SPECIFIC ASPECTS OF SEARCHING FOR AND IMPLEMENTING NEW ENGINEERING SOLUTIONS FOR THE DECOMMISSIONING OF NUCLEAR LEGACY FACILITIES AND THE MANAGEMENT OF RADIOACTIVE WASTE GENERATED DURING THIS PROCESS

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Effective decommissioning of nuclear legacy facilities depends directly on the applied engineering methods providing decontamination, dismantlement and RW management. The effectiveness of widely known and commonly applied methods cannot be seen as a constant value since it is governed by multiple factors, including the specific characteristics of the considered facilities. Pre-decommissioning stage should also consider some alternative techniques, methods, types of equipment and tooling, including those that are currently used outside the scope of nuclear industry. To increase the decommissioning performance, including the efforts implemented under the Federal Target Program Nuclear and Radiation Safety in 2016—2035, on the one hand, some digital and calculation tools providing variant-based evaluation of different alternative options and supporting the selection of an optimal one may be used, and on the other hand — some tools helping to search for and implement more advanced decommissioning and RW management technologies may be developed.

The paper summarizes the assessment of nuclear decommissioning technologies and equipment applied in Russia and abroad showing certain potential for further industrial development. It also considers the scouting results focused on developments, prototypes, technologies and equipment associated with the areas of further industrial development providing opportunities for an increased performance during the implementation of key decommissioning operations.

Keywords: *radioactive waste, digital information models, decommissioning, decontamination, dismantling, radioactive waste management, cleanup of contaminated areas, remotely operated devices, autonomous robotic means, software.*

Nuclear decommissioning efforts implemented under the federal target programs Nuclear and Radiation Safety in 2008—2015 (FTP NRS-1) and Nuclear and Radiation Safety in 2016—2035 (FTP NRS-2) have been evaluated by the Nuclear Safety Institute of RAS. The study showed that certain engineering methods have been introduced under the infrastructure development focused on the final stage of the nuclear life cycle (FSLC) and nuclear decommissioning projects based on the experience of design development or operating organizations with no account taken of other options applied at similar nuclear facilities (NF) abroad and non-nuclear enterprises.

Data on the methods and equipment used in Russia and abroad for nuclear decommissioning purposes have been overviewed based on relevant information and analytical sources, including international experience (over 70 literature sources), most advanced methods and technical solutions applied in Russia and abroad (over 40 sources), which revealed the areas with certain technological gaps and some potential for further development.

To date, technical support level in nuclear decommissioning, radioactive waste (RW) management and nuclear cleanup is governed by some conservative attitude prevailing in nuclear industry (certainly, viewed as an inherent part of the safety culture), the preferential use of manual labor due to its lower cost and a set of relatively simple tools or standard methods applied at the operational stage of nuclear facilities. The threshold for the new contractors and suppliers willing to enter this area of activity remains high, which is partially explained by the lack of flexibility in the procurement of goods from small innovative enterprises [1] and the existing licensing and certification requirements for those supplying products and services within the industry. The cost of new equipment turns out to be too high, since given the current industrial setting such equipment is often considered non-reusable, i. e., can be applied only once at a considered facility undergoing decommissioning with no opportunities provided for its subsequent reuse, sale or lease.

Despite the ongoing R&D and the first advances in the development and application of methods considered fundamentally new for the Russian practice (laser cutting [2], laser decontamination [3], robotic disassembly systems [4]), their further integration into decommissioning designs goes extremely slow.

Technological development zones

Discussed in more detail below are most relevant and promising methods and equipment that can be currently proposed under decommissioning, RW management and cleanup designs.

Tools and equipment for the comprehensive engineering and radiation survey (KIRO)

KIRO planning and implementation is seen as a fundamental stage under the entire decommissioning project. Therefore, some mistakes made at this stage may increase the risks of the decommissioning process discontinuation and require the review of technical specifications at the decommissioning stage, thereby, increasing the costs and leading to schedule overruns. Most common mistakes involve incorrectly generated measuring grid and incorrect sampling point selection, overly conservative interpretation of the results obtained due to insufficiently detailed work planning, data desynchronization due to inadequate standards and rules required to be followed to describe the results of the engineering surveys. Often attempts are made to minimize the number of measurements, thereby, reducing personnel exposure at the KIRO stage. Obviously, radiation exposure reduction is seen as an objective factor. Nevertheless, this goal can be achieved not only by reducing the research efforts, but also, for example, by replacing pedestrian gamma-ray surveys with remote measurements by robotic devices (robots with tracked or wheeled chassis and unmanned aerial vehicles (UAV) [5—7]). This is especially true in case of decommissioning tasks focused on nuclear facilities with large areas and/or high gamma exposure and complex architecture and only some limited accessibility. For the same purposes, it seems convenient to use gamma cameras providing preliminary examination or visualization of real-time radiation monitoring data, as well as mapping out the movements of personnel in a way reducing its exposure (Figure 1). Thereby, one can preliminarily outline the areas with increased contamination and specify the level of

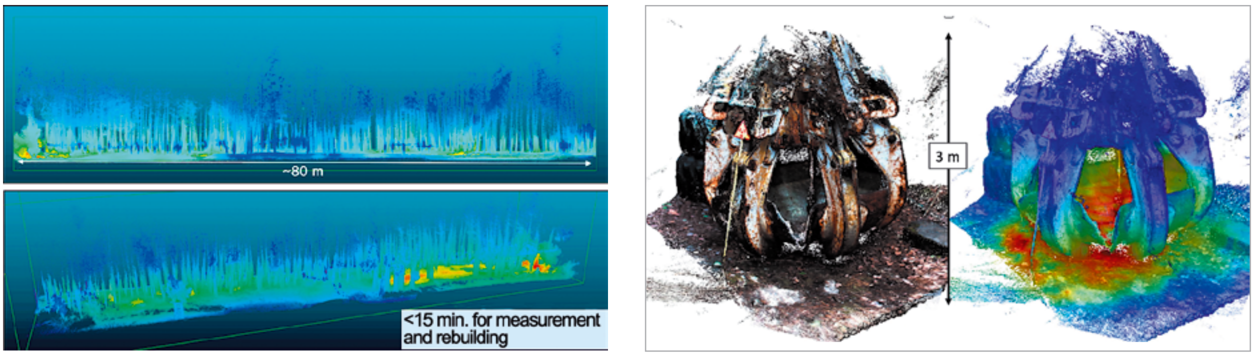

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Figure 1. Digital modelling of a measurement object [5]:
a) forest in the Fukushima prefecture contaminated with ^{137}Cs and ^{134}Cs;
b) lifting tool of a crane in the Chernobyl exclusion zone contaminated with ^{137}Cs

Table 1. Equipment of automatic scanning and measurement systems

Type	Main components	Capabilities and design purpose
Radiation monitoring equipment and tools	Gamma cameras, radiometers-dosimeters, spectrometers, samplers, mechanic arms, etc.	Acquisition of real-time data on the radiation situation and their visualization, sampling, measurements inside the hard-to-reach spots (cracks, holes, recesses)
Lazer 3D scanning equipment	Lazer scanners (LIDAR technology)	Scanning, processing and compiling a 3D model of an object, incl. the real time mode
Navigation equipment	Position/orientation sensors (GPS/IMU) and video cameras	System orientation in space: controlled by operator or an autonomously compiled route
Deployment platforms	Mobile robotic platforms, UAVs	Hauling equipment setups in space given hazardous radiation conditions, difficult terrains

detail required for the research depending on the contamination nature and level.

This area of radiation examination can be further improved based on automatic scanning methods and measurement systems (complexes) with the equipment and tools for radiation monitoring, 3D laser scanning and navigation installed on mobile robotic platforms or UAV (Table 1).

Most of the components constituting to these systems are already widely used in various industries (for example, laser scanners used to create digital twins of existing objects; sets of video cameras, lidars, GPS/IMU modules — in remotely controlled vehicles; special robotic platforms — for reconnaissance/inspection purposes, explosive operations, etc.): combinations of their designs and their combined application provide ample opportunities for the radiation and physical surveys of the studied facilities [5—7].

Decontamination of structures and equipment

Decontamination of building structures and basic process equipment is seen as a most important nuclear decommissioning stage. Nevertheless, the decommissioning methods currently implemented in Russia have not yet been optimized to the extent possible considering the decommissioning tasks at hand. For example, decontamination compositions (formulations) used during normal operation are often applied at this stage. Nevertheless, minimization of chemical impact on the equipment should be no longer seen as a relevant requirement at the decommissioning stage. Another case in point is the trend for adhering to an already established RW management flowchart. For example, almost all large nuclear fuel cycle enterprises implement some methods providing liquid decontamination of the equipment resulting in rather large secondary liquid radioactive waste (LRW) streams. At the same time, the fundamental trend for minimized LRW generation considering the scheduled closure of deep LRW disposal facilities [8] should result in a transition to liquid-free decontamination methods, for example, the blast cleaning method that gained some recognition only a few years ago. LRW inventory can be reduced and the decontamination factor increased also through more intensive use of already existing liquid methods based on the ultrasound effect. Although this technology cannot be considered novel, it did not become popular mainly due to the high cost of the equipment required and the technical limitations involved.

Concrete chipping is commonly performed using perforators, jackhammers, etc. to decontaminate the floors. The depths reached during such decontamination may vary, since this parameter cannot be set beforehand if such methods are applied. Thus, excessive concrete chipping is generated, which increases the RW amount subject to packaging. Grinding methods with purpose-designed floor-standing machines provide uniform removal of a given floor layer with no additional RW amounts generated. Moreover, in case of high-level radioactive contamination, this method avoids mixing of the wastes with different activity levels, i.e., layer-by-layer removal. Other important advantage of this method is seen in denser RW packaging designs and minimized opportunities for secondary radioactive contamination due to automatic collection and primary packaging of the material.

Dismantling and extraction of structures and equipment

Building structures and equipment are mainly dismantled and cut manually with some large construction equipment involved, whereas, remotely controlled devices are applied quite rarely. In almost all cases, a person can be replaced by a robotic manipulator with the operator himself remaining at some distance from the work area. It appears feasible to apply robots in case of high gamma fields or high levels of surface radioactive contamination and under large-scale decommissioning efforts. Important advantages of this method are seen in a substantial reduction of personnel exposure, staffing levels and opportunities for timeline tightening.

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Figure 2. a) a laser mounted on the Maestro robotic arm [9]; b) cutting by the LaserSnake2 device [10]

Wire and laser cutting systems (for concrete and metal, respectively) with no personnel directly involved in the work area are seen as another opportunity that may increase the dismantling efficiency during nuclear cleanup. In case of wire cutting, the personnel should assist only during equipment installation, surface drilling with diamond drills (if necessary) and rope laying. In case of laser cutting involving flexible waveguides or manipulators, personnel assistance can be avoided almost completely (Figure 2). Another promising method is the disc cutting that can be applied both in case of concrete and metal structures.

RW management

RW management methods and technologies can be upgraded based on a transition to remote operations with manipulators that would mimic the movements implemented by an operator, for example, robotic devices engaged in RW cutting, segregation and packing into containers (the so-called robotic arms). Performance of already applied RW disposal methods may be increased at the RW generation sites through the use of modular installations (for example, conditioning process with LRW processing or crushing of construction waste to increase the filling degree of the available container storage capacities).

Another promising RW management option is seen in more accurate waste segregation seeking to reduce the waste volumes. A streaming radiation monitoring and segregation line is fitted with mobile spectrometric installations, gamma cameras visualizing the contamination, as well as automatic waste segregation systems involving robotic arms. It involves radiometry and dosimetry methods applied in combination with artificial vision providing waste segregation by contamination levels, radionuclide composition, morphology, geometric characteristics, etc.

Segregation and cleanup of chemically/radioactively contaminated soil

When it comes to contaminated soil, several methods are applied to reduce the RW amounts:

- mechanical segregation;
- hydroseparation (separation of the target fraction);
- liquid decontamination (washing, including reagent and ultrasonic washing)

In case of soil decontamination, effective application of mobile installations requires the development of measurement systems enabling preliminary soil segregation. The higher is the measurement quality, the more complete and accurate segregation level can be achieved. In particular, systems designed to measure soil in excavator buckets or enabling its automatic streamline segregation are applied abroad. FREMES, a unit with similar designs, has been recently supplied to the AECC site [11].

Mobile devices are applied for soil decontamination as well (for example, by the hydroseparation method). For this purpose, the soil fraction with the highest level of radionuclide contamination (often the finest one) is segregated: after being measured, it's mostly applied in backfilling operations, where required. The fraction enriched with radionuclides is removed from it as RW.

To reduce the amount of RW subject to disposal, the separated soil fraction with the highest contamination level can be decontaminated using different reagent compositions. In some cases, for certain soil types, additional ultrasonic decontamination may prove to be effective.

As it comes to the above three methods involved in the management of radioactively contaminated soil, the mechanical segregation stage (streamline or in batches) is seen as an essential element of the management system. One of the other two methods is selected depending on numerous factors, and, probably, their joint application would contribute to the highest performance level (hydroseparation method implemented jointly with another cleanup step to treat some individual fractions).

Due to some substantial differences in the physical and chemical properties of soils and the nature of contamination, a specific cleanup flowchart should be developed to address the contamination of each individual radioactively contaminated site, since literally no standard cleanup solution can be proposed. The key stages of such flowchart would involve a soil survey to assess the contamination volumes and levels, its segregation and RW extraction, which can be performed by conveyor sorting, measurement in a bucket or in a big bag. This stage is followed by the RW treatment stage implemented either in-situ or at the site of an appropriate enterprise based on the decontamination methods providing the reduction of waste volumes subsequently subject to disposal.

Technology readiness level and its assessment

The TRL (Technology Readiness Level) scale can be used to evaluate the technological readiness of certain promising nuclear decommissioning, RW management and nuclear cleanup methods for Russia [12] (Table 2). According to the TRL scale, relevant methods can be divided into 3 groups:

TRL 1—3: a new scientific insight requiring further feasibility study that would yield a scientific principle.

TRL 4—6: Technical feasibility of a scientific insight has been demonstrated theoretically/experimentally, development of an appropriate product based on the considered method is required. This stage results in a method/prototype.

TRL 7—9: Basic method and product prototypes are available; the next stage requires the development and establishment of appropriate production capacities. This stage results in a serial product intended for the market.

It should be noted that some equipment used in the decommissioning are produced abroad and applied in Russia as ready-made technical solutions either since similar equipment are not produced in Russia or such equipment do not meet the required characteristics, including the reliability level. Some of the devices and methods have been actively used in other industries, and if appropriate managerial tools are in place, they can be also used to address the tasks relevant for the FLCS.

The list of promising solutions given in Table 2 mainly involves high-tech equipment. If one decides to deploy such production in Russia, it would require full-fledged production capacities with domestically produced components and our own computer-aided design system for microcircuit development, which may take quite a long time.

Table 2. Promising technical solutions

Technology/equipment	TRL for Russia	Available Russian designs and productions
KIRO		
Gamma-cameras	9	yes
Robotic and unmanned vehicles used as chassis (platform)	6	yes
Automated scanning and measurement systems: gamma cameras, spectrometers, LIDAR, GPS/GLONASS, video cameras	Have not been developed	
Decontamination of structures and equipment		
Lazer decontamination	6	yes
Ultrasonic decontamination	9	yes
Floor sanding systems	Have not been developed	
Blast cleaning	9	Yes, but not applied in the nuclear sector
Dismantling and extraction of building structures and equipment		
Construction demolition robots with special attachments (milling cutters, grinding attachments, etc.)	9	Yes, but limited production capacities
Diamond Wire Cutting Systems	9	Yes, but not applied in the nuclear sector
Lazer cutting	6	yes
RW management		
Modular RW processing units	6–9	yes
Equipment for radiation monitoring and activity visualization inside the RW packages	8–9	Yes, but fitted with foreign detectors
Automatic streamline RW segregation systems	3–4	No
Segregation and decontamination of chemically/radioactively contaminated soil		
Units for activity control and automatic soil segregation	5–6	no
Mobile soil decontamination units	5	yes

However, the industrial production of microprocessors and microcircuits in Russia currently lags far behind the world leaders [13] (Baikal, Elbrus and other Russian-designed chips were produced in Taiwan). For this reason, nuclear industry in this area is very dependent on the Russian microelectronics industry.

Depending on the current readiness level, the portfolio of new engineering methods in nuclear decommissioning can be structurally presented as follows:

1) procurement of the required approved standard production equipment (TRL 7—9);

2) refinement or adaptation of new engineering methods and equipment (TRL 4—6);

3) development of new methods and equipment addressing some specific needs and tasks (TRL 1—3).

Organizational arrangements

The above activities implemented as part of nuclear decommissioning, RW management and cleanup effort would require certain conditions and tools that should be arranged for to provide adequate interaction with the customers within the industry and potential partners outside its scope. The set of measures that should be implemented to support these methods is viewed as a systematic, continuous process constituting to the innovation management system of the State Corporation Rosatom and covering all life cycle stages of relevant technologies. Such activities may be implemented effectively, if the existing system for new product development is added with the following items considered important in terms of nuclear decommissioning and RW management:

(1) development of a thinking shop providing scientific and technical project support;

(2) upgrading the management system in nuclear decommissioning to enhance the project-oriented activity model in this area;

(3) identification of an experimental site - a pilot site where the proposed methods can be developed and tested;

(4) improvement of the knowledge management system, development of a unified information environment and a data-centric approach to work management.

Figure 3 presents a continuous technological support model focused on the processes associated with the development and implementation of new solutions at different TRL stages.

The model provides for the development of technological chains at the life cycle stages described in accordance with the TRL assessment methodology presented in GOST R 58048 [13].

Under the proposed model, the TRL scale is integrated with the business processes supporting the search for new solutions and methods (start-ups and small innovative teams) — scouting; R&D implemented in accordance with the industrial needs; testing under in situ conditions — piloting; promoting conditions for the extended application of new technologies in nuclear decommissioning;

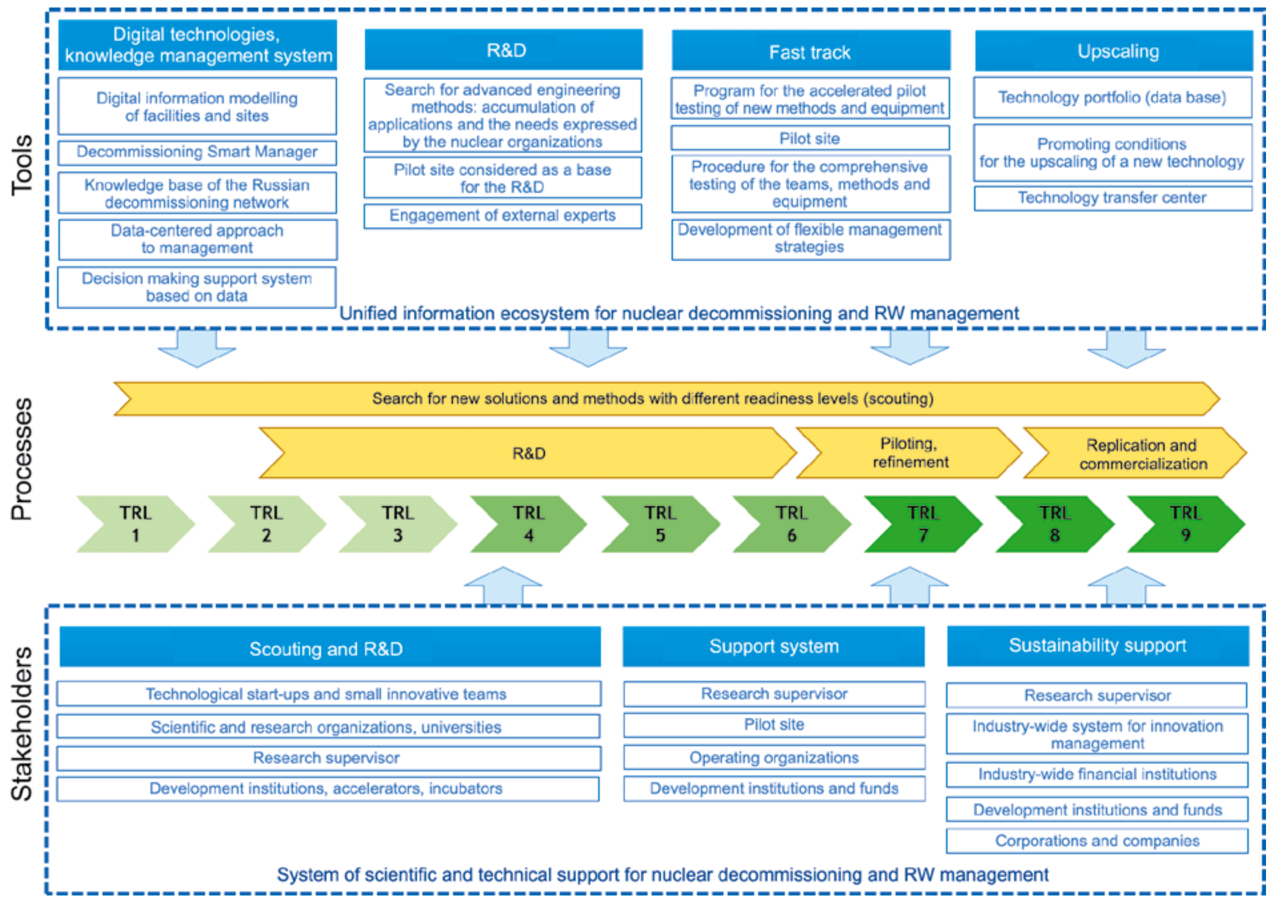

Figure 3. Model of scientific and technological support in nuclear decommissioning

commercialization and replication of technical solutions.

Scientific and technical support

Under the described scientific and technological support model, the decommissioning research supervisor plays the role of an advisory and expert advisory body seeking to provide more efficient development, upgrading and promotion of the proposed engineering methods: providing open access to external experts taking part in consultations on highly specialized topics; development of R&D contributing to promising projects in nuclear decommissioning and RW management and technology transfer; collection of applications and needs from industry organizations regarding some specific engineering methods; development and updating of a database (portfolio) summarizing the available methods.

Organizational support of piloting

When it comes to new developments, the term piloting usually stands for testing under real-life conditions, suggesting that some method or technology is tested to demonstrate the feasibility of its application at a particular enterprise. Organizational piloting provides for a set of resources and procedures enabling a comprehensive study of methods and equipment involved in the considered decommissioning and RW management operations: to assess their compatibility with the technological stack, applicability, efficiency, compliance with relevant technical characteristics and safety requirements. Fast-track is a set of procedures implemented to speed up the testing process and the introduction of innovations in a company.

Most time-consuming and complicated processes can be accelerated if the supplier or the contractor is acting outside the scope of SC Rosatom: procurement, contract signing, comprehensive expertise involving small innovation teams, standard methods applied to evaluate the effectiveness of the tested technologies (according to the A/B testing principle).

Knowledge management system

Digital transformation of the key management and support processes is seen as an important tool that can potentially increase the efficiency and reduce the time within the fast-track model. Project-oriented model representing certain nuclear decommissioning and RW management activities can be also enhanced, which is seen as another important tool covering the following areas: development of a system supporting the decision-making on the strategy, options and methods followed during the implementation of these operations based on complete and reliable data, including the predictive analytical tools; improvement of scientific and technological support mechanisms supporting digital design development, reengineering and modeling, including the digital twin method (DT) with the DT developed both for nuclear facilities subject to decommissioning and the decommissioning projects; establishment of a unified digital platform integrating relevant nuclear decommissioning methods and a knowledge management system.

Digital environment

Globally and in Russia, in particular, Building Information Models (BIM) of facilities subject to decommissioning are currently viewed as common tools mainly applied to identify the actual configuration of facilities, the equipment layouts, the spread of contamination; to estimate the generated inventory of RW and other waste streams; to refine the operations proposed to dismantle the contaminated equipment, structural elements of reactors and for some other purposes [14]. Large arrays of digital data on nuclear facilities can be evaluated using the calculation tools designed by the Nuclear Safety Institute of RAS (IBRAE RAS) based on the experience accumulated during the development of BIM for sites, buildings and structures at the pre-decommissioning stage. Decommissioning Smart Manager software provides financial and economic estimates. It can forecast waste generation by waste types and categories, provide a sensitivity analysis and identify the most critical stages and processes both as regards the pre-decommissioning and decommissioning stages. These include the KIRO program, assessment of RW and industrial waste streams, application of certain methods and equipment, etc.

The dismantlement costs are calculated based on federal unit prices (FER) for individual construction operations that are applied with an account taken of relevant coefficients and indices. As regards the operations typically implemented under the nuclear decommissioning projects and not listed in the FER, the Decommissioning Smart Manager provides a pricing database purposely developed by IBRAE RAS based on the analyzed market supply and the available practical experience [15]. Using the software, one can compare different methods and equipment in terms of the generated RW inventory, the required resources, cost and timing, and choose the best option.

The digital environment basically seeks to increase the efficiency of data processing and establish an industry-specific knowledge management system for nuclear decommissioning and RW management. To address these tasks, IBRAE RAS has implemented and has been testing the beta version of a website of the Russian Industry Network for Decommissioning — an ecosystem promoting knowledge, research, development and innovations, uniting the stakeholders involved in these processes. Individuals possessing relevant competencies, knowledge and skills constitute to the core of the decommissioning network. Its key task is seen in the development of an information ecosystem enabling the exchange of experience and innovation support in this area. To date, over 40 organizations are involved in the decommissioning and RW management projects run by SC Rosatom. Since the number of decommissioned facilities is growing rapidly, an information resource is required that would help the organizations to communicate between themselves sharing their points of view, to learn about recent advances in engineering and equipment development, to provide feedback on their application, ongoing tests, get acquainted with lessons learned by other stakeholders, successful and bad decommissioning experience.

Supply market overview

At the first piloting step, developments, prototypes, methods and equipment were scouted to improve the efficiency of the basic decommissioning operations. The search implemented under the broad strategy underlying this technique has covered the following areas: patents, licenses, industrial associations, self-regulatory organizations, development institutions, as well as certain companies familiar to IBRAE RAS staff through publications, participation in conferences, etc. Only the companies that previously had no experience in supplying serviced or performing work for the SC Rosatom enterprises were listed, which was viewed as the basic search condition.

Eventually, 167 organizations were listed with 155 Russian organizations and 12 foreign organizations from China and Brazil.

The developments, technologies and equipment supplied by these companies were further evaluated and the list was reduced to 109 organizations. Figure 4 presents the breakdown of these companies by activity areas in nuclear decommissioning, i.e., by types of products or supplied services.

The study showed that decontamination and dismantling are seen as most common decommissioning areas, whereas the smallest number of companies renders the services associated with nuclear cleanup and remediation.

Dismantlement of industrial buildings, structures and infrastructure facilities is viewed as an

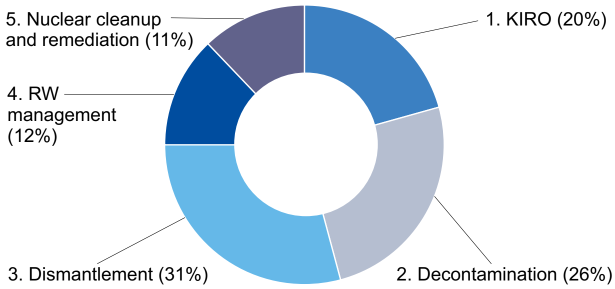

Figure 4. Breakdown of the identified promising engineering technologies in the field of nuclear decommissioning (according to the activity types)

advanced area in the construction industry. These companies usually possess a developed fleet of purpose-designed equipment and offer turnkey services for utility system removal, dismantling, demolition, waste management and site cleanup. Organizations providing decontamination services deliver materials and equipment for electrochemical, ultrasonic, laser decontamination methods, implying the use of robotic devices fitted with appropriate working tools enabling the mechanical treatment.

As discussed earlier in the article, no universal method can be proposed for radioactively and chemically contaminated soil treatment. Each site requires some particular soil treatment method to be selected or adapted; depending on the scope of contaminant spread, a decision is made on the equipment needed for soil segregation, treatment, decontamination, packaging, etc.

22 organizations expressed their interest for further interaction (Figure 5). Most companies (60) either did not give a clear answer or showed no interest in the project.

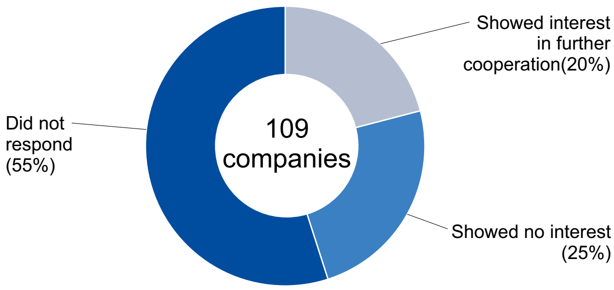

Figure 5. Types of feedback from the companies

The information provided by the organizations about their business, services provided, digital products, equipment, materials produced, as well as their work experience was analyzed by six experts possessing theoretical and practical competencies as regards the entire work scope associated with nuclear decommissioning. No requirements were imposed on the form of the review performed by the experts: it could be any type of feedback, i. e., comments, assumptions. The review itself was based on data available on the existing and widely used decommissioning methods, new R&D, as well as on the specific features of nuclear facilities listed in FTP NRS-2. The following three criteria were considered in the review:

1) uniqueness and novelty of the development;

2) technical feasibility as regards its implementation at nuclear facilities;

3) the prospects of wide application at FSLC.

The resulting expert reviews were brought to a single format governed by fuzzy logic: high value (definitely positive feedback), medium-high value (rather positive feedback), confirmation is required (no feedback can be provided since no critically important data on the considered method/equipment are available), medium-low value (rather negative feedback) and low value (definitely negative feedback).

The following relationship could be traced between the novelty and the feasibility indicators: if a high novelty level was indicated by the experts, the feasibility level was usually evaluated as low, since it was difficult to predict the potential wide application in case of some novel untested methods, and vice versa in case of already common ones with a low novelty level. The breakthrough technologies mostly scored zero since the experts needed additional supporting information.

Further interaction with the companies showed that the methods/equipment supplied by at least six of them could be piloted, which has been demonstrated by the scouting results amounting to 6%. The final list featured three organizations whose equipment and software could be used in KIRO, two companies supplying soil cleanup methods and one company producing remotely controlled devices for dismantlement operations.

Conclusion

The current technological support level in nuclear decommissioning, RW management and nuclear cleanup shows great potential for further development considering the following key areas:

- application of digital and calculation tools enabling variant-based analysis of various solutions and supporting the selection of an optimal one;
- introduction of technologies that proved to be successful in other countries implying the use of Russian equipment through localization, license transfer or joint production;
- managerial tools supporting the search for and introduction of more advanced methods.

Already widespread application of digital information models, Decommissioning Smart Manager software application in multivariate calculations of possible decommissioning strategies can be considered as the first progress in this area. Further on, the website of the Russian Decommissioning Network is going to be launched and a few new engineering methods considered as having potential for widespread implementation in the decommissioning area are going to be selected for further piloting.

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