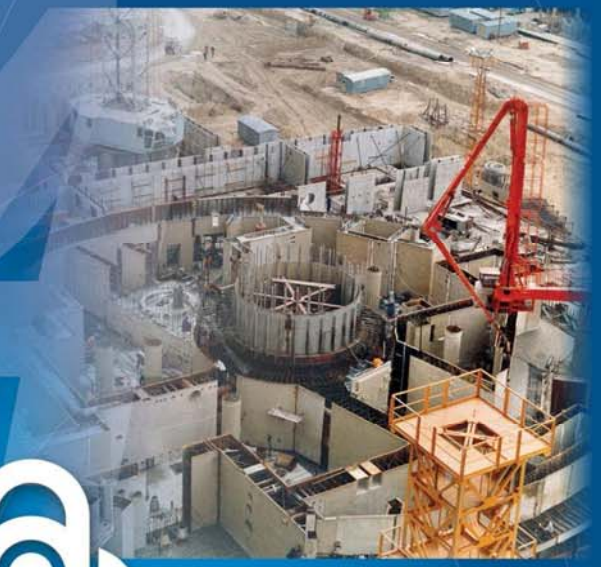


“АЕЦ КОЗЛОДУЙ” ЕАД
KOZLODUY NPP PLC

Ageing Management Activities of t Components of Kozloduy NPP Plc.

GALYA DIMOVA
Kozloduy NPP Plc.
BULGARIA

40 години
40 years

Unit	Type	In Exploitation
5	VVER 1000/V 320	1987
6*	VVER 1000/V 320	1991

SALTO

Phase 1

Complex Assessment

Phase 2

Complex Analysis

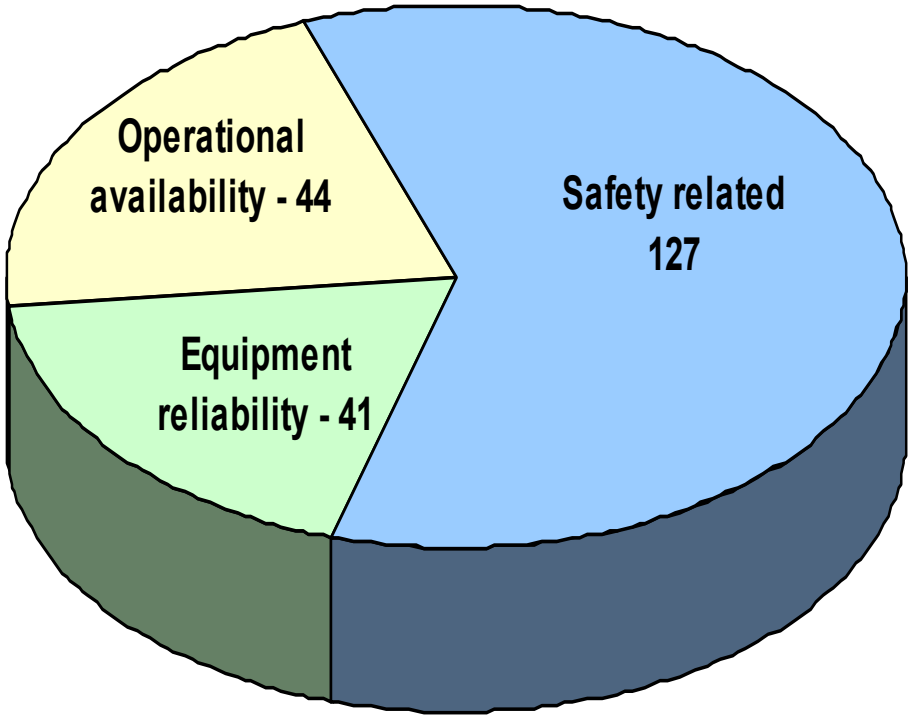
Phase 3

Licensing Documenta-tion

2010 2011 2013 (2015*) 2017 (2019*)

Modernization program

Structure of MP set of 212 technical measures



- Safety-related;
- Reliability of equipment;
- Operational availability

Objectives of Ageing Management Program

40 ГОДИНИ

Assessment and management of ageing to achieve :

- Effective operation and maintenance
- High reliability
- Decreasing of probability of component failure
- To assure strict distribution of responsibilities among departments and their activities towards AM of SSC
- To produce complex of organizational, technical and methodological activities towards assuring or reassessment of lifetime characteristics of SCC
- To integrate all processes of AM

Main components and drivers of AMP

Components:

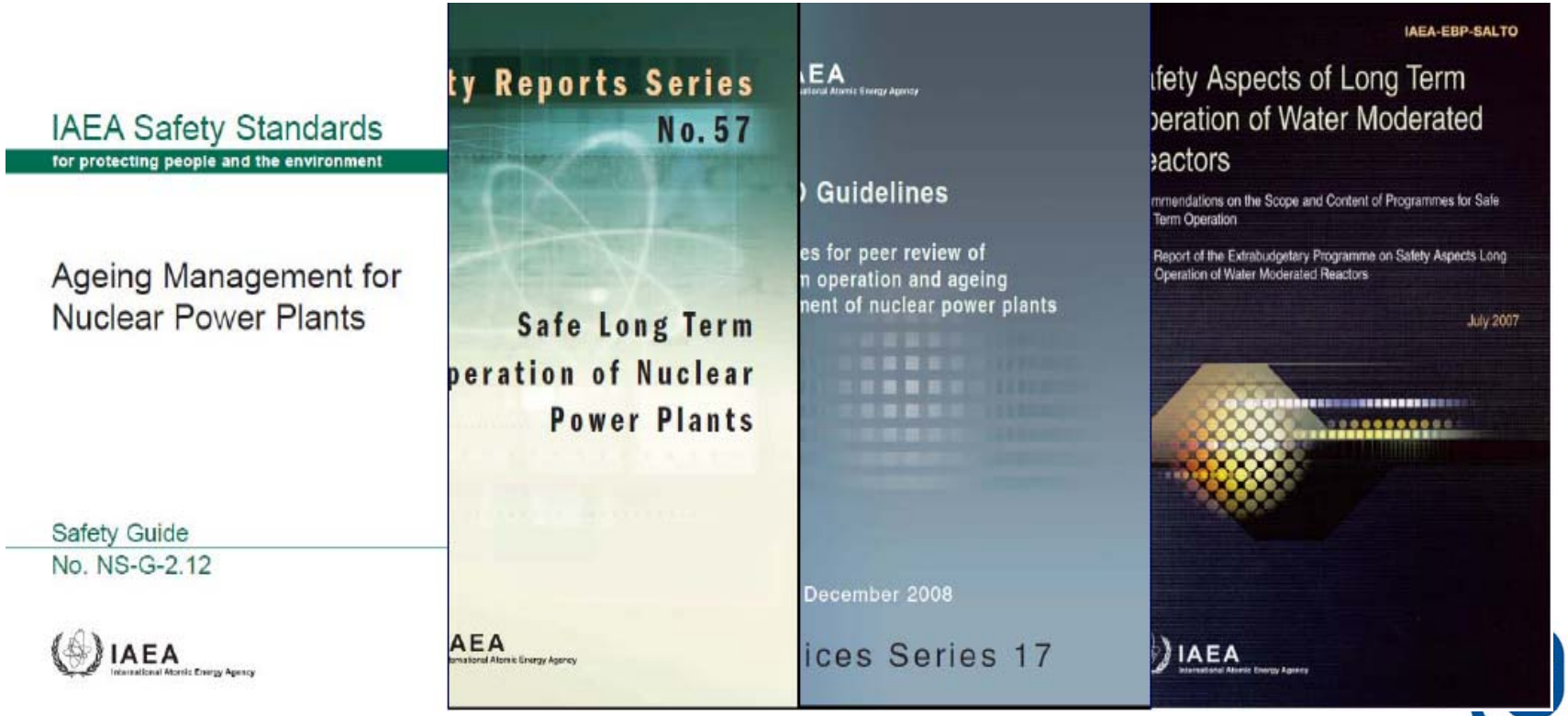
- Maintenance activities and programs;
- Equipment qualification;
- In-service inspection;
- Surveillance and monitoring;
- Monitoring of chemical modes;
- Design changes

Life-time management Programs

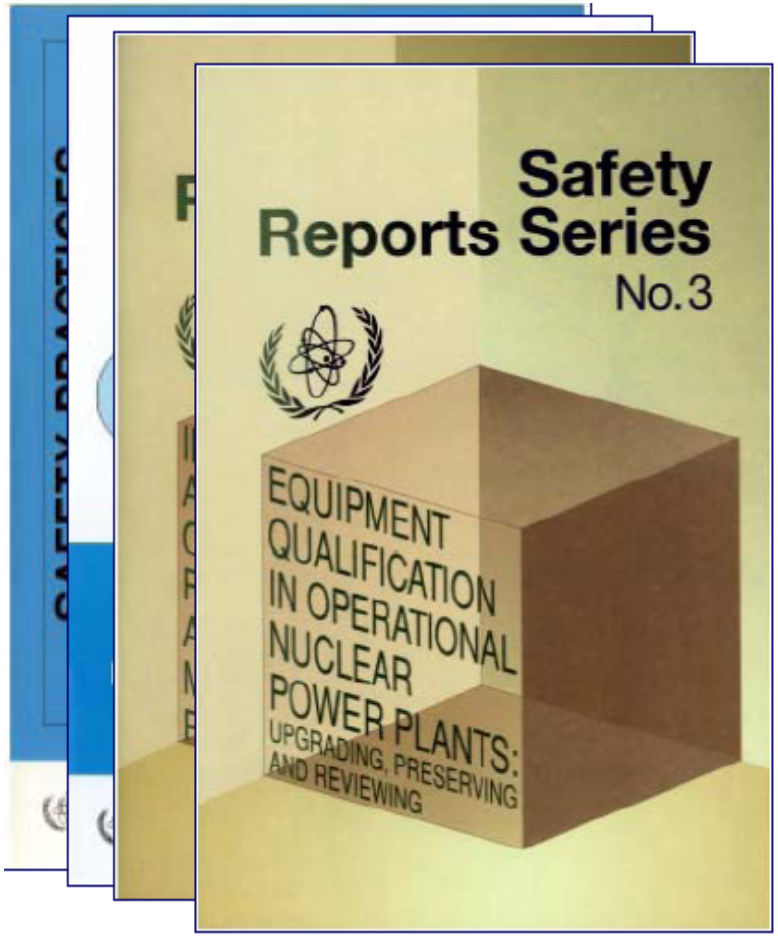
- General program, index 30.OU.00.AD.58;
- Program for RPV (korpus), index 30.OU.00.PR.17;
- Program for Pressurezes and Main Pipelines, index 30.OU.00.PR.30;
- Program for Main Coolant Pumps, index 30.OU.00.PR.31;
- Program for aggregates, index 30.OU.00.PR.22 & 30.OU.00.PR.32;
- Program for SGs;
- Program for RPV (internals).

IAEA documents

- Safety Guide : NS-G-2.12, Ageing Management for NPPs (2008)
- Safety Report : SRS- 57, Safe Long Term Operation of NPPs,(2008)
- EBP : Safe long term operation for water moderated reactors(2007)
- Safety Series : SS-17, SALTO Guidelines for peer review of LTO (2008)



IAEA documents



- Data Collection and Record Keeping for the Management of Nuclear Power Plant Ageing (Safety Practice: Safety Series No.50-P-3)
- Methodology for the Management of Ageing of Nuclear Power Plant Components Important to Safety (Technical Report Series No.338)
- Implementation and Review of Nuclear Power Plant Ageing Management Programmes (Safety Report Series No.15)
- Equipment Qualification in Operational Nuclear Power Plants (Safety Report Series No.3)

Legislative base of PLIM

In Republic of Bulgaria there is a strict requirement for NPP to have AMP according to the Law for safety use of nuclear energy

According to article 48, p. 15 of the Regulation for issuing licenses to for safety use of nuclear energy the Licensee must elaborate AMP and to account for its accomplishment to the Regulator.

This was embedded in the last license for units 5&6 of KNPP

РЕПУБЛИКА БЪЛГАРИЯ
АГЕНЦИЯ ЗА ЯДРЕНО РЕГУЛИРАНЕ

ЛИЦЕНЗИЯ

Серия: Е Регистрационен № 00174

ЗА ЕКСПЛОАТАЦИЯ НА ЯДРЕНО СЪОРЪЖЕНИЕ

Председателят на Агенцията за ядрено регулиране, на основание чл. 15, ал. 1 и ал. 3, т. 1, във връзка с чл. 35, ал. 2 и ал. 3 и чл. 36 от Закона за безопасно използване на ядрената енергия и писмено заявление за издаване на лицензия за експлоатация на ядрено съоръжение № СВ-10851 от 22.11.2002 г. и писмо № Д"БиК" 410 от 14.02.2003 г., придружени от всички необходими документи,

ИЗДАВА

на "АЕЦ Козлодуй" ЕАД със седалище и адрес на управление гр. Козлодуй, община Козлодуй, област Враца, регистрирано с решение на Врачански окръжен съд по ф.д. № 582, описк за 2000 г., данъчен номер 1064513415 и БУЛСТАТ 106513772, наричано "Лицензиант",

лицензия за експлоатация на трети енергиен блок на АЕЦ "Козлодуй"

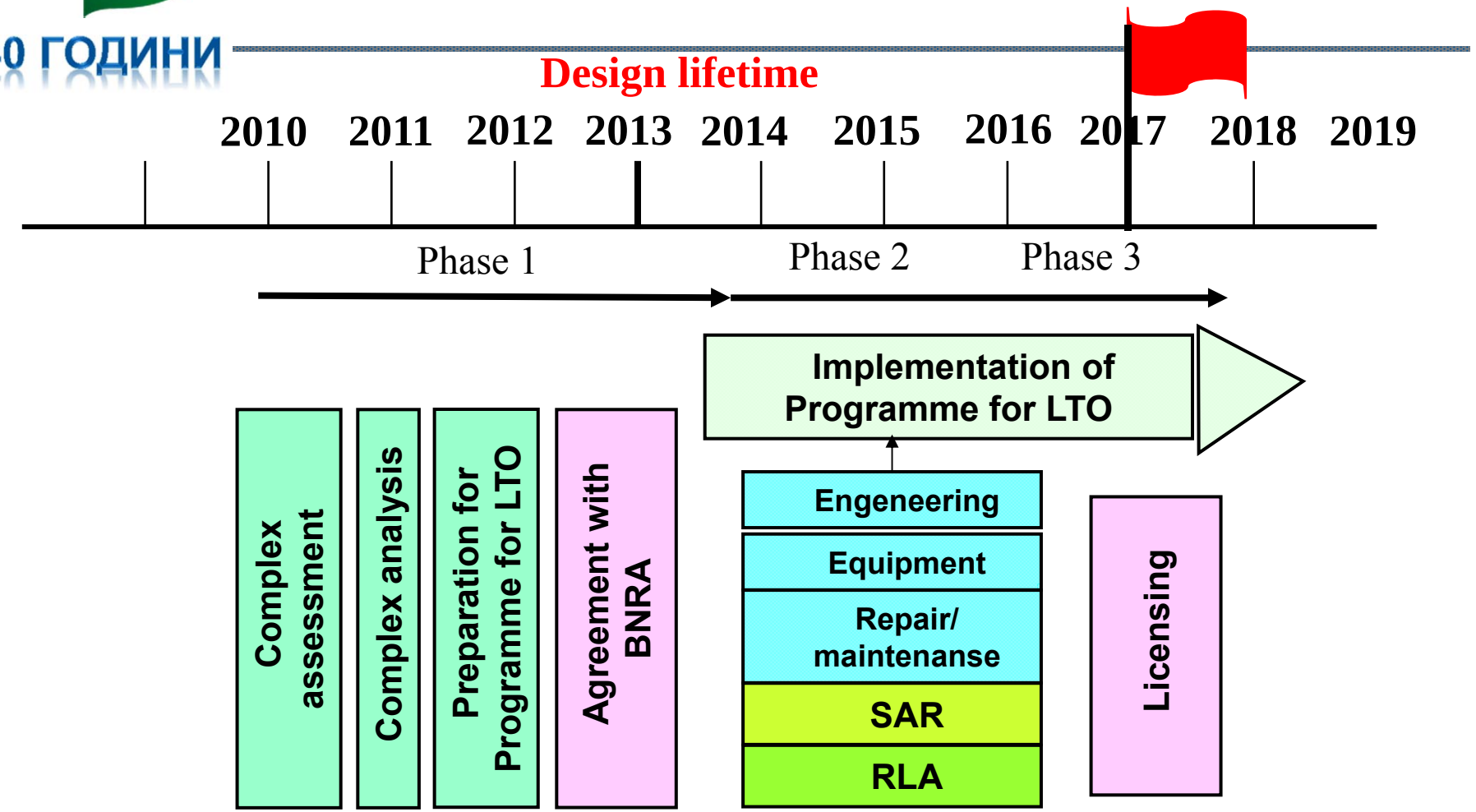
Лицензията съдържа като неразделна част Условия и Приложения № 1- 6.

Срок на лицензията: осем години.

Дата на издаване: 22.05.2003 г.

ПРЕДСЕДАТЕЛ:
доц. д-р Емил Ваперев

Schedule for LTO preparation of unit 5



Phase 1.
CA objectives

- Set of organizational, technical and methodological measures for PLEX of Units 5 and 6 in accordance with up-to-date normative - technical requirements for NPP in operation.
- Terms and measures necessary for providing the lifetime of structures, systems and components (SSC) until expiring of the present Licenses in 2017 for unit 5, respectively, in 2019 for unit 6, and expectations for long term operation for the next 15 and 20 years of each unit.

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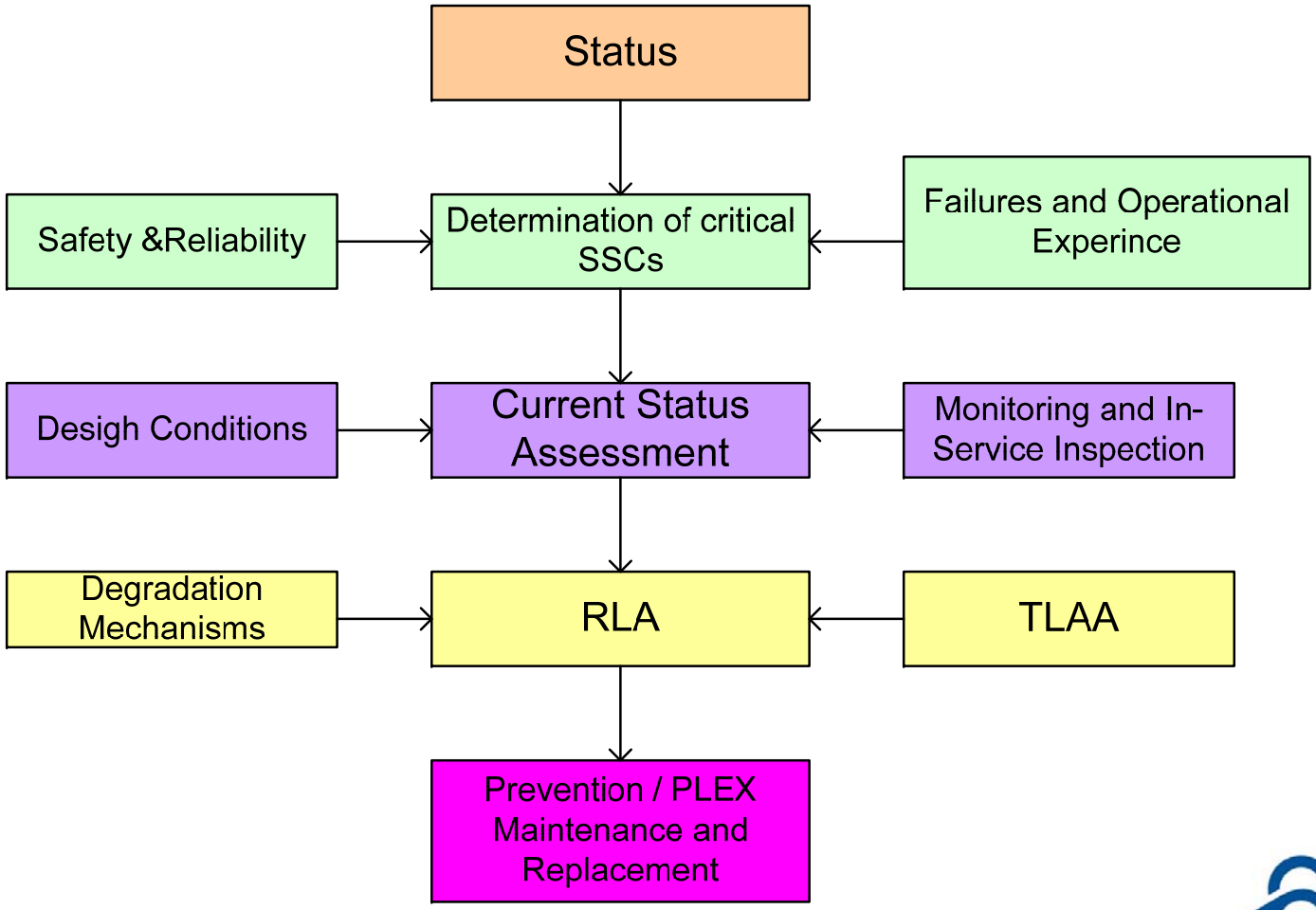
Phase 1.
CA scope

- Assessment of actual condition of the equipment and building;
- Review of methods for control (non-destructive), examination and monitoring;
- Effectiveness of methods;
- Necessity of additional control / examination/ servise;
- Residual life-time assessment;
- Necessity of changing/repair of a part (all) of type equipment;
- Implementation of Time Limited Ageing Analysis (TLAA).

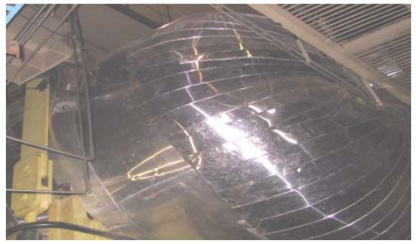
Phase 1. CA Approach
Focus on Structures and Components

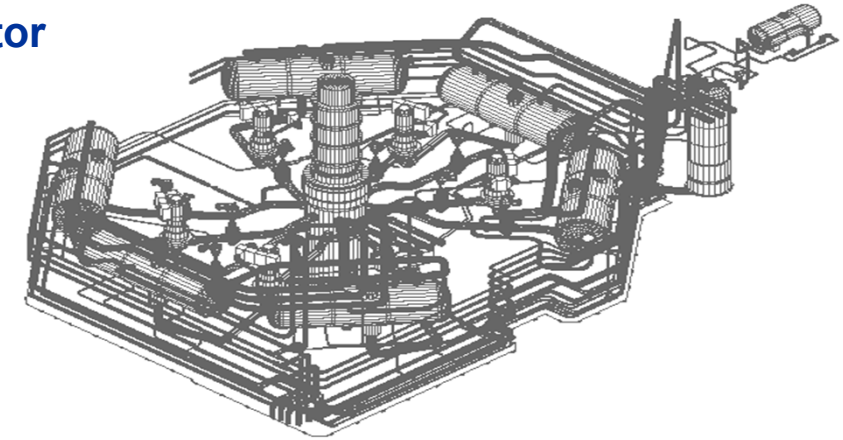


Primary circuit components

Steam Generator

Ageing mechanisms:
- Corrosion;
- Fatigue
- Thermal Ageing;





Pressurizer

Ageing mechanisms:
- Thermal Ageing;
- Corrosion;
- Fatigue

Main Coolant&Surge Pipes

Ageing mechanisms:
- Thermal Ageing;
- Corrosion;
- Fatigue

Main Coolant Pump

Ageing mechanisms:
- Thermal Ageing;
- Corrosion;
- Wear

Pressurizer Safety Valves&Relief Pipe

Ageing mechanisms:
- Fatigue;
- Corrosion;
- Wear

Secondary circuit components

40 ГОДИНИ

Piping / supports of MSL, MFWL, EFWL:

- Stress & fatigue analyses;
- Erosion & corrosion

Valves:

- Monitoring program;
- Analytical verification of ability for function;
- Parameters relevant for functi (stress and fatigue)

Civil structures

Reactor building;

Turbine building;

Auxiliary building;

Diesel generator building;

Ventilation stack;

Double channel and

Pump stations

Ageing mechanisms

- Periodical freezing and thawing
- Aggressive chemical environments,
- Reinforcement corrosion.

Electrical and I&C Equipment

Mechanical parts

•Fatigue, Wear, Erosion

•Corrosion and Chemical Attack

• Thermal Ageing, Contact erosion (burning), Radiation, Atmospheric influences;

Insulation materials

•Thermal Ageing;

Lubrication materials /Oils

• Thermal ageing with oxidation

• Contamination (dust, mechanical particles)

Battery

•Temperature;

•Cell voltage versus discharging time

Switch board and motors

•Number of switching cycles;

•Current during switching;

•Mechanical wear;

•Available supply of spare parts

Diesel generator

•Operating hours;

•Available supply of spare parts

Cables

•Temperature, radiation, current;

•Quality of cable installation work;

•Used material for coating

I&C

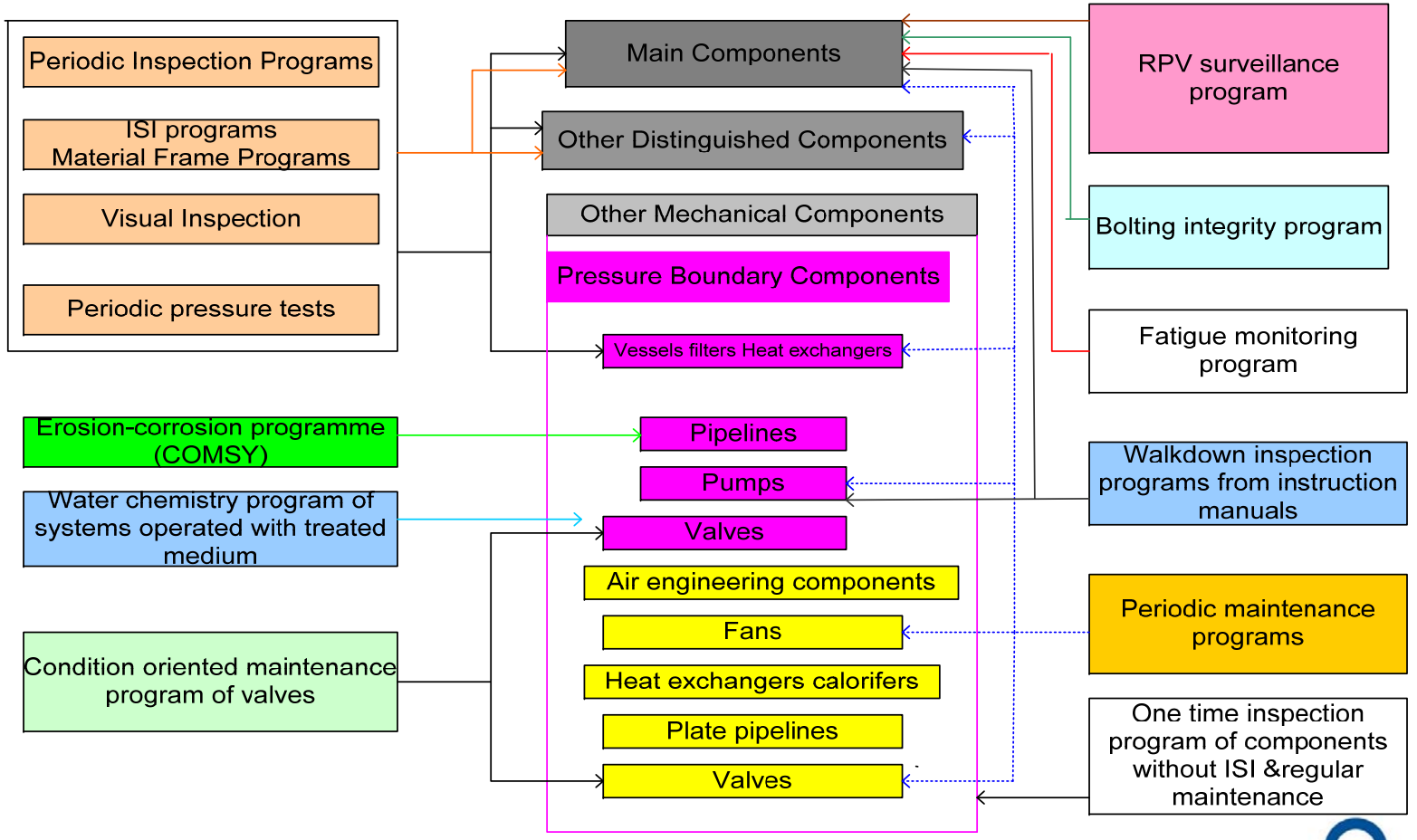
•Temperature, radiation, current, obsolesce

Complex assessment of actual physical status and rest lifetime assessment

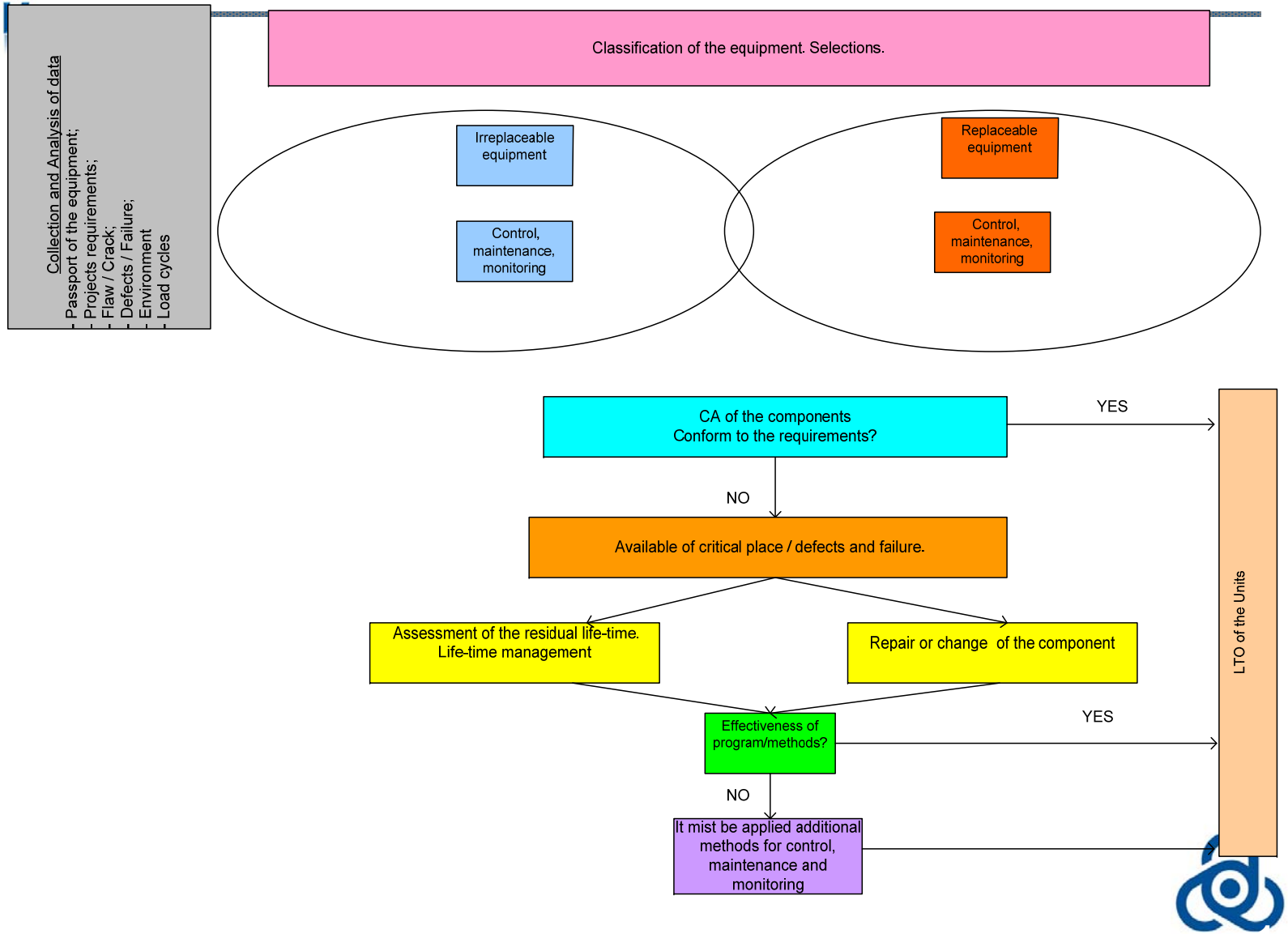
- RPV and Reactor internals
- Pressurizes
- MCP
- SG
- Civil constructions
- Primary, Secondary High-energy Pipelines
- I&C
- Cables and penetrations
- Electrical equipment
- Generator
- DG
- Turbine
- Heat exchangers
- Pumps
- Valves
- Ventilation systems
- Fire systems

The final list shall be specified and agreed on acceptance of methodology for performance of complex assessement.

Phase 1
Review of Operative AMP



Phase 1


Collection and Analysis of data
- Passport of the equipment;
- Projects requirements;
- Flaw / Crack;
- Defects / Failure;
- Environment
- Load cycles
Classification of the equipment. Selections.
Irreplaceable equipment
Control, maintenance, monitoring
Replaceable equipment
Control, maintenance, monitoring
CA of the components Conform to the requirements?
YES
NO
Available of critical place / defects and failure.
Assessment of the residual life-time. Life-time management
Repair or change of the component
Effectiveness of program/methods?
YES
NO
It mist be applied additional methods for control, maintenance and monitoring
LTO of the Units

Scoping and screening (e.g.)

Componen Grouping	Materials	Environment or Stressors Degradation	Mechanism/ Ageing Effect	Safety Strategy	Practice for Inspection or Testing
Pressurizer Shell/heads	**Carbon Steel with stainless steel cladding**	**Chemically treated borated water or saturated steam 270–343 C (554–650 F)**	**Cumulative fatigue damage/ Fatigue**	**Conservative Analysis provides technical justification for that Fatigue will not be a problem during the period of extended operation (This fatigue analysis is a TLAA)**	**In–Service Inspection for Components of the reactor coolant pressure boundary to detect service induced flaws**
			Loss of material/ Boric acid corrosion of external surfaces	**Non-destructive testing to detect, monitor and trend damage**	**All Member States have some type of program for visual examination of exterior surfaces.**
			Crack initiation and growth/ Stress	**Control Water Chemistry and Non-destructive Testing to detect, monitor and trend**	**In–Service Inspection for Components of the reactor coolant pressure boundary**

Phase 1. Results

- Analysis of technical standard documentation (TSD). List of TSD applicable to implementation of Kozloduy NPP;
- Methodology of comprehensive assessment and life time analysis of equipment and facilities for Units 5&6 of KNPP.
- General program for comprehensive assessment of the AC and RLT analysis of SSCs for Units 5&6 of KNPP;
- Program for comprehensive assessment of the AC and RLT analysis of the components for Units 5&6 of KNPP, designed by OKB Gidropress (I circuit). *Report*
- Program for comprehensive assessment of the AC and RLT of the turbine of Units 5&6 of KNPP. *Report;*
- Program for comprehensive assessment of the AC and RLT analysis of the Main Coolant Pumps (removable part) of Units 5&6 of KNPP. *Report.*
- Program for comprehensive assessment of the AC and RLT analysis of the Electro-technical equipment of Units 5&6 of KNPP. *Report*;
- Program for comprehensive assessment of the AC and RLT analysis of the Heat exchangers of Units 5&6 of KNPP. *Report*;
- Program for comprehensive assessment of the AC and RLT analysis of the crans of Units 5&6 of KNPP. *Report*
- Program for comprehensive assessment of the AC and RLT analysis of support system of Units 5&6 of KNPP. *Report* ;
- Program for comprehensive assessment of the AC and RLT analysis of pump equipment of Units 5&6 of KNPP. *Report* ;
- Program for comprehensive assessment of the AC and RLT analysis of the buildings of Units 5&6 of KNPP. *Report*

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Phase 1.

Effectiveness of the Program and Methods for control

Dergradation Mechanism	*Program/methods for control, maintenance and monitoring*	*Effectivenes*
Erosion-corrosion	➢Analysis and improvement of water-chemistry rate; ➢Corrosion investigation for precipitation; ➢NDT; ➢UT of the thickness of the wall.	➢The measurable parameters of water-chemistry rate must be responsible to the norms; ➢All deviations from norms must be eliminated in-time; ➢Any deviation from norms, that may disturb the units from the NOC is inadmissible; ➢Monitoring of the thickness of the wall of the pipelines.

Phase 1.

Effectiveness of the Program and Methods for control

Dergradation Mechanism	*Program/methods for control, maintenance and monitoring*	*Effectivenes*
➢Embrittlement and hardening due to radiation; ➢Embrittlement due to flaws	➢Surveillance program, ➢p-T analysis; ➢NDT	I criterion: Resistance against fast fracture is assured (for emergency conditions or anticipated operational transients) if the transition temperature of the component material is lower than its maximum allowable value. All applicable methods permits in time found the flaw and repair the components. Residual lifetime of the component with flaws, found by NDT during in-service inspections, is to be calculated. II criterion: The criterion of residual lifetime of the component with flaws determined by NDT carried out during outages and shutdowns is exclusion of growth of the flaws over the allowed value during the period of the assumed technical lifetime of the component as mentioned, for example, in design.

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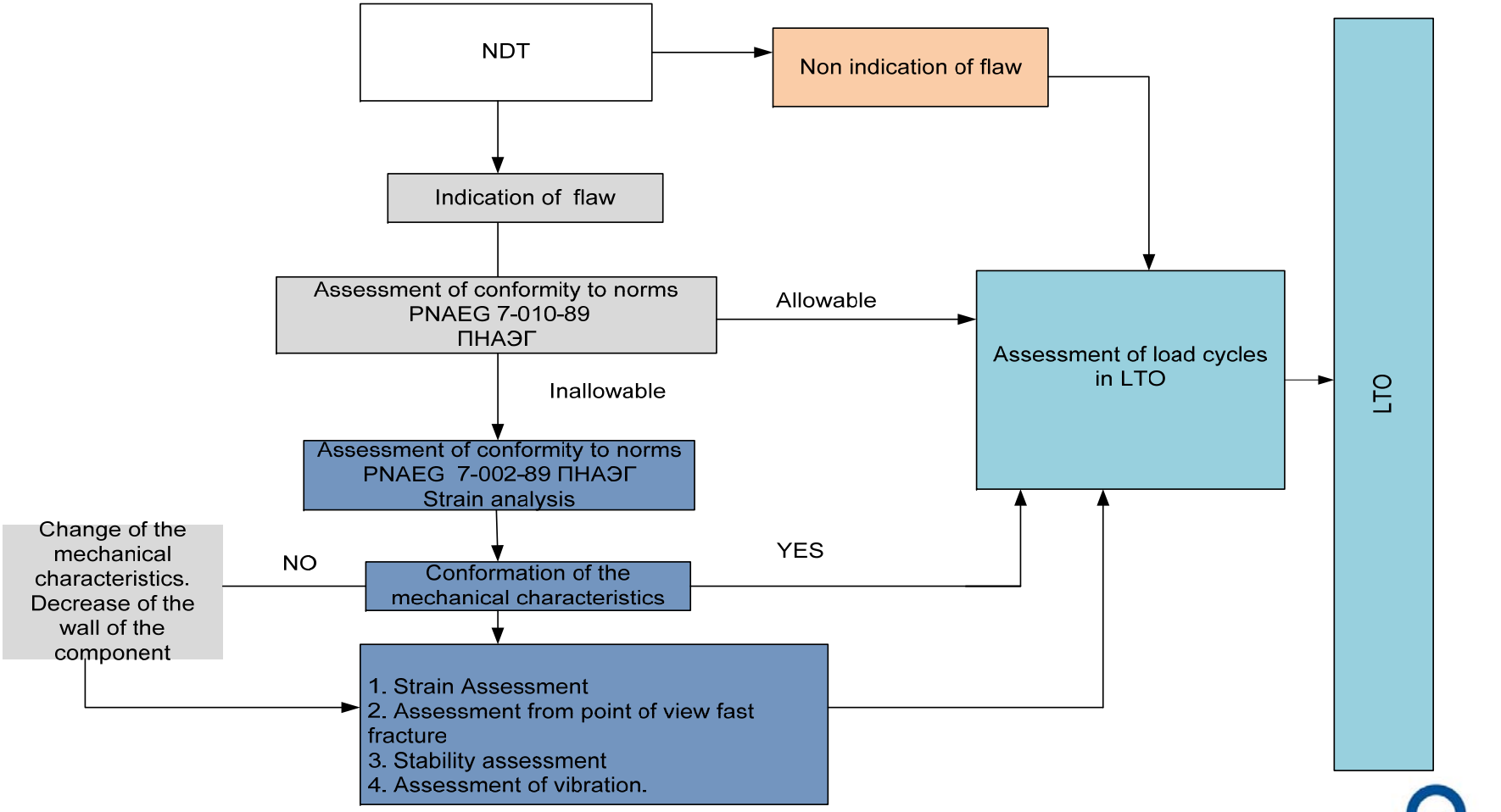
Phase 1.

Effectiveness of the Program and Methods for control

Degradation Mechanism	*Program/methods for control, maintenance and monitoring*	*Effectivenes*
Fatigue damage	➢**RPV surveillance program;** ➢**Fatigue analysis;** ➢**NDT and hydraulic tests**	➢**Criterion: All applicable methods permits in time found the flaw and repair the components.**
Thermal ageing	➢**RPV surveillance program** ➢**RT; Metallography;** ➢**Hydraulic tests**	
Wear	**VT** **Test**	

Phase 1: Assessment of acceptabilty of flaws, found during NDT



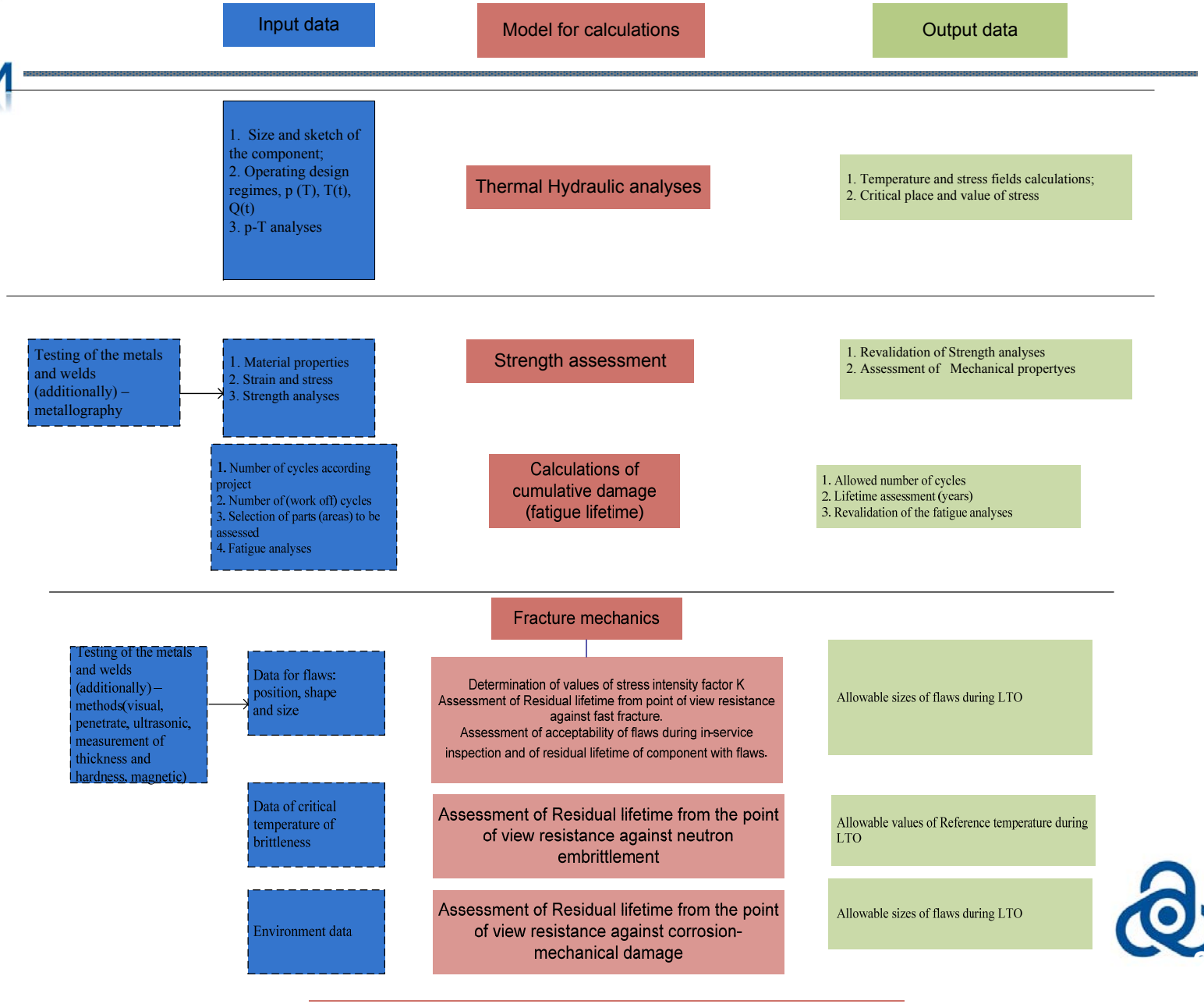
Phase 2: Complex Analysis

Implementation of Program for LTO includes the parts:

- Engineering
- Equipment
- Repair / maintenance.

40 ГОДИНИ

Methodology for Lifeime assessment of KNPP



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Phase 2: LTO ENGINEERING PROCESS

1. Scoping and screening process in order to define the scope of structures and components (SCs) that will be evaluated for LTO .
2. Review existing plant programs and practices to ensure that they will remain effective and to identify modifications and/or new programs in ensuring that SCs are able to perform their designated safety function for the period of LTO. Each existing plant program to be used for LTO should be reviewed against the requirements on slide 21.
3. Review each SC within the scope of LTO to ensure that the effects of ageing are managed properly so that the SC is capable of performing its designated safety function. The review should include a technical explanation concerning management of ageing effects for each structure and component identified, so that their intended function(s) will be maintained consistent with the current licensing basis for the period of extended operation.
4. Existing plant specific TLAAs should be reviewed and revalidated with new assumed time of plant operation. The evaluation of each identified TLAA should justify that the safety function of the SC will remain within design safety margins during the period of LTO.
5. Identify and implement requirements for modification of existing plant programs and development of new programs.
6. Document the results of the engineering process and re-validation of the TLAAs in an update to the FSAR as appropriate.

Phase 2: Complex Analysis

- Analysis of stress and fatigue;
- Analysis of erosion and corrosion (thinning calculation using the verified programs);
- Testing of components or parts of them;
- Control measures during operation (monitoring for fatigue analysis based on the actual transients);
- Correction of procedures for Maintenance, repair and operation of components in regard with their longer operation;
- Recommendations and measures for actualization of AMP of units 5 and 6 and related to it programs for LTO and qualification of main components;
- Measures for using and improving the existing information systems and databases for the purposes of LTO and PLEX of Units 5 and 6 with options for 20 years;
- The Program for preparation for LTO have to be implemented in a process of the future licence renewal
- The review of the rest safety aspects directly related to the substantiation of necessity of PLEX - operational experience and feedback effectiveness, operational organization, safety indicators, safety and quality management, staff training and qualification, emergency readiness and radiological impact to environment is subject to PSR provided in submitted in PLEX plan-schedule.

Phase 2: Relations between NPP Kozloduy LTO and PSR

- Assessment of NPP Kozloduy real preparedness for its safety operation after the year 2019 will be subject of a following NPP Kozloduy extended PSR (2016-2017).
- Preliminary in year 2011-2013 a Complex assessment of actual physical status, subject to the terms of reference are developed on the basis and in compliance with the requirements set out in Article 22 of the Operating licenses of unit 5 № 03000/02/10.2009 and unit 6 № 03001/02/10.2009 and according to Ageing management program (AMP) of units 5 and 6 of NPP Kozloduy "№ 30.OU.00.AD.58.

Phase 2: Implementation of Program for preparation for LTO

- In Programs for preparation of units for PLEX shall be integrated the results from the work reports on the previous stages and shall be provided at least the following groups of measures:

- Replacement of obsolete equipment made its lifetime;

- Rest Lifetime Assessments (RLA) and substantiation of necessity of RLA of irreplaceable components;

- Modification of procedures for maintenance, repair and operation of components in regard with their

TLAAs revalidation for LTO

1. Involve SSC within the scope of LTO;
2. Consider the effects of ageing;
3. Involve time-limited assumptions defined by the current operating term;
4. Were determined to be relevant in making a safety determinations as required by national regulations;
5. Involve conclusions or provide the basis for conclusions related to the capability of the SSC to perform its intended function(s);
6. Are contained or incorporated by reference in the CLB

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TLAAs revalidation for LTO – criteria

1. The analysis remains valid for the period of long -term operation,
2. The analysis has been projected to the end of the period of LTO, or
3. The effects of ageing on the intended function(s) will be adequately managed for the period of LTO.

TLAAs revalidation for LTO

Reactor pressure vessel irradiation embrittlement

- This group of TLAAs time concerns the effect of irradiation embrittlement on the reactor vessel.
- The analyses ensure that embrittlement does not exceed prescribed limits and addresses regulatory requirements for the fracture toughness of the reactor pressure vessel.
- The calculations are based on periodic assessment of the neutron fluence and resultant changes in the reactor vessel material fracture toughness.
- Further, the analyses include the effect of the warm-pre-stressing and the role of the cladding, particularly for the PTS analysis.

TLAAs revalidation for LTO

Metal fatigue

This TLAA involves the thermal and mechanical fatigue analyses of plant mechanical components within the scope of LTO. Specific components have been designed and analyzed considering transient cycle assumptions identified in vendor specifications and design basis documentation. Typical analyses that are performed include:

- Reactor vessel structural integrity
- Reactor vessel internals structural integrity
- SSC in the reactor coolant pressure boundary
- Control rod drive mechanism structural integrity
- Steam generator structural integrity
- Pressuriser structural integrity
- Reactor coolant pump structural integrity

TLAAs revalidation for LTO

Fracture mechanics analysis

- Leak-before-break(LBB) analysis (depending upon design and regulatory requirements)
- Component/piping indication analysis

Loss of preload

- Typical components that require losses of pre-load analysis are reactor vessel bolting and containment tendons.

Loss of material

- This TLAA involves analyzing the potential for loss of material and compromising function due to wear of passive or active components within the scope of LTO. Typical components that require analysis for

БЛАГОДАРЯ ЗА ВНИМАНИЕТО!