Suggestion/Recommendation: The applicant must present analyses that demonstrate reactor stability and safety within the intended operational regime as well as likely operational transients. If this regime encompasses boiling, the influence of boiling must also be quantified.

Specific Comments on Part 1

Location	Comment
3 Page 4	**"features that enhance safety by reducing challenges to items relied on for safety (IROFS)"** Refer to major comment regarding referencing to 10CFR70 and IROFS.
6b Page 35	**"Certain operations with fuel or unirradiated SNM will be subject to the requirements of 10CFR70 ... defined as items relied on for safety (IROFS)"** While fresh fuel at a reactor facility licensed under 10CFR50 is generally done by incorporating 10CFR70 into the license reference, B&W is not aware of any reactor facilities that have adopted the Subpart H requirements of 10CFR70 regarding IROFS. This would appear to set an undesirable precedent for this type facility. See also major comment regarding 10CFR70.
6b Page 36	**"the regulatory limits pertaining to chemical exposure prescribed in 10CFR70.61 will also apply to the radioisotope production facility"** See major comment regarding 10CFR70.
4a2.2.1 page 8	**"All information should be current"** What does the NRC mean by "current?" Very little "current" data exists on AHR behavior and operations. However, a significant amount of relevant historical data exists. If "current" refers to the design being submitted, this comment may be ignored.
4a2.2.1 page 9	**"Separate descriptions should be given for the critical and subcritical fuels"** There will be a region of operation in which subcritical, critical and supercritical fuel will behave essentially identically. Consider radiolytic gas onset as another way to delineate fuel classification/description.

4a2.2.1 page 9	**"Physical properties significant to safety ... such as ... power density and distribution"** In AHRs, the liquid fuel form is able to deform and can be highly mobile depending on the reactor's design. In these situations the power distribution has less safety significance than heterogeneous reactors or even stagnant AHRs.
4a2.2.1 page 9	**"Physical properties significant to safety ... such as ... void formation or collapse"** See major comment above.
4a2.2.1 page 10	**"How does the thermal-hydraulic design prevent boiling of the coolant and/or formation of radiolytic gas bubbles that may cause reactivity transients?"** Boiling of the coolant may not need to be "prevented." Analyses may indicate that boiling of the coolant is useful for steady state heat removal or coolant boiling may improve safety under certain transient conditions. The formation of radiolytic gas bubbles during a reactivity transient is a desirable safety feature. Radiolytic gas formation quickly "turns around" significant power transients (assuming the gas is saturated; if not saturated, gas onset will be delayed until the saturation limit is reached). This behavior is one of the main reasons AHRs were characterized as being safe (Parkins, 1958). The concern should be quantifying the magnitude of likely transients that are deemed operationally significant. The applicant must determine which individual phenomena are the most safety significant based upon the design of the reactor.
4a2.3 page 12	**"Safety-related features that prevent loss of coolant"** Analyses have indicated that loss of coolant may actually shutdown the reactor or cause a significant decrease in power. This was shown experimentally in SUPO (Bunker, 1963) and the CR&D water boiler (J.W. Flora, J.W. Shortfall, E.J. Strain, "Operating Characteristics of the Water Boiler," LRL-151, (1954)). If this is indeed the case, the loss of coolant could serve as a safety feature not a safety concern. Thus, the coolant loss must be assessed objectively, not with the initial goal of prevention. Maintaining cooling capacity is still an important part of the design process to ensure reactor reliability.
4a2.5.1 page 14	**"The limiting core configuration for a reactor is the core that would yield the highest power density using the fuel specified for the reactor."** While power density is a very useful indicator of reactor conditions, it may not be the most suitable way to define the limiting core configuration. For instance, the configuration with the most available excess reactivity is the one that would result in the largest reactor transient. Thus, the applicant should determine the limiting core configuration which may not necessarily be dictated by power density but other operating parameters.
4a2.5.1 page 14	**"This includes the expected effects of radiolysis on power oscillations resulting from formation and movement of voids, effects of malfunctions in the recombiner and the possible resulting pressure pulses causing the fuel solution density changes, and the**

	effects of temperature changes or gradients in the solution." KEWB was developed to experimentally answer some of the questions outlined. One of the aforementioned reports offers an excellent and succinct summary of the KEWB program (Bunker, 1963).
4a2.5.1 **page 14**	**"Discussion of the safety considerations for different core configurations including a limiting core configurations that would yield the highest power densities and fuel temperatures"** Power density and temperature are both important reactor responses on which to judge reactor performance. However, for atmospheric AHRs there is a clearly defined maximum temperature (governed by the solution's saturation temperature). This means temperature is self limiting and may not be a safety significant parameter during some transients. Other parameters must also be assessed; for example: pressure, hydrogen concentrations, etc. Thus, the safety considerations for different core configurations must be assessed objectively, not with the initial focus on power density and fuel temperatures.
4a2.5.1 **page 14**	**"power stability effects of uneven, stochastic surface frothing, as well as void formation and collapse"** Parameters that will influence reactor stability are not limited to surface frothing and voiding changes. Proprietary analyses have shown that surface effects like frothing and sloshing have less influence on stability than phenomena occurring in high worth regions like heat transfer and voiding.
4a2.5.2 **page 15**	**"show that reactivity coefficients are sufficiently negative to prevent or mitigate damaging reactor transients"** Quantifying the available amount of excess reactivity is equally important to showing reactivity coefficients are sufficiently negative.
4a2.5.2 **page 15**	**"should include peak-to-average values for thermal hydraulic analyses"** In a homogenous system that is deformable and mobile, peak-to-average fluxes are significantly less important that other thermal hydraulic properties. In a well mixed AHR, the temperature profile will not be proportional to the flux profile. Experiments from the TRACY showed that even under large reactivity insertions, the axial temperature profile was relatively flat (K. Nakajima, Y. Yamane, K. Ogawa, et. al. "TRACY Transient Experiment Databook 1) Pulse Withdrawal Experiment" JAERI-Data/Code 2002-005 (2002)). Recent computational analyses have shown a similar decoupling of fission and temperature distributions was likely to have existed in the SUPO reactor (A.G. Buchan, C.C. Pain, M.D. Eaton, "Dynamics and heat transfer characteristics of the water boiler reactor – SUPO", International Conference in Nuclear Criticality (ICNC) (2011)).
4a2.5.2 **page 16**	**"the limiting power density has been associated with propensity for the core to become unstable with increasing power density"** See major comment above.
4a2.6	**"The calculations and experimental measures to determine the coolant conditions**

page 17	**ensuring that fuel solution boiling does not occur"** See major comment above.
4a2.7 pages 18	**"Malfunction or failure of components in this system could cause excessive pressure that could have positive reactivity feedback to the fuel solution and operating instability"** This phenomenon was observed in SUPO during normal operations as cited above. KEWB went a long way in detailing this type of behavior. Researchers also quantified the reactivity effect of pressurization in the CR&D water boiler; in the CR&D water boiler the effect was small (J.W. Flora, J.W. Shortfall, E.J. Strain, "Operating Characteristics of the Water Boiler," LRL-151, (1954)). Suggest focusing on quantifying the positive reactivity feedback and its influence on time-dependent behavior which would capture instability issues and other operational issues as well.

Specific Comments on Part 2

Location	Comment
1.5 pages 15	**"For AHR applications, the following bullets may be added for related facilities:"** The applicant is likely to cite other facilities not included on the list. Some other facilities including: the KEWB reactors in Canoga Park, Ca; the L-54 at Walter Reed, SILENE in France; etc. Also, HRE is radically different from the other listed AHRs. HYPO, SUPO, and TRACY may all be characterized as "water boilers" whereas HRE cannot.
4a2.3 page 31	***"Fuel chemistry has been shown to affect corrosion and result in possible loss of vessel integrity based on the experience from the operation of previous reactors, as described in References 2 and 3."*** The above technical rationale appears to place too much emphasis on HRE observations. In "Two Years of HRE-2 Operation," P.N. Haubenreich details some of the conclusions from HRE operations (article published in Nuclear Science and Engineering, Volume 8, pages 467-479, 1960). Haubenreich notes "the HRE-2 core tank suffered damage by corrosion and local melting because of a combination of factors involving the chemical stability of the fuel solution and the hydrodynamics of the core tank. It is believed that these difficulties can be avoided, although, as emphasized by HRE-2 experience, careful design of the core is necessary." Reading through Haubenreich's article it is apparent that HRE-2 and water boilers (SUPO, KEWB, TRACY, SILENE, etc) are very different types of AHRs. Some of the most significant differences include: higher pressures, higher power, higher temperatures, less favorable core thermodynamics, and differing core cooling philosophies. Thus, drawing conclusions about water boilers from HRE-2 must be a careful and measured exercise.

	The lower pressure, lower power, and more favorable thermodynamics of water boilers is again, a large reason they were characterized as being so safe. Specifically concerning corrosion in a water boiler (SUPO), according to Bunker (*Status Report of the Water Boiler Reactor,* 1963), corrosion contributed "a reduction in wall thickness of only ~0.0001 in. On the other hand, if most of the corrosion has occurred in a localized area, the sphere could conceivably start leaking at any time." Bunker's observation is significant for two reasons. Firstly, bulk corrosion is unlikely to be a significant concern for vessel integrity. Secondly, localized corrosion is a more significant concern. However, a well mixed, chemically stable system is unlikely to experience localized corrosion as the mechanism for localized corrosion is fissioning of solid uranium against the vessel wall.
4a2.5.1 page 35	**"The reactor kinetic parameters and behavior should be shown, along with the dynamic reactivity parameters of the instrumentation and control systems."** Can the NRC be more explicit about the meaning of "dynamic reactivity parameters of the instrumentation and control systems?"
4a2.5.1 page 35	**"the control systems will prevent ... an uncontrolled addition of reactivity"** What does the NRC mean by "an uncontrolled addition of reactivity?" Also, the magnitude of available the reactivity is probably the most important consideration when studying the loss of fuel barrier integrity from a nuclear transient.
4a2.5.1 page 35	**"If only one core configuration will be used over the life of the reactor, the applicant should clearly indicate this."** The core of an AHR is more dynamic that the core of a heterogeneous reactor. This is especially true of the core's "configuration." In an AHR, the uranium concentration, pH, temperature, power density, geometry (e.g., solution level and surface shape) are all almost constantly changing. Depending on the number of variables considered necessary to define the core's configuration, this dynamic behavior could result in an almost infinite number of core configurations. However, the phenomena that cause the changes in the core's configuration are well understood, measureable, and quantifiable. Instead of defining a single core configuration, for an AHR, it might be more appropriate to define operating ranges for the reactor (e.g. temperature between 60-100°C, pH between 0.5-1.5, etc). Those ranges could then be used to define the reactor's core configuration. Other specific actions could also be used to define a new "core configuration." For example, the addition of new fuel could mark a new configuration.
4a2.5.1 page 36	**"control rods and instrumentation is designed to prevent uncontrolled reactor transients."** What does the NRC mean by "uncontrolled reactor transients?"
4a2.5.3 page 38	**"xenon and samarium override"** Xenon will mostly come out of solution as it is a gas.
4a2.6 page 40	**"the power shape may still cause some hot spots, which may lead to instabilities and ultimately fuel and fission product precipitation."**

	The statement above is likely derived from HRE-2 operating experience. The NRC should consider that HRE-2 is a significantly different system than a well-mixed, low power, atmospheric pressure AHRs (e.g., water boilers). HRE-2 operated at temperatures between 200-300°C. Water boilers operated at atmospheric pressure meaning the saturation temperature was around 100°C. Thus, a hot spot in an atmospheric AHR would result in boiling and a maximum temperature equal to the saturation temperature. Also, boiling would result in the rapid formation of a large void which would substantially decrease the reactivity of the system (demonstrated experimentally in KEWB and SUPO reactors). HRE-2 operated between 1000-2000 psig. In this high pressure environment, radiolytic gas would remain in solution. In water boilers, radiolytic gas is produced once the solution's saturation limit is reached. Analytical work has indicated that the movement of radiolytic gas in the solution causes the fuel to be very well mixed. It can be hypothesized that the absence of radiolytic gas formation and movement in HRE-2 is partially responsible for unfavorable thermodynamic behavior. The likelihood of hot spots is large dependent on the design presented to the NRC. However, for the reasons cited above, water boiler type systems are extremely unlikely to exhibit "hot spots." Also, how "hot spots" "lead to instabilities" is unclear and would require additional clarification by the NRC.
4a2.6 page 41	**"The departure-from-nucleate-boiling ratio should be no less than 2.0 along any coolant coil."** The departure-from-nucleate-boiling ratio (DNBR) is not an applicable measurement for safety within an AHR. DNBR is appropriate for solid fueled reactors because the departure from nucleate boiling would result in a large increase in fuel temperature. However, in AHRs, the heat source is in the bulk solution (ie where the coolant is for solid fuels). The corresponding temperature increase in the solution would be limited to the saturation temperature of the solution (for atmospheric AHRs, this would be around 100°C) and additional heat transfer pathways would still exist (e.g., conduction through the vessel wall and mass transfer into the plenum through radiolytic gas formation and boiling).
4a2.6 page 41	**"Since this forms part of the fuel barrier, this section should consider the associated cooling systems and show their ability to maintain their functions and fuel barrier integrity under normal and abnormal operations."** Per definitions on page 18, gas treatment system would be fission product barrier and submerged portion of cooling coils would be part of the fuel barrier. Both are part of the primary system boundary.
4a2.7 page 42	**"any pressure transient within the reactor core"** Safety significant pressure transients can originate elsewhere in the gas management system.
4a2.7 page 43	**"The spike is generally terminated by the negative reactivity effect of void formation caused by radiolytic gas generation."**

	In criticality accidents and a steady state AHRs, void formation will occur on different time scales. For criticality accidents, the solution's initial state is sub-critical and not saturated (no radiolytic gas is present). A certain amount of energy (a threshold value dictated by the solution's properties) must be deposited in the system before radiolytic gas begins to come out of solution. Once this energy threshold has been reached, radiolytic gas no longer remains dissolve and voids being to form which has a rapid effect on "turning over" the power transient. In an AHR operating at steady state radiolytic gas will already be present. Thus, changes in reactivity will more-or-less instantly alter the voiding rate of the system. The result is that steady state AHRs will response quicker to reactivity insertions than an AHR in which the gas onset energy threshold has not been reached. **"The actual first spike yield and total fission yield during accidents and planned critical excursion can vary widely, so fairly conservative assumptions should be made concerning the assumed dynamics during a prompt critical excursion."** Experimental and analytical work has been effective in quantifying the magnitude of the first fission spikes and the total energy release during reactivity insertions for solution systems (Miyoshi, 2009). The magnitude of the first spike and total energy released are largely dependent on the magnitude and rate of the reactivity insertion. Even if large amounts of reactivity are present, a slow the rate of insertion yields relatively unremarkable transient evolution. Thus, limiting the speed of control elements should result in an AHR that can operate conservatively.
4b.1 Page 46, last 2 bullets	**"implementation of... safety features of the production facility ...per the requirements of 10CFR70 .... criticality safety program... chemical safety program"** Refer to major comment regarding 10CFR70.
5a2.2 page 55	**"The liquid fuel solution in an AHR is expected to be highly corrosive and contain mobile radioactive fission product species."** It is the applicant's responsibility to characterize the corrosive nature of the fuel solution. Characterizing the fuel as "highly corrosive" without defining "highly corrosive" or knowing the fuel base is presumptuous of the NRC.
6b.3 pages 75 and 76	**References to 10CFR70 and the term IROFS** Refer to major comment regarding 10CFR70.