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Licensing Requirements for Long Term Operation in Spain: the case of Santa María de Garoña Nuclear Station

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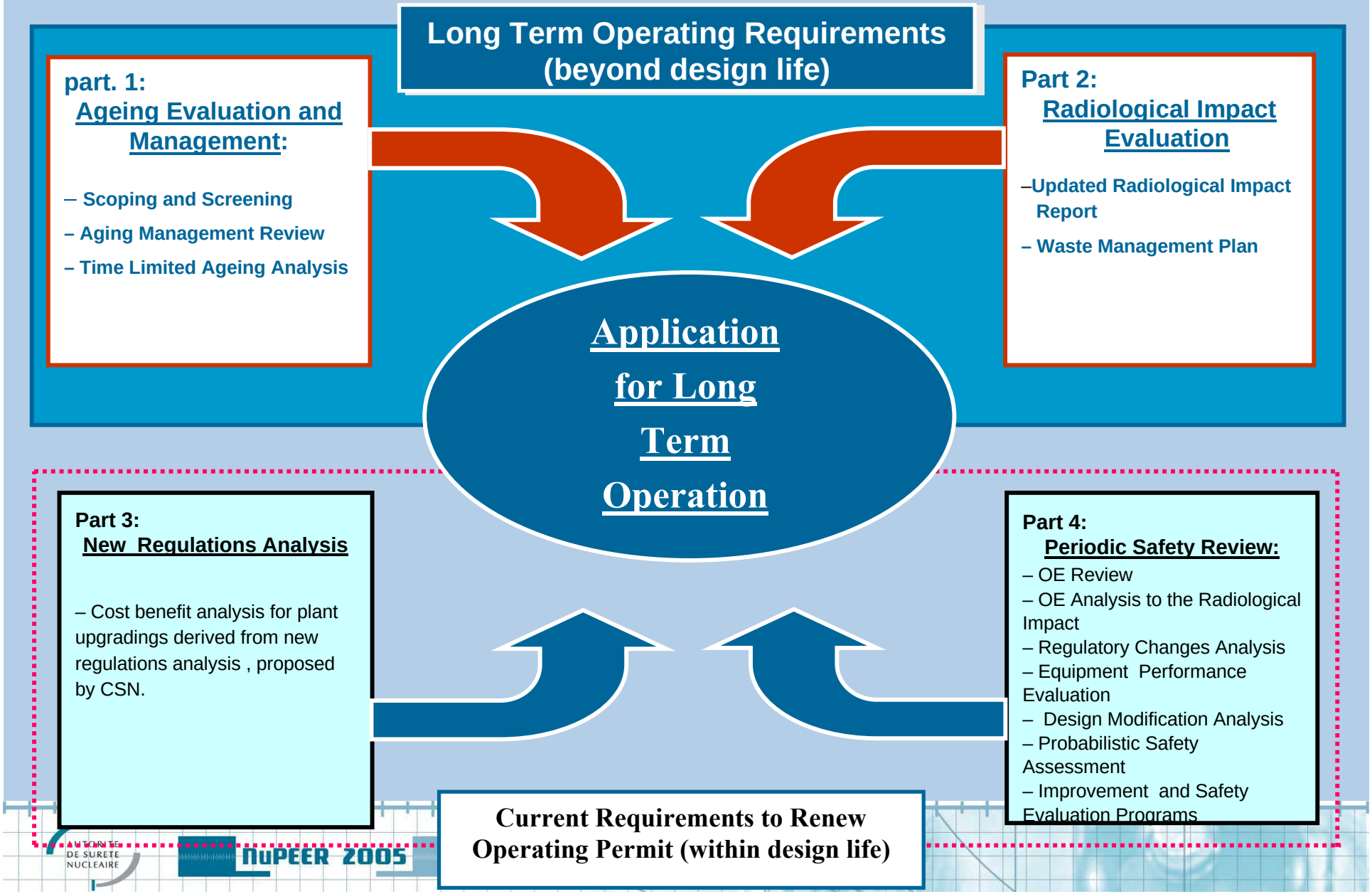
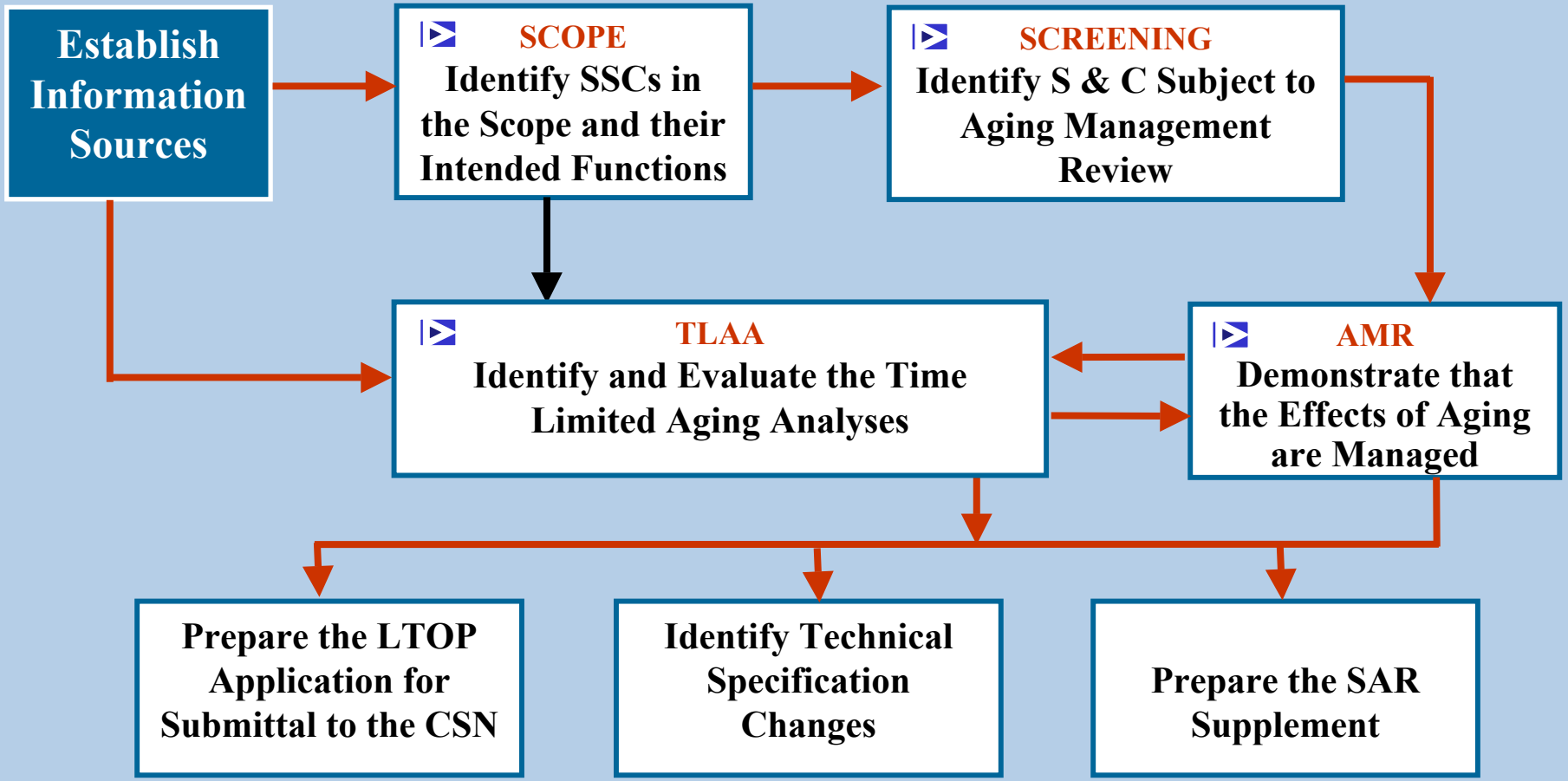
PRESENTATION TOPICS

- 1. Spanish Regulatory framework for long term operation
- 2. Ageing Management Evaluation
  - Scoping & Screening
  - Ageing Management Review (AMR)
  - Time-Limited Ageing Analysis (TLAA)
- 3. The case of SMG: preliminary results
  - -Rx vessel AMR
  - -Examples of Ageing Management Programs
  - -List of evaluated TLAA
  - -Vessel Neutron Embrittlement evaluation
- 4. Conclusions

SPANISH LTOP REGULATORY FRAMEWORK



EVALUATION OF AGEING MANAGEMENT



SSCs: Systems, Structures and Components

TLAA: Time-limited ageing analysis

SCOPE OF SYSTEMS, STRUCTURES AND COMPONENTS

Plant systems, structures, and components within the scope shall meet any of the following criteria:

1.- Safety-related systems, structures and components which are those relied upon to remain functional during and following design-bases events to ensure the following functions:

a) The integrity of the reactor coolant pressure boundary;

b) The capability to shut down the reactor and maintain it in a safe shutdown condition; or

c) The capability to prevent or mitigate the consequences of accidents that result in potential offsite exposure.

2.- All nonsafety-related systems, structures and components whose failure could prevent satisfactory accomplishment of any of the functions above mentioned.

3.- All systems, structures and components relied on in safety analyses or plant evaluations to perform a function that demonstrates compliance with the regulations for fire protection, environmental qualification, pressurized thermal shock, anticipated transients without scram and station blackout.

SCREENING: STRUCTURES AND COMPONENTS SUBJECT TO AMR

From those systems, structures, and components within the scope those structures and components subject to an ageing management review are identified. Those structures and components shall encompass those that:

- **perform an intended function without moving parts or without a change in configuration or properties. These structures and components include, but are not limited to, the reactor vessel, the reactor coolant system pressure boundary, steam generators, the pressurizer, piping, pump casings, valve bodies, heat exchangers, ventilation ducts, the containment, the containment liner, electrical and mechanical penetrations, equipment hatches, seismic category I structures, electrical cables and connections, cable trays and electrical cabinets, excluding but not limited to, pumps (except casing) valves (except body), motors, diesel generators, air compressors, snubbers, the control rod drive, ventilation dampers, pressure transmitters, pressure indicators, water level indicators, switchgears, cooling fans, transistors, batteries, breakers, relays, switches, power inverters, circuit boards, battery chargers, and power supplies; and**
- **are not subject to replacement based on a qualified life or specified time period.**

The goal of the Ageing management Review step is, for each structure and component identified in the screening step,

"*to demonstrate that the effects of ageing will be adequately managed so that the intended functions will be maintained consistent with the current licensing bases for the period of extended operation".*

In performing the demonstration, it should be considered all programs and activities associated with the structures or components.

Plant programs and activities that apply to the structures or components should be reviewed to determine if they include actions to detect and mitigate the effects of ageing.

AGEING MANAGEMENT PROGRAMS

Ageing management programs are generally of four types: prevention, mitigation, condition monitoring and performance monitoring.

- *Prevention programs preclude the ageing effect from occurring, for example coating programs to prevent external corrosion of a tank.*

- *Mitigation programs attempt to slow the effects of ageing, for example, chemistry programs to mitigate internal corrosion of piping.*

- *Condition monitoring programs inspect and examine for the presence of and extent of ageing effects, for example, visual inspection of concrete structures for cracking and ultrasonic measurement of pipe wall for erosion-corrosion induced wall thinning.*

- *Performance monitoring tests the ability of the structure or component to perform its intended function, for example, heat balances on heat exchangers for the heat transfer intended function of the tubes.*

TIME LIMITED AGEING ANALYSIS

TLAA are those license calculations and analyses that:

- Involve systems, structures and components within the scope
- Consider the effects of ageing
- Involve time-limited assumptions defined by the original design plant life, i. e. 40 years;
- Were determined to be relevant by the licensee in making a safety determination;
- Involve conclusions or provide the basis for conclusions related to the capability of the system, structure and component to perform its intended function (as defined in the scoping process)
- Are contained or incorporated by reference in the current licensing bases.

A list of time-limited aging analyses shall be provided, and it shall be demonstrated that:

- The analyse remain valid for the period of extended operation;
- The analyses have been projected to the end of the period of extended operation; or
- The effects of ageing on the intended function will be adequately managed for the period of extended operation.

SANTA MARIA DE GAROÑA NUCLEAR STATION

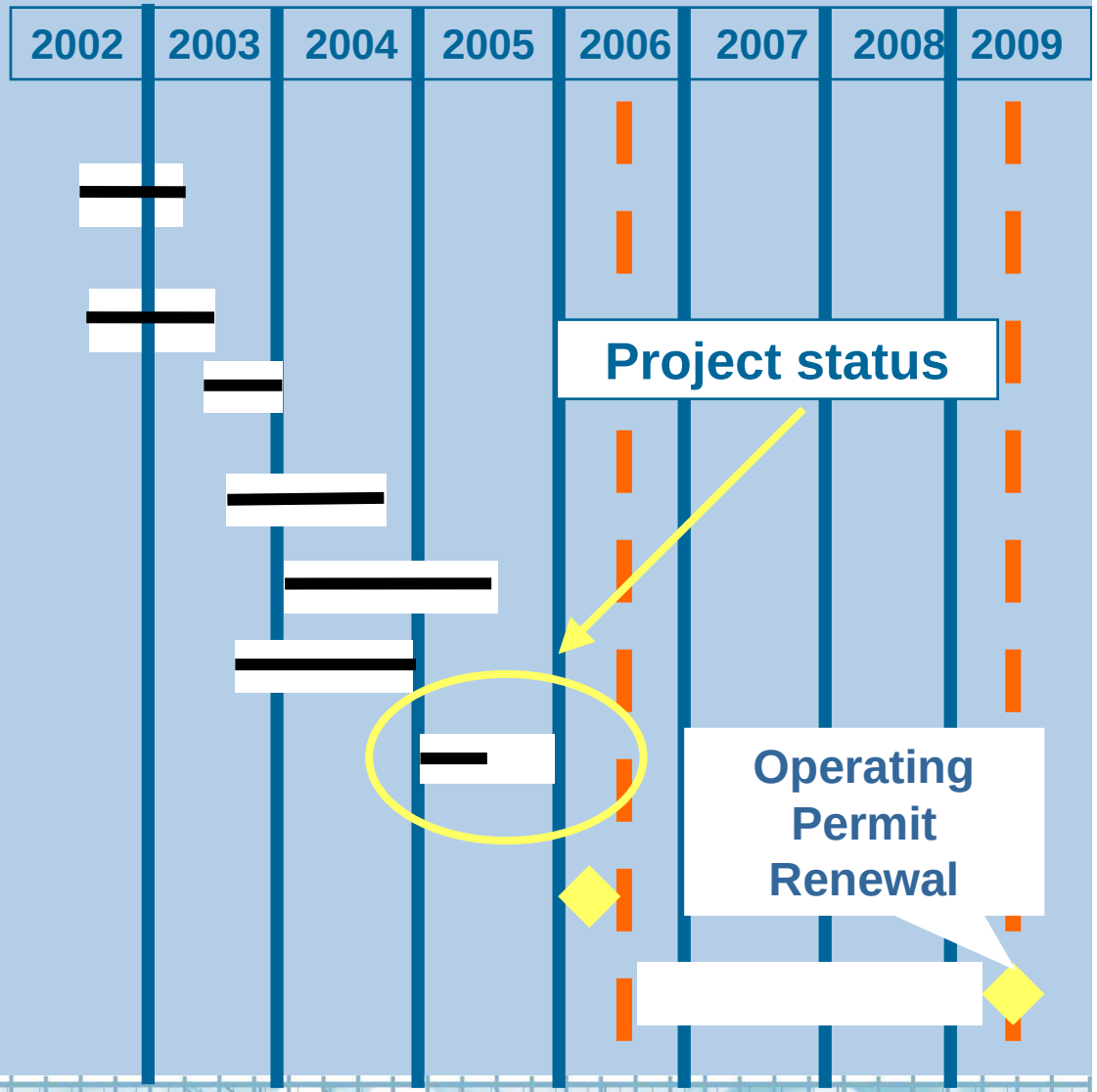
GE Boiling Water Reactor-3 Mark – I Containment

- Electric output: 466 MW electric
- Operation Starting: March 1971
- Plants of similar design and vintage:
  - ✓ Muhleberg (Switzerland)
  - ✓ Monticello (USA)
  - ✓ Dresden 2 & 3 (USA)
  - ✓ Quad Cities 1 & 2 (USA)
  - ✓ Fukushima (Japan)

PROJECT 2019: CURRENT STATUS

Tasks:

- Project Plan
- Methodology, Procedures, Training
- Maintenance Programs review and Operating Experience
- SSC Scoping, and Screening
- Aging Management Review
- Time-limited Ageing Analysis
- Prepare Periodical Safety Review (PSR) and New regulation Analysis
- Submit Application to CSN
- CSN evaluation



AGEING MANAGEMENT REVIEW REACTOR VESSEL

Component type	Intended function	Material	Environment Ext/internal	Aging effect that require management	AMP	GALL item no.	GALL TABLE item no.	Notes
RPV BOTTOM HEAD	Structural support to components	Low alloy steel	Nitrogen / Air in containment	Not applicable	Not applicable	IV.A1.1-a	Not applicable	C, 3
RPV BOTTOM HEAD	Structural support to components	Low alloy steel	Nitrogen / Air in containment	Fatigue crack initiation and growth	Fatigue crack initiation and growth (Section 4.3.1)	IV.A1.7-a	3.1-1.1	A, 3
RPV BOTTOM HEAD	Fission products barrier / pressure retention	Low alloy steel with stainless steel cladding	Reactor water	Loss of material - Crevice corrosion - Pitting corrosion	PGE-03:In service inspection PGE-04:Water chemistry control	IV.A1.1-a	Not applicable	F, 2
RPV BOTTOM HEAD	Fission products barrier / pressure retention	Low alloy steel with stainless steel cladding	Nitrogen / Air in containment	Not applicable	Not applicable	IV.A1.1-a	Not applicable	G, 1, 2
RPV BOTTOM HEAD	Fission products barrier / pressure retention	Low alloy steel with stainless steel cladding	Reactor water	Fatigue crack initiation and growth	Not applicable (Section 4.3.1)	IV.A1.6-a	3.1-1.1	A
… / …	… / …	… / …	… / …	… / …	… / …	… / …	… / …	… / …
CORE SHROUD	Core structural integrity	Stainless steel	Reactor water	Loss of material - Crevice corrosion - Pitting corrosion	PGE-04:Water chemistry control PGE-10: Internals	IV.B1.1-a	Not applicable	H, 1
CORE SHROUD	Core structural integrity	Stainless steel	Reactor water	Loss of material - Crevice corrosion - Pitting corrosion	PGE-04:Water chemistry control PGE-10: Internals	IV.B1.1-b	Not applicable	H, 1
CORE SHROUD	Core structural integrity	Stainless steel	Reactor water	Reduction of toughness - Irradiation embrittlement	PGE-10: Internals	IV.B1.1-a	Not applicable	H, 1
… / …	… / …	… / …	… / …	… / …	… / …	… / …	… / …	… / …

C, A, F, G and H – General notes
3, 2 and 1 – Notes specific for CNSMG

EXAMPLES OF AGEING MANAGEMENT PROGRAMS

- ASME Section XI Inservice Inspection, subsections IWB,IWC and IWD
- Water Chemistry
- Reactor Head Closure Studs
- BWR Vessel ID Attachment Welds
- BWR Feed water Nozzle
- BWR Vessel Internals
- Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS)
- Flow-Accelerated Corrosion
- Buried Piping and Tanks Surveillance
- Structures Monitoring Program
- Fire Protection
- Inaccessible Medium Voltage Cables not subjected to 19 CFR 50.49 Environmental Qualification Requirements.

TLAA LIST (I)

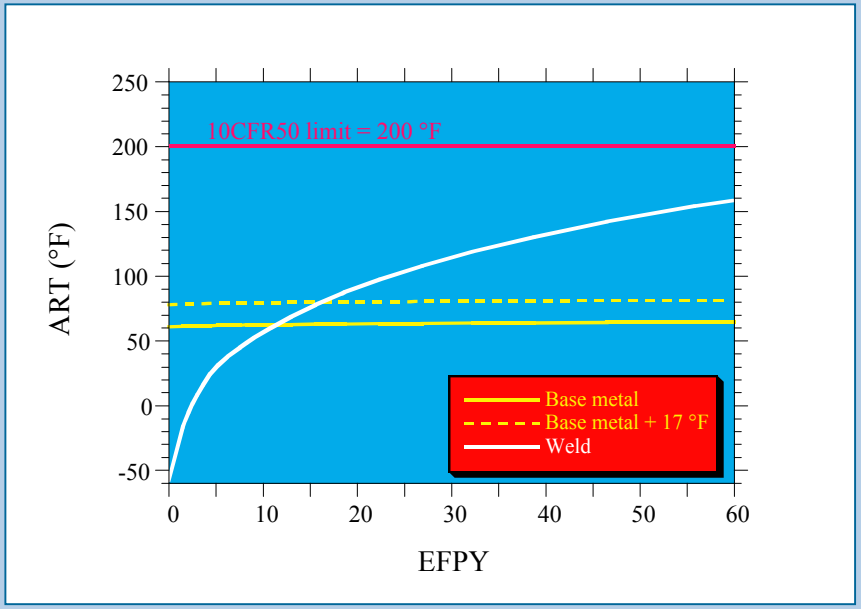
NO.	DESCRIPTION	RESOLUTION	TYPE
	Neutron embrittlement of RPV and internals		
1	USE reduction of RPV material	Extension	Generic
2	RT_{NDT} shift of RPV material	Extension	Generic
3	RPV thermal shock caused by low temperature coolant injection	Extension	Generic
4	Shroud (and tie rods) thermal shock caused by low temperature coolant injection	Validation	Generic
5	P-T curves	Extension	Generic
	Metals fatigue		
	Reactor pressure vessel		
6	RPV fatigue analysis	Extension	Generic
7	Recirculation outlet nozzles fatigue analysis	Extension	Generic
8	Recirculation inlet nozzles fatigue analysis	Extension	Generic
9	Feed water nozzles fatigue analysis	Extension	Generic
10	Core spray nozzles fatigue analysis	Extension	Generic
11	Jet pumps instrumentation nozzles fatigue analysis	Extension	Generic
12	CRD return line nozzle fatigue analysis	Extension	Generic
13	Shroud support low cycle thermal fatigue analysis	Extension	Generic
	Internals		
14	Shroud tie rods low cycle thermal fatigue analysis	Validation	Generic
15	Jet pump diffuser to shroud support plate weld fatigue analysis	Extension	Generic
16	Core spray internal lines fatigue analysis	Extension	Generic
17	Nuclear instrumentation housings fatigue analysis	Extension	Specific
	Piping systems		
18	Recirculation piping fatigue analysis	Extension	Generic
19	B31.1, ASME III class 2 and 3 or ASME VIII class B and C piping and components fatigue analysis	Validation	Generic

TLAA LIST (II)

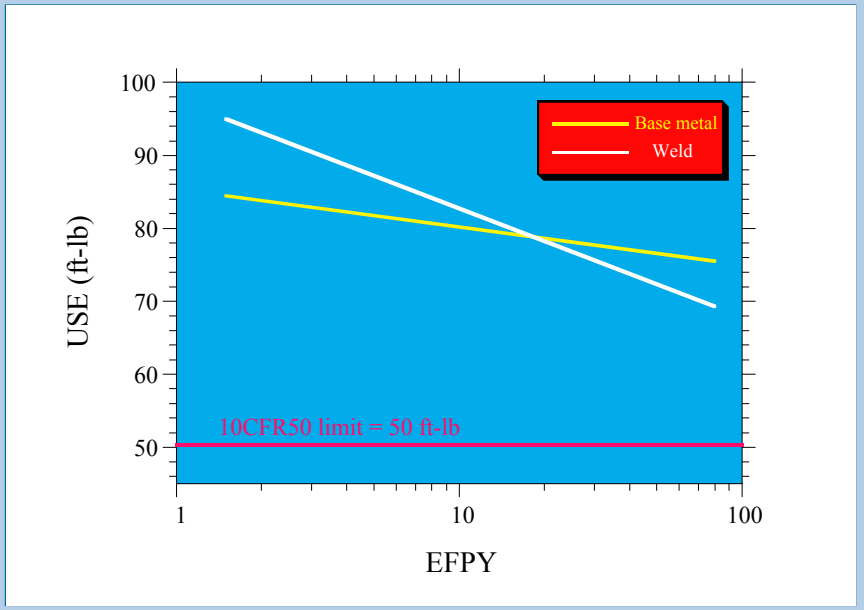
NO.	DESCRIPTION	RESOLUTION	TYPE
	Other primary circuit analyses		
20	Isolation condenser fatigue analysis	Extension	Generic
21	Recirculation pumps fatigue analysis	Extension	Specific
22	Environmental assisted fatigue (GSI 190)	Extension and aging management	Generic
	Primary containment fatigue		
23	Fatigue analysis of the suppression chamber, vents and downcomers	Extension	Generic
24	Fatigue analysis of SRV discharge piping inside the suppression chamber, external suppression chamber attached piping and associated penetrations	Extension	Generic
25	Drywell-to-suppression chamber vent line bellows fatigue analyses	Validation	Generic
26	Stress analysis of containment penetrations caused by pressurization cycles	Validation	Generic
27	Primary containment process penetrations bellows fatigue analysis	Validation	Generic
28	ECCS filters fatigue analysis	Extension	Specific
	Other fatigue analyses		
29	Reactor building crane load cycles	Extension	Generic
30	High energy lines break postulated locations	Aging management	Generic
	Environmental effects		
31	Environmental qualification of electrical equipment	Extension and aging management	Generic
32	Dedication processes	Extension	Specific
33	Radiation degradation of drywell shell expansion gap polyurethane foam	Validation	Generic
34	Safeguard systems set points calculation	No TLAA	Specific

TLAAs 1 & 2

RT_{NDT} SHIFT



USE REDUCTION



NEUTRON EMBRITLEMENT WILL NOT CHALLENGE SMG VESSEL BEFORE 54 EFFECTIVE FULL POWER YEARS OF OPERATION (60 ACTUAL YEARS OF OPERATION)

CONCLUSIONS

- **Licensing requirements for long term operation of nuclear power plants in Spain has been stated and Santa María de Garoña will be the first plant facing to those requirements.**
- **Those requirements put emphasis in ageing issues to assure that key plant equipment will perform its intended function during extended operating period, in such a manner that licensing bases are maintained.**
- **A robust methodology is available to evaluate relevant ageing effects for key plant equipment.**
- **Preliminary results of SMG ageing management evaluation show that there are no technical obstacles which would preclude life extension of the plant to 60 years and beyond.**