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Use of Nuclear Power Sources in Outer Space

**PRELIMINARY DRAFT REPORT OF THE JOINT TECHNICAL WORKSHOP
ON THE OBJECTIVES, SCOPE AND GENERAL ATTRIBUTES OF A
POTENTIAL TECHNICAL SAFETY FRAMEWORK FOR NUCLEAR POWER
SOURCES IN OUTER SPACE**

Note by the Secretariat

1. The present document contains the preliminary draft report of the workshop, which was considered and adopted by the Working Group on the Use of Nuclear Power Sources in Outer Space at its second and fourth meetings, held on 27 February and 28 February 2006, respectively.
2. The preliminary draft report will be reproduced as an annex to the report of the Working Group at the current session of the Subcommittee.

Preliminary Draft Report of the Joint Technical Workshop on the Objectives, Scope and General Attributes of a Potential Technical Safety Framework for Nuclear Power Sources in Outer Space

1. Background

1. Over the past years, formal and informal discussions within the Working Group on the Use of Nuclear Power Sources in Outer Space of the Scientific and Technical Subcommittee (COPUOS/STSC), and between the Working Group on NPS and representatives of IAEA, have led to the conclusion that further work on any of the potential options for cooperating with IAEA in developing a technical safety framework for nuclear power sources in outer space (NPS) would be assisted significantly by holding a joint workshop. The joint workshop facilitated an exchange of views between the Working Group and IAEA on the objective, scope and general attributes of a potential international safety framework for NPS. The exchange improved mutual understanding of the respective roles and methods of working of the IAEA and the COPUOS/STSC and assisted in examining the main questions that would arise in cooperating to develop an international safety framework for space nuclear power sources.
2. The main objectives of the Workshop were:
 - a. to enhance the proposed outline of objectives, scope and attributes for an international technically based framework of goals and recommendations for the safety of planned and currently foreseeable NPS applications in outer space; and
 - b. to enhance the definition of potential implementation options for establishing an international technically based framework of goals and recommendations for the safety of planned and currently foreseeable NPS applications in outer space.

2. Observations

3. The Workshop provided useful information pertinent to the current multi-year work plan of the STSC Working Group on NPS. The Workshop provided a forum for sharing views and information between national and international/regional agencies, participating member States and the IAEA; the latest information on ongoing, currently planned and foreseeable applications of space NPS; the unique design considerations for NPS applications in space; information on NPS in relation to space debris; the scope, attributes and objectives of a space NPS safety framework, most notably the minimum essential elements of such a framework from the perspective of both radioisotope and reactor applications; and observations

and questions relevant to the two options under consideration by the Working Group for implementing a space NPS safety framework.

Currently Planned and Foreseeable Applications of Space NPS

(a) According to current knowledge and capabilities, nuclear power sources are the only available energy option to power some space missions and significantly enhance others. Some ongoing and foreseeable missions would not be possible without the use of NPS.

(b) Space nuclear power sources have been in use for more than four decades. Fission reactors have not been flown for several years and no specific plans exist for using them in the near future. However, space reactors are expected to be needed for scientific and exploration missions, specifically for the Moon and Mars. Earth orbital missions requiring high power (e.g., communications, inter-orbital space tugs) are also foreseeable.

(c) Radioisotope power systems (including radioisotope heater units) are currently in use and their continued use is planned.

(d) Missions to Mars are planned by national and international/regional space agencies that might use space radioisotope power sources (including radioisotope heater units).

(e) The environments for space NPS applications (from launch through operation to retirement) are radically different from the environment for terrestrial applications.

(f) Space reactors are very different from terrestrial reactors in design and operation. The specific environments (both operating and potential accident conditions) create very different safety design and operation criteria.

(g) Space mission requirements lead to unique mission-specific designs for space NPS, launch systems, and mission operations.

Objectives, Scope and Attributes of a Space NPS Safety Framework

(h) The Workshop based its deliberations on the “Outline of objectives, scope and attributes for an international technically based framework of goals and recommendations for the safety of planned and currently foreseeable nuclear power source applications in outer space” (A/AC.105/L.253/Rev.2). Observations included the following:

- i. Several reasons were expressed by Workshop participants for having an international space safety framework for space NPS. These include: the necessity of having common safety criteria for space NPS missions; providing assurance that space NPS safety is being addressed appropriately; and providing a common basis for cooperative international space missions using NPS.
- ii. The current STSC “Outline” document A/AC.105/L.253/Rev.2 generally describes the consensus view of the type of safety framework envisioned by the

Workshop participants. However it is very general and would need to be made more specific to form the basis for a collaborative development of a safety framework between the COPUOS and IAEA.

- iii. The view was expressed that such a framework could provide a basis for future, possibly binding agreements.
- iv. The workshop identified common elements deemed essential to an effective safety framework: the framework should be internationally accepted, provide high level guidance, and address both RPS and reactor systems. It should further promote the establishment or use of national safety processes that are credible, reliable and transparent. Such national processes should include both technical and programmatic elements that seek to mitigate risks arising from the use of NPS through all relevant phases of a mission.

Implementation Options for a Space NPS Safety Framework

(i) The Workshop participants received an overview of the two implementation options being considered by the Working Group on NPS for establishing a space NPS safety framework: Option 1, a cooperative COPUOS STSC/IAEA safety framework development; and Option 3, a multilateral safety framework development involving interested national and international/regional agencies followed by a COPUOS review conducted with various levels of IAEA involvement. In addition, a summary of the key issues in coordinating COPUOS and IAEA processes for implementing the two options was presented. During the Workshop several observations, comments and questions emerged, some general to both options and some specific to either Option 1 or Option 3.

i. General Observations and Comments

1. Comprehensive space NPS safety frameworks exist and are in use in two member states. Some member states have been cooperating recently to develop a plan for a regional space NPS nuclear safety framework.
2. Terrestrial aspects of space NPS activities fall within the scope of existing IAEA safety standards.
3. The IAEA is in the process of combining three existing IAEA “Safety Fundamentals” documents into one. These IAEA “Safety Fundamentals” are intended to form the foundation for all other documents in the Safety Standards Series, including Requirements and Guides.
4. The currently consolidated IAEA draft “Safety Fundamentals” are not written with space NPS applications in mind. The degree of their potential relevance to developing an

international space NPS safety framework would need to be studied.

5. For all current IAEA safety standards, the Agency has the expertise (either within the IAEA or by engaging technical consultants) and resources to provide for the implementation of such standards including peer reviews, education, and training.
6. The IAEA currently does not have space NPS expertise. In the event the IAEA were to participate in the development of a space NPS safety framework, the Agency would need to engage space expertise from those with space NPS experience within the space community, including the NPS Working Group.
7. If the IAEA were to co-sponsor a space NPS safety framework, then the IAEA and COPUOS would need to agree on arrangements for maintaining expertise and providing for the implementation of the framework.
8. The list of implementation options may be incomplete.

ii. Comments/Questions Pertinent to Option 1

Option 1 of the possible collaborative approaches considered by the NPS WG (A/AC.105/L.254/Rev.2) requires COPUOS/STSC and the IAEA to coordinate their respective document development processes with the objective of cosponsoring a safety framework for space NPS. Discussions during the Workshop identified the potential advantages of this option and several questions that would need to be addressed before such an option could be implemented. Some general observations and comments are listed below.

1. Publication of an international space NPS safety framework co-sponsored by IAEA and COPUOS would benefit from the international standing and technical competences of both organizations. Such a safety framework would likely be widely recognized and help elaborate national safety frameworks (including standards) for space missions involving NPS.
2. The safety standard development process established by the IAEA is recognized as providing an effective mechanism for achieving technically sound safety standards that reflect an international consensus.
3. Several questions pertinent to Option 1 require further elucidation, including: the coordination of the IAEA and COPUOS work and decision processes; the language(s) used for conducting a collaborative framework development; the funding sources for supporting the development of a safety framework (e.g., interpretation/translation services, publication,

meetings, etc.); and the organization and management of the work program of developing a safety framework.

iii. Comments/Questions Pertinent to Option 3

Option 3 involves three alternative approaches for the IAEA's participation with the STSC in reviewing a safety framework developed by a multilateral group of agencies and experts. In the first approach, the COPUOS asks the IAEA to conduct a technical assessment of the framework to assist the STSC's consideration of the framework. In the second approach, the IAEA (making use, as appropriate, of its review and approval processes) cooperates with the STSC in conducting a technical assessment of the framework. In the third approach, a technical representative of the IAEA first assists the multilateral group's development of a space nuclear safety framework and then supports the STSC in the review of the framework. Several comments and questions concerning Option 3 were raised in the Workshop discussions, some of which were general to Option 3 and others that were relevant only to specific variants of the option.

1. For all variants of Option 3, the IAEA has no mechanism for endorsing, publishing or supporting any space NPS safety framework developed outside the Agency's existing safety standard development process. However, IAEA participation in any of the variants of Option 3 could be noted in an introductory paragraph accompanying either the assessment of a multilateral space NPS safety framework (i.e., Options 3A or 3B) or the actual development and review of such a framework (i.e., Option 3C).
2. The safety standard development process established by the IAEA could serve as an effective model for use by a multilateral group of national and international/regional agencies and experts on how to achieve a consensual technically sound space NPS safety framework, but the IAEA structure and mechanisms would not be available for this process
3. IAEA participation in any of the variants of Option 3 could help assure that potential conflicts between a multilaterally-developed space NPS safety framework and existing terrestrial nuclear safety standards were identified, avoided and/or adequately explained.
4. Several questions pertinent to Option 3 require further elucidation, including: the language(s) used for conducting a multilateral framework development, the funding sources for supporting the development of a safety framework (e.g., interpretation/translation services, publication, meetings, etc.).

In addition, for Option 3B, further questions involve the coordination of the IAEA and COPUOS work and decision processes, and the organization and management of the work program.

iv. Questions to be Addressed to the IAEA

1. Are there any restrictions within the IAEA statute or prior determinations by the Board of Governors that could prevent the Agency from acting in collaboration with COPUOS in the common development and support of a safety framework for space NPS? If there are no such restrictions, what would be the proper procedure for COPUOS to request such an activity by the IAEA?
2. Other than the collaboration referred to in Question 1, what form of consultancy/review support would the IAEA be prepared to provide to COPUOS or a multilateral group of national and international/regional agencies and experts in the development of a safety framework for space NPS?
3. Recognizing that the Agency has not formulated safety standards for space NPS, and that specific aspects of an international space NPS safety framework could differ from generally accepted terrestrial practices (e.g., the use of highly enriched fuel in space reactors), would the Agency be prepared to make the necessary policy decisions, resource allocations, possible adjustments to the terms of reference for its safety standards committees and/or related actions to cooperate with COPUOS or the multilateral group (as mentioned in Question 2) in preparation of a space NPS safety framework? What would be the realistic timeframes for such actions?

3. Conclusions

4. The joint technical workshop on the objectives, scope and general attributes of a potential technical safety framework for nuclear power sources in outer space was successful in detailing the scope, attributes and objectives as well as the implementation options of a potential international safety framework for the use of nuclear power sources in outer space. The workshop greatly benefited from the active participation of and presentations made by representatives of the IAEA and COPUOS.
5. The workshop confirmed and emphasized the need for nuclear power sources for several types of space missions and the potential benefit of an international safety framework for the use of nuclear power sources in space applications.
6. The workshop highlighted the special environment for space nuclear power sources, and the resulting different safety requirements for space and terrestrial nuclear power source applications.

7. The workshop helped to better understand respective mechanisms of the IAEA and COPUOS development and decision processes, and characterised advantages, drawbacks and peculiarities of the different implementation options.
8. In detailing the scope, attributes and objectives as well as the implementation options of such a framework, the workshop participants identified those questions for the IAEA which are important to address prior to the Working Group's recommendation of a specific implementation option in 2007. It is recommended that those questions should be submitted to the IAEA for clarification prior to the intersessional meeting of the Working Group on NPS in June 2006.