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# Dismantling design for the loop rooms on the MR reactor

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ABSTRACT

The recently completed international co-operation project was aimed at planning for decommissioning the MR reactor identified as a pilot plant for the decommissioning of the other shutdown reactors on the site. The MR reactor was a pool-type, materials testing reactor with the total thermal power of 50 MW which incorporated pressure tubes containing fuel under test. The MR facility includes the reactor with its nine loop rig rooms containing pumps, heat exchangers and experimental equipment as well as systems and equipment located in other buildings in the complex. The objective of the MR reactor decommissioning project was to identify dismantling equipment and the decommissioning methodology for the reactor, loop rooms and redundant services to permit the refit and re-use of the building for a different nuclear related purpose. The dismantling design comprises two separate, but combined, tasks, namely, the dismantling of reactor installation itself and dismantling of experimental loops. The techniques proposed to undertake the dismantling operations within the loop rooms are described. Two options have been developed for removing contaminated equipment from the high radiation field loop rooms and packaging the waste into approved waste containers. The benefits and detriments of both methods have been identified, which allows implementing the safe, timely and cost-effective decommissioning.


## 1. Introduction

Project NSP/05-R73R74R82U34 "Decommissioning Planning for MR and GAMMA Research Reactors and Equipment Design for Decommissioning MR Research Reactor at the Kurchatov Institute, Moscow" funded by the UK BERR (Department of Business, Enterprise and Regulatory Reform) was implemented during 2006–2008. The goals of this international co-operation project were the following: (1) development of preliminary decommissioning designs for both reactors; (2) acquisition of knowledge of modern methodologies and international experience relevant to the development of the decommissioning design and its application to local site conditions; (3) identification and analysis of the current problems of the decommissioning work at the site. The Project was aimed at developing the main decommissioning documents for the MR and GAMMA reactors consistent with international and Russian standards, including the design for reactor dismantling and decontamination of process equipment. The objective of the MR reactor decommissioning project is to identify dismantling equipment and the decommissioning methodology for the reactor, loop rooms and redundant services to permit the refit and re-use of the building for a different nuclear related purpose. This is considered the fundamental part of decommissioning planning for these research nuclear reactors located at the Kurchatov Institute. The Project has the following main elements:

- development of the decommissioning concept and overall programme;
- review of the current state of the reactor, survey of existing facilities, and determination of levels of direct radiation dose and radioactive contamination;
- preparation of preliminary decommissioning design/preparation for dismantling;
- development of methodology and design for fuel removal activities and equipment;
- development of design for reactor dismantling and decontamination of process equipment;
- development of radiation protection documentation including techniques for protection of decommissioning personnel and environmental protection measures;
- preparation of Safety Assessment Reports for Nuclear Regulatory Approval.

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As the result of the project execution all prescribed tasks were fulfilled successfully. The final status of this project was that the documentation is in place to allow the Kurchatov Institute to proceed with procurement and implementation of the safe, timely and cost-effective reactor decommissioning programme. It was established that the preferred decommissioning strategy should be the phased immediate dismantling without deferral aimed on the final status of MR reactor for a nuclear re-use application (Cross et al., 2007; Bylkin et al., 2008). The main feature of this strategy that will affect the MR decommissioning is that the MR reactor hall is planned to be used as a temporary fuel store for the other research reactors on the site as they are decommissioned. The reactor system including its core components and loop systems and associated plant rooms are to be decommissioned to leave the reactor hall for further use.

Decommissioning the MR facility has some special problems associated with the following features:

- the close proximity of a densely populated urban environment;
- the presence of the RFT reactor which is entombed in the MR reactor hall;
- the reactor having been shut down for a long time (since 1993);
- difficult access to the nine experimental loop installations in basement rooms around the reactor;
- the high levels of contamination in the reactor's experimental loops;
- technological systems situated in the complex of buildings;
- building 37/2 which contains a hot laboratory, sharing the special drainage and ventilation systems with the reactor building 109 – the store for spent fuel assemblies.

The dismantling design consists of two separate, but combined, tasks, namely, the dismantling of the reactor installation itself and dismantling of experimental loops. The design foresees that the reactor installation will be dismantled using existing procedures and tooling, long handled tools, and crane mounted, remotely controlled tools in the sequence from the periphery to the centre, from the top down; the sequence of segmentation procedures and engineering arrangements are presented in Craig et al. (2008). At the same time decommissioning of the experimental loops presents a number of challenges the most important of which are:

- the equipment to be dismantled is contained within a large number of rooms located in the basement of the reactor building;
- contamination levels and radiation fields in these rooms are too high to allow long term man entry;
- and the weight and size of equipment and components from the experimental loops and the limited space and access to the loop rig rooms.

This paper describes the techniques proposed to undertake the dismantling operations within the loop rooms in order to minimise the radiation exposure.

## 2. Facility description

Russian Research Centre Kurchatov Institute (RRC KI) is the largest nuclear research centre in the country and has operated as a nuclear research institute since 1943. The majority of Soviet nuclear reactors were designed in the Institute and a number of research reactors were operated on the site. Since the institute was founded the suburbs of Moscow have expanded so that the Institute is surrounded by residential properties and it is therefore desirable to decommission the research reactors to eliminate the risks from accidents.

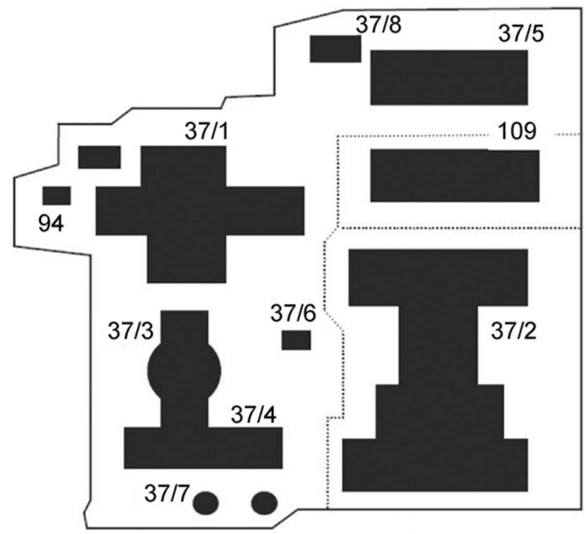


**Fig. 1.** MR reactor facility complex.

The site of RRC KI is located in the north-west region of Moscow. It occupies a significant area (about 100 hectares) and is fully located in the city. Several research reactors (MR, RFT, GAMMA, OR ("Fuel Plant") and Facility "R") are located at this main site. Currently, 5 reactor installations of moderate power (from 12 originally constructed on the site) are still in operation, others are partially/completely dismantled or finally shutdown. Currently decommissioning is planned or implemented for six reactor installations, namely, RTF, MR, WWR-2, ROMASHKA, ENISEY and GAMMA (Ponomarev-Stepnoy et al., 2006). The problem of decommissioning of shutdown research reactors has become urgent in Moscow. In July 1998 the Moscow Government, at the initiative of RRC KI, adopted a resolution "On accelerating the decommissioning of radiation-hazardous objects in the Russian Research Centre Kurchatov Institute".

The MR facility incorporates the MR material testing reactor with nine loop rigs, as well as the systems and equipment located in the buildings and rooms described below (Fig. 1; Tables 1 and 2). The MR reactor was a combined pressure tube, pool-type materials testing reactor with a design that combined the flexibility of pool-type operations with the practicality of being able to test both materials and various fuels in independently serviced loops. The total thermal power, including the fuel in the experimental loops, was 50 MW. MR was hence able to simulate a variety of power reactor conditions with flexibility to re-configure the core to suit a variety of experimental needs.

The MR reactor was operated from 1963 until it was permanently shutdown in 1993. The MR reactor is currently in final shutdown mode following its initial shutdown in 1993 and subsequent transfer to nuclear safe state in 1996. All the fuel except for one experimental fuel element was removed by 1996 and the reactor and loop rigs have been under care and surveillance since then. Remaining fuel will have been removed from the facility prior to decommissioning work commencing.

The reactor hall comprises reactor pool, storage pool, dry CPS storage to store SFA of the loop rigs, and RFT shaft with a steel vessel and reactor internals, with graphite blocks in the core and in the reflector. On top, the vessel is covered with a layer of concrete, which has a steel slab shielding over it. According to the global decommissioning strategy for the RRC KI reactors, the RFT shaft housing the reactor internals should be dismantled together with the MR dismantling. The MR buildings and rooms housing the equipment to be dismantled as well as the room classification based