

*VIENNA, 7-9 February 1994*

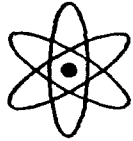
---

## **OVERVIEW OF THE ITALIAN ACTIVITIES IN THE FIELD OF LIFE MANAGEMENT OF NUCLEAR POWER PLANTS.**

Alfredo Pini - ENEA/DISP

257  
Content:

- 1) NUCLEAR ENERGY SCENARIO IN ITALY
- 2) REACTOR PRESSURE VESSEL INTEGRITY
- 3) PIPING INTEGRITY
- 4) CONTAINMENT INTEGRITY
  - 4.1) STEEL CONTAINMENT
  - 4.2) REINFORCED CONCRETE CONTAINMENT
- 5) SEISMIC RISK



**INTERNATIONAL ATOMIC ENERGY AGENCY**  
**WORKING GROUP on LIFE MANAGEMENT of NUCLEAR POWER PLANTS**

**ENEA-DISP**

*VIENNA, 7-9 February 1994*

---

**1) NUCLEAR ENERGY SCENARIO IN ITALY**

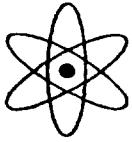
**1A) BEFORE CHERNOBYL ACCIDENT: THREE NUCLEAR POWER PLANTS OPERATING, TWO PLANTS (FOUR UNITS) IN CONSTRUCTION.**

**1B) ON DEC. 17 1987 ITALIAN PARLIAMENT RESOLUTION FOLLOWING A PUBLIC REFERENDUM: 1) NO NUCLEAR POWER PLANTS OPERATING FOR A FIVE YEARS PERIOD (THE SO CALLED FIVE YEARS MORATORIUM); 2) R & D ON NEW REACTORS FOCUSED ON THE POSSIBILITY OF USING PASSIVE SAFETY FEATURES.**

**1C) DESIRABLE FEATURES OF FUTURE REACTORS SET BY A GOVERNMENT COMMITTEE:**

- NO NEED OF PLANNED EVACUATION
- NO LAND CONTAMINATION
- DESIGN AGAINST THE SO CALLED RCAs (REALISTIC CONCEIVABLE ACCIDENTS)
- HIGH PLANT AVAILABILITY FACTOR
- USE OF PASSIVE SAFETY FEATURES
- ENHANCED TRANSPARENCY OF SAFETY (SIMPLICITY, ROBUSTNESS)

252



**INTERNATIONAL ATOMIC ENERGY AGENCY**  
WORKING GROUP on LIFE MANAGEMENT of NUCLEAR POWER PLANTS

**ENEA-ISP**

*VIENNA, 7-9 February 1994*

---

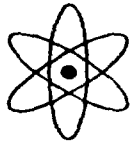
**1) NUCLEAR ENERGY SCENARIO IN ITALY**

**1D) PRESENT GOALS:**

- DOSE AT FENCE (800 m) LESS THAN 1 rem IN 36 HOURS WITHOUT ANY PROTECTIVE MEASURE
- DOSE INTEGRATED THROUGH THE ACCIDENT PERIOD LESS THAN 5 rem WITHOUT ASSUMING POPULATION EVACUATION
- OVERALL DOSE IN THE ENTIRE LIFE LESS THAN 10 rem
- SELECTION OF RCAs AND EVALUATION OF PLANT RESPONSE
- FEASIBILITY OF A NEW LEAK-TIGHT CONTAINMENT SYSTEM FOR SMALL LWRs

**RESEARCHES AND STUDIES IN ITALY WERE SIGNIFICANTLY MODIFIED AND DIRECTED TO MEET THE AFOREMENTIONED GOALS**

326



VIENNA, 7-9 February 1994

---

## 2) REACTOR PRESSURE VESSEL INTEGRITY

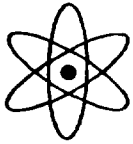
### 2A) PTS EVALUATION. NEW FINITE ELEMENT CODE TO EVALUATE PTS ACCIDENT. THE NEW CODE WILL INCLUDE:

- EFFECT OF CLADDING ON CRACK PROPAGATION
- EFFECT OF RESIDUAL STRESSES
- EFFECT OF STABLE TEARING PRIOR TO CRACK INSTABILITY
- PROBABILISTIC EVALUATION

### 2B) LOWER HEAD INTEGRITY FOLLOWING A SEVERE ACCIDENT

- HIGH TEMPERATURE DATA GENERATION AND COLLECTION. CREEP AND THERMAL EXPANSION COEFFICIENT ON SA533-B. STUDY ABOUT THE EFFECT OF CONSTRAINED THERMAL EXPANSION ON METALLURGICAL TRANSFORMATION OF SA533-B.
- 2D THERMO-MECHANICAL FEM ANALYSES.
- EFFECTIVENESS OF EXTERNAL COOLING BY MEANS OF REACTOR CAVITY FLOODING
- MODEL OF DYNAMIC LOADING TO RPV FOLLOWING STEAM EXPLOSION

254



*VIENNA, 7-9 February 1994*

---

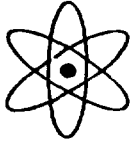
## 2) REACTOR PRESSURE VESSEL INTEGRITY

2C) IRRADIATION DAMAGE. IN THE LATE 80's AN EXPERIMENTAL PROGRAM PRODUCED DATA ON SA508 Cl.3 STEEL. A TOTAL OF 25 TENSION TESTS, 162 CHARPY TESTS, 56  $K_{Ic}$  TESTS, 30  $K_{Ic}$  TESTS AND 17 CRACK-ARREST TESTS WERE PERFORMED. NINE CRACK-ARREST TESTS ON IRRADIATED MATERIAL REMAIN TO BE PERFORMED

## 2D) INTERNATIONAL PROJECTS

- TMI-VIP (THREE MILE ISLAND - VESSEL INVESTIGATION PROJECT) PROMOTED BY OECD/NEA
- NESC (NETWORK FOR EVALUATING STEEL COMPONENTS) PROMOTED BY CEC
- CORVIS (CORIUM REACTOR VESSEL INTERACTION STUDY) PROMOTED BY PSI
- FALSIRE Phase 2 (FRACTURE ANALYSIS of LARGE SCALE INTERNATIONAL REFERENCE EXPERIMENTS) PROMOTED BY OECD/CSNI/FAG

255



**INTERNATIONAL ATOMIC ENERGY AGENCY**  
**WORKING GROUP on LIFE MANAGEMENT of NUCLEAR POWER PLANTS**



*VIENNA, 7-9 February 1994*

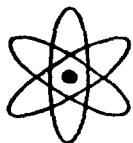
---

**3) PIPING INTEGRITY**

**3A) INTERNATIONAL PROJECTS**

IPIRG (INTERNATIONAL PIPING INTEGRITY RESEARCH GROUP) MANAGED BY USNRC AND FUNDED BY NUCLEAR REGULATORY AUTHORITIES, ELECTRIC POWER UTILITIES AND RESEARCH CENTERS OF DIFFERENT COUNTRIES. THE AIM OF THE PROJECT IS TO DEVELOP AND VALIDATE METHODS FOR PREDICTING THE FRACTURE BEHAVIOUR OF CRACKED NUCLEAR REACTOR PIPING SUBJECTED TO BOTH DYNAMIC AND CYCLIC LOADS.

256



*VIENNA, 7-9 February 1994*

---

**4.1) CONTAINMENT INTEGRITY. STEEL CONTAINMENT**

**4.1A) STEEL CONTAINMENT BEHAVIOUR UNDER STATIC AND DYNAMIC LOADS**

- ULTIMATE STRENGTH ANALYSIS UNDER STATIC LOADS
- DYNAMIC EFFECTS CAUSED BY HYDROGEN EXPLOSION USING A SPECIAL PURPOSE FINITE ELEMENT CODE CALLED "DETO"

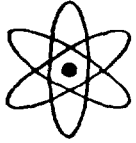
**4.1B) FAILURE CRITERIA UNDER DYNAMIC AND BI-AXIAL LOADS**

- EXPERIMENTAL PROGRAM ON SA537 Cl.1 STEEL TO DETERMINE MATERIAL BEHAVIOUR (STRAIN RATE RANGING FROM 1 TO 500 s<sup>-1</sup>) AND TO OBTAIN STRAIN BASED FAILURE CRITERIA

**4.1C) FUNCTIONAL REQUIREMENTS**

- FEASIBILITY OF PASSIVE COOLING
- FEASIBILITY OF INTERNAL PROTECTIVE SHIELDS
- LEAK TIGHTNESS

257



*VIENNA, 7-9 February 1994*

---

## **4.2) CONTAINMENT INTEGRITY. REINFORCED CONCRETE CONTAINMENT**

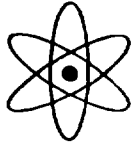
### **4.2A) CONTAINMENT BEHAVIOUR UNDER STATIC LOADS**

- CONCRETE PERFORMANCE IN THE HIGH TEMPERATURE RANGE
- ANALYSIS OF STRUCTURAL RESPONSE DURING SEVERE ACCIDENT FOR HIGH TEMPERATURE AND PRESSURE LOADS.

### **4.2B) CONTAINMENT BEHAVIOUR UNDER IMPACT LOADS**

- THEORETICAL FORMULATION OF A VISCO-PLASTIC MODEL FOR A SPECIAL PURPOSE FINITE ELEMENT CODE CALLED "DYNA"
- STUDY TO DETERMINE THE SIZE OF THE CRACK OPENING FOLLOWING THE APPLICATION OF AN IMPACT LOAD





*VIENNA, 7-9 February 1994*

---

**5) SEISMIC RISK**

**5A) NEW EVALUATION OF SEISMIC GROUND MOTION FOR DIFFERENT ITALIAN SITES TO DETERMINE SEISMIC INPUT FOR STRUCTURE**

- STATISTICAL APPROACH TO THE INTERPRETATION OF ITALIAN STRONG MOTION DATA TO OBTAIN ATTENUATION LAWS OF SEISMIC MOTION

**5B) SEISMIC RISK REDUCTION BY BASE ISOLATION TO STUDY THE POSSIBILITY OF THE PLANT COMPONENTS TO RESIST TO SEVERE EARTHQUAKES AND TO ADAPT A STANDARD PLANT TO VARIOUS SITE CONDITIONS CHANGING THE ISOLATION SYSTEM**

- EXPERIMENTAL PROGRAM ON HDLRB (HIGH DAMPING LAMINATED RUBBER BEARINGS). TESTS ON SINGLE BEARING, ON REDUCED SCALE MODELS AND ON REAL STRUCTURE
- NUMERICAL ANALYSES TO SIMULATE THE BEHAVIOUR OF THE BEARING AND OF THE ISOLATED STRUCTURE
- PROPOSAL OF GUIDE-LINES FOR SEISMICALLY ISOLATED NPPs

209 / 260