Document Preparation Profile (DPP)

1. IDENTIFICATION

Document Category	**Safety Guide**
Working ID:	**DS407**
Proposed Title:	**Criticality Safety**
Proposed Action:	**new document**
Published Title/Date	**none**
Safety Series No.:	**none**
SS Committee(s):	**WASSC, NUSSC, RASSC, TRANSSC**
Technical Officer(s):	**Ernst Warnecke, NSRW**

2. OBJECTIVE

(*In no more than 150 words describe what the document is intended to achieve and in particular, identify the target users and intended impact on them*)

Nuclear materials containing fissile radionuclides have to be managed in such a way as to ensure sub-criticality. Sub-criticality has to be maintained, e.g. during the operation of fuel cycle facilities and the management of spent fuel and radioactive waste containing fissile material, including handling, processing, use, storage, transport and disposal (operation and post-operation).

Criticality safety depends on many factors, in particular mass, concentration, geometry and enrichment. It depends on the existence of moderators, neutron poisons and reflectors. Administrative measures may also be taken in order to ensure sub-criticality, e.g. limiting the amount or concentration of fissile radionuclides. Sub-criticality has to be ensured during normal operation of facilities and in the case of incidents and accidents.

Providing guidance and up-to date recommendations on ensuring sub-criticality when dealing with fissile material is the objective of this Safety Guide (SG).

A safety standard with a systematic coverage of criticality safety is not available in the IAEA Safety Standards Series. Filling this gap is the goal of the proposed SG. Existing information on criticality safety, e.g. in the transport safety standards, be will be taken into account (see interfaces).

The SG is intended to provide recommendations to regulators and operators who are dealing with fissile material.

3. BACKGROUND

(In no more than 150 words describe the rationale for the development of the document and provide a justification considering its added value over existing publications on the topic)

Fissile material is involved in the operation of many facilities, in particular fuel cycle facilities, and in the management of radioactive waste generated by the respective operations.

Ensuring criticality safety is not only a matter for large commercial fuel cycle and radioactive waste management facilities. It has also to be ensured at prototype and research facilities.

The activities associated with fuel cycle facilities are rather diverse. They include wet chemical processes, powder technology, compaction and sintering, dissolution of fissile materials and processing them in aqueous / organic solutions as well as managing fissile materials as radioactive waste. Such activities involve many chemical and physical processes entailing substantial changes in the factors affecting criticality. Particular attention is needed in pre-operational criticality safety assessment and in the assessment and control of equipment modifications and procedural changes.

The management of spent fuel, both its reprocessing as a valuable resource and its processing as a radioactive waste for disposal, needs special attention because of its unique properties (e.g. radionuclide content, radiation levels and heat generation).

Spent fuel is often managed under the assumption of fresh fuel. This is a conservative approach neglecting the fact that fissile material was burnt and fission products, many of them being neutron poisons, were generated at the reactor. Giving burnup credit is a much more realistic approach provided that the proper assessment tools are available.

Radioactive waste containing fissile material arises from certain fuel cycle facilities. It is processed and stored until a final solution is available.

Criticality safety has to be provided also in a repository for radioactive waste. The operational phase of a repository is somehow similar to a waste storage facility. The situation is quite different in the post closure phase with the often assumed access of (more or less salinated) waters to the waste, the leaching of radionuclides and the potential for re-concentration by precipitation or sorption.

The guidance on criticality safety will encompass all the above mentioned situations, including the prerequisites for criticality calculations.

4. INTERFACES

(Summarize relationships between the document and other publications or documents in preparation, as well as any interaction with other organizations)

The proposed SG will be developed as part of the IAEA Safety Standards Series. Comprehensive and systematic guidance on criticality safety does neither exist in the IAEA Safety Series nor in the Safety Standards Series. A limited amount of information can be found, e.g. in the transport safety standards and the draft fuel cycle facility safety standards. Such information will be taken into account and referenced.

This SG will be in line with the Joint Convention that addresses criticality safety in articles 4 and 11 and will be based on the Safety Principles delineated in the Safety Fundamentals (SF-1).

It will take the relevant requirements of various IAEA Safety Standards into account, in particular the requirements on “Safety assessment and verification” (DS 348); “The Management System for facilities and Activities” (GS-R-3); “Predisposal management of radioactive waste (WS-R-2) and “Decommissioning of Facilities Using Radioactive Materials” (WS-R-5); “Regulations for the safe transport of radioactive material” (TS-R-1; 2005 edition); “Geological disposal of radioactive waste” (WS-R-4); “Safety of fuel cycle facilities” (DS316) and “Preparedness and response for a nuclear or radiological emergency”

(GS-R-2). It will link to existing IAEA guides and those in draft and take the Safety Report No. 9 on "Safe handling and storage of plutonium" into account.

Non IAEA standards and relevant drafts will also be taken into account, in particular ISO Standards (No. 1709, 7753 and 14943), ANS Standards (Subcommittee 8 products) and DIN Standards (No. 25403, 25471, 25474, 25478 and 25712). It is also intended to involve ISO in the drafting process.

The SG will be developed with the involvement of WASSC, NUSSC, RASSC and TRANSSC. It is intended to liase and co-ordinate with NSNI and to consult NEFW. The SG will be published as a "General Safety" Guide in the "Thematic Area" under "Assessment and Verification".

5. OVERVIEW

(In no more than 150 words describe expected content of the document, such as summary of the scope, style, structure, terminology and any other points to take into account when drafting. ***Attach*** *any detailed information, e.g. outline of chapter heading, extended Table of Contents, etc.)*

The SG on "Criticality Safety" will provide guidance and recommendations on how to ensure sub-criticality in facilities and activities involving fissile material. The respective recommendations will be given in a comprehensive and systematic way covering all types of civilian facilities and activities involving fissile material, including research establishments and activities. It will include consideration of specific issues such as burnup credit and encompass ensuring sub-criticality at normal operations of facilities as well as under incidents and accidents.

Reactor operations and facilities / activities in military or defence programmes will be excluded. This SG will apply if and when fissile material from military and defence programmes is transferred permanently to and managed within exclusively civilian programmes.

The content of the SG is organised in such a way as to outline the recommendations to the important factors that ensure sub-criticality. This includes recommendations on safety margins and the need for criticality detection and alarm systems. Recommendations on the tools that are needed for criticality calculations will then be outlined with particular emphasis on prerequisites that ensure correct and / or conservative calculations. Consideration will then be given to criticality safety in fuel cycle facilities and in the management of radioactive waste. Handling, transport, storage, fuel fabrication, reprocessing of spent fuel, processing of radioactive waste and its disposal, including operation and post-operation, will be covered by this SG. This will include considerations on how to provide safety under normal operations and incidents and accidents.

A tentative table of contents is attached.

6. PRODUCTION: Provisional schedule for preparation of the document, outlining expected dates for:

Approval of DPP by the Steering Committee	Feb. 2006
Approval of DPP by the Safety Standards Committees	April 2006
Approval of DPP by the CSS	Nov. 2007
Development: (consultant meetings, technical committee meetings)	2007/2008
Approval of draft by the Steering Committee	III/2008
Approval by the Safety Standards Committees for submission to Member States	IV/2008
Revision of draft by taking into account the Comments by the Member States	II/2009

Approval on the revised draft by the Steering Committee	II/2009
Approval by the Safety Standards Committees for submission to the CSS;	IV/2009
Editing	IV/2009
Endorsement by the CSS	II/2010
Submission to Publications Committee	II/2010
Target publication date	III/2010

ATTACHMENT
Proposal for the CONTENT of the draft safety guide on
"Criticality Safety"

1. Introduction
Background
Objective
Scope
Structure

2. Approach to criticality safety and safety criteria
General
Criticality indices and correlations
K_{eff} and safety margins
Normal operation
Incidents/accidents
Burnup credit
Criticality detection and alarm systems; γ-n detectors

3. Factors important for ensuring sub-criticality
General
Technical practices (geometry, neutron poisons etc.)
Administrative measures (procedures, responsibilities etc.)
Measurements and detection

3. Criticality Safety Assessment
General
Nuclear and other data requirements
Calculation software
Validation and verification
Operational limits

4. Criticality Safety in Practices
General
Fuel cycle facilities
Transport and handling
Storage
Processing
Disposal (operation and post-operation)

References
Contributors to Drafting and review
Bodies for the Endorsement of Safety Standards