

# LAS/ANS Symposium



## **ELETRONUCLEAR's Response to the Fukushima Dai-ichi Nuclear Accident Management of Emergency Conditions**

Rio de Janeiro, July 5<sup>th</sup> 2012

Paulo Werneck



**Eletrobras**  
Eletronuclear

**ANGRA 2 - PWR**

**Power: 1.350 MW**

**Tecnology: Siemens/KWU**

**Initial Operation: January/2001**

**ANGRA 1 - PWR**

**Power: 640 MW**

**Tecnology: Westinghouse**

**Initial Operation: January/1985**



Angra 1

Angra 2

Angra 3



# Angra Nuclear Station

2015

ANGRA 3 - PWR


Power: 1.405 MW

Tecnology: Siemens/KWU



# **Eletronuclear Fukushima** **Response Plan**

# 1<sup>st</sup> Document - Preliminary Report

 <b>RELATÓRIO</b>	CLASSE	Nº
ASSUNTO/MOTIVO	PÁGINA 1 / 65	
<b>AVALIAÇÃO DAS LIÇÕES APRENDIDAS COM O ACIDENTE NAS USINAS DA CENTRAL DE FUKUSHIMA NO JAPÃO E SUAS IMPLICAÇÕES SOBRE AS UNIDADES DA CNAAA</b>	LOCAL/DATA	Rio, 19.07.2011
	REDATOR	Paulo Vieira e outros
	U.O./TEL.	DT / 7263
REFERÊNCIA	CÓDIGO ARQUIVO <b>DT-006/11</b>	
SUBTÍTULO	EMENTE, NO SUMÁRIO: (DURAÇÃO)	Para ser providenciado Para conhecimento prazos
<b>OBJETIVO</b> Este Relatório tem por objetivo previstos ou em curso, consid avaliação das lições aprendidas Daiichi no Japão.  O Relatório será encaminhado atendimento ao Ofício 082/11 – C ELETRONUCLEAR proceda a ur da CNAAA considerando a ocorrê  O anexo apresentado ao final do considerados pela Eletronuclear.	<ul style="list-style-type: none"><li>• Plant Comparison Angra x Fukushima;</li><li>• Design Criteria for Protection Against External Events;</li><li>• Preliminary Evaluation of Plant Behavior for Station Blackout and Loss of Ultimate Heat Sink;</li><li>• Stress Test</li><li>• <b>Measures for Mitigation of Consequences from Severe Accidents</b></li></ul>	

# Plan General Structure

## Main Evaluation Areas of FUKUSHIMA RESPONSE PLAN

### PROTECTION FROM RISK EVENTS

**Focus:**

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

### COOLING CAPACITY

**Focus:**

Reactor and Spent Fuel Pool cooling capacity in case of beyond design basis accidents

### MITIGATION OF RADIOLOGICAL CONSEQUENCES

**Focus:**

Mitigation of radiological consequences in case of severe accidents

# Initiatives of Evaluation Area “Risk Events”

<b>PE11</b>	<b>Earthquakes</b>
PE111	Updating and reevaluation of geological data basis
PE112	Updating and reevaluation of seismic data basis and seismic threatening
PE113	Reevaluation of safety margins in the seismic design of Angra 1 and 2

<b>PE12</b>	<b>Landslides</b>
PE121	Updating of site geological and geotechnical survey
PE122	Reevaluation of slope stabilization works and slope monitoring system
PE123	Evaluation of extreme slope rupture conditions
PE124	Evaluation of stability and integrity of pre-treated water reservoir in case of landslides

<b>PE13</b>	<b>Tidal Waves</b>
PE131	Implementation of acquisition, processing and monitoring systems for ocean and meteorological data
PE132	Reevaluation of maximum sea wave height at NP Station shore
PE133	Reevaluation of mole integrity

<b>PE14</b>	<b>Rains</b>
PE141	Revision of site flooding study for extremely severe weather conditions

<b>PE15</b>	<b>Tornadoes and Hurricanes</b>
PE151	Evaluation of impact of tornadoes on Angra 1 and 2 safety related structures, systems and components
PE152	Reevaluation of threatening by hurricanes

<b>PE2</b>	<b>Plant Internal Events</b>
PE211	Conclusion of internal flooding study for Angra 1
PE221	Conclusion of the revision of Angra 1 “Fire Hazard Analysis - FHA”



# Main Initiatives of Evaluation Area “Cooling Capacity”

<b>RF11</b>	<b>Reactor Cooldown over Secondary Side for Angra 1</b>
RF111	Verification of Angra 1 plant conditions for performing "bleed-and-feed" operation through the Steam Generators, under beyond-design-basis conditions, including station black out
RF112	Implementation of mobile water pumping units to feed Angra 1 Steam Generators

<b>RF31</b>	<b>Spent Fuel Pool Cooling in Angra 1</b>
RF311	Calculation of Angra 1 spent fuel pool water temperature increase in case of loss of cooling systems
RF312	Study on alternative cooling possibilities for the Angra 1 spent fuel pool

<b>RF41</b>	<b>Alternatives for Emergency Power Supply in Angra 1</b>
RF412	Study on extension of Angra 1 batteries autonomy

<b>RF43</b>	<b>Alternatives for Emergency Power Supply to the NP Station</b>
RF431	Implementation of manual interconnection of emergency power busbars of Angra 1 and Angra 2
RF432	Study on additional emergency power supply unit for the site
RF433	Feasibility study for a small hidro power plant at Mambucaba river
RF434	Study to define alternative schemes for oil resupplying for the emergency power diesels
RF435	Purchasing of mobile emergency diesel unit and connections to supply both Angra 1 and 2

**(and the same studies for Angra 2)**

# Initiatives of Evaluation Area “Mitigation of Consequences”

<b>CR11</b>	<b>Angra 1 Containment Integrity</b>
CR111	Implementation of H2 passive recombiners in Angra 1
CR112	Implementation of filtered containment venting in Angra 1

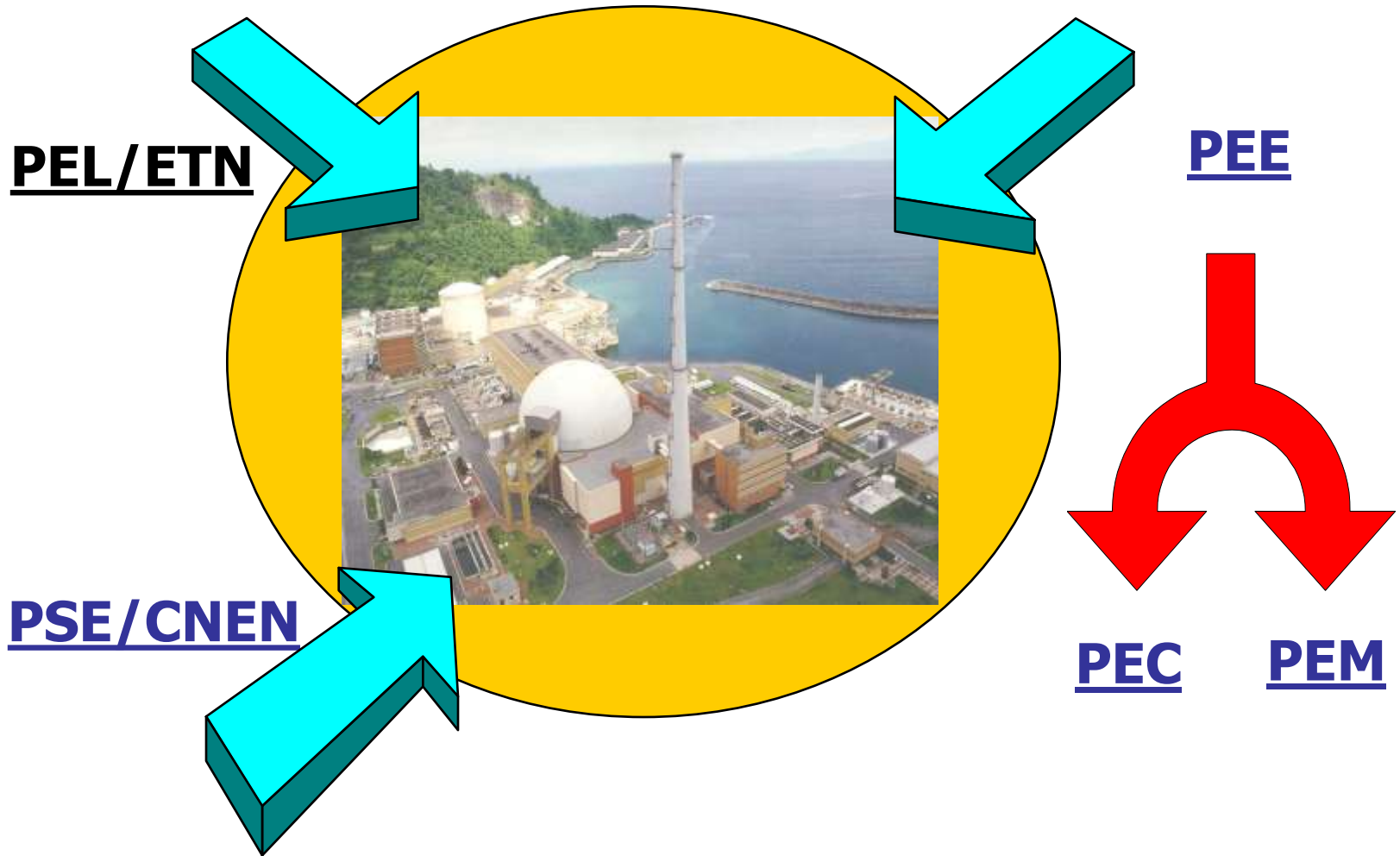
<b>CR12</b>	<b>Angra 2 Containment Integrity</b>
CR121	Implementation of H2 passive recombiners in Angra 2
CR122	Implementation of filtered containment venting in Angra 2

<b>CR21</b>	<b>Angra 1 Post-Accident Instrumentation</b>
CR211	Implementation of containment sampling system in Angra 1 qualified for BDBA conditions

<b>CR22</b>	<b>Angra 2 Post-Accident Instrumentation</b>
CR221	Implementation of primary circuit and containment sampling system in Angra 2 qualified for BDBA conditions

<b>CR31</b>	<b>Support to the Emergency Planning</b>
CR311	Enlargement of wharfs around the site for transportation of personnel and equipment
CR312	Implementation of local alternative evacuation routes for emergency planning
CR313	Implementation of improvements in the Emergency Centers

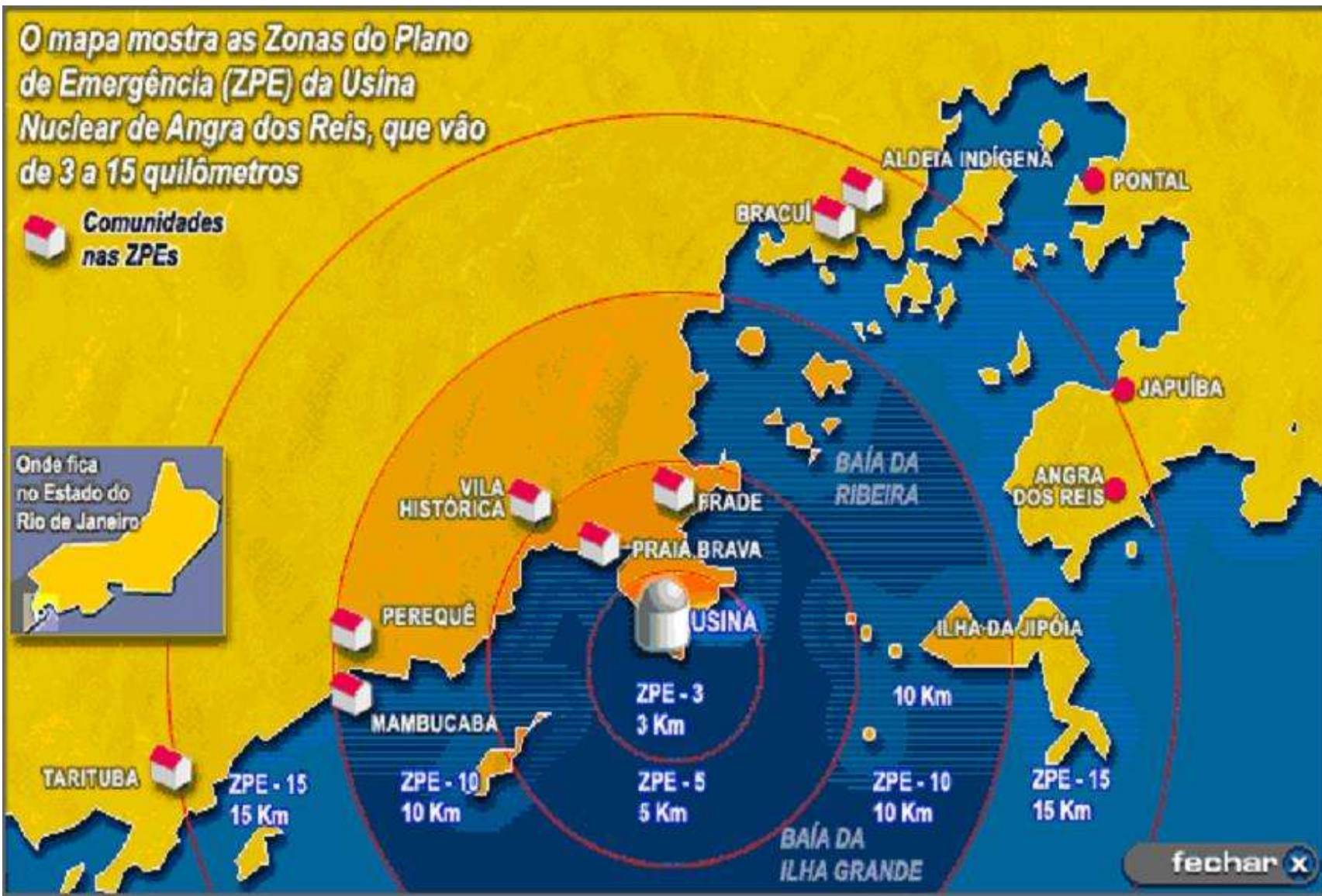
# Emergency Plans



# Emergency Planning Zones - ZPEs

O mapa mostra as Zonas do Plano de Emergência (ZPE) da Usina Nuclear de Angra dos Reis, que vão de 3 a 15 quilômetros

 Comunidades nas ZPEs



# Emergency Planning Zones - ZPEs

- ZPE- 3 (3 km) – Preventive Action Zone
- ZPE- 5 (5 km) – Preventive Action Zone
- ZPE- 10 (10km) – Environment Monitoring Zone
- ZPE- 15 (15 km) – Environment Monitoring Zone

# Sirens



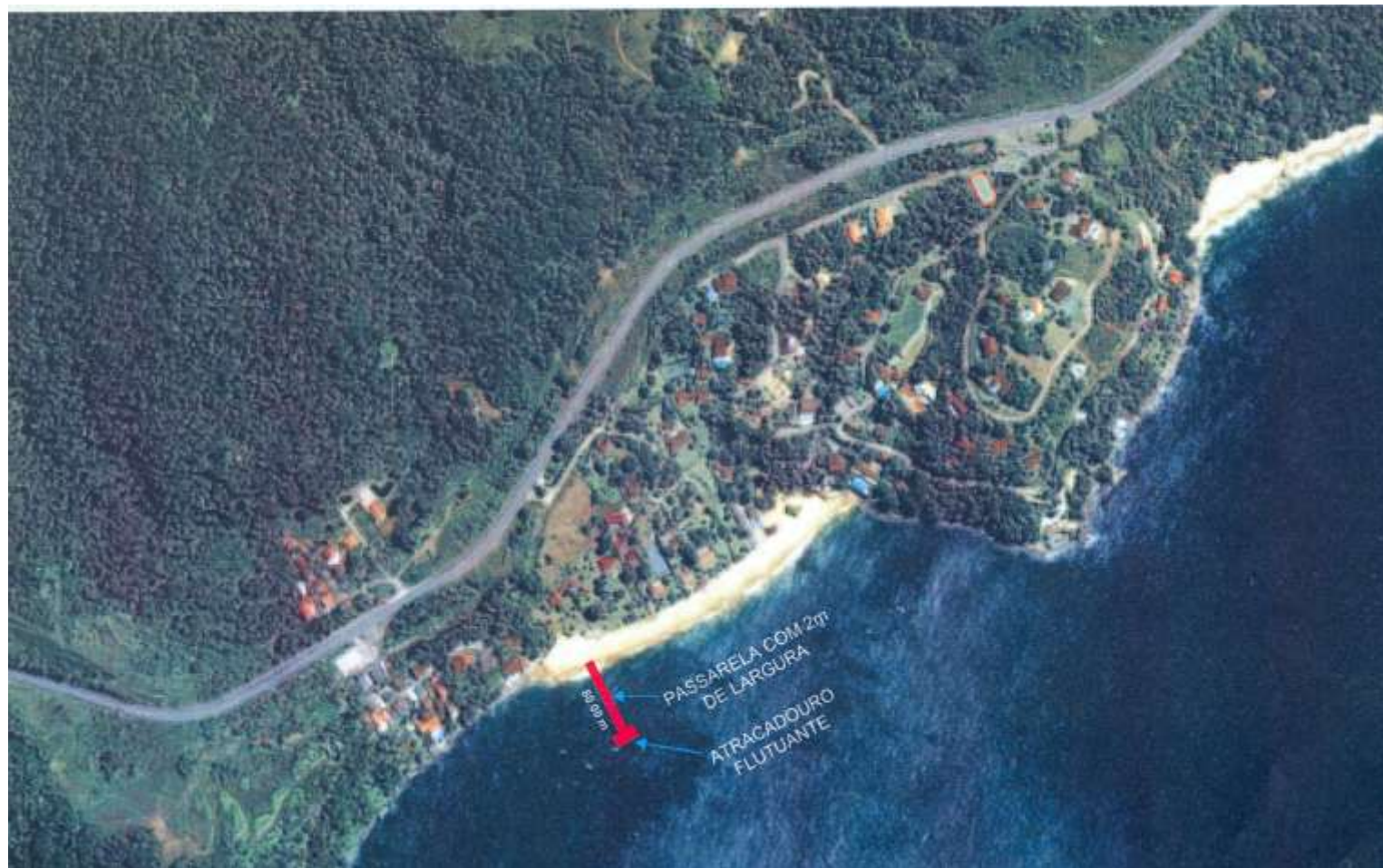
# Sirens





# **Enlargement of wharfs around the site for transportation of personnel and equipment**

# Praia Vermelha Pier



# Frade Pier



# Praia Brava Pier



# Mambucaba Pier

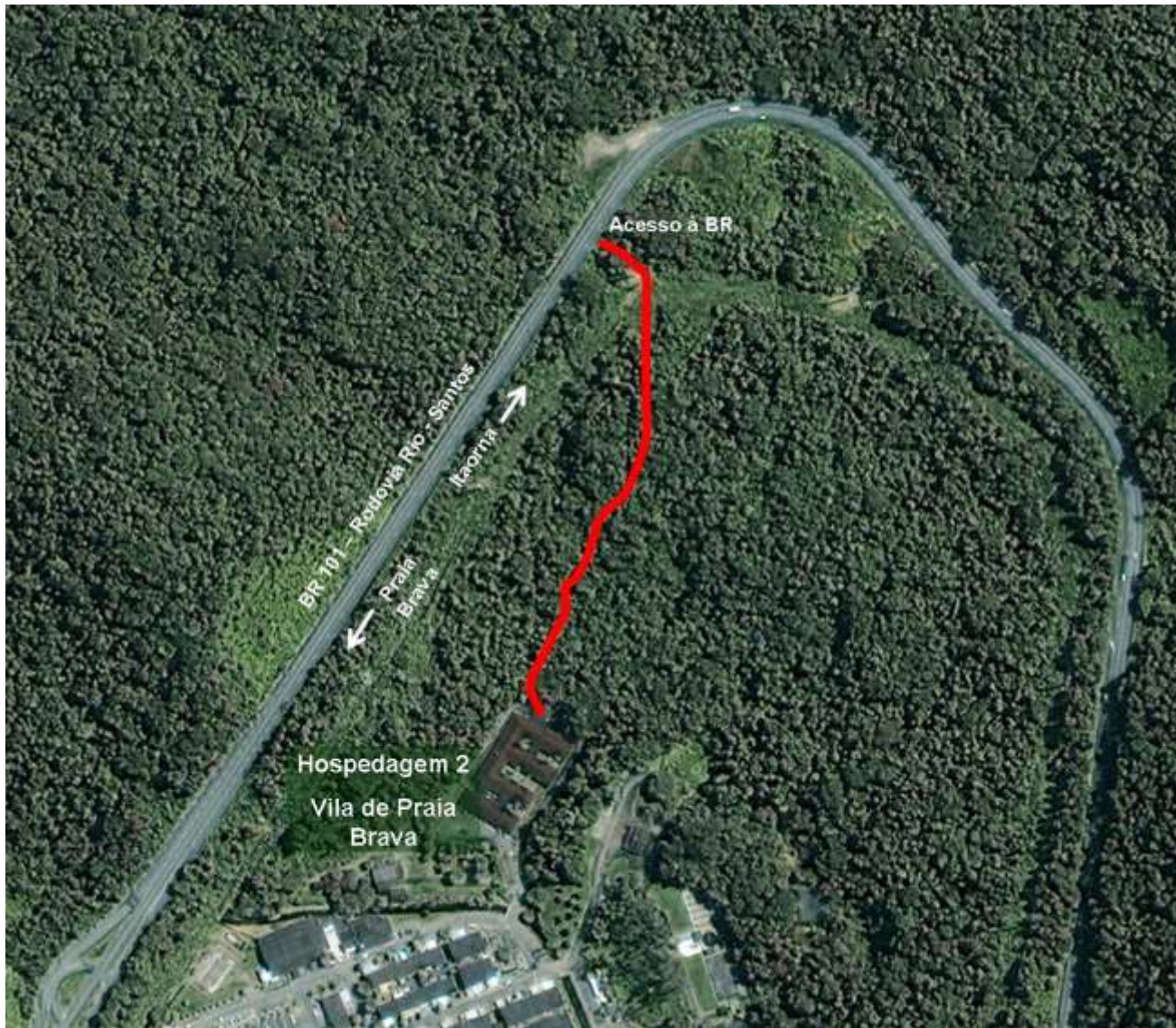


# **Implementation of local alternative evacuation routes for emergency planning**

# Local Alternative Evacuation Routes

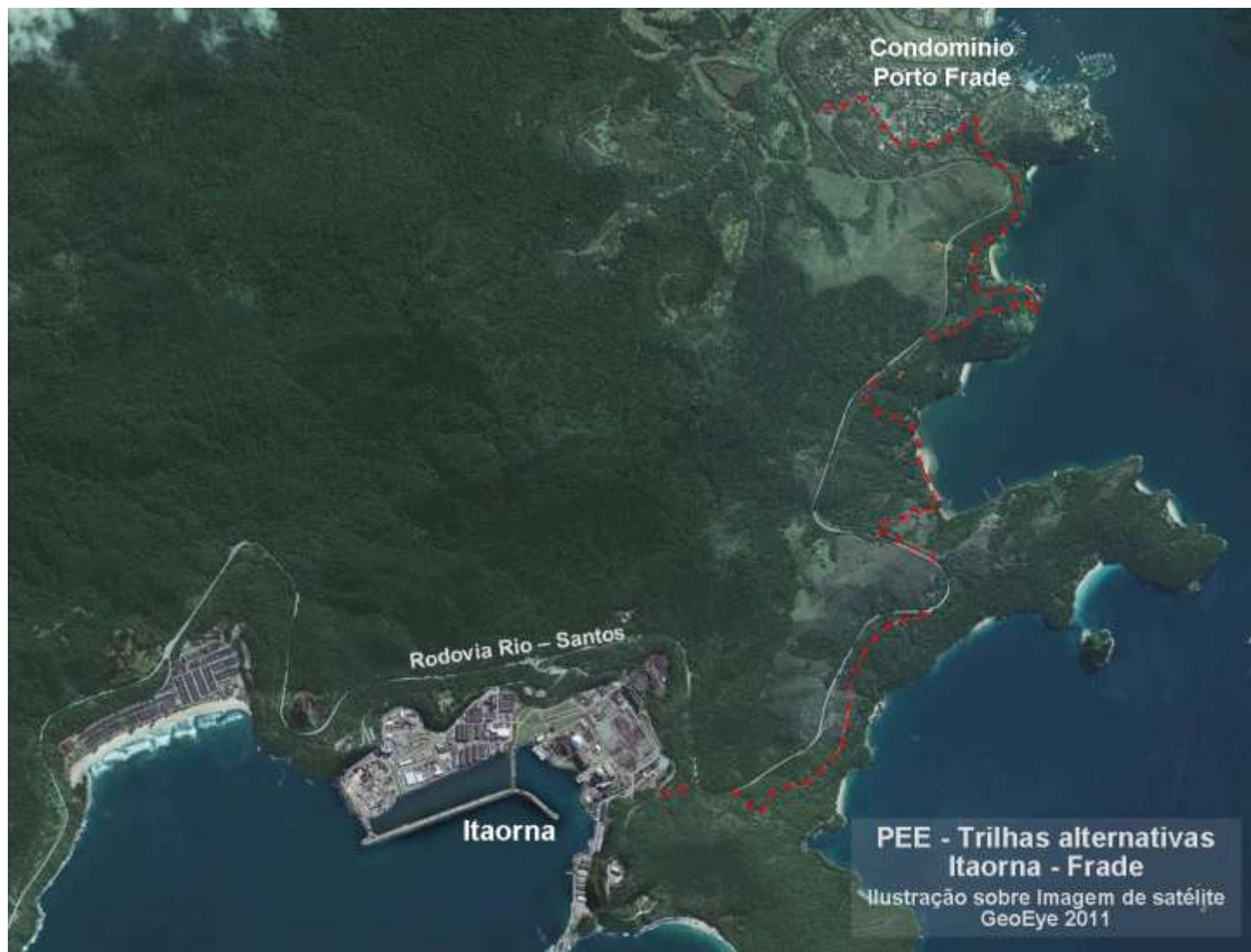


# Local Alternative Evacuation Routes





# Local Alternative Evacuation Routes



# Local Alternative Evacuation Routes



# Local Alternative Evacuation Routes



# Local Alternative Evacuation Routes



# Local Alternative Evacuation Routes



# Local Alternative Evacuation Ways



# **Implementation of improvements in the Emergency Centers**

# Emergency Centers

**Angra 1**

*Technical Support Center*

*Operational Support Center*

For both Units

**Angra 2**

*Technical Support Center*

*Operational Support Center*

*Head Office Emergency Center*

*Infrastructure Emergency Center*

*Medical Center*

*Mambucaba Emergency Center*



# Angra 1 Technical Support Center



# Angra 2 Technical Support Center



# Infrastructure Emergency Center



# Emergency Center Improvements

- Programmed Dialing Phones;
- Video Wall Device (Emergency Plant Status Data Log, Plant Documentation, Internet, Video Conference, Site TV Cameras, Midia);
- Smart Board
- Layout changes;
- Dedicated Diesel Generator

# Thank you !

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