Commission of the European Communities
Joint Research Centre Ispra
Nuclear Experiments Division

6.5.1986
RvdB/jw

ATFI laboratory preparation for

PISC III Program

impaction of steel component

R. van den Bergh

F. Daniele

SUMMARY

This paper describes the modifications of the ATFI cells of the ESSOR reactor for the PISC III program.

PISC is the abbreviation of Program for Inspection of Steel Components.

For this purpose the cells were prepared to enable remote controlled UT and X-ray investigations and cutting of various sizes and geometries of parts deriving from decommissioned reactors containing real defects.

ATFI Laboratory Description:

The initial purpose of the ATFI facilities (Atelier des Tubes de Force Irradies) was to carry out examinations and controls on the irradiated pressure tubes of the Orgel project and the cutting-up of the pressure tubes for delivery to experimental workers, as well to be evacuated as waste.

The ATFI laboratory is divided into four areas according to a decreasing level of contamination risk.

1. The active zone, consisting of the actual three γ-β hot cells.

2. The semi-active zone or rear-zone foreseen for handling of materials to-and-from the cells and those areas with a direct access to the cells.

3. The non-active zone or control zone includes those areas for handling, manipulating and control of the activities in the cells.

4. The conventional annexes foreseen for offices, warehouse, dark room, W.C's etc.

The rear-zone is connected to the non-active areas by means of a cloakroom directly with the outside by the doors on the track platform. This door is locked from the inside.

The whole rear area is serviced by a 12 ton crane able to unload shielded transport cask and carry them into the cells through the different plugs in the roof of the latter.

The active area consists of a shielded unit of three cells in-line in the center of the ATFI laboratory.

The first two cells area on the same level, the third is elevated by 6m in confront of the others. Radiation protection is given by ordinary concrete (density 2.3 gr/cm^3) and a thickness of 1.10m; the division wall between the cells have a thickness of 0.6 m.

The foreseen contact dose-intensity of the outer wall for a source of 7000 Curie of 1 MeV is put against the inside of the wall is less than 0,5 R/h. Measurements done during the acceptance tests of the installed linear acceleration (X-rays up to 2 MeV, 200 r/min at 1 m in distance) gave no evidence of external dose on the outside of the wall.

The divisory walls are incomplete on the top and the rear to leave a passage for the internal crane and the suspended charges.

The crane serving all cells can lift a man load up to 4 tons.

The cells are maintained at a minimum of 15 mm of H_2O.

The Dismantling Cell (3302)

This cell has its floor level at -2m, the dimensions of the cell are:

Length 10.10 m
Width 4,80
Height 4,90 m

The front wall of the cell contains 3 working positions. The windows are made of 4 layers of lead glass (density 3.8 gr/cm^3) with a thickness of 255 mm each and have the same shielding capability as the wall.

Each of these working positions are equipped with 2 Master Slave heavy duty CRL extended-reach handlers mod.E.

Around each window there are twelve passages available closed by standard mild steel plugs filled with cast iron pellets. These plugs can be used for the passage of pipes and tubes or in the case of the one over the window for the installation of a panoramic periscope. On the right and left hand side of the cell there are cable passages available for the command of machinery, measurement and television etc.

Material access to this cell is possible by three plugs situated in the ceiling with the dimensions of 1,80 x 1,80 m and by a door.

The Ultrasonic and X-ray cells (3103, 3104)

These cells have their floor level at -8m, the dimensions of the cells are :

	U.S.	X-RAY
Length	3.20 m	3.00 m
Width	4.80 m	4.80 m
Height	10.90 m	10.90 m

The cells are divided by a wall with a thickness of 60 cm.

The X-ray cell is equipped with a standard window the same as those in the dismantling cell, the U.S. cell is blind.

The material access to the US and X-ray cells is possible by a double plug situated in the ceiling with the dimensions of 4,80 x 1,80m and by a γ door serving both cells.

PISC III Program and ATFI

The PISC Program (Program of Inspection of Steel Components) started at the end of the Seventies by OECD and European Commission. The aim of this program is to improve methods of in-service inspections on vessels and primary circuits components of BWR and PWR and check their reliability.

This was done during the PISC I and PISC II phases by means of round robin tests on non-irradiated pieces with different geometry and dimensions with known inserted artificial defects.

The JRC Ispra was nominated "Referee laboratory" for this program. PISC intends to do the same controls on parts of decommissioned reactor with real defects.

Given the availability of ATFI cells due to the ORGEL program stop, it has been decided to prepare these cells to allow the execution of PISC II program.

The needs of PISC III were to test the samples by different ultrasonic techniques and procedures and to confirm the experimental results by a direct examination. To do that it is

necessary to have the possibility to cut the samples and to make other investigations with N.B. techniques for example high energy X-rays.

The technical specifications were not precise enough because the samples were not yet available: the only information we had was max. weight 4 ton and thickness 250 mm and material type (carbon steel) perhaps with stainless steel cladding. The radioactivity dose was roughly estimated under 1 Rem without any transferable contamination.

With this data we have been obliged to consider what seems the major problem how to cut a 4 ton pieces of steel of whatsoever shape.

We have been forced to choose the oxy cut because the uncertainty about size and geometry of the cuts did not allow a mechanical technique.

The ultrasonic and X-ray equipment were already chosen by our Non Destructive Service and there were no special difficulties to install them in the ATFI cell. atelier de forge -

PISC equipment in the cells

X-Ray Cell

This cell is equipped with a 2 MeV linear accelerator type 200 A. The nominal energy of the electron beam is 2 MeV with a beam intensity of 200 rads/min at 1 meter on the central axis. The A means having the option to switch of/on an energy of 1MeV with an output of 20 rads/min at a distance of 1 m.

The field is defined by a fixed collimator having a right pyramid shape and a total angle of 45°. A supplementary collimator will be installed on the Xray head to reduce the scattering when making X-ray photographs of pieces smaller than the actual Xray field. The X-ray beam has a focal spot size $\leq$ 2 mm in diameter.

The X-ray head is mounted in a positioning system consisting of a motorized yoke and arm movement for rotating and elevating.

The test pieces can be put on a turntable with an X,Y movement X =9720 m Y = 1,44 m table surface 1.5 x 1.5 m. The X-ray head is fitted with a laser beam direction indicator which projects a light beam along the ray center line. The other components of the Linatron such as: the modulator cabinet, the control console and the secondary cooling water unit are placed outside the cell, the same for the commands of the positioning of the turntable and the X-ray head.

The same X-ray head carries an extra X-ray unit of 300 Kv-energy made by Balteau used for Xray examination of smaller test pieces.

This unit is centered by the same laser beam as the Linatron X-ray head, and then by turning the linatron 90° the Balteau unit will be in position.

U.S. Equipment description

Mechanical scanner : An immersion testing manipulator with six degrees of freedom has been installed.

This manipulator alllows different probe combinations (probe heads) to scan 5 different types of test pieces in a water container of about 2 x 2 m large and 1,5 m depth. The geometries of test pieces for which the software is existing today are: flat plate, horizontal cylinder, vertical cylinder, 2 intersecting cylinders (nozzle) and an intersecting plate with a vertical cylinder (inner radius examination).

Manual or automatic scanning is possible in two orthogonal directions over a length of max. 300 mm. The increment between two scan lines is adjustable (min. 1 mm).

Four interchangeable probe heads are available in the hot cell and can be interchanges automatically by the manipulator according to the test programme.

A maximum of nine single (multiplexed) probes can be mounted on one probe head.

Control equipment : The scanner is remote controlled from the control room. Manual, step by step, as well as full automatic microprocessor aided examination can be performed. The operator follows the displacements of the scanner on CCTV monitors.

Two cubicles, located in the control room, contain all the electronics for the PURIST system. One cubicle contains a programmable ultrasonic test instrument which can handle up to 32 channels, each of which can have up to 4 gates. For each gate analog and digitized signals are available for amplitude and time of flight.

This same cubicle contains also a six channel analog recorder with synchronized traces, a microcassette tape recorder on which up to 32 full inspection programmes can be stored, and a printer allowing to print-out selected examination programmes.

A 10 MByte interchangeable hard disc RL02 has also been mounted in this cubicle to allow the storage of a very large amount of test data. This data can be transferred through a Modem to the main JRC computer AMDAHL and be linked to the Euronet system allowing the transfer of the test data to the PISC Data handling computer as well as to an external (abroad) user of the raw test data.

The second cubicle contains mainly the servo amplifiers for the exploration mechanism and also the PDP 11 computer with a WINCHESTER disk containing mainly the software for the exploration of the different test pieces geometries and the software for the transfer of the measurement data to the AMDAHL computer. The content of this disc can also be transferred onto Floppy discs.

In the control room, the further equipment is available:

- operators keyboard allowing to control the majority of the functions for normal operation of the system

- VDU to monitor the system status. The real time position of the six axis of the mechanisms are displayed on this screen

- VT102 console terminal used for powering up and switching off the system for manipulating test data, for software development, for performance monitoring and for fault finding. This console is not usually required during an inspection.

Dismantling equipment

The cell contains 3 major units:

1) a oxy and plasma cutting installation

2) a NC controlled milling machine

3) a hack sawing machine

1. The oxy-cutting installation

This unit consists of a stainless steel basin, 1,80 m x 1,50 m with a suspended cutting grid, and a robot mounted on a track.

The robot has 5 degrees of freedom and is of the joint arm parallelogram spherical type.

All axis and the track are simultaneously programmable.

The robot can be equipped with a flame cutting torch able to cut through a max of 250 mm of normal carbon steel with or without cladding.

To limit the dispersion of aerosols with quantities of contaminents the torch nozzle is equipped with a circular shower and the cutting takes place immediately over water.

The level of the water in the cutting tank can be controlled according to the level of the cut by means of a pump from the storage tank, or a discharge valve to increase or decrease the level in the cutting tank. An additional pump feeds the shower around the nozzle of the torch.

The storage tank, pumps and valves are located in a separate room under the hot-cells.

There is also the possibility to cut stainless steel, therefore we have to change the gas cutting torch with an available plasma torch which is connected with a 500 A plasma unit able to cut through 75 mm of stainless steel.

All the commands of the robot and the cutting units are located outside the cell, infront of the window. The remote handling will be observed by motorized TV cameras mounted on the crane and on the heavy duty manipulator. Other cameras will be located around the cutting tank to have a complete view on the teach-in programming and the cutting process itself.

The milling machine is a conventional NC type with all the commands outside the cell.

The sawing machine is also a conventional one.

CONCLUSIONS

The ATFI facility is now nearly completed. We think to be able to perform the first test on an irradiated sample at the beginning of 1987.

There are some problems to solve, the most important being the handling of X-ray films in the case of very active samples, and the control of smoke and aerosols during the cutting.

The solution to these problems will be investigated during the non-active tests but we estimate that there will be no difficulties to perform tests on not very active samples in the present conditions.

*****

PISC I Ultrasonic procedure

PISC III X-ray — dismantled reactor pieces