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Worldwide Report

NUCLEAR DEVELOPMENT AND PROLIFERATION

(FOUO 7/82)

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WORLDWIDE REPORT

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CZECHOSLOVAKIA

CHEMICAL EFFECTS IN FAST BREEDER REACTORS VIEWED

Prague JADERNA ENERGIE in Czech No 3, 1982 pp 88-90

[Article by Boleslav Eremias and Miroslav Fresl, the G. V. Akimov State Research Institute for the Protection of Materials, Prague: "Influence of the Chemical Composition of Materials on Their Corrosion Resistance and Mass Transport Behavior in Sodium Circuits of Fast Reactors"]

[Text] The article summarizes and evaluates the investigations to date into the corrosion resistance and mass transport behavior in liquid sodium of an extensive series of materials in a wide range of chemical compositions.

1. Chemical Composition of Materials and Their Corrosion

The quantity of information available on corrosion and mass transport in liquid sodium, which could be of immediate use in designing fast reactors, is limited. However, many organizations have investigated the factors that influence the behavior of materials in a sodium environment.

Generally speaking, so far as hot spots (temperatures higher than 500°C) in sodium circuits are concerned, the corrosion behavior of the investigated materials--austenitic steels and alloys, and also chromium-molybdenum steels--in circulating sodium tends to follow the trend of the so-called incubation period. Which means that in the initial stages of exposure to sodium there develop on the surface of the materials films of reaction products with sodium, respectively with the impurities contained in it; with continuing exposure these films tend to disappear, and the material goes over into the region of mass defects that are functions of time [1].

Studies undertaken in a number of laboratories [2, 3] established that the time necessary for the removal of the oxide film of reaction products with sodium significantly depends on the mechanical stability of this film in flowing sodium, and the conclusions state that different rates of corrosion were observed in the process of the film's removal. Other works in this field also pointed out that different types of surface finish could produce films with different degrees of mechanical stability in sodium [4]. Under isothermal conditions and at a stationary concentration of oxygen, the formation of oxide film of reaction products with sodium is limited to the surface of the materials, but it also has been demonstrated [5] that, under certain conditions, this film may form in the regions of grain boundaries as

well. So far it has not been determined whether such formations can weaken the grain boundaries and become the precursors of intercrystalline corrosion attack. If under the conditions of operation this type of intercrystalline attack appears significant in the case of alloys of the Incoloy 800 type and chormium-molybdenum steels of the 9Cr1Mo type, then the state of the material's surface and the distribution of oxidizable elements (Cr, Mo, Al and Ti) in the matrix of the alloy will be critical factors in determining the nature and extent of the attack. Therefore a comparison of the corrosion behavior of the mentioned two alloys with other potential materials for steam generators in installations with fast reactors--such as materials of the AISI 304 or 316 type, or ferritic steels of the 21/4Cr1Mo, 21/4Cr1MoNb or 21/4Cr1MoNiNb type--showed [6] that the effect of chemical composition on the resistance to corrosion and mass transfer in liquid sodium depends significantly on the parameters of the sodium circuits (the temperature and flow velocity of the sodium, and its oxygen content).

In tests at high temperatures (for example, at 650°C) and high sodium flow velocities (greater that 3.7 m/sec), with different contents of oxygen, Incoloy 800 and 9Cr1Mo are insignificantly less sensitive to changes of the oxygen level of the sodium than is AISI 304 or 316, and significantly less sensitive than 21/4Cr1Mo, 21/4Cr1MoNb or 21/4Cr1MoNiNb. At low oxygen levels (less than 30 ppm) the corrosion rates rank as follows: I-800 > 304 > 316 > 9Cr1Mo > 21/4Cr1Mo > 21/4Cr1MoNb > > 21/4Cr1MoNiNb; at higher oxygen levels (over 30 ppm) the rates of corrosion rank as follows: 21/4Cr1MoNb (21/4Cr1MoNiNb) > 9Cr1Mo > 316 > 304 > I-800. In tests at low temperatures (for example, at 550°C) and very low sodium flow velocities (convective sodium loops) and different oxygen levels, the difference between the corrosion rates of austenitic and low-alloy ferritic steels is especially significant; and when both types of materials are tested together and the oxygen content is not high, the corrosion rate is influenced more by the flow velocity and period of exposure than by the oxygen content of the sodium [7]. Although many organizations have made preliminary studies of the corrosion behavior of materials for the sodium circuits of fast reactors, none of these studies is sufficiently detailed to provide an overall picture of the corrosion behavior of all the considered types of materials, especially when two or more types are tested together. The information available from published data on corrosion tests in sodium loops, which characterizes the data mentioned above, is summarized in Tables 1 and 2.

Table 1. Effect of Chemical Composition on the Corrosion Resistance of Materials for the Sodium Circuits of Fast Reactors, at High Temperatures and Sodium Flow Velocities

Material	(1) teplota sodiku [°C]	(2) rychlost sodiku [m/s]	(3) obsah kyslíku [ppm]	(4) korozní rychlost [μm/rok]
21/4Cr1MoNb	650	9	5	2,54
9Cr1Mo	650	9	5	3,64
AISI 316	650	9	5	6,41
I-800	650	9	5	8,89
I-800	650	9	50	178
AISI 316	650	9	50	203
9Cr1Mo	650	9	50	229
21/4Cr1MoNb	650	9	50	254

Comment: The above data were obtained at the Risley Engineering Materials Laboratory (United Kingdom) for periods of exposure from 100 to 1000 hours, at a high degree of the sodium's saturation with corrosion products.

Key to Table 1:
1. Sodium temperature, °C
2. Sodium flow velocity, m/sec
3. Oxygen content, ppm
4. Corrosion rate, μ/year

Table 2. Effect of Chemical Composition on the Corrosion Resistance of Materials for the Sodium Circuits of Fast Reactors, at Low Temperatures and Sodium Flow Velocities

Materiál	(1) teplota sodíku [°C]	(2) rychlost sodíku [m/s]	(3) obsah kyslíku [ppm]	(4) doba expozice [h]	(5) korozní rychlost [μm/rok]
21/4Cr1Mo (21/4Cr1MoNiNb)	550	0.1	13	6 666	4.78
	550	0.2	4.5	6 666	6.83
	550	0.1	13	10 000	3,19
	550	0.2	4,5	10 000	4,53
19Cr11Ni	550	0.1	13	6 666	0,47
	550	0,2	4.5	6 666	0.67
	550	0,1	13	10 000	0.14
	550	0.2	4.5	10 000	0.21

Comment: The above data were obtained at SVUOM [State Research Institute for the Protection of Materials], Czechoslovakia, on samples placed at the inlet of the convective loop's hot branch. The degree of the sodium's saturation with corrosion products was low.

Key to Table 2:
1. Sodium temperature, °C
2. Sodium flow velocity, m/sec
3. Oxygen content, ppm
4. Period of exposure, hours
5. Corrosion rate, μ/year

2. Chemical Composition of the Materials and Mass Transport

Even though the cross section's attenuation by corrosion can be reduced for all the mentioned materials by lowering the sodium's oxygen level, as well as by reducing the sodium coolant's flow velocity and temperature [8], there are two other factors --the extraction of substition elements, and the transport of interstitials--that must be considered before any of the mentioned materials is approved for use in a sodium environment.

Considerable attention in this direction has been devoted particularly to the study of carbon transport in mixed ferritic-austenitic systems that are used for reasons of economy, and also for the sake of thermal efficiency, in practically all prototype steam generators for fast reactors, i.e., BN 350, BN 600, Marcoule, Phoenix and PFR. Since carbon in ferritic steels is unable to form stable carbides with the elements of substitutional alloys, these alloys will have a high carbon activity and

will act as the sources of carbon transport to austenitic steels. For this reason many of the investigations used bimetallic dynamic loops to evaluate the magnitude of carbon transport and its effect on mechanical properties, and to determine whether its harmful effect can somehow be moderated.

A series of investigations at very low sodium flow velocities showed that carbon transport can take place between chromium-molybdenum steels and austenitic alloys, but none of these studies attempted to identify the reaction components participating in this transport or to determine the rate of the controlling process [9]. Since technical difficulties, at the present state of liquid metal technology, rule out the feasibility of doping the sodium for the purpose of modifying carbon transport, considerable effort has been devoted to modifying carbon activity in ferritic steels, to a value similar to the ones calculated for austenitic alloys. In this manner it is possible to design systems with different alloys in such a way that their carbon activity is constant and similar to the activity of carbon in sodium. Then the only carbon transport that takes place is transport between the high- and low-temperature branches of the circuit.

In tests at a temperature of 550°C, very low sodium flow velocities (convective loops) and different contents of oxygen, this fact was vividly demonstrated by observing the mass transport between materials 21/4Cr1Mo, 21/4Cr1/MoNiNb and 19Cr11Ni [7]. The results likewise confirmed that carbon transport was a function of the carbon's stationary activity which, after 10,000 hours of exposure to sodium under the conditions outlined above, was the same for low-alloy steels as for austenitic steels, as well as for the sodium. The difference found between the values of this variable in two separate 10,000-hour experiments led to the conclusion that its value, and hence also the observed carbon transport, is a function of the carbon's initial activity in materials 21/4Cr1Mo and 19Cr11Ni. The negligible carbon transport observed in steel 21/4Cr1MoNiNb showed a moderate rise with an increasing stabilization ratio, confirming the expectation that the long-term effects of carburizing, caused in this material by the action of the sodium, will be similar to the effects published for austenitic steel, but much smaller.

With special attention to the phenomenon of the transport of interstitial elements in a liquid-sodium/stainless-steel system, two methods were available for measuring the surface equilibrium. The first method involves the solution of several thermodynamic equations that express the relationship between carbon activity in the sodium (A_C^{Na}), carbon activity in the steel (A_γ^C), and the carbon concentration at the sodium/steel interface (C). These computations require data on the solubility of carbon in sodium, and knowledge of the temperature correlations of activity and concentration. Researchers in the United States developed a model for austenitic reactor alloy based on this approach. Computer techniques introduced considerable refinements, with special attention to changes in carbon activity produced by mechanical processing and heat treatment.

The obtained results showed good correlation between predictions and experimental measures under the conditions of carburization [10]. However, the main inconvenience of this approach is the need to extrapolate the activity (concentration) data to the low values that were found in many of the tested systems and are predicted at least for the primary circuits of fast reactors.

In distinction from the first method, the second method for measuring surface equilibrium is more direct and avoids the need to solve numerous activity equations. For it was assumed from the very beginning that many of the complex interactions between the sodium, steel and carbon cannot even be defined mathematically. Therefore a standard reference technique was used that measured the equilibrium concentration of a standard material at a fixed temperature. The concentration changes in other alloys within a certain temperature range were then related to the standard data on carbon activity or the system's carbon potential. The results obtained in this case showed good correlation between the predictions and experimental measurements under the conditions of decarburization [11]. A direct quantitative comparison likewise was made, with special attention to the established behavior of nitrogen transport. Within a wide range of the investigated variables, the data on nitrogen transport confirmed that nitrogen followed the same trends as carbon [12]. Furthermore it was demonstrated that the nitrogen content in steels significantly influences the initial carbon activity, and hence also the observed carbon transport from austenitic materials to sodium at 700°C [13]. The presence of Ti as a stabilizing element in austenitic alloys of the Incoloy 800 type likewise has a significant effect on carbon activity in austenitic materials, but also here the transport of carbon and nitrogen can be influenced not only by the temperature, but by the presence of other types of materials in the sodium circuit as well. In this respect the question of carbon transport by the sodium in the austenitic-steel--I-800--9Cr1Mo system remains unclarified [14]. The transition temperature for carburization/decarburization of austenitic steels, the transition temperature for nitriding/denitriding alloys of the I-800 type, and the feasibility of influencing the transition temperatures through the chemical compositions of the materials [15] likewise remain debatable.

In conclusion it should be noted that if the mentioned materials are used for the secondary sodium circuits of fast reactors, the surface or structural changes that can be influenced on the one hand by the chemical composition of the material or the loss of C and N in the hotter sections of the circuit, or on the other hand by carburizing, nitriding as well as oxidation or by the deposition of corrosion products in the cooler sections, may be decisive with respect to any changes in mechanical properties that can arise under the conditions of operation.

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CZECHOSLOVAKIA

DEPOSITS CONTROL IN V-1 PLANT DURING FIRST SHUTDOWN

Prague JADERNA ENERGIE in Slovak No 3, 1982 pp 98-101

[Article by Rudolf Burcl, Jozef Homola, Vladimimr Hroncek and Anna Varadinova, Research Institute of Nuclear Power Plants, Jaslovske Bohunice; and Stefan Cepcek, Nuclear Power Plant, Jaslovske Bohunice: "Investigation of Deposits on the Primary Circuit's Internal Surfaces in the V-1 Nuclear Power Plant During Its First Shutdown for Refueling"]

[Text] The article describes the use of closed-circuit television--the Telekar and Telekop systems--for monitoring deposits on the internal surfaces of the V-1 Nuclear Power Plant's primary circuit. It was found that the overall quantity of deposits was small, and that the state of the surface of the structural materials was very good, which indicates that the primary circuit's chemical regime was properly selected from the viewpoint of the formation and migration of corrosion products.

1. Introduction

A part of the study of the effect that the coolant has on the state of the structural materials in the primary circuits of nuclear power plants is also the investigation of deposits that are formed predominantly by corrosion products. In the processes of the release and deposition of corrosion products there can occur--and as evident from the data published in the literature, there does occur--preferential deposition of corrosion products at certain points in the primary circuit, particularly on surfaces where heat transfer is high, i.e., on the surface of the fuel and in the steam generators. Deterioration of heat transfer can cause complications in the operation of the reactor, and in the extreme case even a nuclear accident.

Preferential formation of deposits (these contain, in addition to active corrosion products, also other adsorbed radionuclides) on the internal surfaces of the steam generator (i.e., the transfer of radioactivity from the active zone) simultaneously worsens the radiation situation, complicating maintenance and repairs.

Even though selection and observation of a suitable chemical regime make it possible to favorably influence the formation and migration of corrosion products, and thus to forestall possible complications, long-term experience with the operation of nuclear power plants shows that it is essential to devote systematic attention not only

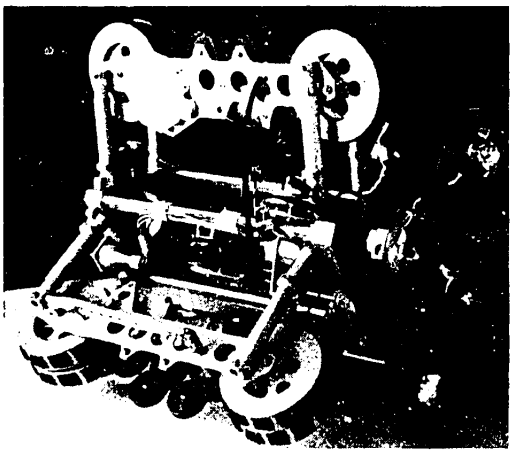

Fig. 1. Telekar's carriage with TV camera (normally mounted on carriage axis) removed.

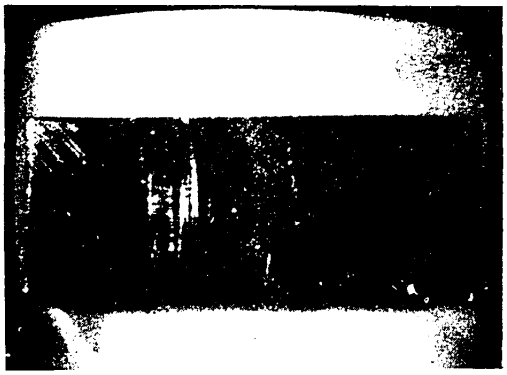

Fig. 2. Sample of a very thin layer of magentite, recorded by Telekar.

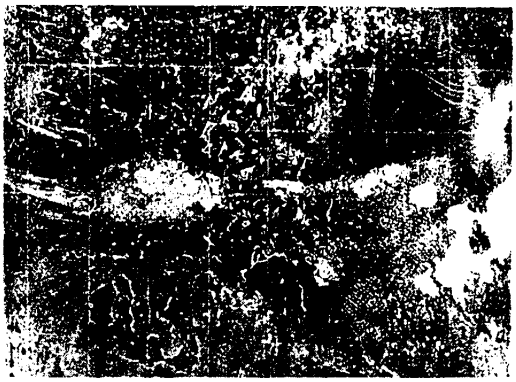

Fig. 3. Sample with a layer of magnetite and intentionally left finger prints. Photograph (raster 10 x 10 millimeters).

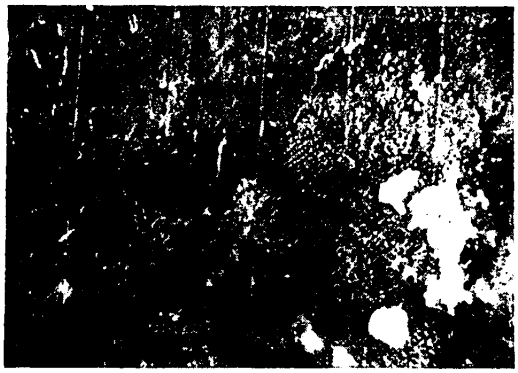

Fig. 4. Close-up of sample in Fig. 3, recorded by Telekar.

to controlling the content of corrosion products in the water of the primary circuit, but also to direct monitoring of the corrosion products deposited on the internal surfaces of the circuit.

The use of closed-circuit television is one of the most convenient methods of monitoring the primary circuit's internal surfaces. In recent years VUJE [Research Institute of Nuclear Power Plants] developed and built the Telekop and Telekar systems

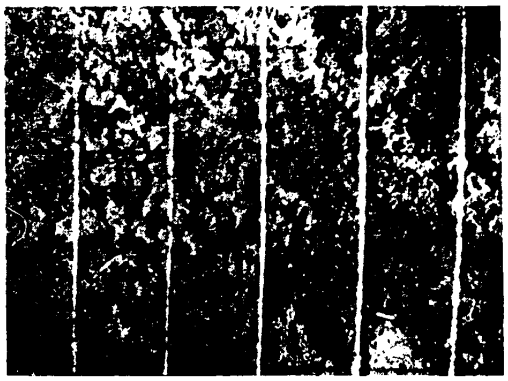

Fig. 5. Sample of a layer of magnetite changing into hematite, recorded by Telekar.

Fig. 6. Clean surface of tubing, practically without deposits. Clearly evident grinding marks.

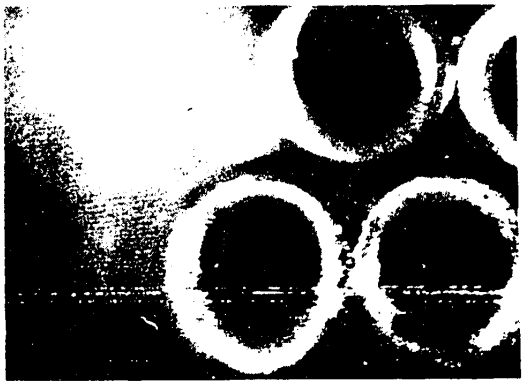

Fig. 7. Header with part of tube plate. Thin layer of magnetite.

Fig. 8. Perpendicular tubing under header. Tracks made by Telekar's wheels. Surface formed during production clearly evident.

that are intended primarily for visual inspection and control of the mechanical state of the primary circuit's internal parts in nuclear power plants of VVER [water-cooled water-moderated power reactor]-440 type [1].

The purpose of our study described below was to experimentally verify the feasibility of using the mentioned systems also for monitoring deposits directly in the primary circuit of one of the reactors at the V-1 Nuclear Power Plant. The information gained can be used to assess quantity, type and distribution of the deposits,

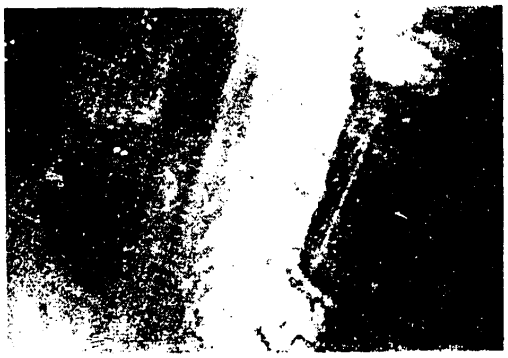

Fig. 9. White deposits on bottom of tubing. Tracks made by Telekar's wheels and the structure of the surface clearly evident.

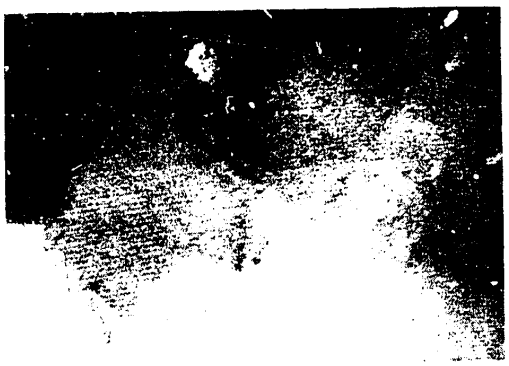

Fig. 10. Deposits on bottom of tubing that was covered by a shallow layer of water. The bottom dark layer along Telekar's tracks, elsewhere the light top layer are evident.

to evaluate their possible effect on the state and operating ability of the installation, and to verify the soundness of the employed chemical regime. Likewise not negligible is the use of the mentioned systems in planning decontamination procedures in the case of extensive modifications and repairs.

2. Experimental Part

2.1. Description of Telekar and Telekop

Telecar is a carriage equipped with a television camera, intended for use in the drained circuit (Fig. 1). It is able to propel itself in the Js 500 line, including elbows, and serves for the inspection of the main circulating line, from the steam generator's header or the reactor, as far as the main circulating pump, respectively the block valve. Telekop is a similar system intended for inspection of the header and tube plates of steam generators.

Both systems, described in detail in [1], are equipped with a TC 125 SN television camera made by Hydroproducts Company (United States). A system of mirrors and built-in lighting make it possible to record shots of the line's entire circumference. Remote control is by cables. The position is recorded and displayed on the control panel.

In the given arrangement the camera records an area of about 25 cm^2. Direct monitoring of the image is possible on the screen. The system has a television recorder, for recording the signals on tape.

2.2. Verification of the Feasibility of Using Telekar to Monitor Deposits

In view of the fact that Telekar and Telekop were developed originally for fault inspection and for monitoring the mechanical state of the primary circuit's equipment,

it was necessary to verify experimentally their suitability for monitoring deposits. Because the limiting part of the systems for the given purpose is their camera, which is identical for both systems, the experiments were conducted only with Telekar. The purpose of the experiments was to check the resolution, the ability to identify the type and determine the quantity of the deposits.

Corrosion products in the primary circuit of pressurized-water reactors consist mostly of magnetite, occasionally with an admixture of hematite. Therefore planar samples with magnetite and hematite layers, differing in their thickness and structure, were prepared artificially. Defects (for example, fingerprints) were planted in them in some instances. The artificially prepared samples were then recorded by Telekar, processed, and the obtained shots were compared with the actual appearance of the samples [2].

For illustration we present some of the obtained shots. Fig. 2 is a sample covered with a very thin layer of magnetite, dull black in color, recorded by Telekar. Figure 3. is a photograph of a sample covered with a thin layer of magnetite, on which fingerprints were left intentionally before recording. Fig. 4 is a detail of this sample, recorded by Telekar from a distance of 25 cm, which corresponds to the actual situation inside the primary circuit. Fig. 5 is a sample with a layer of magnetite gradually changing into hematite, recorded by Telekar.

The results of the experiments confirmed that the television equipment of the systems satisfies the requirements for investigating deposits on the primary circuit's internal surfaces. The prepared set of samples can be used as standards for comparison.

2.3. Use of Telekar and Telekop to Monitor Deposits in the V-1 Primary Circuit

The results obtained with the standard samples became the basis for operational verification of the feasibility of monitoring deposits during the shutdown of the V-1 Nuclear Power Plant's No 1 unit, in June 1980. In the course of this the low-temperature branch of one of the steam generators was inspected, from (and including) the header almost to the circulation pump. The header was inspected by means of Telekop, the rest by Telekar. Since a detailed description of the obtained date would require too much space [3, 4], in the following we present only photographs of selected details that are characteristic of the general situation.

Basically four types of surfaces were encountered in the inspected section. The first type, documented in Fig. 6, is very clean, without deposits and practically also without a layer of corrosion products, as evidenced by the clearly visible grinding marks around the well of the temperature sensor, and by the marks left after finishing the surface during production. In this state are the sides and top of the line along its entire inspected length, with the exception of the perpendicular part under the header.

The perpendicular part under the header and the surface of the header belong to the second type. The surface is coated with a thin layer of dark corrosion products that look like velvet and correspond to magnetite (compared with the aforementioned standard samples and also observed directly by means of Telekar). Fig. 7 shows also some of the tubes in addition to the header surface. In Fig. 8 the tracks of

Telekar's rubber tires also are evident (the dark spots are smeared drops of water), together with the surface structure formed during the production of the tubing.

The bottom of the perpendicular part of the tubing represents the two remaining types of surface, with deposits. A part of the bottom is covered by a thicker layer of white, seemingly crystalline sediment, probably the ramins of boric acid (see Fig. 9). This layer, as can be concluded from the tracks of Telekar in Fig. 9, is brittle and nonadhering. Under it is a surface covered by a thin layer of sediment, respectively of corrosion products of a dark color; it does not coat the structure of the surface formed during the production of the tubing.

The last type of surface (Fig. 10) can be found in some sections of the horizontal part of the tubing covered with water. Here the aforementioned white sediments of boric acid have not crystallized as yet. But it can be observed that the sediment contains two layers: a darker bottom layer, and a lighter top layer. As can be concluded from the tracks of Telekar, the light top layer is very thin, and it appears that also the bottom layer does not exceed in thickness of deposits in the other sections of the tubing.

3. Discussion

The described investigations first of all confirmed the feasibility of using Telekar and Telekop to investigate the type, quantity and distribution of the deposits on the inner surfaces of a nuclear power plant's drained primary circuit. In view of its simplicity, speed and abundant information yield, the method is very valuable and can be recommended as a part of the periodic inspections during extended shutdowns of a nuclear power plant.

Even though only a part of one branch in the primary circuit was inspected, there is nothing to prevent applying the obtained information to the entire primary circuit. The total quantity of deposits on the internal surfaces was found to be very small, practically a thin ^{1}m of adhering corrosion products consisting of magnetite. In some places, particularly in the bottom part of the horizontal sections, thicker layers of sediment were found, evidently crystallized boric acid from the evaporated coolant that remained after draining. These deposits do not pose any danger from the viewpoint of the structural materials' stability.

On the basis of the presented findings it can be established that the chosen and applied chemical regime of the V-1 Nuclear Power Plant's No 1 unit is suitable from the viewpoint of the formation, migration and deposition of corrosion products.

4. Conclusion

1. The study demonstrated that closed-circuit television, specifically the Telekop and Telekar systems, can be used to advantage in monitoring deposits on the inside surfaces of the primary circuit in nuclear power plants.

2. Inspection of a section of the primary circuit in the No 1 unit of the V-1 Nuclear Power Plant showed that the total quantity of deposits on the inside surfaces is very small. Two types of deposits were identified: dark (formed by corrosion products) and light (predominantly boric acid).

3. The obtained results confirm that the chemical regime chosen for the primary circuit of the V-1 Nuclear Power Plant's No 1 unit is sound from the viewpoint of deposit formation.

4. The advantages of using closed-circuit television justify recommending this method for inclusion in the set of periodic inspections performed during extended shutdowns of the reactor when the primary circuit is drained.

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ARGENTINA

SURVEY CONCLUDES NATION NEAR NUCLEAR WEAPON CAPABILITY

PM271213 London THE TIMES in English 27 May 82 p 9

[Dispatch by Christopher Mosey: "Argentina About to Join Nuclear Weapons Club"]

[Text] Stockholm, 26 May--Argentina could be on the verge of acquiring nuclear weapons, according to a survey carried out by the Stockholm International Peace Research Institute (SIPRI) and published tomorrow as part of its "1982 Yearbook."

"With its 1,000 physicists and engineers involved in extensive nuclear research, Argentina is more advanced than Brazil in the nuclear field," says the report. "It is also less dependent upon foreign supplies and even intends to become a regional supplier of heavy water, research reactors, nuclear material and nuclear knowhow."

The yearbook concludes: "From the technological point of view, Argentina is certainly closer to the acquisition of a nuclear-weapon capability than is Brazil. It is estimated that Argentina's power reactor has already produced enough plutonium, contained in spent fuel, to make several dozen nuclear bombs of the Nagasaki type. At the present time, however, spent fuel is being stored near the power reactor for possible future reprocessing."

The yearbook confirms that the Soviet Union has overtaken the United States in the production of conventional armaments but says the United States continues to maintain a technological advantage, particularly in microelectronics and computers.

The institute's researchers say that while "the Soviet Navy continues to improve its ocean-going capacity...this capacity is still inferior to that of the United States."

But the yearbook does confirm that the Soviet Union overtook the United States in the period between 1979 and 1981 as leading exporter of major weapons. "This was partly because of a big increase in arms exports to Inida, and to countries in the Middle East and North Africa. The other reason was a decline in United States exports resulting from the policy of restraint initiated by President Carter in 1977.

"The Soviet Union traditionally charges low prices, has favorable credit terms, and has been prepared to consider barter arrangements; however, more recently it has been looking for payment in hard currency."

The yearbook says the Soviet Union uses arms transfers as an instrument for maintaining and expanding its influence in the Third World, arms transfers playing a greater role than aid or trade.

Referring to chemical weapons, the yearbook forecasts: "The world is moving to the verge of a chemical arms race that could make impossible any further strengthening of the arms control measures in this field." But it says: "There is no hard evidence that the Soviet Union has been producing chemical agents or munitions during the 12 years since United States production stopped."

The institute says that if new long-range missiles are installed by NATO to counter-balance the Soviet two-to-one superiority in this field, "it is a mistake to think that they would serve to re-establish the United States' nuclear umbrella." There is no doubt that, if a war broke out in Europe, both major powers would attempt to keep their own homelands free from attack with nuclear weapons by initially avoiding attacks on the homeland of the other side.

"Thus, the new missiles if introduced, would in all probability have a set of targets in Eastern Europe, west of the Soviet border. For if a nuclear missile fired by United States forces strikes the Soviet Union, the Soviet Union would in all probability retaliate against the United States, whether the missile came from the Federal Republic of Germany or from Montana."

But the yearbook points to one hopeful sign: The growing concern over the arms race in both Western and Eastern Europe.

CSO: 5100/2176

ANSALDO TO DELIVER MAGNET FOR FRENCH TOKAMAK

Rome ATOMO E INDUSTRIA in English 1-15 Apr 82 p 12

[Text]

Following an international tender, Ansaldo was entrusted with the supply to the Commissariat à l'Energie Atomique (CEA) of the large toroidal superconducting magnet for the experimental Tore Supra machine, the construction of which was decided at the Cadarache Center for Nuclear Studies. With this new Tokamak, designed by the Department of Research on Controlled Nuclear Fusion, France plans to attain important advancements towards the exploitation of controlled thermonuclear fusion for production of electricity.

The magnet, of an approximate total weight of 160 tons, will be fabricated at the Ansaldo's Campi (Genoa) plant and delivery is planned within four years.

The Tore Supra technicians have considered that an extremely high fabrication quality standard is an indispensable factor, since the success of the entire project will depend from the reliable operation of the superconducting magnet: among other things, this will require the setup at Campi of a specially equipped and climatized area for fabrication of coils.

Thus, the French project is an addition to the associations of the European Community fusion programme, substantially based on plasma magnetic containment through the development of the toroidal configuration « Tokamak », the acronym, by now used worldwide and drawn by the three Russian words « Tok » (current), « Kamera » (camera) and « Mak » (magnetic), for the machines which have demonstrated to have the highest scientific promise in carrying out fusion experiments in conditions prefiguring those of a nuclear reactor.

Unlike the other Tokamaks and, in particular, the American TFTR, the Japanese JT60 and the same JET (Joint European Torus), being built at Culham (UK) as a European Community project, the French Tore Supra will use for the first time a superconducting magnet, with which the future commercial fusion reactors will be equipped to obtain long duration discharges. The original technical solution adopted for coils is a cryogenic system, cooled by superfluid helium at atmospheric pressure.

The use of superconducting cables that, at temperatures nearing the absolute zero, can pipe steady-state currents of some thousands amperes in small sections and with no energy dispersion, was, with no doubt, a revolutionary step in electromechanical design and technology.

Ansaldo has been already working a decade in this field and can be proud of its important achievements, such as the dipole magnet operating since June 1978 at the 400 GeV SPS proton synchrotron of CERN in Geneva. Presently, Ansaldo is carrying out the construction of the superconducting magnet « Sultan », which will be installed by the Schweizerisches Institut für Nuklearforschung (SIN) at Villigen (Switzerland), and is starting the fabrication of the magnet for the first European superconducting cyclotron, which will be built in Milan by the National Institute of Nuclear Physics (INFN). Thus, Ansaldo is progressively adding to its proven manufacturing experience a design capability which avail itself of the most modern calculating techniques, with the purpose to master completely this new line of product.

Fabrication of the large Tore Supra magnet will allow Ansaldo to obtain a position of preminence on an international level, so that it will be able to be present, with its own vanguard technology, on the market of energy generation machines of the 2000s.

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REFORM OF NUCLEAR AGENCY APPROVED

Rome ATOMO E INDUSTRIA in English 1-15 Mar 82 p 14

[Text]

The last days of February and the first days of March have determined a turn on the legislative level in the life of the Italian Nuclear Agency. In fact, the Industry Committee of the Chamber of Deputies, chaired by On. Enrico Manca, has definitively approved CNEN's Reform Bill, which extends its tasks and changes its name from CNEN into ENEA (National Committee for Research and Development of Nuclear Energy and Alternative Energies).

A second legislative measure, passed by the Industry Commission of the Senate, chaired by Sen. Libero Gualtieri, for the first time in the history of the nuclear Agency has endowed CNEN, thus the new ENEA, with a stable pluriennual financing, for a totale of 2,980 billion lire, covering the whole current 5-year plan 1980-1984. Three hundred billion lire will be appropriated for sources different from nuclear and for energy saving. This last measure had to be returned to the Senate after emendments by the Chamber of Deputies on february 17, 1982 (Ael, February 15, 1982).

Established by Law in 1960, CNEN inherited structures and personnel of the former National Committee for Nuclear Research (CNRN), established by Decree in 1952. At the end of 1971, the Agency underwent a first restructuring that, however, did not modify the delimitations of its jurisdiction to the nuclear sector. Since 1979, the new energy problems due to the urgent need to decrease dependence from oil, have determined the trend to use the technological know-how acquired in many years of nuclear research and development, with the aim to promote and start new energy technologies and studies of energy saving systems in industry and services. The definitive approval of the new National Energy Plan by the Parliament on October 22, 1981, gave the final push to a reform already started, which intended to make CNEN one of the instruments to carry out the new energy policy of the Parliament.

« As of today — one can read from a parliamentary news release dated February 23 — *CNEN will be called ENEA: It was decided by the Industry Committee of the Chamber of Deputies, passing the Agency reform Bill and extending its jurisdiction also to energy sources different from nuclear, as solar, eolian and biomass. The main task of the Agency, whose personnel shall not have any more the contracts of semi-official bodies — shall be to reduce italian dependence from oil, as envisaged by the National Energy Plan. A few days ago the Industry Commission authorized the Agency's 5-years financing, with an appropriation of 2,890 billion lire ».*

The news release reports also the following statement by the Committee Chairman, On. Enrico Manca: *« By extending the tasks of CNEN, which now is ENEA, to sources different from nuclear and changing from the status of the semi-official bodies the economic and juridical conditions of personnel, which represent a technical asset to be retained and increased, we endowed the country with an effective instrument for research and industrial promotion.*

« Thus ENEA will be able to give a remarkable contribution to the attainment of the basic purpose of the National Energy Plan, that is, to reduce Italian dependence from oil. A further support to this object will be given when bill n. 2383 will be passed. It deals with energy saving and renewable energy sources and will appropriate 1,600 billion lire for industrial investments with the purpose to contain energy consumption and to develop renewable energy sources ».

A statement by On. Antonio Laforgia, rapporteur for the legislative measure to the Industry Committee of the Chamber of Deputies, follows:

« CNEN's reform bill, of which I had the honour to be the rapporteur, is finally a reality. I am sure that ENEA, that is CNEN's new name, with new financing through the legislative measure passed last week by the Committee, and renewed in its jurisdictions of research and industrial promotion, shall be able to contribute to solve the country's problems of energy availability, mostly as concerns the Southern Regions. All the most serious possibilities of economic and social development are founded on this availability ».

The Main Points of the Reform

These are the most significant elements of CNEN's reform:

— widening of the institutional tasks to alternative energy sources different from nuclear and, in particular, to the renewable ones, such as solar, eolian, biomass. The engagement in energy-saving promotion activities. The Agency will

not be engaged in coal and geothemal research;

— strengthening its role as promoter of the national industry and that of advisor of Regions and local Agencies;

— new regulations as concerns partnership in companies, which include the possibility for ENEA to hold majority shares, thus operating a more effective control on public investments;

— simplified administrative and control procedures in keeping with the requirements of an Agency which shall operate in close connection with industry, with well defined tasks of economic and productive interests;

— substitution, as concerns personnel administration, of the present semi-official body status with another one, more apt to an efficient accomplishment of the objects depicted above. This last reform is considered as indispensable to retain and increase qualified technical personnel resources at a moment when a significant nuclear power plant construction program is being started in Italy.

A further element representing a remarkable innovation is contained in the financing Act which, in order to strengthen the decision-making and operating autonomy of ENEA's Central Directorate for Safety and Protection (DISP) rules that the Director of this unit, which has the task to guarantee nuclear safety, be appointed by Decree of the Industry Minister. To this Minister the DISP Director must submit an annual report on the activities of the Directorate.

Concerning the PEC and CIRENE projects, within three months the Interministerial Committee for Economic Planning (CIPE) will examine the calendar, the costs and the conditions required for the construction and operation of the two reactors: the Industry Minister will submit CIPE's deliberations to the opinion of the competent Parliamentary Committees; finally, the Minister may propose to CIPE any necessary variation, *« Included, should this be the case, the cancellation of the projects »*.

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ITALY

NUCLEAR POWER PLANT TO BE DEACTIVATED

Rome ATOMO E INDUSTRIA in English 1-15 Mar 82 p 14

[Text]

Enel has decided not to put back into service the Garigliano nuclear power station (160 MWe, BWR), shut down since August, 1978, owing to the development of cracks at the bottom of one of the two heat exchangers for production of secondary steam to be sent to an intermediate stage of the main turbine.

The decision is justified by the serious feasibility and economy problems presented by the re-evaluation works to be carried out, keeping into consideration the residual mean life of the plant, whose commercial operation started in June 1, 1964. In fact, it would have been necessary to exclude from operation the two secondary steam generators, in order to align this nuclear power station to the current generation of BWRs stations, which foresee sending to the turbine the sole primary steam produced by the reactor. Furthermore, the core cooling systems and the related electricity feeding systems in emergency conditions should have been potentiated.

« Deactivation » — as it is called — does not mean decommissioning but rather the removal of the nuclear fuel and its shipment outside the plant. The final disposal of the radioactive materials and decommissioning, an operation which shall require a few years, will be decided when a program will be finalized and approved by the regulatory body, CNEN.

On this subject, the Electricity Board intends to start a European study for a finalized decommissioning project, which should be of remarkable interest for nuclear countries in Europe.

At the same time, Enel will study the siting of a new 1,000 MWe nuclear power station, as envisaged by the National Energy Plan (Appendix A) *« along the last stretch of the Garigliano river »*, since the area is considered suitable to the purpose and well connected to the national grid.

We recall that the station was ordered in 1958 to General Electric by the Società ElettroNucleare Nazionale (SENN), of the IRI Group. Construction started in 1959 over an area of about 100 hectares, owned by the Company and with no installations, within the territory of the Sessa Aurunca (Caserta) Municipality, near a bend of the Garigliano river, about 7 km from the seashore. The reactor became critical on June 5, 1963, and the first connection to the grid was made on January 23, 1964.

Since the beginning of commercial operation (June 1, 1964) to shut down in August, 1978, the station has produced approximately 12.5 billion kWh, with an availability factor of 65.2% and an average of 5,400 hours/year.

CSO: 5100/2184 END