Joint KINS-IAEA-ANNuR/ANSN/FNRBA
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OPERATIONAL LIMITS & CONDITIONS
(OLCs)

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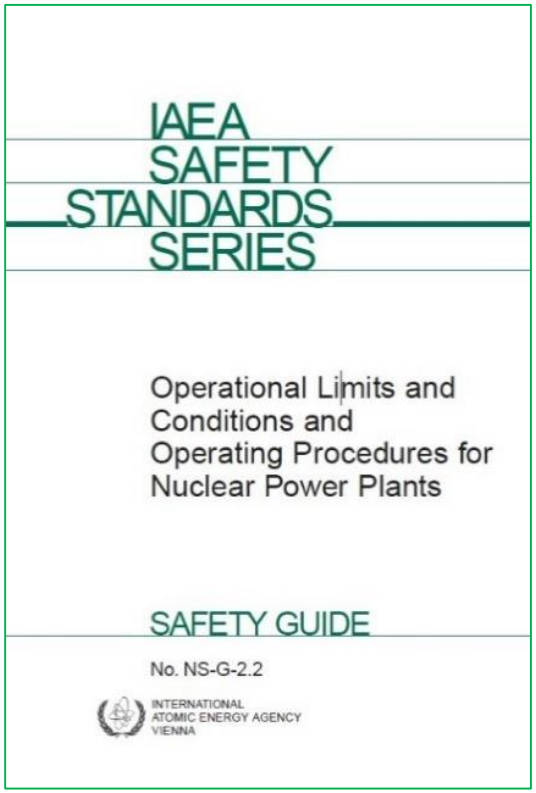
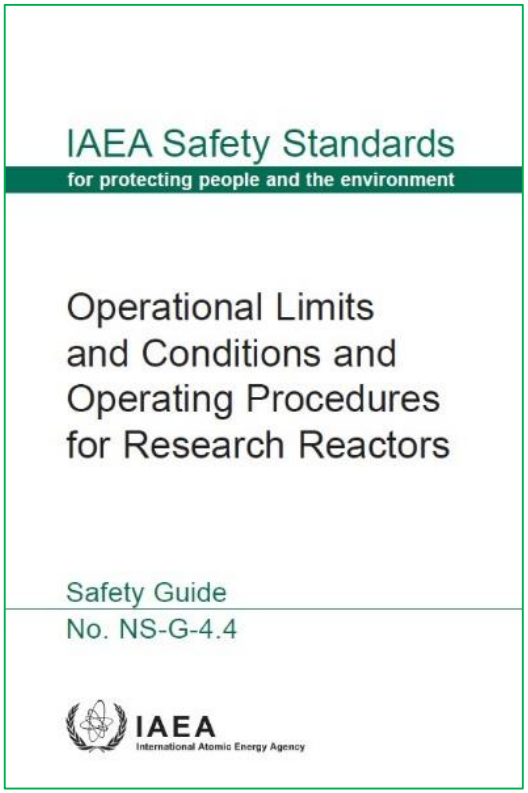
CONTENTS

□ IAEA Safety Requirement and Guidance

- IAEA SSR-2/2, NS-G-2.2, NS-G-4.4





□ IAEA SSR-2/2, Safety of NPPs: Commissioning and Operation

- Requirement 6: Operational limits and conditions (OLCs)

  The operating organization shall ensure that the plant is operated in accordance with the set of OLCs

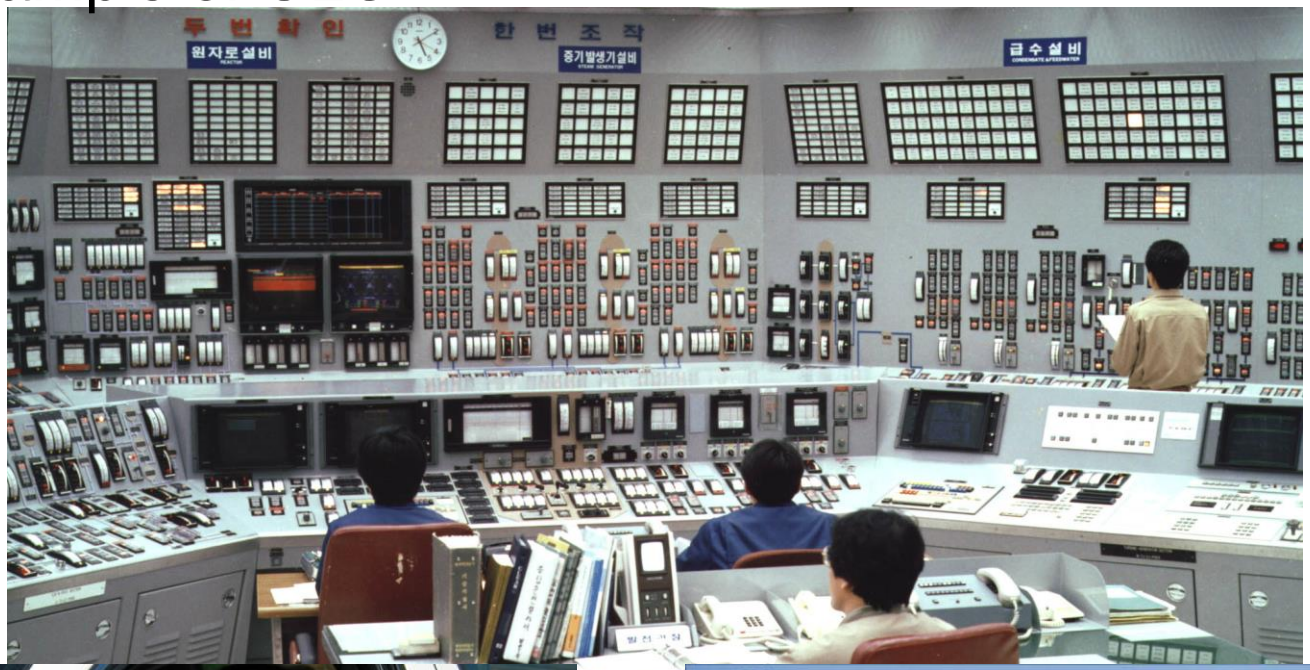
  – Form an important part of the basis for the authorization of the operating organization to operate the plant
  – Reflect the provisions made in the final design as described in SAR
  – Reviewed and revised in consideration of experience, developments in technology & approaches to safety, and changes in the plant
  – Include requirements for normal operation, including shutdown and outage stages, and cover actions to be taken and limitations to be observed by operating personnel

- Include (a) safety limits, (b) limiting settings for safety systems, (c) limits and conditions for normal operation, (d) surveillance and testing requirements, (e) action statements for deviations from normal operation
- Trained in and thoroughly familiar with, operating personnel, OLCs in order to comply with the provisions
- Ensure, operating organization, that surveillance programme is established and implemented to ensure compliance with OLCs, and that its results are evaluated, recorded and retained
- Returned, the plant, to a safe operational state when an event occurs in which parameters deviate from the limits and conditions for normal operation
- Established, a process, to ensure that deviations from OLCs are documented and reported and that actions are taken in response
- Not intentionally exceed, operating organization, the OLCs

□ Definition and terms of OLCs

- A set of operating rules that normally includes:
  - Safety limits and safety system settings on relevant variables and parameters of reactor
  - Limiting conditions on equipment and operational characteristics of reactor
  - Surveillance requirements
  - Administrative requirements
- Junction area of design, safety analysis and plant operations
  - Operating procedures are consistent with and fully implement the OLC
  - Cover the actions that are taken and the limitations that are observed by operating personnel
- Various terms that mean OLCs
  - Operational Technical Specification(OTS), Technical Specifications for safe operation (Tech Specs), Operating Policy and Principal (OP&P), safety specifications, operating rules

- Example of OLC



□ Objectives

- Prevent situations from arising that might lead to accidents, and mitigate the consequences if they do occur
  - Operational experience & conservative decision-making
- Prescribe a set of specific limitations and equipment requirements
  - Form a comprehensive envelope of reactor parameter values and system conditions, for safe reactor operation and for dealing with abnormal situations, typically derived from SAR
  - Ensure site personnel, public and the environment are adequately protected against radiation hazards
  - Agreement between owner and responsible authority on administrative controls, equipment availability, and operational parameters

□ Scope of OLCs

- To consider all aspects of plant operation that bear on safety
  - Process related aspects such as power level, pressure, temperature, flow, and the like
  - Equipment status, personnel status, the existence of potential external threats

□ Development and maintenance of OLCs

- Based on the plant specific safety analysis, uncertainty consideration in safety analysis, and review and amend based on commissioning test results
  - Initially, in co-operation with designers to ensure the adequate time for assessment and approval by regulatory body
- Periodic review to ensure the applicability considering the current operational and regulatory environments

□ Components and space

- Major items
  - Safety Limits (SL)
  - Limiting Safety System Settings (LSSS)
  - Limiting Conditions for Operation (LCO)
  - Surveillance Requirements (SR)
  - Action Statements for deviations from the OLCs (AS)
- Other items
  - Definitions, Applicable Mode, Plant Design Features
  - Standard Format
  - Technical Bases Document
  - Administrative and Management Control Procedures
  - Quality Assurance Program

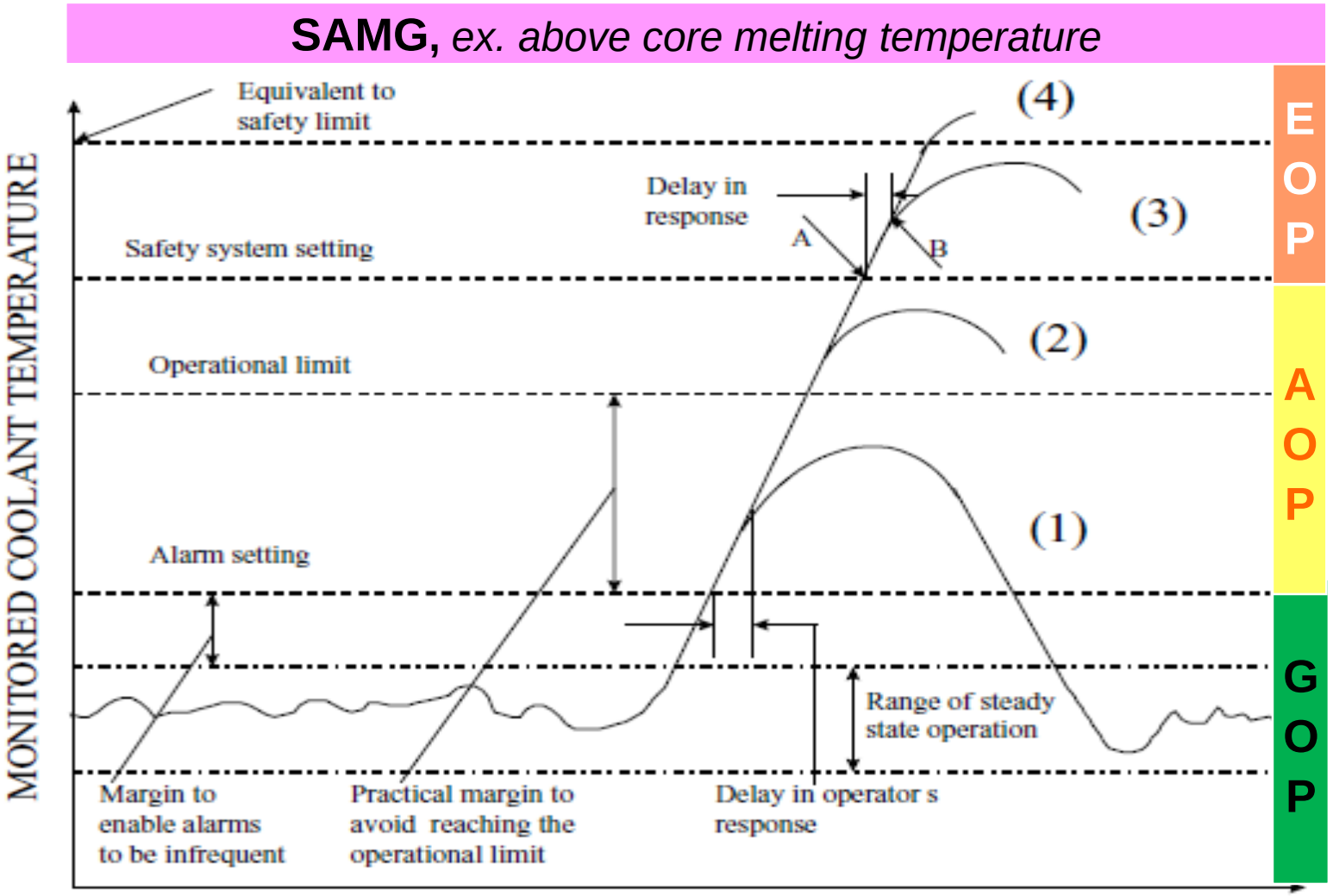
□ Defense-in-Depth

- Underlying concept for the design and operation of nuclear reactors
  - Require a concentric protective barriers, all of which must be breached before the radioactive release can adversely affect human beings or the environment
- Multiple levels of protection
  - Hierarchical deployment of different levels of equipment and procedures to provide a graded protection against a wide variety of transients, incidents and accidents
- Twofold strategy
  - To prevent accidents
  - If prevention fails, to limit their potential consequences and prevent any evolution into more serious conditions

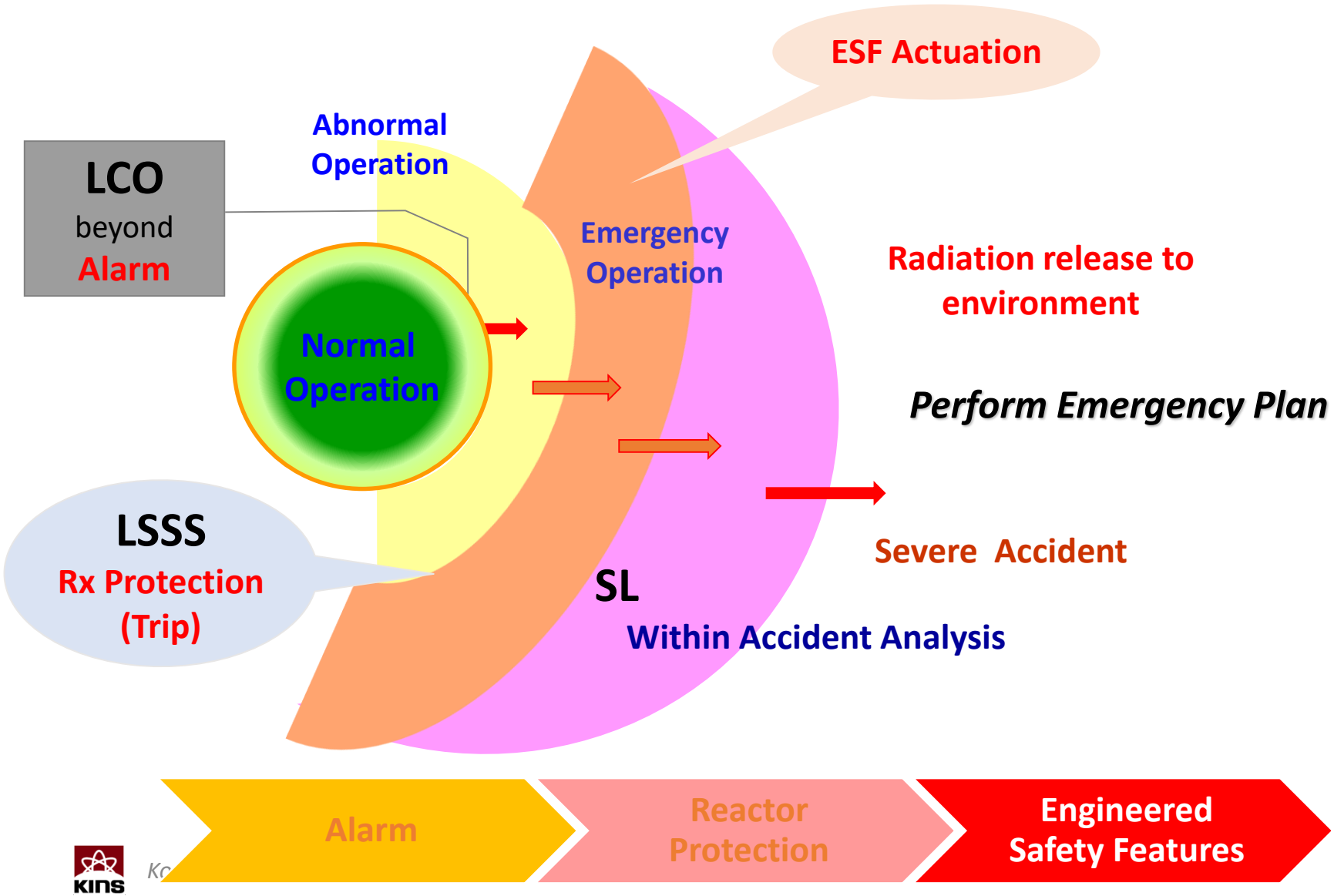
- Levels of DID

	Definition	Means (HW, SW and control)
Level 1	• *Prevention* of abnormal operation and failures - *to confine radioactive material and minimize deviation from normal operation*	• Robust rules & regulations • Conservative design • High quality construction, operation, & maintenance • OEF & Safety Culture
Level 2	• *Control of abnormal operation* and detection of failures - *to bring the pant back to normal operating condition ASAP*	• Auto control & protection system • Monitoring facilities
Level 3	• *Control of accidents* within the design basis - *to prevent core damage*	• ESF • EOP
Level 4	• *Control of severe plant conditions*, preventing accident progression and mitigating the consequences - *to protect the confinement*	• Containment Building • SAMG
Level 5	• *Mitigation of radiological consequences* of significant releases of radioactive material	• Exclusion Area • Radiation Emergency Plan

- SL, LSSS, OL, and alarm setting & operation range



- Operational space



□ Major items of OLCs

- Safety Limits (SL)
  - Limits to process variables within which plant operation is safe
    - Prevent unacceptable releases of radioactive materials from plant
    - Established by means of a conservative approach to ensure that all the uncertainties of safety analyses are taken into account
  - If any SL is exceeded;
    - Reactor should be shut down
    - Normal power operation is restored only after appropriate evaluation has been performed
    - Can not be restarted without prior to regulatory body approval

- To maintain the integrity of fuel cladding and pressure boundary of RCS
  - Essential factor for the integrity of fuel cladding is an adequate cooling of fuel
  - RCS pressure boundary should be kept intact to prevent any loss of coolant and resulting reduction in the effectiveness of cooling
- Usually, SL is the maximum acceptable values with conservatism in relation to their design values for:
  - Local heat transfer rates of fuel cladding
  - Pressure and temperature of RCS

- Limiting Safety System Setting (LSSS)
  - Limits at which Reactor Protection System (RPS) activates reactor trip to prevent SL being exceeded
    - Suppress a transient and/or limit the course of anticipated operational occurrences
  - Limits at which RPS activates Engineering Safety Features Actuation System (ESFAS) that starts Engineering Safety Features (ESF) systems to mitigate core damage during an accident condition
    - Provide a way that either safety limits are not exceeded or the consequences of postulated accidents are mitigated
  - If any LSSS is exceeded;
    - Some setting will cause the reactor to be tripped
    - Some another settings will result in other automatic actions to prevent safety limits to be exceeded
    - Some the other safety system settings will be provided to initiate operation of engineered safety systems

- A range of LSSS parameters
  - Include parameters in safety limits as well as other parameters, or combinations of parameters, which could contribute to reactor transients
- Ensure automatic actuation of safety systems within parameter values assumed in SAR
  - The calculation shall include process uncertainty, overall measurement uncertainty, and transient phenomena of process instrumentation
  - For operational flexibility, actual trip points be set more conservatively than specification values

- Limits and Conditions for Operation(LCO)
  - Include limits on normal process variables, as well as requirements for minimum staffing, minimum operable equipment, and allowable outage times for systems and equipment
    - To ensure that the assumptions of SAR are valid and that established safety limits are not exceeded during plant operation
  - Ensured, acceptable margins, between normal operating values and safety system settings to avoid undesirably frequent actuation of safety systems
  - If any LCO cannot be satisfied;
    - Actions to be taken by operator in the event of deviations from LCOs and within the time allowed to complete these actions

- Include limits on operating parameters, stipulations for minimum amount of operable equipment and prescribed actions to be taken by operator
  - Operability requirements should state the various operating modes, the number of systems or components important to safety that should be either in operating condition or in standby condition
  - Where operability requirements cannot be met the extent intended, the actions to be taken to manoeuver plant to a safer state should be specified, and the time allowed to complete the action should also be stated

- Surveillance Requirements (SR)
  - Requirements for periodic checks, tests, calibrations, and inspections of equipment, components, and processes to establish operability, performance, correct set points, and to assure reliability
    - Ensure that LSSS and LCOs are met at all times
    - Relevant systems and components should be monitored, inspected, checked, calibrated and tested in accordance with an approved surveillance program
  - Surveillance program should be adequately specified to ensure the inclusion of all aspects of limits or conditions
    - Frequency and scope of SR should be stated
    - SR should be specified in procedures with clear acceptance criteria so that there are no doubts concerning system or component operability

- In general, three types of SRs are specified:
  - Operability checks
  - Calibrations
  - Inspections
- Depending on facility and system
  - Operability checks from monthly to quarterly basis
  - Calibrations and inspections from annually to biennially

- Action statements
  - Statements of actions to be taken by operating staff in the event of various abnormal conditions
    - May take the form of emergency operating instructions or similar procedures

CONTENTS

1. History of OTS

- 1960s Initial Technical Specifications (TS)
- 1970s Standard TS (STS)
- 1980s Improvement plan of STS to reflect the TMI lessons learned
- 1990s Improved Standard TS (ISTS) and 4 LCO selection criteria

✓ Policy-making in 1999 to revise STS into the form of ISTS for all the NPPs in Korea

✓ JRTR in the form of ISTS, licensed in 2017

2. Submission of OTS

□ Construction Permit (CP)

Nuclear Safety Act Art. 10 (CP), The Decree Art. 4 (Application of CP)

- Require to describe the OTS related contents in Chapter 16 (OTS) of PSAR

- The purposes
  - Identify and justify parameters, conditions and others to be described in OTS
  - Confirm any items, as early as possible, that require particular concerns to avoid the serious changes of parameters and systems of final design

□ Operating License (OL)

The Act Art. 20 (OL), The Decree Art. 16 (Application of OL)

- Submission of a separate OTS and the contents
  1. Operation of reactor facility
     a. Use and application
     b. Safety limit
     c. Limiting conditions for operation & surveillance requirements
     d. Design features
  2. Radiation and environment control of reactor facility
     a. Radiation protection
     b. Control of radioactive materials
     c. Environment preservation from reactor facilities
  3. Operational management of reactor facility
     a. Organization and functions
     b. Surveillance of reactor facilities
     c. Measures to be taken by operator in the event of emergency
     d. Programs and guidelines

□ Standard Format and Content of OTS

Notice of the NSSC No. 2017-5

- Scope of preparation
  - Operation, radiation and environment control, and operational management of reactor facility

① Operation of reactor facility

  - Use and application
    - Definitions of terms
    - Meanings of logical connectors used to identify the relationships among unsatisfied conditions (AND and OR), required actions, completion times, and surveillance requirements and frequencies
    - Guidelines to establish the prescriptions and the use of completion times
    - Establishment and application methods for surveillance frequencies

– Safety Limits (SL)
  - Prescriptions of safety limits for main process variables
    - Ensure the integrity of physical barriers against the release of radioactive materials
    ✓ Conservative limits on parameters that cannot be safely exceeded
  - In case the safety limit of reactor exceeds
    - Operator shall shut down the reactor
    - Report to NSSC the details and the cause analysis of the event, and the actions taken
    - Resume operation with the approval of NSSC
  - In case the automatic protection system does not perform the required function
    - Operator shall take proper actions
    - Then, report to NSSC the details and the cause analysis of the event, and the actions taken

  ✓ *Decide to secure the integrity of fuel cladding and RCS pressure boundary*
    - *Local heat transfer rates of fuel cladding, pressure and temperature of RCS*

– Limiting Conditions for Operation (LCO)
  - Minimum functions or performances to maintain reactor facility in a safe state
  - In case the limiting conditions are not met
    - Shutdown the reactor or take the required actions to meet the conditions
  - 4 selection criteria of LCO
    1. Instrumentations in control room, to detect and indicate a significant abnormal degradation of RCPB
    2. Process variable, design feature, or operating restriction that is the initial condition of a DBA or transient analysis, assuming the failure of or challenging the integrity of fission product barrier
    3. SSCs that are the part of primary success path and which functions to mitigate a DBA or transient, assuming the failure of or challenging the integrity of fission product barrier
    4. SSCs which operating experience or PRA have shown to be significant to public health and safety

✓ *Normal operational envelope on parameters, that provides comfortable margins to SL and SSS*

– Surveillance Requirements (SR)
  - Tests, corrections and inspections, and the frequencies reflecting operating experience or PSA results to satisfy:
    - Acceptable level of qualities of systems and equipment are maintained
    - Systems and equipment are operated within SL
    - LCOs are abided by
  - ✓ *Monitoring, inspection, checking, calibration and testing of equipment that affect SL, SSS and LCO to ensure the reliable operation*

– Design characteristics
  - Important safety characteristics of design
    - Which is not included in SL, LCO, or SR
    - But causes a significant effect on safety if changed or modified

✓ *No stipulation on LSSS in the format & contents of OTS, and regarded normally as part of LCO*

② Radiation & environment control of reactor facility

- Protection of workers and the public from radiation in accordance with the Act Art. 89 (Exclusion Area)
  1. Preservation of nuclear reactor facility
  2. Radiation safety control
  3. Management of radiation detection equipment
- Control and management of radioactive materials in accordance with the “Standards for Radiation Protection”
  1. Management of radioactive waste
  2. Exhaust and drainage monitoring systems
  3. Matters on receipt and disbursement, transport, storage, and handling of nuclear fuel materials
  4. Handling of radioisotope
- Environmental monitoring to preserve the environment from reactor facilities in accordance with the *“Regulation on the Survey of Radiation Environment and the Assessment of Radiological Impact in the Vicinity of Nuclear Facilities”*

③ Operational management of reactor facility

- Organization and function
  - Operating organization, administrative organization, duty of each department, staffing, responsibility of operational management, Nuclear Review Board (NRB), Plant Nuclear Safety Committee (PNSC), qualification for plant staff and procedures
- Regular inspections of reactor facility
  - Precautions on surveillance, positioning of patrols, and items and actions of surveillance for equipment
- Operator actions in the event of emergency
  - Actions when discovered an emergency situation, actions to be taken after reactor trip, manual reactor trip, and manual actuation of Emergency Core Cooling System (ECCS)

– Programs and Manuals

1. Technical specification bases control program
2. Safety function determination program
3. Program of reactor coolant release sources outside containment
4. In-service inspection (ISI) program
5. In-service test (IST) program
6. Fire protection program
7. Testing program of diesel fuel oil
8. Program of component cyclic and transient limits
9. Offsite dose calculation manual (ODCM)
10. Atmospheric monitoring instrumentation management procedure
11. Guideline for post-accident sampling analysis
12. Radiation monitoring instrumentation management program
13. Radioactive effluents control program
14. Radioactive waste process control program (PCP)
15. Secondary water chemistry control program
16. Ventilation filter testing program (VFTP)
17. Radioactivity monitoring program for explosive gas and liquid storage tank
18. Mobile testing program of hydrogen recombiner.

– Reporting requirements

1. Biannual and annual environmental radiation surveillance report
2. Quarterly operation report
3. Quarterly radiation control report
4. In-service inspection report
5. Accidents and incidents report
6. Reload safety evaluation report

3. Compliance with OTS

The Act Art. 26 (Safety Measures for Operation)

- Licensee to observe OTS

The Act Decree, Art. 41 (Safety Measures for Operation)

- Operator to take safety measures by the Act Art. 26
  3. Patrol and check of reactor facility
  4. Safe operation of nuclear reactor
  5. Self-check of reactor facility

Regulation on Tech. Stds., Art. 53 (Compliance with OTS)

- Licensee to take actions to meet item 3 through 5 of the Act Decree, Art. 41
  1. Monitor the LCOs of OTS, and take proper actions if the conditions are not met
  2. In the event of reactor trip or scram, investigate the cause and any damages to reactor facilities, and ensure the safety before resuming operation
  3. Review and update OTS for safety, as necessary

4. Corrective order & penalty for OTS

The Act Art. 22 (Inspection)

- Inspection of licensee, and corrective order of NSSC
  - Insufficient actions to satisfy the Act Art. 26 (Safety measures for operation), including the observance of OTS
  - # Punishment by a fine less than 3 mil. KRW for violation of the order by the Art. 118 (Penal provisions)

The Act Art. 24 (Revocation of OL)

- Revocation of license, or suspension of operation for a period of less than 1 year
  - Changes of OTS without prior approval
  - OTS below the Standards for License
  - Non-compliance of corrective order in violation of OTS

The Act Art. 26 (Safety Measures for Operation)

- Licensee to observe OTS
  - # Punishment by a fine less than 3 mil. KRW for the violation of OTS by the Art. 118 (Penal provisions)

CONTENTS

□ Reactor pool water level of JRTR Tech Specs

- **SL** : ≥ 4.3 m for Mode 3 operation
- **LSSS**: 9.5 m (RPS pool level Lo-Lo, 9.4 m for SA)
- **LCO** : 9.7 m
- **SR** : Level check per 8 hr., calibration per 12 mon.

□ Actual Tech Specs

Table 1.2-1 Operation Modes

MODE	Title	% Full Power*	Criticality (k_{eff})	PCS Pumps
		POWER OPERATION		
P1	Power Operation	> 0.1	≥ 0.99	ON
P2	Power Startup	≤ 0.1	≥ 0.99	ON
P3	Power Shutdown	N/A	< 0.99	ON or OFF
		TRAINING OPERATION		
T1	Training Operation	≤ 1	≥ 0.99	OFF
T2	Training Shutdown	N/A	< 0.99	OFF

* *Excluding decay heat*

1.0 USE AND APPLICATION

1.1 Purpose

OTS provides an envelope of the parameters that protect the reactor, JRTR personnel, the public, and the environment - - -

1.2 Definitions and Terminologies

TEMINOLOGY	DESCRIPTION
ABNORMAL OPERATION	ABNORMAL OPERATION occurs when the operation of the reactor deviates from normal operation by violating one or more operational limits and/or conditions. Remedial actions shall be taken. - - -
MODE	A MODE shall correspond to any one inclusive combination of core reactivity condition, power level, and the operation status of the Primary Cooling System (PCS) pumps specified in Table 1.2-1.

2.0 SAFETY LIMITS

2.1 Safety Limits (SL) for Power Operation

2.1.2 Reactor Pool Water Level

1) The reactor pool water level shall be at least 4.3 m during operation MODE P3

2.2 Safety Limit (SL) Violation for Power Operation

2.2.2 Violation of the Safety Limit (SL) on the Reactor Pool Water Level

1) IF SL 2.1.2 is violated, restore in compliance with the SL immediately
2) Notify the violation to the regulatory body by telephone within one-working day followed by a written report in 14 days

Table 2.5-1 Trip Parameters and Setpoints of the Reactor Protection System for Power Operation *(LSSS)*

No.	Reactor Trip Parameters	Trip Setpoint for RPS	Trip Setpoint for Safety Analysis
1	Neutron Power Hi	115%FP	120%FP
12	Core DP Lo	23.0 kPa	20.8 kPa
13	RPS Pool Level Lo-Lo	9.5 m	9.4 m
14	Pool Surface Radiation Hi	30 μSv/hr	50 μSv/hr

3.0 LIMITING CONDITIONS FOR SAFE OPERATION AND SURVEILLANCE REQUIREMENTS

3.1 Limiting Conditions for Safe Operation and Surveillance Requirements for Power Operation

3.1.4 Reactor Cooling and Connected Systems

3.1.4.1 Reactor Pool Water Level

LCO 3.1.4.1: **Reactor pool water level shall be maintained higher than 9.7 m** (>9.7 m)

APPLICABILITY: MODES P1, P2

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. The reactor pool water level not within the limit.	A.1 Shut down the reactor.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 3.1.4.1.1 Verify the reactor pool water level to be >9.7 m.	8 hours
SR 3.1.4.1.2 Perform instrument (331-LT-001) calibration.	12 months

4.0 DESIGN FEATURES

4.2 Reactor Core and Fuel

The reactor core consists of 18 fuel assemblies and employs two kinds of reflectors: beryllium and heavy water.

The coolant, which also serves as the moderator, is light water.

4 Control Absorber Rods (CARs) and 2 Second Shutdown Rods (SSRs) are provided to control and shut down the reactor.

4.2.1 Fuel

The fuel plate is composed of a fuel meat surrounded by aluminum cladding.

The fuel meat is made of homogeneously dispersed U3Si2 particles in an aluminum matrix.

The fuel enrichment is 19.75 wt.%.

5.0 ADMINISTRATIVE CONTROL

5.1 Organization and Function

5.1.1 Organization

The JRTR is owned and operated by the Jordan Atomic Energy Commission (JAEC). - - - Figure 5.1-1 presents the Organization chart of the JRTR.

5.1.2 Structure

5.1.3 Responsibilities

The following specific organizational Positions/Levels and Responsibilities have been established:

o JAEC Chairman/JRTR Director, as a licensee, has the ultimate responsibility for the Safety of the JRTR.

5.1.4 Staffing

The following represent the minimum staff to be present in the facility:

a. Reactor in One of the Operation Modes – (MODES P1, P2, or T1)

The minimum staffing that is required when the reactor is operating in Mode P1, P2, or T1 shall be:

A. 1 Senior Reactor Operator (SRO) – licensed by - - - , the Energy and Minerals Regulatory Commission (EMRC);
B. 1 Reactor Operator (RO) – licensed by the EMRC;
C. 1 System Operator (SO) – deemed qualified by the JRTR Manager to serve as an SO; and
D. 1 Radiation Protection Officer (RPO) - licensed by the EMRC.

5.1.5 Nuclear Safety Committee, NuSC

The NuSC provides advice to the JRTR Director on all matters related to nuclear safety.

5.1.6 Facility Staff Qualification

5.2 Review and Audit

Independent review and audit of JRTR operations and programs are performed by NuSC, - - -

5.3 Radiological Protection

An individual or group shall be assigned the responsibility for implementing the Radiological Protection Program (RPP)- - -

5.3.1 Radiological Protection Program

1. Objectives of Radiological Protection
2. Radiological Protection Program
3. Responsibility for Radiological Protection

5.4 Procedures

Written procedures for the following items are established - - -

5.5 Review and Approval of Experiment

Approved experiments shall be carried out in accordance with established and approved procedures.

5.6 Required Actions

5.6.1 Action to be taken in Case of SL Violation

1. The reactor shall be shut down, and reactor operations shall not resume until authorized by the EMRC.
2. The SL violation shall be promptly reported to the JRTR Manager.
3. The SL violation shall be reported to the EMRC.
4. The SL violation report shall be prepared, - - - the following:
   a. Applicable circumstances leading to the violation - - -
   b. Effect of the violation upon reactor facility - - - and on the health and safety of personnel and the public; and - - -
   c. Corrective action to be taken to prevent recurrence.

5.7 Reports

5.8 Records

6.0 REFERENCES

CONTENTS

✓ **Rules governing the operation** of nuclear reactor facility

- Strict compliance with OTS for nuclear safety
  - *Readily accessible* to control room personnel
  - *Highly knowledgeable* of T/S by operators

✓ Still improving the OTS of NPPs and RRx

- Renew the form into the ISTS and reflect operating experience

Safety First KINS,
trusted by the public

Thank You

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