Simposyum
Siting of New Nuclear Power Plants and Irradiated Fuel Facilities
Buenos Aires – Argentina
24-28 June 2013

Panel
"Fukushima Daiichi's Impact in Nuclear Power Programs Worldwide"

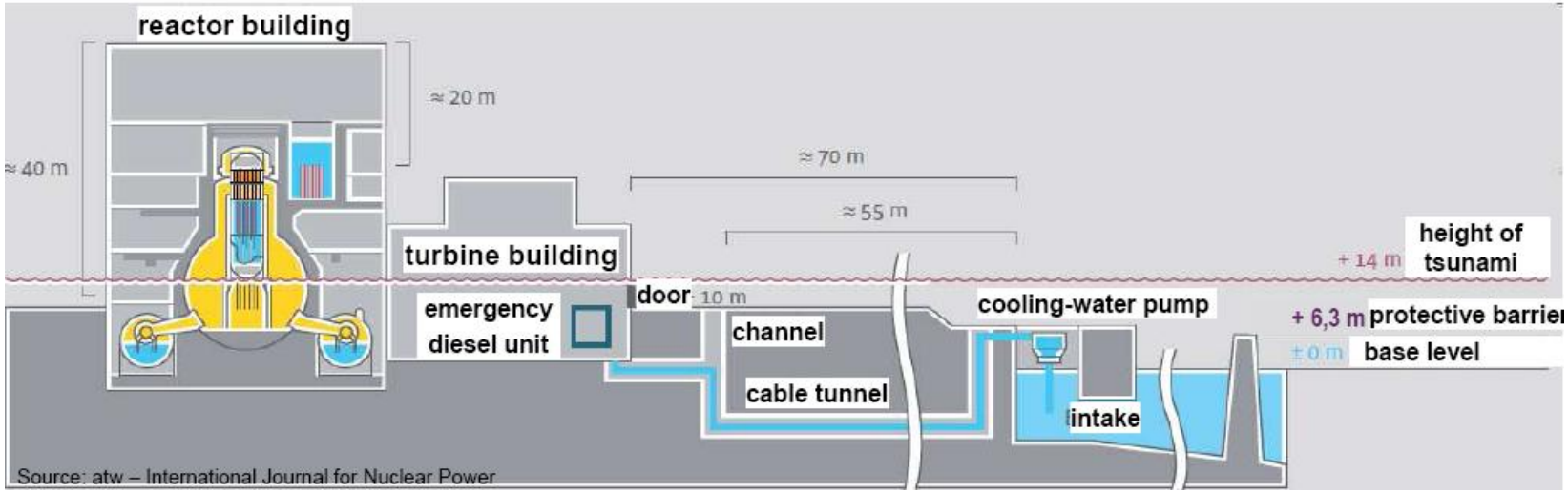
Brazilian Operator's Response to Fukushima Daiichi Accident

Luiz Soares – Technical Director

Fukushima Daiichi Accident

"Events at Fukushima revelaled well known and recurrent issues"

- faulty design (underestimation of tsunami risks; design criteria for tsunamis 5,7m and inadeqaute plant layout);



- insufficient backup systems;
- unproper decision making process ("human error");
- inadequate contingency plans.

Communication from the Commission to the Council and the European Parlament, (Oct.4th 2012)

Nuclear Industry and the Accident

Earthquakes and tsunamis of that intensity will never happen in our plants

We have more updated technology in our reactors

Our plants do not have the defficiencies of Fukushima

Plant modifications will demand large investments

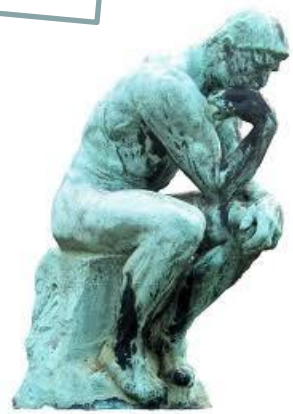
The accident affected public acceptance of nuclear

We can not exclude the possibility of severe accidents

A large accident can cause financial losses that our company can not bear

An accident in one country impact the nuclear industry all over the world

NUCLEAR INDUSTRY



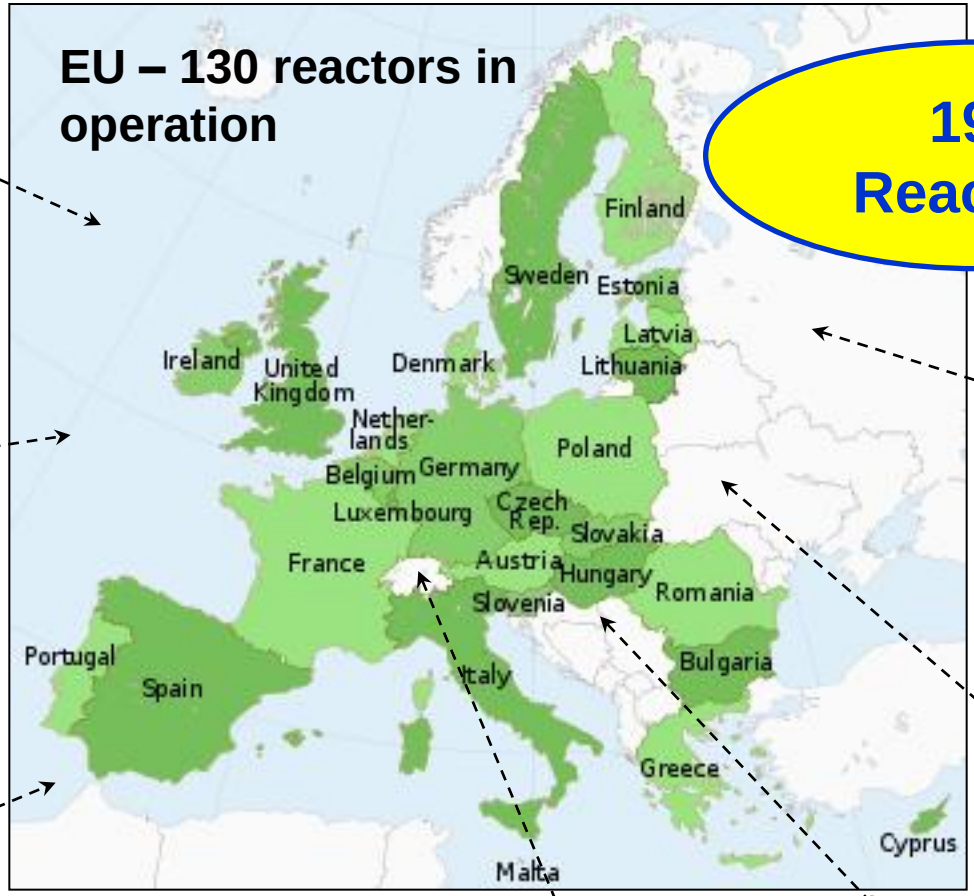
Europe and Iberoamerica: Stress Test

Operator's Reports → Regulator Report → Peer Reviews

2 reactors

2 reactors

2 reactors



190 Reactors

Russia
33 reactors

Ukrania
15 reactors

Switzerland
5 reactors

Armenia
1 reactor

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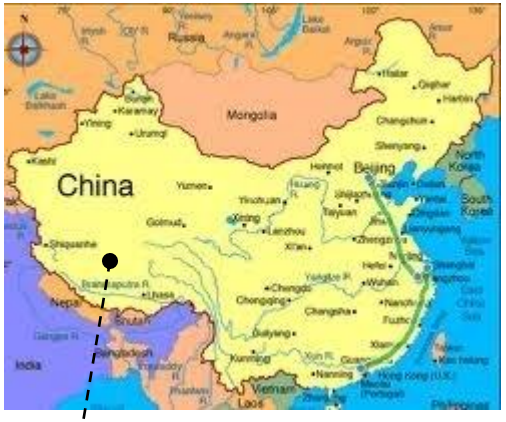
Other National Reevaluation Programs

"Canadian Stress Test" (18 reatores)

"NRC Task Force Safety Reevaluation" (104 reatores)



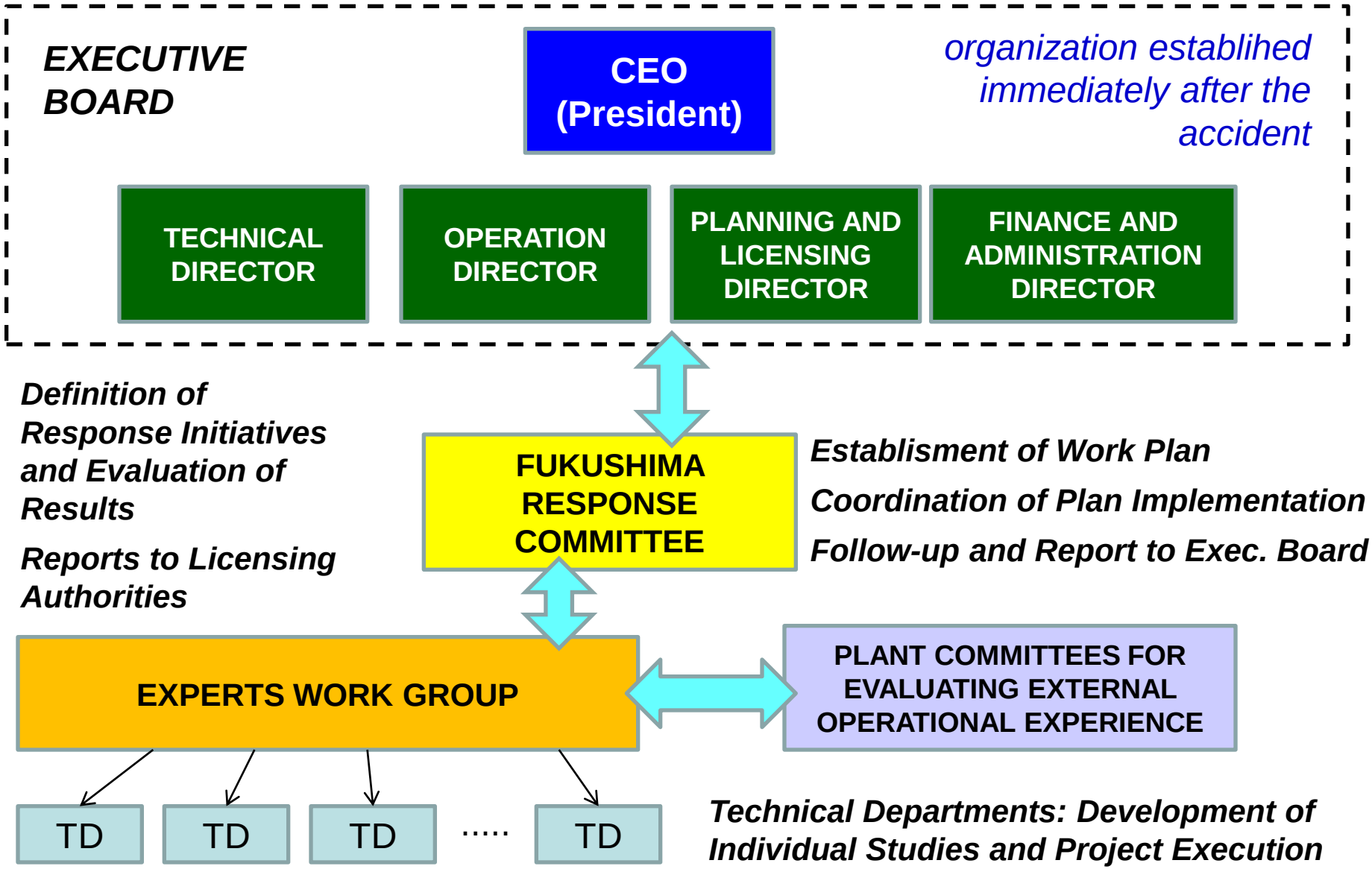
"Safety Evaluation Program" (16 reatores)

"Safety Reassessment Program" (2 reatores)

"Safety Review" (23 reatores)

"Safety Assessment Lessons Learned" (50 reatores)

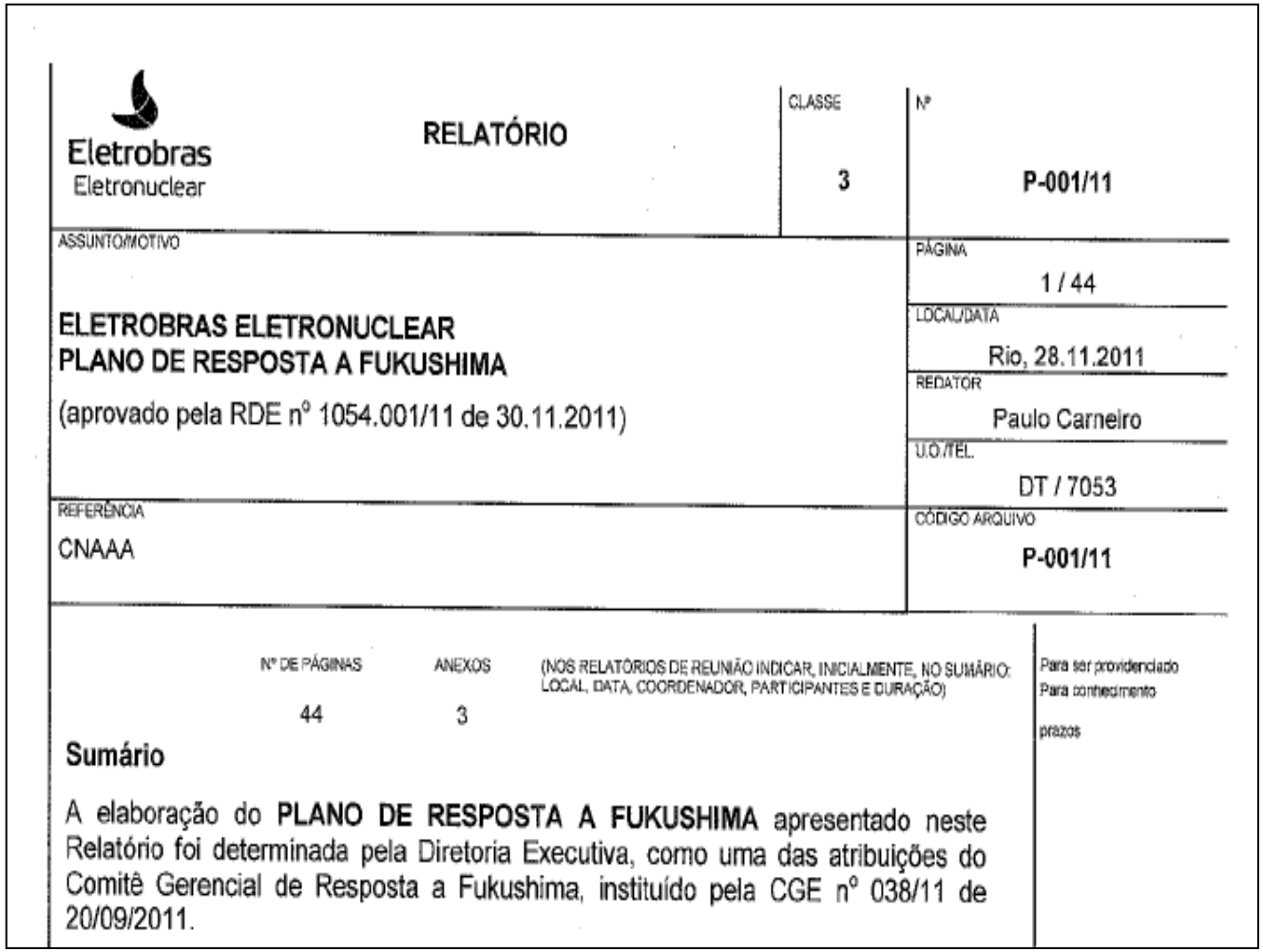
ELETRONUCLEAR ORGANIZATION TO RESPOND TO FUKUSHIMA



Full Integration to Nuclear Industry Initiatives

Fukushima Response Plan

(submitted to CNEN in December 2011)
(revision 1 submitted to CNEN in September 2012)



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RELATÓRIO

CLASSE: 3

Nº: P-001/11

ASSUNTO/MOTIVO

ELETROBRAS ELETRONUCLEAR
PLANO DE RESPOSTA A FUKUSHIMA

(aprovado pela RDE nº 1054.001/11 de 30.11.2011)

PÁGINA: 1 / 44

LOCAL/DATA: Rio, 28.11.2011

REDATOR: Paulo Carneiro

U.O./TEL.: DT / 7053

REFERÊNCIA: CNAAA

CÓDIGO ARQUIVO: P-001/11

Nº DE PÁGINAS: 44

ANEXOS: 3

(NOS RELATÓRIOS DE REUNIÃO INDICAR, INICIALMENTE, NO SUMÁRIO: LOCAL, DATA, COORDENADOR, PARTICIPANTES E DURAÇÃO)

Para ser providenciado
Para conhecimento
prazos

Sumário

A elaboração do **PLANO DE RESPOSTA A FUKUSHIMA** apresentado neste Relatório foi determinada pela Diretoria Executiva, como uma das atribuições do Comitê Gerencial de Resposta a Fukushima, instituído pela CGE nº 038/11 de 20/09/2011.

58 initiatives (studies and projects)

Performance of Stress Tests

Around US$ 150 million being applied from 2012 to 2016

High priority inside the organization

Plan General Structure

Main Evaluation Areas of FUKUSHIMA RESPONSE PLAN

PE — PROTECTION FROM RISK EVENTS

15 initiatives

Focus:
Protection from events with the potential to induce multiple failures in safety systems

Objective:
Assure that safety systems are preserved in case of extreme conditions associated with external or internal events, beyond the design basis.

RF — COOLING CAPABILITY

32 initiatives

Focus:
Reactor and Spent Fuel Pool cooling capability in case of beyond design basis accidents

Objective:
Provide alternative possibilities for reactor and fuel pool cooling, for conditions beyond design basis

CR — MITIGATION OF RADIOLOGICAL CONSEQUENCES

9 initiatives

Focus:
Mitigation of radiological consequences in case of severe accidents

Objctive:
Provide means to minimize the risk of losing containment integrity and releases of radioactivity materials to the environment. Improvements on Emergency Planning

+ Stress Tests: Angra 1 and 2

2 initiatives

Main Evaluation Areas

PROTECTION FROM RISK EVENTS	COOLING CAPABILITY	MITIGATION OF RADIOLOGICAL CONSEQUENCES
Earthquakes	Reactor Cooling Through Steam Generators	Containment Integrity
Rains	Direct Reactor Cooling	Post Accident Instrumentation
Landslides	Spent Fuel Pool Cooling	Support to Emergency Planning
Tidal Waves	Emergency Power Supply	
Tornadoes and Hurricanes	Water Supply	
Plant Internal Events	Procedures for Severe Accident Management	

Stress Tests

Stress Test Report – Angra 1 and 2

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RELATÓRIO

CLASSE	Nº
3	DT-006/12

ASSUNTO/MOTIVO

RELATÓRIO DE AVALIAÇÃO DE RESISTÊNCIA DAS UNIDADES DA CENTRAL NUCLEAR ALMIRANTE ÁLVARO ALBERTO PARA AS CONDIÇÕES DO ACIDENTE DE FUKUSHIMA ("STRESS TEST")

PÁGINA: 1 / 90

LOCAL/DATA: Rio, 29.03.2012

REDATOR: Paulo Carneiro (coordenador)

U.O./TEL.: DT / 7053

REFERÊNCIA: CNAAA

CÓDIGO ARQUIVO: DT-006/12

Nº DE PÁGINAS	ANEXOS	(NOS RELATÓRIOS DE REUNIÃO INDICAR, INICIALMENTE, NO SUMÁRIO: LOCAL, DATA, COORDENADOR, PARTICIPANTES E DURAÇÃO)
90	3	

Para ser providenciado
Para conhecimento
prazos

Sumário

Este relatório tem por objetivo avaliar a resistência das unidades 1 e 2 da Central Nuclear Almirante Álvaro Alberto para condições extremas além das bases de projeto, à luz das lições aprendidas com o acidente ocorrido em 11 de março de 2011 na Central de Fukushima Daiichi no Japão.

Submitted to CNEN in April 2nd, 2012

Performance of Stress Tests for Angra 1 and 2

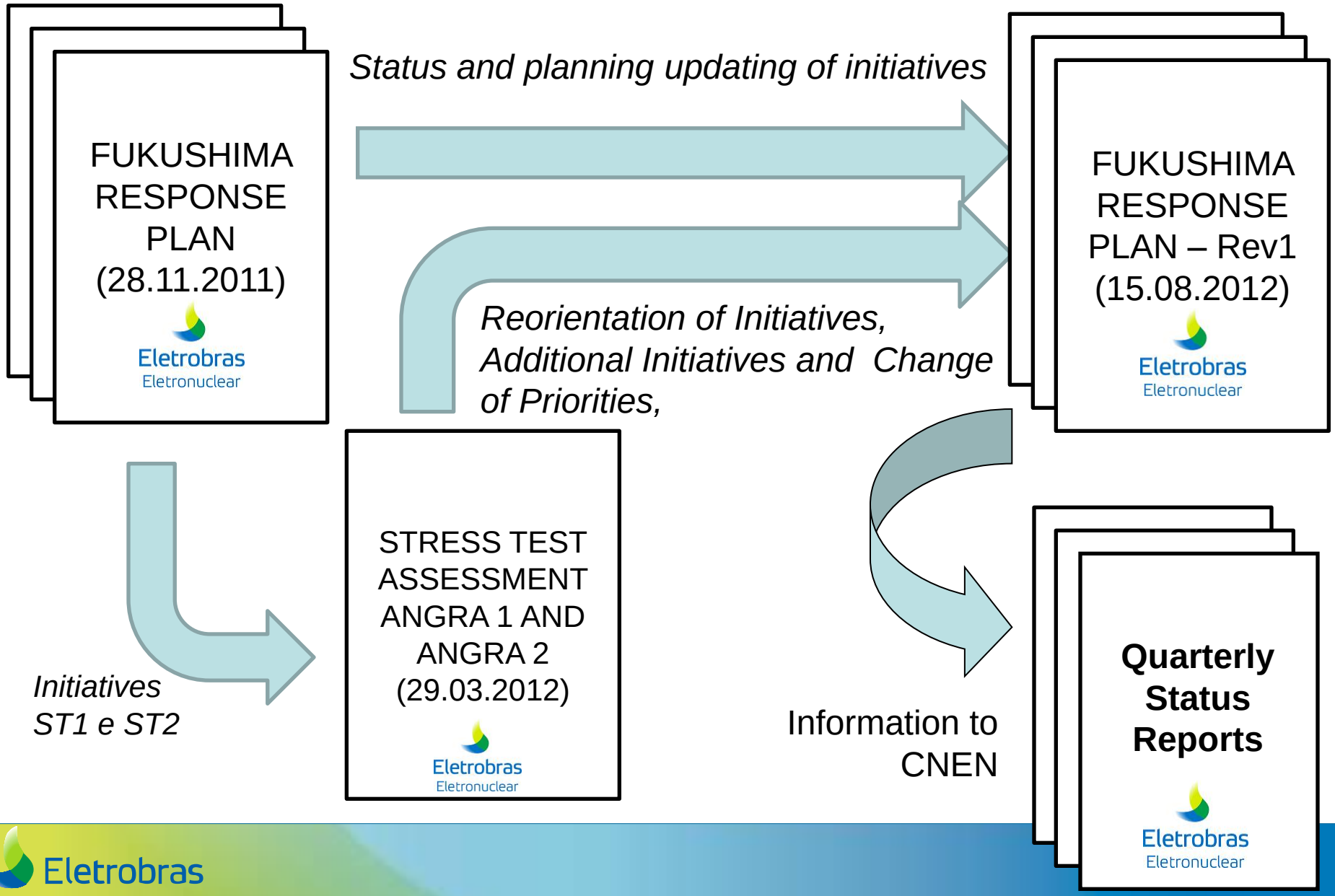
According to specification issued by Iberoamerican Forum of Regulatory Bodies, Nuclear and Radiological (request from CNEN in January 2012)

Compliance with WENRA Specification for Stress Tests

European Commission

Submitted to CNEN on April 2nd, 2012

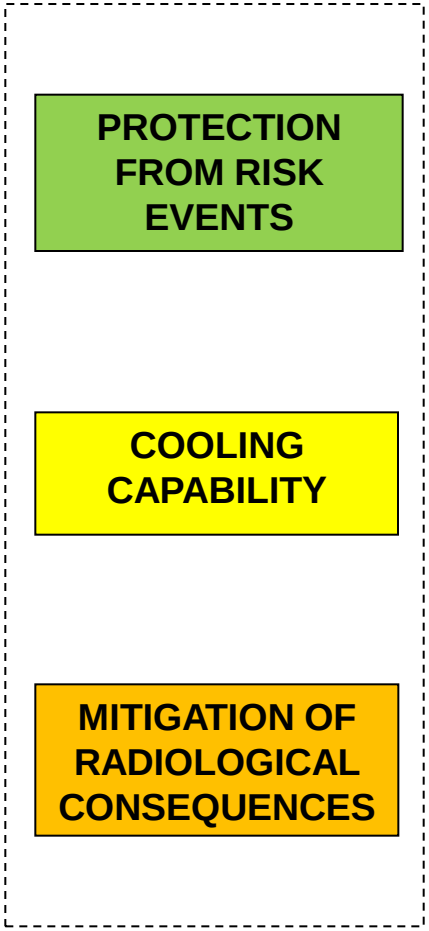
Revision of Fukushima Response Plan



Stress Test Report Angra 1 and 2

Three main areas of evaluation:

- plant capacity to **withstand external events** of large magnitude preserving the operability of essential safety systems for safe plant shutdown;
- **alternative means to assure safe plant shutdown** in case the operability of plant safety systems is impacted by external events of large magnitude;
- countermeasures to mitigate radiological consequences in case a severe accident can not be avoided.



Fukushima Response Plan in line with Stress Test approach

Tsunamis excluded

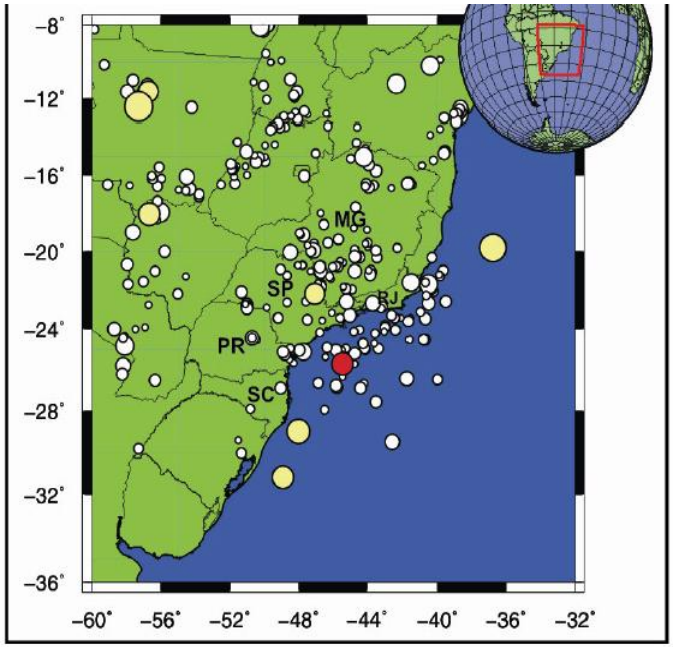
No possibility of Tsunamis at the Brazilian coast confirmed by independent studies carried out in 2005

Maximum conceivable earthquake magnitude at ocean: 7.0

Brazilian coast far from the boundaries of tectonic plates;

Tectonic plates in front of Brazilian coast with diverging movement instead of converging (no subduction zone)

NPP located in a low seismicity region



More relevant earthquakes in Brazil within 200 miles from the plant

1967 - Cunha, SP - 4.1 m_b (50km)

- basis for seismic design;
- max. peak ground acceleration 0,067g
- 0,1g considered for the design

2008 – São Vicente – 5.2 m_b (250km)

- peak ground acceleration at site 0,002g

- maximum ground peak acceleration confirmed by probabilistic assessment (probability less than 10^{-4}/year);

- updating of seismic and geological data *(ongoing, conclusion 2016)*
- evaluation of safety margins according to EPRI methodology; *(2014)*
- expectation of adequate safety margins considering results for similar plants.

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NPP installed in a region of protected sea water

Plant construction level 5,15m above sea water level, jetty protection from sea waves

plant construction level

access level do safety buildings

Angra 1 e 2

+ 8,00m to + 8,50m

+ 5.60m

+ 5.15m

0 CNG

sea side

PROTECTION JETTY

(protection from waves up to 4.40m high over maximum sea water level of +1.50m)

0 CNG

plant side

Reevaluation of wave heights considering extreme meteorological conditions *(ongoing, conclusion 2013)*

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+1,197m maximum according to updated reevaluation

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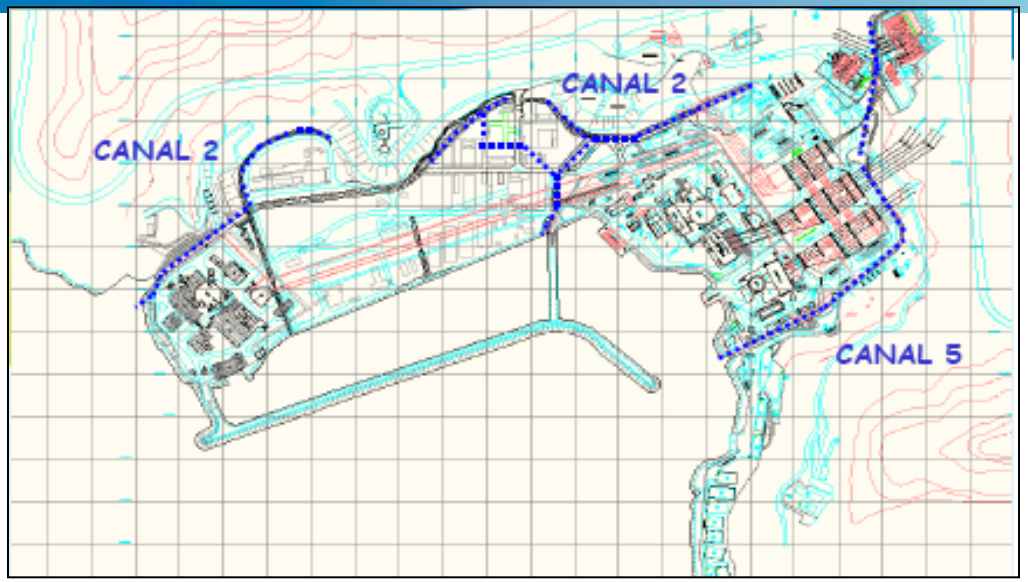
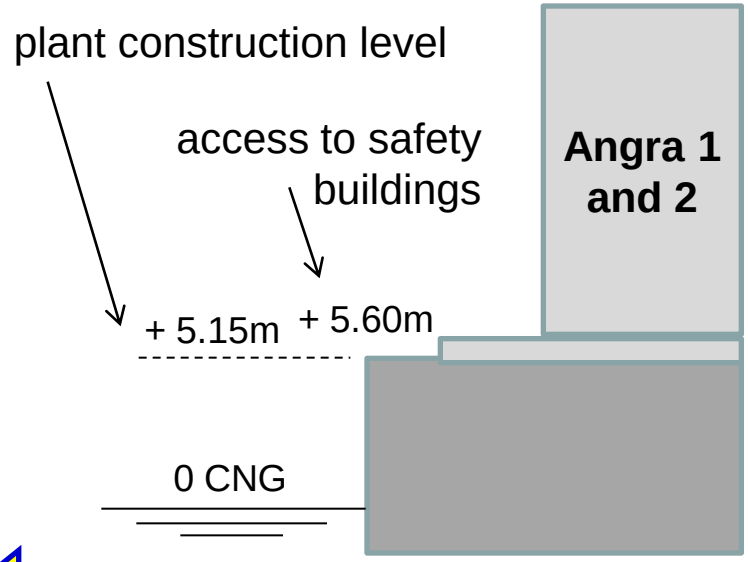
Specific Angra Site Hazard – Heavy Rains



Flooding calculated considering rain fall of 10,000 years recurrence time (311 mm/hr)



Simulation considering more conservative channel obstruction scenarios with continued operation of circulating water pumps (ongoing, conclusion in August 2013):

- expectation that the elevation +5.60 will not be exceeded;
- possibility of additional measures under evaluation to enlarge safety margins (Angra 2 emergency feedwater building already designed for +8,15)

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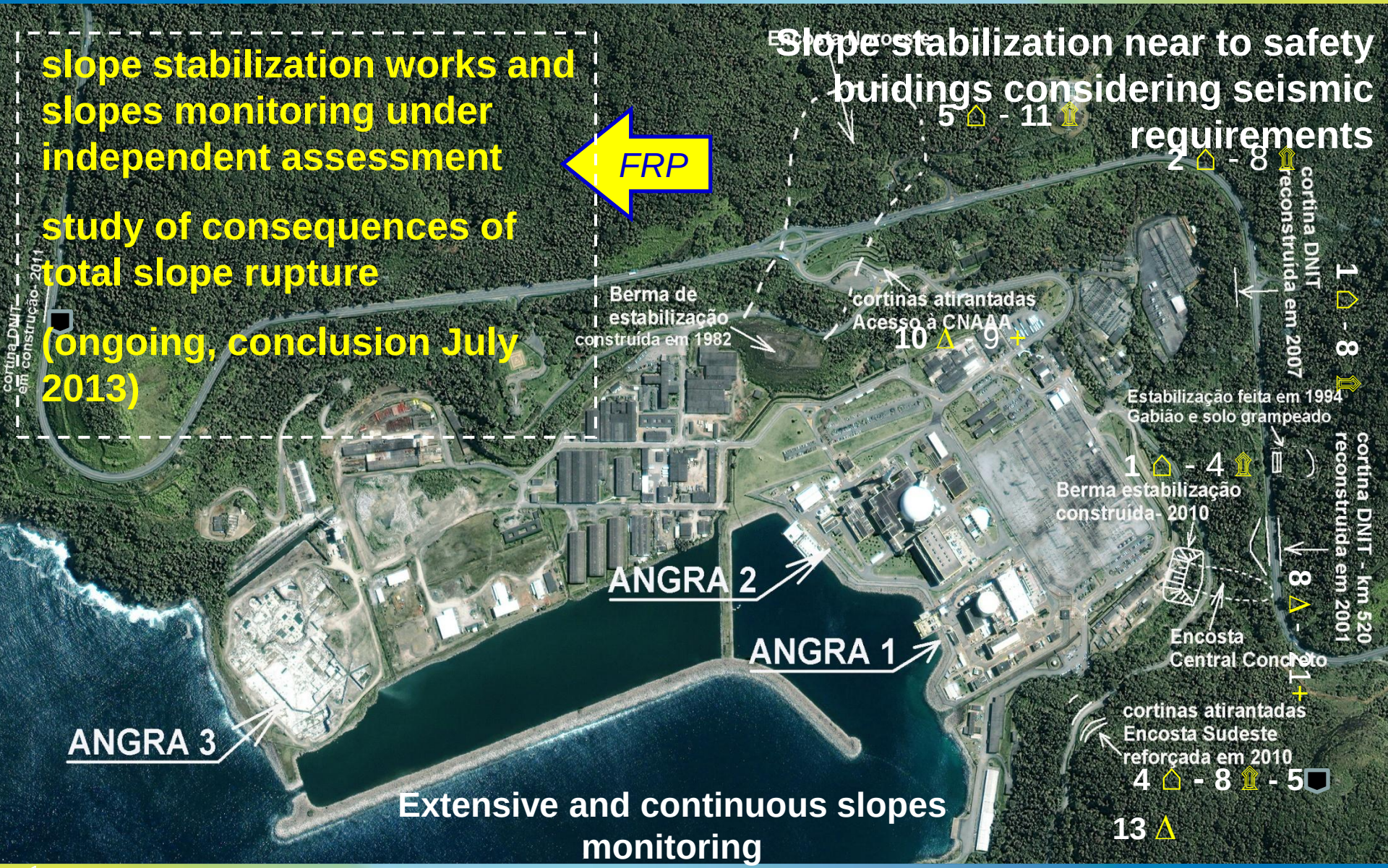
Specific Angra Site Hazard – Risk of Landslides



Evaluation of Station Blackout Scenarios (SBO)

Favorable power supply conditions in Angra 1 and Angra 2

Improvements under evaluation or design

- ✓ increased flooding protecion (Angra 1); *(2014)*
- ✓ alternative diesel cooling chain (Angra 1); *(2014)*
- ✓ manual interconnection of Angra 1 and 2 emergency busbars *(2015)*

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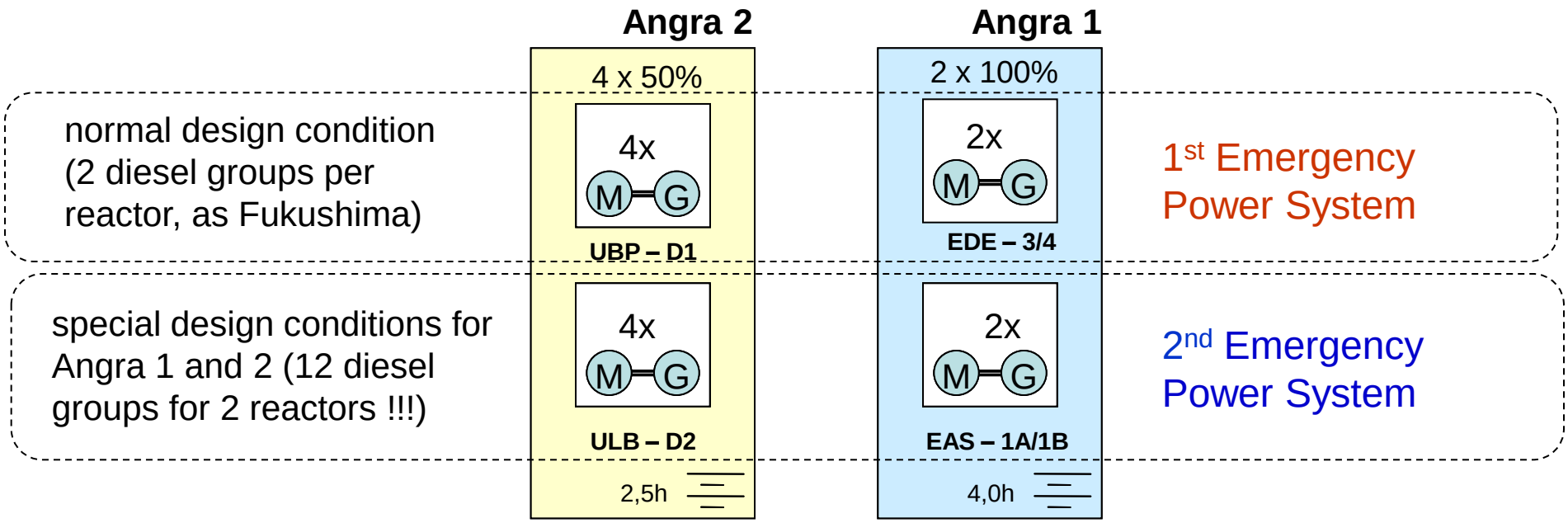

Evaluation of Station Blackout Scenarios (SBO)

Other favorable Angra conditions to face SBO

- both units are engineered with mechanical driven pumps for feeding the steam generators (power supply not necessary);
- large amounts of stored fuel available for long term operation of diesel generators.

Initiatives for increasing reliability of external power supply (under evaluation)

Small hydropower plant at Mambucaba River

provisions for “house loading operation”;

dedicated transmission lines from Santa Cruz Power Plant

Evaluation of Loss of Heat Sink Condition

Favorable Angra conditions:

- water intake structures in area of protected sea water (Ilha Grande Bay);
- water intake structures protected by jetty 8,0m high above average seawater level;
- very low probability of water intake blockage to the extent of impairing minimum flow for residual heat removal;
- water availability at site enough for long term cooling through steam generators (about 30 hours SG feeding without tank refilling);
- possibility of feeding steam generators by fully passive means (fire fighting system, water reservoir of 5400 m^3 at 110m height;
- additional seismic protected reservoir 4000m^3 for SG passive injection *(planned for 2015);*

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Additional Resources for Facing SBO and LUHS

For each unit, installation in 2014:

- mobile diesel generator for supplying essential systems for plant safe shutdown (480V-1800kVA);
- portable disel generator for batterie charging (480V-450kVA);
- mobile water pumps as an alternative mean for feeding the steam generators (75m head and 27kg/s;
- mobile water pumps for refilling water reservoirs and pools (20m head and 20kg/s);
- mobile air compressor for Angra 1 as alternative mean for remote actuation of main steam and feedwater valves

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Mitigation of Consequences

Severe Accident Management:

• Angra 1: SAMGs already available, um der implementation with Westinghouse)

(conclusion April 2014);

• Angra 2: SAMGs under preparation (joint project AREVA and ELETRONUCLEAR) *(conclusion December 2014).*

Equipment to protect containment integrity:

• passive H_2cathalytic recombiners

(already purchased, installation in 2014 in Angra 1 and 2015 in Angra 2)

• filtered containment venting

(technical and commercial conditions under discussion for ordering still in 2013)

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Luiz Soares
lsoares@eletronuclear.gov.br