廃止措置中の原子力施設におけるIAEA保障措置ガイドライン及びDIQガイドライン

2022年3月1日

保障措置実施に係る連絡会

国際原子力機関（IAEA）　保障措置分析官　筒井康二

目次

1. 背景

- 廃止措置中の原子力施設が世界で増加

67％が稼働年数30年以上

今後、廃止措置施設が更に増加

（現在）

稼働中 (In Operation)	443
廃止措置中 (Permanent shut-down)	**194**

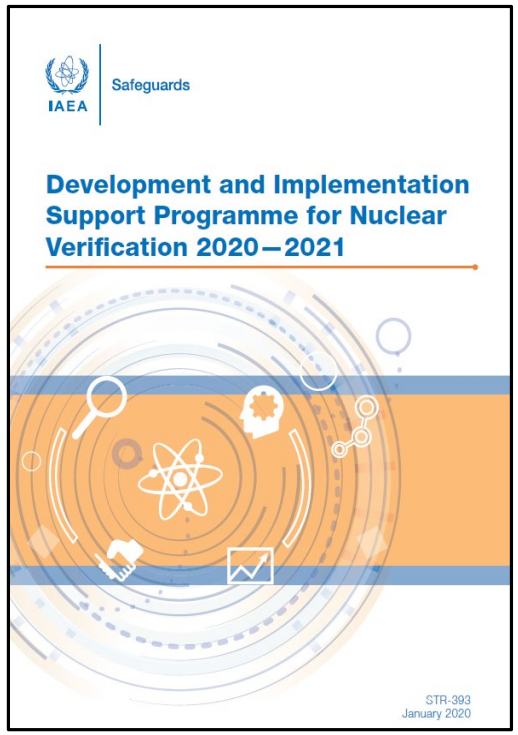
1. 背景（続き）

- 日本でも24/57 (42%) の実用発電用原子炉が廃止措置中（他の多くの核燃料サイクル施設（例：研究炉、再処理、ウラン転換・濃縮施設）も同様に廃止措置中）
- 廃止措置中の施設に対して効果的・効率的な保障措置を実施するためのガイドラインが有用

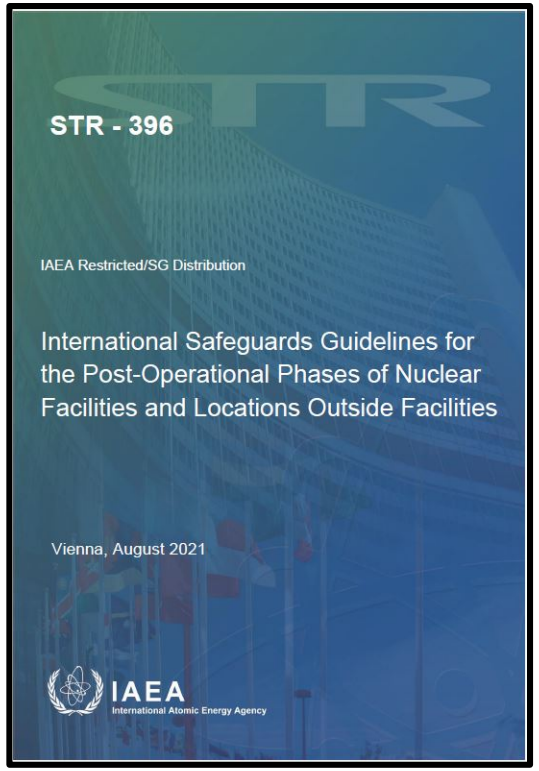
資源エネルギー庁　HPより

2. 廃止措置ガイドライン概要（目的）

- 増加している廃止措置中の施設に国際約束に基づく保障措置を効果的・効率的に実施するための準備
- IAEA保障措置局の目標として廃止措置施設のガイドライン作成
- STR(Safeguards Technical Report)-396として**2021年8月に承認**



Priority Objectives	R & D Needs
P.5 Prepare for new types of facilities and **decommissioning**	Address identified gaps in facility-specific guidance, training and tools for conducting verification activities during **decommissioning**



2. 廃止措置ガイドライン概要（位置付け）

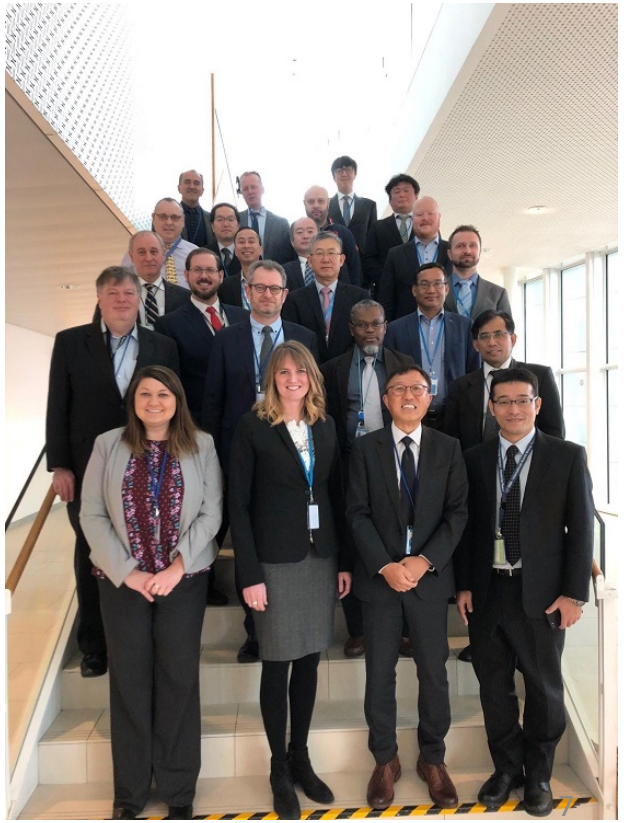
- ガイドラインはIAEAと国が効果的・効率的に保障措置を実施するための**説明目的**であり、**活用はボランタリー**
- ガイドラインは**法的拘束力を持たない**
- 効果的・効率的な保障措置実施のためにガイドラインを有効活用

(FOREWORDからの抜粋)
The information contained in this document is provided for **explanatory purposes** and **its use is voluntary.**
The descriptions in this document have **no legal status** and are not intended to add to, subtract from, amend or derogate from, in any way, the rights and obligations of the IAEA and the States set forth in the agreements and any protocols thereto concluded between States and the IAEA.
This document, rather, provides information which States may find useful in implementing their safeguards obligations with the IAEA.

（DIQガイドラインも同様）

2. 廃止措置ガイドライン概要（専門家会合）

- 廃止措置及びDIQガイドラインは専門家会合を通して開発
- 専門家会合は、3回開催
  2019/1/28-2/1(5日間), 2019/5/20-24(5日間), 2020/2/3-2/6(4日間)
- 約35名（IAEA、加盟国10か国＋EC）が参加



3. 保障措置活動の根拠となる国際約束（日・IAEA保障措置協定）

- 核物質及び核物質を取り扱える重要な機器を設計情報(DIQ)の提供

Article 43 (b) of INFCIRC/255

A description of the general arrangement of the facility with reference, to the extent feasible, **to the form, location and flow of nuclear material** and to the **general layout of important items of equipment which use, produce or process nuclear material.**

- 設計情報のアップデート（保障措置に関する変更がある場合）

Article 45 of INFCIRC/255

The Agency shall be provided with **design information in respect of a modification relevant for purposes of safeguards** under this Agreement, for examination, and shall be informed of any change in the information provided to it under Article 44, sufficiently in advance for the safeguards procedures to be applied under this Agreement to be adjusted when necessary.

3. 保障措置活動の根拠となる国際約束
（モデル施設附属書（FA））

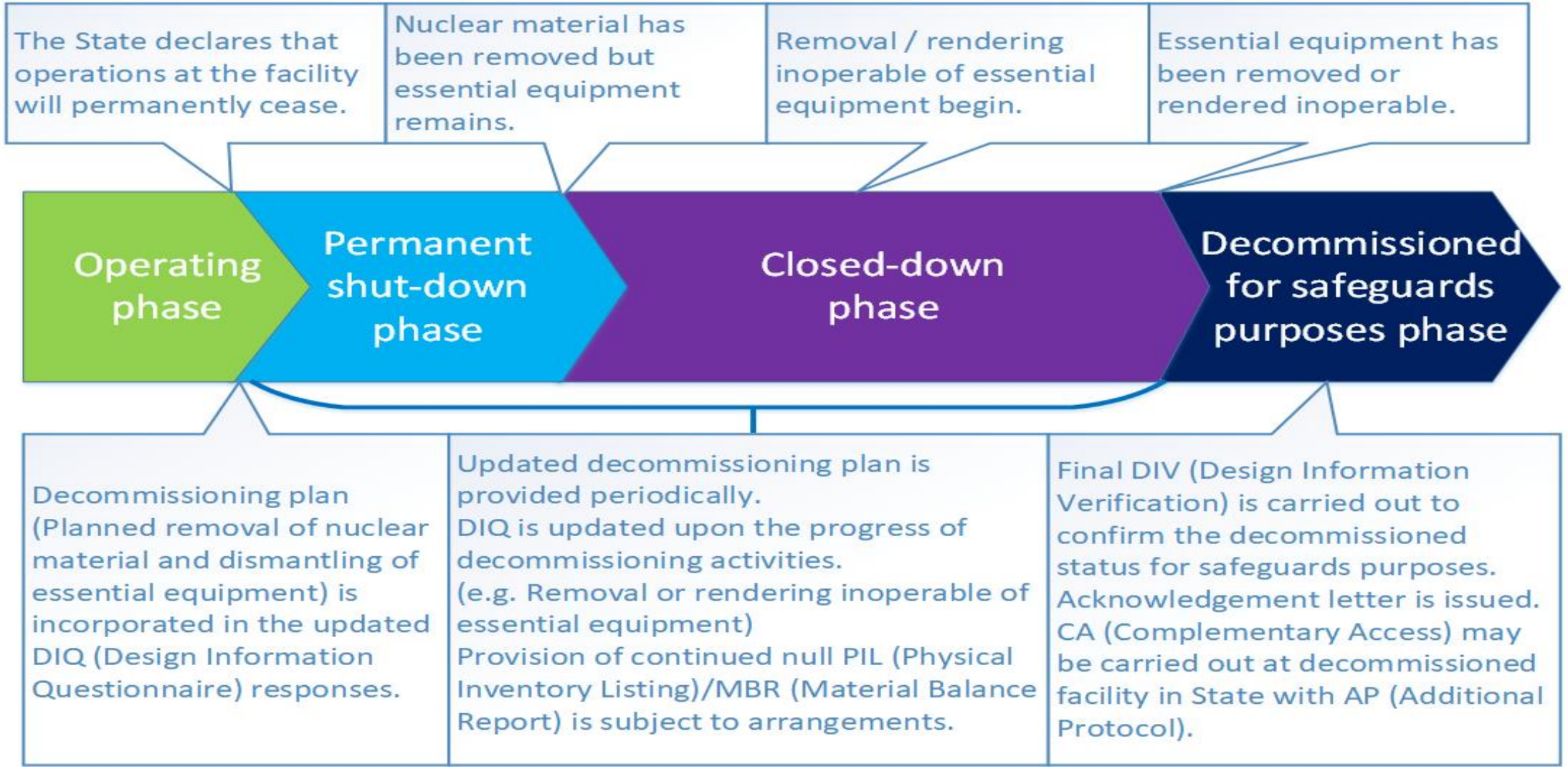
- 重要な変更の具体例（核物質のクリーンアウト、廃止措置等）

Code 2.2 (for Light Water Reactors)

Changes in the information on the facility to be provided in advance.

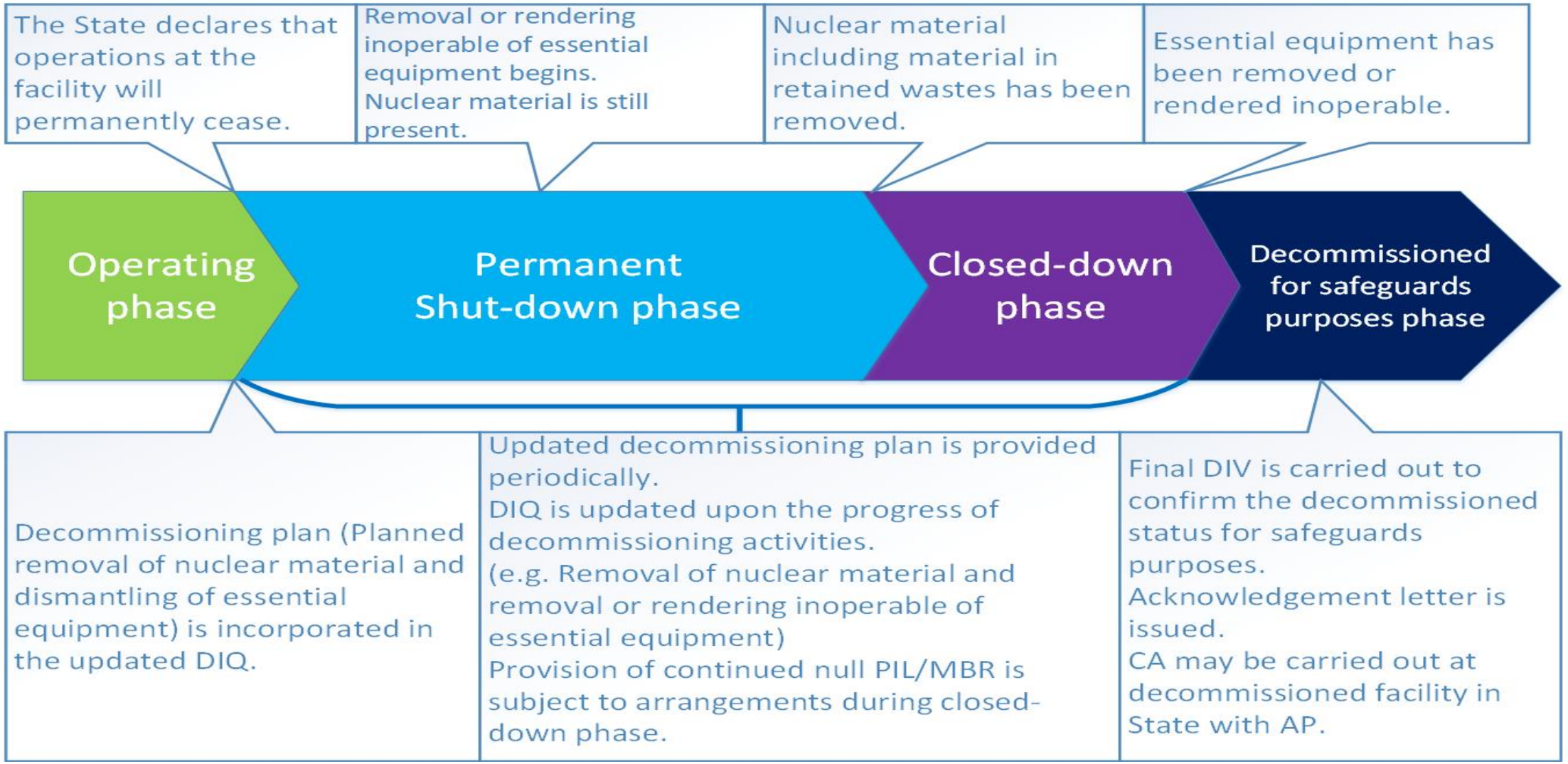
- Any change in the purpose, type or layout of the facility;
- Change influencing the access to the reactor vessel and/or its cover;
- Change in the method of storage of irradiated fuel and/or in the spent fuel storage capacity;
- Change in the access routes to the reactor area or fuel handling area;
- Change in the shipping containers and/or the routes followed by irradiated fuel within the facility;
- **Proposed changes in status of facility, with dates, with particular reference to temporary and permanent stopping of operations, final cleanout of nuclear material, and to decommissioning.**

4. 廃止措置ガイドライン（アイテム施設廃止措置段階）



- 廃止措置の段階に応じて設計情報が変わる
- DIQを適時適切にアップデートしてIAEAに情報提供

4. 廃止措置ガイドライン（バルク施設の廃止措置段階）



- 廃止措置の段階に応じて設計情報が変わる
- DIQを適時適切にアップデートしてIAEAに情報提供

4. 廃止措置ガイドライン（Essential Equipment：重要な機器）

Essential equipment

Equipment, systems, and structures essential to the operation of a facility, **which use, produce, process or store nuclear material** and affect the operational status, function and capabilities, inventory and/or throughput from a safeguards perspective.

- 国/事業者が重要な機器（核物質を使用、生成、処理、保管出来る機器）のリストをIAEAにDIQで提供
- IAEAは、申告された重要な機器の情報を基に、Essential EquipmentをDIE/DIVで特定　（⇒重要な機器にはIAEAが注目。重要な機器の変更は「重要な変更」。）

（参考）

✓ DIQで申告された重要な機器
✓ 追加議定書　付属書II
✓ 原子力供給グループのガイドライン (INFCIRC/254)

4. 廃止措置ガイドライン（計量報告）

- 計量報告は、**全ての核物質（保管廃棄物含む、免除及び終了された核物質は例外）**が無くなるまで継続
- 全ての核物質が無くなれば、施設のステータスは”Closed-down”に変更（DIQのアップデート）
- IAEAは、“Closed-down”のステータス（核物質が無いこと）をPIVあるいはDIVで確認
- Closed-down以降の計量報告については加盟国とIAEAで交渉

（参考）

Article 18 (d) of INFCIRC/255Add.1

***Closed-down facility* or *closed-down location outside facilities* means an installation or location where operations have been stopped and the nuclear material removed but which has not been decommissioned.**

4. 廃止措置ガイドライン（保障措置終了：測定済廃棄(LD)）

- 環境中に排出され、回収が不可能となった核物質
- **Conditioned waste**: 特別に処理され、実質的に回収が出来ず、原子力利用が出来ない（とIAEAが確認した）廃棄物中の核物質
- **Unconditioned waste:**処理はされていないが、非常に濃度が低く、実質的に回収が出来ず、原子力利用が出来ない（とIAEAが確認した）廃棄物中の核物質

（参考）

Article 11 of INFCIRC/255

Safeguards under this Agreement shall terminate on nuclear material upon determination by the Agency that the material has been **consumed, or has been diluted in such a way that it is no longer usable** for any nuclear activity relevant from the point of view of safe-guards, or **has become practically irrecoverable**.

4. 廃止措置ガイドライン (保障措置終了:測定済廃棄(LD))

Conditioned wasteの保障措置終了の流れ

1. 予定している廃棄物処理についてIAEA担当者に相談（国とともに）

2. 予定している廃棄物処理の情報提供（国経由）
   - ●処理方法(例：ガラス固化、セメント処理)
   - ●廃棄物中の核物質の濃度及び物質形態
   - ●廃棄物中の核物質に対するアクセス方法

3. IAEAは、**保障措置終了の基準**を満たしているか判断

4. IAEAは、結果を国側に通知

4. 廃止措置ガイドライン（保障措置目的での廃止措置完了）

保障措置目的での廃止措置完了は、以下の点を考慮してIAEAが決定する。

- **引き続き廃止措置済施設を確認できるIAEAの能力/権利（例：CA、特別査察）**
- **操業中の施設の能力**
- **残存する機器や構造物の状況から再操業するまでの困難さ**

（参考）

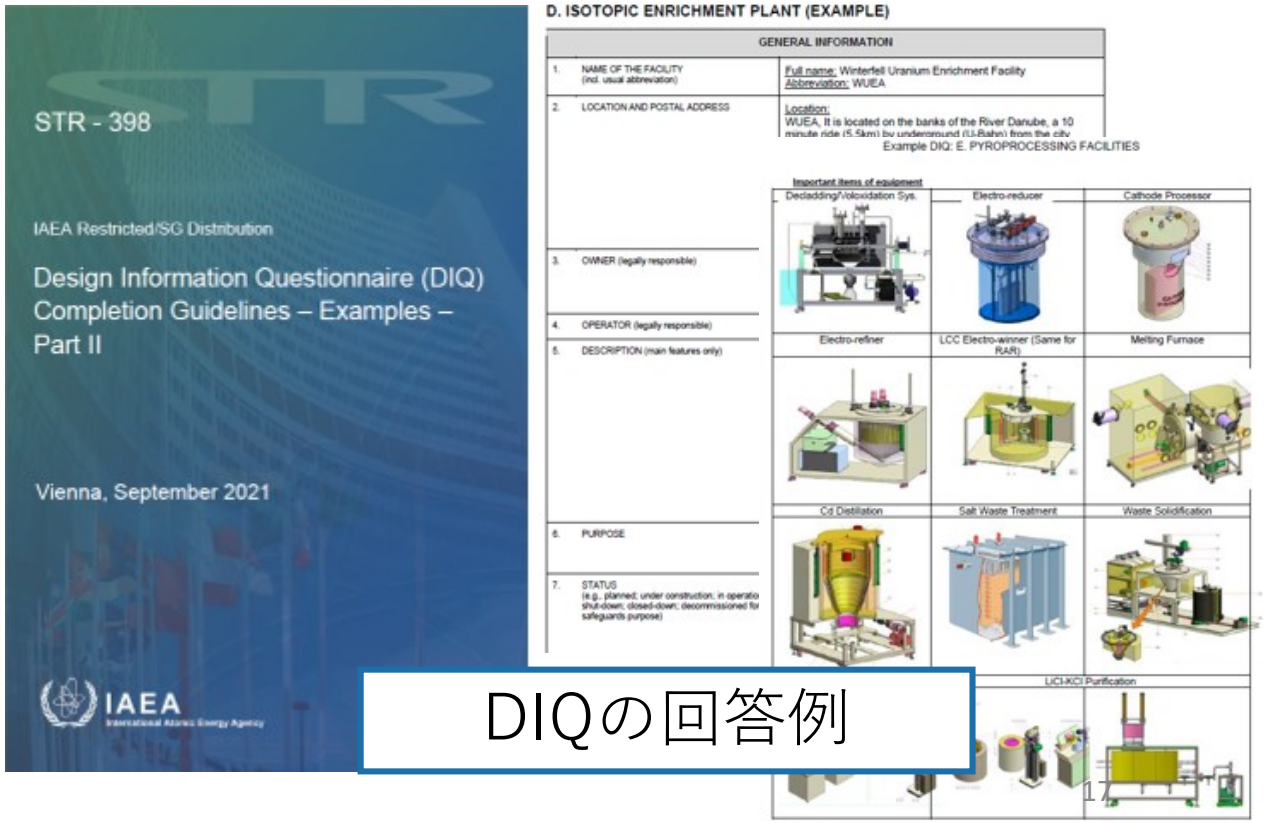
Article 18 (c) of INFCIRC/255Add.1

***Decommissioned facility* or *decommissioned location outside facilities* means an installation or location at which residual structures and equipment essential for its use have been removed or rendered inoperable so that it is not used to store and can no longer be used to handle, process or utilize nuclear material.**

5. DIQガイドライン（概要）

- IAEAが効果的/効率的な保障措置手段を適用するため、設計情報が重要
- 設計情報は、DIQ(Design Information Questionnaire)に従って提出
- DIQのガイドラインを有効活用し設計情報の提供（e.g.情報の詳細レベル）
- 2021年9月にSTR(Safeguards Technical Report)-398として承認

DIQの質問及び適切な回答の説明



DIQの回答例

5. DIQガイドライン（構成）

Design Information Questionnaire (DIQ) Completion Guidelines – PART I

I. Introduction (10 pages)
ガイドラインの概要、商業上機密情報の取り扱い、設計情報の提供の法的枠組み

II. Explanatory notes for general information for all facility types (7 pages)
Q.1～Q.12 の施設共通の質問の説明

III. Explanatory notes for the general types of facilities (219 pages)
施設タイプごと(10施設+LOF)の質問の説明

Design Information Questionnaire (DIQ) Completion Guidelines – Examples PART II

I. Introduction (2 pages)
ガイドラインの概要、DIQの種類

II. Example DIQ responses (500 pages)
施設タイプごとの記載例

5. DIQガイドライン（記載例）

- DIQの記載例（11施設＋１LOF）が参照可能
- IAEAに提供する設計情報のレベルが把握できる

H. RESEARCH REACTORS (EXAMPLE)

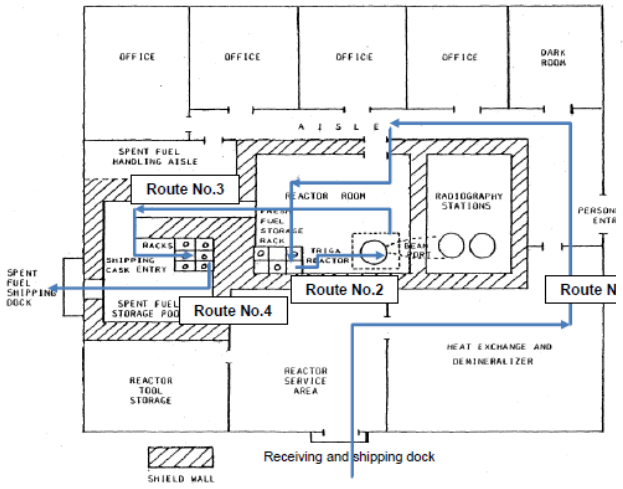
	GENERAL INFORMATION	
1.	NAME OF THE FACILITY (incl. usual abbreviation)	Full name: Winterfell Research Reactor Abbreviation: WFRR
2.	LOCATION AND POSTAL ADDRESS	Location: It is located on the banks of the River Danube, a 10-minute ride (5.5 km) by underground (U-Bahn) from the city center. GPS Coordinates: 48.2356° N, 16.4166° E Postal address: Vienna International Centre PO Box 100 1400 Vienna, Austria
3.	OWNER (legally responsible)	Winterfell State University Vienna International Centre PO Box 100 1400 Vienna, Austria
4.	OPERATOR (legally responsible)	Winterfell State University
5.	DESCRIPTION (main features only)	

General characteristics	TRIGA (Training, Research, Isotopes, General Atomics) pool type research reactor
Nuclear material type	Low enriched uranium (19.5 wt. % U235)
Design capacity	2 Mega Watt Thermal
Nominal inventory	See Attachment No. 34.1
Nominal throughput	Not applicable

6.	PURPOSE	Research in nuclear physics, radiography, radiation chemistry, biology, isotope production, shielding studies	
7.	STATUS (e.g., planned; under construction; in operation; shut-down; closed-down; decommissioned for safeguards purpose)	In operation	
8.	CONSTRUCTION SCHEDULE DATES (if not in operation)	Start of Construction	Commissioning / Operation
		1990	1995 / 1996

Example DIQ: H. RESEARCH REACTORS

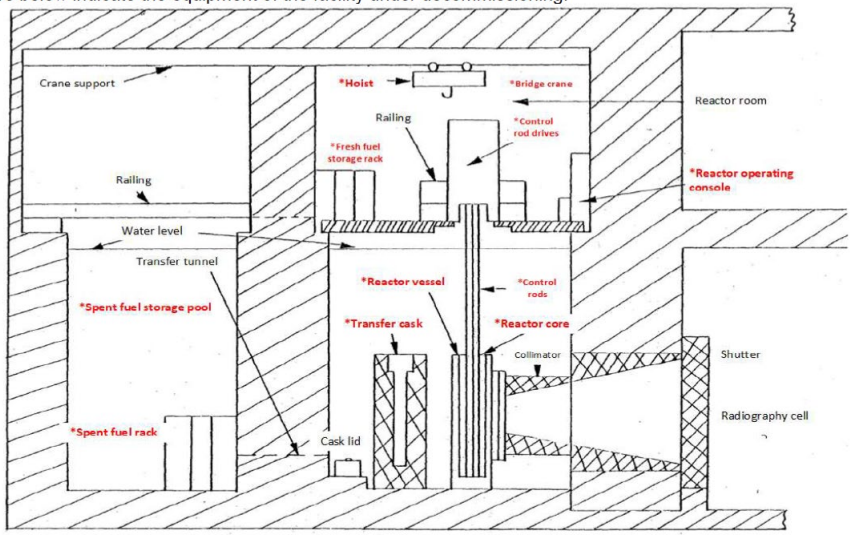
Attachment No. 10.3 Routes followed by nuclear material



Route No.1: Receipt of fuel to fresh fuel storage	Campus road ➔ Receiving and shipping dock ➔ Reactor service area ➔ Reactor room ➔ Fresh fuel racks (All movements are manual using hand carry or push carts
Route No.2: Fresh fuel storage to reactor core	Fresh fuel racks ➔ Reactor core via bridge crane and grapple
Route No.3: Reactor core to spent fuel storage	Reactor core ➔ Reactor transfer cask via bridge crane with grapple ➔ Cask transfer tunnel ➔ Spent fuel storage pool ➔ Spent fuel storage racks via bridge crane with hoist
Route No.4: Spent fuel storage to shipment	Spent fuel racks ➔ Shipping cask via bridge crane with hoist ➔ Shipping cask entry via bridge crane with hoist ➔ Shipping dock ➔ Truck via fork lift

Attachment No. 59.3 Removing or rendering inoperable of essential equipment

The figure below indicate the equipment of the facility under decommissioning.



* Essential equipment

5. DIQガイドライン（施設のステータス）

- 施設のステータスに **”shut-down, ”closed-down“, “decommissioned for safeguards purposes”**を追加
- 施設のステータスの説明をガイドラインに記載

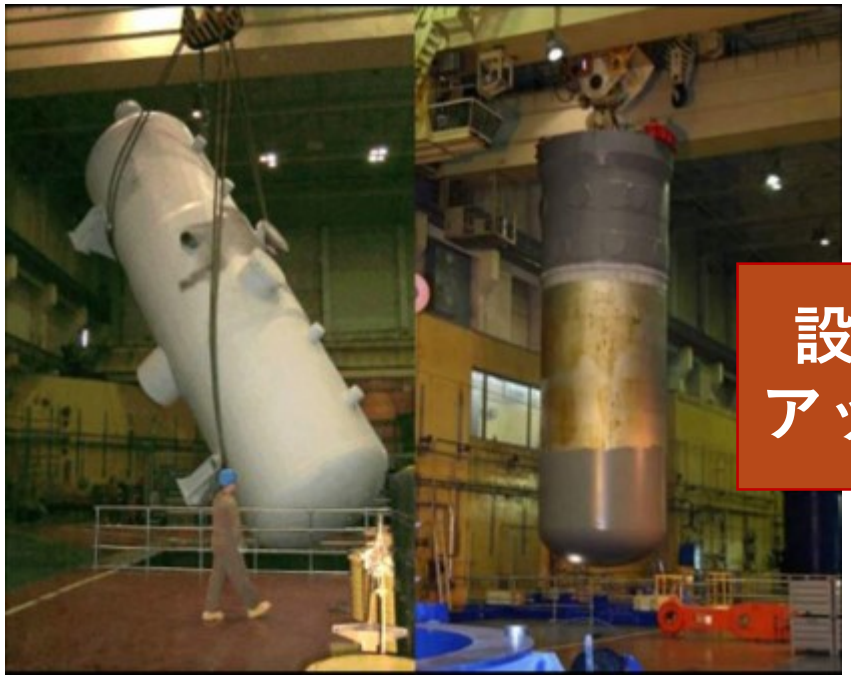
GENERAL INFORMATION	
7.	STATUS (e.g., planned; under construction; in operation; **shut-down**; **closed-down**; **decommissioned for safeguards purposes**)

5. DIQガイドライン（廃止措置計画）

- 廃止措置計画に関する情報の提供（新DIQテンプレート）
- Essential equipmentの情報は、要望があればIAEAが国に提供

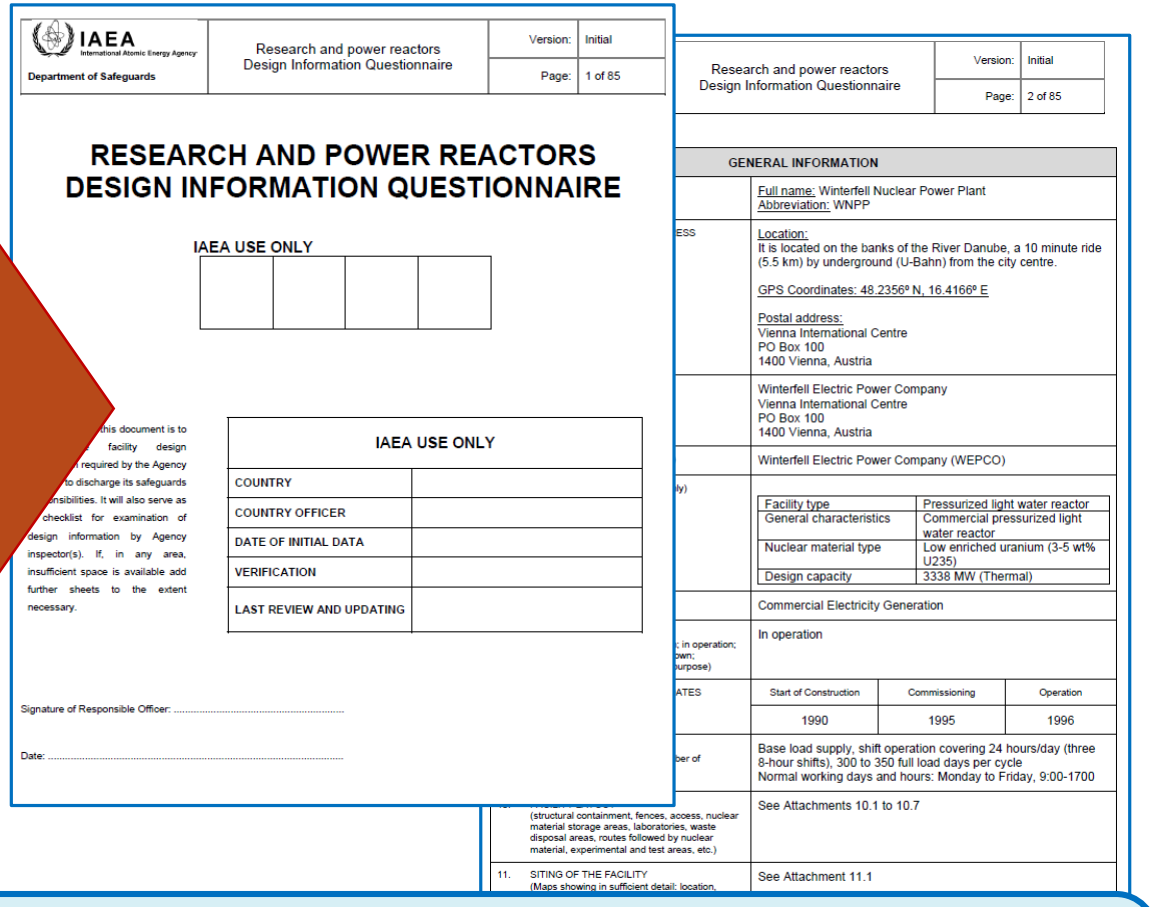
FACILITY DECOMMISSIONING PLAN i) Key events of the decommissioning plan ii) Removal and recovery of nuclear material iii) Removal or rendering inoperable of the essential equipment		PLAN(S) ATTACHED UNDER REF. Nos.
GUIDANCE FOR COMPLETING THE QUESTION	i) Provide a schedule of the key events of the facility's 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.	

6. 廃止措置中のIAEAへの情報提供（DIQアップデート）



参考図：蒸気発生器や原子炉圧力容器の解体
（ドイツの廃止措置）

設計情報のアップデート



IAEA International Atomic Energy Agency
Department of Safeguards

Research and power reactors Design Information Questionnaire

Version: Initial
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RESEARCH AND POWER REACTORS DESIGN INFORMATION QUESTIONNAIRE

IAEA USE ONLY

IAEA USE ONLY	
COUNTRY	
COUNTRY OFFICER	
DATE OF INITIAL DATA	
VERIFICATION	
LAST REVIEW AND UPDATING	

Signature of Responsible Officer: .....

Date: .....

Research and power reactors Design Information Questionnaire

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GENERAL INFORMATION

Full name: Winterfell Nuclear Power Plant
Abbreviation: WNPP

Location:
It is located on the banks of the River Danube, a 10 minute ride (5.5 km) by underground (U-Bahn) from the city centre.

GPS Coordinates: 48.2356° N, 16.4166° E

Postal address:
Vienna International Centre
PO Box 100
1400 Vienna, Austria

Winterfell Electric Power Company
Vienna International Centre
PO Box 100
1400 Vienna, Austria

Winterfell Electric Power Company (WEPCO)

Facility type	Pressurized light water reactor
General characteristics	Commercial pressurized light water reactor
Nuclear material type	Low enriched uranium (3-5 wt% U235)
Design capacity	3338 MW (Thermal)

Commercial Electricity Generation

In operation

Start of Construction	Commissioning	Operation
1990	1995	1996

Base load supply, shift operation covering 24 hours/day (three 8-hour shifts), 300 to 350 full load days per cycle
Normal working days and hours: Monday to Friday, 9:00-1700

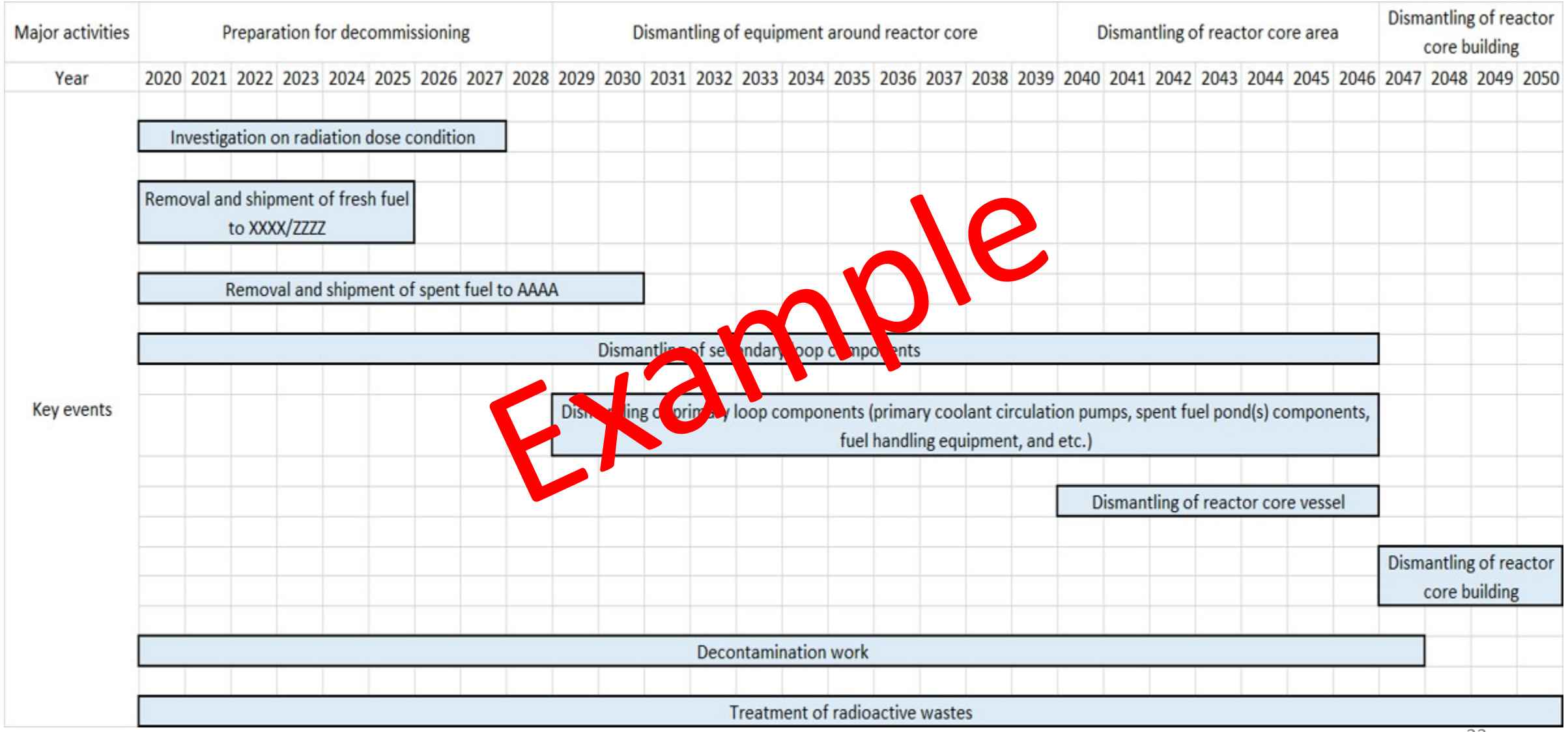
See Attachments 10.1 to 10.7

11. SITING OF THE FACILITY (Maps showing in sufficient detail: location,

See Attachment 11.1

廃止措置中の設計情報の変更（例：Essential equipmentの解体）の情報をIAEAに提供（**DIQのアップデート**）

6. 廃止措置中のIAEAへの情報提供（DIQ：重要な工程）



6. 廃止措置中のIAEAへの情報提供（DIQ：核物質の払出し）

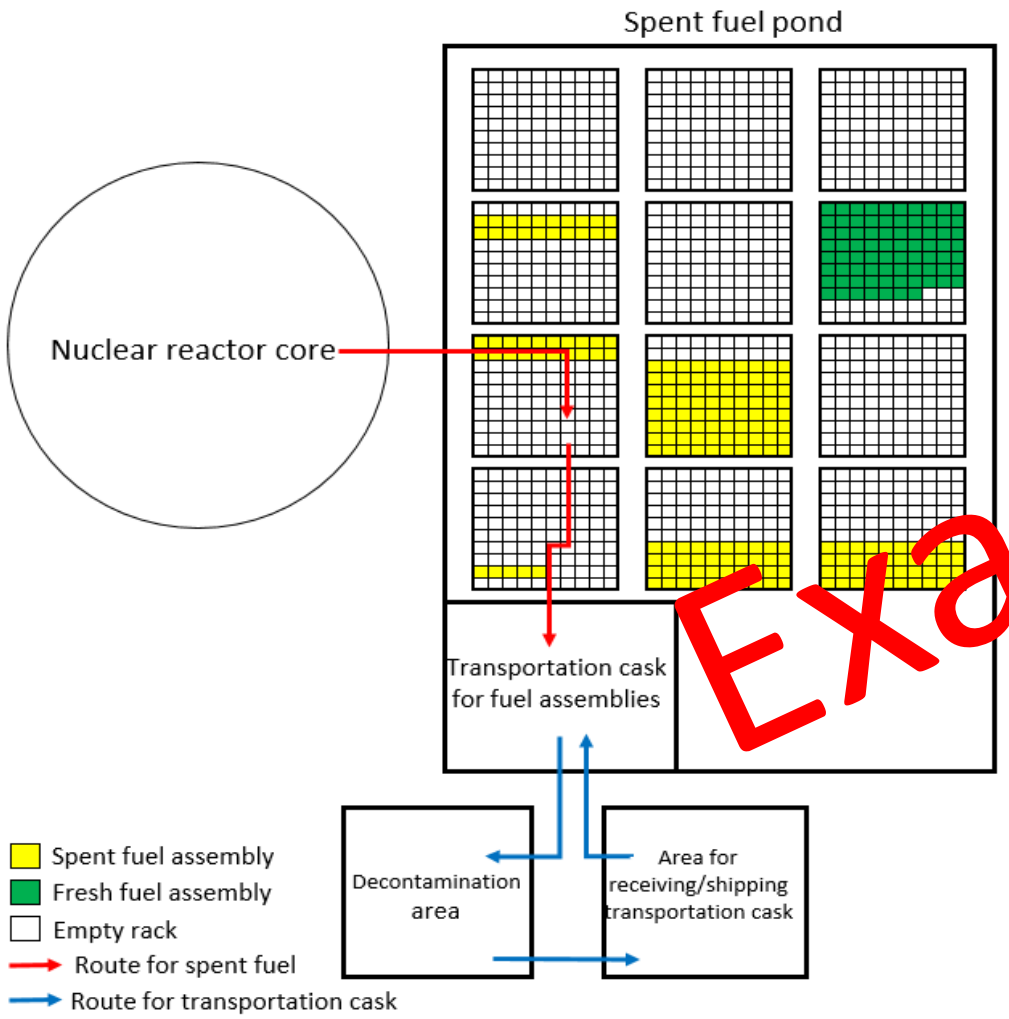
Safeguards

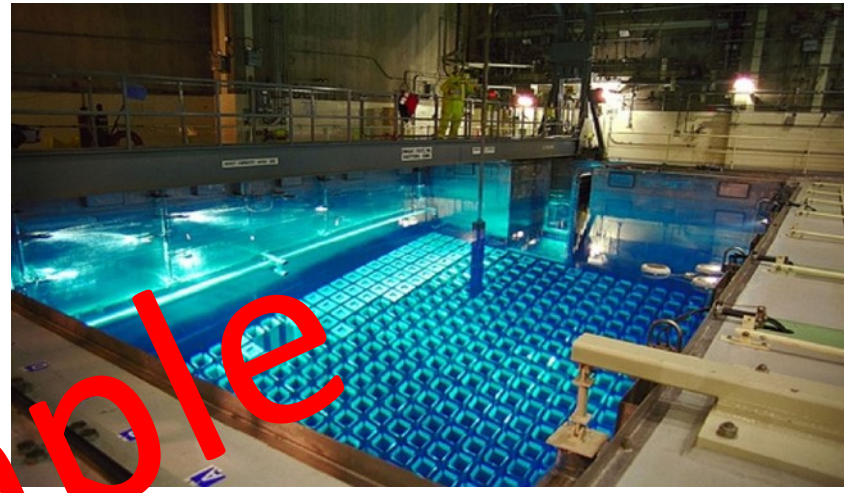
Removal of nuclear material (**Example for Light Water Reactor**)
Following is information on the removal of nuclear material during the decommissioning phase. This information is updated annually as needed.

- Table below indicates the number of fresh and spent fuel assemblies stored at the facility as of February 2021.
- *** fresh fuels will be shipped to other nuclear reactor unit (MBA: XXXX) on the site by 2025.
- *** fresh fuels will be shipped to a fuel fabrication facility (MBA: ZZZZ) by 2025
- All spent fuels stored in spent fuel pools will be moved to a dry storage facility (MBA: AAAA) by 2030.

Storage location	Fresh fuel	Spent fuel
Fresh fuel storage	** fuel assemblies (** tons Uranium, ** kg U235)	
Spent fuel pond		** fuel assemblies (** tons Uranium, ** tons Plutonium)

6. 廃止措置中のIAEAへの情報提供（DIQ：核物質の払出し）

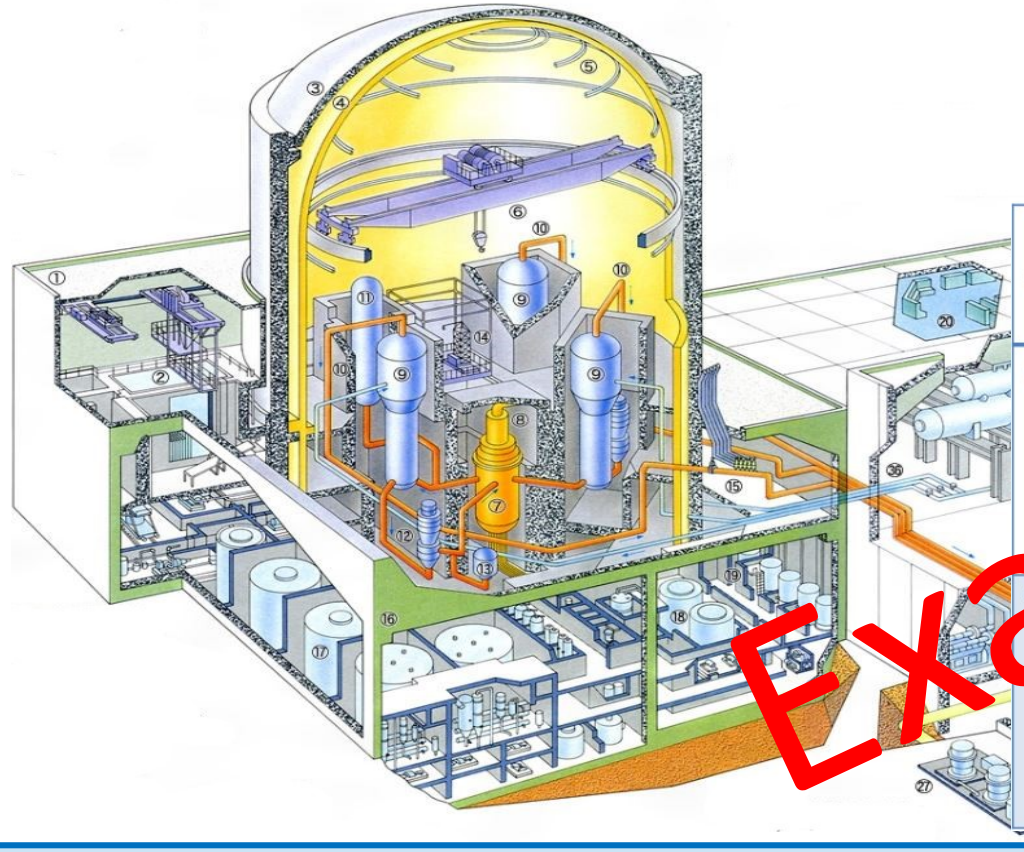




Spent Fuel Pond

Transportation Cask

6. 廃止措置中のIAEAへの情報提供（DIQ：Essential equipmentの解体）



Name of equipment/structure	Removal / Rendering inoperable of equipment/structure	
	Period	Method
6. Reactor hall polar crane*	2040-2046	The reactor hall polar crane will be removed and disassembled. The disassembled crane will be fragmented by cutting. The fragmented equipment will be stored at low level radioactive waste storage on the site.
7. Reactor core vessel*	2040-2046	The reactor core vessel will be removed and shipped to other disposal facility for cutting. The disposal facility is as follows. Name of disposal facility: ********** Address of disposal facility: **********

Example

Essential equipmentが解体される時期と方法についてIAEAにDIQで情報提供
Essential equipmentの状態をIAEAが**DIE/DIV** (Design Information Examination / Design Information Verification)で確認

7. まとめ

- 廃止措置中の原子力施設への効果的・効率的な保障措置のためには以下２点が必要
  1）IAEAと国/事業者間での早い段階でのコミュニケーション
  （**Safeguards-by-Design**の概念。廃止措置ガイドラインが有用）
  ✓廃止措置計画の重要なイベント
  ✓核物質の払出、除去、回収
  ✓Essential equipmentの解体(使用不可)
  2）設計情報のIAEAへの適時適切な提供（DIQガイドラインが有用）
  ✓Part I (質問及び回答方法等)
  ✓Part II(回答の記載例)
- ガイドラインを参考として柔軟かつ有効に活用しつつ、IAEAとの間で適切な情報共有を行いながら協議を進めることが必要