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# DISMANTLING EXPERIENCE IN THE JAERI'S REPROCESSING TEST FACILITY DECOMMISSIONING

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## ABSTRACT

The Japan Atomic Energy Research Institute (JAERI) has been carrying out a project since 1990 to develop decommissioning technologies under a commission from the Science and Technology Agency, using JAERI's Reprocessing Test Facility (JRTF), which is Japan's first engineering-scale spent fuel reprocessing facility. The aim of this project is to establish technologies for the dismantling of non-reactor facilities contaminated by TRU nuclides. Actual dismantling work was carried out in 1996 as one part of this project and glove-boxes and other incidental facilities were dismantled in order to provide a waste storage yard. Since 1998, the hot cave and the solvent recovery cells, and other interior facilities housing dissolving, extraction and separation equipment have been dismantled. Chiyoda Corporation was contracted to carry out these dismantling operations.

This paper will illustrate the dismantling of the installations in the hot cave where the main reprocessing facilities and equipment were installed.

## INTRODUCTION

The JRTF that was constructed in 1966 is Japan's first test facility designed to reprocess spent fuel using the Purex process. From 1968 to 1969, the facility was operated to reprocess the uranium metal fuels (with aluminum cladding, specific burnup of 600 MWD/t) obtained from the JRR-3 research reactor. These were the first successful reprocessing tests carried out in Japan, and they resulted in the recovery of 200 grams of plutonium. The facility was later shut down in 1970.

The project to develop dismantling technologies at the JRTF consists of three phases. In Phase I, technologies for the dismantling of non-reactor facilities were surveyed, a basic plan for decommissioning of the JRTF was formulated, and effluent waste from reprocessing operations was treated for disposal. In Phase II, various dismantling technologies, including remote control dismantling system for large sized vessels, were developed for application at JRTF. Phase III started in 1996, and in this phase, actual dismantling work has been carried out in accordance with the basic plan laid down in Phase I, and using the dismantling technologies developed in Phase II. For exchanging information, experience and database of this decommissioning project, JAERI participated in the OECD/NEA co-operative program on decommissioning

## DESCRIPTION OF THE HOT CAVE

The hot cave houses a dissolving tank, regulating vessels, an evaporator, three pulse columns, a fuel rod carrying machine, other installations and connecting pipes. These installations were used in the dissolving, extraction and separation processes and the co-decontamination process in JRTF from 1968 to 1969. Fig.1 shows a vertical section of the installations in the hot cave. The hot cave measures approximately 5 meters wide, 5 meters long and 10 meters high. Except for the ceiling, the floor and walls are lined with stainless steel. After operations, the process equipment and pipes in the hot cave were cleaned up with nitric acid. The maximum surface dose rate of the equipment was 380 μSv /hr. However, the surface dose rate measured as high as 4.5 mSv/hr in some sampling pipes that could not be cleaned up. The maximum surface contamination of the interior of the equipment was 6.6 x $10^3$ Bq/cm$^2$ alpha and 5.8 x $10^3$ Bq/cm$^2$ beta gamma.

## ACTUAL DISMANTLING ACTIVITY OF THE HOT CAVE

Dismantling of the installations in the hot cave was divided into three phases: preparation, dismantling, and post dismantling .

### Preparation

For the purpose of classification, labels were used to mark the sections to be cut off, articles to be dismantled and kinds of fluid in pipes. Sections where radiation levels were high were shielded with lead sheeting in order to reduce the external radiation exposure of workers. In order to prevent the spread of airborne contamination and to contain the contamination in working area during the dismantling of the installations, temporary containment structures that was named greenhouse ("GH") were constructed. Greenhouses shown in Fig.2 consists of four-chambers and maintain a negative pressure compared to the outside. Each greenhouse was made of scaffolding pipes and vinyl acetate plastic sheets and was equipped with ports through which waste was taken out. In addition, observation windows and monitoring instrument was used to keep track of operations, and a radiation monitoring system was used to monitor the airborne contamination levels during the operations.

GH-1 was where pipes and equipment were dismantled and the wastes were packed and carried out. GH-2 was where workers' protective clothes were surveyed for contamination and, if contaminated, were decontaminated. GH-3 was where protective clothes were surveyed for contamination and workers put on and took off their protective clothes. GH-4 was where workers received final contamination surveys.

**Dismantling**

In the hot cave, which measured 10 meters from floor to ceiling, five levels of scaffolding were set up to ensure the safety of the workers before the dismantling of the installations. Pipe dismantling operations were conducted so that work could be conducted easily, waste could be collected by kind of fluid, and the spread of contamination could be prevented. Pipes were dismantled starting from the top and moving to the bottom of each kind of fluid. First, the less contaminated cooling water pipes, hot water pipes, and electric wire pipes were removed. Then the washing water, instrumentation and air pipes, which were potentially contaminated, were taken down. Finally, contaminated pipes for the liquid waste, process effluent, ventilation, and sampling effluent were disassembled. The tubes and pipes, which had been removed, were cut into pieces with a stationary band saw set up in the dismantling chamber in order to prevent any spread of contamination in the hot cave.

Vessels and equipment were installed on the third and fourth floors of the structure. After considering installation positions, first the vessels and equipment on the lower floor and then those on the upper floor were hauled down with chain blocks into the dismantling chamber on the first floor. In the dismantling chamber, the vessels and equipment were holed to check for any contamination inside. After the measurement was completed, they were temporarily decontaminated, and then cut into pieces.

Mechanical cutting tools designed to produce few sparks and debris were used in order to dismantle the installations in the hot cave.

### Post dismantling

All remaining through pipes were cut off 10 centimeters from the wall and ceiling. The cut sections were then sealed with welds and stop joints. Tags indicating the names of the line number and fluid were hanged on these remaining pipes. Supports, anchor bolts and other projections on the floors, walls and ceilings were cut off and removed. Then the floors, walls, and ceilings were caulked. Mobile scaffolds were set up so that the hot cave could be decontaminated and then surveyed for residual contamination. Finally the greenhouses were all removed.

### Protective Clothing

During the dismantling of the installations, the workers wore protective air ventilated suits and full-face respirators depending on airborne contamination levels and the surface contamination levels of the installations being dismantled. Workers also wore protective covers over their air ventilated suits so that the suits could be protected against contamination and used repeatedly.

### Health Physics

During the work, radiation control was conducted by measuring the airborne contamination and surface contamination in the work area and greenhouses every day. Workers wore film badges and pocket dosimeters at all times in order to monitor external exposure. In order to protect against internal (inhalation) exposure, workers wore protective air ventilated suits and full-face respirators, which were appropriate for the work they were involved in. The selection of the protective clothing was based on airborne contamination levels in the working area and the greenhouses. All workers underwent a contamination survey before leaving the greenhouses, and after work, all of the workers underwent whole body counter checks for radiation exposure. Some of the workers also underwent an examination for internal exposure with the bioassay method.

### Dismantling Tools

Band saws, disk grinders, circular saws with carbide chipped blades, and saber saws, all of which were designed to generate few sparks and debris, were used for dismantling the installations. Band saws were used mainly to cut off pipes, pipes housed inside vessels, and racks. Disk grinders were used mainly to cut off irregular objects such as the end plates of vessels. Circular saws with carbide chipped blades were used to cut off plane plates such as the shells of the vessels. Saber saws were used to cut off close-packed pipes that could not be reached by the band saws.

### Waste Management

Wastes produced from the dismantling work were divided into primary waste and secondary waste. The primary waste was further classified according to the type and amount of radioactivity into alpha-contaminated waste and beta (gamma)-contaminated waste, which were further divided into metal and non-metal waste. All of the waste was packed into 200-liter steel drums; alpha-contaminated waste was placed into stainless steel drums with inner plastic container, and beta (gamma)- contaminated waste was placed into carbon steel drums.

The secondary waste, resulting from the dismantling work, included used protective clothing such as rubber gloves, waste cloth, suit covers, and vinyl acetate plastic sheets. Classified as beta (gamma)- contaminated waste, the secondary waste was further divided into combustible and noncombustible waste, which was then put into 20-liter carton boxes. In addition, metallic secondary waste, such as used size dismantling and scaffolding tools, was stored into 200-liter steel drums.

## EXPERIENCE IN THE DISMANTLING OF THE INSTALLATIONS IN THE HOT CAVE

### Working Efficiency and Collective Radiation Dose

The total of 6,300 man-days, including supervisors, was required to dismantle the installations in the hot cave. The dismantling rate of the main vessels was derived from data on the required manpower and the weight of the vessels to be dismantled. Fig.3 shows the correlation between the weight of the vessels and the required manpower.

The radiation control for the workers has been maintained at satisfactorily low levels. The collective radiation external dose was approximately 19 man-mSv. The maximum individual annual dose was approximately 2 mSv/year, which is well below the regulatory limit (50mSv/year). The results of internal exposure measurements using the whole body counter were below the detection threshold.

## The Dispersal Rate of Radioactive Materials

The dispersal rate of radioactive materials produced when contaminated objects were cut into pieces was measured in order to provide data for a safety assessment of the working environment. The dispersal rate (see equation 1 below) is the radioactive contamination dispersed and floating in the air as a result of cutting an object to that of the object itself. A circular saw with a carbide chipped blade was used because this type of saw is commonly used to disassemble vessels. For comparison purposes, data were obtained on some contaminated objects that were fixed by paint and other contaminated objects that were not fixed. As shown in equation 1, the radioactive contamination of the object to be cut was derived from the surface contamination of the object to be cut and its surface area. The amount of radioactivity dispersed and floating in the air was derived from the radioactive contamination in the air during the cutting and the air change rate.

$$q = ( C \quad V \quad N \quad T ) / ( S \quad a ) \qquad \text{(Eq. 1)}$$

Where,

q: Dispersal rate during cutting

C: Radioactive contamination in the air ($Bq/cm^3$)

V: Volumes of dismantling chamber ($cm^3$)

N: Air change rate (times/hr)

T: Working hours (hr)

S: Surface contamination of the object to be cut ($Bq/cm^2$)

a: Surface area of the object to be cut ($cm^2$)

Fig.4 shows the relationship between the surface contamination of the object to be cut and the dispersal rate for alpha nuclides. The dispersal rate for the contamination-fixed objects was one-fourth to one-half lower than that of the objects which were not contamination-fixed. Thus, the measurement results suggest that contamination fixation is effective in reducing the dispersal rate and airborne radioactive contamination in the working area. In addition, it was found that as long as the surface contamination of an object to be cut is below 100 $Bq/cm^2$, the dispersal rate tends to stay constant at the order of $10^{-3}$ regardless of the surface contamination. In the study under review, measurements were made only six times; however, in order to make a general assessment, objects with a high surface contamination must also be included in measurements of the dispersal rate. Finally, in order to increase the accuracy of measurement, consideration must be given to the method used to calculate radioactivity.

## The Amount of Waste Resulting from Dismantling

Twenty eight tons of waste was produced from the dismantling of the installations in the hot cave. Primary waste amounted to approximately 15 tons, and secondary waste came to approximately 13 tons. This waste was stored in 67 stainless steel 200 liter-drums and 104 carbon steel 200 liter-drums. The secondary waste was placed in about 3,500 combustible carton boxes, 300 noncombustible carton boxes, and 19 pails for metal waste. Used filters were put in eight packages. This waste was placed temporarily in the JRTF, and then carried to the waste disposal site, where the waste was stored and disposed of.

## CONCLUSION

The installations in the hot cave, which housed the facilities and equipment involved in the main reprocessing steps at the JRTF, were safely dismantled using conventional mechanical cutting tools. Future plans have been made to carry out actual dismantling works. Significant data and experiences are being accumulated in the project and are expected to contribute to the decommissioning of similar facilities in the future.

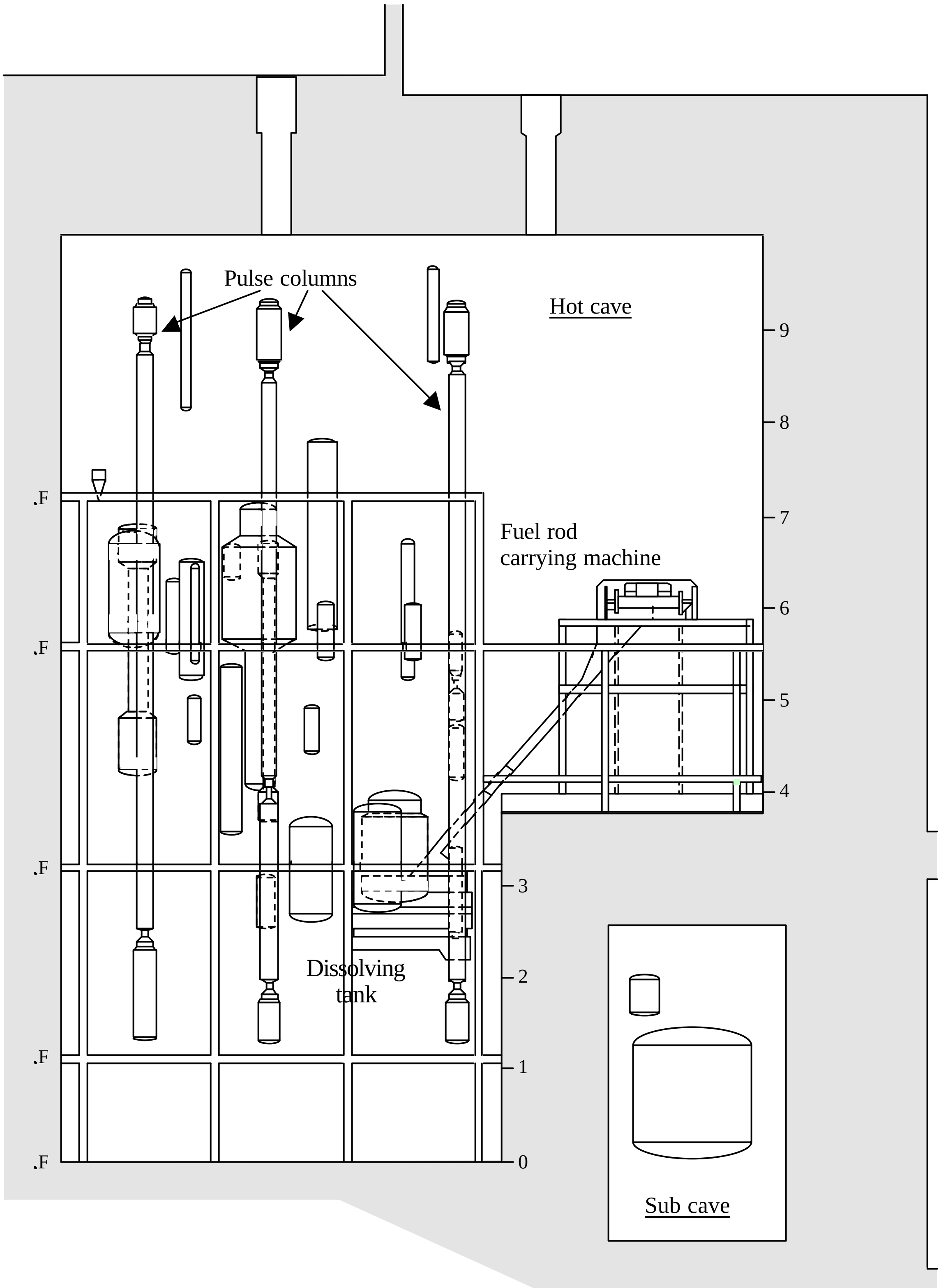


Fig.1. Vertical section of the installations in the hot cave

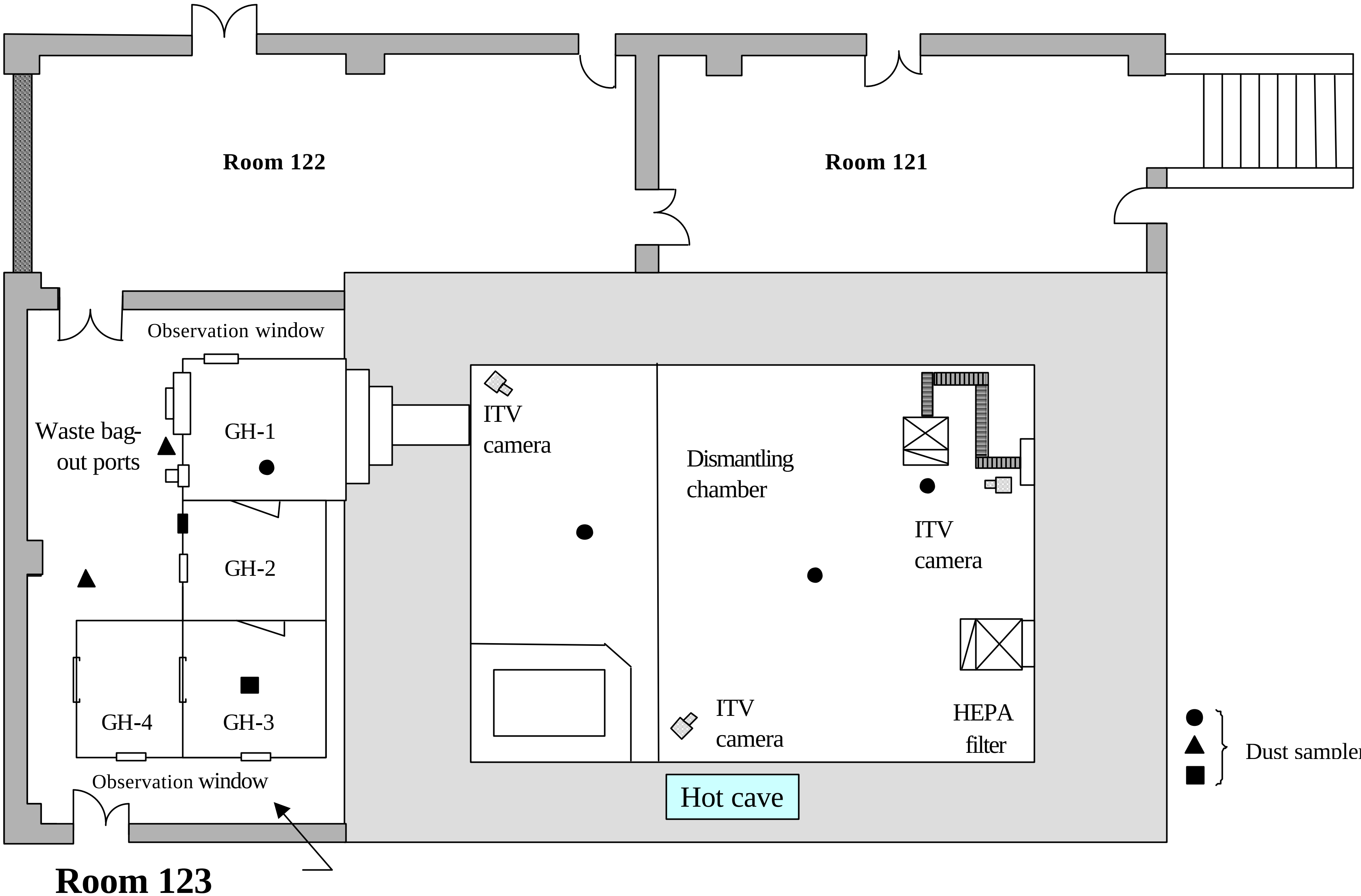


Fig. 2. Layout of greenhouses

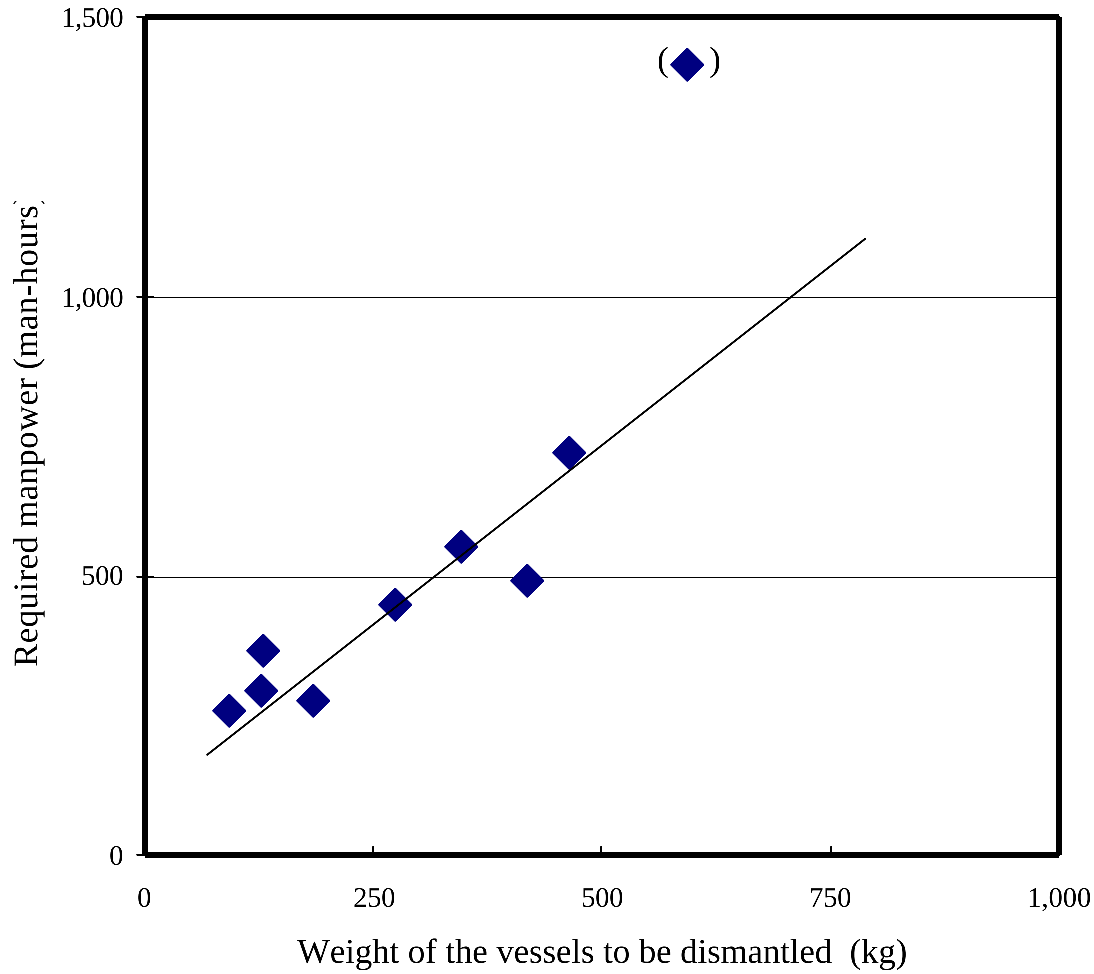


Fig.3 Correlation between weight of the vessels to be dismantled and the required manpower

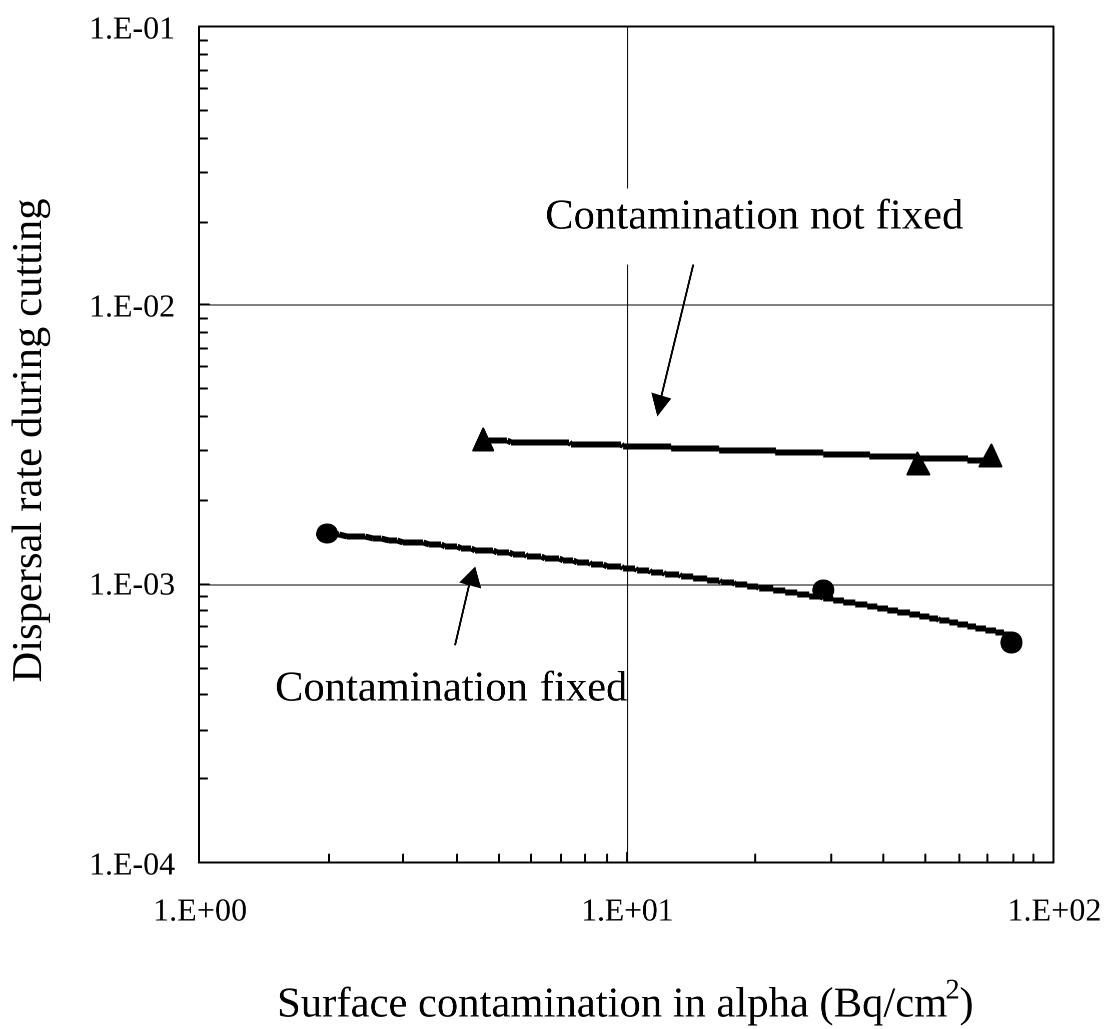


Fig.4 Relationship between dispersal rate and surface contamination