

PETRA, A HOT CELL PRE-INDUSTRIAL FACILITY
FOR WASTE MANAGEMENT STUDIES. SFEN-RECOD 87/0045/JG/da
 B.A.HUNT, H.DWORSCHAK, S.BERTELLI, G.MAGNI (CEC, ISPRA, ITALY)
 R.NANNICINI, V.MORONI (ENEA, Italy)*

INTRODUCTION

At the JRC Ispra Establishment of the European Community a hot-cell facility named (PETRA) is under construction. PETRA is a facility which will considerably upgrade the Commission of the European Communities research emphasis on radioactive waste management, by verification, demonstration and optimisation of concepts already under study. The facility will be able to produce various types of fully active conditioned waste resulting from the operation of a Purex type fuel reprocessing plant in standard or modified forms. The project intends to deal with the waste generating fuel cycle process modes, specifically orientated to identify, analyse and verify modifications potentially suitable to minimise waste arisings and to improve waste quality in function of both effectiveness and safety of final disposal.

PETRA FACILITY DESCRIPTION

Lay-out

The hardware for the hot experimental verification of this project is to be installed in three hot cells (4305, 4306, 4307) of the ADECO Laboratory on a surface area of 43 m² (Figure 1).

The decision to install the PETRA facility in the existing spare hot cells of ADECO, which forms a part of the licensed nuclear installations in the ESSOR reactor complex, was motivated by economical reasons. Indeed, the facility enjoys the extended support possibilities provided by the already operating cells and the connected storage pool, the intervention area, the decontamination facilities, the hot workshop, the ventilation system, the radiation protection surveillance and monitoring of all utilities including highly reliable power supply systems etc.

Two of the existing operational hot cells (4411,4304) will be utilised for performing mechanical operations on either irradiated fuel material or conditioned waste specimens. One of these cells (4411) has a working height of 6 metres with different entry possibilities.

* Collaboration Contract J.R.C. Ispra-ENEA COMB-MEPIS

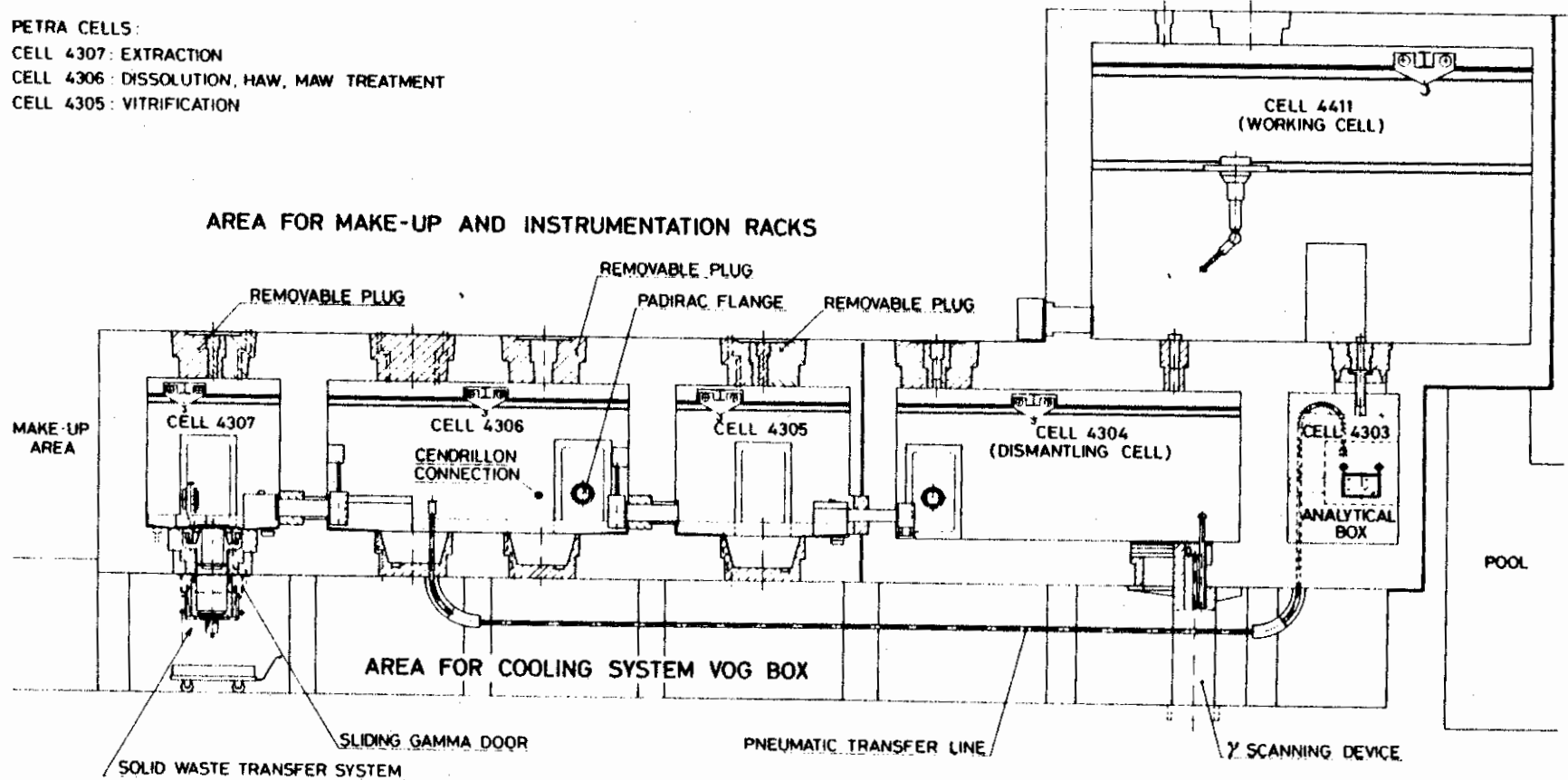
Figure 1 VERTICAL CROSS-SECTION OF THE ADECO HOT CELLS

PETRA CELLS:

CELL 4307: EXTRACTION

CELL 4306: DISSOLUTION, HAW, MAW TREATMENT

CELL 4305: VITRIFICATION



Hot analytical support will be provided in an additional shielded area. Pneumatic systems are used to transfer the samples from the process cells and subsequently to the Radiochemistry building for radiometric assay.

The lay-out of the process equipment in PETRA is referred to a batch-wise treatment capacity of 6 kg U through the following single unit operations such as :

- dissolution and feed clarification (by filtration),
- HA - codecontamination cycle and solvent regeneration,
- U/Pu concentration,
- U/Pu calcination,
- HAW concentration,
- MAW concentration,
- Denitration and eventually oxalate precipitation,
- Vitrification,
- Actinides purification.

Most of these unit operations will be performed on a day-shift schedule and in anyway in a sequential operating mode. PETRA will also be able to accept waste solutions transported by a "cendrillon" type system, from wherever they may be available, thus enhancing the flexibility of the facility.

DESIGN CRITERIA

The design philosophy adopted has been to select only proven and established technology.

The in-cell equipment comprises :

- 18 vessels of cylindrical and slab shapes respectively with volumes in the range from 10-120 litres.
- 4 heatable units with their condensers, to serve as reactors and evaporators (nominal evaporation rate 10 l/h)
- a furnace for calcination
- a vitrification unit with drum dryer producing a 2 dm³ glass block.
- 6 mixer-settler batteries for counter-current extraction operations
- 2 off-gas scrubbing columns in series
- 2 filters for liquids and 2 off-gas filters
- 8 dosimetric pumps and one peristaltic pump
- 27 vacuum pots to support liquid transfer by air lifts
- sampling system for all vessels and heatable units.

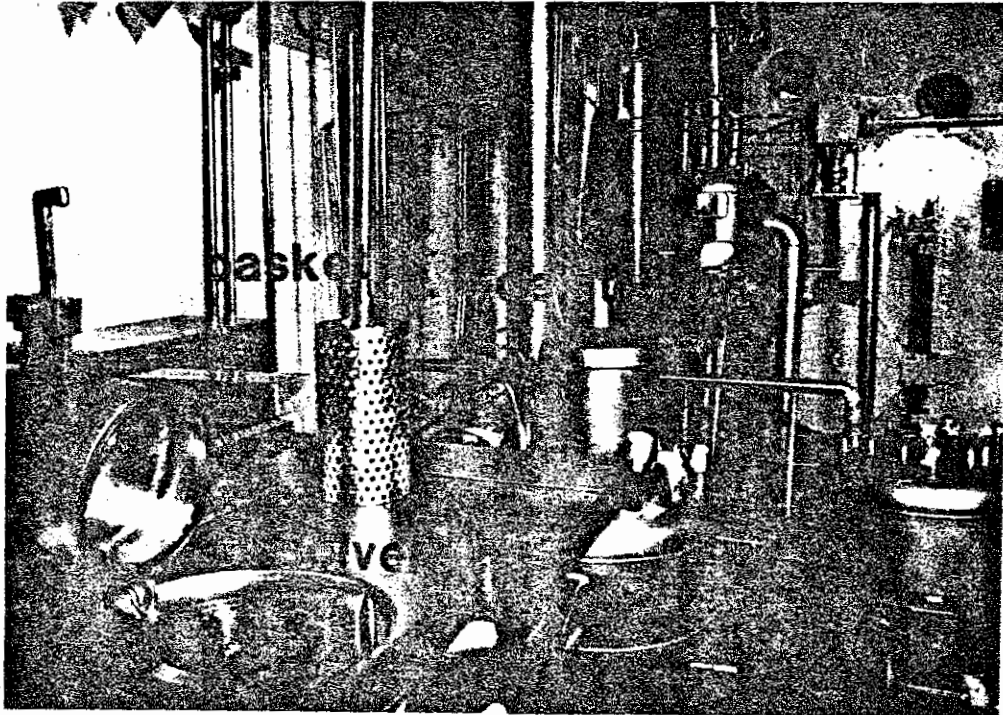


Photo showing dissolver lid and basket, drip tray and denitrator vessel in cell 4306.

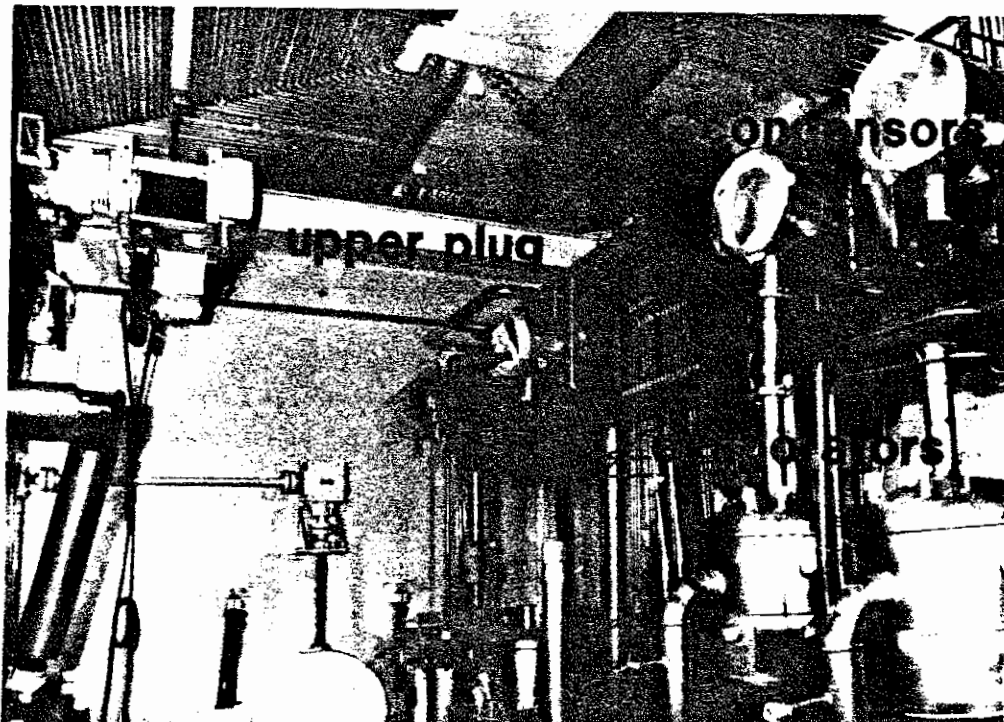


Photo showing upper plug connections/penetrations, evaporators and their condensers in cell 4306

In cell 4307 a new alpha-tight solid waste transfer and handling device has been set-up. This device mates with a receiving station of the centre for final waste treatment.

All construction material is basically AISI 316L SS except the reactors, which are built in Incoloy 825.

In order to minimise the risk of fire, all units in which organic solvent is involved have been placed in cell 4307, from which on the contrary any unit requiring heating is excluded.

The single units of the in-cell equipment are interconnected with metal to metal couplings, which can be handled remotely. Accordingly, to an order of priority established on operational requirements (e.g. filters and crucibles), on foreseen maintenance frequencies (e.g. dosimetric pumps) and eventually on process scheme variations, the units have been placed in positions accessible for remote handling, in order to assure a high degree of flexibility whilst at the same time minimising exposure to operators. For this purpose a 1:5 scale model was used for optimising component lay-out purposes.

It has been assured that in stand-by conditions, no active liquid is in contact with these connections.

At the points where removable components like mixer settlers, pumps, filters etc., are installed, special drainable drip trays are provided. All air-lift transfer systems, are installed above the static liquid head of the vessels and so can drain back to the latter. In stand-by conditions there are therefore no dead-liquid volumes in the pipe work. Equipment and cell walls can be washed by jets and the liquid collected in drip trays, from where it is transferred to sump vessels and evaporators. The integrity of the cells is supported by a high efficient dynamic containment barrier based on a very reliable ventilation system. The telemanipulators and all other penetrations are gas-tight.

PROCESS CONTROL AND INFORMATION SYSTEM

The general level of instrumentation will be similar to that applied in other facilities of this kind, with the exception that time domain reflectometry (TDR) is foreseen. This is a tight "static" system (no dip-tubes with purge air) capable of detecting the presence of two immiscible liquid phases in a vessel, allowing for example, to control efficiently any unexpected presence of solvent. The concept of remote handling has also been extensively applied to all in-cell instrumentation.

The PETRA plant process control and information system has been designed in order to satisfy in one logical and physical structure the different needs of its potential users, process operators, process engineers, analytical chemists, data analysts and so on, assuring at the same time, flexibility and safety. From the hardware point of view the system is based on a three level hierarchical architecture, the low level of which is devoted to data acquisition and process control. The other two levels are devoted to graphical supervision and management (Figure 2). All the application software has been developed and implemented under the two industrial standard operating systems, MS-DOS and Unix System V.

The relational Data Base UNIFY, supported by Unix, has been chosen as the main tool for data retrieval.

Apart from the specialised macro language utilised for data acquisition and process control, all the operating procedures have been developed with the programming languages Fortran 77 and C. The well known query language SQL has been adopted as the Unify interface.

RESEARCH ACTIVITIES

The PETRA facility offers the opportunity for pursuing research on the management of radioactive waste from LWR fuel material with increasing high burn-up rates to be considered typical for the future as well as on any other waste streams resulting for e.g. from non-standard fuel material. In order to make the best possible use of the facility, support and information on critical problem areas in the field of waste management is being supplied by a group of European experts. A comprehensive overview on types and amounts of process streams is shown in Figure 3.

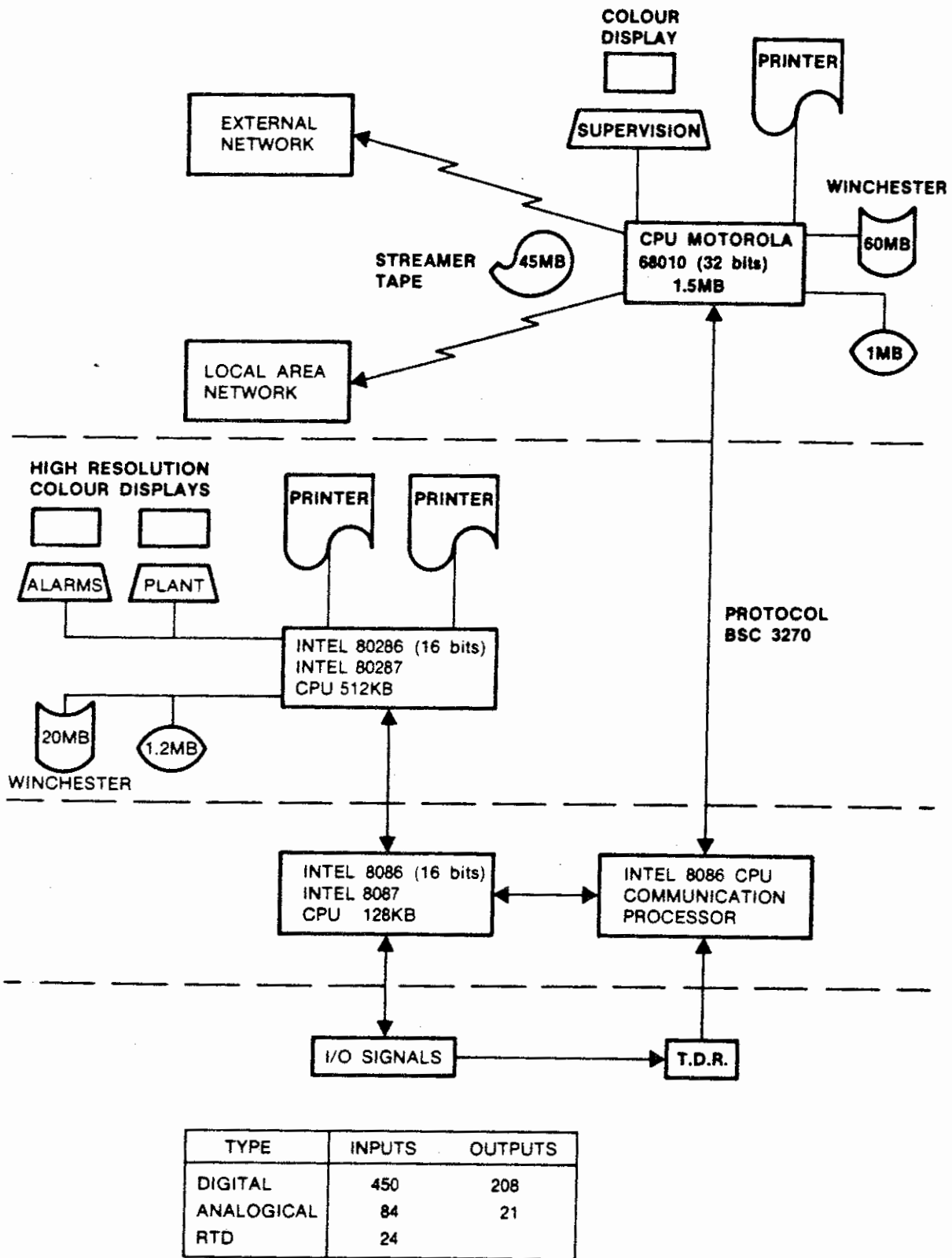


Figure 2 Hardware set-up for process control system

