CENTRAL ELECTRICITY GENERATING BOARD

RESEARCH DIVISION

BERKELEY NUCLEAR LABORATORIES

EEC WORKING GROUP

ON HOT LABORATORIES AND REMOTE

HANDLING

1981 Plenary Meeting -

Karlsruhe, Federal Republic of Germany

THE INSTALLATION OF A REMOTELY OPERATED SCANNING ELECTRON MICROSCOPE AT BERKELEY NUCLEAR LABORATORIES

By

V.J. Haddrell, M.S. Paisey, G.K. Rickards

SESSION 1. EEC Hot Laboratories and

Remote Handling Group Meeting, Karlsruhe, May 1981

THE INSTALLATION OF A REMOTELY OPERATED SCANNING ELECTRON MICROSCOPE AT BERKELEY NUCLEAR LABORATORIES

- by -

V.J. Haddrell*, M.S. Paisey* and G.K. Rickards*

SUMMARY

A ISI Super IIIA scanning electron microscope fitted with an ORTEC EEDSII X-ray microanalyser has been adapted for remote operations. This equipment is being installed in an existing shielded metallographic facility at Berkeley Nuclear Laboratories.

The details of the modifications to the instrument, the remote equipment and the installation arrangements, are described.

*Berkeley Nuclear Laboratories

INTRODUCTION

Light microscopes were adapted for remote operations to examine irradiated materials over 25 years ago and these instruments have evolved over the years to produce microscopes which readily integrate into PIE facilities and provide a comprehensive examination capability; maintenance can also be readily undertaken without contravening the best hot laboratory practices. The scanning electron microscope (SEM) has been used for irradiated materials studies for about 10 years but it has not reached a stage of remote development comparable with the light microscope. With increases in radiation levels associated with the fuels, and especially the structural alloys, plus the adoption of more stringent regulations regarding man-doses, it was considered prudent to look at SEM's with a view to meeting an operating and maintenance criteria similar to that for remote optical examinations.

Accepting the SEM's could be considered more complicated than light microscopes they are nevertheless made-up of modules which, in the case of the smaller contemporary SEM's, are little different in dimensions than the modules of light microscopes. With this in mind, and in a situation where there was a pressing need to increase the magnifications obtained from the remote optical microscopes (X1500 MAX) used for routine examinations of irradiated fuel and structural materials at BNL, the feasibility of fully remoting an SEM was given detailed consideration. Coincident with this feasibility study a small shielded cell adjacent to a shielded light microscope became available. Although this cell was rather small its ideal situation, being next to a light microscope forming part of an metallographic complex, was sufficient incentive to influence the choice of an SEM to suit the available cell.

Having reviewed the available instruments (late 1978) it was decided to adapt an ISI Super III A, see Figure 1, as it offered a compact size and was readily adaptable for remote operation because the major components, i.e. column, diffusion pump, etc could be treated as modules and therefore re-positioned to meet the ergonomics of the cell and allow maintenance operations. The arrangement of the stage was also attractive both for sample loading and for motorising all of the stage movements. The provisions of X-ray microanalysis equipment for this SEM was also investigated and the ORTEC EEDS II system, using the small 5 litre capacity dewar, was considered suitable.

THE INSTALLATION

The facility with space for the SEM consisted of two interconnected containment boxes separated and surrounded by 300mm of steel. The containment box for the SEM measures approximately 930mm L x 670mm W x 900 H and is constructed of welded mild steel with perspex panels and glove ports. A tong and window is fitted in the end wall with another window in the front wall. The rear shielding wall can be rolled aside to give access for routine maintenance and adjustments through the glove ports. As the rear of this and associated cells are partitioned-off from the operating areas it forms a maintenance area where major alterations, which can involve breaking the containment, can be carried-out in a controlled environment.

The limited space and the existing tong position resulted in few available options for the arrangement of the in-cell modules. The chosen layout, see Figures 2 and 3, re-positioned the diffusion pump and associated valve mechanism from the rear of the column to the side and raised it to clear the X-ray detector nose. This pump assembly is supported on a bracket fixed to a common base plate; heat baffles have been added to the rear and the column side of the pump for added protection. The instrument column is fixed to the same common base plate and oriented such that the chamber door, when open, results in the stage being positioned for good viewing and easy loading and unloading of the sample by the tong. The position of the detector and cyrostat is nominally unchanged but the assembly is mounted on a motorised slide fixed to the common base plate to provide lateral adjustment of the detector.

The stage movements are all actuated by miniature electric motors housed in a module supplied by Cambridge Technology of Cambridge which is attached to the chamber door, see Figure 3; the opening and closing of this door employs an electrical actuator. Control cables for these motors and other services, i.e. vacuum valve controls, heater, detector, etc, are routed out of the containment box rear wall to the operating face via bulkhead connectors. The backing pump and diffusion pump cooling water pipework is brought out of containment box to the rotary pump and cooling unit sited on the operating face. A thermally insulated pipe sealed to the top of the cryostat is provided for topping-up the cryostat.

The top of the instrument column penetrates the roof of the containment box to position the filament outside the box. Access is therefore readily provided for filament changing by rolling the rear shielding door aside. The containment seal where the column penetrates the box is provided by the PVC gaiter. clamped to the column and the box. This arrangement assists in eliminating vibrational problems. To isolate the whole instrument assembly the common base plate is fitted with anti-vibration feet and the pipe runs to the instrument includes flexible sections.

The actual control console remains unaltered, while the backing pump, cooling unit, power packs, etc. are housed in cabinets. The stage movement control is in the form of a small keyboard and readout and it incorporates a microprocessor to provide positional re-call. The X-ray analysis control and output is unchanged. All of these units are sited on the operating face.

FUTURE DEVELOPMENT

As well as providing the much needed routine examinations of fissile and non-fissile irradiated materials at magnifications in excess of those provided by the light microscope, it is hoped that with the higher radiation levels which are possible with a fully remoted instrument in a heavily shielded cell, to establish the limits to which the electronic and detection system of scanning electron microscopes can be taken. To this end experiments will be carried-out employing collimation and other techniques. Further refinements to the equipment to ease maintenance problems are also anticipated.

Finally it is hoped that the remoting and use of this simple SEM will provide the necessary experience to allow more sophisticated versions to be installed so that this powerful research tool can be used, as is the light microscope, as a natural part of any post irradiation examination programme.

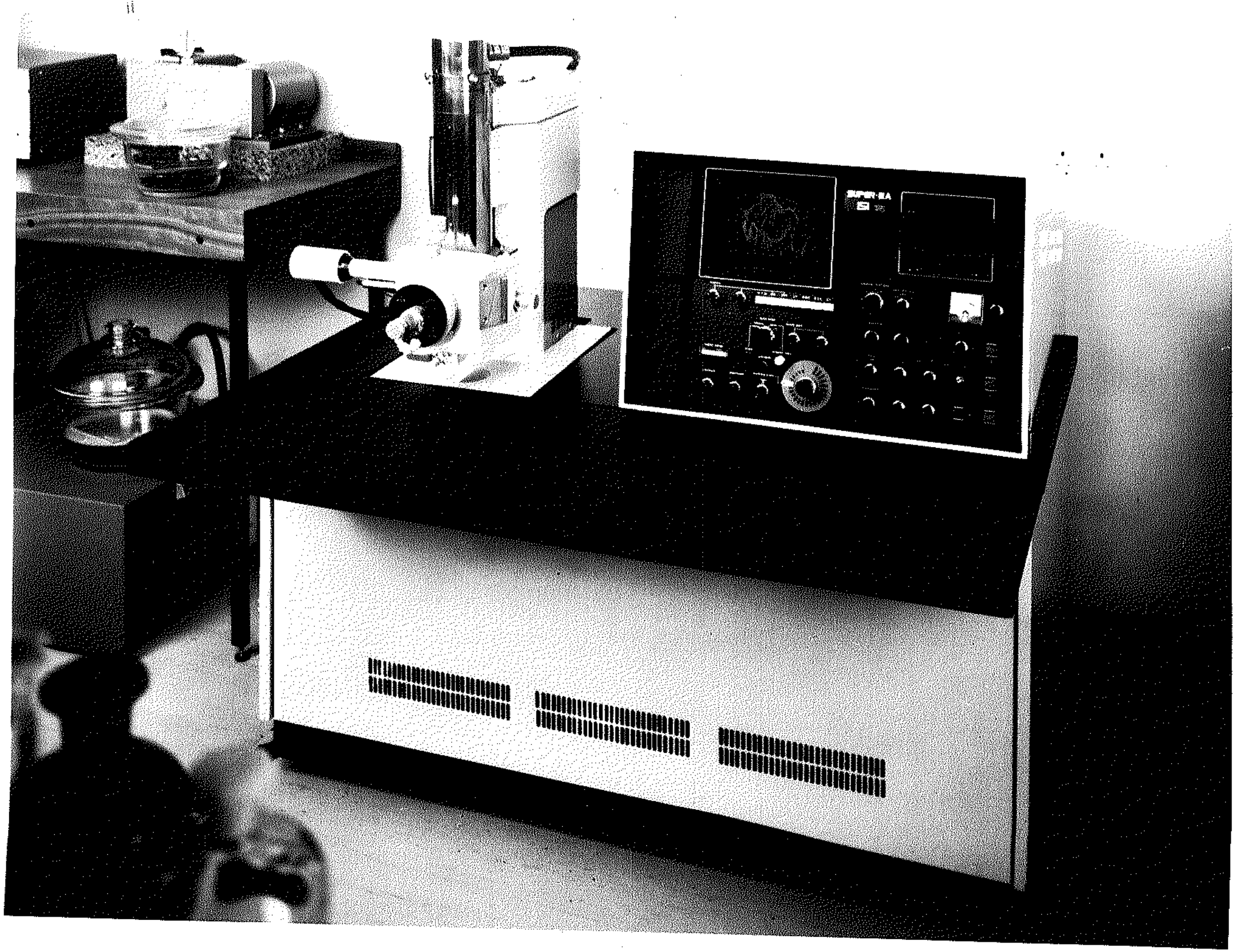

FIG 1 : ISI Super IIIA Scanning electron microscope

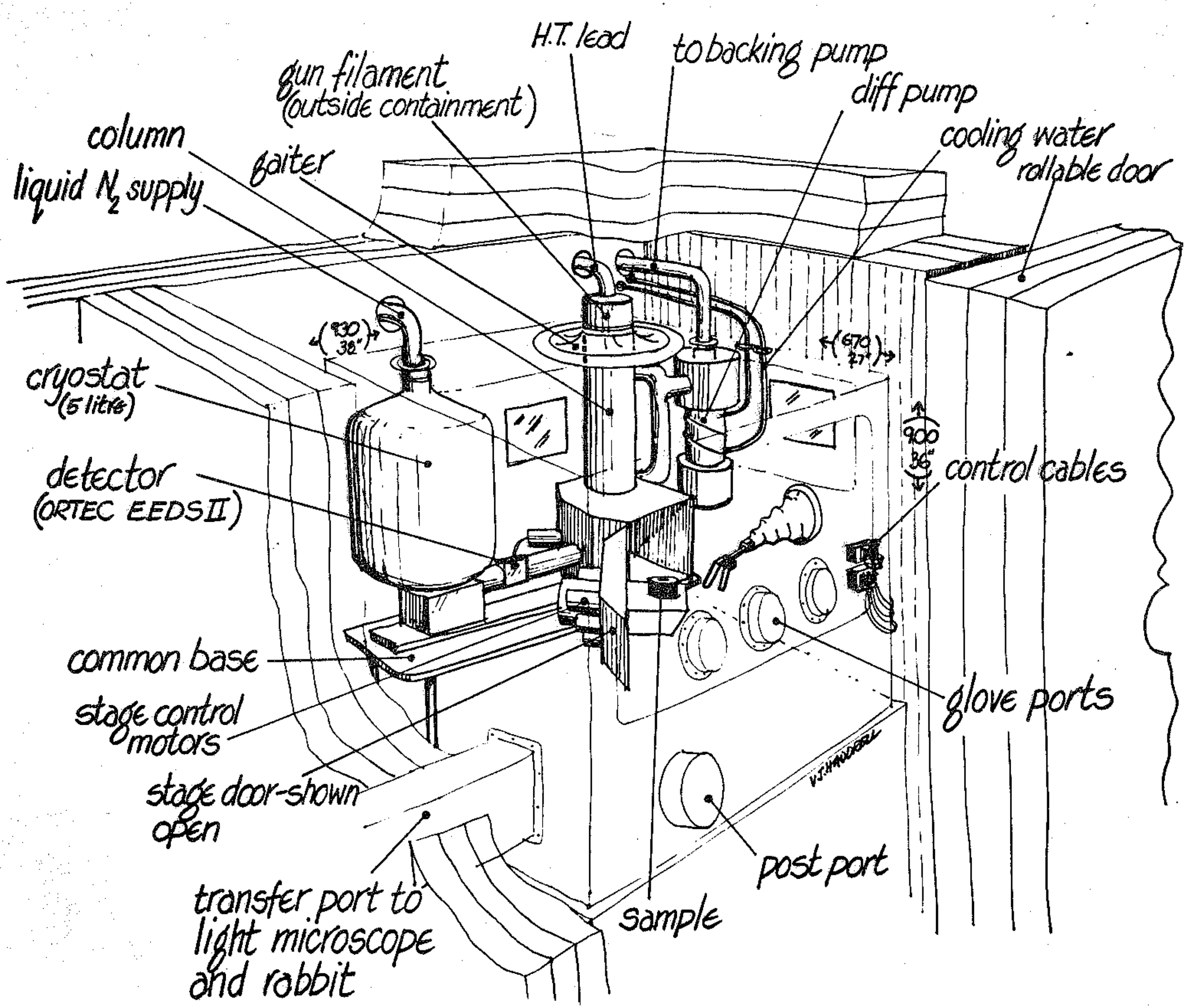

FIG 2 : Arrangement of instrument in cell shown diagrammatically.

1. Column
2. Gaiter seal
3. Vacuum valve gear
4. Diffusion pump
5. Stage z motion motor
6. Stage motion motor and gearbox housing
7. Cryostat
8. Detector
9. Slide
10. Baseplate

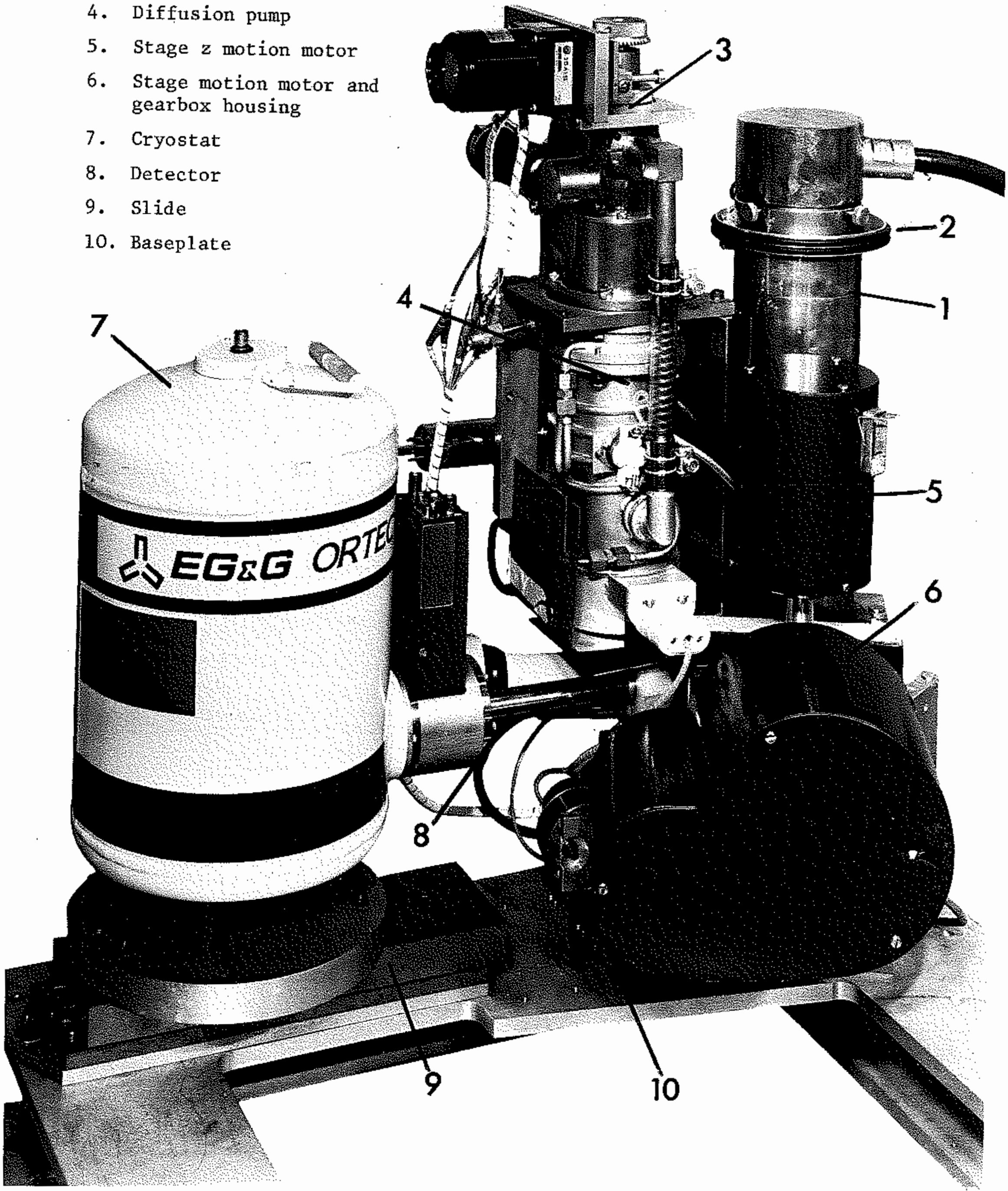

FIG 3 : Re-arranged instrument.

DISTRIBUTION

Mr. A. C. Demildt	SCK/CEN, Boeretang 200 - B 2400 Mol, Belgium
Mr. G. Böhme	Kernforschungszentrum Karlsruhe, Abt. RBT-IT, Postfach 3640, D-7500 Karlsruhe, Federal Republic of Germany
Mr. H. Müller	Kernforschungsanlage, Heisse Zellen, D-517 Julich 1, Postfach 1913, Federal Republic of Germany
Mr. H. Hougaard	Danish National Laboratory Risø, DK-4000 Roskilde, Denmark
Mr. G. Lefort	DSN/SESLU, Centre d'Etudes Nucléaires de Fontenay-aux-Roses, BP No 6, F-92260 Fontenay-aux-Roses, France
Mr. G. Pugnetti	CNEN, Laboratorio Operazioni Calde - Casaccia, Casella Postale N 2400, I-00100 Roma, Italia
Mr. H. J. Wervers	Energie Onderzoek Centrum, Petten (NH), The Netherlands
Dr. S. A. Cottrell	Atomic Energy Establishment Winfrith, Dorchester, Dorset, DT2 8DH
Dr. V. W. Eldred	Windscale Nuclear Power Development Laboratories, Sellafield, Seascale, Cumbria, CA20 1PF
Mr. G. Samsel	Europäisches Institut für Transurane, Postface 2266, D-7500 Karlsruhe, Federal Republic of Germany