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SOUPLETHANE TECHNIQUE

COATING OF NUCLEAR CIVIL WORKS OR EQUIPMENT

1.- technical files :
- . test reports, references
- . King Fahd University of Petroleum & Minerals Research Institute

2.- marketing files :
- . field of applications

I. TECHNICAL FILE

. Decontamination test : C.E.A. (99 %)

. Irradiations test : 1 x 10 power 9 rads – (10 megagrays)

. Protection against neutron rays / gadolinated polyurethane

. Provoked fracturing tests in concrete : L.C.P.C., VERITAS

.External Waterproofing of reactor building against gas back pressure (6 bars up to 15 bars)

.Underwater application of SOUPLETHANE 5N and adhesion test report(on steel)

VERITAS laboratory test done for STMI

. Diffusion of radon gas thru SOUPLETHANE

. P.M.D.S. booklet (applications)

. Resistance to chemical agents, particularly nitric acid and formol…

. Resistance to fire : SOUPLETHANE 5 COR FRB (M1) rated M1 (CSTB test)*

**NON FLAMMABLE*

. Upper heat capacity

. Permeability to water, to water vapour, to oxygen : L.N.E. tests

. Resistance to shocks, wear, punching : ELF test, SHELL test , CSTB tests (floors according to European norms)

. Aging tests : SEPTEN

. A.D.R. test (reference accident) : SEPTEN and CEMETE, CHINA POWER

. Hydrogen permeability test : TECHNIGAZ technique

. Inertia test of SOUPLETHANE to demineralised water

. Diffusion coefficient to ion chlorides – LERM

. Cathodic disbondment test ASTM 8 (for ballast tanks)

DECONTAMINATION TEST

C.E.A. test (joined) : excellent decontamination to fission products:

– 99 % decontamination, and

_ low susceptibility to contamination (3 to 5 %). **CLASS A 1**

SOUPLETHANE has been tested also by COGEMA in la HAGUE to control its decontaminability to Pu (powder). It is very good (the tested sample was in the civil engineer's office, who had made those tests).

SOUPLETHANE has been tested during 6 months to control its resistance to the mechanical pressure of the jet of liquids used for the decontamination of the equipment (300 bars pressure at some centimetres from the coating). Conclusive test.

SOUPLETHANE can be simply decontaminated with demineralised water (without any need of chemical products).

II .COMMERCIAL FILE

Application fields and specifications :

- ***Hot cells*** : alternative solution to stainless steel
References

- Decontaminatable coatings of floors, walls and ceilings
References

- ***Gas barrier coating*** : EDF reactor building (internal to ensure confinement in case of severe accident)
References

- ***Gas barrier coating*** : EDF reactor building (external to ensure confinement in case of severe accident)
References

- Waterproofing of pools storing contaminated or radiant liquids
References

- Internal and external coating of metallic (or concrete) pipes
References

- Waterproofing of the roof of concrete tanks storing irradiating products
References

- Coating of the wooden floor of vehicles carrying contaminated materials
References

- Coating of unloading areas for aggressive or contaminated chemicals
References

- Coating of concrete or metallic tanks storing aggressive chemical products
References

- Coating of retention tanks (secondary containment)
References

- Confinement of cracked concrete or steel drums storing radioactive products
References

- ***Coating of nuclear wastes*** : ion exchange resins and others

- ***Waterproofing of lids of concrete drums storing radioactive products***
References

- ***Insulation of electrical connecting boxes***

References

- ***Coating of concrete sewers for corrosive effluents***

References

- ***Coating of asbestos cement cylinders submerged in demineralised water***

References

- ***Coating of nuclear pools***

References

- ***Biological protection :***
    - gamma radiation
    - neutron radiation
    - radon diffusion

- ***Dismantling of installations*** :
    - contamination fixing to sanitize the contaminated rooms
    - biological protection

- ***Waterproofing of civil engineering*** – founds - roofs

HOT CELLS

Specifications :

- sand or grid blasting of concrete substrate (or acid attack)
- sealing with resin cement of vertical parts or ceiling.
- Concrete primer (200 g/m²), hardening primer.
- SOUPLETHANE 5/6 N : applied by spraying in one continuous coat
- Replacement of stainless steel : 1 cm thickness of SOUPLETHANE (on floors, walls or ceilings).

Technical interest :

- easy to apply, easy connection on stainless steel structures.
- Decontaminates more easily than stainless steel. No sweating after. Possible decontamination with simple cleaning with demineralised water.
- Decontaminatable with a Pu powder contamination.
- Resists to heavy jet cleaning pressures (300 bars).
- Applied on 1 cm thickness, SOUPLETHANE guarantees the waterproofing and the confinement even in case of fracturing of the concrete civil work until more than 1 cm thickness (case of seism, accidental explosion in the workplace, airplane crash…)
- SOUPLETHANE is an integral part with the concrete structure, which is not the case of stainless steel, which is a mechanically fixed up “skin”, non adherent to the structure. The mechanical vibrations are easily absorbed by the SOUPLETHANE resin for example, as they induce a strain on stainless steel (welds).

References :

- hot cells : COGEMA, la HAGUE (T0 Building)
- heavy materials decontamination workshop : SOMANU in Maubeuge.

COATING OF DECONTAMINATABLE FLOORS, WALLS AND CEILINGS

Specification :

- sand or grid blasting of concrete or acid attack.
- sealing concrete blow holes with resin.
- SOUPLETHANE 5N application on a 2 mm coat thickness, in one single layer (this thickness guarantees the good resistance of the coating, even in case of cracking of the concrete).

References :

- Metallic structures in Marcoule (USSI)
- Decontaminated floor in CADARACHE.
- Floor and walls of the reactor area (Belleville, Paluel)
- Chemicals unloading area UF6 in EURODIF.
- Floor of the robots repairing workshop – C.E.A. Saclay
- Floor of the cyclotron (C.I.S. – BIO) – Saclay
- Floor of the C.E.A. workshop in Fontenay – aux - Roses
- Floor : COGEMA - Marcoule

GAS BARRIER COATING inside reactor bulding

Specifications :

- sand or grid blasting or acid attack.
- Filling blow holes with resin.
- SOUPLETHANE 5N : 2 mm thickness.

References :

- Reactor area CPN EDF – floor and walls. Air- and gas tight.Nuclear Thermal power plants of BELLEVILLE, PALUEL.
- National stud farms : biogas tightness.
- Sewers-treatment of wastes : sky of digesters - BAYEUX City. H2S tightness.

GAS BARRIER COATING outside reactor building

Specifications :

- sandblast or gridblast.
- Filling blow holes with resin.
- SOUPLETHANE 5/6N : 7 mm thickness+ fiberglass fabric 500g/m²
  (resists up to 15 bars back pressure of gas)

References :

- Nuclear reactor domes of EDF : first project to start in 2015 during decennal inspection and maintenance of nuclear plant.

WATERPROOFING OF POOLS STORING CONTAMINATED OR RADIANT LIQUIDS

Specifications :

- sand blasting.
- Filling concrete blow holes with resin.
- Concrete primer P201
- SOUPLETHANE 5N : 5 mm thickness.

References :

- Two 1 000 m3 concrete tanks storing nuclear muds highly radioactive and chemically aggressive : COGEMA – La HAGUE .
- Coating of Stainless steel nuclear pools : nuclear plant of KOZLODUY - Bulgaria.
- Concrete tanks KER : E.D.F. – Pierrelatte – Tricastin
- Concrete tanks KER, SEK : E.D.F. - Flamanville

INTERNAL AND EXTERNAL COATING OF PIPES

Specifications :

- sand blasting.
- No steel primer needed : SOUPLETHANE UR5/6 has an adhesion on steel of 20 Mpa
- SOUPLETHANE UR5/6 : 5 mm internal thickness, 2 mm external thickness.
- Joints treatment. Technique avoiding the use of flanges.
- Treatment of joint welds : see enclosed document

Case of leaking pipes :
-In situ lining up to a thickness of 1 cm SOUPLETHANE UR6
(tested and qualified by British Energy)

References :

- Sea disposal pipes - COGEMA plant – La HAGUE .
- Coating of steel flanges on dry circuit salt water. C.P.N. of Paluel.
- Coating of water boxes in BUGEY nuclear power plant
- Internal lining of cooling water pipes – sea water: BRITISH ENERGEY – 1 cm thick
- Internal lining of leaking water pipes : France, UKRAINE from 3 mm to 1 cm thick

WATERPROOFING OF THE ROOF OF CONCRETE TANKS STORING IONISED PRODUCTS

Specifications :

- SOUPLETHANE 5N resin casting on the roof, poured out from pails.
  Thickness : about 5 mm.

Reference :

- COGEMA – La HAGUE : As a concrete tank was giving off a too large radiation, the lid of the tank has been covered with a mass of water to absorb the largest part of the radiation. The waterproofing of the roof has been realised with SOUPLETHANE cast on the roof on the basis of a 5 mm average thickness.

COATING OF THE WOODEN FLOOR OF VEHICLES

Recommendations :

- Application of the wooden floor of trailers carrying nuclear wastes :
  3 mm SOUPLETHANE 5N layer

References :

- Semi-trailer carrying effluents : C.P.N. of Chinon
- Semi-trailer carrying effluents : C.P.N. of Saint-Laurent-des-Eaux
- Semi-trailer carrying effluents : C.P.N. of Tricastin

COATING OF AGGRESSIVE OR CONTAMINATED CHEMICALS UNLOADING AREAS

Specifications :

- grid blasting
- concrete primer P201 (200 g/m²)
- SOUPLETHANE 5 COR N : 5 mm thick, with a non-skid finishing

References :

- EURODIF : U.F. 6 unloading area
- C.P.N. of Nogent – sur - Seine : unloading area with chlorhydric acid.
- DCAN of Toulon : unloading area
- EURODIF – Tricastin : industrial floors

COATING OF CONCRETE OR METAL TANKS STORING AGGRESSIVE CHEMICAL PRODUCTS

Specifications :

- sand blasting.
- SOUPLETHANE UR 5/6 : 5 mm to 1 cm thickness, if necessary.

References :

- EURODIF : internal lining of 2 stainless steel tanks storing all effluents coming from the laboratory. Thickness : 7 mm. In use for 23 years without any damage.
- Thermal power plant Phénix : internal coating of concrete tanks storing corrosive effluents (Ph = 1).
- Neutralization tank of the thermal power plant E.D.F. in le Havre : Ph from 1 to 12. In use for 15 years without any damage.
- COGEMA Marcoule : coating of steel tanks for treatment of surface (thickness 1cm to resist also to shocks).
- COGEMA Marcoule : coating of sewers – waterproofing and anti-corrosion : thickness 3 cm (in place of stainless steel).
- DASSAULT : coating of sewers in a surface treatment workshop

COATING OF RETENTION TANKS

Specifications :

- sand blasting or brushing of concrete.
- Concrete primer
- SOUPLETHANE 5N : 2 mm or 4 mm thickness, depending on the aggressiveness of products.

References :

- Thermal power plant Phénix : external retention tank to store nitric acid (60 %).
- C.E.A. Marcoule : retention for hydrochloric acid
- C.E.A. Saclay : retention for acids and chemicals unloading areas.
- EURODIF : containment tanks
- SOCATRI : containment tanks

CONFINEMENT OF CRACKED CONCRETE DRUMS STORING RADIOACTIVE PRODUCTS

Specifications :

- SOUPLETHANE 6N coating of about 3 mm thickness (in case of repairing of already filled up drums).
- In case of new concrete drums, application of a 2 mm film thickness inside the drum, and waterproofing of the lid in applying a 2 mm thick film. SOUPLETHANE resists to temperature (more than 80 °C) than can emanate during the hardening of concrete (coating of effluents in concrete). This raise of temperature sometimes causes a cracking of concrete, and therefore waterproofing defaults. A 2 mm thickness of SOUPLETHANE resin is equal to a concrete thickness of 4 to 6 m in what concerns the diffusion of liquids (water permeability). The SOUPLETHANE film resists also chemically to products being stored (put in liquid solution because of the water excess in concrete).

References :

- C.P.N. of Fessenheim : ANDRA and Mr. BEUNARDEAU from E.D.F., 6 Ampère street, SAINT-DENIS 93. Treatment of a dozen cracked concrete containers.
- CADARACHE : coating of concrete drums
- DRUMS STORING WASTES : project in GERMANY

WATERPROOFING OF LIDS OF CONCRETE DRUMS STORING RADIOACTIVE PRODUCTS

Specifications :

- Application of a 2 mm SOUPLETHANE 5N film on the lid. It will ensure the waterproofing of the lid poured on the concrete container, bridging the crack coming from the shrinkage of the concrete during the curing.
- Other technique : SOUPLETHANE pouring in the drum, in order to fill the space between the solid wastes and concrete lid.

References :

- S.G.N. : Test of filling up with resin asbestos cement drums (neither shrinking of the poured resin, nor bubbling …).

INSULATION OF ELECTRICAL CONNECTION BOXES

Specifications :

- In case of accident (saturated water vapour in the building), the electrical connections are not waterproofed, which represents a severe risk for safety. With SEPTEN, SOUPLETHANE has been qualified to insulate the electrical connections in the boxes and the connectors by pouring SOUPLETHANE inside the connecting boxes.

References :

- Most of the E.D.F. thermal power plants in France. Also the thermal power plant of KOEBERG in South Africa.
- Joucomatic for the connectors.

COATING OF ASBESTOS CEMENT CYLINDERS STORING EFFLUENTS

Specifications :

- Apply a 2 mm SOUPLETHANE 5N film thickness on the cylinders. These cylinders are then immerged in pools filled with demineralised water, in order to reduce their activity. The cement could contaminate the demineralised water. SOUPLETHANE has been applied to make the cylinder inert, without risk of altering the quality of water.

References :

- COGEMA THE HAGUE

COATING OF WATER BOXES OF HEAT EXCHANGERS

Specifications :

- Grid blasting
- Spraying of SOUPLETHANE UR6 at a thickness of 3 mm(no primer)

Reference:

- Nuclear Power Plant EDF - BUGEY

COATING OF NUCLEAR POOLS

For New projects :

Directly apply SOUPLETHANE 5/6N on concrete – Thickness 1 cm
Coating resists in immersion to hydrolysis up to 90°C

References: TOSHIBA is specifying this technique on new nuclear projects
(traditional stainless steel pools always leak!)

For repair and revamping:

Specification :

- sand blasting of stainless steel.
- SOUPLETHANE 6N : about 1 cm thickness.

References :

- Nuclear plant of KOZLODUY.
- Tests realized by STMI : application by pouring SOUPLETHANE in the bottom of a stainless steel tank, in which a 2 mm crack was made. The poured resin has polymerised in immersion and filled in the leak at the crack level.
- Other tests realized by VERITAS at STMI request have proved that SOUPLETHANE can be used to repair pools in immersion (SOUPLETHANE application under water. Bonding measured by VERITAS : over 8 Mpa).

DISMANTLING OF INSTALLATIONS

Specifications :

- SOUPLETHANE 6N resin spraying on the contaminated substrates (floors, walls, ceilings, equipments), which will fix contaminations and will make the substrates safe. Thickness : 4 mm

References :

- Dismantling : COGEMA in la HAGUE – sewers, rooms. Works realized by Radiacontrôle.
- STMI : C.E.A. in Fontenay-aux-Roses.
- IRSN : Cadarache – tanks - SURA - CABRI

WATERPROOFING OF CIVIL ENGINEERING

Specifications :

- External Waterproofing of the concrete work under construction, on a concrete slab before pouring the concrete structure. (waterproofing of founds). This solution enables to realize a complementary safety waterproofing barrier in case of problem of confinement, and also to avoid the water infiltrations coming from external sources outside the building.

  Possibility to make waterproofing totally adherent to the concrete substrate, and to the concrete structure.

  Waterproofing resists also to chemical agents, products coming from the workshops can be chemically aggressive (nitric acid, boric acid solutions …).
  Recommended thickness : 3 mm. This thickness is equal to a 6 to 8 m thickness of concrete (water permeability).

BIOLOGICAL PROTECTION OF NUCLEAR ROOMS

TECHNICAL PROBLEM :

- Some nuclear rooms are heavily contaminated and irradiating, and the human interventions for maintenance works or dismantling require beforehand to coat the rooms with a biological protection against gamma rays.

EXISTING TECHNIQUES :

- Operators generally intervene in those rooms by putting lead sheets or bricks in heavily radiant places. This type of intervention is delicate, uneasy to realize, and risky :
- Operators must be protected themselves with lead protections, which complicates manipulations.
- Their intervention time is limited.
- The technique does not always resolve efficiently the problems of protection (case of ducts, sewers…).

SOUPLETHANE TECHNIQUE :

- If rooms are heavily radiant, and have also conducts or pipes , equipment, …., we recommend the following process :
- Distant manipulation by robot and electrostatic spraying of SOUPLETHANE resin with a spinning wheel : this kind of application guarantees a close, perfect film around cables, conducts,…, and can be done on floor, walls and ceiling.
- Distant manipulation by robot as well as resin and lead powder electrostatic spraying with a spraying gun at the same time.
- The application goes on, alternating the layers : resin – lead – resin – lead,… until the required thickness to obtain the sought after reducing of the radiation intensity.
- The thickness can be several cm. The application is made in one continuous layer, and there is no human exposition during this operation, the equipment and the operator being distant, in a healthy room.
- The resin spraying can be done also by HIGH PRESSURE pump spraying in case of necessity to coat floors, walls, ceilings only . For equipment, electrostatic spraying is more convenient.

COATING OF CONCRETE CONTAINERS

TECHNICAL PROBLEM :

- The concrete containers storing nuclear waste are buried and a waterproofing of these containers must be ensured with an appropriate waterproofing coating.

- The required performances are following :
  .Strong bonding to concrete
  .No permeability to liquids and gas (lixiviats, water vapour, given off gas inside the container, …)
  .Guarantee of waterproofing even in case of cracks in concrete
  .Counter pressure resistance in case of liquids pushing from inside the container
  .Resistance and preservation of the required properties under radiation effect
  .Resistance to chemical agents in the container (boric acid,…)
  .Resistance to temperature in case of exothermic reaction in the container (until 80° C)
  .Mechanical resistance to shocks during the container burying and the filling in
  .Resistance to punching
  .Good preservation of the properties during aging (50 years)
  .Resistance to deterioration under effect of ground micro-organisms
  .Preservation against diffusion of RADON gas.

EXISTING TECHNIQUES :

- *System of strengthened, hard resins :*
- Strengthened epoxy, strengthened polyester, metacrilates,… .
- Delicate systems of application, risks of porosity of the film, risk of cracks in case of cracking of the concrete substrate. Fragile in case of violent impact (aggregates shocks during the burying). The coating comes apart off the substrate in case of counter pressure, which makes it fragile, and leaks can occur through the smallest porosity of the coating.
- *Waterproofing with flexible resin :*
- Risks of fragility when shocks, bad resistance to counter pressure, not resistant to chemical agents
- In case of a quick polymerizing twin-component resin, the porosity of the waterproofing film is caused by the degassing of the concrete pores, and by the air included in the film during the spraying of resin. The obtained film is not waterproofed and is permeable to gas and lixiviats. In case of violent shocks, it may degrade under effect of the shock.

SOUPLETHANE TECHNIQUE FOR PROTECTION OF CONCRETE CONTAINERS

- Grid blasting of concrete, dust cleaning
- Sealing with resin to get a continuous substrate without any bubbling of concrete.
- Application of a concrete primer, hardening primer, sealing porosities of concrete.
- Treatment of angles with glass fabric to guarantee a continuous waterproofing without any risk of porosity.
- Supplying and application of SOUPLETHANE in a 2 mm thick layer
- SOUPLETHANE can also be reinforced with a glass fabric (500g/m^2) Overall thickness : 3mm

INTEREST OF THE SOUPLETHANE TECHNIQUE :

- SOUPLETHANE bridges cracks in concrete over 4 mm width for a 2 mm thick film.
- SOUPLETHANE resists to a counter pressure without breaking up of waterproofing for a 10 bars counter pressure (C.E.B.T.P. test)
- SOUPLETHANE is chemically very resistant (used as an internal coating of tanks storing chemical products).
- SOUPLETHANE is gas – and – watertight. The first coat of SOUPLETHANE applied on concrete is a slow curing formula, so avoiding porosities of the film caused by the concrete degassing. SOUPLETHANE is a barrier to diffusion of RADON gas.
- SOUPLETHANE resists to radiations. It has been tested under integrated doses of 1 x 10 power 9 rads (COGEMA, USSI, SEPTEN tests).
- Aging : SOUPLETHANE has been applied 30 years ago on sea pipes carrying effluents of the COGEMA plant in la Hague, and it is today still not changed. Some applications

have been made for 32 years in a water tower, without any problem of resistance or breaking up of waterproofing (chimney in ROPHEMEL, Compagnie Générale des Eaux).

- Resistance to impacts : SOUPLETHANE absorbs the energy of impacts by elastic deformation of the protective coat. Tests realized in SHELL laboratory in Rouen have proved that SOUPLETHANE, as a waterproofing coating, has not been damaged by an impact caused by the fall on the corner of a 15 kg concrete cube from 1,5 m height (that is to say : a 230 joules energy).

References: CEA Saclay - EDF Fessenheim - CEA Cadarache

COATING OF CASKS

Casks are in stainless steel, and strongly irradiating.
Moreover temperature of casks can be very high (150°C).
SOUPLETHANE 5/6N can be directly applied on a hot substrate up to 160°C (VICAT POINT of SOUPLETHANE is 200°C)

Application is done by a robot handling spraying gun from a HP two component pump placed at a large distance from the drums (possibly in another room)
Coat thickness : 5 mm minimum (direct spraying, no surface preparation)

References : Projects are presently studied with AREVA NC (temperature resistance tests have been done)

IRRADIATIONS TESTS

Tests realized by :

I. COGEMA in 1979. Report n° 1 07 79 of Mr. A. BERNARD (10 power 9 rads)

Several conclusions result from these tests :

1. "The polyurethane system applied on metal or concrete is classed in the category of systems, whose resistance to gamma irradiations is very good."
2. Among the two tested systems, "we will prefer the polyurethane system, due to the hardest surface, which is an important factor, because it avoids scratches that are preferential points of fixing of the radio-elements." (Cf. tests of Mr. LELAIDIER).
3. Resistance to chemical agents with irradiation :

Conclusion :

"No chemical attack does appear on the samples, despite the important doses integrated into the products. At this level, the test confirms the different chemical results obtained without any irradiation.
The irradiation measure shows a more important radiolysis on the epoxy resin than in what concerns the polyurethane resin, but slight, compared to those obtained in the same conditions with other coating products.
Both products fit the application in the new tanks, the choice of polyurethane resin is confirmed for its higher reliability facing the radiolysis of the coating."

The chief of Works section

R. SAUVE.

The detailed report is available and can be consulted on demand.

II. TESTS REALIZED BY USSI (project for MARCOULE) - 10 power 9 rads : (10 megagrays)

Conclusive tests, and following them works have been realized (coating of metallic crane structures in an ionised environment…)

III. TESTS REALIZED BY SEPTEN (in the laboratory of the Renardières) :

Tested until 10 power 7 rads

Following those tests, insulation applications of electrical connections boxes have been realized on different E.D.F. plants in France and South Africa.

IV. IRRADIATION TEST REALIZED BY ORIS LABORATORY :

- integrated doses 10 power 7 rads

No noted alteration of samples irradiated compared to the reference sample.

V. IRRADIATION TESTS DONE BY CHINA POWER LABORATORY

VI. IRRADIATION TESTS DONE BY DCNS (for submarines)

TESTS OF RESISTANCE TO CRACKS IN CONCRETE

L.C.P.C. test joined. An 2 mm SOUPLETHANE resin film stands without any damage 3 to 4 mm width provoked cracks in concrete.

VERITAS : a coat hickness of 2 mm of SOUPLETHANE 5N can bridge concrete cracks of 5 mm

1 cm thickness of the film could stand cracks of more than 1 cm width without any damage.

RESISTANCE TO SHOCKS

TESTS REALIZED BY ELF :
- joined report : impact shocks of a metallic ball falling on the 2,5 mm thick coating.
Impact energy : 250 joules. No damage.

TESTS REALIZED BY SHELL (laboratory of Grand Couronne) :
- impact of a 15 kg concrete block on the edge from a 1,5 m height.
Energy : 230 joules. Conclusive test.

TEST REALIZED BY CSTB :
an impact of a weight of 1 kg falling on the coating from a height of 2 meters does not affect at all the coating (coat thickness : 1,5 mm)

TEST REALIZED BY HITACHI : Japan
Very strong impact test (a steel beam of 400 kg from a height of 10 meters) on SOUPLETHANE 5 COR – 5 cm thickness – Energy : 40 000 kilo joules

TEST OF THERMAL AGING

This test has been realized by SEPTEN in the laboratory of the Renardières, simulating a life time of 40 years (the reference accident included : water vapour + irradiation doses). Conclusive test.

TEST OF REFERENCE ACCIDENT(LOCA TEST)

Test realized in the CEMETE Laboratory of E.D.F. in 1982. Test simulating a reference accident : thermal shock at 160°C of vapour overheated at 5 bars. Samples tested on metal and mortar. No blistering, no peeling off, no cracking.
Test done by DCNS for nuclear submarines : temperature 240°C
LOCA test done by China Power .

HYDROGEN PERMEABILITY

Application of a cloth in resin. Tests realized by TECHNIGAZ for the gas tightness. The cloth forms a sandwich including an aluminium sheet , on which are glued two glass clothes (TRIPLEX glass cloth, manufactured by BROCHIER Company).

STABILITY TEST IN THE PRESENCE OF DEMINERALISED WATER

Cf. IANESCO Laboratory test joined.

- No material migration in water