

International Safeguards Guidelines for Nuclear Facilities under Decommissioning
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ABSTRACT

Taking into account the increasing number of nuclear facilities reaching the end of their operating life cycle, the International Atomic Energy Agency (IAEA) has developed new safeguards guidelines for facilities in the post-operational phases (permanent shut-down, closed-down, decommissioned for safeguards purposes). The process of a facility transitioning from a status of permanent shut-down, to closed-down, to decommissioned for safeguards purposes may not be straightforward, and the effort required to implement safeguards during the post-operational phases will be dependent upon removal/recovery of nuclear material, and the removal/rendering inoperable of residual structures and equipment that is essential for facility operation.

This paper summarizes the essential features and recommendations of the new guidelines, including safeguards considerations during the various post-operational life cycle phases, updating the facility design information, re-categorization of a facility, determination of decommissioned status for safeguards purposes, and the general need for effective coordination between the State, facility operator, and the IAEA. The guidelines will enhance understanding of the safeguards obligations of all stakeholders, and support effective and efficient safeguards implementation during the post-operational phases.

1. INTRODUCTION

An increasing number of nuclear facilities are either reaching the end of their operating lifetime or are being removed from operation due to reasons such as domestic energy policy, changing energy markets, financial considerations, or other unforeseen conditions. This results in permanent cessation of operations, closing down the installation and removing the nuclear material, and decommissioning the facility in accordance with State regulatory requirements. These requirements should consider, as part of the overarching decommissioning effort, the State's obligations under its safeguards agreements with the IAEA. The post-operational phases of a nuclear facility begin when operations have been permanently stopped, and continue until the time when the facility is fully decommissioned. The term 'decommissioning' refers to the legal, regulatory, administrative and technical actions taken to remove all or some of the regulatory controls from a facility. The broader decommissioning effort is governed by State or corporate decisions that take into consideration economic, environmental, political, and social concerns that may impact the post-operational implementation schedule.

For the purposes of safeguards, an IAEA determination of a facility status as decommissioned for safeguards purposes may not directly align with the State regulatory perspective in determining that a facility is decommissioned. When the IAEA determines that a facility has reached the status of decommissioned for safeguards purposes, IAEA verification activities, such as ad hoc and routine inspections, as well as design information examination/verification (DIE/DIV), cease. For States with an additional protocol (AP) in force, complementary accesses may be carried out to confirm the continued decommissioned status of the facility. The purpose of the guidelines is to facilitate, through safeguards by design, the effective and

efficient implementation of safeguards during the post-operational life cycle phases of facilities. It addresses facilities that are designated as permanent shut-down, closed-down, or decommissioned for safeguards purposes.

2. POST-OPERATIONAL LIFE CYCLE PHASES FOR FACILITIES

Once a State decides that a facility will permanently cease operations, it is important to coordinate with the IAEA regarding considerations for how post-operational activities will be performed to reduce the effort required for the application of safeguards. When the State decides to change the operational status of the facility, the updated design information must be provided to the IAEA in accordance with the State's safeguards agreement.

Before activities associated with permanent shut-down can commence, a facility operator notifies the State authority of its plan. Post-operational information relevant to safeguards should then be submitted in an updated IAEA Design Information Questionnaire (DIQ) responses. There are increased opportunities for optimizing safeguards if the State provides the IAEA with timely and complete information on the planned activities for the permanent shut-down and closed-down phases, including their expected duration. The Subsidiary Arrangements (General Part) to a State's safeguards agreement, along with the specific Facility Attachment, require the State to inform the IAEA in advance of any modification to the facility status that can impact safeguards implementation. When doing so, States should inform the IAEA on the schedule for the post-operational phases that will work toward the facility being decommissioned for safeguards purposes.

2.1. Permanent shut-down phase

A facility is in the permanent shut-down phase when the operations related to the purpose of the facility, as declared in the design information, have been permanently stopped but nuclear material remains at the facility. This phase may include activities related to the decommissioning (e.g., dismantling of equipment, decontamination, cleanout) of the facility. When the State decides that a facility will be designated permanent shut-down, the change in operational status should be communicated to the IAEA through an updated response in the DIQ because it can improve the planning and scheduling of safeguards activities.

During this phase, the IAEA continues to apply safeguards measures to verify that the nuclear material has not been diverted and the facility is not being misused. Safeguards measures may include periodic interim and physical inventory verification of nuclear material, and design information examination/verification activities to verify that the facility design is still consistent with the State declaration. For States with an additional protocol in force, complementary access may also be performed to ensure the absence of undeclared nuclear material and activities. During the permanent shut-down phase, the inventory of some nuclear material strata may become zero. When this occurs, the safeguards verification effort may decrease. In some facilities, equipment may be removed and/or rendered inoperable during the permanent shut-down phase. If residual nuclear material exists in equipment, the nuclear material should be removed from the equipment and the remaining hold-up nuclear material should be quantified when the equipment is dismantled during the decommissioning activities. The difference between previously estimated hold-up and measured hold-up after the dismantling of equipment would contribute to the material unaccounted for (MUF) in the material balance report (MBR). When nuclear material is recovered during the

decommissioning process, MUF and cumulative material unaccounted for (CuMUF) should be assessed by the State or Operator in coordination with the IAEA. Nuclear material recovered from equipment or any other source should be declared and is subject to IAEA verification.

2.2. Closed-down phase

The facility status becomes closed-down after the IAEA confirms that the nuclear material including retained waste is removed from the facility. A facility is in the closed-down phase when operations related to the purpose of the facility, as declared in the facility's DIQ response have been permanently stopped and the nuclear material, including material in hold-up and retained waste, removed but equipment or structures essential for its use while in operation remain. A facility holding only nuclear material on which safeguards has been terminated or exempted can still be considered as closed-down. In cases where there are terminated or exempted materials at a closed down facility, the State should work closely with the IAEA to ensure that correct nuclear material accountancy is maintained during the decommissioning activities (e.g., re-applying safeguards to nuclear material on which safeguards have been terminated before starting any type of processing or de-exemption of nuclear material as required).

Before the IAEA can confirm that the facility has reached the status of closed-down, the State should declare a final nuclear material inventory for the last material balance period to the IAEA. This final physical inventory should be zero. In some specific cases, the State may continue to report a null physical inventory listing (PIL)/material balance reporting (MBR) during the closed-down phase, subject to a specific arrangement between the State and the IAEA. The safeguards activities at a closed-down facility shift from an emphasis on nuclear material verification to design information examination/verification to confirm the continued absence of processing activities as well as the absence of nuclear material. The frequency and timing of design information examination/verifications may be dependent upon the progress of decommissioning activities.

2.3. Decommissioned for safeguards purposes phase

Upon request by the State, the IAEA will determine the decommissioned status of a particular facility based on its examination and independent verification of information provided by the State; for example, the IAEA must confirm that the facility is under the closed-down phase, and that residual structures and equipment essential for facility have been sufficiently removed or rendered inoperable (e.g. through cutting, crushing, melting, filling with concrete, drilling) so that the facility is not used to store and can no longer be used to handle, process, or utilize nuclear material. In making this determination, the IAEA will assess the efforts and resources that would be required to return the facility to operation from a decommissioned status. The IAEA will also consider its continuing capability to detect future undeclared activities at the facility and the importance of those activities within the State's acquisition pathway for weapons-usable nuclear material. Once the IAEA confirms that the facility has been decommissioned for safeguards purposes, routine/ad-hoc safeguards inspections and DIE/DIV at the facility would end. After this time, for States with a CSA (comprehensive safeguards agreement) and an additional protocol in force, complementary access may be conducted to confirm the continued status of decommissioned for safeguards purposes and to verify that an undeclared nuclear fuel cycle capability has not been installed in the decommissioned facility.

The IAEA's determination for a facility to be decommissioned for safeguards purposes may take into consideration as follows:

- The IAEA's ability to continue to confirm the decommissioned status of the facility;
- The facility's capability to use, process or produce nuclear material if operational; and
- The importance of the remaining equipment and structures for restarting the operation of the facility, e.g.:
 - Important items of equipment of the facility for storing, use, production, or processing of nuclear material;
 - Other important items of equipment that support the operation of the facility (e.g., heat exchangers for power or research reactors);
 - Essentially designed or prepared equipment (e.g., equipment listed in Annex II of INFCIRC/540 (Corrected));
 - Instruments and other equipment (e.g., measuring and control instruments and equipment) and structures that may support/affect the operational status, function and capabilities of the facility, and verification of nuclear material inventory and/or throughput from a safeguards perspective; and
 - The effort required to reinstall the above-mentioned equipment to restart the operation of the facility.

3. SAFEGUARDS CONSIDERATIONS AT FACILITIES IN POST-OPERATIONAL LIFE CYCLE PHASES

During the post-operational life cycle phases, there may be certain types of inventory changes (e.g., transfer to retained waste, retransfer of nuclear material from retained waste, reapplication of safeguards to previously exempted nuclear material, termination of safeguards on waste, or accidental gains when previously unreported nuclear material is discovered during clean-up or decontamination activities) that are not common during normal operations. In addition, it may not be uncommon for the chemical and/or physical form of nuclear material to change due to increased decontamination activities at a facility. Decontamination and clean-up efforts may also result in changes to the various forms of containment for reportable nuclear material. The State should work closely with the IAEA to ensure that the correct material accountancy is maintained during the facility's post-operational phases.

3.1. Nuclear material in retained waste

After a facility has been permanently shut-down and the declared nuclear material inventory becomes zero, the facility may still have on site retained waste. Retained waste is defined as nuclear material generated from processing or from an operational accident, which is deemed to be unrecoverable for the time being, and stored in an MBA, but for which the conditions for termination of safeguards are not met. A facility cannot be considered closed-down as long as there is retained waste at the facility. The nuclear material in the retained waste will remain subject to safeguards measures even though retained waste is not included in the facility's physical inventory list.

Before the following actions are taken at a facility with the retained waste, the amount of retained waste should be returned to the original MBA accounts based on the same values reported previously in accounting reports as transfers to waste.

- Processed, repacked, conditioned and/or

- Transferred to another MBA and/or
- Termination of safeguards (Measured discards) (See 3.2 below).

If a new weight is determined for material in retained waste during the decommissioning activities, that change should be accounted for in the MBA books. Therefore, the material should be first returned from the retained waste using the same basis as when transferred to waste and then the change in weight made after any subsequent processing and/or determination of new values. The State should communicate with the IAEA for applying appropriate material accountancy to the re-measured nuclear material.

3.2. Termination of safeguards on nuclear material in waste

Safeguards may be terminated on nuclear material in waste in three types of material forms during the post-operational phases:

- Nuclear material that has been dispersed into the environment and is irretrievably lost;
- Conditioned waste that has been treated by specific actions (e.g., incorporated or dispersed within a matrix), rendering the nuclear material contained in the waste practicably irrecoverable and thus not suitable for further nuclear use; and
- Unconditioned waste with very low concentration of nuclear material which is practicably irrecoverable and thus not suitable for further nuclear use.

Before conditioning waste for the purpose of termination, the State should consult with the IAEA to ensure that the proposed conditioning will meet termination criteria. In order to terminate safeguards on nuclear material in waste, the IAEA must determine that the nuclear material is 'practicably irrecoverable'. The IAEA's determination that nuclear material meets the criteria for termination of safeguards depends on a number of factors including the material form of the waste and the concentration of nuclear material in the waste. The nuclear material for which safeguards has been terminated is no longer subject to safeguards inventory verification. Waste from decommissioning activities that retains low concentrations of nuclear material as surface contamination may be considered as either unconditioned or conditioned waste, depending on the degree to which the contamination is fixed, as well as its concentration and sub-surface distribution. Before commencing a project to process waste from decommissioning activities contaminated with nuclear material, the State should consult with the IAEA to determine whether the final form meets termination criteria.

Termination of safeguards on nuclear material requires that conditions (a) to (d) below are met:

- (a) The State has notified the IAEA of the location of the waste in question at the time of termination;
- (b) The State has agreed to report to the IAEA without delay on subsequent transfer of any waste in question to another location;
- (c) The State has agreed to inform the IAEA in advance of planned chemical or physical processing for recovery of any contained material; and
- (d) The State has agreed to re-apply safeguards to any nuclear material in waste on which safeguards have been terminated before starting any type of processing as described in (c) above.

3.3. Rendering essential equipment in operable

For safeguards purposes, ‘rendered inoperable’ means that the equipment is not used to store and can no longer be used to handle, process or utilize nuclear material. As a practical matter, this means that such equipment cannot be repaired and returned to use in any facility. Examples of techniques that can render equipment inoperable include cutting, crushing, melting, filling with cement, and drilling.

3.4. Removal of essential equipment

In order for the IAEA to determine that the facility is decommissioned for safeguards purposes, sufficient essential equipment needs to be removed or rendered inoperable such that the facility cannot be returned to operation. During the decommissioning process, equipment essential to the facility’s operation might be relocated within or outside of the facility. In many cases, it is likely that the removed equipment will be stored within the facility being decommissioned or on the site of the facility, while waiting to be rendered inoperable (e.g., cutting, crushing, melting, filling with concrete, and drilling) and prepared for disposal. Intact essential equipment that has been removed, but not rendered inoperable, has the potential to be re-used in another facility. To ensure that the IAEA has a complete record of nuclear fuel cycle activities in the State, the planned location for storage at the facility or at another location(s), including storage(s) outside the facility, or plans and reasons for re-use of the essential equipment, should be communicated to the IAEA through the updated facility DIQ responses. If the planned location for storage, or the plans for re-use of essential equipment, subsequently change before the facility is fully decommissioned, this should be communicated to the IAEA through a further update to the facility DIQ responses.

If operable essential equipment is to be exported outside of the State, it may be subject to State regulatory requirements and export controls. If a State has an additional protocol in force, the export of specified equipment is required to be declared in accordance with Article 2.a (ix) of INFCIRC/540 (Corr.).

3.5. Updating design information during the post-operational phases

The State is required to update the design information before and after changes are made to a facility that would impact the safeguards implementation, in accordance with paragraph 45 of INFCIRC/153 (Corr.). Updating a DIQ response is a key activity for post-operational facilities because the status of nuclear material and essential equipment will be changed significantly. Timely updates also help ensure that IAEA safeguards inspectors are aware and prepared for changing safety/security environments and safeguards measures.

The facility decommissioning plan should include a schedule of key events or milestones in the process, a plan on nuclear material removal or recovery, and a plan for how and when sufficient essential equipment will be removed or rendered inoperable. The State should provide any safeguards-relevant information available to the IAEA, even if it is incomplete, in order to aid the IAEA in revising the safeguards measures applied for the facility. As additional safeguards-relevant information becomes available, or information changes, the State should notify the IAEA by updating the facility’s DIQ responses. The following table shows the questions related to post-operational information that have been incorporated into DIQ templates as well as guidance for completing each question.

Guidance for completing POST-OPERATIONAL INFORMATION in DIQ template

POST-OPERATIONAL INFORMATION						
<p>This section should only be completed after the decision has been made for the facility to be permanently shut down. Changes in activities during the post-operational phases should be addressed in relevant questions within the previous sections of the DIQ. When the decision has been made for permanent shut-down, the DIQ responses should be revised as soon as information is available in order to aid the IAEA in revising the safeguards measures applied for the facility. Even after being permanently shut down, significant changes to the facility design or operations should be reflected in updates to the DIQ responses (e.g., operating status, flow of nuclear material, etc.).</p>						
DECOMMISSIONING SCHEDULE DATES		<table border="1" style="width: 100%;"> <tr> <td style="width: 50%; text-align: center;">End of Operations</td> <td style="width: 50%; text-align: center;">Decommissioned</td> </tr> <tr> <td style="height: 20px;"></td> <td style="height: 20px;"></td> </tr> </table>	End of Operations	Decommissioned		
End of Operations	Decommissioned					
GUIDANCE FOR COMPLETING THE QUESTION	Provide the dates when operation of the facility is expected to end and the date when decommissioning of the facility is expected to be completed.					
IAEA USE OF THE INFORMATION	This information is to be used for revising the facility-specific safeguards measures to be applied and scheduling activities.					
FACILITY DECOMMISSIONING PLAN i) Key events of the decommissioning plan ii) Removal and recovery of nuclear material iii) Removal or rendering inoperable of the essential equipment		PLAN(S) ATTACHED UNDER REF. Nos.				
GUIDANCE FOR COMPLETING THE QUESTION	i) Provide a schedule of the key events of the facility’s decommissioning plan (an attachment as necessary). ii) Provide a plan containing estimates of how and when nuclear material will be recovered and/or removed (e.g., loose material consolidated into items, removal of items, recovery/removal of material from decontamination activities, and recovery/removal of nuclear material in waste) (an attachment as necessary). iii) Provide a plan indicating how and when essential equipment will be removed or rendered inoperable (an attachment as necessary). The plan should include the location for storage or rendering inoperable of the equipment at the facility or at another location(s), including storage(s) outside the facility. The list of essential equipment will be provided by the IAEA to the State and operator.					

IAEA USE OF THE INFORMATION	This information is to be used for revising the facility-specific safeguards measures to be applied and scheduling activities.
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Throughout the post-operational life cycle, significant changes to the facility design or operations should be reflected in updates to the DIQ responses (e.g., changes in operating conditions, changes in flow and inventory key measurement points, changes in nuclear material accountancy procedures). The list of essential equipment for a given facility should be shared through communications between the State and IAEA after the decision has been made for the facility to be permanent shut-down.

Throughout all life cycle phases, including post-operational phases, the State should update the DIQ responses if important items of equipment that store, use, produce or process nuclear material are introduced to the facility, removed from the facility, or rendered inoperable. For example, at a bulk handling facility, if any specific equipment to process nuclear material recovered during cleanout is newly introduced into the facility, the State should notify the IAEA by updating its DIQ responses to include these items of equipment.

4. CONCLUSIONS

The new document, ‘International Safeguards Guidelines for the Post-Operational Phases of Nuclear Facilities and Locations Outside Facilities’, aims to enhance understanding of the safeguards obligations of both States and the IAEA, and improve State cooperation in safeguards implementation during the post-operational lifecycle phases of nuclear facilities. The guidance is thus an important contribution to the IAEA's ongoing efforts to encourage safeguards by design at all phases of the nuclear lifecycle.

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