REVISS/MAYAK: A NEW PARTNERSHIP IN RADIOISOTOPE SUPPLY

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SUMMARY. This paper describes how REVISS Services (UK) Ltd, the joint venture company formed between Amersham International plc, Production Association MAYAK and Techsnabexport, is able to provide an extensive range of radioisotope and radiation source products and services, including Cobalt-60 sources and services for the irradiation processing industry supplied under the PURIDEC Irradiation Technologies brand. The paper discusses the history, facilities and capabilities of Mayak and describes how REVISS's special expertise enables it to also effectively procure products and services from other suppliers in Russia.

1. INTRODUCTION

MAYAK Production Association, which is the main manufacturing supplier to, and a key shareholder in REVISS services, is situated in the Urals region of Russia about 100 miles from Ekaterinburg. It was formerly a closed and secret city not open to Western visitors, and not even shown on maps. Its development into a world supplier of radioisotope products is one of the brightest examples of the re-orientation of the world's nuclear industry, particularly in Russia.

The history of the company dates back to the late 1940's when the first nuclear reactor designed for Pu-239 production was commissioned on the Chelyabinsk-65 site on June 19, 1948. Over the next 40 years MAYAK grew rapidly to become the most powerful defence nuclear complex of the former Soviet Union, whose main function was to support the national military program. In this respect, MAYAK'S development mirrors DoE Hanford in the U.S and AWRE in the UK. Advanced technology and equipment, and experienced, well trained and highly professional personnel were all focused on achieving the goals of the defence program and all production-related and even social activities were covered by a dense curtain of secrecy.

Following political changes in the late 1980's and the early 1990's, the Russian economy changed dramatically with the result that military spending was cut, causing problems for financing and managing the MAYAK industrial complex. Conversion of military production into development and manufacture of products and processes for peaceful applications was the only viable way for the company to develop and maintain its technical and R&D potential. A positive aspect of political and economic reform was the ability of MAYAK to participate in a joint venture company with Amersham International-REVISS Services Ltd - see Figure 1. REVISS better enabled MAYAK products to access export markets and gradually MAYAK developed from an industrial military complex to a center of Nuclear Fuel Reprocessing and Radioisotope Manufacturing.

Today MAYAK'S activities cover the whole range of nuclear cycle operations relating to reprocessing and handling of radioactive
materials, including reactor irradiation of targets, reprocessing of targets and spent fuel from nuclear power stations, extraction and purification of radioisotopes, fabrication of radiation and heat sources and recycling and solidification of radioactive waste using an advanced vitrification technology.

2. PRODUCTION FACILITIES AND CAPABILITIES

Based on its continuing developments in the Reactor, Reprocessing and Radioisotope Product divisions, and as a result of successful implementation of the conversion program and close co-operation with its joint venture partner Amersham International plc to form REVISS Services, MAYAK is now known as a world class supplier of Cobalt-60, particularly for Gamma Processing Plants, and Caesium-137, as well as a major international supplier of other radioisotopes, including Pu-238 which is purchased by the US DoE for fabrication of the radioisotope thermoelectric generators for NASA's long term deep space missions.

Two highly efficient reactors used for radioisotope production are now in operation. A wide range of radioisotopes is produced by irradiation including Co-60 (both LSA and HSA), C-14 and Ir-192. The neutron specification of the reactors is sufficient to achieve a specific activity as high as 300 Ci/g for Co-60.

Most reactor produced radioisotopes, except Co-60 and Ir-192, require physio-chemical reprocessing of either irradiated targets or spent fuel assemblies. MAYAK successfully operates multi-stage separation processes which enable extraction from the spent fuel, and the subsequent purification, of a variety of high quality radioisotopes, in particular Cs-137.

Both primary and secondary encapsulation of the raw material is carried out in hot cells equipped with manipulators. MAYAK's facilities for fabrication of Cs-137 and Co-60 sources are arranged to minimize the possibility of contaminating the finished products and to ensure that they are fabricated, quality tested and loaded into containers in clean hot cell conditions. This is achieved by physical segregation of the production lines for primary and secondary encapsulation. All source fabrication cells are lined inside with stainless steel and have sufficient radiation and biological shielding to allow for holding significant activities of Co-60 with complete safety for personnel. Wide lead glass windows, easy to use manipulators and all necessary auxiliary equipment provide safe and effective production operations including source encapsulation, measurement and testing. The tested and Quality Assurance certified sources are finally loaded into transport containers directly in the hot cell and then shipped to PURIDEC/REVISS in the UK. Alternatively, when immediate shipment is not required, the finished sources can be temporarily stored in a pond connected to the production line by means of conveyor system. The storage pond is a 6 meter deep stainless steel encased tank with a licensed capacity of many MCi. The pond is filled with water as vapour condensate which is replaced on a regular basis. The water conditions are constantly monitored for chloride ion content, general hardness, pH and radionuclide content. After storage in the pond, before loading into containers and subsequent shipment, sources are rigorously re-inspected to verify that they meet customer and quality assurance requirements.

Additionally, when there is a need for prototype testing to meet requirements for ISO Classification and IAEA Special Form certification of sources, MAYAK has the necessary facilities and equipment, as well as qualified and authorised personnel, to perform all the required testing and to provide results within the required time-scales.

3. PRODUCT RANGE

The REVISS range of radioisotope/radiation source products is now the most extensive available world-wide. It includes, from MAYAK:

Radiation sources:-
- Cobalt-60 Sources

Cobalt-60 sources and services, including irradiation plant are supplied by REVISS under its PURIDEC Irradiation Technologies brand.

Over the last few years MAYAK's production output has increased manyfold from a few
MCi per year, due largely to the success of PURIDEC Irradiation Technologies in the market. The increased volume includes Cobalt-60 sources manufactured for:

- Sterilization of medical disposable products, food preservation and other irradiation applications (MAYAK designed GIK-A3 sources and REVISS designed RSL2089 sources - equivalent to Amersham International’s type X2089), plus raw materials for REVISS’s RSL1800 dry storage source design.

- Gamma teletherapy for medical radiotherapy

Neutron irradiated and nickel plated metal Cobalt-59 discs (dia. 7.0-20.0mm) and slugs (dia. 0.8 and 1.4mm) are used as the active core for fabrication of Co-60 sterilization and therapy sources. These are doubly encapsulated into 316L stainless steel capsules in hot cells by using Tungsten Inert Gas (Argon) welding.

MAYAK is able to make standard sources with capsule designs and curie contents ranging from 170 mCi (therapy) to over 15,000 Ci (sterilization). These are produced to customer specifications so that dimensions and activities of sources for almost any design of wet storage irradiator can be supplied whilst sources for dry storage irradiators are also provided.

All Co-60 sources undergo rigorous quality control including weld section examination, radiation measurement, helium leak, bubble, immersion and wipe tests. They can also be tested for ISO Integrity Classification, and if necessary, IAEA Special Form certified for transportation purposes. Based on the high manufacturing and quality standards achieved by MAYAK, and PURIDEC’s ongoing surveillance programme, a source working life of up to 20 years is offered.

- Caesium-137
  In the last few years MAYAK’s Cs-137 production output has increased due to the successful marketing efforts of REVISS Services Limited. MAYAK’s production capacity of many hundreds of kCi of Cs-137 sources per year can be made available for various applications including:
  - Research and calibration
  - Therapy

- Blood irradiation
- Sterilization
- Process control

Caesium Chloride with Cs-134 content < 1% and <3% and specific activity 22-23 Ci/g is used as active material for the manufacture of finished sources. The sources are doubly encapsulated, sealed by TIG welding and subsequently quality tested by bubble, helium leak and wipe tests. Their individual activity range is from 1 Ci to 4,000 Ci.

- Strontium-90
  For power/heat sources
- Americium-241
  For smoke detectors and in neutron sources
- Iridium-192
  For industrial radiography

Bulk radioisotopes:-
- Carbon-14
- Krypton-85
  (Low and high enrichments)
- Tritium gas
- Neptunium-237
- Strontium-90

Additionally stable isotopes, cyclotron products and other nuclides can be provided via REVISS’s contacts with organisations such as:
RIAR, Dimitrovgrad (P-33, Cf-252 ....)
“Cyclotron”, Obninsk (Co-57, Cd-109 ....)
“Avangard”, Arzamas (Po-210 ....)
Khlopin Radium Institute, St Petersburg, (Fe-55 ....)

4. PURIDEC IRRADIATION TECHNOLOGIES

PURIDEC Irradiation Technologies, as mentioned above, is the brand name of the business group providing Cobalt-60 sources and services for the irradiation industry. It was initially set up by Amersham International Plc but is now fully integrated into REVISS Services (UK) Ltd. PURIDEC has over 35 years of experience in the design and manufacture of Cobalt-60 sources and now exclusively markets the NUKEM range of industrial irradiation plants. NUKEM's
experience goes back to 1962 when H.S. Marsh Ltd, now part of the NUKEM organisation, built the world's first commercial irradiator for Johnson & Johnson in the UK. This partnership enables PURIDEC to combine its own skills in manufacturing, handling and transporting radiation sources with NUKEM's vast experience in designing, manufacturing and building nuclear, chemical and other processing plants. Thus PURIDEC's product range now includes:

- RSL2089 source design for wet storage irradiators - transported in small lightweight containers
- RSL1800 source design for dry storage irradiators
- Special source designs for research and other small irradiators
- Installation of sources into all types of irradiator
- Calculation of source loading patterns to achieve optimum plant performance in line with customers' objectives.
- Irradiation plants, including tote and pallet types, for all applications
- Engineering services including design and manufacture of source racks and modules
- Installation of PURIDEC's leading PC based control system, including automated dosimetry and product tracking, into existing plants
- Source surveillance programmes to support safety of plant operation
- Training programmes covering safety, plant operation, dosimetry, etc.

5. QUALITY ASSURANCE

MAYAK would never be able to access export markets without achieving and maintaining internationally recognised quality standards, based on its old traditions of military production when quality was a decisive factor. MAYAK's production capabilities have been upgraded to supply products within a ISO9001 compliant quality system.

All technological processes are documented and approved. Goods-in inspection is performed for all materials in process (components and raw materials). Quality monitoring and traceability throughout the production process is maintained via route cards. Positive product release ensures that products meet the customer specification and is compulsory, with the results being recorded in Quality Records supplied with the sources. All MAYAK's Quality Assurance procedures are based on ISO standards and techniques. Weld sections are routinely prepared from welded inactive process control samples to verify the required penetration. Containment of the finished sources is checked during the process of fabrication by using wipe, bubble and immersion tests, and also helium pressurization or helium pre-filled leak tests. The finished products have a very low contamination level as required by customers and this is confirmed by a wipe test. Radiation measurements of sources can be made to the customer's requirements including Exposure Dose Rate and Air Kerma Rate measurement in low scatter conditions or by comparison with a certified standard. Activity distribution scanning etc. is also available. In addition, there are other measurement facilities available which enable MAYAK to perform more accurate activity measurements using calorimetry and also alpha/beta/gamma spectrometry and precise elemental analysis using an Inductive Coupled Plasma spectrometer.

Finally all REVISS/PURIDEC major source despatches and other services follow written procedures and are made within a fully comprehensive ISO9001 compliant Quality Assurance system.

6. CONCLUSIONS

Using the skills and facilities developed as a result of its earlier defence activities MAYAK has reoriented to manufacture peaceful products and become, via its joint venture company REVISS Services (UK) Ltd, not just a major supplier of radioisotopes and other associated products, but the supplier with the largest product range. Products are manufactured to the highest possible standards of quality assurance enabling REVISS to offer its customers CHOICE, QUALITY and SERVICE.
Figure 1