

MC&A Instrumentation Catalog

Каталог приборов для учета и контроля ядерных материалов

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1 ABBREVIATIONS

Below is a list of major abbreviations found in the Catalog.

Abbreviation in Russian	Abbreviation in English	Description	Описание
БНЛ	BNL	Brookhaven National Laboratory	Брукхэвенская национальная лаборатория
ИФТП	IFTP	Institute of Physics & Technical Problems	Институт физико-технических проблем
ФЭИ, ГНЦ РФ	IPPE, SSC RF	State Scientific Center of Russian Federation, Institute of Physics and Power Engineering	Государственный научный центр Российской Федерации Физико-энергетический институт
ЛАНЛ	LANL	Los Alamos National Laboratory	Лос-Аламосская национальная лаборатория
ЛЛНЛ	LLNL	Lawrence Livermore National Laboratory	Ливерморская национальная лаборатория им. Лоуренса
УиК ЯМ	MC&A	Material Control & Accounting	Защита, учет и контроль ядерных материалов
ЗУиК ЯМ	MPC&A	Material Protection, Control & Accounting	Защита, учет и контроль ядерных материалов
ОРНЛ	ORNL	Oak Ridge National Laboratory	Оук-Риджская национальная лаборатория
С3ТНЛ	PNNL	Pacific Northwest National Laboratory	Северо-западная тихоокеанская национальная лаборатория
ПИЯФ	PNPI	State Science Center, St. Petersburg Nuclear Physics Institute	Государственный научный центр Российской Федерации Петербургский институт ядерной физики им. Б.П. Константинова
РФЯЦ ВНИИЭФ	RFNC VNII EF	Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics	Российский федеральный ядерный центр Всероссийский научно-исследовательский институт экспериментальной физики
РФЯЦ ВНИИТФ	RFNC VNIITF	Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics	Российский федеральный ядерный центр Всероссийский научно-исследовательский институт технической физики
НИИИТ	RIPT	Research Institute of Pulse Technology	Научно-исследовательский институт импульсной техники
СНИИП	SNIIP	Union Research Institute of Instrumentation Design	Союзный научно-исследовательский институт приборостроения
СНЛ	SNL	Sandia National Laboratories	Сандийские национальные лаборатории
ВНИИА	VNIIA	All-Russian Research Institute of Automatics	Всероссийский научно-исследовательский Институт Автоматики
ВНИИТФА	VNIITFA	All-Russian Research Institute of Technical Physics and Automatization	Всероссийский научно-исследовательский институт технической физики и автоматизации
РФА	XRF	X-Ray Fluorescence Analysis	Рентгено-флуоресцентный анализ

2 INTRODUCTION

Background

In 1981 and 1985, two editions of a catalog of non-destructive nuclear measurement instrumentation, and material control and surveillance equipment, were published by Brookhaven National Laboratory (BNL) [2.1 and 2.2]. The last edition of the catalog [2.2] included one hundred and twenty-five entries covering a wide range of devices developed in the United States and abroad. More than ten years have elapsed since the publication of the more recent Catalog. Devices described in it have undergone significant modifications, and new devices have been developed. Therefore, in order to assist specialists in the field of Material Control and Accounting (MC&A), a new catalog has been created.

Work on this instrumentation catalog started in 1997 as a cooperative effort of Brookhaven National Laboratory (BNL), operated by Brookhaven Science Associates under contract to the US Department of Energy, and the All-Russian Research Institute of Automatics (VNIIA), subordinate institute of the Atomic Energy Ministry of the Russian Federation, within the collaborative US-Russia Material Protection, Control, and Accounting (MPC&A) Program.

Devices Represented

Most of the equipment included in the Catalog are non-destructive assay (NDA) measurement devices employed for purposes of accounting, confirmation, and verification of nuclear materials. Other devices also included in the Catalog are employed in the detection and deterrence of unauthorized access to or removal of nuclear materials (material control: containment and surveillance).

Equipment found in the Catalog comprises either: (1) complete devices or systems that can be used for MC&A applications; or (2) parts or components of complete systems, such as multi-channel analyzers, detectors, neutron generators, and software. All devices are categorized by their status of development – from prototype to serial production.

Some devices are listed with only one developer or supplier. This does not necessarily signify that there are no other developers or suppliers of those devices. The authors provide no assurance that the present Catalog includes an exhaustive enumeration of all developers or suppliers of MC&A equipment, nor completeness of devices within each class.

Data Collection

The bulk of the information for the Catalog was gathered in the summer of 1997 in the course of visits by the representatives of BNL and VNIIA to a number of US national laboratories and developers, manufacturers, and suppliers in the private sector in the US. During these visits, a detailed questionnaire to the host organizations was prepared and used. Letter requests containing a similar questionnaire were sent to various companies in the US, Russia and other countries that design and manufacture MC&A instrumentation. In the majority of cases, the requested information came in the form of company catalogs and brochures, technical descriptions, or journal publications. Note that the Catalog includes only technical information. Price information is not included.

After the collected information was processed and edited by the authors, the printed versions of the corresponding device descriptions were sent to the providers of the information for review, comment and correction. The authors made every effort to present the obtained information completely and accurately.

Terminology

Since the device descriptions were provided by organizations in different countries, the authors tried to minimize inconsistencies by employing terminology commonly used in the technical literature on NDA methods and instrumentation.

Electronic and Paper Versions

All data were entered in a database developed in MS ACCESS (TM). The database was used for processing, viewing, and printing information throughout all stages of the Catalog preparation. Unlike the previous two BNL editions of the Catalog [2.1 and 2.2], a current electronic version is being sent to users together with the paper

version. The electronic version will provide users with the opportunity to conduct fast and complex formalized searches (using a pre-determined list of keywords for making selections) as well as searches in free mode. The electronic database enables users to review data and print reports on selected devices in English or Russian.

Catalog Distribution

The Catalog is available on request to any organization involved in handling and processing of nuclear materials or development, manufacturing, and distribution of MC&A equipment. The general distribution package will include paper and electronic versions.

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The MC&A Instrumentation Catalog and Electronic Database were created by a cooperative effort of specialists from Brookhaven National Laboratory and the All-Russia Research Institute of Automatics. The VNIIA effort was supported under a contract between BNL and VNIIA. Dozens of additional specialists both from US and Russia contributed to the Catalog effort during 1997 and 1998.

The authors are grateful to BNL and VNIIA staff for providing valuable advice and expertise in the course of work on the Catalog. Clemens Auerbach (BNL), the author of the second edition of the previous catalog, for meticulously reading and correcting the text of the catalog, and providing suggestions on the Catalog structure and device categorization; and Jack Allentuck, Leslie G. Fishbone (BNL) (one author of the first edition of the previous catalog), Ray Parsick (BNL), Andrey Sviridov, Alexei Lavrushin, and Nikolai Isaev (VNIIA) for providing managerial guidance of this collaborative work.

In the summer of 1997, a team of specialists from BNL and VNIIA visited several US national laboratories and equipment developers, manufacturers, and suppliers. During these visits, many US specialists, in addition to providing detailed information on specific devices, made important suggestions related to organization of the device data and structure of the Catalog and its database. They included: Benjamin Campagnuolo, Robert D. McElroy, Jr., Markku Koskelo, Jim Calarisi (Canberra); Peggy Williams and Bradley S. Weil (ORNL); Scott Huches and Harold Wheat Jr. (Lockheed Martin Energy Systems); T.J. Paulus, Ronald M. Keyser, B. Kennedy, Kevin Buxton, Amy H. Kennedy (EG&G Instruments, ORTEC); Steve Kadner, John Kraus, Wendy Roman (Aquila Technologies Group, Inc.), Wayne D. Ruhter, Mark Rowland, Anthony Lavietes, Arden D. Dougan (LLNL); Mario Hug, Kinichi Kusumoto, and Mark J. McCarthy (NNC); Mark Killinger, Dan Haggard, Rich Arthur, Mary Bliss, Bruce Geelhood, Harry Miley (PNNL); John Matter and Darryl Drayer (SNL); E. Chris Horley and Mark Mullen (LANL); Edward Browning (QUANTRAD Sensor); and Joseph R. Wachter (Pajarito Scientific Corporation).

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Information on instrumentation developed and manufactured in Russia was gathered, processed, and input into the database by Natalya Moshkina, Gregory Strelnikov, and Oleg Morozov (VNIIA). They also did most of the translation work. Natalya Moshkina and Igor Sazonov (VNIIA) provided invaluable support in developing the database structure.

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3 METHODS AND EQUIPMENT FOR MC&A

This section contains brief descriptions of the main methods and types of equipment currently used in MC&A applications; the authors borrowed heavily from [3.1 and 3.2]

3.1 NON-DESTRUCTIVE ANALYSIS

3.1.1 GAMMA SPECTROMETRY

Most nuclear materials of concern in MC&A emit gamma rays and these can be used for NDA of the materials. Gamma rays have well defined energies which are characteristic of the isotopes emitting them. Determination of the gamma ray energies serves to identify the isotopic composition of the materials. When combined with a measurement of the intensities they can provide quantitative information on the amount of material that is present. Enriched uranium fuel, for example, has a strong 186 keV gamma ray associated with the alpha decay of U235 and the U235 enrichment can be determined by measuring the intensity of this gamma ray. Plutonium samples generally contain the isotopes Pu238, Pu239, Pu240, Pu241 and Pu242 as well as decay products, which give rise to a highly complex mix of characteristic gamma ray energies. The date of discharge of irradiated fuel from a reactor can be verified by measuring the relative intensities of gamma rays associated with fission and activation products. The 662 keV gamma ray from Cs137 is particularly important for this type of determination.

To detect gamma rays the radiation must interact with the detector to give up all or part of the photon energy. The basis of all gamma ray detector systems is the collection of this liberated electrical charge to produce a voltage pulse whose amplitude is proportional to the gamma ray energy. In a gamma ray spectrometer these pulses are sorted according to amplitude (energy) and counted using suitable electronics, such as a single- or multichannel analyser. With a multichannel analyser the gamma rays analyzed at different energies can be displayed or plotted to produce a gamma ray energy spectrum which provides detailed information on the measured material.

3.1.1.1 GAMMA DETECTORS

The gamma ray detectors most commonly used are either scintillators — usually activated sodium iodide (NaI) crystals — or solid state semiconductors — usually high purity germanium (Ge) or cadmium telluride (CdTe) crystals. The NaI detectors can be made with large volumes and generally have higher gamma detection efficiencies than Ge detectors. Their uses in MC&A applications include, for example, the verification of fresh U235 fuel enrichment as well as the presence of spent fuel through detection of fission product gamma radiation. Their ability to distinguish between gamma rays of different energies, however, is relatively poor and of the three types of detector they have the lowest energy resolution.

Germanium detectors have far superior energy resolution to NaI detectors and are better suited to the task of resolving complex gamma ray spectra and providing information about the isotopic content of materials. The Ge detectors used range in size from small planar types to large (80-90 cm³) coaxial detectors. A disadvantage of these detectors is that they must be operated at very low temperature, which is usually achieved by cooling with liquid nitrogen.

Standard CdTe detectors (and CdZnTe detectors) do not need cooling and of the three detectors they have the highest intrinsic detection efficiency. Recent progress in fabrication techniques has substantially improved CdTe resolution. Until 1997 the standard volumes available were relatively small (20 and 60 mm³). Nevertheless, their portability and small size made them especially suitable for use in confined spaces, such as in verification measurements of fresh fuel assemblies whose design permits insertion of the detector probe into the assembly interior, and of spent fuel bundles stored underwater in closely packed stacks. Much larger CdZnTe detectors have recently been fabricated with volumes of up to 1500 mm³, providing a substantial increase in detector efficiency.

3.1.2 NEUTRON COUNTING

There is a number of different types of neutron counting equipment using passive and active detector systems to determine the amount of fissile material.

Neutrons can be emitted from non-irradiated nuclear fuel in three ways:

- Spontaneous fission from fissile isotopes such as those of Pu;
- Induced fission from fissile isotopes (typically by means of a low energy neutron source);
- Alpha particle induced reactions, (α , n), involving light elements such as oxygen and fluorine.

Fission neutrons in the first two categories are emitted in groups of two or more for each fission event. This signature is detected as a neutron coincidence. Nearly all the isotopes of U, Pu and other transuranium elements emit alpha particles. These interact with light elements present in compounds (e.g. oxides and fluorides) or as impurities (e.g. B, Be and Li) to form an undesirable neutron background. Neutron coincidence counting discriminates against this background by processing the neutron pulses to select correlated (in time) detection events and eliminating the (α , n) background neutrons, which are emitted singly and thus are uncorrelated.

Passive detector systems determine the mass of Pu on the basis of the spontaneous fission of primarily its even-numbered isotopes (Pu238, Pu240 and Pu242, with Pu240 the dominant contributor). The major fissile isotope, Pu239, has a typical abundance in fuel of 60-80% yet it contributes insignificantly to spontaneous fission. Isotopic abundance must be known or verified —typically by a high resolution gamma ray measurement. Using the isotopic abundance the coincident-neutron count rates can then be converted into a value for the total Pu mass in a sample. For uncontaminated samples, measurement accuracy is of the order of 1% or less.

The fissile isotope U235 does not undergo sufficient spontaneous fission for practical passive detection. In this case an active system incorporating AmLi neutron sources is used to 'interrogate' the U235 content by neutron induced fission. For low energy incident neutrons the U238 in a sample contributes insignificantly to the measured coincident-neutron count rates even though U235 may be enriched to only a few per cent (e.g. low enrichment fuels).

Neutron detectors employ various neutron capture reactions to function. The reactions produce energetic particles, which in turn ionize a gas and produce a charging pulse. The choice of detector (i.e. the capture material) is based mainly on the neutron detection sensitivity required and on the insensitivity to other radiation, e.g. gamma rays. Nearly all detectors have the highest sensitivity for low energy neutrons. Consequently in many neutron detector systems the detectors are surrounded with a moderator material such as polyethylene to slow down the energetic neutrons to thermal energies.

3.1.2.1 GROSS NEUTRON COUNTING

Gross neutron counting refers to the sum of all neutrons detected. Here the neutron source cannot be characterized since coincidence requirements are not applied. The presence of significant numbers of neutrons is often a sufficient indication that fissile nuclear material is present. All the neutron coincidence detection systems (discussed below) give total neutron count rates as well as coincidence count rates.

3.1.2.2 NEUTRON COINCIDENCE COUNTING

Neutron coincidence counting has evolved into a very stable, reliable and accurate technique to determine Pu and U235 content. Modern, well designed neutron coincidence systems are capable of reliably processing pulses over a very large range of input count rates (i.e. over more than six orders of magnitude). This stability is achieved by judicious selection and placement of amplifier electronics to minimize noise interference. These electronics boards, when located at the detector head, amplify and shape the pulses, apply lower level discrimination to (50 ns wide) logic pulses to the external pulse controller (the electronics controller).

Reliable coincidence counting is also due to a sophisticated pulse processing circuit (shift register electronics) in the external electronics controller. Pulses within a specified time period (normally set at 64mks) of one another may be termed correlated (i.e. "coincident") neutron pulses. This correlation time is associated with the slowing down of neutrons in the moderator. The shift register electronics keeps track of coincidences between pulses separated by about 1000 mks (accidentals) and coincidences in the first 64 mks (real coincidences plus accidentals) and subtracts the former to give the real coincidences. Other small corrections are also automatically applied.

PASSIVE DETECTOR SYSTEMS have one of two basic geometrical configurations: well detectors completely enclose the sample, and collar detectors encircle the sample (e.g. a fuel assembly). Well detectors have the preferred geometry since they have the capability of detecting all the neutrons emanating from the sample. Collar detectors are an alternative detector design that is appropriate when the sample becomes too large for placement inside a well detector. Whereas calibrated passive well detectors measure the total mass of Pu in a sample, collar detectors measure Pu mass per unit length of the fuel assembly. This linear density must then be multiplied by an effective length to give the total Pu mass in the assembly. There are many different passive detector systems, with their design features optimized for specific sample sizes, shapes or Pu mass ranges. About twenty such systems are currently used in nuclear safeguards.

ACTIVE DETECTOR SYSTEMS use neutron sources (typically AmLi) to interrogate the U235 in the sample. Again the well geometry is preferred but the collar geometry is the only practical solution when the sample is a fuel assembly. The full detector system includes the detector head, which detects the neutrons and houses the neutron source; the electronics controller, which powers the detector and determines the neutron coincidence rates; the portable computer for control and data analysis to determine U235 content; and the printer for generating reports.

3.1.2.3 SPENT FUEL MEASUREMENT

NEUTRON EMISSION AND DETECTION. Spontaneous fission of Cm242 and Cm244 is the major source of neutrons emanating from spent fuel. These isotopes are produced in the nuclear reactor fuel assemblies through multiple neutron capture events. The fission products in the spent fuel produce an extremely high radiation background in which the neutrons must be detected. This high radiation environment determines the techniques that can be deployed for spent fuel verification. One approach is to choose a detector which is basically gamma ray insensitive. Another approach is to shield against the gamma rays but allow the neutrons to pass through the shield to the neutron detector. Spent fuel verification methods include not only neutron detection but also gamma ray and ultraviolet light (Cerenkov radiation) detection.

3.1.2.4 NEUTRON DETECTORS

Mechanisms for detecting neutrons in matter are based on indirect methods. Neutrons, as their name suggests, are neutral. The process of neutron detection begins when neutrons, interacting with various nuclei, initiate the release of one or more charged particles. The electrical signals produced by the charged particles can then be processed by the detection system.

Two basic type of neutron interactions with matter are available. First, the neutron can be scattered by a nucleus, transferring some of its kinetic energy to nucleus. If enough energy transferred, the recoiled nucleus ionizes the material surrounding the point of interaction. This mechanism is only efficient for neutrons interacting with light nuclei. Second, the neutron can cause a nuclear reaction. The products from these reactions, such as protons, alpha particles, gamma rays, and fission fragments, can initiate the detection process.

Detectors employing either the recoil or reactions mechanism can use solid, liquid, or gas-filled detection media. Although the choice of reactions is limited, the detecting media can be quite varied, leading to many options.

GAS-FILLED NEUTRON DETECTORS. He3 and BF3 Thermal-Neutron Detectors finds many applications in passive and neutron assay because they are relatively stable, efficient, and gamma-insensitive. In the case of BF3, the gas is enriched in B10. Helium-3 is only about 1 ppm of natural helium, so it is usually obtained by separation from tritium produced in reactors. The detection efficiency for thermal neutrons is high, and the interaction probability for gamma rays is low. However, if the gamma dose is more than emitted by typical plutonium and uranium samples, the response of He3 and BF3 detectors will be affected.

He4 and CH4 fast neutron detectors rely on the recoil of light nuclei to ionize the gas in the tube. The interaction is elastic scattering of the neutron by light nucleus. Despite the apparent disadvantages of recoil-type detectors in terms of lower efficiency and stability, the detection process take place without prior thermalization of the incident neutron. Thus the neutron is detected very rapidly and some information on its initial energy is preserved.

PLASTIC AND LIQUID (ORGANIC) SCINTILLATOR are often used for fast-neutron detection because of their fast response and modest costs. Fast response is particularly beneficial for coincidence counting applications where the ratio of real to accidental coincidence events can a significant impact on the statistical precision of measurement. The major disadvantage of organic scintillators in nondestructive applications is their high gamma-ray sensitivity.

3.1.3 CALORIMETRIC ASSAY

Calorimetry is the quantitative measurement of heat. It measures the transfer of energy from one system to another caused by temperature differences. When applied to MC&A calorimetry measures the rate of heat generation (power) from radio-nuclides. Radiometric calorimeters are designed to measure the power associated with alpha, beta, or gamma decay of radioactive materials.

Radiometric calorimeters operate on the principle that almost all of the energy associated with the decay of radioactive materials placed in the sample chamber is absorbed in the form of heat within the calorimeter. The radioactive decay of all uranium and plutonium isotopes generates heat, but only the plutonium isotopes, because of their shorter half-lives and thus higher specific activities, generate heat at a high enough rate (power) to be measured accurately. Most of the plutonium decay energy is released as alpha or beta particles and converted to heat energy through absorption. A small portion is carried away by neutrons and gamma rays, however this portion is generally less than 0.01% of the total decay energy.

Methods of calorimetry are now being applied with precision and accuracy in the passive nondestructive assay of nuclear materials, especially plutonium and tritium. The important features and advantages of calorimetric assay are listed below:

- The entire sample can be measured.
- The assay is independent of sample geometry (only equilibrium time is affected).
- The assay is independent of matrix material composition and distribution, including nominal moisture concentrations.
- The assay is independent of nuclear material distribution within the sample, including the effects of sample self-attenuation.
- Electric current and potential measurements are directly traceable to reference materials.
- Calorimetric assay is applicable to a wide range of material forms (including metals, alloys, oxides, fluorides, mixed oxides, waste, and scrap). Representative plutonium standards are not need.
- Calorimetric assay is comparable to chemical assay in precision and accuracy provided that isotopic composition is well characterized.
- Calorimetric assay is a completely nondestructive assay procedure when coupled with high-resolution gamma-ray spectroscopy isotopic analysis.

An important disadvantage to calorimetric assay is that it is time consuming. In general the technique employs equipment which is less portable although more accurate than other nondestructive assay techniques applicable to nuclear material measurement. It can often provide accurate reference measurements for improving the calibration of other assay techniques such as neutron coincidence counting.

Calorimetric assay is most precise for materials with high plutonium concentrations such as powders, fuel pellets, and metals. Calorimeters are being used extensively for nuclear materials accountability and for shipper-receiver confirmatory measurements of plutonium. When applied to concentrated, homogeneous plutonium-bearing materials, calorimetry is comparable in accuracy to precision weighing and chemical analysis. For high-density scrap which has homogeneous isotopic composition, calorimetry plus gamma-ray spectroscopy can approach a precision and accuracy to within 1%.

3.1.4 K-EDGE DENSITOMETRY

The K-edge Densitometer is used to determine the Pu concentration in solutions. The system consists of a high resolution Ge detector, a multichannel analyser and a portable computer. A Se57/Co57 source of low energy gamma rays is positioned for the gamma radiation to pass through the solution. The absorption of this radiation gives a sensitive measure of the Pu in its path.

3.2 DESTRUCTIVE ANALYSIS

3.2.1 URANIUM, THORIUM OR PLUTONIUM BY K-EDGE X-RAY DENSITOMETRY

K-edge X ray densitometry is applicable to all U, Th and Pu materials and to mixed U-Th or U-Pu samples containing a sufficient amount of the analyte: a precision and accuracy of about 0.2%rel. may be achieved when the concentration of the analyte ranges from 80 to 150 g/L. The method is very selective, but the determination of the major actinide, such as Pu, may be biased by the presence of a minor actinide element of lower atomic number, such as U.

3.2.2 PLUTONIUM BY K X-RAY FLUORESCENCE ANALYSIS

K X ray fluorescence analysis is applied to samples of PuO₂ and Pu nitrate solutions containing at least 3-4 mg Pu with the addition of known amounts of U as an internal standard. It is also used for Pu assay in samples of MOX and U-Pu nitrate solutions in combination with a determination of the U content by titration or by K-edge X ray densitometry. A precision and accuracy of 0.2%rel. are achievable.

3.3 CONTAINMENT AND SURVEILLANCE

Containment and surveillance (C/S) techniques are extensively deployed now owing to their flexibility and cost effectiveness. The main C/S means are radiation monitors, optical surveillance and sealing systems.

3.3.1 RADIATION MONITORS

Radiation monitors are located at the periphery of nuclear-material and radioactive-contamination control areas to detect accidental or covert removal of radioactive materials. Two types of radiation monitors are in use today: contamination monitors and nuclear material monitors. Contamination monitors detect contamination on the surface of the person or an object where the radiation comes from an extended area viewed without intervening absorbers. Nuclear-material monitors must be able to detect small, possibly shielded quantities of nuclear material that may be hidden.

Nuclear-material monitors have to meet requirements to search each person, package, or vehicle leaving a nuclear-material access area. Contamination monitors meet radiation safety standards for monitoring persons leaving a radioactive-contamination area. In both cases, visual or manual searches may be ineffective, but radiation monitors sense radiation emitted by materials and can conduct unobtrusive, sensitive, and efficient searches. The monitors provide timely notice of contamination or diversion before the controlled material can leave an access area.

Diversion monitors are either automatic portal monitors or hand-held monitors. The versatile hand-held monitor has many applications, including contamination monitoring. Their effectiveness depends on the operator making a thorough scan. In contrast, portal monitors are fully automatic.

3.3.1.1 DETECTORS FOR RADIATION MONITORS

Radiation monitors use different types of radiation detection depending on whether they are designed to detect contamination or diverted nuclear material. Gas proportional counters are most appropriate for detecting the radiation from contamination, and scintillators are most appropriate for detecting the penetrating radiation from diverted material.

Plastic scintillation detectors are solid organic scintillators that contain fluorescent compounds dissolved in the polymer solute. These materials have low density and low atomic number so they lack strong photoelectric absorption. They detect gamma rays by detecting Compton recoil electrons, and they detect neutrons by detecting recoil protons. These detectors do not display full-energy peaks; they display a continuous spectrum from the Compton edge down to zero energy. Although organic scintillators are poor energy spectrometers and have low intrinsic detection efficiency, they make excellent large-area, low-cost radiation counters. Their low cost results from

the use of inexpensive materials and simple packaging; NaI crystals, on the other hand, are expensive to grow and to protect from moisture and thermal shock.

3.3.2 OPTICAL SURVEILLANCE SYSTEMS

Optical surveillance is most effective in storage areas (such as spent fuel storage ponds) with relatively few activities that could be interpreted as the removal of nuclear material. A typical application would consist of two or more cameras positioned to completely cover the storage area. The field of view of the cameras is such that any movement of items that might constitute the removal of nuclear material is easily identified. This means that items have to be sufficiently large in the field of view to be identified and that one or more images have to be recorded during the movement. The image recording may be set at a periodic frequency (significantly shorter than the fastest removal time) or the motion (i.e. scene change) may trigger the recording. Optical surveillance is intrinsically an unattended operation that may be enhanced by the remote transmission of image data or system operation data (i.e. the status of the surveillance system).

Optical surveillance equipment has undergone a transition from analog video systems to digital surveillance systems. Digital surveillance systems were essentially mandated by the strong commercial industrial trend in the manufacture of low cost digital components providing significantly improved system performance.

3.3.3 SEALING SYSTEMS

Seals are typically applied to individual items containing nuclear material. A seal can help to indicate that material was neither introduced into nor removed from a container and, at the same time, provides a unique identity for the sealed container. Unattended monitoring equipment is often also sealed. Most seals are usually applied for extended periods of time. These seals may be either single-use seals that are replaced when checked or seals that are verifiable in situ, i.e. they can be checked for integrity and identity in the field. If the seals are in situ verifiable then the verification activity must be efficient (to limit radiation exposure to the inspector) and extremely reliable. The in situ verification activity must consist of checking the item containment as well as the seal and the method of its attachment to the item.

A sealing system comprises the containment (container) enclosing the nuclear material, the means of applying the seal (e.g. a metal wire) and the seal itself. All three components must be examined in order to verify that the sealing system has fulfilled its function of ensuring continuity of knowledge of the identity and integrity of the nuclear material concerned. There are single-use seals: metallic and adhesive seals; in situ verifiable seals: fiber optic, ultrasonic, electronic seals.

3.4 UNATTENDED AND REMOTE MONITORING

The use of unattended instrument systems has always been a requirement for MC&A. Optical surveillance systems, for example, are inherently unattended systems since their prime function is to survey an area over extended periods of time. Contemporary unattended monitoring systems employing radiation detection sensors are increasingly being used to detect the flow of nuclear material past key points in the facility process area. For complex nuclear facilities where the plant is automated (remotely operated), unattended assay and monitoring techniques are an integral part of a practicable MC&A implementation approach.

Unattended use necessitates that special considerations be included in the instrumental system design if the system is to be reliable and cost effective in providing credible, independent data. This means that the system must operate without failure over extended periods, including times when the facility power supply is interrupted. The unit should operate automatically and periodically record and transmit its status. If data are to be sent over unsecured transmission pathways then the data must be authenticated. And if data are to be shipped off-site then they must be encrypted to meet the requirements of the facility and the State for confidentiality of information. Because of the stringent design considerations unattended and remote monitoring equipment typically has to be flexible, modular and highly reliable.

In summary, the primary advantages of unattended and remote verification techniques are:

- Reduced inspection efforts,

- Reduced radiation exposure of inspectors,
- Reduced level of intrusiveness in the operation of nuclear facilities.

3.5 REFERENCES

[3.1] Techniques and Equipment. International Nuclear Verification Series, No 1. International Atomic Energy Agency, Vienna, 1997.

[3.2] Passive Nondestructive Assay of Nuclear Materials. Edited by: Doug Reilly, Norbert Ensslin, and Hastings Smiths, Jr., 1991

4 STRUCTURE OF DETAILED DEVICE INFORMATION

This section describes the structure of the device information presented in Catalog. The description of each device follows a fixed structure emulating the structure of the previous catalog developed by Brookhaven National Laboratory [2.1 and 2.2]: the description is divided into two parts, as described below.

The first part consists of the main qualitative device characteristics important for MC&A users. The complete list of these characteristics follows:

DEVICE NAME
MODEL
SUPPLIER
USE CATEGORY
DEVICE TYPE
MEASUREMENT METHOD
MEASURED PROPERTY
NUCLEAR MATERIAL
PHYSICAL FORM
ENVIRONMENT OF USE
STATUS
PORTABILITY
DEVELOPER
MANUFACTURER

Below are brief descriptions of these characteristics and their possible values.

DEVICE NAME

As a rule, the device name is unique and is supplied by the device developer or manufacturer. Sometimes, the same device name is used by different developers or manufacturers.

MODEL

The device's model names are unique for each device and are supplied by the developer or manufacturer.

SUPPLIER

Name of the supplier of the device. Often, an abbreviation in addition to the full name of the supplier is provided.

USE CATEGORY

Shows one of two MC&A applications of the device: accounting (equipment for accounting, confirmation, and verification measurements) and containment and surveillance (containment and surveillance equipment).

DEVICE TYPE

Corresponding lists of device types for the two Use Categories are shown below.

Accounting:

calorimeter
densitometer
detector
identifier
measurement system
multichannel analyzer
neutron counter
neutron generator
rod scanner
software
spectrometer

5 USERS GUIDE FOR ELECTRONIC VERSION

Installation

The MC&A Instrumentation Catalog database was prepared using MS ACCESS™, Microsoft Office 97. The database is distributed on a CD containing a runtime version of MS ACCESS™ and the database file, "MCA Catalog 1_0 Distribution".

1. If you do not have a full version of MS ACCESS 97 on your machine, install its runtime version:
 - open the CD directory on the distribution disk using MS Windows Explorer™,
 - click on the SETUP installation file, and follow instructions.
2. If you do have a full version of MS ACCESS 97, copy the Catalog database "MCA Catalog 1_0 Distribution.mdb" from CD onto your hard drive. Since this file is copied from a CD, it is a READ ONLY file. Therefore, you have to change its property from READ ONLY to READ/WRITE. To do so a) open Explorer, b) highlight the database file name, c) click right-button on your mouse, d) go to "Properties" and un-check the READ ONLY box.
3. The distribution CD contains several Cyrillic fonts that were used in the Catalog's reports and computer screens. These fonts have to be installed on the user" machine using the MS Windows fonts utility.

User Interface

The user interface consists of three major screens: MAIN, SEARCH/PRINT, and MISCELLANEOUS. The MAIN screen opens automatically when the database is loaded. This screen has three buttons: "Open Database", "Miscellaneous", and "Exit". Pressing any of the first two buttons leads the user to corresponding screens; pressing the "Exit" button closes the database and MS ACCESS. Note: On the MAIN screen one can see pictures of American and Russian flags. Clicking on those pictures switches between English and Russian for the MAIN and MISCELLANEOUS screens.

The "Open Database" button opens the SEARCH/PRINT screen designed to interrogate the database and print reports on the searches. The "Miscellaneous" button opens a menu screen providing the user with miscellaneous information on the database, companies, instrumentation descriptions, etc. From this screen the user can also print the entire database. The Exit button closes the database and MS ACCESS.

SEARCH/PRINT Screen

This screen is reached by pressing "Open Database" button on the main screen.

The database search can be performed by using from one to seven search key words or expressions entered in the four green and three blue fields. The green fields are used for a free entry of the search key words or expressions in the selected language; the entire record for each device is searched for the first three entries; Device ID search should be used in combination with other fields to narrow the search results. Each of the blue fields allows the user to do searches by Use Category, Device Type, and Supplier, respectively. Once the key words/expressions are selected, pressing the button with binoculars will conduct the requested search (leaving the search fields empty will show the entire database).

The user can request results of the searches to be arranged according to one of the three sorting orders indicated on the SEARCH/PRINT screen.

After search is completed, pressing the buttons on the left of each record in the resulting window will show and print the Catalog page corresponding to the selected device. The entire group of devices identified by the search can be reviewed by pressing the "glasses" button, or directly printed by pressing the "printer" button located at the top of the window. Listing of selected devices can be viewed or printed by pressing a blue list button. Note that clicking on the cell showing the name of the supplier will open a report page with information on that particular company.

The working language for the searches and reports prepared for printing is selected by pressing one of the two buttons located at the top of the screen.

6. LIST OF DEVICES

This section provides a list of all devices present in Catalog. The devices are arranged in the same order as the devices listed in Section 7, Detailed Device Information. The sorting order is as follows:

1. USE CATEGORY
2. DEVICE TYPE
3. SUPPLIER, and
4. DEVICE NAME

The devices are grouped by USE CATEGORY: DEVICE TYPE. The identifiers shown on the left of each entry correspond to the large numbers on the pages in Section 7. When the user of the electronic version of the Catalog chooses a different sorting order available in the SEARCH/PRINT screen (button "Open Database" in the main window), the listing will not have a sequential numbering of devices.

Accounting: Calorimeter

1	Heat Flow Calorimeters	Калориметры теплового потока	<i>LANL (ЛАНЛ)</i>
2	Calorimeter	Калориметр	<i>SNIP-ASCUR (СНИП - АСКУР)</i>
3	Calorimetric System for the Fissile Material Mass Measurement	Калориметрическая измерительная система для контроля массы делящихся материалов	<i>SSC IPPE (ФЭИ, ГНЦ РФ)</i>

Accounting: Densitometer

4	Radioisotopic Densitometer	Плотномер радиоизотопный	<i>IFTP (ИФТИ)</i>
5	KED/KXRF Hybrid Densitometer	Комбинированный плотномер по К-краю поглощения и РФА	<i>LANL (ЛАНЛ)</i>

Accounting: Detector

6	NaI Detector Shield/Collimators	Детекторы NaI с защитой и коллиматорами	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
7	Gamma-Ray and Neutron Detector Electronics Unit	Электронный блок для детекторов нейтронного и гамма-излучений	<i>Davidson Co. Inc. (Корпорация Дэвидсон)</i>
8	Coaxial and Planar Safeguard Germanium Detectors	Коаксиальные и планарные германиевые детекторы для целей гарантий	<i>EG&G Instruments, Inc. ORTEC (EG&G Инструментс, Инкорпорейшен, ОРТЕК)</i>
9	Portable Detector Probe	Портативный детекторный зонд	<i>EG&G Instruments, Inc. ORTEC (EG&G Инструментс, Инкорпорейшен, ОРТЕК)</i>
10	Gamma Detection Units	Блоки детектирования гамма-излучения	<i>IFTP (ИФТИ)</i>
11	X-Ray Detection Unit	Устройство детектирования рентгеновского излучения	<i>IFTP (ИФТИ)</i>
12	X-Ray Detection Units (БДЕР-Г-7К)	Блоки детектирования рентгеновского излучения (БДЕР-Г-7К)	<i>IFTP (ИФТИ)</i>
13	X-Ray Detection Units (БДЕР-ГЕ-9К)	Блоки детектирования рентгеновского излучения (БДЕР-ГЕ-9К)	<i>IFTP (ИФТИ)</i>
14	X-Ray Detection Units (БДЕР-К-7К)	Блоки детектирования рентгеновского излучения (БДЕР-К-7К)	<i>IFTP (ИФТИ)</i>

<u>Accounting: Detector</u>			
15	X-Ray Detection Units (БДЕР-КЕ-9К)	Блоки детектирования рентгеновского излучения (БДЕР-КЕ-9К)	<i>IFTP (ИФТИ)</i>
16	Electro-Mechanically Cooled Ge Detector System	Система электромеханического охлаждения для Ge детектора	<i>LLNL (ЛЛНЛ)</i>
17	Detection Unit	Блок детектирования	<i>PA MAYAK (ПО МАЯК)</i>
18	Scintillating Fibers Neutron Detectors	Нейтронные детекторы из сцинтилирующих волокон	<i>PNNL (С3ТНЛ)</i>
19	Miniature Spectrometric Detection Unit	Миниатюрный спектрометрический блок детектирования	<i>PNPI (ПИЯФ, ГНЦ)</i>
20	Gamma Probe	Гамма-зонд	<i>Quantrad Sensor Division (Отделение "Квантрад Сенсор")</i>
21	Neutron Probe	Нейтронный зонд	<i>Quantrad Sensor Division (Отделение "Квантрад Сенсор")</i>
22	Large Volume Spectrometric Detector	Спектрометрический детектор большого объема	<i>RITEC Ltd. (ТОО "РИТЭК")</i>
23	Spectrometric Detection Probe	Спектрометрический зонд	<i>RITEC Ltd. (ТОО "РИТЭК")</i>
24	Gamma Spectrometric Unit	Спектрометрический датчик гамма-излучения	<i>RSC Kurchatov Institute, SPC REKOM (РНЦ "Курчатовский институт" НИИТ "РЭКОМ")</i>
25	Scintillation Detection Assemblies	Сцинтиляционные блоки детектирования	<i>SNIIP- Green Star, Ltd. (СНИИП - ТОО "Грин Стар")</i>
26	Scintillation Detection Unit	Блок детектирования сцинтиляционный	<i>SPC Aspect (НПЦ "АСПЕКТ")</i>
27	Automated Neutron Flux Meter	Измеритель нейтронного потока автоматизированный	<i>VNIIA (ВНИИА)</i>
28	Neutron Counter	Счетчик нейтронов	<i>VNIITFA (ВНИИТФА)</i>
<u>Accounting: Identifier</u>			
29	CdZnTe Detector System for Uranium (CZT U Probe)	Система детектирования на основе CdZnTe для урана (CZT U Зонд)	<i>EG&G Instruments, Inc. ORTEC (EG&G Инструментс, Инкорпорейшен, ОРТЕК)</i>
30	Shipper Receiver Confirmatory System	Система подтверждения для отправителя-получателя	<i>LANL (ЛЛНЛ)</i>
31	Hand-Held Pu and U Assay Meter	Ручной прибор для анализа Pu и U	<i>National Nuclear Corporation (Национальная Ядерная Корпорация)</i>
32	Portable Hand-Held Ruggedized Nuclear Detection and Radionuclide Identification System	Портативная носимая система для грубого обнаружения и идентификации радионуклидов	<i>Quantrad Sensor Division (Отделение "Квантрад Сенсор")</i>
33	Installation for the Radiation Object Passportization	Установка радиационной паспортизации объектов	<i>RFNC VNIEF (РФЯЦ ВНИИЭФ)</i>
34	Portable Analyzer for the Nuclear Materials Inventory	Переносной анализатор для инвентаризации ядерных материалов	<i>RFNC VNIITF (РФЯЦ ВНИИТФ)</i>
35	Stationary Post for the Inventory of Containers with NM	Стационарный пост для инвентаризации контейнеров с ядерными материалами	<i>RFNC VNIITF (РФЯЦ ВНИИТФ)</i>
36	Universal Radiometer-Spectrometer	Универсальный радиометр-спектрометр	<i>SPC Aspect (НПЦ "АСПЕКТ")</i>

<u>Accounting: Identifier</u>			
37	Nuclear Material Quick Identifier	Идентификатор делящихся материалов	<i>SSC IPPE (ФЭИ, ГНЦ РФ)</i>
38	Neutron Device for FM Presence Control	Прибор для контроля наличия делящихся материалов по нейтронному излучению "Брегет"	<i>VNIIA (ВНИИА)</i>
<u>Accounting: Measurement System</u>			
39	Plutonium Can Contents Monitor	Монитор для определения содержания плутония в контейнерах	<i>BNFL Instruments (BNFL Instruments)</i>
40	Plutonium Inventory Measurement System	Измерительная система для инвентаризации плутония	<i>BNFL Instruments (BNFL Instruments)</i>
41	Uranium Drum Enrichment Monitor	Монитор обогащения урана для бочек	<i>BNFL Instruments (BNFL Instruments)</i>
42	Glovebox Neutron/Gamma Counter	Нейтронный/гамма счетчик для перчаточных боксов	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
43	Neutron and Gamma Unattended Plutonium Safeguards System	Нейтрон-гамма система обеспечения гарантий по плутонию без участия оператора	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
44	Passive/Active Cf-252 Shufflers	Пассивные/активные калифорнийские "Шафлеры"	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
45	Plutonium Canister Input Verification Counter	Счетчик для проверки входных контейнеров с плутонием	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
46	The Californium-252 Shuffler	Калифорнийский "шафлер"	<i>LANL (ЛАНЛ)</i>
47	Shuffler Detector	Детектор типа "Шафлер"	<i>National Nuclear Corporation (Национальная Ядерная Корпорация)</i>
<u>Accounting: Multichannel Analyzer</u>			
48	Miniature Modular Multi-Channel Analyzer	Миниатюрный модульный многоканальный анализатор	<i>AQUILA Technologies Group, Inc. (Акула Технолоджи Групп, Инкорпорейшен)</i>
49	Portable Multichannel Analyzer	Переносной многоканальный анализатор 2056-В	<i>Davidson Co. Inc. (Корпорация Дэвидсон)</i>
50	Amplifier and MCA Plug-in Card with Emulation Software	Усилитель и карта расширения МКА с программным обеспечением эмуляции	<i>EG&G Instruments, Inc. ORTEC (EG&G Инструментс, Инкорпорейшен, ОРТЕК)</i>
51	EtherNim High Speed Multichannel Buffer	Высокоскоростной многоканальный буфер 921E EtherNim	<i>EG&G Instruments, Inc. ORTEC (EG&G Инструментс, Инкорпорейшен, ОРТЕК)</i>
52	MCA Plug-In Card and Software	Карта расширения МКА с программным обеспечением	<i>EG&G Instruments, Inc. ORTEC (EG&G Инструментс, Инкорпорейшен, ОРТЕК)</i>
53	Miniature Multi-Channel Analyzer and Multi-Channel Scaler	Миниатюрный многоканальный анализатор и многоканальный счетчик	<i>GBS Elektronik (GBS Электроник)</i>
54	Hand-Held Multi-Channel Analyzer for Nuclear Spectroscopy	Носимый многоканальный анализатор для ядерной спектроскопии	<i>Quantrad Sensor Division (Отделение "Квантрад Сенсор")</i>
55	Independent Multichannel Pulse Height Analyzer	Автономный многоканальный амплитудный анализатор	<i>SPC Aspect (НПЦ "АСПЕКТ")</i>
56	Multichannel Pulse Height Analyzers, "AI" Series	Анализаторы многоканальные амплитудные серии "AI"	<i>SPC Aspect (НПЦ "АСПЕКТ")</i>

<u>Accounting: Multichannel Analyzer</u>			
57	Hand-Held, 256 Channel Multi-Channel Analyzer	Носимый 256-канальный анализатор	<i>TSA Systems Ltd. (TSA Систем Лимитед)</i>
<u>Accounting: Neutron Counter</u>			
58	Active Well Coincidence Counter	Активный колодезный счетчик совпадений	<i>AEA Technology plc (AEA Технолоджи)</i>
59	Automated Neutron Monitor for Plutonium	Автоматизированный нейтронный монитор для плутония	<i>AEA Technology plc (AEA Технолоджи)</i>
60	High Efficiency Passive Neutron Coincidence Counter	Пассивный счетчик нейтронных совпадений высокой эффективности	<i>AEA Technology plc (AEA Технолоджи)</i>
61	Neutron Coincidence Analyzer	Анализатор нейтронных совпадений	<i>AEA Technology plc (AEA Технолоджи)</i>
62	Portable Shift Register	Портативный сдвиговый регистр	<i>AQUILA Technologies Group, Inc. (Аquila Технолоджи Групп, Инкорпорейшен)</i> <i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
63	Active Well Neutron Coincidence Counter	Активный колодезный счетчик нейтронных совпадений	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
64	Flat-Squared Neutron Coincidence Counter (special order)	Плоский счетчик нейтронных совпадений (спец. заказ)	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
65	High Level Neutron Coincidence Counter	Счетчик нейтронных совпадений высокого уровня	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
66	Inventory Sample Neutron Coincidence Counter	Счетчик нейтронных совпадений для инвентаризационных образцов	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
67	Neutron Coincidence Collars	Воротниковые счетчики нейтронных совпадений	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
68	Neutron Coincidence Electronic Analyzer	Анализатор нейтронных совпадений	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
69	Pu Scrap Multiplicity Counter	Счетчик множественности для плутониевого скрапа	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
70	Shielded Neutron Assay Probe	Экранированный нейтронный зонд	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
71	Universal Fast Breeder Reactor Subassembly Counters	Универсальные счетчики для сборок реакторов-размножителей	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
72	Active Well Coincidence Counter	Активный колодезный счетчик совпадений	<i>LANL (ЛАНЛ)</i>
73	High Level Neutron Coincidence Counter	Счетчик нейтронных совпадений высокого уровня	<i>LANL (ЛАНЛ)</i>
74	Los Alamos Neutron Coincidence Counters	Лос-Аламосские нейтронные счетчики совпадений	<i>LANL (ЛАНЛ)</i>
75	Passive Neutron Multiplicity Counter	Пассивный счетчик множественности нейтронов	<i>LANL (ЛАНЛ)</i>
76	Receipts Assay Monitor for UF6 Cylinders	Монитор для входного контроля контейнеров с UF6	<i>LANL (ЛАНЛ)</i>
77	The Uranium Neutron Coincidence Collar	Воротниковый счетчик нейтронных совпадений для урана	<i>LANL (ЛАНЛ)</i>
78	Active Well Coincidence Counter	Активный колодезный счетчик совпадений	<i>National Nuclear Corporation (Национальная Ядерная Корпорация)</i>

<u>Accounting: Neutron Counter</u>			
79	High-Level Neutron Coincidence Counter	Счетчик нейтронных совпадений высокого уровня	<i>National Nuclear Corporation</i> (Национальная Ядерная Корпорация)
80	Inventory Sample Coincidence Counter	Счетчик совпадений для инвентаризационных образцов	<i>National Nuclear Corporation</i> (Национальная Ядерная Корпорация)
81	Neutron Slab Detector	Плоский нейтронный детектор	<i>National Nuclear Corporation</i> (Национальная Ядерная Корпорация)
82	Passive Neutron Coincidence Collar	Пассивный воротниковый счетчик нейтронных совпадений	<i>National Nuclear Corporation</i> (Национальная Ядерная Корпорация)
83	Portable Shielded Neutron Assay Probe	Портативный экранированный нейтронный зонд	<i>National Nuclear Corporation</i> (Национальная Ядерная Корпорация)
84	Uranium Neutron Coincidence Collar	Воротниковый счетчик нейтронных совпадений для урана	<i>National Nuclear Corporation</i> (Национальная Ядерная Корпорация)
85	Glovebox Counter for Pu	Счетчик плутония для перчаточных боксов	<i>PNNL (C3THL)</i>
86	GlovePort Monitor	Монитор для перчаточных боксов	<i>Pajarito Scientific Corporation</i> (Научная Корпорация Пайарито)
87	Neutron Area Holdup Monitor	Нейтронный монитор отложений	<i>Pajarito Scientific Corporation</i> (Научная Корпорация Пайарито)
88	Packet Assay Monitor	Монитор для анализа упаковок	<i>Pajarito Scientific Corporation</i> (Научная Корпорация Пайарито)
89	Neutron Coincidence Counter	Счетчик нейтронных совпадений	<i>SPC Aspect (НПЦ "АСПЕКТ")</i>
<u>Accounting: Neutron Generator</u>			
90	Pulse Neutron Generator for Detection of TRU Waste	Импульсный нейтронный генератор для трансурановых отходов	<i>MF Physics Corporation</i> (Физическая Корпорация MF)
91	Pulse Neutron Generators	Импульсный нейтронный генераторы	<i>VNIIA (ВНИИА)</i>
<u>Accounting: Rod Scanner</u>			
92	Active Uranium Fuel-Rod Scanner	Активный сканер урановых топливных стержней	<i>LANL (ЛАНЛ)</i>
93	Active Fuel Rod Scanning System	Активная система сканирования топливных стержней	<i>National Nuclear Corporation</i> (Национальная Ядерная Корпорация)
94	Passive Fuel Rod Scanning System	Пассивная система сканирования топливных стержней	<i>National Nuclear Corporation</i> (Национальная Ядерная Корпорация)
95	Scanner	Сканер	<i>SSC IPPE (ФЭИ, ГНЦ РФ)</i>
<u>Accounting: Software</u>			
96	Gamma Waste Assay Software	Программное обеспечение гамма-анализа отходов	<i>Canberra Industries, Inc.</i> (Канберра Инд., Инкорпорейшен)
97	Gamma-Ray Spectrum Analysis Code for Determining Plutonium Isotopic Abundances	Программа анализа спектров гамма-излучений для определения изотопного состава плутония	<i>Canberra Industries, Inc.</i> (Канберра Инд., Инкорпорейшен)
98	Genie-2000 Series	Серия Genie-2000	<i>Canberra Industries, Inc.</i> (Канберра Инд., Инкорпорейшен)

<u>Accounting: Software</u>			
99	Multi-Group Uranium Analysis Software	Программное обеспечение мульти-группового анализа урана	<i>Canberra Industries, Inc.</i> (Канберра Инд., Инкорпорейшен)
100	Analysis Software for Isotopic Ratios of Plutonium	Программное обеспечение для анализа изотопных соотношений плутония	<i>EG&G Instruments, Inc. ORTEC</i> (<i>EG&G Инструментс, Инкорпорейшен, OPTEK</i>)
101	Analyzer for Isotopic Ratios of Plutonium or Uranium	Анализатор изотопных соотношений плутония или урана	<i>EG&G Instruments, Inc. ORTEC</i> (<i>EG&G Инструментс, Инкорпорейшен, OPTEK</i>)
102	Analyzer for Isotopic Ratios of Uranium or Waste	Анализатор изотопных отношений урана или отходов	<i>EG&G Instruments, Inc. ORTEC</i> (<i>EG&G Инструментс, Инкорпорейшен, OPTEK</i>)
103	Analyzer for Uranium Enrichment	Анализатор обогащения урана	<i>EG&G Instruments, Inc. ORTEC</i> (<i>EG&G Инструментс, Инкорпорейшен, OPTEK</i>)
104	HMS-III Holdup Software	Программное обеспечение для отложений HMS-III	<i>EG&G Instruments, Inc. ORTEC</i> (<i>EG&G Инструментс, Инкорпорейшен, OPTEK</i>)
105	NaI Analysis Software	Программное обеспечение эмуляции анализа с NaI детектором	<i>EG&G Instruments, Inc. ORTEC</i> (<i>EG&G Инструментс, Инкорпорейшен, OPTEK</i>)
106	Nuclide Navigator	Нуклидный навигатор	<i>EG&G Instruments, Inc. ORTEC</i> (<i>EG&G Инструментс, Инкорпорейшен, OPTEK</i>)
107	Program ISOTOPIC	Программа ISOTOPIC	<i>EG&G Instruments, Inc. ORTEC</i> (<i>EG&G Инструментс, Инкорпорейшен, OPTEK</i>)
108	Spectroscopy Software for Germanium Detector Gamma-Ray Analysis	Спектроскопическое программное обеспечение для анализа гамма-излучения с использованием Ge детекторов	<i>EG&G Instruments, Inc. ORTEC</i> (<i>EG&G Инструментс, Инкорпорейшен, OPTEK</i>)
109	Spectroscopy Software with CONNECTIONS	Спектрометрическое программное обеспечение CONNECTIONS	<i>EG&G Instruments, Inc. ORTEC</i> (<i>EG&G Инструментс, Инкорпорейшен, OPTEK</i>)
110	CZTU Software	Программное обеспечение CZTU	<i>LLNL (ЛЛНЛ)</i>
111	Plutonium Gamma-Ray Measurement Program	Программа измерения гамма-излучения плутония	<i>LLNL (ЛЛНЛ)</i>
112	Uranium Analysis Software (U235)	Программное обеспечение анализа урана (U-235)	<i>LLNL (ЛЛНЛ)</i>
113	Gamma-Ray Spectrum Analysis Code	Программа обработки гамма-спектров	<i>SPC Aspect (НПЦ "АСПЕКТ")</i>
114	PROGRESS-Gamma (SCD) Software	Программное обеспечение "Прогресс-Гамма (ППД)"	<i>VNIIFTRI, SPA DOZA (ГП "ВНИИФТРИ" НПП "ДОЗА")</i>
115	PROGRESS-Gamma Software	Программное обеспечение "Прогресс-Гамма"	<i>VNIIFTRI, SPA DOZA (ГП "ВНИИФТРИ" НПП "ДОЗА")</i>
<u>Accounting: Spectrometer</u>			
116	InSpector Multichannel Analyzer	Многоканальный анализатор InSpector	<i>Canberra Industries, Inc.</i> (Канберра Инд., Инкорпорейшен)
117	U-Pu InSpector	Уран-Плутониевый Инспектор	<i>Canberra Industries, Inc.</i> (Канберра Инд., Инкорпорейшен)
118	DART Portable High-Performance Multichannel Analyzer	Портативный многоканальный анализатор высокого качества DART	<i>EG&G Instruments, Inc. ORTEC</i> (<i>EG&G Инструментс, Инкорпорейшен, OPTEK</i>)

Accounting: Spectrometer

119	DSPEC Digital Gamma-Spectrometer	Цифровой гамма-спектрометр DSPEC	<i>EG&G Instruments, Inc. ORTEC (EG&G Инструментс, Инкорпорейшен, ОРТЕК)</i>
120	Gamma-Ray Spectrometer	Гамма-спектрометр 92X-II	<i>EG&G Instruments, Inc. ORTEC (EG&G Инструментс, Инкорпорейшен, ОРТЕК)</i>
121	MatchMaker EtherNim Acquisition Interface Module	Модуль MatchMaker для интерфейса	<i>EG&G Instruments, Inc. ORTEC (EG&G Инструментс, Инкорпорейшен, ОРТЕК)</i>
122	MicroNOMAD Portable, Miniature MCA for Use with NaI(Tl), CZT, and Other Moderate-Resolution Detectors	Портативный миниатюрный МКА для использования с детекторами NaI (Tl), CZT и др. детекторами среднего разрешения MicroNOMAD	<i>EG&G Instruments, Inc. ORTEC (EG&G Инструментс, Инкорпорейшен, ОРТЕК)</i>
123	Spectrum MasterTM: Gamma Spectroscopy Workstations	Гамма-спектрометрическая рабочая станция Spectrum MasterTM	<i>EG&G Instruments, Inc. ORTEC (EG&G Инструментс, Инкорпорейшен, ОРТЕК)</i>
124	Pu-238 Isotopic Analysis System	Система анализа изотопаPu-238	<i>LLNL (ЛЛНЛ)</i>
125	Generalized-Geometry Gamma-Ray Holdup Assay	Система для гамма- анализа отложений в обобщенной геометрии	<i>LANL (ЛАНЛ)</i>
126	Plutonium Isotopic Analysis System	Система анализа изотопного состава плутония	<i>LANL (ЛАНЛ)</i>
127	Gamma-Spectrometric Unit	Спектрометрическое устройство гамма-излучения	<i>PNPI (ПИЯФ, ГНЦ)</i>
128	Scout Nuclear Material ID Kit	Идентификатор ядерных материалов "Скаут"	<i>Quantrad Sensor Division (Отделение "Квантрад Сенсор")</i>
129	Gamma Spectrometer	Спектрометр гамма-излучения	<i>RFNC VNITTF (РФЯЦ ВНИИТФ)</i>
130	Spectrometric Device for the Gamma Energy Analysis and Flux Density Control	Спектрометрический прибор контроля плотности потока и энергетического состава гамма-излучения	<i>RIPT (НИИИТ)</i>
131	Spectrometric Device for Gamma Energy Analysis	Спектрометрический прибор контроля энергетического состава гамма-излучения	<i>RIPT (НИИИТ)</i>
132	Hand-Held All-Weather Spectrometer of the Nuclear Radiation	Всепогодный носимый спектрометр ядерных излучений	<i>SNIIP- Green Star, Ltd. (СНИИП - ТОО "Трин Стар")</i>
133	Installation for the X-Ray Fluorescent Analysis	Установка для рентгено-флуоресцентного анализа	<i>SNIIP- Green Star, Ltd. (СНИИП - ТОО "Трин Стар")</i>
134	Laboratory Spectrometric System	Лабораторный спектрометрический комплекс	<i>SNIIP- Green Star, Ltd. (СНИИП - ТОО "Трин Стар")</i>
135	Multichannel Spectrometer	Многоканальный спектрометр	<i>SNIIP- Green Star, Ltd. (СНИИП - ТОО "Трин Стар")</i>
136	Portable Spectrometric System Based on Scintillation Detector	Переносной спектрометрический комплекс на базе сцинтилляционного детектора	<i>SNIIP- Green Star, Ltd. (СНИИП - ТОО "Трин Стар")</i>
137	Portable Spectrometric System Based on Semiconductor Detector	Переносной спектрометрический комплекс на базе полупроводникового детектора	<i>SNIIP- Green Star, Ltd. (СНИИП - ТОО "Трин Стар")</i>
138	Scintillation Spectrometric Installation	Сцинтилляционная спектрометрическая установка	<i>SNIIP- Green Star, Ltd. (СНИИП - ТОО "Трин Стар")</i>

Accounting: Spectrometer

139	Single Board Spectrometer	Одноплатный спектрометр	<i>SNIIP- Green Star, Ltd.</i> (<i>СНИИП - ТОО "Грин Стар"</i>)
140	Spectrometric Rate Meter, "Купол"	Радиометр спектрометрический, "Купол"	<i>SNIIP-Automatics (СНИИП - АВТОМАТИКА)</i>
141	Gamma Spectrometer with Scintillation Detector	Гамма-спектрометр со спиритуационным детектором	<i>SPC Aspect (НПЦ "АСПЕКТ")</i>
142	Gamma Spectrometer with Semiconductor Detector	Гамма спектрометр с полупроводниковым детектором	<i>SPC Aspect (НПЦ "АСПЕКТ")</i>
143	Portable Scintillation Gamma-Spectrometer	Портативный спектрометр энергии гамма-излучения спиритуационный	<i>SPC Aspect (НПЦ "АСПЕКТ")</i>
144	Semiconductor Alpha Spectrometer	Полупроводниковый альфа спектрометр	<i>SPC Aspect (НПЦ "АСПЕКТ")</i>
145	Installation "SPANDEM"	Установка "СПАНДЕМ"	<i>SSC IPPE (ФЭИ, ГНЦ РФ)</i>
146	PROGRESS-Gamma (SCD) Semiconductor Gamma Spectrometer	Гамма-спектрометр полупроводниковый "Прогресс-гамма (ППД)"	<i>VNIIFTRI, SPA DOZA (ГП "ВНИИФТРИ" НПП "ДОЗА")</i>
147	X-Ray Fluorescent Spectrometer	Рентгено-флуоресцентный спектрометр	<i>VNIIFTRI, SPA DOZA (ГП "ВНИИФТРИ" НПП "ДОЗА")</i>

Accounting: Waste Measurement System

148	Packet Monitor	Монитор для упаковок	<i>AEA Technology plc (AEA Технологии)</i>
149	Passive Neutron Coincidence Counter	Пассивный счетчик нейтронных совпадений	<i>AEA Technology plc (AEA Технологии)</i>
150	Segmented Gamma Scanner	Сегментный гамма-сканер	<i>AEA Technology plc (AEA Технологии)</i>
151	Versatile Passive Neutron Monitor	Изменяемый пассивный нейтронный монитор	<i>AEA Technology plc (AEA Технологии)</i>
152	TRU Drum Monitor	Монитор бочек, содержащих трансуранные элементы	<i>BNFL Instruments (BNFL Instruments)</i>
153	Automated Waste Assay System	Автоматизированная система анализа отходов	<i>Canberra Industries, Inc.</i> (<i>Канберра Инд., Инкорпорейшен</i>)
154	Box Assay Counters	Счетчики для анализа контейнеров	<i>Canberra Industries, Inc.</i> (<i>Канберра Инд., Инкорпорейшен</i>)
155	Combined Thermal Epithermal Neutron Counter	Комбинированный счетчик тепловых и надтепловых нейтронов	<i>Canberra Industries, Inc.</i> (<i>Канберра Инд., Инкорпорейшен</i>)
156	Curved Passive Neutron Slab Counters	Пассивные нейтронные счетчики с огибающей поверхностью	<i>Canberra Industries, Inc.</i> (<i>Канберра Инд., Инкорпорейшен</i>)
157	Flat-Squared Canister Counters	Плоские счетчики для ящиков	<i>Canberra Industries, Inc.</i> (<i>Канберра Инд., Инкорпорейшен</i>)
158	Large-Volume Decommissioning Counter	Счетчик для разделения отходов больших объемов	<i>Canberra Industries, Inc.</i> (<i>Канберра Инд., Инкорпорейшен</i>)
159	Low Level Passive Neutron Counter for 200 Liter Drums	Пассивный счетчик нейтронов для 200 л бочек с низкоактивными отходами	<i>Canberra Industries, Inc.</i> (<i>Канберра Инд., Инкорпорейшен</i>)
160	Low Level Waste Assay System	Система анализа низкоактивных отходов	<i>Canberra Industries, Inc.</i> (<i>Канберра Инд., Инкорпорейшен</i>)
161	Passive Neutron Coincidence Drum Counters	Пассивные счетчики нейтронных совпадений для бочек с отходами	<i>Canberra Industries, Inc.</i> (<i>Канберра Инд., Инкорпорейшен</i>)

Accounting: Waste Measurement System

162	Passive Neutron Slab Counters	Пассивные плоские нейтронные счетчики	<i>Canberra Industries, Inc.</i> (Канберра Инд., Инкорпорейшен)
163	Segmented Gamma Ray Scanner	Сегментный гамма-сканер	<i>Canberra Industries, Inc.</i> (Канберра Инд., Инкорпорейшен)
164	Segmented Waste Assay System	Система сегментного анализа отходов	<i>Canberra Industries, Inc.</i> (Канберра Инд., Инкорпорейшен)
165	Waste Activity Monitor	Монитор активности отходов	<i>Canberra Industries, Inc.</i> (Канберра Инд., Инкорпорейшен)
166	Waste Curie Monitor	Монитор активности отходов	<i>National Nuclear Corporation</i> (Национальная Ядерная Корпорация) <i>ORNL (ОРНЛ)</i>
167	Active-Passive Neutron Examination and Assay System	Активная-пассивная система нейтронного анализа	<i>Pajarito Scientific Corporation</i> (Научная Корпорация Пайарито)
168	Container Assay Systems	Системы анализа контейнеров	<i>Pajarito Scientific Corporation</i> (Научная Корпорация Пайарито)
169	Drum Assay Systems	Система анализа бочек	<i>Pajarito Scientific Corporation</i> (Научная Корпорация Пайарито)
170	Imaging Area Neutron Coincidence Counter	Счетчик нейтронных совпадений с изображением зоны	<i>Pajarito Scientific Corporation</i> (Научная Корпорация Пайарито)
171	Mobile Assay System	Мобильная аналитическая система	<i>Pajarito Scientific Corporation</i> (Научная Корпорация Пайарито)
172	Plutonium Container Assay Monitor	Монитор для анализа контейнеров с плутонием	<i>Pajarito Scientific Corporation</i> (Научная Корпорация Пайарито)
173	Low Level Waste System for FM Mass Determination	Аппаратурный комплекс для определения массы ДМ в низкоактивных отходах	<i>VNIITFA (ВНИИТФА)</i>
174	Fissile Nuclides Concentration Meter for Solutions	Концентратомер делящихся нуклидов в растворах	<i>VNIITFA (ВНИИТФА)</i>
175	Indicator of the Transuranium Nuclide Content	Индикатор содержания трансурановых нуклидов	<i>VNIITFA (ВНИИТФА)</i>

Accounting: XRF System

176	Transmission-Corrected X-Ray Fluorescence Analysis System	Система РФА с поправкой на прохождение	<i>LLNL (ЛЛНЛ)</i>
177	Portable CdTe XFA-Spectrometer for Fast Analysis of Element Analysis on-Situ	Портативный CdTe РФА-спектрометр для экспресс анализа элементного состава объектов по месту	<i>PNPI (ПИЯФ, ГНЦ)</i>
178	Device for the X-Ray Fluorescent Material Content Determination	Прибор рентгенофлуоресцентного определения состава материалов	<i>VNIITFA (ВНИИТФА)</i>

179	X-Ray Radiometric Uranium Concentratorometer	Рентгенорадиометрический концентратомер урана	<i>VNIITFA (ВНИИТФА)</i>
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Containment and Surveillance: Detector

180	Alpha Probe	Альфа-зонд	<i>Quantrad Sensor Division</i> (Отделение "Квантрад Сенсор")
181	Detection Unit (БДИГ-28Н)	Блок детектирования (БДИГ-28Н)	<i>SNIIP-Kon (СНИИП-КОНВЭЛ)</i>
182	Detection Unit (БДИГ-29Н)	Блок детектирования (БДИГ-29Н)	<i>SNIIP-Kon (СНИИП-КОНВЭЛ)</i>

Containment and Surveillance: Hand-held Monitor

183	Hand-Held Monitors	Ручные мониторы	<i>Canberra Industries, Inc.</i> (Канберра Инд., Инкорпорейшен)
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Containment and Surveillance: Hand-held Monitor

184	Source Monitor	Монитор источников излучения	<i>National Nuclear Corporation (Национальная Ядерная Корпорация)</i>
185	NaI Area Monitor	Монитор NaI	<i>Pajarito Scientific Corporation (Научная Корпорация Пайарито)</i>
186	Device for Radioactive Material Searching (ДОГ-2)	Прибор для поиска радиоактивных материалов (ДОГ-2)	<i>RFNC VNIEF (РФЯЦ ВНИИЭФ)</i>
187	Device for Radioactive Material Searching (ДОН-2)	Прибор для поиска радиоактивных материалов (ДОН-2)	<i>RFNC VNIEF (РФЯЦ ВНИИЭФ)</i>
188	Hand-Held Radiation Monitor (БИРК-2)	Носимый радиационный монитор (БИРК-2)	<i>RFNC VNIEF (РФЯЦ ВНИИЭФ)</i>
189	Hand-Held Radiation Monitor (РГМ-2)	Носимый радиационный монитор (РГМ-2)	<i>RFNC VNIEF (РФЯЦ ВНИИЭФ)</i>
190	Hand-Held Radiation Monitor (РГМ-3Н)	Носимый радиационный монитор (РГМ-3Н)	<i>RFNC VNIEF (РФЯЦ ВНИИЭФ)</i>
191	Gamma and Neutron Rate Meter for Flux Density Control (СРПС7)	Радиометрический прибор контроля плотности потока нейтронного и гамма-излучения (СРПС7)	<i>RIPT (НИИИТ)</i>
192	Hand-Held Gamma Monitor	Портативный монитор гамма-излучения	<i>RIPT (НИИИТ)</i>
193	Hand-Held Gamma Monitor-Spectrometer	Ручной монитор-спектрометр гамма-излучения	<i>RIPT (НИИИТ)</i>
194	Hand-Held Gamma-Neutron Rate Meter	Носимый гамма-нейтронный радиометр	<i>SNIIP-Automatics (СНИИП - АВТОМАТИКА)</i>
195	Portable Neutron Monitor	Переносной нейтронный монитор	<i>SNIIP-Kon (СНИИП-КОНВЭЛ)</i>
196	X-Ray Rate Meter-Dosimeter	Радиометр-дозиметр рентгеновского излучения	<i>SNIIP-Kon (СНИИП-КОНВЭЛ)</i>
197	Radiation Monitor	Радиационный монитор	<i>SSC IPPE (ФЭИ, ГНЦ РФ)</i>
198	Hand-Held Personal Radiation Monitor	Ручной радиационный монитор для контроля персонала	<i>TSA Systems Ltd. (TSA Систем Лимитед)</i>
199	Hand-Held Radiation Monitor for NM Detection "Gnome"	Ручной радиационный монитор для обнаружения ядерных материалов "Гном"	<i>VNIIA (ВНИИА)</i>
200	Hand-Held Radiation Monitor for NM Detection "Guard"	Ручной радиационный монитор для обнаружения ядерных материалов "Страж"	<i>VNIIA (ВНИИА)</i>

Containment and Surveillance: Portal Monitor

201	Neutron Vehicle Portal Monitors	Нейтронные транспортные порталные мониторы	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
202	Neutron/Gamma Portal Monitor	Нейтрон-гамма порталный монитор	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
203	Pedestrian Portal Monitor (neutron)	Пешеходный порталный монитор (нейтронный)	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
204	SNM Pedestrian Portal Gamma Monitors	Пешеходный порталный гамма-монитор СЯМ	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
205	SNM Vehicle Portal Gamma-Monitor	Транспортный порталный гамма-монитор СЯМ	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>

Containment and Surveillance: Portal Monitor

206	SNM Vehicle Portal Gamma-Monitoring Station	Транспортная портальная станция гамма-мониторинга СЯМ	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
207	Vehicle Contamination Monitors	Транспортные мониторы	<i>Canberra Industries, Inc. (Канберра Инд., Инкорпорейшен)</i>
208	Radiation Control System	Система радиационного контроля	<i>JV Polimaster (СП "Полимастер")</i>
209	Plutonium Vehicle Monitor	Транспортный монитор плутония	<i>National Nuclear Corporation (Национальная Ядерная Корпорация)</i>
210	Radiation Monitoring System for Vehicles and Loads (Scrap Monitor)	Система радиационного мониторинга для транспорта и грузов (монитор скрапа)	<i>National Nuclear Corporation (Национальная Ядерная Корпорация)</i>
211	Asphalt Panel, Portal Monitor	Асфальтовая панель, порталный монитор	<i>PNNL (С3ТНЛ)</i>
212	Pedestrian Radiation Monitor, Post KPRM	Пешеходный радиационный монитор, Пост КПРМ	<i>RFNC VNIIIEF (РФЯЦ ВНИИЭФ)</i>
213	Gamma and Neutron Rate Meter for Flux Density Control (СРПС2)	Радиометрический прибор контроля плотности потока нейтронного и гамма-излучения (СРПС2)	<i>RIPT (НИИИТ)</i>
214	Portal Gamma Monitor (СМГИЗ.01)	Портальный монитор гамма-излучения (СМГИЗ.01)	<i>RIPT (НИИИТ)</i>
215	Portal Gamma Monitor (СМГИ5)	Портальный монитор гамма-излучения (СМГИ5)	<i>RIPT (НИИИТ)</i>
216	Vehicle Gamma Monitor	Транспортный монитор гамма-излучения	<i>RIPT (НИИИТ)</i>
217	Pedestrian Portal Monitor (ППМ КИ-01S)	Пешеходный порталный монитор (ППМ КИ-01S)	<i>RSC Kurchatov Institute (РНЦ "Курчатовский институт")</i>
218	Neutron and Neutron/Gamma Detectors	Нейтронный и нейтрон-гамма детекторы	<i>SAPHYMO (САФИМО)</i>
219	Portal Pedestrian Radiation Monitor	Портальный пешеходный радиационный монитор	<i>Scientific Engineering Center "NPR" (НТЦ "ЯФИ")</i>
220	Vehicle Portal Radiation Monitor	Портальный транспортный радиационный монитор	<i>Scientific Engineering Center "NPR" (НТЦ "ЯФИ")</i>
221	Device for Searching Hidden Radiactive/Fissile Materials	Устройство обнаружения скрытых Р/А и делящихся материалов	<i>SNIIP-Kon (СНИИП-КОНВЭЛ)</i>
222	High Sensitivity Radiation Monitors	Высокочувствительные радиационные мониторы	<i>SNIIP-Kon (СНИИП-КОНВЭЛ)</i>
223	Stationary Custom System for the Detection of Fissile and Radioactive Materials	Стационарная таможенная система обнаружения делящихся и радиоактивных материалов	<i>SPC Aspect (НПЦ "АСПЕКТ")</i>
224	Device for Radioactive Material Removal Control	Прибор для контроля перемещения радиоактивных материалов	<i>SSC IPPE (ФЭИ, ГНЦ РФ)</i>
225	Pedestrian Portal Monitor (PM-700/701)	Пешеходный порталный монитор (PM-700/701)	<i>TSA Systems Ltd. (TSA Систем Лимитед)</i>
226	Vehicle Portal Monitor	Транспортный порталный монитор	<i>TSA Systems Ltd. (TSA Систем Лимитед)</i>
	<p><u>Containment and Surveillance: Position Control System</u></p>		
227	Authenticated Item Monitoring System	Система контроля подлинности объектов	<i>SNL (СНЛ)</i>

<u>Containment and Surveillance: Position Control System</u>			
228	Authenticated Tracking and Monitoring System	Система прослеживания и контроля подлинности объектов	<i>SNL (СНЛ)</i>
<u>Containment and Surveillance: Radiation Control System</u>			
229	Neutron Slab Monitor	Нейтронный монитор-пластина	<i>AEA Technology plc (AEA Технолоджи)</i>
230	Remote Scanning Gamma Spectrometer	Дистанционный сканирующий гамма-спектрометр	<i>RSC Kurchatov Institute, SPC REKOM (РНЦ "Курчатовский институт" НИТ "РЭКОМ")</i>
231	CTM Data Processing Unit	Устройство обработки данных СТМ	<i>SAPHYMO (САФИМО)</i>
232	Installation for the Radiation Control	Установка радиационного контроля	<i>SNIIP-Kon (СНИИП-КОНВЭЛ)</i>
<u>Containment and Surveillance: Seal</u>			
233	COBRA Seal	Пломба "Кобра"	<i>AQUILA Technologies Group, Inc. (Акила Технолоджи Групп, Инкорпорейшен)</i>
234	Digital Camera Module 14	Цифровая камера Module 14	<i>AQUILA Technologies Group, Inc. (Акила Технолоджи Групп, Инкорпорейшен)</i>
235	Fiber Optic Seal	Волоконно-оптическая пломба	<i>AQUILA Technologies Group, Inc. (Акила Технолоджи Групп, Инкорпорейшен)</i>
236	Fiber-Electric Seal	Волоконно-электрическая пломба	<i>AQUILA Technologies Group, Inc. (Акила Технолоджи Групп, Инкорпорейшен)</i>
237	Mechanical Seal	Механическая пломба	<i>AQUILA Technologies Group, Inc. (Акила Технолоджи Групп, Инкорпорейшен)</i>
238	Paper Tape E-Tag Seal	Бумажная пломба - этикетка E-Tag	<i>AQUILA Technologies Group, Inc. (Акила Технолоджи Групп, Инкорпорейшен)</i>
239	Seal Imaging System	Система просмотра изображений пломб	<i>AQUILA Technologies Group, Inc. (Акила Технолоджи Групп, Инкорпорейшен)</i>
240	Video Tape Sealing System	Система опломбирования видеокассет	<i>AQUILA Technologies Group, Inc. (Акила Технолоджи Групп, Инкорпорейшен)</i>
241	Auto Cobra Seal Verifier	Автоматическое устройство проверки пломб типа "Кобра"	<i>Mitsubishi Heavy Industries, Ltd. (ТОО "Мицубиси - тяжелая промышленность")</i>
242	Tag-Seal for Containers with NM	Пломба-этикетка для контейнеров с ЯМ	<i>RFNC VNIIEF (РФЯЦ ВНИИЭФ)</i>
243	Autonomic Device for the Automatic Identification of the Optical Seals	Автономное устройство автоматической идентификации оптических пломб	<i>RFNC VNIITF (РФЯЦ ВНИИТФ)</i>
244	Lock - Sealing Device	Запорно-пломбировочное устройство	<i>RFNC VNIITF (РФЯЦ ВНИИТФ)</i>
245	Loop Optical Seal	Петлевая оптическая пломба	<i>RFNC VNIITF (РФЯЦ ВНИИТФ)</i>
246	Second-Generation Reflective Particle Tag	Этикетка с отражающими частицами. Второе поколение	<i>SNL (СНЛ)</i>
247	Tamper-Evident Shrink-Wrap Seal	Обжимная пломба с индикацией вмешательства	<i>SNL (СНЛ)</i>

Containment and Surveillance: Software

248 GENERAL Advanced Review Software Программное обеспечение просмотра видеоизображений GENERAL

249 Radioactive Material Inventory System Система инвентаризации радиоактивных материалов

Containment and Surveillance: Video Surveillance System

250 GEMINI Surveillance System Система наблюдения GEMINI

251 Modular Integrated Video System Модульная интегрированная видео система

252 Portable Surveillance Unit Портативное устройство наблюдения

*AQUILA Technologies Group,
Inc. (Аquila Технолоджи Групп,
Инкорпорейшен)
ORNL (ОРНЛ)*

*AQUILA Technologies Group,
Inc. (Аquila Технолоджи Групп,
Инкорпорейшен)*

*AQUILA Technologies Group,
Inc. (Аquila Технолоджи Групп,
Инкорпорейшен)*

SNL (ЧНЛ)

7. DETAILED DEVICE INFORMATION

Accounting: Calorimeter**Heat Flow Calorimeters****1****MODEL:****SUPPLIER:** *Los Alamos National Laboratory***USE CATEGORY:** Accounting**DEVICE TYPE:** Calorimeter**MEASUREMENT METHOD:** Calorimetry

Passive

MEASURED PROPERTIES: Effective Isotope Mass**NUCLEAR MATERIAL(S):** Pu, HEU, Np, Th**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Stationary or Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Los Alamos National Laboratory**DESCRIPTION****PURPOSE**

Radiometric calorimetry is a nondestructive assay technique for determining the thermal power output of peat-producing nuclear materials.

PRINCIPLES OF OPERATION

Calorimetric assay of plutonium bearing samples routinely obtains the highest precision and accuracy of all NDA techniques. Since the heat measurement result is completely independent of material and matrix type, calorimeters are well suited for nearly all plutonium sample types and multi-kilogram quantities of highly enriched uranium (HEU).

Precision calorimeter systems are used to determine the power output (watts) of various radionuclides over a broad range of power levels and sample types. Systems have been manufactured to measure the thermal power of samples from 0.00020 to 500.0 watts for samples ranging from 0.5 to 14.0 inches in diameter and up to 24.0 inches in length. Sample types have ranged from aqueous waste to weapons components.

The design of the calorimeter is determined by the size and heat output of the items to be measured and the requested accuracy in the final gram quantity result. Typical assay times are between one and six hours with a measurement bias of less than 1% one relative standard deviation (1RSD). Measurement times are dominated by sample characteristics and not calorimeter components.

Heat flow calorimetric assay is achieved by precisely measuring the temperature difference across a constant and calibrated thermal gap. Where one side of the thermal gap, reference, is used as an infinite heat sink with very little temperature fluctuation, less than ± 0.001 Deg C. The temperature of the sample side of the thermal gap is measured relative to the reference temperature. The greater the increase in temperature on the sample side of the gap due to radioactive decay the greater the signal output of the temperature sensor. The calibration of the temperature sensor response to power is used to convert the sensor output to watts of power produced by the source. Gamma isotopic measurement or mass spectrometry is used to determine the isotopic composition of the sample.

This allows the calculation of the sample effective specific power, Peff. The power of the sample in watts is divided by Peff in watts/gram to give total heat producing mass of the sample (i.e. Pu total mass). Isotopic information also allows the calculation of gram quantities of each of the individual heat producing isotopes present (i.e. Pu-239 mass, Pu-240 mass, etc.).

FUNCTIONAL BLOCKS**SPECIFICATIONS****Measurement time:**

Sample dependent (nominal 1 to 8 hours)

Accuracy:

0.1% (3 grams Pu, 1" diameter cavity)

0.2% (40 grams Pu, 5" diameter cavity)

user specified (currently up to 14" diameter)

Cavity dimension:**SOFTWARE**

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Calorimeter**Calorimeter**
MODEL: YX-12II

2

SUPPLIER: SNIIP-ASCUR**USE CATEGORY:** Accounting**DEVICE TYPE:** Calorimeter**MEASUREMENT METHOD:** Calorimetry

Passive

MEASURED PROPERTIES: Effective Isotope Mass**NUCLEAR MATERIAL(S):** Pu, Th**PHYSICAL FORM(S) OF NM:****STATUS:** One-of-a-kind**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** SNIIP-ASCUR**MANUFACTURER:** SNIIP-ASCUR**DESCRIPTION****PURPOSE**

The calorimeter is intended to measure the heat flux from samples containing heat releasing materials and to determine the mass of these materials in the process of their production and control by the known specific released heat.

PRINCIPLES OF OPERATION

Two stages of measurement of temperature increase rate of the calorastat with a sample placed are: the registration of the released heat and registration of this heat including the additional electric calibration heat released inside of the calorstat. Only one stage of measurement is used when heat releasing materials are detected.

FUNCTIONAL BLOCKS

Basic set:

- calorimeter with the detector-resistance thermometer,
- measurement-information unit,
- connection cables.

SPECIFICATIONS

Upper limit of the measured heat flux

10 W

Measurement error in a range of 5-10 W

no more than 0,3%

Single measurement time

no more than 10 hours depending on

the sample thermal properties

not more than 10 mW

no more than D145 mm x 235 mm

Sensitivity limit

706 mm x 1360 mm x 545 mm

Overall sample size

553 mm x 400 mm x 604 mm

Overall size:

calorimeter

200 kg

rack

20 kg

Weight:

V = 220V (-15%, +10%),

calorimeter

f = 50+-1 Hz,

rack

harmonics content up to 5%

Required power supply

up to 500W

RS-422, RS-232C

Power consumption

Interface

The calorimeter can be built-in in metal modules of the process equipment with the environment temperature change rate no more than 1'C/hour. The calorimeter itself can operate under aggressive conditions.

Storage conditions - air temperature from 5 to 40'C, relative humidity no more 80% at 25'C and in case of no-vapor of acids and alkalines.

Transportation conditions - any distances by car or railway (in closed vehicles), water transport (in ship holds), air transport (in hermetic compartments).

SOFTWARE

Software for the calculation of the measured sample heat flux.

ADDITIONAL INFORMATION

Control - by built-in means of the automatic control of the metrological characteristics and the correct operation.

Warranty - 18 months.

Life time - 10 years.

Time between failures - 20000 hours.

Possible delivery time - 15 months (first delivery), 9 months (next deliveries).

The delivery of calorimeters for different size samples is possible.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Calorimeter**Calorimetric System for the Fissile Material Mass Measurement****3****MODEL:****SUPPLIER:** *SSC IPPE, State Scientific Center of Russian Federation, Institute of Physics and Power Engineering***USE CATEGORY:** Accounting**DEVICE TYPE:** Calorimeter**MEASUREMENT METHOD:** Calorimetry

Passive

MEASURED PROPERTIES: Effective Isotope Mass**NUCLEAR MATERIAL(S):** Pu, U**PHYSICAL FORM(S) OF NM:****STATUS:****PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** *SSC IPPE, State Scientific Center of Russian Federation, Institute of Physics and Power Engineering***MANUFACTURER:** *SSC IPPE, State Scientific Center of Russian Federation, Institute of Physics and Power Engineering***DESCRIPTION****PURPOSE***Determination of fissile material masses by using measurement results of heat released from products containing these materials. The system is able to distinguish (determine) plutonium of different isotopic compositions.***PRINCIPLES OF OPERATION**Measures the released heat and determines the mass of products made out of fissile materials: for uranium - using external irradiation by a neutron flux of $1E+6$ n/cm 2 *sec, for plutonium - without irradiation.**FUNCTIONAL BLOCKS**

- calorimeter
- communication line with PC
- interface
- micro-computer compatible with IBM PC

The system is designed as a modular system and can work with a single or a number of (up to 16) sensors.

SPECIFICATIONS

Sensitivity to the heat released

at a temperature of $T \leq 20^{\circ}\text{K} - 50^{\circ}\text{K}$ $\leq 1E-7$ W/cm 3

Sensitivity to mass of

the fissile material:

uranium (irradiation of $1E+6$ n/cm 2 *sec) 0.001 g

plutonium (no irradiation) 0.001 g

Relation of the calorimeter reaction chamber

volume to the calorimeter volume 80% - 90%

Overall size of the calorimeter reaction chamber

diameter 4 - 50

height 10 - 100

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Densitometer

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Radioisotopic Densitometer

MODEL: ИР-1026

SUPPLIER: IFTP, Institute of Physical & Technical Problems

USE CATEGORY: Accounting

DEVICE TYPE: Densitometer

MEASUREMENT METHOD: Gamma-Absorption
Active

MEASURED PROPERTIES: Density

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM: Solution

STATUS: Serial Production

PORTABILITY: Stationary

ENVIRONMENT OF USE: Industrial

DEVELOPER: IFTP, Institute of Physical & Technical Problems

MANUFACTURER: IFTP, Institute of Physical & Technical Problems

DESCRIPTION

PURPOSE

Device is used for continuous density measurement of pulps and solutions transferred along the pipeline without a contact and for process control.

PRINCIPLES OF OPERATION

Device measures attenuation of gamma radiation.

Densitometer is calibrated "on-line" by traditional laboratory techniques. The process control is performed by displaying data on the digital tableau and using a diagram. The destabilizing effects of temperature is compensated by the established temperature mode.

FUNCTIONAL BLOCKS

- scintillation detector unit (БД)
- data processing unit (БОИ)
- gamma radiation unit of type БГИ-75А

SPECIFICATIONS

Measurement range	from 500 kg/m ³ to 3000 kg/m ³
Acceptable sensitivity interval in this range	from 50 kg/m ³ to 500 kg/m ³
Operation state setting time	10s, 20s, 60s, 100s, 200s, 300s
Accuracy	up to 1 kg/m ³
Power supply	220 V
Power consumption	44 VA
Operation temperature range:	
detection unit	from 0°C to +50°C
data processing unit	from +5°C to +40°C
Max. distance between БОИ and БД	500 m
БОИ overall size	343 mm x 312 mm x 155 mm
Weight:	
БД	9 kg
БОИ	10 kg

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Densitometer**KED/KXRF Hybrid Densitometer****5****MODEL:****SUPPLIER:** *Los Alamos National Laboratory***USE CATEGORY:** Accounting**DEVICE TYPE:** Densitometer**MEASUREMENT METHOD:** XRF

Active

MEASURED PROPERTIES: Element Concentration**NUCLEAR MATERIAL(S):** Th, U, Np, Pu, Am**PHYSICAL FORM(S) OF NM:** Solution**STATUS:** Limited Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Los Alamos National Laboratory**DESCRIPTION****PURPOSE**

Used to determine concentrations of thorium, uranium, neptunium, plutonium, and americium. Can also be applied to mixed solutions without separating the fissionable elements: thorium-uranium, uranium-plutonium, neptunium-plutonium-americium.

PRINCIPLES OF OPERATION

Employes a combination of two complementary assay techniques: absorption K-edge densitometry (KED) and x-ray fluorescence (XRF). The KED technique measures the transmission of a tightly collimated photon beam through the sample; KED is therefore insensitive to radiation emitted by the sample material. Fission product levels of about 1 Ci/ml can be tolerated. The technique is also insensitive to matrix variations. XRF can measure the fluorescent x-rays from the same sample and can be used to determine the SNM ratios. Careful calibration with well-characterized solution standards is required. Because the precision of the system is about 0.2%, standards should be known to 0.05%. Solutions have to be freshly prepared and stored in such a way that the concentration does not change.

FUNCTIONAL BLOCKS**SPECIFICATIONS**

Measurement time 1000 seconds

Accuracy:

200 gU/L	0.2% (KED)
2gPu/L	0.75% (XRF+KED)

Bias

depends on calibration and is often smaller than precision by a factor 2 to 5

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES.**

Application Note, KED/KXRF Hybrid Densitometer, LAPL-96-49, May 1996.

Accounting: Detector**6****NaI Detector Shield/Collimators****MODEL: JSC-45, JSC-46, JSC-47****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** Gamma
Passive**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** *Canberra Industries, Inc.***MANUFACTURER:** *Canberra Industries, Inc.***DESCRIPTION****PURPOSE**

The JSC-45 JSC-46 and JSC-47 are designed as remote detector probes for use with the Canberra's JHH-41 Hand-Held Verification Instrument.

PRINCIPLES OF OPERATION

There are variable positions for the detector with reference to the front face of the composite shield which reduces low-energy x-ray background; an optional carrying strap allows more freedom of movement.

The detector is surrounded by high-density polyethylene and cadmium to reduce lead x-ray background. The detector can be moved inside the shield from flush to 3.2 cm from the front face of the shield by means of screws on the side of the shield. Moving the detector farther from the front face of the shield allows tighter collimation.

A male sub-D connector located at the rear of the housing connects the HV board, via a removable cable, to the JHH-41. The HV board is located near the detector to make the cable more tenable, buffer the analog signal from the detector to reduce noise, and to eliminate the need for resetting the HV when the remote detector is changed from the JSC-45, JSC-46 or JSC-47 to the JSP-12 Shielded Neutron Assay Probe.

FUNCTIONAL BLOCKS

- NaI(Tl) detector
- high/voltage/preamp PC board with LED stabilization circuitry
- collimator
- lead composite shield
- optional carrying strap
- high voltage (HV) power supply
- preamplifier
- temperature-stability circuitry

SPECIFICATIONS**Detector dimensions:**

JSC-45	2.5 cm x 1.3 cm thick
JSC-46	2.5 cm x 5.1 cm thick
JSC-47	5.1 cm x 1.3 cm thick

Detector efficiency

approximately 9%

Collimator diameter

2.5 cm (JSC-45 and JSC-46)

5.1 cm (JSC-47)

Shield size

8.9 cm tall, 21.0 cm long, 6.4 cm wide

Lead size

0.6 cm

Shield weight

eight pounds

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Detector**Gamma-Ray and Neutron Detector Electronics Unit**
MODEL:

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SUPPLIER: *Davidson Co. Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** Gamma, neutron
Passive**MEASURED PROPERTIES:** Radiation Intensity**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Davidson Co. Inc.**DESCRIPTION****PURPOSE***Can be used for either measurement of the burn-up of spent fuel at fuel a storage site or for core discharge monitor at reactor site.***PRINCIPLES OF OPERATION**

Measures current from ion chambers and counts pulses from neutron counters. Records data as a function of position or time and logs results on an optional printer mounted in the instrument.

FUNCTIONAL BLOCKS

- Gamma module with ion chamber HV supply.
- Neutron counter module with neutron detector HV supply.
- preamp power
- microprocessor, clock, memory, program PROMs, I/O communication and control interface.
- keyboard and LCD display.
- low voltage power supplies and batteries..
- built-in wide range battery charger.

SPECIFICATIONS

Power supply	Two internal 12 volt 3.5 AH gel-cell rechargeable batteries with internal charger
Operating time	20 hours on a fully charged battery
Overall size	15" wide, 5" high, 13.5" deep
Weight	10 lbs. without battery pack, 15 lbs. with battery pack

SOFTWARE

PROMs as required for application.

ADDITIONAL INFORMATION

The GRAND-3 serves as the platform for the hardware implementation of two plug-in Personality Modules to be used in the measurement of gamma and neutron radiation

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Detector**Coaxial and Planar Safeguard Germanium Detectors****8****MODEL: SGD****SUPPLIER: EG&G Instruments, Inc. ORTEC****USE CATEGORY:** Accounting**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** Gamma**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** EG&G Instruments, Inc. ORTEC**MANUFACTURER:** EG&G Instruments, Inc. ORTEC**DESCRIPTION****PURPOSE**

SGDs feature a choice of fixed, portable, and custom, cryostats, a robust aluminum endcap, a streamline low-power preamplifier assembly, and a LN2-free option. The detectors are designed for best performance safeguards isotopic applications software (FRAM-LANL, MGA-LLNL distributed by ORTEC)

PRINCIPLES OF OPERATION**FUNCTIONAL BLOCKS****SPECIFICATIONS**

		at 122 keV	at 1.33 MeV
SGD Planars:	16 mm dia	510 eV	
	25 mm dia	520 eV	
	36 mm dia	550 eV	

SDG Coaxial	0.75 keV	1.75 keV
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SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Detector

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Portable Detector ProbeMODEL: CZTPack**SUPPLIER:** EG&G Instruments, Inc. ORTEC

USE CATEGORY: Accounting
DEVICE TYPE: Detector
MEASUREMENT METHOD: Gamma
 Passive

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:**

STATUS: Serial Production
PORTABILITY: Portable
ENVIRONMENT OF USE: Industrial
DEVELOPER: EG&G Instruments, Inc. ORTEC
MANUFACTURER: EG&G Instruments, Inc. ORTEC

DESCRIPTION**PURPOSE**

The CZTPack Portable Detector Probe provides all needed electronics to perform room temperature, portable gamma spectroscopy, for medium-resolution applications in low-energy gamma and x-ray analysis, such as Nuclear Safeguards Inspection, Nuclear Material Verification, and Counter-Smuggling Operations.

PRINCIPLES OF OPERATION

CZTPack operates in concert with a room-temperature cadmium-zinc-telluride (CZT) semiconductor detector, which provides energy resolution much better than NaI detectors for measurement of low- to medium-energy photons.

CZTPack is available with an external BNC connector for input from any size CZT detector. The detector may be at the end of a coaxial cable, thus allowing the detector to be placed in immediate contact with the source.

CZTPack operates with either the MicroNOMAD or MicroACE MCAs.

FUNCTIONAL BLOCKS

- 125-mm³ (5 mm x 5 mm x 5 mm) CZT detector.
- external BNC connector

SPECIFICATIONS

Resolution	3% FWHM at 122 keV
Operation temperature	0 to 50 degrees C
Power supply	+12Volts from the MicroNOMAD (or Micro-ACE); 55 mA, 650 mW
Overall size	5.8 cm x 13.5 cm x 3.3 cm
Weight	0.26 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

1. A.D.Lavietes, J.H.McQuaid, W.Ruhter, W.M. Buckley, T.J.Paulus. "A transportable high resolution gamma-ray spectrometer and analysis system applicable to mobile, autonomous or unattended applications", 37-th INMM Annual Meeting, Proceedings, Naples Florida, July 28- August 1, 1996
2. A.D.Lavietes, J.H.McQuaid, T.J.Paulus. "Preliminary Uranium enrichment analysis results using Cadmium Zinc Telluride detectors", Nuclear Instruments & Methods in Physical Research, vol.A380, 406-409, 1996.
3. A.D.Lavietes (LANL), J.H.McQuaid (BNC), T.J.Paulus (EG&G ORTEC). "Cadmium Zinc Telluride detector system for nuclear material assay." 38-th INMM Annual Meeting Proceedings, July 20-24, 1997, Phoenix Arizona

Accounting: Detector

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Gamma Detection Units**MODEL: БДЕГ-Г-1К****SUPPLIER: IFTP, Institute of Physical & Technical Problems****USE CATEGORY:** Accounting**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** IFTP, Institute of Physical & Technical Problems**MANUFACTURER:** IFTP, Institute of Physical & Technical Problems**DESCRIPTION****PURPOSE***Gamma radiation spectrometry.***PRINCIPLES OF OPERATION****FUNCTIONAL BLOCKS**

- coaxial Ge(Li) semiconductor detector
- submerged cryostat
- preamplifier
- HV filter
- nitrogen sensor built into Dewar
- Dewar CK-16

Detector has separate design versions for detection of radiation beams directed vertically or horizontally.

SPECIFICATIONS

Measured energy range	50 keV - 10 MeV
Energy resolution on 1332keV line	1,8 keV - 3,5 keV
Detection efficiency for (3x3) "NaI on 1332keV line	5 - 20 % no more than 0,03 %
Integral non-linearity	
Operation conditions	from -10°C to +50°C up to 90% at 30°C from 630 mm to 800 mm of mercury thermometer
temperature	
relative humidity	
atmosphere pressure	
Overall size	D367 mm x 1040 mm
Weight with nitrogen	30 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Detector

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X-Ray Detection Unit**MODEL:** УДЕР-КИ-10К**SUPPLIER:** IFTP, Institute of Physical & Technical Problems**USE CATEGORY:** Accounting**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** X-Ray**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:****PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Field and Industrial Laboratories**DEVELOPER:** IFTP, Institute of Physical & Technical Problems**MANUFACTURER:** IFTP, Institute of Physical & Technical Problems**DESCRIPTION****PURPOSE***Used as a part of process monitoring and control systems at nuclear fuel production and reprocessing facilities.***PRINCIPLES OF OPERATION**

Detection of X-ray radiation of any spatial orientation.

FUNCTIONAL BLOCKS

- small sized detection unit on base of silicon detector with a thermoelectric cooler
- power supply unit for cooler and magnet pump
- set of connection cables

SPECIFICATIONS

Detected energy range	1.5 keV - 60 keV
Energy resolution for 5.9 keV line	210 eV - 240 eV
Sensitive surface area	25 mm ²
Integral non-linearity	0.1%
Max. stat. pulse rate	5E+4
Overall size	80 mm x 210 mm
Weight	2.5 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Detector**12****X-Ray Detection Units (БДЕР-Г-7К)****MODEL: БДЕР-Г-7К****SUPPLIER: IFTP, Institute of Physical & Technical Problems****USE CATEGORY:** Accounting**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** Gamma, X-Ray
Passive and Active**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:****DEVELOPER:** IFTP, Institute of Physical & Technical Problems**MANUFACTURER:** IFTP, Institute of Physical & Technical Problems**DESCRIPTION****PURPOSE***Detection and spectrometry of the X-ray and gamma radiation.***PRINCIPLES OF OPERATION****FUNCTIONAL BLOCKS**

- high purity germanium detector
- submerged cryostat
- preamplifier
- HV filter
- nitrogen presence sensor
- Dewar CK-16

Detector has separate design modes for vertically and horizontally directed the radiation flux detection.

SPECIFICATIONS

Detected radiation energy range 3-661 keV

Energy resolution (eV):

Sensitive surface area, mm ²	Energy	
	5.9 keV	122 keV
20	165-240	480-540
50	180-260	490-550
100	195-280	495-555
200	210-320	500-570
300	250-350	530-600
500	300-400	550-650
800	340-500	580-670
1000	360-520	595-700

Overall size	367 mm x 1005 mm
Weight with nitrogen	30 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Detector**13****X-Ray Detection Units (БДЕР-ГЕ-9К)****MODEL: БДЕР-ГЕ-9К****SUPPLIER: IFTP, Institute of Physical & Technical Problems****USE CATEGORY:** Accounting**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** Gamma, X-Ray
Passive and Active**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:****DEVELOPER:** IFTP, Institute of Physical & Technical Problems**MANUFACTURER:** IFTP, Institute of Physical & Technical Problems**DESCRIPTION****PURPOSE***Detection and spectrometry of the X-ray and low energy gamma radiation.***PRINCIPLES OF OPERATION****FUNCTIONAL BLOCKS**

- high purity germanium detector
- power supply system

SPECIFICATIONS

Detected radiation energy range

3 keV-661 keV

Sensitive surface area, mm ²	Energy resolution, eV for 5.9 keV	Energy resolution, eV for 122 keV
20	200-250	540-590
50	250-300	550-600
100	300-350	555-605
200	320-400	570-620
300	350-450	600-650
500	400-525	650-720
800	500-600	670-750
1000	550-650	700-780

Overall size

400 mm x 280 mm x 120 mm

Weight

4 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Detector**X-Ray Detection Units (БДЕР-К-7К)****14****MODEL: БДЕР-К-7К****SUPPLIER: IFTP, Institute of Physical & Technical Problems****USE CATEGORY:** Accounting**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** X-Ray

Active

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:****DEVELOPER:** IFTP, Institute of Physical & Technical Problems**MANUFACTURER:** IFTP, Institute of Physical & Technical Problems**DESCRIPTION****PURPOSE***Detection and spectrometry of the X-ray and gamma radiation.***PRINCIPLES OF OPERATION****FUNCTIONAL BLOCKS**

- silicon detector
- submerged cryostat
- preamplifier
- HV filter
- nitrogen presence sensor
- Dewar CK-16

SPECIFICATIONS

Detected radiation energy range

1,5-60 keV

Energy resolution (eV) :

Sensitive surface area, mm ²	5.9 keV	Energy	59,6 keV
20	165-240		430-490
50	185-270		440-500
100	210-300		470-530
200	250-350		500-580
300	280-430		530-630
500	400-550		570-680

Overall size

367 mm x 1005 mm

Weight with nitrogen

30 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Detector**15****X-Ray Detection Units (БДЕР-КЕ-9К)****MODEL: БДЕР-КЕ-9К****SUPPLIER: IFTP, Institute of Physical & Technical Problems****USE CATEGORY:** Accounting**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** X-Ray
Active**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:****DEVELOPER:** IFTP, Institute of Physical & Technical Problems**MANUFACTURER:** IFTP, Institute of Physical & Technical Problems**DESCRIPTION****PURPOSE***Spectrometry of the X-ray radiation.***PRINCIPLES OF OPERATION****FUNCTIONAL BLOCKS**

- silicon detector
- power supply system

SPECIFICATIONS

Detected radiation energy range	1.5-60 keV
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Sensitive surface area, mm ²	Energy resolution for 5.9 keV, eV
20	200-250
50	250-300
100	300-350
200	350-420
300	430-500
500	550-650

Overall size	400 mm x 280 mm x 120 mm
Weight	4 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Detector

Electro-Mechanically Cooled Ge Detector System

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MODEL: EMC-HPGeSUPPLIER: *Lawrence Livermore National Laboratory*

USE CATEGORY: Accounting

DEVICE TYPE: Detector

MEASUREMENT METHOD:

MEASURED PROPERTIES:

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Prototype

PORTABILITY: Portable

ENVIRONMENT OF USE: Field

DEVELOPER: Lawrence Livermore National Laboratory

MANUFACTURER: Lawrence Livermore National Laboratory

DESCRIPTION

PURPOSE

An Electromechanically-Cooled (EMC) High-Purity Germanium (HPGe) radiation system provides near liquid nitrogen (LN) energy resolution in a rugged, long-lived, portable and low-power consuming package.

PRINCIPLES OF OPERATION

This is an Electromechanically-Cooled (EMC) High-Purity Germanium (HPGe) radiation system which provides near liquid nitrogen (LN) energy resolution in a rugged, long-lived, portable and low-power consuming package.

Several of those LLNL-developed EMC-HPGe systems have been successfully deployed in various applications with HPGe detectors ranging in size from a 500 cm² planar detector to a 50 % coaxial detector. The typical EMC-HPGe system provides energy resolution within about 10 % of a standard LN-cooled detector and consumes less than 100 W. The mean life time-to-failure of a typical EMC-HPGe is 50,000 h (about 6 years) and these systems are well suited to most HPGe detector applications which are not LN conductive. LLNL-developed EMC-HPGe systems have been demonstrated to the U.S. Customs, Nuclear Emergency Search Team (NEST), and the International Atomic Energy Agency (IAEA), and a system has been deployed within the European Communities' Safeguards Directorate (EURATOM).

FUNCTIONAL BLOCKS

- High Purity Germanium Detector.
- Requires an MCA.

SPECIFICATIONS

Measurement range	standard HPGe operation
Measurement time	various, depending on source size, activity and source-detector geometry
Power supply	requires +12 VDC
Overall size	6" x 9" x 21"
Weight	17 kg

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

J.Mauger, T.Lavietes, B.Bandong, W.Ruhter, S.Kreek (LLNL). An Electromechanically-Cooled (EMC) High-Purity Germanium (HPGe) Radiation Detector. 38-th INMM Annual Meeting Proceedings, July 20-24, 1997, Phoenix, Arizona.

Accounting: Detector

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Detection Unit**MODEL: МБД-216, МБД-217, МБД-218, МБД-234, МБД-235****SUPPLIER: PA MAYAK, Production Association MAYAK****USE CATEGORY:** Accounting**DEVICE TYPE:** Detector**MEASUREMENT METHOD:****MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Limited Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** PA MAYAK, Production Association MAYAK**MANUFACTURER:** PA MAYAK, Production Association MAYAK**DESCRIPTION****PURPOSE***Used as a part of production control devices at nuclear facilities***PRINCIPLES OF OPERATION**

Detecting of thermal neutrons, amplifying and transferring detector signals on the second devices.

FUNCTIONAL BLOCKS

- Hermetic stainless steel body;

- Neutron detector:

МБД-216	СНМ-16;
МБД-217	СНМ-17;
МБД-218	СНМ-18;
МБД-234	СНМ-34;
МБД-235	СНМ-35;

- Built-in amplifier;

- Input coaxial cable for power supply for the detector;

- Multi-wire shielded cable for power supply of amplifier and for output signal.

SPECIFICATIONS**Efficiency of neutron detection:**

	МБД-216	МБД-216	МБД-216	МБД-216	МБД-216
no less than	64%	64%	80%	60%	25%

Power supply:

МБД-216	МБД-217	МБД-218	МБД-234	МБД-235
+2600±300V	+2600±300V	+2200±300V	+2500±200V	+2000±100V

Temperature operation range:

- 50°C to + 50°C

Overall size:

	МБД-216	МБД-216	МБД-216	МБД-216	МБД-216
length:	525 mm	660 mm	770 mm	1429 mm	1420 mm
diameter:	34 mm	34 mm	44 mm	34 mm	34 mm
Weight:	2.8 kg	2.8 kg	4.0 kg	4.0 kg	4.0 kg
Length of cables:			up to 15 m		

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Detector**Scintillating Fibers Neutron Detectors****18****MODEL:****SUPPLIER:** *Pacific Northwest National Laboratory***USE CATEGORY:** Accounting**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** Neutron

Passive

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Limited Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Laboratory**DEVELOPER:** Pacific Northwest National Laboratory**MANUFACTURER:** Pacific Northwest National Laboratory**DESCRIPTION****PURPOSE**

As the thermal neutron sensitive elements in a fast neutron detection system, scintillating fibers can be dispersed within moderator, improving neutron economy over that possible with commercially available He-3 or BF₃ proportional counters. These fibers permit both large-area devices and extremely small devices.

PRINCIPLES OF OPERATION

Three prototype detectors are described in Ref. 1.

- a) High-efficiency, large-area airbone neutron detector detects small discrete neutron sources.
- b) Reactor-flux monitor. The fibers and fiber ribbons are arranged to fit within a cylinder approximately 15 cm in diameter.
- c) Storage-container monitor incorporates four bilayer ribbons of scintillating fiber stacked upon each other. This is equivalent to wrapping a 7.5-cm-diameter He-3 tube (10 atm) around the storage can.

FUNCTIONAL BLOCKS

High-efficiency, large-area airbone neutron detector:

- 12 modules totalling 0.42 m² of active area in a rugged aluminum box.

Reactor-flux monitor:

- fibers and fiber ribbons (0.5 meters long) fabricated from fibers containing lithium enriched in Li-6.

Storage-container monitor:

- four 7.5-cm-wide bilayer ribbons of scintillating fiber

SPECIFICATIONS

operational transmission length of cerium-activated lithium silicate scintillating fibers	greater than 2 meters
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SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Glass-fiber-based Neutron Detectors for High- and Low-flux Environments, Mary Bliss, et.al., Photoelectronic Detectors, Cameras, and Systems, Proc. SPIE 2551, 108-117, 1995

Accounting: Detector

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Miniature Spectrometric Detection UnitMODEL: PCZT-G**SUPPLIER:** PNPI, St-Petersburg Nuclear Physics Institute**USE CATEGORY:** Accounting**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):** Fresh and spent fuel**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** PNPI, St-Petersburg Nuclear Physics Institute**MANUFACTURER:** PNPI, St-Petersburg Nuclear Physics Institute**DESCRIPTION****PURPOSE**

Detection of gamma radiation with energy from 30 keV to 2000 keV. Used in verifying systems for fresh and spent fuel. The device is of particular interest for measurement of difficult to-access objects (e.g. middle of central section of fuel assemblies)

PRINCIPLES OF OPERATION

The device detects gamma radiation and is a part of a spectrometric system. Compatible with portable multichannel analyzers.

FUNCTIONAL BLOCKS

The device is a miniature hermetic probe and includes:

- CdZnTe detector;
- preamplifier.

The probe is connected hermetic with cable (from 0.2m to 20m) for connection with next electronics.

SPECIFICATIONS

Energy resolution for gamma energy

122 keV:	no more than 6 keV
662 keV:	from 7 keV to 20 keV

Gamma detection sensitivity for energy

122 keV:	from 0.2 mm ² to 0.6 mm ²
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Transformation factor for built-in preamplifier:

0.25 mmV/keV

±12 V

Preamplifier power supply:

D8.2 mm x 90 mm

Overall size:

from 0.2 m to 20 m

Cable length:

from 0°C to +40°C

Operation temperature range:

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Detector**20****Gamma Probe****MODEL: SC-GX1, GX2, GX3****SUPPLIER: Quantrad Sensor Division, Applied Electron Corp.****USE CATEGORY:** Accounting**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** Gamma
Passive**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Field**DEVELOPER:** Quantrad Sensor Division, Applied Electron Corp.**MANUFACTURER:** Quantrad Sensor Division, Applied Electron Corp.**DESCRIPTION****PURPOSE**

Designed for low to medium energy gamma spectroscopy. Can be used for confirmatory measurements and identifying gamma emitting isotopes as well as for waste management applications.

PRINCIPLES OF OPERATION**FUNCTIONAL BLOCKS**

- 1" x 1" to 3" x 3" NaI(Tl) scintillation detectors,
- integral crystal,
- PMT,
- HV power supply
- amplifier,
- coiled 4" cable interface to Scout multichannel analyzer.

SPECIFICATIONS

Range of detected gamma	100 Kev - 2.5 MeV
Energy resolution for Cs-137 gammas	8-9%
Weight	up to 1.5 pounds.

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Detector

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Neutron Probe**MODEL: SC-NP1****SUPPLIER:** *Quantrad Sensor Division, Applied Electron Corp.***USE CATEGORY:** Accounting**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** Neutron

Passive

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Quantrad Sensor Division, Applied Electron Corp.**MANUFACTURER:** Quantrad Sensor Division, Applied Electron Corp.**DESCRIPTION****PURPOSE***Designed to detect thermal and fast neutrons, confirm presence of nuclear materials, nuclear safeguards, emergency response - locate neutron sources.***PRINCIPLES OF OPERATION**

Detects neutrons by way of the Li-6 (n, alpha)T reaction.

FUNCTIONAL BLOCKS

- 1" x 3" Li-6I(Eu) scintillation detector,
- external (removable) polyethylene neutron moderator,
- coiled cable (4') interface to Scout MCA.

SPECIFICATIONS

Weight 1.5 pounds

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Detector**Large Volume Spectrometric Detector**
MODEL: CZT/500**22****SUPPLIER:** RITEC Ltd.**USE CATEGORY:** Accounting**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** Gamma
Passive**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Field**DEVELOPER:** RITEC Ltd.**MANUFACTURER:** RITEC Ltd.**DESCRIPTION****PURPOSE**

The Large Volume Spectrometric Detector, model CZT/500 is miniature portable gamma-ray detection unit used mainly to verify the presence and enrichment of fresh nuclear fuel or verify the presence of spent nuclear fuel bundles.

PRINCIPLES OF OPERATION

Measure characteristic gamma rays. The devices contain detectors from wideband semiconductor material - CdTe or CdZnTe, which work at room temperature and do not require special cooling systems.

FUNCTIONAL BLOCKS

- semiconductor detector, model CZT/500
- miniature preamplifier (is optional)

SPECIFICATIONS

Energie range	100-1000 keV
Detector CZT/500:	
size	10 x 10 x 5 mm
energy resolution	not more 30keV at 662 keV
Overall size:	
detector	diameter of 23 mm and a length of 33 mm.
preamplifier	diameter of 23 mm and a length of 65 mm.

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

1. R. Arlt, D.E. Rundquist, P. Siffert, M. Rihter, A. Khusainov, V. Ivanov et. al., Use of Room Temperature Semiconductor Detectors for Verification of Nuclear Material in International Safeguards - Recent Advances, Symposium Semiconductors for Room Temperature Radiation Detector Applications, Proceedings, v.302, 1993, San Francisco, California.
2. R. Arlt, V.I. Ivanov, P. Dorogov, Development of Large Volume Hemispherical CdZnTe Detectors for Use in Safeguards Application, 19th Annual Symposium on Safeguards and Nuclear Material Management, ESARDA Proceedings, 1997.
3. R. Arlt, D.E. Rudquist, Room Temperature Semiconductor Detectors for Safeguards Measurements, Nuclear Instruments & Methods in Physical Research, A380, pp. 455-461, Elsevier Science B.V., Netherlands, 1996.

Accounting: Detector

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Spectrometric Detection Probe

MODEL: SDP310/20, SDP310/60, SDP310/I&C/20, SDP310/I&C/60

SUPPLIER: *RITEC Ltd.*

USE CATEGORY:	Accounting
DEVICE TYPE:	Detector
MEASUREMENT METHOD:	Gamma Passive
MEASURED PROPERTIES:	Radiation Intensity
NUCLEAR MATERIAL(S):	
PHYSICAL FORM(S) OF NM:	Assembly / TBC
STATUS:	Serial Production
PORTABILITY:	Portable
ENVIRONMENT OF USE:	Field
DEVELOPER:	RITEC Ltd.
MANUFACTURER:	RITEC Ltd.

DESCRIPTION

PURPOSE

PURPOSE The Spectrometric Detection Probe, models SDP310/20; SDP310/60; SDP310/LC/20; SDP310/LC/60; SDP310/60s; SDP310/LC/20s; SDP310/LC/20s; SDP310/LC/60s are miniature portable gamma-ray detection units used mainly to verify the presence and the enrichment of fresh nuclear fuel or verify the presence of spent nuclear fuel bundles.

PRINCIPLES OF OPERATION

Measure characteristic *gamma* rays. The devices contain detectors from wideband semiconductor material - CdTe or CdZnTe, which work at room temperature and do not require special cooling systems.

FUNCTIONAL BLOCKS

- removable probe containing gamma-radiation semiconductor detectors, hybrid film preamplifier, housing
- connecting cable and connector(s)

SPECIFICATIONS

SPECIFICATIONS The letter "s" in the detection probe model name means - Super Grade Detector. The letters "LC" in the detection probe model name mean - Long Cable.

letters 'LC' in the detection probe model name
Energie range 100-1000 keV

Energie range	100-1000 keV
Detectors:	
size	up to 3 x 3 x 1.5 mm ³ for SDP310/20, SDP310/LC/20, SDP310/20s, SDP310/LC/20s
	up to 5 x 5 x 2.5 mm ³ for SDP310/60, SDP310/LC/60, SDP310/60s, SDP310/LC/60s
energy resolution	not more than 12 keV at 662 keV for SDP310/20s, SDP310/LC/20s not more than 15 keV at 662 keV for SDP310/60s, SDP310/LC/60s not more than 22 keV at 662 keV for SDP310/20, SDP310/LC/20 not more than 26 keV at 662 keV for SDP310/60, SDP310/LC/60
peak-to-Compton ratio	not less than 2.5 at 662 keV for SDP310/20s, SDP310/LC/20s not less than 2.8 at 662 keV for SDP310/60s, SDP310/LC/60s not less than 1.6 at 662 keV for SDP310/20, SDP310/LC/20 not less than 1.8 at 662 keV for SDP310/60, SDP310/LC/60

Overall size: not less than 1.0 at 302 rev/sec
removable probe diameter of 8 mm, length of 85 mm

connecting cable	length is from 0.2 to 1 m for SDP310/20, SDP310/60, diameter 5.5 mm
	length is from 1 m to 8 m for SDP310/LC/20, SDP310/LC/60, (optional: up to 20 m), diameter 5.5 mm.
Connectors	5-pin FGG.2B704 LEMO type or 9-pin "D" type for SDP310/20, SDP310/60, SDP310/20s, SDP310/60s 9-pin "D" type, BNC and SVH for SDP310/LC/20, SDP310/LC/60, SDP310/LC/20s, SDP310/LC/60s

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

1. R. Arlt, D.E. Rundquist, P. Siffert, M. Rihter, A. Khusainov, V. Ivanov et. al., Use of Room Temperature Semiconductor Detectors for Verification of Nuclear Material in International Safeguards - Recent Advances, Symposium Semiconductors for Room Temperature Radiation Detector Applications, Proceedings, v.302, 1993, San Francisco, California.
2. R. Arlt, V.I. Ivanov, P. Dorogov, Development of Large Volume Hemispherical CdZnTe Detectors for Use in Safeguards Application, 19th Annual Symposium on Safeguards and Nuclear Material Management, ESARDA Proceedings, 1997.
3. R. Arlt, D.E. Rudquist, Room Temperature Semiconductor Detectors for Safeguards Measurements, Nuclear Instruments & Methods in Physical Research, A380, pp. 455-461, Elsevier Science B.V., Netherlands, 1996.

Accounting: Detector**24****Gamma Spectrometric Unit****MODEL:****SUPPLIER: RSC Kurchatov Institute, SPC REKOM****USE CATEGORY:** Accounting**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** Gamma
Passive**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:****PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** RSC Kurchatov Institute, SPC REKOM**MANUFACTURER:** RSC Kurchatov Institute, SPC REKOM**DESCRIPTION****PURPOSE***Spectrometric measurements for the energy range from a few keV to a few MeV.***Application fields:**

- gamma-spectrometry
- radiometry, dosimetry
- gamma defectoscopy
- medicine
- process control of the NPP
- custom control and so on.

PRINCIPLES OF OPERATION**FUNCTIONAL BLOCKS**

- CsI(Tl) scintillation detector
- silicon photodiode

A detection unit with built-in preamplifier can be provided.

SPECIFICATIONS

Scintillator volume

1 cm³ to 20 cm³

Energy resolution on 662 keV line

7% (1 cm³) to 10% (20 cm³)

Detected energy range

60 keV - 3 MeV

Dimension of the detection unit

D25 mm x 60 mm (1 cm³)D44 mm x 60 mm (20 cm³)**SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Detector**Scintillation Detection Assemblies****25****MODEL: БДЭГ-30 и БДЭГ-36****SUPPLIER: SNIIP- Green Star, Ltd.****USE CATEGORY:** Accounting**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** Gamma
Passive**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORATABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** SNIIP- Green Star, Ltd.**MANUFACTURER:** SNIIP- Green Star, Ltd.**DESCRIPTION****PURPOSE***Detection of X- and gamma radiation***PRINCIPLES OF OPERATION****FUNCTIONAL BLOCKS**

- housing within a metal shield;
- photomultiplier tube (PMT);
- scintillation crystal;
- PMT voltage denominator;
- three connectors:
 - high voltage for the PMT high voltage;
 - output from the PMT anode;
 - output from the last dynode.

Detection blocks are manufactured in two modifications - with amplifier and without it.

SPECIFICATIONS

PMT operation voltage	no more than 1250 V
-----------------------	---------------------

Total resistance of the PMT voltage	
-------------------------------------	--

denominator	4 MΩ
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PMT signal conversion factor	1 V/MeV
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amplifier output voltage (if it is used) is linear up to 5 MeV.	
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Detection assemblies modifications:

Assembly type	Monocrystal type	Monocrystal sizes	PMT diameter mm	Resolution, %
BDEG-30	NaI(Tl)	1.75" x 1.75"	52	7.0
BDEG-30-1	NaI(Tl)	2.0" x 2.0"	52	7.5
BDEG-30-2	CsI	1.75" x 1.75"	52	7.0
BDEG-30-3	CsI	2.0" x 2.05"	52	7.5
BDEG-36	NaI(Tl)	3.0" x 3.0"	80	7.5

SOFTWARE**ADDITIONAL INFORMATION**

CsI detection assemblies have the same energy resolution as NaI(Tl), but they have the better mechanical and climatic characteristics, higher density and higher effective atomic number crystal.

Detection assemblies with other crystal sizes, diameter and height not exceeding 3" for NaI(Tl) and 2" for CsI

crystals are available.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Detector**Scintillation Detection Unit**
MODEL: БДС-Г**26****SUPPLIER:** *SPC Aspect***USE CATEGORY:** Accounting**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** Gamma
Passive**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Field, Laboratory**DEVELOPER:** SPC Aspect**MANUFACTURER:** SPC Aspect**DESCRIPTION****PURPOSE***Designed to detect gamma radiation and determine a spectrum. This device is used in a spectrometer.***PRINCIPLES OF OPERATION****FUNCTIONAL BLOCKS**

The device is a unit with built-in modules:

- high voltage divider;
- voltage transformer;
- preamplifier;
- amplifier;
- stabilization system by LED peak.

SPECIFICATIONS

Detected energy range	0.05 - 3 MeV
Energy resolution for 662 keV line	<8%
Integral instability	no more than 1%
Temperature instability	<0.1%/C
Time instability for 24 hours continuous operation	<1%
Additional instability of the transformation ratio under a pulse rate increasing from the background level to 50000 s ⁻¹	<1%
Maximum unfolded pulse height of output spectrometric signals	no less than 5 V
Output signal	bipolar, positive
Constant component on the unit output	< ±5 mV
Output resistance	<10 ohm
Overall size	D 92 mm x 300 mm
Weight	< 3 kg

SOFTWARE**ADDITIONAL INFORMATION**

- free warranty service;
- detectors may be delivered with crystals of different sizes (for example, 150 x 100, 150 x 20, 80 x 80 and so on) on an individual demand, including detectors with a well;
- delivery possibility of detectors with an extended operation temperature range (from -25 to +50)°C on an individual demand.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Detector***Automated Neutron Flux Meter******MODEL: ИНПА*****27****SUPPLIER: VNIIA, All-Russian Research Institute of Automatics****USE CATEGORY:** Accounting**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** Neutron

Passive

MEASURED PROPERTIES: Radiation Intensity**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:****PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** VNIIA, All-Russian Research Institute of Automatics**MANUFACTURER:** VNIIA, All-Russian Research Institute of Automatics**DESCRIPTION****PURPOSE***Measurement of neutron flux density emitted by pulsed neutron generators or other pulsed neutron radiation sources.***PRINCIPLES OF OPERATION**

Device measures: characteristics of neutron flux in presence of accompanying x-ray radiation and electromagnetic noise; and neutron flux from pulsed neutron generator targets. A companion small-sized detection unit allows performance of measurements in hard-to-access locations.

FUNCTIONAL BLOCKS

- БД1 and БД2 detection units
- БИ measurement unit

SPECIFICATIONS

Detected radiation	fast neutron of 2.5; 14MeV
Measurement range	1E+4 - 1E+9 neutrons/sq.sm *sec
Measurement error	15%
Power supply	=23-28.5 V ~220V (50; 60Hz)
Overall size:	
БД1	37 mm x 40 mm x 90 mm
БД2	48 mm x 62 mm x 115 mm
БИ	130 mm x 280 mm x 135 mm
Weight: БД1	0.2 kg
БД2	0.5 kg
БИ	2.9 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Detector

Neutron Counter

MODEL: CHM-66

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SUPPLIER: VNIITFA, All-Russian Research Institute of Technical Physics and Automatization

USE CATEGORY: Accounting

DEVICE TYPE: Detector

MEASUREMENT METHOD: Neutron

Passive

MEASURED PROPERTIES:

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Prototype

PORTABILITY:

ENVIRONMENT OF USE:

DEVELOPER: VNIITFA, All-Russian Research Institute of Technical Physics and Automatization

MANUFACTURER: VNIITFA, All-Russian Research Institute of Technical Physics and Automatization

DESCRIPTION

PURPOSE

Can be used in active and passive well coincidence counters (like AWCC and others) for the thermal neutron detection.

PRINCIPLES OF OPERATION

FUNCTIONAL BLOCKS

- stainless cathode
- glass insulator
- He-3 filling

SPECIFICATIONS

Operation voltage	1600 V
Max. amplitude resolution	8 %
Max. amplitude scattering	10 %
Min. efficiency of the thermal neutron registration	70 %
Operation temperature range	-25°C to +100°C
Diameter	26.4 mm
Length	604 mm

SOFTWARE

ADDITIONAL INFORMATION

Foreign analog - RS-P4-0820-103 counter of Reuter-Stokes firm.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Identifier**29****CdZnTe Detector System for Uranium (CZT U Probe)****MODEL: EG&G ORTEC Model Number 297****SUPPLIER: EG&G Instruments, Inc. ORTEC****USE CATEGORY:** Accounting**DEVICE TYPE:** Identifier**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):** Pu, LEU, HEU, Fe-55 through Cs-137**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Field**DEVELOPER:** Lawrence Livermore National Laboratory**MANUFACTURER:** EG&G Instruments, Inc. ORTEC**DESCRIPTION****PURPOSE***Developed for rough estimates of U enrichment.***PRINCIPLES OF OPERATION****FUNCTIONAL BLOCKS**

Pocket-size system based on EG&G MicroNomad portable multi-channel analyzer. Uses Cadmium-Zinc-Telluride detector.

SPECIFICATIONS

Measurement time

variable (depends on source size, activity, and source-detector geometry)

± 10 %

Accuracy

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

1. Anthony D. Lavietes, James H. McQuaid, Wayne D. Ruhter (LLNL), and T.J. Paulus (EG&G ORTEC), Development of a Portable Ambient Temperature Radiometric Assaying Instrument, Transactions of Nuclear Science

2. Anthony D. Lavietes, James H. McQuaid, Wayne D. Ruhter, William M. Buckley (LLNL), and T.J. Paulus (EG&G ORTEC), A Transportable High-Resolution Gamma-Ray Spectrometer and Analysis System Applicable to Mobile, Autonomous or Unattended Applications, Nuclear Instruments and Methods in Physics Research

3. Anthony D. Lavietes, James H. McQuaid, Wayne D. Ruhter (LLNL), and T.J. Paulus (EG&G ORTEC), Development of a Portable Ambient Temperature Radiometric Assaying Instrument, 1994 IEEE Nuclear Science Symposium and Medical Imaging Conference, Norfolk, Virginia, October 30 - November 5, 1994 (UCRL-JC-117141)

Accounting: Identifier**Shipper Receiver Confirmatory System****MODEL: SRCS****30****SUPPLIER:** *Los Alamos National Laboratory***USE CATEGORY:** Accounting**DEVICE TYPE:** Identifier**MEASUREMENT METHOD:** Gamma

Active

MEASURED PROPERTIES: Radiation Intensity**NUCLEAR MATERIAL(S):** U**PHYSICAL FORM(S) OF NM:** Container**STATUS:** Limited Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Los Alamos National Laboratory**DESCRIPTION****PURPOSE***Produces a unique fingerprint for a sealed shipping container of uranium.***PRINCIPLES OF OPERATION**

A unique fingerprint are produced by measuring the gross weight of the container and the intensity of gamma rays emitted at 185.7, 1001, and 2614 keV. This fingerprint can confirm that the container was not tampered with during shipping between facilities or while in storage at a facility. The measurement does not require calibration and the container does not have to be opened.

FUNCTIONAL BLOCKS

Low resolution NaI (Tl) detectors

SPECIFICATIONS

Measurement time	200 seconds
Sensitivity	discrepancy between values of measured attributes is measured within 1%

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Application Note, Shipper-Receiver Confirmatory System, LALP-93-16, March 1993.

Accounting: Identifier

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Hand-Held Pu and U Assay Meter
MODEL: HM-4

SUPPLIER: *National Nuclear Corporation*

USE CATEGORY: Accounting

DEVICE TYPE: Identifier

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition

NUCLEAR MATERIAL(S): Pu, U

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Hand-held

ENVIRONMENT OF USE: Field

DEVELOPER: National Nuclear Corporation

MANUFACTURER: National Nuclear Corporation

DESCRIPTION**PURPOSE**

Typical applications might include checking fuel rods for voids or dummy pellets, assaying UF6 cylinders, semi-quantitative assay of uranium content or enrichment, or plutonium content in circumstances where it is difficult to set up and employ a fixed detector.

PRINCIPLES OF OPERATION

Two SCA counting channels can be set to cover the 186 keV peak of U-235 and a background region, or the 300-450 keV region for Pu-239 counting.

FUNCTIONAL BLOCKS

- 1.9cm x 1.9cm NaI detector with Am-241 stabilization of the high voltage bias supply.

- two SCA

Accessories :

- aluminum travel case
- 110/220V battery charger
- extender board for troubleshooting
- operations manual

SPECIFICATIONS

Measurement time	2 to 60 seconds
Power supply	six AA rechargeable NiCad batteries
Continuous operation	12 hours
Overall size	280mm x 115mm x 83mm
Weight	2.5 kg
Gross weight with accessories	7.5 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Identifier**Portable Hand-Held Ruggedized Nuclear Detection and Radionuclide Identification System****32*****MODEL: Explorer*****SUPPLIER:** *Quantrad Sensor Division, Applied Electron Corp.***USE CATEGORY:** Accounting**DEVICE TYPE:** Identifier**MEASUREMENT METHOD:** Neutron, Gamma
Passive**MEASURED PROPERTIES:** Isotopic Composition**NUCLEAR MATERIAL(S):** U-235, U-238, Pu-239, Np-237, Ba-133, Ho-166, Ir-192, Ra-226, Bi-297, Th-232, Cs-137, Co-60, Na-22, Tc-99, Tl-201, Ga-67, Cr-57, I-131**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORATABILITY:** Hand-held**ENVIRONMENT OF USE:** Field**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Quantrad Sensor Division, Applied Electron Corp.**DESCRIPTION****PURPOSE***Explorer performs radionuclide identification. Identified materials include medical isotopes.***PRINCIPLES OF OPERATION**

Explorer detects both gamma rays and neutrons. The Explorer is engineered for harsh environmental operation and its two modes of operation permit either a simple one button isotope identification system or a full-featured gamma-ray spectroscopy system.

FUNCTIONAL BLOCKS

sealed aluminum enclosure house:

- detectors:

- NaI(Tl) photo-multiplier detector
- pair of He-3, 20 atm proportional counters

- electronics

- rechargeable nickel metal/hydride batteries

SPECIFICATIONS

Continuous operating time	16 hours
Gamma FWHM resolution for Cs-137	less than 10%
Operation temperature	-20°C to +50°C
Power supply	rechargeable Nickel Metal/Hydride 2.8 Ah battery
Overall size	168 mm x 158 mm x 73 mm
Weight	6.5 pounds

SOFTWARE

Can store and view 31 spectra

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Identifier**33****Installation for the Radiation Object Passportization****MODEL: YPII-2****SUPPLIER:** RFNC VNIIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics**USE CATEGORY:** Accounting**DEVICE TYPE:** Identifier**MEASUREMENT METHOD:** Gamma, Neutron
Passive**MEASURED PROPERTIES:** Radiation Intensity**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:** Container**STATUS:** Limited Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:****DEVELOPER:** RFNC VNIIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics**MANUFACTURER:** RFNC VNIIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics**DESCRIPTION****PURPOSE***Automatic comparative analysis of radioactive objects, in particular containers, with NM without opening them.***PRINCIPLES OF OPERATION**

After neutron and gamma channel calibrations the initial radiation passport of the object (a set of gamma energy distribution parameters and a neutron flux density) is measured in the fixed geometry defined by the installation design. Radiation passport is stored in the PC data base.

For repeated measurements (for example during the physical inventory or after transportation) the above-mentioned procedure is repeated and the new radiation passport is compared with the initial by using the statistical hypothesis test.

Data processing and storage is executed by NoteBook PC.

This set of parameters and their complex interdependence makes substitution of the contents virtually impossible.

FUNCTIONAL BLOCKS

Easily controlled moveable metal platform with a manipulator on which the measurement unit containing NaI-spectrometer and He-3 neutron detector is situated.

Delivery set located:

- Installation YPII
- NoteBook PC
- Calibration sources in containers,
- Software,
- User's manual,
- Formular

SPECIFICATIONS

Measured energy range:

gamma radiation

from 0.05 MeV to 3 MeV

neutron radiation

from 1E-1 eV to 1E+7 eV

Energy resolution on a line of 1,33MeV

no less than 5%

Operation state settling time

15 min

Continuous operation time

no more than 8 h

Power consumption

no more than 100 Wt

Overall size

1900 mm x 800 mm x 600 mm

Weight

100 kg

SOFTWARE

ADDITIONAL INFORMATION
REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Identifier**Portable Analyzer for the Nuclear Materials Inventory****34****MODEL:****SUPPLIER:** RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics**USE CATEGORY:** Accounting**DEVICE TYPE:** Identifier**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):** Pu, U**PHYSICAL FORM(S) OF NM:** Container**STATUS:** Prototype**PORATABILITY:** Portable**ENVIRONMENT OF USE:****DEVELOPER:** RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics**MANUFACTURER:** RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics**DESCRIPTION****PURPOSE***Determination of NM type in secure containers without opening them.***PRINCIPLES OF OPERATION**

The detection of the NM inherent gamma radiation.

FUNCTIONAL BLOCKS

- portable automated spectrometric system on the base of work-station "InSpector" (Canberra);
- NoteBook computer;
- scintillation or semiconductor detector.

SPECIFICATIONS

Preparation time for the operation	~ 10 min
Inventory time	~ 2 min per one container
Weight (including PC and detector (without shield)):	
with scintillation detector	~ 7 kg
with semiconductor detector	~ 20 kg

SOFTWARE**ADDITIONAL INFORMATION**

Has the possibility of the operation directly in storehouse (with background shielding).

REFERENCES

Данные получены из РФЯЦ-ВНИИТФ . Письмо от 01.08.96 № 280-08/312.

Data received from RFNC-VNIITF . Fax from 10.08.96 № 280-08/312

Accounting: Identifier**Stationary Post for the Inventory of Containers with NM****MODEL:****35****SUPPLIER:** *RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics***USE CATEGORY:** Accounting**DEVICE TYPE:** Identifier**MEASUREMENT METHOD:** Gamma, Neutron
Passive**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):** U, Pu**PHYSICAL FORM(S) OF NM:** Container**STATUS:** Prototype**PORATABILITY:** Stationary**ENVIRONMENT OF USE:****DEVELOPER:** RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics**MANUFACTURER:** RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics**DESCRIPTION****PURPOSE***Inventory of nuclear materials in containers without opening them.***PRINCIPLES OF OPERATION**

The detection of the inherent neutron and gamma radiation from nuclear materials.

The container inventory is performed by means of the comparison of the NM radiation images.

FUNCTIONAL BLOCKS

- fast-acting scintillation gamma spectrometer consisting of detection unit and multichannel analyzer made as IBM PC plate;
- neutron rate meter consisting of high sensitive detection unit СРПС2.001.000 and IBM PC plate containing detection unit and counting unit control board;
- IBM PC.

Can includes scales.

SPECIFICATIONS

Preparation time for the operation

~ 10 min

Inventory time

~ 3 min per one container

Background gamma shield

SOFTWARE

Integrated software

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика (Данные получены из РФЯЦ-ВНИИТФ. Письмо от 01.08.96 № 280-08/312.)

Data received from RFNC-VNIITF. Fax from 01.08.96 № 280-08/312

Accounting: Identifier**36****Universal Radiometer-Spectrometer**
MODEL: MKC-A021**SUPPLIER:** *SPC Aspect***USE CATEGORY:** Accounting**DEVICE TYPE:** Identifier**MEASUREMENT METHOD:** Gamma, Neutron
Passive**MEASURED PROPERTIES:** NM Type**NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:****STATUS:** Limited Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Field**DEVELOPER:** SPC Aspect**MANUFACTURER:** SPC Aspect**DESCRIPTION****PURPOSE**

Designed to detect, localize and identify radioactive materials. Radiometer can be used for non-destructive NM control, surface alpha- and beta- contamination, and also for NM and RM movements control.

PRINCIPLES OF OPERATION

The device has two operational modes:

- 1) searching mode fixes the exceeding of the counting rate in the preset ROI of gamma spectrum, as well as in the neutron channel - over the corresponding background values, taking into account statistical significances of their values. The excess is displayed on the LCD and confirmed by the LED indication and sound signal.
- 2) spectrometric mode provides the acquisition of alpha-, beta-, and gamma- spectra, spectra displaying on the LCD, the energy calibration, the isotope identification and other procedures for the spectra process performed by the code built-in the ROM.

Device can measure:

- alpha- and beta- particles flux density;
- gamma and neutron radiation exposition dose rate (EDR).

FUNCTIONAL BLOCKS

Two built-in channels for the nuclear radiation detection:

- gamma channel: scintillation detector CsI(Tl) or NaI(Tl). Stabilization of gamma channel is executed by the LED spike peak;
- neutron channel: two He-3 detectors at a pressure of 8 atm embedded in the polyethylene moderator.

External detector of the surface alpha- and beta- contamination - Si semiconductor detector.

An additional remote detection unit can be connected to the radiometer.

Delivery set includes:

- Radiometer MKC-A021;
- main adapter;
- program for the data exchange with PC;
- operational documentation.

SPECIFICATIONS

radiation	measured property	measurement range	energy range, keV or nuclide	main error %
alpha	flux density	10-3E+5	0-10000	20
beta	- // -	20-2E+5	300-3000	20
gamma	EDR, mkZv/h	0.1-30	50-3000	20
epi-thermal and fast neutrons	-//-	1-1000	1-14000	20

Spectrometric mode:	
relative energy resolution for 662 keV	no more than 8%
Maximum input pulse rate	50000 pulses/sec
CsI(Tl) crystal size	25 mm x 50 mm
Spectrometer channel number	1024
number of sets of 1024 channel spectra stored in the buffer	30
Operation temperature range	from -20°C to +50°C
Power supply	NiCd-accumulators for no less than 5 h or standard batteries placed in removal modules and main supply (110-240V, 50-60Hz)
Overall size	290 mm x 160 mm x 135 mm
Weight	3.6 kg
Interface	RS-232

SOFTWARE

The software performs:

- spectrum measurement with the exposure in real time;
- energy calibration;
- the automatic mode of the spectra acquisition and process, including the radionuclide identification, spectra storage;
- display of spectra and results of their process on the built-in LC screen;
- the possibility of spectra and processing results printing in the graphical mode;

ADDITIONAL INFORMATION

Device has the weatherproof enclosure.

Device passes a primary test when it is produced and the following annual certification.

Warranty - 1 year.

Possible delivery time - from 3 to 6 months.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Identifier

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Nuclear Material Quick Identifier

MODEL: ИДЕМ

SUPPLIER: *SSC IPPE, State Scientific Center of Russian Federation, Institute of Physics and Power Engineering*

USE CATEGORY: Accounting

DEVICE TYPE: Identifier

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition

NUCLEAR MATERIAL(S): Pu, U, Th

PHYSICAL FORM(S) OF NM:

STATUS:

PORTABILITY: Portable

ENVIRONMENT OF USE:

DEVELOPER: *SSC IPPE, State Scientific Center of Russian Federation, Institute of Physics and Power Engineering*MANUFACTURER: *SSC IPPE, State Scientific Center of Russian Federation, Institute of Physics and Power Engineering*

DESCRIPTION

PURPOSE

Timely determination of type and isotopic composition of fissile and fertile materials.

PRINCIPLES OF OPERATION

The device analyzes a measured gamma spectrum in specific energy windows. The spectrum is divided into 7 ranges which are set by threshold discriminators in the electronics module: 40, 80, 165, 265, 870, 1070, 1300, and 3000 keV. Spectrum analysis consists of the comparison of the information from different energy regions to the reference values. It allows determination of the fissile material type.

Screen displays type and enrichment of the identified material, for example: "U-90%", "U-36%", "U", "Pu", "Np", "Th", "other r.a. materials".

FUNCTIONAL BLOCKS

- Gamma detection module based on NaI (Tl) of D63x63 mm

- Main module:

- discriminators
- analyzer
- logical unit
- information board

SPECIFICATIONS

Min. mass of the identified material	>=1 g
Identification time	<=10 sec
Max. external gamma radiation rate under which the detector can operate without a special shielding	200 mR/h 220 V - 240 V
AC voltage	49 to 51 Hz
Frequency	unlimited
Continuous operation time	30 m
Max. distance between the detector and the main module	from +10°C to +35°C
Operation temperature range	85% at 25°C
Relative humidity	
Overall size:	90 mm x 90 mm x 250 mm
detection module	440 mm x 300 mm x 200 mm
main module	
Weight	8 kg

SOFTWARE

ADDITIONAL INFORMATION

Device provides the identification of fresh and irradiated materials, is stable to ambient air temperature, pressure

and humidity influences, and also to sinusoidal vibrations stresses.
Warranty - 1 year. Life time - 6 years.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Identifier**Neutron Device for FM Presence Control****38****MODEL: Брегем****SUPPLIER: VNIIA, All-Russian Research Institute of Automatics****USE CATEGORY:** Accounting**DEVICE TYPE:** Identifier**MEASUREMENT METHOD:** Neutron

Passive

MEASURED PROPERTIES: Radiation Intensity**NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:****STATUS:** Limited Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** VNIIA, All-Russian Research Institute of Automatics**MANUFACTURER:** VNIIA, All-Russian Research Institute of Automatics**DESCRIPTION****PURPOSE***This device is designed for confirmatory measurements of NM.***PRINCIPLES OF OPERATION**

Comparison of neutron fluxes measured in three energy ranges by detectors whose registration efficiency depends on the neutron energy.

FUNCTIONAL BLOCKS

Three detection channels consist of:

- Si; Si(Li-6) or CdTe detector
- amplifier
- deriver
- amplitude discriminator

Store unit

LC indicator

SPECIFICATIONS

Sensitivity	0.2-0.3 counts/n*sm^2
Detection limit	10 g of Pu
Measurement time	25 sec
Power supply	9V, battery of 6F22 type
Overall size	185 mm x 205 mm x 52 mm
Weight	1.2 kg

SOFTWARE**ADDITIONAL INFORMATION**

Device can be integrated with a microprocessor controller programmed to compare the measurement results with data from database, and indicate the presence of the specific FM.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Measurement System

Plutonium Can Contents Monitor
MODEL:

39

SUPPLIER: BNFL Instruments**USE CATEGORY:** Accounting**DEVICE TYPE:** Measurement System**MEASUREMENT METHOD:** Gamma, Neutron Coincidence Counting

Passive

MEASURED PROPERTIES: Weight, Effective Isotope Mass, Isotopic Composition**NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:** PuO₂ in cans**STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** BNFL Instruments**MANUFACTURER:** BNFL Instruments**DESCRIPTION****PURPOSE***Fast and accurate measurement of the total plutonium content and isotopic composition of filled PuO₂ product cans.***PRINCIPLES OF OPERATION**

Passive neutron coincidence counting and isotopic composition determination based on gamma spectroscopy. Correction for neutron multiplicity effects within the product can. High resolution gamma spectrometry incorporating mathematical algorithms for plutonium isotopic composition determination and used advanced dead-time correction algorithms. Measurement control, including automatic regular self-checking of neutron detectors, gamma detector and counting electronics is included in the system. Automatic data quality checking. Fully automatic operation coupled with plant control system.

A combination of data from the two measurements (neutron coincidence counting and gamma spectroscopy) allows a full characterization of the material within the can.

All can loading and unloading operations are performed automatically. The monitor provides a number of switch outputs to identify the location of the product can as it is loaded, measured and unloaded.

FUNCTIONAL BLOCKS

- neutron coincidence counter including 10 He₃ detectors;
- gamma spectrometer including a low energy Ge high resolution detector.

SPECIFICATIONS

Dynamic measurement range:	<1 kg up to 8 kg Pu
Measurement time:	30 minutes
Total uncertainty:	<±5% plutonium mass <±3% isotopic composition

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Measurement System**Plutonium Inventory Measurement System**
MODEL: FissTrack**40****SUPPLIER: BNFL Instruments**

USE CATEGORY: Accounting
DEVICE TYPE: Measurement System
MEASUREMENT METHOD: Neutron
Passive
MEASURED PROPERTIES: Weight
NUCLEAR MATERIAL(S): Pu
PHYSICAL FORM(S) OF NM: Miscellaneous
STATUS: Limited Production
PORABILITY: Stationary
ENVIRONMENT OF USE: Industrial
DEVELOPER: BNFL Instruments
MANUFACTURER: BNFL Instruments

DESCRIPTION**PURPOSE**

Measurement and tracing of Pu distribution through a plant. Used for near real-time materials accounting and safeguards.

PRINCIPLES OF OPERATION

FissTrack is a total neutron counting system with advanced mathematical algorithms. The system provides operators with a measure of plutonium content for a number of specified vessels, measurement zones (e.g. process cells) totals and overall plant total. The measurement is updated on a near time real basis, every 15 minutes, 24 hours a day. It also capable of providing blockage alarms and can be used for criticality safety. FissTrack uses basic information about the chemical and isotopic composition of the plutonium in a facility to enable the total plutonium mass to be determined.

FUNCTIONAL BLOCKS

- He3 detectors;
- Electronics for total neutron counting;
- Computers for control and data processing;
- Alarm signal system;
- Software for measurement control and data processing.

SPECIFICATIONS

Neutron detectors: The number of detectors required depends on the size of the plant and number of monitoring zones required. For a typical system of approximately 30 zones, up to 90 He3 detectors can be deployed.

Monitoring Zone size: User defined. Typically size of plant cell.

Dynamic range: 100 g - 100 kg
Measurement time: 15 minutes
Typical accuracy: To within 5% of actual mass

SOFTWARE

Algorithms within the software enable FissTrack to cope with a number of different material batches, with widely different isotopic compositions, flowing through the plant at any time.

ADDITIONAL INFORMATION

BNFL Instruments working in conjunction with plant design engineers and operators, design each system so that it is seamlessly integrated into the plant. Systems have been installed into a new plant or as an upgrade to an existing plant.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Measurement System**Uranium Drum Enrichment Monitor****MODEL:****41****SUPPLIER:** BNFL Instruments**USE CATEGORY:** Accounting**DEVICE TYPE:** Measurement System**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):** U**PHYSICAL FORM(S) OF NM:** UO₃ in drums**STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** BNFL Instruments**MANUFACTURER:** BNFL Instruments**DESCRIPTION****PURPOSE***Fast and accurate measure of the %U235 enrichment of filled uranium product drums***PRINCIPLES OF OPERATION**

The Uranium Drum Enrichment Monitor (UDEM) may be located within the UO₃ drum handling and filling plant and linked into the main drum transfer procedures to allow fully automatic procedures.

Following calibration of the system UDEM is ready to operate.

Two high resolution gamma spectrometry systems are used to acquire pulse height spectra from either side of the filled product drum. Information from the acquired spectra is used to calculate the %U235 enrichment.

Two independent measurements of the %U235 enrichment are obtained, one from each sub-system, and the average of these values is calculated and output to the plant control computer.

All drum loading and unloading operations are performed automatically. UDEM provides a number of proximity switch outputs to identify the location of the product drum as it is loaded, measured and unloaded.

FUNCTIONAL BLOCKS

- Two gamma spectrometry systems. Each of them consists of one 2000mm² Low Energy Ge high resolution gamma detector

- Automated System with loading and unloading of drums

SPECIFICATIONS

Typical measurement range: 0.2% U235

Total uncertainty: <6% of measured %U235

Measurement time: 600 sec

SOFTWARE**ADDITIONAL INFORMATION**

The UDEM system may be configured to monitor a range of chemical compositions and enrichments of uranium product solids in most geometries. A typical configuration is for UO₃ product in the range 0-2% U235.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Measurement System

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Glovebox Neutron/Gamma Counter
MODEL: JCC-15**SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Measurement System**MEASUREMENT METHOD:** Gamma, Neutron Coincidence Counting
Passive**MEASURED PROPERTIES:** Weight**NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:** Oxide, Nitrite, Powder, Pellets, Solutions**STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Canberra Industries, Inc.**MANUFACTURER:** Canberra Industries, Inc.**DESCRIPTION****PURPOSE**

This device is designed for high accuracy measurements of plutonium, reducing the need for destructive analysis. It mounts below the drywall of a glovebox and provides simultaneous neutron coincidence and gamma isotopic analysis.

PRINCIPLES OF OPERATION

The Glovebox Neutron/Gamma System is a combination of a passive neutron coincidence counter and a gamma spectroscopy system that is placed around the drywall of the glove box of the On-Site Laboratory (OSL). The OSL concept was developed by the EURATOM Safeguards Directorate to allow high accuracy measurements of plutonium samples, reducing the need for destructive analysis.

The design was modified to place a Low Energy Germanium (LEG) detector inside the counter, close to the sample, to simultaneously measure the plutonium isotopic. Both the top and bottom plugs are made from graphite and polyethylene. The bottom plug was altered to fit around the LEG detector and the cold finger, reflecting neutrons back into the counter and flattening the axial response. The system is mounted on a trolley to facilitate positioning the counter under the glove box.

The neutron counter was further modified by splitting the body into two parts to allow placement around the drywell.

The measured isotopes are used as input to the neutron coincidence software to convert the Pu-240-effective to total plutonium mass.

FUNCTIONAL BLOCKS

- OSL Neutron Counter
- JAR-12 Neutron Coincidence analyzer
- Low Energy Germanium (LEG) Detector
- eighteen He₃ tubes
- NIM electronics
- JAB-01 Amplifier/Discriminator board
- high voltage junction box
- LED indicators
- data processor with software.
- top and bottom plugs both the made from graphite and polyethylene
- high density polyethylene moderator
- trolley

Connections between the OSL and the JSR-12 include:

- +5 V
- HV

- single ORed output signal.

SPECIFICATIONS

Detector efficiency	40%
Cavity dimension:	
drywell OD	5.1 cm
sample volume	10 mL
Overall size	74.9 cm x 74.9 cm x 30.7 cm
Weight	34 kg

SOFTWARE

The plutonium gamma-ray spectrum is very complex, with several multiplet structures. Software like MGA, which was developed at Lawrence Livermore National Laboratory (LLNL), uses the integrals of these close lying peaks to calculate the isotopic composition of plutonium.

ADDITIONAL INFORMATION

Based on LANL design (INVS III).

REFERENCES

1. H. Wagner, et. al., Proceedings of the ESARDA Meeting, 1992.
2. M.C. Miller, H.O. Menlove, and P.A. Russo, A High Efficiency Neutron Coincidence Counter for Small Samples, Proceedings of the Fourth International Conference on Facilities Operations - Safeguards Interface, Albuquerque, NM, September 1991, p. 420.

Accounting: Measurement System

Neutron and Gamma Unattended Plutonium Safeguards System

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MODEL: NEGUS

SUPPLIER: *Canberra Industries, Inc.*

USE CATEGORY: Accounting
 DEVICE TYPE: Measurement System
 MEASUREMENT METHOD: Gamma, Neutron Coincidence Counting
 Passive
 MEASURED PROPERTIES: Radiation Intensity
 NUCLEAR MATERIAL(S): PuO₂
 PHYSICAL FORM(S) OF NM:
 STATUS: Serial Production
 PORTABILITY: Stationary
 ENVIRONMENT OF USE: Industrial
 DEVELOPER: *Canberra Industries, Inc.*
 MANUFACTURER: *Canberra Industries, Inc.*

DESCRIPTION

PURPOSE

This is a fully integrated system for unattended monitoring of PuO₂ canisters and combines passive neutron measurement with gamma ray measurement for increased accuracy. Normally installed at large automated facilities, these unattended systems are designed to reduce the amount of time that an inspector spends on site, thus reducing potential dose, impact on the plant operator and the manpower costs associated with more conventional attended systems.

PRINCIPLES OF OPERATION

The system utilizes intelligent front end acquisition devices for maximum data compression and redundancy incorporating sophisticated analysis of gamma spectra using MGA-U. The central CPU system is connected remotely, and is used for data analysis, storage and review. The secure architecture protects the system from unauthorized access.

The concept of unattended plutonium safeguards using NonDestructive Assay systems has been developed previously [1,2,3] and is implemented at several nuclear facilities.

Typically these facilities have many different acquisition stations, with the following potential data sources at each one. The neutron data collected using passive neutron measurement systems, gamma-ray data collected using high-purity germanium detectors, and sensor information which might indicate item identity, position, direction of motion, etc.

These acquisition stations might be located at the entrance to a processing plant so that incoming fuel can be assayed, near a common fuel storage area, at a location which corresponds to the end product of the plant, etc. Since the physical dimensions of the facility are in general quite large, one approach to unattended safeguards is to place one or two computer(s) at each acquisition station; two computers would be installed if redundancy was needed. Each computer would be responsible for acquisition control, data storage, data analysis and report generation at a particular acquisition station.

The drawback to this type of system is that the most convenient location for the computer might be in a potentially hostile and highly controlled area. In addition, integration of the results from all facility acquisition stations would be difficult given the large number of independent stations.

An alternate approach is possible within a facility that has a Local Area Network (LAN, e.g. a coaxial or fiber optic cable) that connects each of the acquisition stations.

FUNCTIONAL BLOCKS

- JCC-35 Neutron/Gamma Counter:
 - 18 He-3 tubes

- JSR-12 electronics

SPECIFICATIONS

Detector active length 50.8 cm

Detector diameter 2.54 cm

Cavity dimension 59.0 x 21.6 cm

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

1. S.F. Klosterbuer, E.A. Kern, J.A. Painter, S. Takahashi, "Unattended Mode Operation of Specialized NDA Systems", 30th Annual INMM Conference, Orlando, Florida, USA, 1989.
2. B.G.R. Smith, J.D. Outram, M. Storey, "Unattended Mode Monitoring of Passive Neutron Coincidence Detector Systems Using a Commercial Data Logger", 13th Annual ESARDA Symposium on Safeguards and Nuclear Material Management, Avignon, France, 1991.
3. B.G.R. Smith, P. Van Dyck, and P. DerBaix, "Unattended Mode Monitoring of High Resolution Gamma-Ray Spectra", 13th Annual ESARDA Symposium on Safeguards and Nuclear Material Management, Avignon, France, 1991, pp. 263-271.

Accounting: Measurement System**44****Passive/Active Cf-252 Shufflers****MODEL: WM-3200****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Measurement System**MEASUREMENT METHOD:** Neutron

Passive, Active

MEASURED PROPERTIES: Effective Isotope Mass**NUCLEAR MATERIAL(S):** Pu-238, Pu-240, Pu-242, Cf-252, Cm-242, Cm-244**PHYSICAL FORM(S) OF NM:** Waste**STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Canberra Industries, Inc.**DESCRIPTION****PURPOSE**

The WM-3200 systems are useful for non-destructive assay of milligram to kilogram quantities of both U and Pu in a wide variety of forms and matrix materials.

PRINCIPLES OF OPERATION

The WM-3200 Series Passive/Active Shuffler System operates in an active interrogation mode to measure fissile radionuclides. A high-speed transfer mechanism "shuffles" an intense Cf-252 source between the shield assembly and the counting chamber. When the source is in the shielded position, delayed neutrons from the sample are counted. The passive mode measures spontaneously fissioning radionuclides (i.e., Pu-238, Pu-240, Pu-242, Cf-252, Cm-242 and Cm-244).

These counters perform active interrogation of fissile isotopes in 200 L drums, passive measurement of even isotopes of plutonium, and have an add-a-source option for matrix corrections and thermal interrogation for improved sensitivity. The counters use fast interrogation for reduced self-shielding effects.

FUNCTIONAL BLOCKS**SPECIFICATIONS**

Measurement time	500 and 1000 seconds
Counter efficiency	17.5%
Sensitivity:	
active fast mode	111 mg U-235 in paper
	402 mg U-235 in iron
active thermal mode	24 mg U-235 in paper
	61 mg U-235 in iron
passive mode	3 mg Pu-240-effective in paper
	2.57 mg Pu-240-effective in iron

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Measurement System**Plutonium Canister Input Verification Counter****45****MODEL:****SUPPLIER:** *Canberra Industries, Inc.*

USE CATEGORY:	Accounting
DEVICE TYPE:	Measurement System
MEASUREMENT METHOD:	Neutron, Gamma
	Passive
MEASURED PROPERTIES:	Weight
NUCLEAR MATERIAL(S):	Pu
PHYSICAL FORM(S) OF NM:	Solution, Oxide
STATUS:	Serial Production
PORTABILITY:	Stationary
ENVIRONMENT OF USE:	Industrial
DEVELOPER:	Canberra Industries, Inc.
MANUFACTURER:	Canberra Industries, Inc.

DESCRIPTION**PURPOSE***Measurement of plutonium content in canisters.***PRINCIPLES OF OPERATION**

The counter is using simultaneous passive neutron coincidence counting and gamma isotopes for verification of plutonium content in up to 5 cans inside a stainless steel canister. The device has a flat axial counting response over the height of the canister.

FUNCTIONAL BLOCKS

- a telescope Ge detector - 12% coax
- LEGe detectors
- cryostat
- integral load cell platform

SPECIFICATIONS

Measurement range	from 4.5 kg to 18 kg Pu
Neutron efficiency	7.4 %
Cavity size	164.5 cm x 18.2 cm

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Measurement System

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The Californium-252 Shuffler

MODEL:

SUPPLIER: *Los Alamos National Laboratory*

USE CATEGORY: Accounting

DEVICE TYPE: Measurement System

MEASUREMENT METHOD: Neutron

Active, Passive

MEASURED PROPERTIES: Effective Isotope Mass

NUCLEAR MATERIAL(S): U

PHYSICAL FORM(S) OF NM: Waste

STATUS: Limited Production

PORTABILITY: Stationary, Portable

ENVIRONMENT OF USE: Industrial

DEVELOPER: Los Alamos National Laboratory

MANUFACTURER: Los Alamos National Laboratory

DESCRIPTION

PURPOSE

One of the most accurate methods available for measuring uranium waste. In different variations was used to measure uranium solids, MOX, U ore, uranium scrap and sweepings, spent fuel assemblies, hot waste, UF6, leached hulls, HEU finished products, High-density HEU scrap and waste, tails, alumina, hot uranium solutions.

PRINCIPLES OF OPERATION

When the Cf-252 source is in the interrogation position, neutrons from the source induce fissions in the sample. After a few seconds of interrogation, the source is quickly removed to a shielded position, and delayed neutrons emitted by fission fragments are counted. By shielding the source exceptionally well, shuffler hardware can also serve as a passive neutron counter.

FUNCTIONAL BLOCKS

SPECIFICATIONS

Measurement time 1000 seconds

Sensitivity:

U-235	300 mg (20 mg in thermal mode)
Pu-240	4 mg (passive)

Accuracy 15% for waste barrels

Cavity dimension diameter 30 inches

SOFTWARE

Implemented on a small computer, software provides measurement control, routine assay, and data archiving.

ADDITIONAL INFORMATION

REFERENCES

LANL Application Note, LALP-90-15, August 1994.

Accounting: Measurement System**47****Shuffler Detector**
MODEL:**SUPPLIER:** *National Nuclear Corporation***USE CATEGORY:** Accounting**DEVICE TYPE:** Measurement System**MEASUREMENT METHOD:** Neutron

Active

MEASURED PROPERTIES: Effective Isotope Mass**NUCLEAR MATERIAL(S):** U**PHYSICAL FORM(S) OF NM:** Miscellaneous**STATUS:****PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** National Nuclear Corporation**DESCRIPTION****PURPOSE**

Similar to "The Californium-252 Shuffler" and "Passive/Active Cf-252 Shufflers" by LANL and Canberra. See general description for those entries. A different variation was used to measure uranium solids, MOX, U ore, uranium scrap and sweepings, spent fuel assemblies, hot waste, UF6, leached hulls, HEU finished products, high-density HEU scrap and waste, tails, alumina, and hot uranium solutions.

PRINCIPLES OF OPERATION**FUNCTIONAL BLOCKS****SPECIFICATIONS****SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Multichannel Analyzer

Miniature Modular Multi-Channel Analyzer**MODEL: M3CA****48****SUPPLIER:** AQUILA Technologies Group, Inc.**USE CATEGORY:** Accounting**DEVICE TYPE:** Multichannel Analyzer**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** AQUILA Technologies Group, Inc.**DESCRIPTION****PURPOSE**

The Miniature Modular MultiChannel Analyzer, M3CA is a new spectroscopy-grade, 4096 channel multichannel analyzer (MCA) developed by Los Alamos National Laboratory (LANL) for use in the domestic nuclear industry with application in domestic and international nuclear safeguards.

PRINCIPLES OF OPERATION

The M3CA system consists of a "building block" that includes the hardware, firmware, and software. The hardware and firmware portion is the Miniature Modular MCA (M3CA), while the software library provides the interface between high-level languages and the M3CA. Three important features make the M3CA system unique:

1. Modularity - The M3CA basic building block is easily interfaced to a variety of computers and data loggers, which allows for quick, economical, and reliable configuration.
2. Portability - The M3CA fits in a 10 x 22 x 9 centimeter box, including its bias supply and batteries, making it belt-sized or easily carried in a shoulder holster. Remote and unattended operation is provided during periods while the unit is not connected to a central computer system.
3. Low Power - The M3CA is designed with low-power circuitry to operate in remote or unattended mode for long periods while the unit is temporarily isolated from main power. The M3CA system functions in a wide range of applications from low end and low-power to high performance applications such as high-count-rate plutonium-isotopic analysis systems. Use of low-power, high density programmable logic arrays provides a greater degree of ruggedness and reliability than larger systems. Lower operating temperatures also result from low-power circuitry, increasing reliability. At input rates exceeding 60,000 counts per second, state-of-the-art analog circuitry allows the M3CA to produce spectra equivalent to or better than those available from standard rack-mounted or mainframe-powered instruments. A powerful set of software tools makes developing application programs comparatively simple. The M3CA consists of four main printed circuit boards which are separated by function, allowing new boards to be exchanged with original boards as different functions are needed. The processor features a low power mode that is evoked when the processor chip is placed in sleep mode. The processor board's firmware uses macros to control all of the parameters that can be set by the user. If the application requires a user interface window, it is provided by the external controller software. The controller hardware can be any device capable of issuing ASCII commands via serial interface, such as intelligent data loggers, palm-top computers, or PCs. MS-DOS compatibility is not required.

FUNCTIONAL BLOCKS

- four main printed circuit boards:

- amplifier board
- Analog to Digital Converter (ADC)
- processor board
- power supply board
- + daughter board on the power supply unit

provides high voltage bias

All boards have 8-bit readable ports used for board IDs or for configuration sense switches.
In addition, all boards except the processor board have switched power inputs.

SPECIFICATIONS

Channel number	4096
Power supply	main or battery
Overall size	10 cm x 22 cm x 9 cm

SOFTWARE

Two levels of software support the M3CA.

- Written in C, the software contained in the EPROM on the processor board controls the MCA hardware.
- A library that runs on any IBM-PC compatible computer provides the application programmer with functions that perform the most commonly used M3CA functions. The library functions handle all timing and communications protocol of the interface between the PC and the M3CA.

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Multichannel Analyzer**Portable Multichannel Analyzer**
MODEL: 2056-B**49****SUPPLIER:** *Davidson Co. Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Multichannel Analyzer**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Field**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Davidson Co. Inc.**DESCRIPTION****PURPOSE***Acquire, digitize, store, and analyze nuclear events to save and display isotopic spectra***PRINCIPLES OF OPERATION**

A ramp type analog to digital converter is used to convert pulse height to time. A counter follows to count oscillator clock pulses to determine the channel number in which to store the event in memory.

FUNCTIONAL BLOCKS

- linear amplifier and 4K channel ADC
- solid state memory
- live display circuits for internal CRT
- control for key board, LCD display, and I/O RS232
- digital recorder
- microprocessor and program PROMs
- three high voltage power supplies for detectors.
- preamp power
- low voltage power supplies and rechargeable gel-cell battery

The internal CRT provides live enhanced display of spectra during data accumulation. It has a resolution of 2048 by 256, four intensities, digital and analog expansion with roll, and automatic power down after four minutes

SPECIFICATIONS

Power supply with an external charger Internal 12 volt 7.0 AH gel-cell rechargeable battery

Operating time 10 hours on a fully charged battery

Overall size 7" deep x 11" wide x 9" high

Weight 7.2 kg

SOFTWARE

Basic Data Analysis for Pulse Height Analysis and Multi-Channel Scaling. User Programs include Autocycle/learn, plot on an Epson type printer, measure activity, and efficiency calibration.

Optional user programs are:

- (1) U-235 ENRICHMENT measurement with NaI detector and UF6 CYLINDER ENRICHMENT measurement with HPGe detector,
- (2) CI series 90 interface I/O data format,
- (3) 8 bit binary interface I/O data format (for fast data dumps),
- (4) Acquire and transfer

ADDITIONAL INFORMATION

A new optional high performance Spectroscopy Amplifier has been developed for the 2056-C PMCA by a consultant for the IAEA with LANL and Davidson assisting in the implementation. The new amplifier adds more features such as a pulse width rejecter and a monitor on the CRT for pole/zero adjustment. The final version of the amplifier installed in the PMCA performs as well as lab grade systems giving wider use to the 2056-C in field applications. Additionally, a new ADC developed by Davidson and LANL and used with the new amplifier gives faster processing times due to a dual conversion slope and better differential non-linearity due to an averaging circuit. The new ADC also features a single channel window (calibrated during PHA operation) in which pulses can be counted in the Multi-Channel Scaling mode.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Multichannel Analyzer

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Amplifier and MCA Plug-in Card with Emulation SoftwareMODEL: *microAce*SUPPLIER: *EG&G Instruments, Inc. ORTEC*

USE CATEGORY: Accounting

DEVICE TYPE: Multichannel Analyzer

MEASUREMENT METHOD: Gamma

MEASURED PROPERTIES: Isotopic Composition

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY:

ENVIRONMENT OF USE: Industrial

DEVELOPER: *EG&G Instruments, Inc. ORTEC*MANUFACTURER: *EG&G Instruments, Inc. ORTEC*

DESCRIPTION

PURPOSE

This device, intended for NaI detectors, includes amplifier, spectrum stabilizer, ADC, and memory on a 2/3 slot plug-in card. It includes a high-resolution 32-Bit MCA Emulation software for Windows 95 or NT. It has automatic nuclide identification and job streaming and on-line calculation of nuclide activities, even during data acquisition. The ADC operates as 256, 512, 1024, or 2048 channels.

PRINCIPLES OF OPERATION

FUNCTIONAL BLOCKS

- Amplifier,
- Spectrum Stabilizer,
- ADC, and
- Memory.

SPECIFICATIONS

The power use 1.5 watts.

SOFTWARE

Windows 95 or NT: MAESTRO TM

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Multichannel Analyzer**EtherNim High Speed Multichannel Buffer****51*****MODEL: 921E EtherNim*****SUPPLIER:** EG&G Instruments, Inc. ORTEC**USE CATEGORY:** Accounting**DEVICE TYPE:** Multichannel Analyzer**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** EG&G Instruments, Inc. ORTEC**MANUFACTURER:** EG&G Instruments, Inc. ORTEC**DESCRIPTION****PURPOSE**

The 921E is an ultra high performance Multichannel buffer (MCB) with 16K resolution high speed (<1.5 microsec) ADC, designed for high rate spectroscopy applications.

PRINCIPLES OF OPERATION

Used in conjunction with the ORTEC 672 amplifier, an SGD Ge detector and a suitable software application such as PC/FRAM or MGA, the 921E finds application in ultra-high throughput systems for isotopic ratio analysis. The build-in Ethernet connection facilitates computer interfacing.

FUNCTIONAL BLOCKS**SPECIFICATIONS****SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

R.M.Keyser, T.R.Twomey. "Development in high performance spectrometer systems for safeguards applications", 38-th INMM Annual Meeting Proceedings, July 20-24, 1997, Phoenix Arizona

Accounting: Multichannel Analyzer

MCA Plug-In Card and Software

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MODEL: TRUMP

SUPPLIER: EG&G Instruments, Inc. ORTEC

USE CATEGORY: Accounting

DEVICE TYPE: Multichannel Analyzer

MEASUREMENT METHOD: Gamma

MEASURED PROPERTIES: Isotopic Composition

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY:

ENVIRONMENT OF USE: Industrial

DEVELOPER: EG&G Instruments, Inc. ORTEC

MANUFACTURER: EG&G Instruments, Inc. ORTEC

DESCRIPTION

PURPOSE

TRUMP is a fully functional MCA-on-a-card for use with personal computers, available a 2k or 8k resolution. TRUMP provides a <8 microsec ADC, spectrum stabilizer and data memory on a single plug-in-card and is used in conjunction with MAESTRO (TM) MCA emulation software under Windows 95 or NT or other ORTEC application software packages.

PRINCIPLES OF OPERATION

FUNCTIONAL BLOCKS

SPECIFICATIONS

SOFTWARE

MAESTRO TM for Windows (MAESTRO II TM Optional)

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Multichannel Analyzer**Miniature Multi-Channel Analyzer and Multi-Channel Scaler****53****MODEL: MCA 166****SUPPLIER: GBS Elektronik GmbH im Technologie-Zentrum****USE CATEGORY:** Accounting**DEVICE TYPE:** Multichannel Analyzer**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Field, Industrial**DEVELOPER:** GBS Elektronik GmbH im Technologie-Zentrum**MANUFACTURER:** GBS Elektronik GmbH im Technologie-Zentrum**DESCRIPTION****PURPOSE***Battery powered high performance Multi-Channel Analyzer/Multi-Channel Scaler module.***PRINCIPLES OF OPERATION**

All MCA setup parameters are computer controlled and can be set through software, with the exception of the HV polarity which requires exchange of the HV power supply module.

FUNCTIONAL BLOCKS

- High voltage and preamplifier supply
- main amplifier
- pulse shaper
- multichannel analyzer
- scaler

SPECIFICATIONS

4K resolution (minus 3.1% = 128 channels used for sliding scale averaging)

Channel splitting 128-4096 (-3.1% channels for each range)

Differential non linearity < 1%

Integral non linearity < 0.1%

Power supply rechargeable Li-ion batteries without memory effect.

Battery life time without power saving mode is at least 6 hours for standard IAEA HPGe detector and

at least 12 hours for standard NaI Harshaw Crysmatec) and standard CdTe detectors (SDP310, RITEC, Latvia) at operating temperature of 20 degrees C.

Measurement time	> 1 sec
Measurement time range	0.01 sec - 500 sec
Data collection	in three memory groups 3 x 4096 channels 32 bit deep
Temperature range	0...+50 degrees C
Relative humidity	up to 90%, non condensing
Overall size	155 mm x 95 mm x 50 mm
Weight of module	680g
Weight of charger	320g

SOFTWARE

MCA, SPEC, MCS, U235, LEN6, RATE, UF6 (DOS), WinMCA, Mmcdeval (W95)

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Multichannel Analyzer**Hand-Held Multi-Channel Analyzer for Nuclear Spectroscopy****54****MODEL: Scout512 Series****SUPPLIER: Quantrad Sensor Division, Applied Electron Corp.**

USE CATEGORY: Accounting
DEVICE TYPE: Multichannel Analyzer
MEASUREMENT METHOD: Gamma, Alpha, X-ray
 Passive
MEASURED PROPERTIES: Isotopic Composition
NUCLEAR MATERIAL(S):
PHYSICAL FORM(S) OF NM:
STATUS: Serial Production
PORTABILITY: Hand-held
ENVIRONMENT OF USE: Field
DEVELOPER: Quantrad Sensor Division, Applied Electron Corp.
MANUFACTURER: Quantrad Sensor Division, Applied Electron Corp.

DESCRIPTION**PURPOSE**

Designed for gamma, alpha, and x-ray spectroscopy. Can be used for verification of enriched uranium or plutonium and weapons verification, site surveying, and waste container evaluation/monitoring.

PRINCIPLES OF OPERATION

Can be configured with a NaI probe for gamma spectroscopy applications, an x-ray probe for fluorescence studies, or a sensor for alpha and beta spectroscopy applications.

FUNCTIONAL BLOCKS

Electronics:

- Pulse-height-to-time convertor;
- Multichannel Analyzer

SPECIFICATIONS

Storage capacity is up to 244 individual spectra, each with date and time stamp
 Pulse-Height to Time convertor:

resolution	512 channel
linearity	+/- 1 channel
maximum count per channel	4.29E9 (32 bit)

Multichannel Analyzer:

maximum input rate	41,000 counts per second.
Operation temperature	0C to +50C

Power supply

Power supply	internal rechargeable battery (can be supplemented by an external battery
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pack,

pack,	or an automotive battery)
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Operation continuous time

Operation continuous time	8-10 hours between charges
from battery	100 mA during data acquisition

Power requirement

Power requirement	100 mA during data acquisition
Operating time	> 6 hours

with NaI Gamma probe

with NaI Gamma probe	> 6 hours
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Overall size

Overall size	4.5" x 2" x 7.5" including HP LX computer
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Weight

Weight	0.82 kg
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SOFTWARE

ScoutMaster: HP and DOS compatible; works in survey, collect, and view modes; calculates the dose/dose rates; prints out spectra to parallel/serial port or saves as bitmap file; 8 regions of interest (ROI) analysis; total, ROI and Background Corrected counts; spectrum background subtraction; isotope identification; user-editable isotope library for gamma, alpha, and X-ray analysis.

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Multichannel Analyzer**Independent Multichannel Pulse Height Analyzer****MODEL: AI-8K/NB****55****SUPPLIER:** SPC Aspect**USE CATEGORY:**

Accounting

DEVICE TYPE:

Multichannel Analyzer

MEASUREMENT METHOD:

Beta, Gamma

Passive

MEASURED PROPERTIES:

Isotopic Composition

NUCLEAR MATERIAL(S):**PHYSICAL FORM(S) OF NM:****STATUS:**

Serial Production

PORTABILITY:

Hand-held

ENVIRONMENT OF USE:

Field, Laboratory

DEVELOPER:

SPC Aspect

MANUFACTURER:

SPC Aspect

DESCRIPTION**PURPOSE**

To acquire and process the spectrometric information, and output it to the external units. The analyzer is a base for the portable gamma and beta spectrometers used in the field and lab conditions. The analyzers are used in different science and engineering applications using nuclear physical analysis methods.

PRINCIPLES OF OPERATION**FUNCTIONAL BLOCKS**

Base set:

- AI-8K/NB analyzer;
- portable external power adapter with the built-in recharge device;

Additional (per request):

- gamma and beta radiation detector (scintillation or semiconductor of a high purity germanium);
- Pb shield screens, collimators;
- portable NOTEBOOK PC with printer;
- software;
- Al case;
- interface for NOTEBOOK.

SPECIFICATIONS

Operation pulse height range	0.03-5 V
Channel number	1024
	1024-8198
Differential non-linearity	0.5-1%
Integral non-linearity	0.03%
Code series generator frequency	100 MHz
Power supply	main ~220 V or from built-in accumulator
Continuous operation time	up to 7 hours
from built-in accumulator	from -25°C to +50°C
Operation temperature range	in accordance with IP65 of DIN40050
Dust-moisture shield	graphical liquid crystal screen with
Indication	the LED indication with the resolution of 240x64
Power independent storage capacity	32 spectra and a set of parameters for a month, the dates and times support
Overall size	260 mm x 160 mm x 57 mm
Weight	no less than 2 kg

SOFTWARE

SOFTWARE

Measurement control, preliminary spectra process

ADDITIONAL INFORMATION

The free warranty service, delivery of updated software versions, and technical consultations during one year are available.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Multichannel Analyzer**Multichannel Pulse Height Analyzers, "AH" Series**
MODEL:**56****SUPPLIER:** *SPC Aspect***USE CATEGORY:** Accounting**DEVICE TYPE:** Multichannel Analyzer**MEASUREMENT METHOD:** Alpha, Beta, Gamma
Passive**MEASURED PROPERTIES:** Alpha, Beta, Gamma Spectra**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Laboratory**DEVELOPER:** SPC Aspect**MANUFACTURER:** SPC Aspect**DESCRIPTION****PURPOSE**

To acquire and process the spectrometric information, and output it to the external units. The analyzers are used in different science and engineering applications using nuclear physical analysis methods.

PRINCIPLES OF OPERATION**FUNCTIONAL BLOCKS****Basic set:**

- spectrometric ADC plug-in IBM PC unit or independent unit for the spectra acquisition;
- IBM PC with printer;
- software;

Additional units (on demand):

- spectrometric trunks for NIM, VECTOR and other modules;
- measurement generators;
- detectors;
- shielding screens;
- software for gamma, beta-, and alpha- spectrometry.

SPECIFICATIONS

Operation pulse height range	0.05 - 10 V
Channel number	from 1024 to 8192
Input number	from 1 to 8
Differential non-linearity	0.3-1%
Integral non-linearity	0.03%
Code series generator frequency	100 MHz

SOFTWARE

Provides control, visualization, input/output to external devices, calibration as a function of energy and spectrum shape, processing of alpha, beta, and gamma spectra.

ADDITIONAL INFORMATION

- free warranty service, new software versions supply, and technical consultation during one year;
- possibility of using IBM PC for tasks on the automation of the process and management activity simultaneously with sample measurements;
- possibility of including as spectrometer parts (on demand) of any additional units such as: fax, modem, fax-modem, copier; shielding screen; van (for transportable labs), TV, video, household appliances and so on.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Multichannel Analyzer**57****Hand-Held, 256 Channel Multi-Channel Analyzer****MODEL: mMCA-430****SUPPLIER: TSA Systems Ltd.****USE CATEGORY:** Accounting**DEVICE TYPE:** Multichannel Analyzer**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity**NUCLEAR MATERIAL(S):** Any radio isotope with gamma energy in the 60 - 2,000 keV range**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Field**DEVELOPER:** TSA Systems Ltd.**MANUFACTURER:** TSA Systems Ltd.**DESCRIPTION****PURPOSE**

The mMCA-430 can quickly confirm the presence of SNM. For applications that do not require neutron counting, the basic instrument serves as an field-grade, gamma MCA.

PRINCIPLES OF OPERATION

The monitor can be set up and run using the internal keypad or its Windows based communications program. For ease-of-use, data can be displayed digitally or graphically on-screen. Compact graphics display provides a quick view of the spectrum. The PC program permits more detailed viewing capabilities. Data may be exported in comma-separated variable format for use by other software programs. To save battery power, the mMCA-430 automatically defaults to a "power-save" mode when it is inactive.

FUNCTIONAL BLOCKS

- an internal, LiI(Eu) detector for neutron counter
- 256-channel field-grade multi-channel analyzer
- internal, battery-backed RAM
- compact graphics display

SPECIFICATIONS**Power supply:**

standard	six, "AA" size alkaline cells (minimum 8 hours of operation)
rechargeable	lead-acid battery (minim of 12 hours of operation), a universal input power supply/battery charger is included

with

this option.

Overall size:

standard	10" h x 4.75" w x 3" d (25cm x 11.9cm x 7.5cm)
rechargeable	9.5" h x 4.75" w x 4" d (24cm x 12cm x 10cm)

Weight:

standard instrument	1.4 kg,
rechargeable	2.3kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Neutron Counter**58****Active Well Coincidence Counter****MODEL: N33 AWCC****SUPPLIER: AEA Technology plc, Harwell Instruments****USE CATEGORY:** Accounting**DEVICE TYPE:** Neutron Counter**MEASUREMENT METHOD:** Neutron Coincidence Counting

Active, Passive

MEASURED PROPERTIES: Effective Isotope Mass**NUCLEAR MATERIAL(S):** U-235 + F isotopes (Pu, U-238, UO₂, LEU, HEU, U-Th fuel); Pu-240 + SF isotopes**PHYSICAL FORM(S) OF NM:** Waste**STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** AEA Technology plc, Harwell Instruments**MANUFACTURER:** AEA Technology plc, Harwell Instruments**DESCRIPTION****PURPOSE**

Device is employed for the assay of a wide variety of waste streams spanning the full range of uranium enrichments. The system can also be used in passive mode for the detection of plutonium only.

PRINCIPLES OF OPERATION

The Active Well Coincidence Counter, model N33, uses Am-241/Li sources to interrogate sample continuously. The outputs of a number of neutron detectors are processed to determine the coincidence counting rate from induced fissions in the sample in the presence of the singles neutrons from the Am-241/Li source. The N33 can measure down to 1.7g U-235 by coincidence counting in assay times of 1000 seconds.

FUNCTIONAL BLOCKS

- two Am-241/Li sources
- number of neutron detectors

SPECIFICATIONS

Size of accepted packages	up to 195mm in diameter and 410 mm in length
Cavity dimension	cylinder: 417 mm x D217 mm
Measurement time	1000, 1800 s
Sensitivity:	
passive (1000 s)	< 0.5 mg Pu-240
active (1800 s)	0.6 g U-235 (active reals)
Accuracy:	
passive	1-2%
active	3-5%

SOFTWARE

DOS/Windows

ADDITIONAL INFORMATION**REFERENCES**

S.Croft et al. Design and Performance of the Harwell N33 Active Well Coincidence Counter, Proceedings of the 36-th Annual INMM Meeting, pp. 1135-1140

Accounting: Neutron Counter

Automated Neutron Monitor for Plutonium
MODEL:

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SUPPLIER: AEA Technology plc, Harwell Instruments

USE CATEGORY:	Accounting
DEVICE TYPE:	Neutron Counter
MEASUREMENT METHOD:	Neutron Coincidence Counting Passive
MEASURED PROPERTIES:	Effective Isotope Mass
NUCLEAR MATERIAL(S):	Pu
PHYSICAL FORM(S) OF NM:	powder, assemblies
STATUS:	Serial Production
PORTABILITY:	Stationary
ENVIRONMENT OF USE:	Industrial
DEVELOPER:	AEA Technology plc, Harwell Instruments
MANUFACTURER:	AEA Technology plc, Harwell Instruments

DESCRIPTION**PURPOSE**

Used for monitoring of the flow of plutonium in MOX fuel fabrication for reasons of safeguards. Three systems have recently been designed, for monitoring the MOX fuel during various stages of the fuel fabrication process, including feed PuO₂ canisters, MOX fuel pin magazines, and complete MOX fuel assemblies.

PRINCIPLES OF OPERATION

Each of the three counting systems consists of an open ended measurement collar formed by polyethylene modules into which He-3 proportional counters are embedded. The modules are encased in cadmium to suppress both background interference from extraneous neutron sources in the plant and back-scattered neutrons within the sample which may otherwise induce unwanted additional fission events. An outer stainless steel cladding houses the cadmium clad modules and associated electronics providing environmental protection and acting as a fire precautionary measure. The stainless steel enclosures may be fitted with seals which indicate if the cover plates have been violated.

FUNCTIONAL BLOCKS

- polyethylene modules encased in cadmium
- embedded He-3 proportional counters
- electronics
- stainless steel enclosures (may be fitted with seals)

SPECIFICATIONS**SOFTWARE****ADDITIONAL INFORMATION**

The counting system configurations were designed with the aid of Monte Carlo calculations to attain flat detection efficiency.

REFERENCES

S. Croft et. al., Design & Performance of Neutron Detector Assemblies for a MOX Fuel Fabrication Plant, Proceedings, 19th Annual ESARDA Symposium, pp. 245-249 (1997).

Accounting: Neutron Counter

High Efficiency Passive Neutron Coincidence Counter

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MODEL: N95

SUPPLIER: AEA Technology plc, Harwell Instruments

USE CATEGORY: Accounting

DEVICE TYPE: Neutron Counter

MEASUREMENT METHOD: Neutron Coincidence Counting
Passive

MEASURED PROPERTIES: Effective Isotope Mass

NUCLEAR MATERIAL(S): Pu-240 + SF isotopes

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Portable

ENVIRONMENT OF USE: Industrial

DEVELOPER: AEA Technology plc, Harwell Instruments

MANUFACTURER: AEA Technology plc, Harwell Instruments

DESCRIPTION

PURPOSE

The N95 is a high efficiency passive neutron counter, designed for high accuracy, high sensitivity plutonium assay. It is suitable for both routine safeguards applications and waste material contaminated with plutonium.

PRINCIPLES OF OPERATION

The Pu-240 effective mass is determined by applying time correlation analysis to the detected neutron pulse stream. Optimum detection efficiency for a minimum number of detectors is ensured by arranging the detectors in two concentric rings. The N95 therefore provides a cost effective non - destructive assay tool. This also minimizes the energy and spatial dependencies, thus ensuring that the sensitivity of the system response to the characteristics of the measurement sample (position and matrix) is minimized. Removable graphite end plugs and external polyethylene "shims" at the top and bottom are incorporated, to flatten the axial response profile. A removable internal cadmium liner is used to shield the N95 from external neutrons. A removable internal cadmium liner can also be used for applications where induced self-multiplication in the sample may otherwise pose a problem. The system is mounted on a trolley for portability. The graphite end plugs may be removed, allowing over - size items to be assayed. In this way, the N95 may also be operated on its side, so that long items can be scanned through the sensitive region.

FUNCTIONAL BLOCKS

- a high density polyethylene cylindrical moderator
- 36 embedded 25.4 mm diameter He-3 proportional counters
- graphite end plugs
- external polyethylene "shims" at the top and bottom
- outer and internal cadmium liners
- trolley

SPECIFICATIONS

Detection efficiency	approx 43.5%
Lower limits of detection (LLD)	< 1 mg Pu-240 (1000 s)
Measurement time	900 s
Sensitivity	< 1 mg Pu-240
Accuracy	1-2%
Cavity dimension	445 mm x D190 mm

SOFTWARE

DOS/Windows

ADDITIONAL INFORMATION

Monte - Carlo modeling was used to optimize the configuration of the moderator and detectors and detailed characterization measurements were subsequently carried out to prove the design.

REFERENCES

PMJ Chard et al. Characterisation of the Harwell N95 high efficiency passive neutron counter. Proc. 17-th Annual ESARDA Symposium, pp. 551-556.

Accounting: Neutron Counter

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Neutron Coincidence AnalyzerMODEL: N97SUPPLIER: *AEA Technology plc, Harwell Instruments*

USE CATEGORY: Accounting

DEVICE TYPE: Neutron Counter

MEASUREMENT METHOD: Neutron Coincidence Counting

MEASURED PROPERTIES: Effective Isotope Mass

NUCLEAR MATERIAL(S): Pu

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Portable

ENVIRONMENT OF USE: Industrial

DEVELOPER: AEA Technology plc, Harwell Instruments

MANUFACTURER: AEA Technology plc, Harwell Instruments

DESCRIPTION**PURPOSE**

The N97 Neutron Coincidence Analyzer is a free-standing, mains-powered unit which performs signal processing functions required in the assay of plutonium.

PRINCIPLES OF OPERATION

The principle of measurement involves separating the coincident neutrons arising from the time correlated spontaneous fission events of Pu-238, 240, 242 ("reals") from the random coincidences ("accidentals") arising from other sources. The difference in count rate between the two enables the spontaneous fission coincidence count rate to be determined, which is a function of the mass of Pu-238, 240, 242 present.

For a full assay system the N97 is connected to a moderator assembly containing thermal neutron detectors and charge amplifier/discriminators. A microcomputer loaded with an application program connects to the serial port of the N97 to allow system characterization and operation.

The N97 interfaces to the moderator assembly signal outputs via one of plug-in adaptors, each enabling a different signal format to be accepted - up to six individual input channels are provided by adaptors nos. 1 to 3 and up to eight channels by adaptor no. 4. All power supplies required by the moderator assembly are available as outputs from the N97; also included is a separate scaler for general counting applications.

FUNCTIONAL BLOCKS

N97 includes:

- four plug-in adaptors
- scaler

SPECIFICATIONS

Operational temperature range

0 to 40 °C

Overall size

455 mm x 350 mm x 177 mm

Weight

8.82 kg excluding NCA adaptors and IEC style mains cord

SOFTWARE

Enables the user to set counting parameters and accrue data, in addition to determining and verifying the operating characteristics of a neutron coincidence counting system. DOS/Windows

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Neutron Counter

Portable Shift Register

MODEL: PSR

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SUPPLIER: *AQUILA Technologies Group, Inc.*

USE CATEGORY: Accounting

DEVICE TYPE: Neutron Counter

MEASUREMENT METHOD: Neutron Coincidence Counting

MEASURED PROPERTIES: Effective Isotope Mass

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Hand-held

ENVIRONMENT OF USE: Field

DEVELOPER: *AQUILA Technologies Group, Inc.*MANUFACTURER: *AQUILA Technologies Group, Inc.*

DESCRIPTION

PURPOSE

The Portable Shift Register (PSR) is a battery operated, self contained, neutron coincidence counter that provides in-plant measurements to demonstrate compliance with regulations (domestic and international), in-plant process control, and in-field environmental monitoring/safeguards measurements.

PRINCIPLES OF OPERATION

The PSR provides a combined set of hardware and software tools for neutron coincidence and multiplicity counting. These tools cover the range of applications from portable to battery operated, to remote and unattended, to installed in-plant. The portable PSR electronics package contains the circuit boards, battery, and bias supply. The PSR processes incoming signals from standard neutron detectors to count neutron singles, coincidences, and optionally determined multiplicities. It also provides low and bias voltages for the detector, resident control, and data storage, and for the firmware to control the hardware interface with an external controller. The PSR utilizes a standard RS-232 serial interface and command set and protocol, compatible with currently used instruments that also allow the PSR to be used with existing user programs. Also included is a powerful, versatile software tool kit that makes developing and implementing the hardware and interface parts of application-specific software easy. The PSR can be reconfigured to be an intelligent peripheral in the evolving miniature and modular multi-channel analyzer family of instruments. The PSR may optionally be purchased as an AC-powered bench top instrument as well.

FUNCTIONAL BLOCKS

- circuit boards
- battery
- bias supply

SPECIFICATIONS

Overall size 8 cm x 10 cm x 20 cm
 Interface standard RS-232 serial port

SOFTWARE

A software tool kit including a library written in Microsoft C is available with the PSR to make writing the hardware and interface applications simple.

ADDITIONAL INFORMATION

Performs all measurements made by previous neutron coincidence counter instruments developed at Los Alamos National Laboratory (LANL).

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Neutron Counter

Active Well Neutron Coincidence Counter
MODEL: JCC-51

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SUPPLIER: *Canberra Industries, Inc.*

USE CATEGORY:	Accounting
DEVICE TYPE:	Neutron Counter
MEASUREMENT METHOD:	Neutron Coincidence Counting
MEASURED PROPERTIES:	Active, Passive
NUCLEAR MATERIAL(S):	Effective Isotope Mass
PHYSICAL FORM(S) OF NM:	LEU, HEU
STATUS:	scrap, pellets, powder
PORTABILITY:	Serial Production
ENVIRONMENT OF USE:	Portable
DEVELOPER:	Industrial
MANUFACTURER:	Los Alamos National Laboratory
	Canberra Industries, Inc.

DESCRIPTION

PURPOSE

This device is designed to make active neutron measurements on items such as bulk UO₂ samples, high-enrichment uranium metals, UAl alloy scraps, LWR fuel pellets and U-238Th fuel materials. Americium-Lithium (AmLi) neutron sources (one in the top plug and one in the bottom plug) induce fission in the uranium sample and the coincidence neutrons are counted. If the AmLi sources are removed, the counter can be operated in a passive mode to assay plutonium.

PRINCIPLES OF OPERATION

The counter can be operated in two active modes: thermal mode and fast mode. Thermal mode is used for low-enrichment material such as UO₂ pellets, U₃O₈ powder and low content scrap (<50g U235), high-enrichment material including U-235Th and U-233Th (HTGR fuels) and samples with large quantities of hydrogenous materials such as scrap with plastic bags, uranyl nitrate (few g/L to few hundred g/L) and plutonium solutions (few g/L to few hundred g/L). The fast mode is used for high-enrichment uranium metal. For thermal mode, the internal cadmium sleeve and cadmium in the end plugs are removed.

Detectors are arranged in two concentric rings to maximize efficiency. The tubes are divided into six groups of seven, and each group is wired together and connected to one JAB-01 channel.

For assay of large samples such as fuel rods or plates, the counter is turned on its side, the end plugs are removed and an MTR Insert (JWI-11) is positioned inside the counter. The cart is used to support the counter in the horizontal position.

The sample well height can be increased by removing one or both of the polyethylene discs in the top and bottom plugs. Enlarging the sample well will increase the absolute efficiency because the ends of the He-3 tubes are not as shielded, but decrease the precision because the random background from the AmLi source is increased.

A cadmium sleeve is wrapped around the outside of the counter to reduce the background and to reduce personnel exposure.

FUNCTIONAL BLOCKS

- forty-two He-3 tubes embedded in the high-density polyethylene
- electrical connections:
 - +5 V
 - HV
 - single "ORed" output signal.
- fast Amptek electronics

Two AmLi neutron sources (JNS-01), 5.E+4 n/sec, JSR-12 Neutron Coincidence Analyzer, a computer and analysis software are required for neutron coincidence counting but are not included with the JCC-51.

SPECIFICATIONS

Sensitivity 1 g in thermal mode

	23 g in fast mode
Precision	1.5%/20g in thermal mode 3.8%/200 g in fast mode
Cavity dimension	20.6 cm x 35.1 cm x 22.9 cm
Overall size	73.7 cm x 49.3 cm
Weight	125 kg (including cart)

SOFTWARE

Canberra Neutron Assey Software

ADDITIONAL INFORMATION

REFERENCES

Menlove, H.O. Description and Operation Manual for the Active Well Coincidence Counter, Report LA-7823-M. Low Alamos, New Mexico, Los Alamos National Laboratory, 1979.

Accounting: Neutron Counter

Flat-Squared Neutron Coincidence Counter (special order)

MODEL: JCC-41

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SUPPLIER: *Canberra Industries, Inc.*

USE CATEGORY: Accounting

DEVICE TYPE: Neutron Counter

MEASUREMENT METHOD: Neutron Coincidence Counting
Passive

MEASURED PROPERTY: Effective Isotope Mass

NUCLEAR MATERIAL(S): Pu

PHYSICAL FORM(S) OF NM: PuO₂ mixed oxides (PuO₂-UO₂), metal carbides, fuel rods, fast critical assemblies, solution, scrap, and waste

STATUS: Serial Production

PORTABILITY: Portable

ENVIRONMENT OF USE: Industrial

DEVELOPER: *Canberra Industries, Inc.*MANUFACTURER: *Canberra Industries, Inc.*

DESCRIPTION

PURPOSE

The JCC-41 is designed for in-plant measurements of large plutonium samples (up to several kg Pu), but can be used for plutonium waste samples with milligram quantities of plutonium. It is intended to assay plutonium samples including PuO₂ mixed oxides (PuO₂-UO₂), metal carbides, fuel rods, fast critical assemblies, solution, scrap, and waste.

PRINCIPLES OF OPERATION

The JCC-41, which is based on Monte Carlo design calculations performed at Los Alamos National Laboratory [1], measures the effective Pu-240 mass in a sample by detecting coincidence neutrons from the spontaneous fission of the even numbered isotopes of plutonium.

A cadmium sleeve surrounds the sample cavity to prevent the reentry of thermalized neutrons into the sample, which could induce fission in the sample and adversely affect the results. It provides radiation protection for personnel as well as background reduction.

Outside the cadmium sleeve is a polyethylene/cadmium liner to flatten the axial response. Twenty-four He-3 tubes are embedded in the high-density polyethylene. The tubes are arranged in a single ring around the sample with optimum spacing between the tubes for maximum counter efficiency.

The tubes are divided into six groups of four with each group wired together and connected to one of the six JAB-01 Amplifier/ Discriminator circuit boards which are mounted inside a high voltage junction box. LED indicator lights are placed externally on the junction box to indicate proper operation of each JAB-01 channel. The external polyethylene shielding and special design (graphite end plugs and polyethylene/cadmium liner) give uniform response axially over the sample cavity, making the counter relatively insensitive to matrix effects.

FUNCTIONAL BLOCKS

- JCC-41 counter head:
 - twenty-four He-3 Detectors
 - fast Amptek electronics
- cylindrical-shaped sample cavity
- exterior neutron shielding
- sample hoist mechanism
- electrical connections between the JCC-41 and the JSR-12:
 - +5 V
 - HV
 - single "ORed" output signal.

A JSR-12 Neutron Coincidence Analyzer, a computer and analysis software are required for coincidence counting but are not included with the JCC-41.

SPECIFICATIONS

Detector efficiency

>24%

Sensitivity

better than 28 counts/sec per gram Pu-240

Measurement time	1000 sec
Precision	2.4% for 0.06 gram Pu-240
Measurement range	several mg to several kg Pu
Sample cavity size	51 cm x 24 cm
Overall size	204.5 cm x 62.2 cm x 62.2 cm
Counter size	92.5 cm x 62.2 cm x 62.2 cm
Weight	318 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Menlove, H.O., Palmer, R., Eccleston, G.W., and Ensslin, N., Flat-Squared Counter Design and Operation Manual. Report LA-11635. Los Alamos, New Mexico: Los Alamos National laboratory (LANL), 1989.

Accounting: Neutron Counter

High Level Neutron Coincidence Counter

MODEL: JCC-31 (HLNC)

65

SUPPLIER: *Canberra Industries, Inc.*

USE CATEGORY: Accounting
 DEVICE TYPE: Neutron Counter
 MEASUREMENT METHOD: Neutron Coincidence Counting
 Passive
 MEASURED PROPERTIES: Effective Isotope Mass
 NUCLEAR MATERIAL(S): Pu
 PHYSICAL FORM(S) OF NM: PuO₂, Mixed oxides (PuO₂-UO₂), metal carbides, solution, powder, pellets, fuel rods, fast critical assemblies, scrap, and waste
 STATUS: Serial Production
 PORTABILITY: Portable
 ENVIRONMENT OF USE: Industrial
 DEVELOPER: Los Alamos National Laboratory
 MANUFACTURER: Canberra Industries, Inc.

DESCRIPTION

PURPOSE

The device is intended to assay plutonium samples including PuO₂, mixed oxides (PuO₂-UO₂), metal carbides, fuel rods, fast critical assemblies, solution, scrap, and waste.

PRINCIPLES OF OPERATION

The JCC-31 measures the Pu-240 effective mass in a sample by detecting coincidence neutrons from the spontaneous fission of plutonium. The effective mass of Pu-240 is the mass of Pu-240 which would emit the same number of spontaneous fission neutrons per second as the combined Pu-238, Pu-240 and Pu-242 in the sample.

A cadmium sleeve surrounds the sample cavity to prevent the re-entry of thermalized neutrons into the sample, which could induce fission in the sample and adversely affect the results. Outside the cadmium sleeve is a ring of high-density polyethylene with eighteen He₃ tubes placed in the polyethylene.

The tubes are arranged in a single ring around the sample with optimum spacing between the tubes for maximum counter efficiency for a transportable counter. The tubes are divided into six groups of three with each group wired together and connected to one JAB-01s are mounted inside a sealed junction box. LED indicator lights are places externally on the junction box to indicate proper operation of each JAB-01 channel. Electrical connections between the JCC-31 and the JSR-12 include +5 V, HV, and a single "ORed" output signal.

A cadmium sleeve wrapped around the outside of the JCC-31 provides radiation protection for personnel as well as background reduction.

FUNCTIONAL BLOCKS

- 18 He-3 detectors in aluminum cladding
- fast Amptek electronics.

A JSR-12 Neutron Coincidence Analyzer, a computer and analysis software are required for coincidence counting but are not included with the JCC-31.

SPECIFICATIONS

He-3 Active length x dia	50.8 x 2.54 cm
He-3 Detector efficiency	18%
Gate setting	64 microsec
Die-away time	50 microsec
Measurement range	1 g to 10 kg of Pu
Cavity dimentions	41 cm x 17.5 cm
Overall size	73.7 cm x 34 cm
Weight	34 kg

SOFTWARE

ADDITIONAL INFORMATION

Is based on a technology transfer from Los Alamos National laboratory(LANL),

REFERENCES

H.O. Menlove and M. Krick (1979). The High-Level Neutron Coincidence Counter (HLNCC): User's

Manual. Report LA-7779-M. Los Alamos, New Mexico, Los Alamos National Laboratory.

Accounting: Neutron Counter**Inventory Sample Neutron Coincidence Counter****MODEL: JCC-12 (INVS)****66****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Neutron Counter**MEASUREMENT METHOD:** Neutron Coincidence Counting
Passive**MEASURED PROPERTIES:** Effective Isotope Mass**NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:** Liquid, Powder, Pellets**STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Canberra Industries, Inc.**DESCRIPTION****PURPOSE***The device is designed for measuring Pu in small samples ranging from 0.1 to 500 g.***PRINCIPLES OF OPERATION****FUNCTIONAL BLOCKS**

- 16 He-3 tubes (6 atm) in aluminum cladding.

A JSR-12 Neutron Coincidence Analyzer, computer, and analysis software are required but not included with the device.

SPECIFICATIONS

Detector efficiency	35% with smallest sample configuration
	29% with polyethylene sleeve removed
Measurement range	0.1 to 500 g Pu
Cavity dimension	14 cm x 5 cm
Overall size	46.2 cm x 27.9 cm
Weight	20.5 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

H.O. Menlove, et.al., Inventory Sample Coincidence Counter Manual, LANL Report LA-9544-M, Los Alamos, 1982

2. Edition Ten Product Catalog, Canberra Industries, Inc.

Accounting: Neutron Counter**67*****Neutron Coincidence Collars******MODEL: JCC-71 (JCC-72, JCC-73)*****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Neutron Counter**MEASUREMENT METHOD:** Neutron Coincidence Counting
Active, Passive**MEASURED PROPERTIES:** Effective Isotope Mass**NUCLEAR MATERIAL(S):** U, Pu**PHYSICAL FORM(S) OF NM:** Assembly (fresh)**STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Canberra Industries, Inc.**DESCRIPTION****PURPOSE**

This devices are designed for neutron coincidence measurement of uranium in PWR, BWR and CANDU fuel assemblies, or plutonium in MOX full assemblies.

PRINCIPLES OF OPERATION

The Model JCC-71 Neutron Coincidence Collar is a passive/active neutron counter for the measurement of the U-235 content per unit length in fresh PWR, BWR and CANDU fuel in the passive mode. In the active mode, an AmLi source is required to interrogate the fuel, and coincidence counting of the induced fission neutrons from U-235 is performed. To measure the U-238 content, the AmLi source is removed, a fourth bank of He-3 detectors is added, and the counter is operated in a passive mode, counting the coincidence neutrons from spontaneous fission of U-238. The collar measures the U-235 and U-238 content along the axis of the assembly, not the enrichment. Since the U-235 content is of primary interest for safeguard purposes, only the active measurement is necessary. Pu-containing fuel rods are measured in the passive mode because of the high spontaneous fission rate.

For the passive mode, there are four counter banks composed of high-density polyethylene for moderation of the fission neutrons. If operated in the active mode, one bank of detectors is replaced with a polyethylene bank containing the AmLi interrogating source.

The Neutron Coincidence Collar is designed to allow modification of the geometry to close-couple the detectors with the fuel type. For the smaller BWR fuel, the side detector banks are moved into the inner screw hole position. The fourth bank of tubes (passive mode) is hinged to facilitate placing the counter around fuel assemblies. For the active mode, the fourth side of the counter is a polyethylene moderator with a tungsten source bottle for the AmLi source. The AmLi neutrons are thermalized in the polyethylene and induce fission in the U-235. The average energy from the induced fission is higher than the moderated AmLi neutrons and gives fast neutron multiplication which allows the measurement to penetrate into the interior of the fuel assemblies. For HEU fuel, cadmium liners can be added to improve neutron penetrability.

The Neutron Coincidence Collar is designed to be insensitive to parameters such as open channels for control rods, enrichments, angular orientation of the fuel in the Collar, fuel pellet density, and any protective bagging. Cladding type (zinc alloy or stainless steel), different fuel pellet diameter, and neutron absorbers (Gd₂O₃) can affect the measurement.

FUNCTIONAL BLOCKS

- He-3 tubes: JCC-71 (passive mode) - 24
 - JCC-71 (active mode) - 18
 - JCC-72 (active mode) - 16
 - JCC-73 (active mode) - 20

- AmLi source (ordered separately)

- fast Amptek electronics

- optional transport container

A JSR-12 Neutron Coincidence Analyzer, a computer and analysis software are required for coincidence counting but are not included with the JCC-71, 72 and 73.

SPECIFICATIONS

SPECIFICATIONS

Required AmLi source strength:

JCC-71

5E+4 n/s

JCC-72 and JCC-73

1E+5 n/s

Tube active length

33 cm x 2.54 cm (aluminum cladding)

Efficiency:

JCC-71 (passive PWR configuration)

14%

JCC-72 (active)

13%

JCC-73 (active)

16%

Gate setting

64 microsec

Sensitivity (JCC-71)

2.2 rods for iron substitution

2.8 rods for empty substitution

Cavity dimension

40 cm x 23.5 cm x 23.5 cm

40 cm x 16.5 cm x 23.5 cm

Weight (JCC-71)

38 kg

SOFTWARE**ADDITIONAL INFORMATION**

These devices are based upon technology transfer from the Los Alamos National Laboratory.

Since more neutron collars are being installed at facilities for measuring designated fuel types (BWR or PWR), the Neutron Coincidence Collar was redesigned by Los Alamos National Laboratory to make two separate counters: the JCC-72 for BWR and CANDU fuel assemblies and the JCC-73 for PWR fuel assemblies.

REFERENCES

1. H.A. Menlove, Description and Performance Characteristics for the Neutron Coincidence Collar for the Verification of Reactor Fuel Assemblies, LANL Report LA-8939-MS, Los Alamos, 1981
2. Edition Ten Product Catalog, Canberra Industries, Inc.

Accounting: Neutron Counter**Neutron Coincidence Electronic Analyzer****MODEL: JSR-12, JSR-14****68****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Neutron Counter**MEASUREMENT METHOD:** Neutron Coincidence Counting**MEASURED PROPERTIES:** Effective Isotope Mass**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** *Canberra Industries, Inc.***MANUFACTURER:** *Canberra Industries, Inc.***DESCRIPTION****PURPOSE**

JSR-14 is a battery powered, portable unit for operation in totals, coincidence, and multiplicity mode. Neutron coincidence electronics used with all Canberra passive and active neutron counters.

PRINCIPLES OF OPERATION

The JSR-12 Neutron Coincidence Analyzer separates coincidence neutron events from random neutron events, and thus provides a method of counting neutron signatures from spontaneously fissioning isotopes or induced fissions from fissile isotopes. At the conclusion of each counting interval (operator selected), the unit provides information on total counts, reals plus accidentals and accidentals as displayed on the front panel. Most significantly, it does this without substantial deadtime by a unique technique in which a new coincidence gate is started for each neutron event presented at the input.

FUNCTIONAL BLOCKS

- standard RS-232C serial port
- LCD alphanumeric display
- internal battery-backed time-of-day and day-of-year realtime clock
- automatic non-volatile storage for 3000 data runs
- internal burst pulser
- data RAM

SPECIFICATIONS

Power supply	110/220 V
Speed	4 MHZ
Storage capacity	up to 3000 data runs
Measurement time	adjustable from 0.1 seconds to 9.9E+9 seconds
Overall size	8.9 cm x 28.9 cm x 50.8 cm
Weight	5.9 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Neutron Counter

Pu Scrap Multiplicity Counter**MODEL: PSMC-01****69****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Neutron Counter**MEASUREMENT METHOD:** Neutron Multiplicity Counting
Passive**MEASURED PROPERTIES:** Effective Isotope Mass**NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:** Scrap**STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Canberra Industries, Inc.**DESCRIPTION****PURPOSE**

The Plutonium Scrap Multiplicity Counter (PSMC) is a high efficiency neutron counter designed for measuring impure samples such as mixed-oxide (MOX) scrap materials.

PRINCIPLES OF OPERATION

The PSMC design is optimized for multiplicity counting to include high efficiency in multiplicity counting, the triples rate is proportional to the efficiency cubed. PSMC has four rings of He-3 proportional detectors arranged to flatten the energy response, and graphite end plugs to flatten the axial response by reflecting neutrons back into the He-3 detection region. The deadtime is small because the counter has 19 amplifiers to reduce the deadtime.

The PSMC uses Canberra's 2150 multiplicity electronics module, which is an extension of the JSR-12 Neutron Coincidence Counter Electronics (NCCE) module. Where the JSR-12 simply sums the R+A and the A gates, the 2150 multiplicity distribution is used to determine the singles (S), doubles (D), and triples (T) rates which can be used to solve for three unknowns: the Pu-240-effective mass, sample multiplication, and the alpha value (the alpha value is the ratio of the uncorrelated to spontaneous fission neutron events).

FUNCTIONAL BLOCKS

- 80 He-3 proportional detectors
- graphite end plugs
- 19 amplifiers
- Canberra's 2150 multiplicity electronics module

SPECIFICATIONS

Efficiency	about 55%
Cavity dimensions:	41 cm x 20 cm (HxD)
Overall size:	66 cm x 66 cm x 80 cm (LxWxH)

SOFTWARE**ADDITIONAL INFORMATION**

The PSMC is a commercialized version of a multiplicity counter originally developed by Los Alamos National Laboratory.

REFERENCES

1. H.O. Menlove, et. Al., Plutonium Scrap Multiplicity Counter Operation Manual, Los Alamos National Laboratory Report LA-12479-M, January 1993.
2. D. Davidson and R. McElroy, Comparison of Neutron Coincidence and Multiplicity Counting Techniques for Safeguards, Proceedings of the 16th Annual Meeting of INMM Japan Chapter, December 7-8, 1995, Tokyo, page 163.

Accounting: Neutron Counter**70****Shielded Neutron Assay Probe****MODEL: JSP-12****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Neutron Counter**MEASUREMENT METHOD:** Neutron Coincidence Counting
Passive**MEASURED PROPERTIES:** Effective Isotope Mass**NUCLEAR MATERIAL(S):** Pu, U**PHYSICAL FORM(S) OF NM:** Holdup**STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Canberra Industries, Inc.**MANUFACTURER:** Canberra Industries, Inc.**DESCRIPTION****PURPOSE**

This device is a modification of JCC-71, designed specifically for detecting holdup of Pu or UF6.

PRINCIPLES OF OPERATION

This device can be operated in a total neutron or coincident neutron mode. The probe has directional shielding. It is operated with Canberra's JHH-50 hand-held monitor.

FUNCTIONAL BLOCKS**SPECIFICATIONS****SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Canberra Catalog, Edition 10.

Accounting: Neutron Counter

Universal Fast Breeder Reactor Subassembly Counters

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MODEL: JCC-61 & 62

SUPPLIER: *Canberra Industries, Inc.*

USE CATEGORY: Accounting
 DEVICE TYPE: Neutron Counter
 MEASUREMENT METHOD: Neutron Coincidence Counting
 Passive
 MEASURED PROPERTIES: Effective Isotope Mass
 NUCLEAR MATERIAL(S): Pu
 PHYSICAL FORM(S) OF NM: Assembly (fresh)
 STATUS: Limited Production
 PORTABILITY: Portable
 ENVIRONMENT OF USE: Industrial
 DEVELOPER: Los Alamos National Laboratory
 MANUFACTURER: Canberra Industries, Inc.

DESCRIPTION

PURPOSE

This device is designed for passive neutron measurement of plutonium in fast breeder reactor fuel subassemblies.

PRINCIPLES OF OPERATION

The JCC-61 and JCC-62 quantitatively measure fast breeder fuel sub-assemblies, individual fuel pins, or a group of fuel pins. They count coincidence neutrons from the spontaneous fission of the even numbered isotopes of plutonium. Subassemblies can be lowered through the top of the counter using a crane. If this is not possible, the door opens to allow side entry. For ease in moving, the door can be removed.

He-3 tubes are surrounded by a polyethylene and cadmium sleeve in the central region to flatten the axial response and decrease counter die-away time. The cadmium stops 15 cm (5.9 in.) from the bottom and 17.5 cm (6.9 in.) from the top to compensate for end leakage. The counter is under-moderated to minimize weight and to maximize the amount of plutonium that can be measured. The cadmium liner inside the sample cavity prevents reentry of thermal neutrons which could induce fission in the fuel and adversely affect the measurement.

The He-3 tubes are arranged in a single ring, and are divided into six groups of two. Each group is wired together and connected to one JAB-01 Amplifier/Discriminator circuit board. The six JAB-01s are mounted inside a high voltage junction box. LED indicator lights are placed externally to the junction box to indicate the proper operation of each JAB-01 channel.

FUNCTIONAL BLOCKS

- twelve He-3 tubes
- polyethylene
- cadmium sleeve
- six JAB-01 Amplifier/Discriminator circuit boards
- high voltage junction box
- LED indicator lights
- electrical connections between the JCC-61 or JCC-62 and the JSR-12 include:
 - +5 V
 - HV
 - single "ORed" output signal

A JSR-12 Neutron Coincidence Analyzer, a computer and analysis software are required for coincidence counting but are not included with the JCC-61 or JCC-62.

SPECIFICATIONS

Measurement range	up to 16 kg (24% Pu-240)
Detector efficiency	7% (JCC-61) 6% (JCC-62)
Cavity dimension:	
JCC-61	132 x 16.5 cm
JCC-62	132 x 23 cm
Overall size	
JCC-61	142.5 x 31 cm

JCC-62 149 x 50 cm
Weight (JCC-61) 55 kg

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

1. Menlove, H.O., et al., Universal Fast Breeder Reactor Subassembly Counter Manual, Report LA-10226-M, Los Alamos, New Mexico, Los Alamos National Laboratory, 1984.

Accounting: Neutron Counter

Active Well Coincidence Counter
MODEL: AWCC

72

SUPPLIER: Los Alamos National Laboratory

USE CATEGORY: Accounting
 DEVICE TYPE: Neutron Counter
 MEASUREMENT METHOD: Neutron Coincidence Counting
 Active
 MEASURED PROPERTIES: Effective Isotope Mass
 NUCLEAR MATERIAL(S): Pu, U-238, UO₂, LEU, HEU, U-Th fuel
 PHYSICAL FORM(S) OF NM:
 STATUS: Serial Production
 PORTABILITY: Portable
 ENVIRONMENT OF USE: Industrial
 DEVELOPER: Los Alamos National Laboratory
 MANUFACTURER: Los Alamos National Laboratory

DESCRIPTION

PURPOSE

Measurement of U235 content in high enriched U samples. Active neutron measurements on items such as bulk UO₂ samples, high enrichment uranium metals, UAl alloy scraps, LWR fuel pellets, U238Th fuel materials. Best suited for high-mass, highly enriched uranium samples; should not be used for low U-235-mass samples, except for well-defined samples in thermal mode.

PRINCIPLES OF OPERATION

AWCC counts the emission rate of prompt neutrons from induced fissions in the sample. The counter surrounds the sample with He-3 neutron detectors and irradiates the sample with neutrons from AmLi sources installed above and below the sample. The analysis electronics measures the coincidence neutron count rate, which is proportional to the amount of fissionable material (U-235) in the sample. Coincidence counting differentiates the fission signal from the undesired neutron counts from the random AmLi interrogation source and from room background.

FUNCTIONAL BLOCKS

SPECIFICATIONS

Measurement time	1000 seconds
Sensitivity	1 g
Accuracy (absolute)	0.3 g U-235 (thermal mode) 24 g U-235 (fast mode)
Cavity dimension	diameter 22 cm

SOFTWARE

ADDITIONAL INFORMATION

Was tested on 93% U-235 metal buttons (1-4 kg), cans of uranium-aluminum scrap, cans of uranium-oxide powder, mixtures of uranium oxide and graphite, and uranium-aluminum ingots and fuel pins.

REFERENCES

Hastings A. Smith, Jr. (LANL) and Peter Schillebeeckx (ECJRC, Ispra), Nondestructive Assay of Special Nuclear Material for Uranium Fuel-Fabrication Facilities, Tripartite International Conference on MPC&A for Uranium Fuel Fabrication Facilities, IPPE, Obninsk, Russia, April 21-25, 1997

Accounting: Neutron Counter**High Level Neutron Coincidence Counter****73****MODEL:****SUPPLIER:** *Los Alamos National Laboratory***USE CATEGORY:** Accounting**DEVICE TYPE:** Neutron Counter**MEASUREMENT METHOD:** Neutron Coincidence Counting

Passive

MEASURED PROPERTIES: Effective Isotope Mass**NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:** Oxide**STATUS:** Limited Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Los Alamos National Laboratory**DESCRIPTION****PURPOSE**

Measurement of Pu. Used for bulk PuO₂ powder, mixed-oxide powder, pellets, pins, and trays. Design is modular so that its configuration can be modified to accommodate different geometries such as plates and pins.

PRINCIPLES OF OPERATION**FUNCTIONAL BLOCKS****SPECIFICATIONS**

Measurement range	up to 5 kg of Pu
Sensitivity	0.25 to 2 g of Pu
Cavity dimension	diameter 17.5 cm, height 35-41 cm
Weight	48 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

D. Reilly, N. Ensslin, H. Smith, Jr., and S. Kreiner, Passive Nondestructive Assay of Nuclear Materials, NUREG/CR-5550, LA-UR-90-732, March 1991

Accounting: Neutron Counter

Los Alamos Neutron Coincidence Counters
MODEL:

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SUPPLIER: *Los Alamos National Laboratory*

USE CATEGORY: Accounting

DEVICE TYPE: Neutron Counter

MEASUREMENT METHOD: Neutron Coincidence Counting
 Passive

MEASURED PROPERTIES: Effective Isotope Mass

NUCLEAR MATERIAL(S): Pu

PHYSICAL FORM(S) OF NM: Waste, Scrap, Liquid, Powder, Pellets, Cake, Assembly, Rod

STATUS: Serial Production

PORTABILITY:

ENVIRONMENT OF USE: Industrial

DEVELOPER: Los Alamos National Laboratory

MANUFACTURER: Los Alamos National Laboratory

DESCRIPTION**PURPOSE**

Used for pure and impure oxides, metal, scrap from molten salt extraction, PuF4, scrap, and waste.

PRINCIPLES OF OPERATION

Neutrons from the sample are slowed down by the polyethylene and detected by the He-3 tubes. The tubes send signals to preamplifiers in the high-voltage junction box. The signals are then sent to a computer for processing. The graphite improves the uniformity of the neutron detection efficiency throughout the sample cavity.

FUNCTIONAL BLOCKS**SPECIFICATIONS**

Measurement range	several mg of Pu-240; fraction of 1 liter to 200 liters
Measurement time	5 minutes

SOFTWARE

Software is available for assay, calibration, and measurement control.

ADDITIONAL INFORMATION

Names of the counters: Passive/Active Well Counter, Feed Coincidence Counter, Waste Coincidence Counter, Flat-squared Counter, In-line Counter, Drum Counter, Counter for 5-gal Pails, Horizontal In-line Counter, Vertical In-line Counter, Moisture Correction Counter, Confirmatory Measurements Counter, Dual-range Coincidence Counter, Pu-238 Heat Source Counter, High Level Neutron Coincidence Counter (HLNC-II), Inventory Sample Counter, Universal Fast Breeder Reactor Counter, Pin-tray Counter, Capsule Counter, Birdcage Counter, Canister Counter, Plutonium Nitrate Bottle Counter, Material Accountancy Glovebox Counter, Holdup Slab Counter. These devices are also manufactured by commercial suppliers such as Canberra and NNC.

REFERENCES

Los Alamos Application Note, Passive Neutron Coincidence Counters, December 1992, LALP-92-52

Accounting: Neutron Counter

Passive Neutron Multiplicity Counter

75

MODEL:**SUPPLIER:** *Los Alamos National Laboratory***USE CATEGORY:** Accounting**DEVICE TYPE:** Neutron Counter**MEASUREMENT METHOD:** Neutron Multiplicity Counting
Passive**MEASURED PROPERTIES:** Effective Isotope Mass**NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:** Metal, Scrap**STATUS:** Limited Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Los Alamos National Laboratory**DESCRIPTION****PURPOSE***Measurement of Pu in metal, scrap, impure oxides.***PRINCIPLES OF OPERATION****FUNCTIONAL BLOCKS**

- 126 He3 tubes are arranged around the sample cavity;
- junction box contains the amplifiers.

SPECIFICATIONS

Measurement time	1000 seconds
Accuracy for 1 kg Pu metal or slightly impure oxides	0.3% to 2%
Cavity dimension	D20 cm x 41 cm
Overall size	height 92 cm, width 64 cm

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

LANL Application Note, LALP-94-44

Accounting: Neutron Counter**Receipts Assay Monitor for UF6 Cylinders****MODEL: RAM****76****SUPPLIER: Los Alamos National Laboratory**

USE CATEGORY: Accounting
DEVICE TYPE: Neutron Counter
MEASUREMENT METHOD: Neutron Coincidence Counting
Passive, Active
MEASURED PROPERTIES: Effective Isotope Mass
NUCLEAR MATERIAL(S): U
PHYSICAL FORM(S) OF NM: Fluoride
STATUS: Limited Production
PORTABILITY: Portable
ENVIRONMENT OF USE: Industrial
DEVELOPER: Los Alamos National Laboratory
MANUFACTURER: Los Alamos National Laboratory

DESCRIPTION**PURPOSE**

Determination of effective isotope mass of U235 in UF6 cylinders.

PRINCIPLES OF OPERATION

Device uses the passive neutron technique, based on self-interrogation and coincidence counting. Passive neutrons from (alpha,n) reactions in UF6 are utilized to induce fission reactions (active) in the U-235.

FUNCTIONAL BLOCKS

- 20 He3 tubes; active length: 61 cm
- fast AMPTEK electronics

SPECIFICATIONS

Measurement time	120 (cadmium liner down)
	360 seconds (cadmium liner up)
Accuracy	0.5%

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

D. Reilly, N. Ensslin, H. Smith, Jr., and S. Kreiner, Passive Nondestructive Assay of Nuclear Materials, NUREG/CR-5550, LA-UR-90-732, March 1991

Accounting: Neutron Counter**77****The Uranium Neutron Coincidence Collar****MODEL: UNCC****SUPPLIER:** *Los Alamos National Laboratory***USE CATEGORY:** Accounting**DEVICE TYPE:** Neutron Counter**MEASUREMENT METHOD:** Neutron Coincidence Counting
Active, Passive**MEASURED PROPERTIES:** Effective Isotope Mass**NUCLEAR MATERIAL(S):** U**PHYSICAL FORM(S) OF NM:** Assembly (fresh)**STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Los Alamos National Laboratory**DESCRIPTION****PURPOSE**

Measurement of the U235 content in fresh fuel assemblies. The UNCC can be applied in fissile content determination in boiling-water-reactor (BWR), pressurized-water-reactor (PWR), and other type fuel assemblies for accountability, criticality control, and safeguards purposes.

PRINCIPLES OF OPERATION

The fuel assembly is surrounded on three sides with He-3 detectors, and the interrogating AmLi source is encased in moderating material on the fourth side of the assembly. When no interrogation sources are present, the passive neutron coincidence rate gives a measure of the U238 through the spontaneous fission reactions.

FUNCTIONAL BLOCKS**SPECIFICATIONS**

Measurement time	1000 seconds
Accuracy	0.6% to 0.9%
	0.1% for longer assay durations and fixed geometry
Cavity dimension	40 cm
Weight	30 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Hastings A. Smith, Jr. (LANL) and Peter Schillebeeckx (ECJRC, Ispra), Nondestructive Assay of Special Nuclear Material for Uranium Fuel-Fabrication Facilities, Tripartite International Conference on MPC&A for Uranium Fuel Fabrication Facilities, IPPE, Obninsk, Russia, April 21-25, 1997

Accounting: Neutron Counter

Active Well Coincidence Counter
MODEL: AWCC

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SUPPLIER: *National Nuclear Corporation*

USE CATEGORY: Accounting

DEVICE TYPE: Neutron Counter

MEASUREMENT METHOD: Neutron Coincidence Counting
Active

MEASURED PROPERTIES: Effective Isotope Mass

NUCLEAR MATERIAL(S): Pu, U-238, UO₂, LEU, HEU, U-Th fuel

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Portable

ENVIRONMENT OF USE: Industrial

DEVELOPER: Los Alamos National Laboratory

MANUFACTURER: National Nuclear Corporation

DESCRIPTION

PURPOSE

Measurement of U235 content in high enriched U samples. Active neutron measurements on items such as bulk UO₂ samples, high enrichment uranium metals, UAl alloy scraps, LWR fuel pellets, U238-Th fuel materials.

PRINCIPLES OF OPERATION

FUNCTIONAL BLOCKS

SPECIFICATIONS

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Neutron Counter**High-Level Neutron Coincidence Counter****MODEL: HLNCC, HLNCC-II****79****SUPPLIER: National Nuclear Corporation**

USE CATEGORY: Accounting
 DEVICE TYPE: Neutron Counter
 MEASUREMENT METHOD: Neutron Coincidence Counting
 Passive
 MEASURED PROPERTIES: Effective Isotope Mass
 NUCLEAR MATERIAL(S): PuO₂, PuF₄, MOX
 PHYSICAL FORM(S) OF NM:
 STATUS: Serial Production
 PORTABILITY: Portable
 ENVIRONMENT OF USE: Industrial
 DEVELOPER: Los Alamos National Laboratory
 MANUFACTURER: National Nuclear Corporation

DESCRIPTION**PURPOSE**

Measurement of Pu. Used for bulk PuO₂ powder, mixed-oxide powder, pellets, pins, and trays. Design is modular so that its configuration can be modified to accommodate different geometries such as plates and pins.

PRINCIPLES OF OPERATION

Count coincidence neutrons from the spontaneous fission of plutonium. The He-3 tubes are divided into six groups of three. Each group has its own preamplifier/discriminator. Pulses resulting from neutron events are discriminated on the basis of pulse height from noise and gamma-ray events at the output of the amplifier. This allows for faster results with shorter dead time. The sample cavity is lined with a removable cadmium sleeve to prevent thermalized neutrons from reentering the counting chamber.

FUNCTIONAL BLOCKS

- eighteen He-3 tubes (4 atm) housed in a cylindrical polyethylene body
- Amptek A-111 hybrid charge-sensitive preamplifier/discriminator

SPECIFICATIONS

Device efficiency	17.5%.
Cavity dimension	14 cm high by 17.5 cm in diameter.
Weight	34 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

1. Passive Nondestructive Assay of Nuclear Materials (PANDA), NUREG/CR-5550, March 1991, Chapter 17.2
2. Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Neutron Counter**Inventory Sample Coincidence Counter**
MODEL: ISCC**80****SUPPLIER: National Nuclear Corporation**

USE CATEGORY: Accounting
DEVICE TYPE: Neutron Counter
MEASUREMENT METHOD: Neutron Coincidence Counting
Passive
MEASURED PROPERTIES: Effective Isotope Mass
NUCLEAR MATERIAL(S): U, Pu
PHYSICAL FORM(S) OF NM: Powder, pellets
STATUS: Serial Production
PORTABILITY: Portable
ENVIRONMENT OF USE: Industrial
DEVELOPER: Los Alamos National Laboratory
MANUFACTURER: National Nuclear Corporation

DESCRIPTION**PURPOSE**

Measurement of Pu in 0.1-500 g samples.

PRINCIPLES OF OPERATION**FUNCTIONAL BLOCKS****SPECIFICATIONS**

Measurement range	0.1 to 500 g Pu
Measurement time	200 sec
Sensitivity	0.1 g Pu
Accuracy	1 %
Cavity dimension	5-cm-diam by 14-cm-tall (removing polyethylene liner, diameter can be increased to 8.8 cm)

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

PANDA, 1991, p. 506

Accounting: Neutron Counter**Neutron Slab Detector****MODEL: SD-1A****81****SUPPLIER:** *National Nuclear Corporation***USE CATEGORY:** Accounting**DEVICE TYPE:** Neutron Counter**MEASUREMENT METHOD:** Neutron

Passive

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:** Holdup**STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** National Nuclear Corporation**DESCRIPTION****PURPOSE***Slab Detector is a large area neutron detector designed for measuring plutonium holdup in process equipment and processing areas.***PRINCIPLES OF OPERATION**

Holdup measurements can be made with an SD-1 suspended in the middle of a room in a fraction of the time required for gamma-ray measurements made with NaI(Tl) detectors.

The five He-3 tubes are connected in parallel to an electronic unit that provides the high voltage and signal processing electronics. The detector requires preamplification.

FUNCTIONAL BLOCKS

- four removable cadmium panels (for the front, rear, and side surfaces)
- a removable 0.5" thick polyethylene sheet (for the front surface of the detector).
- the five He-3 proportional counters (2.54 cm diameter by 50.8 cm active length, 4 atm pressure)
- AMPTEK (LANL) preamplifier.
- polyethylene moderator 10.2 cm deep, 64.7 cm high and 35.6 cm wide with a cadmium outer cover
- electronic unit

SPECIFICATIONS

Operating voltage	1000-1200 V.
Frontal sensitive area	22" x 12".
Continuous operation	100 to 300 hours
Weight	35 pounds

SOFTWARE**ADDITIONAL INFORMATION**

The detector is compatible with standard scalers and ratemeters.

REFERENCES

1. Supplier/Developer Data - Информация от поставщика/разработчика
2. Proceedings of INMM, Vol. 5, No. III, Fall 1976, p. 533

Accounting: Neutron Counter**Passive Neutron Coincidence Collar****MODEL: PNCC****82****SUPPLIER: National Nuclear Corporation**

USE CATEGORY: Accounting
DEVICE TYPE: Neutron Counter
MEASUREMENT METHOD: Neutron Coincidence Counting
Passive
MEASURED PROPERTIES: Effective Isotope Mass
NUCLEAR MATERIAL(S): Pu
PHYSICAL FORM(S) OF NM: Assembly (fresh)
STATUS: Serial Production
PORTABILITY: Portable
ENVIRONMENT OF USE: Industrial
DEVELOPER: Los Alamos National Laboratory
MANUFACTURER: National Nuclear Corporation

DESCRIPTION**PURPOSE**

Used for verification of plutonium content in fresh assemblies.

PRINCIPLES OF OPERATION

Similar to UNCC except that the side containing the AmLi source has been replaced by a fourth detector bank and removable cadmium liners have been placed between the detector and fuel assembly.

FUNCTIONAL BLOCKS**SPECIFICATIONS**

Measurement time 1000 sec
Accuracy 0.75%
Dimensions same as UNCC

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

PANDA, 1991, p. 521

Accounting: Neutron Counter**Portable Shielded Neutron Assay Probe****MODEL: SNAP-II****83****SUPPLIER:** *National Nuclear Corporation***USE CATEGORY:** Accounting**DEVICE TYPE:** Neutron Counter**MEASUREMENT METHOD:** Neutron

Passive

MEASURED PROPERTIES: Radiation Intensity**NUCLEAR MATERIAL(S):** Pu, U**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORABILITY:** Hand-held**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** National Nuclear Corporation**DESCRIPTION****PURPOSE***SNAP-II is used for measuring neutron yields of samples of plutonium metal, ingots or oxide buttons and uranium in various forms to determine their Pu-240 or U-238 content.***PRINCIPLES OF OPERATION**

Two He-3 detectors are used to measure neutrons. In addition to the measurement of large or small containers, a small hole (1.9 cm in diameter) through the interior allows the insertion of small samples or fuel pins for high efficiency counting. The probe requires preamplification, and is compatible with standard scalers and ratemeters.

FUNCTIONAL BLOCKS

- Two He3 detectors
- Cabel/Connectors

SPECIFICATIONS

Measured range:

Pu	10 g - 2500 g
U	several kilograms
Operating voltage	1500 V
Overall size	24 cm x 30.5 cm

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Neutron Counter

Uranium Neutron Coincidence Collar
MODEL: UNCC

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SUPPLIER: National Nuclear Corporation

USE CATEGORY: Accounting

DEVICE TYPE: Neutron Counter

MEASUREMENT METHOD: Neutron Coincidence Counting
 Active

MEASURED PROPERTIES: Uranium Content per Unit Length

NUCLEAR MATERIAL(S): U

PHYSICAL FORM(S) OF NM: Assembly (fresh)

STATUS:

PORTABILITY:

ENVIRONMENT OF USE:

DEVELOPER: National Nuclear Corporation

MANUFACTURER: National Nuclear Corporation

DESCRIPTION**PURPOSE**

Measurement of the U235 content in fresh fuel assemblies. The UNCC can be applied in fissile content determination in boiling-water-reactor (BWR), pressurized-water-reactor (PWR), and other type fuel assemblies for accountability, criticality control, and safeguards purposes.

PRINCIPLES OF OPERATION

The method employs an AmLi neutron source to induce fission reactions in the fuel assembly and coincidence counting of the resulting fission reaction neutrons.

FUNCTIONAL BLOCKS

- three banks of He-3 tubes (total 18; 2.54 cm diam and 33 cm long)
- AmLi source embeded in a high-density polyethylene body with no cadmium liners.

SPECIFICATIONS

Measurement time	1000 sec
Accuracy	0.6 to 0.9 % for 1000 sec runs (can be 0.1% for longer runs and fixed geometry)
Weight	about 30 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

PANDA, 1991, p. 520

Accounting: Neutron Counter**Glovebox Counter for Pu****85****MODEL:****SUPPLIER:** *Pacific Northwest National Laboratory***USE CATEGORY:** Accounting**DEVICE TYPE:** Neutron Counter**MEASUREMENT METHOD:** Neutron
Passive**MEASURED PROPERTIES:** Effective Isotope Mass**NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:** Holdup**STATUS:** One-of-a-kind**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Laboratory**DEVELOPER:** Pacific Northwest National Laboratory**MANUFACTURER:** Pacific Northwest National Laboratory**DESCRIPTION****PURPOSE***Developed to measure hold-ups in glove boxes and for determining location of hold-up.***PRINCIPLES OF OPERATION****FUNCTIONAL BLOCKS**

- system of lead collimators
- detector developed by Princeton Gamma-Tech.
- stand reaching elevations of 8 meters.

SPECIFICATIONS**SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Neutron Counter

GlovePort Monitor
MODEL: GPM

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SUPPLIER: *Pajarito Scientific Corporation*

USE CATEGORY: Accounting
DEVICE TYPE: Neutron Counter
MEASUREMENT METHOD: Neutron Multiplicity Counting
 Passive
MEASURED PROPERTIES: Effective Isotope Mass
NUCLEAR MATERIAL(S): Pu-238, Pu-240, Pu-242, Cm-244
PHYSICAL FORM(S) OF NM: Waste
STATUS: One-of-a-kind
PORTABILITY: Portable
ENVIRONMENT OF USE: Industrial
DEVELOPER: Pajarito Scientific Corporation
MANUFACTURER: Pajarito Scientific Corporation

DESCRIPTION

PURPOSE

Used for waste and residue packages contained within processing glove boxes.

PRINCIPLES OF OPERATION

Passive neutron measurements. Assays are performed using the passive neutron multiplicity analysis technique. Fully mobile and quickly relocatable between gloveboxes.

FUNCTIONAL BLOCKS

- He-3 counters.

SPECIFICATIONS

Measurement time	10 minutes
Sensitivity	0.1 g total Pu
Accuracy	< 10%
Maximum package size	6.5" diam x 13" height.
Overall size	3' x 3' footprint

SOFTWARE

Data can be stored on disk and printed.

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Neutron Counter**87****Neutron Area Holdup Monitor****MODEL: NAHM****SUPPLIER:** Pajarito Scientific Corporation**USE CATEGORY:** Accounting**DEVICE TYPE:** Neutron Counter**MEASUREMENT METHOD:** Neutron

Passive

MEASURED PROPERTIES: Effective Isotope Mass**NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:** Holdup**STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Pajarito Scientific Corporation**MANUFACTURER:** Pajarito Scientific Corporation**DESCRIPTION****PURPOSE***Performs continuous analysis of plutonium waste and residue buildup in plutonium processing facilities.**Provides criticality safety analysis.***PRINCIPLES OF OPERATION**

Detects neutrons by detectors connected to a Central Processing System. Each detector is a modular aluminum structure housing a single He-3 detector and a single-channel amplifier/discriminator.

FUNCTIONAL BLOCKS

16 neutron detectors:

- He-3 proportional counter
- single-channel amplifier/discriminator

Central Processing System :

- P C,
- video monitor,
- power distribution unit,
- high and low voltage power supplies,
- CAMAC data acquisition electronics.

SPECIFICATIONS

He-3 counter	2" diameter x 36" long, bare or polyethylene wrapped
Measurement time	continuous with user-defined analysis time-slice.
Sensitivity	< 2g for a time-slice on the order of minutes

SOFTWARE

Based on Windows 95 and NT. Can be networked to facility control computer.

ADDITIONAL INFORMATION

Protected against all forms of electrical interference.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Neutron Counter

Packet Assay Monitor
MODEL: PAM

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SUPPLIER: *Pajarito Scientific Corporation*

USE CATEGORY: Accounting

DEVICE TYPE: Neutron Counter

MEASUREMENT METHOD: Neutron Multiplicity Counting
Passive

MEASURED PROPERTIES: Effective Isotope Mass

NUCLEAR MATERIAL(S): Pu-238, Pu-240, Pu-242, Cm-244

PHYSICAL FORM(S) OF NM: Waste

STATUS: One-of-a-kind

PORTABILITY: Portable

ENVIRONMENT OF USE: Industrial

DEVELOPER: Pajarito Scientific Corporation

MANUFACTURER: Pajarito Scientific Corporation

DESCRIPTION

PURPOSE

Designed for plutonium analysis of TRU wastes and residues contained within processing gloveboxes.

PRINCIPLES OF OPERATION

Neutron detection is performed by using He-3 proportional counters. Assays are performed using the passive neutron multiplicity analysis technique. Monitor can be relocated between different gloveboxes.

FUNCTIONAL BLOCKS

SPECIFICATIONS

Cavity dimension 1' x 2' x 2'

SOFTWARE

Menu driven operation from either 3" local control panel or personal computer. Results are shown on the screen, recorded to disk, or printed. Fully automatic operation can be integrated with plant control system.

ADDITIONAL INFORMATION

PAM is protected against all forms of electrical interference.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Neutron Counter

Neutron Coincidence Counter

MODEL: CHC-A01

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SUPPLIER: SPC Aspect

USE CATEGORY: Accounting

DEVICE TYPE: Neutron Counter

MEASUREMENT METHOD: Neutron Coincidence Counting

Active, Passive

MEASURED PROPERTIES: Effective Isotope Mass

NUCLEAR MATERIAL(S): Pu, U-235

PHYSICAL FORM(S) OF NM:

STATUS: One-of-a-kind

PORTABILITY: Stationary

ENVIRONMENT OF USE: Laboratory

DEVELOPER: SPC Aspect

MANUFACTURER: SPC Aspect

DESCRIPTION

PURPOSE

Device is designed to determine U-235 mass in active mode and Pu-239 mass in passive mode. It can be used for NM inspection and control.

PRINCIPLES OF OPERATION

The device has the following operation modes:

- 1) active - with using of two AmLi neutron sources each of 1E+3 n/s intensity;
- 2) passive
 - thermal (with moderator)
 - fast.

Electronics modules are designed as NIM modules and allow analysis of the coincidence rate in the optimized gate.

Setting the parameters and processing the measurement results are performed by IBM PC.

FUNCTIONAL BLOCKS

Delivery set includes:

- 42 proportion He-3 counters;
- moderation block with configuration inserts;
- electronics for data collection and processing;
- program for data processing and exchange with PC;
- operational documentation

SPECIFICATIONS

Measurement time

1000 s

Sensitivity for U-235

thermal mode

no less than 5 g

fast mode with measuring volume of D320 x 530

no less than 200 g

fast mode with measuring volume of D320 x 200

no less than 100 g

Detection efficiency for U-238 fission neutrons

35%

Operation environment

from 10°C to +50°C

Power supply

220 V, 50 Hz

Overall size

1281 x 1215 x 800 mm

Sample cavity size

D 320 mm x 540 mm

Weight

450 kg

Standard interface

RS-232

SOFTWARE

Counter uses the software that allows performance of the measurement result processing.

ADDITIONAL INFORMATION

The device must pass a primary test at the end of the production process, and annual certification.

Life time - 1 year.

Possible delivery time - from 4 to 6 months.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Neutron Generator

Pulse Neutron Generator for Detection of TRU Waste
MODEL: A-210/A-211**90****SUPPLIER:** *MF Physics Corporation***USE CATEGORY:** Accounting**DEVICE TYPE:** Neutron Generator**MEASUREMENT METHOD:** Neutron

Active

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:****ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Sandia National Laboratories**MANUFACTURER:** MF Physics Corporation**DESCRIPTION****PURPOSE***The Model A-210/A-211 neutron generators are designed by SNL and used by LANL and other DOE Laboratories in waste assay applications which are based on thermal neutron decay.***PRINCIPLES OF OPERATION**

The A-210/211 pulsed neutron generator uses a miniature, sealed neutron tube, the "Zetatron," to produce $1E+8$ 14.3 MeV neutrons/s by accelerating a mixed gas beam of deuterium and tritium ions into a mixed deuterium-tritium in titanium target.

Both the accelerating voltage and ion source voltage are pulsed so as to assure that virtually no neutrons are produced between pulses. The pulse width is approximately 10 microseconds and the pulse repetition frequency is adjustable (10, 50, 100 Hz).

The A-210 and A-211 differ only in that the A-210 is insulated with sulfur hexafluoride and the A-211 is insulated with Fluorinert FC-77.

FUNCTIONAL BLOCKS

A-210 system consists of:

- compact, portable accelerator assembly:
 - "Zetatron" neutron generating tube:
 - Penning ion source,
 - gas occlusion filaments,
 - accelerating section
 - tritium impregnated titanium target.
 - high voltage pulse transformer
- control chassis,
- drive chassis
- interconnect cables.
- upgraded version of the SNL developed MA-165 controller.

SPECIFICATIONS

Pulse rates	from 10 Hz to 100 Hz
Nominal neutron outputs	up to $1 E+8$ neutrons/s.
Deterioration	less than 50 % after 300 hours operation (Guaranteed)

SOFTWARE**ADDITIONAL INFORMATION**

MF Physics offers a complete line of neutron generators. Other generators of interest for nuclear materials assay and nuclear safeguards applications are the Model A-325 which is a very versatile machine and is well suited to a number of analytical applications. The Models A-910/920 are specialized instruments for imaging individual elements utilizing the associated particle, time of flight technique. These instruments are particularly useful for analysis and imaging of facilities and devices which are not amenable to inspection by more conventional techniques.

REFERENCES

REFERENCES

E. Rhodes and C.E. Dickerman (ANL), Associated-Particle Sealed-Tube Neutron Probe for Nonintrusive Inspection, 14th International Conference on the Application of Accelerators in Research and Industry, November 6-9, 1996, Denton, Texas, USA

Accounting: Neutron Generator**91****Pulse Neutron Generators**

MODEL: ИНГ-01, ИНГ-03, ИНГ-06, ИНГ-07, ИНГ-08, ИНГ-10, ИНГ-11
SUPPLIER: VNIIA, All-Russian Research Institute of Automatics

USE CATEGORY: Accounting
DEVICE TYPE: Neutron Generator
MEASUREMENT METHOD: Neutron
 Active

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:**

STATUS: Serial Production

PORTABILITY:

ENVIRONMENT OF USE: Industrial

DEVELOPER: VNIIA, All-Russian Research Institute of Automatics

MANUFACTURER: VNIIA, All-Russian Research Institute of Automatics

DESCRIPTION**PURPOSE**

The generators can be used in different NM assay systems, including wastes.

PRINCIPLES OF OPERATION**FUNCTIONAL BLOCKS**

- neutron tube unit:
- commutation unit
- control and power board
- connection cables

SPECIFICATIONS

	MODEL	ИНГ-01	ИНГ-03	ИНГ-06/ИНГ-08	ИНГ-07	ИНГ-10/ИНГ-11
Pulse rates		to 30 Hz	100 Hz	to 10 kGz	20 kHz	to 30 Hz
Neutron yield, n/s		4E+08	1E+10	1E+08	3E+09	1E+08/5E+07
Pulse width, mks		1	0.8	25-125	10-200	1
Operation time until the neutron yield decreases to 0.1 of the original yield, hr		100	500	500	75	
Overall size						
Diameter, mm		62	130	70/34	190	34/27
Length, mm		890	950	1300/2200	440	1240/1500
Operation temperature range, Deg. C		-30+60	-30+40	-30+100	-30+40	-30+120

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Rod Scanner**Active Uranium Fuel-Rod Scanner****92****MODEL:****SUPPLIER:** *Los Alamos National Laboratory***USE CATEGORY:** Accounting**DEVICE TYPE:** Rod Scanner**MEASUREMENT METHOD:** Neutron, Gamma

Active

MEASURED PROPERTIES: Weight**NUCLEAR MATERIAL(S):** U**PHYSICAL FORM(S) OF NM:** Rod (fresh)**STATUS:** Limited Production**PORATABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Los Alamos National Laboratory**DESCRIPTION****PURPOSE***Measurement and quality control of NM of the rod.***PRINCIPLES OF OPERATION**

Rods move past the shielded neutron source and then past a gamma or neutron detector. The induced activity is a measure of the fissile content of the rod at the location being measured.

FUNCTIONAL BLOCKS**SPECIFICATIONS**

Measurement time	30 seconds
Accuracy	better than 1%

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Hastings A. Smith, Jr. (LANL) and Peter Schillebeeckx (ECJRC, Ispra), Nondestructive Assay of Special Nuclear Material for Uranium Fuel-Fabrication Facilities, Tripartite International Conference on MPC&A for Uranium Fuel Fabrication Facilities, IPPE, Obninsk, Russia, April 21-25, 1997

Accounting: Rod Scanner

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Active Fuel Rod Scanning System*MODEL:***SUPPLIER:** National Nuclear Corporation**USE CATEGORY:** Accounting**DEVICE TYPE:** Rod Scanner**MEASUREMENT METHOD:** Neutron, Gamma
Active**MEASURED PROPERTIES:** Element Concentration**NUCLEAR MATERIAL(S):** U**PHYSICAL FORM(S) OF NM:** Fuel rod (fresh)**STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** National Nuclear Corporation**MANUFACTURER:** National Nuclear Corporation**DESCRIPTION****PURPOSE**

The scanner performs measurements on the finished LWR fuel rods such as fuel stack enrichments, length of rod and fuel column, and verification of the plenum composition. It also detects defects in the fuel rod such as enrichment deviant pellets and gaps.

PRINCIPLES OF OPERATION

Utilizes state-of-the art nondestructive active assay techniques. The rod scanner automatically declares the acceptance or rejection of fuel rods based on design tolerances set by the user and stored in database.

FUNCTIONAL BLOCKS

The NNC active scanner hardware consists of a rod transport system, an irradiator, a detector system, an electronics system and data processing and control computer system.

SPECIFICATIONS

Measurement time	9 meters (350 inches) per minute 700 production rods (162 inches long) in eight hours (including calibration - part of daily maintenance procedures.)
Accuracy	1 % for >2% enrichment 1.5% for <2% enrichment

SOFTWARE

NNC application programs are included.

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Rod Scanner**Passive Fuel Rod Scanning System****94****MODEL:****SUPPLIER:** *National Nuclear Corporation***USE CATEGORY:** Accounting**DEVICE TYPE:** Rod Scanner**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):** U, Pu**PHYSICAL FORM(S) OF NM:** Fuel Rod (fresh)**STATUS:** Limited Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** National Nuclear Corporation**MANUFACTURER:** National Nuclear Corporation**DESCRIPTION****PURPOSE**

The scanner performs various real-time measurements on the finished PWR and BWR fuel rods including fuel stack enrichments, length of rod and fuel column, and optionally the Gadolinium content. It also detects defects in the fuel rod such as enrichment deviant pellets, gaps and Gadolinium deviation (optionally).

PRINCIPLES OF OPERATION

Utilizes state-of-the art nondestructive passive assay techniques. The rod scanner automatically declares the acceptance or rejection of fuel rods based on design tolerances set by the user and stored in a database.

FUNCTIONAL BLOCKS

The scanner hardware consists of a rod transport system, a densitometer, an enrichment detector, a Gadolinium detector (option), an electronics subsystem and data processing and control computer system.

SPECIFICATIONS**SOFTWARE**

NNC application programs are included

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Rod Scanner**95****Scanner****MODEL:**

SUPPLIER: *SSC IPPE, State Scientific Center of Russian Federation, Institute of Physics and Power Engineering*

USE CATEGORY: Accounting

DEVICE TYPE: Rod Scanner

MEASUREMENT METHOD: Item Counting, Gamma
Passive

MEASURED PROPERTIES: Number of Items, NM type

NUCLEAR MATERIAL(S): Pu, U

PHYSICAL FORM(S) OF NM:

STATUS: One-of-a-kind

PORTABILITY: Stationary

ENVIRONMENT OF USE: Industrial

DEVELOPER: SSC IPPE, State Scientific Center of Russian Federation, Institute of Physics and Power Engineering

MANUFACTURER: SSC IPPE, State Scientific Center of Russian Federation, Institute of Physics and Power Engineering

DESCRIPTION**PURPOSE**

Conducting physical inventory; the device determines the number of pellets with NM and the type of NM in a fuel rod without disassembling it.

PRINCIPLES OF OPERATION

Operator takes out a pre-selected fuel rod from the active zone with a manipulator using the coordinate data and places it exactly over the detection unit. After the scan is complete, the fuel rod is returned to its location. Operating personnel don't make physical contact with fuel rods during the FM identification.

Besides scanning, the device can determine three types of NM: plutonium, and uranium of two enrichments - 36% and 90% (of U-235).

FUNCTIONAL BLOCKS

- Detection unit (БДЭГ-20Р1) in the Pb enclosure:
 - mechanism for setting a distance of a fuel rod relatively to detector;
 - collimating block;
- Electronics block for data acquisition and processing (including PC);
- Scanning mechanism (manipulator BFS).

SPECIFICATIONS

Min. speed of fuel tube passing
through the detector collimator

17 mm/sec

Identification time

less than 1 min for all rod pellets
with an active zone length of 1 m

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Software**96****Gamma Waste Assay Software**
MODEL: GWAS**SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Software**MEASUREMENT METHOD:** Gamma**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:** Waste**STATUS:** Serial Production**PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** Canberra Industries, Inc.**MANUFACTURER:** Canberra Industries, Inc.**DESCRIPTION****PURPOSE**

The Gamma Waste Assay Software (GWAS) is used with all Canberra gamma waste assay systems and the menus share a common look and feel with other Canberra Systems products.

PRINCIPLES OF OPERATION

All Genie-PC analysis engines can be used in this package. It features a relational database to track sample information, datafile locations, and key analysis results. It comes with an extensive QA package for ensuring good measurement control and includes trending with warning setpoints for investigation and action, control charting, etc. The software includes customer editable report template files to permit customization. The Genie-PC MCA view window is available at all times and it has multiple matrix corrections algorithms. Optional non-uniformity correction routines are available.

FUNCTIONAL BLOCKS**SPECIFICATIONS****SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Software**97****Gamma-Ray Spectrum Analysis Code for Determining Plutonium Isotopic Abundances****MODEL: MGA****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Software**MEASUREMENT METHOD:** Gamma**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** Lawrence Livermore National Laboratory**MANUFACTURER:** *Canberra Industries, Inc.***DESCRIPTION****PURPOSE**

MGA (Multi-Group Analysis) code is used with systems based on germanium detectors to accurately determine the relative abundances of various actinide isotopes in any size and type of plutonium sample (metal, oxide, solution).

PRINCIPLES OF OPERATION

The Multi-Group Analysis (MGA) software determines relative plutonium isotopic abundances in nondestructive assay applications and determines the relative amounts of other non-plutonium actinides. It incorporates a sophisticated peak fitting and multiplet deconvolution algorithm to improve the accuracy in samples with complex isotope mixtures. It requires no efficiency calibration for matrix density, thickness or container characteristics. It operates in either one or two detector modes. In addition to the primary application of measuring Pu isotopes, MGA can be used to determine other actinides such as U-235, U-238, Np-237 and Am-241. In the single detector mode, MGA uses information from several regions of the energy spectrum that lie within an energy range of approximately 0-300 keV or in the high energy only mode from 0-1000 keV. In the two detector mode, MGA uses information from the low energy spectrum which has a range of about 0-1000 keV. The primary analysis in the low energy only and two detector modes is performed using the multiplet region at 94-104 keV. This region is a very complex multiplet, consisting of gamma ray peaks from plutonium and its progeny as well as numerous x-rays. But it is in this region where the most intense gamma ray emissions occur, thus providing the best possible detection sensitivity. MGA also uses the characteristic plutonium lines at 129 keV and 208 keV which must also be present. To be able to unfold this complex multiplet region, MGA automatically adjusts the energy and peak shape calibration for each spectrum using peaks that are characteristic of all plutonium samples; 59keV, 129keV, and 208keV. To take into account the physical processes that affect the observable gamma ray intensities at different energies, such as the detector efficiency as a function of energy, and gamma ray attenuation in absorbing materials between the sample and the detector as well as within the plutonium sample itself, MGA internally develops an intrinsic efficiency curve by evaluating 10 peaks from three isotopes. Most common applications can be accommodated with a single detector. The Canberra LEGe is the detector of choice in such cases due to its exceptional low energy peak shape and resolution characteristics over a wide range of count rates. Such a high performance detector is recommended for optimum performance with MGA. In some applications, particularly those involving thick or dense container walls, the high energy spectrum collected with a typical coaxial detector is recommended to supplement the low energy MGA spectrum. In some cases the high energy only mode is recommended. In this case, in addition to the normal low energy spectrum peak regions, three high energy regions are examined and evaluated. While this results in a more complex system implementation, Canberra systems designed around this technique can still be operated by routine operating personnel.

FUNCTIONAL BLOCKS**SPECIFICATIONS**

Measurement time

several minutes

Accuracy

<1%

SOFTWARE

SOFTWARE

Canberra MGA is available in DOS, VMS, OS/2, W3, Windows 95/NT. The software can be used directly with Canberra's Neutron Assay Software (NAS).

ADDITIONAL INFORMATION

Canberra MGA was developed by LLNL and Canberra.

REFERENCES

R. Gunnink, MGA: Gamma-Ray Spectrum Analysis Code for Determining Plutonium Isotopic Abundances, Vol. 1 and 2, UCRL-LR-103220, LLNL, April 3, 1990.

Accounting: Software**98****Genie-2000 Series****MODEL:****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Software**MEASUREMENT METHOD:** Gamma**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** *Canberra Industries, Inc.***MANUFACTURER:** *Canberra Industries, Inc.***DESCRIPTION****PURPOSE**

Genie-PC is a comprehensive software package for data acquisition and spectrum analysis using personal computers. It provides independent support for multiple detectors, extensive networking capabilities and a wide range of optional capabilities for specific applications. Acquisition and analysis capabilities are fully integrated into the two graphical user interface environments - an interactive mode for knowledgeable spectroscopist and a batch mode for routine, repetitive counting operations.

PRINCIPLES OF OPERATION

The Genie-PC software supports all Canberra PC based multi-channel analyzers, plus several of the hardwired stand-alone analyzers. Genie-PC has been designed such that MCAs physically connected to one PC can be accessed via a network from another PC.

The layered software analysis options are:

S401C Gamma Analysis Option which provides efficiency correction, nuclide identification, activity calculation, automatic interference corrections and MDA calculations;

S409C Alpha Analysis Options which provide a special peak search and analysis capabilities optimized for the unique characteristics of alpha spectra. It also provides for tracer and tracerless activity analysis and reagent corrections;

S406C Interactive Peak Fit provides the ability to graphically view peak search results and the quality of peak fit. It also provides the ability to modify fit parameters, add or delete peaks, modify ROI limits and make other adjustments to peak analysis interactively;

S407C Multi-Group Analysis for Uranium is a special program developed to calculate uranium enrichment from a wide variety of samples without the necessity of a prior efficiency calibration;

S408C Multi-Group Analysis is a special program developed to calculate plutonium isotopic concentrations from a wide variety of samples without the necessity of a prior efficiency calibration. The Canberra version of MGA is optimized for successful analysis of the difficult spectra associated with plutonium bearing waste and other low level applications;

S405C Quality Assurance Software provides the ability to track any system performance parameters over time (typically detector FWHM and peak position, backgrounds and nuclide activities). It also provides a set of statistical tests to identify system problems.

The application options are :

S403C PROcount-PC Counting Procedures Software which is designed to provide the operator of a standard gamma spectroscopy system with a proceduralized user interface oriented to non-spectroscopist operators. Straightforward procedures are provided for sample counting, calibration and background counting, quality assurance and system maintenance;

S470C Alpha Analyst Counting Procedures Software provides a standard set of counting procedures for the operator of an alpha spectroscopy system. Straightforward, technician oriented procedures are provided for sample counting technician oriented procedures are provided for sample counting, calibration, background

subtraction and quality control. It is intended to complement the Alpha Analyst integrated alpha spectroscopy system, but also operates in conjunction with traditional manual spectrometers; S435C Uranium Plutonium InSpector Software combines the capabilities of MGA and MGAU (listed above) into a simple, proceduralized user interface for the application; S473C In Situ Object Calibration Software (ISOCS) develops calibrations for large or unusual sample geometries without calibration sources. It requires characterization of the detector by Canberra.

FUNCTIONAL BLOCKS**SPECIFICATIONS****SOFTWARE****ADDITIONAL INFORMATION**

The minimum computer requirements are: 486 Processor with 66 MHZ clock speed (Pentium is recommended), 20 MB of memory, OS/2 operating system, and 500 MB of hard disk capacity. The software is available in Windows 95.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Software**Multi-Group Uranium Analysis Software****MODEL: MGA-U****99****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Software**MEASUREMENT METHOD:** Gamma**MEASURED PROPERTIES:** Isotopic Composition**NUCLEAR MATERIAL(S):** Uranium: from depleted to HEU**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** Dr. I.R. Gunnink, consultant**MANUFACTURER:** *Canberra Industries, Inc.***DESCRIPTION****PURPOSE**

Multi-Group Analysis for Uranium (MGA-U) software is integrated into Canberra waste and safeguards instruments to perform a sophisticated analysis with minimal operator interaction.

PRINCIPLES OF OPERATION

The Multi-Group Analysis for Uranium (MGA-U) determines uranium enrichment in non-destructive assay applications and uses sophisticated peak fitting and multiplet deconvolution to provide analysis results. In the normal mode, it requires no efficiency calibration for matrix density, matrix type, or container characteristics. In the enrichment meter mode, it does require one calibration measurement with known container characteristics.

In the normal mode, MGA-U uses information from either two or three regions of the energy spectrum, depending on the specific application. For most applications, two regions that lie within an energy range of approximately 0-300 keV are used. The primary enrichment information is derived from the U-235 and U-238 gamma peaks in the 88 - 100 keV energy range. Additionally, the K-beta region is used to develop a local intrinsic efficiency curve - to establish the detector efficiency as a function of energy, the amount of attenuation caused by the sample container and the amount of self-absorption in the uranium material itself. The process eliminates the need for an efficiency calibration prior to making sample measurements.

In the enrichment meter mode, MGA-U requires one calibration measurement with a standard of known enrichment and known container wall thickness. The results of this calibration measurement are automatically stored for further use on any samples with known container wall thicknesses. The enrichment meter mode is useful for very thick container walls where the normal mode may not have enough data to provide good results or for freshly processed samples.

The Canberra LEGe is the detector of choice for MGA-U work due to its exceptional low energy peak shape and resolution characteristics over a wide range of count rates. Such a high performance detector is recommended as MGA-U is dealing with regions of the spectrum where very complex gamma/x-ray multiplets are encountered.

FUNCTIONAL BLOCKS**SPECIFICATIONS**

Assay time	up to one hour to get reasonable statistics
Accuracy	from 1 to 2%

SOFTWARE**ADDITIONAL INFORMATION**

Spectra collected with HpGe detectors which are optimized for high resolution at low energies are recommended.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Software**Analysis Software for Isotopic Ratios of Plutonium****MODEL: MGA****100****SUPPLIER: EG&G Instruments, Inc. ORTEC****USE CATEGORY:** Accounting**DEVICE TYPE:** Software**MEASUREMENT METHOD:** Gamma**MEASURED PROPERTIES:** Isotopic Composition**NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** Lawrence Livermore National Laboratory**MANUFACTURER:** EG&G Instruments, Inc. ORTEC**DESCRIPTION****PURPOSE**

The Multi-Group Analysis (MGA) code analyzes plutonium gamma-ray spectra to determine isotopic ratios of plutonium and other actinides in arbitrary samples. Samples may vary in size (milligram to kilogram quantities), isotopic and chemical composition, and age since chemical purification and removal of Am241.

PRINCIPLES OF OPERATION

MGA uses the most intense gamma-ray peaks in a plutonium spectrum, for example, the 94- to 104- keV peaks. Although the 94- to 104-keV region is complex and difficult to analyze, it can provide measurement precisions of 1 % or better and reduce measurement times to only a few minutes. MGA also analyzes peaks from U235, U238, Np237, Am243-Np239, and fission products, whose relative abundances may also be determined.

FUNCTIONAL BLOCKS

- detector
- data acquisition hardware

SPECIFICATIONS

Measurement range	10 mg to many kg
Measurement time	10 min
Accuracy	0.1 % to 2 %
Bias	less than 1 %

SOFTWARE

Designed to analyze plutonium gamma-ray spectra from high-resolution germanium detectors

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Software

Analyzer for Isotopic Ratios of Plutonium or Uranium

MODEL: PC/FRAM

SUPPLIER: EG&G Instruments, Inc. ORTEC

USE CATEGORY: Accounting

DEVICE TYPE: Software

MEASUREMENT METHOD: Gamma

MEASURED PROPERTIES: Isotopic Composition

NUCLEAR MATERIAL(S): Pu, U

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY:

ENVIRONMENT OF USE:

DEVELOPER: Los Alamos National Laboratory

MANUFACTURER: EG&G Instruments, Inc. ORTEC

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DESCRIPTION

PURPOSE

For information see "Pu-238 Isotopic Analysis System" by LANL in this catalog.

PRINCIPLES OF OPERATION

FUNCTIONAL BLOCKS

SPECIFICATIONS

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Software**Analyzer for Isotopic Ratios of Uranium or Waste****MODEL: ISOTOPIC****102****SUPPLIER: EG&G Instruments, Inc. ORTEC****USE CATEGORY:** Accounting**DEVICE TYPE:** Software**MEASUREMENT METHOD:** Gamma**MEASURED PROPERTIES:** Isotopic Composition**NUCLEAR MATERIAL(S):** U**PHYSICAL FORM(S) OF NM:** Waste**STATUS:****PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** Oak Ridge National Laboratory**MANUFACTURER:** EG&G Instruments, Inc. ORTEC**DESCRIPTION****PURPOSE**

ISOTOPIC operates in conjunction with EG&G ORTEC GammaVision to analyze a wide variety of samples in different matrices and geometries. In addition to being able to analyze general gamma-emitting waste samples, ISOTOPIC can also determine Uranium enrichment.

PRINCIPLES OF OPERATION

The program uses co-ax geometry and analyzes a wide range of samples and sample shapes. It has an analysis engine only; GammaVision software is used for hardware control and spectrum storage.

FUNCTIONAL BLOCKS**SPECIFICATIONS****SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Software**103****Analyzer for Uranium Enrichment****MODEL: EMETER****SUPPLIER:** *EG&G Instruments, Inc. ORTEC***USE CATEGORY:** Accounting**DEVICE TYPE:** Software**MEASUREMENT METHOD:** Gamma**MEASURED PROPERTIES:** Isotopic Composition**NUCLEAR MATERIAL(S):** U**PHYSICAL FORM(S) OF NM:****STATUS:****PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** Brookhaven National Laboratory**MANUFACTURER:** EG&G Instruments, Inc. ORTEC**DESCRIPTION****PURPOSE***EMETER is a program for measuring the enrichment of uranium samples using NaI detectors.***PRINCIPLES OF OPERATION**

The program controls the spectrum collection and analyzes it. The program was written at ORTEC based on prior work at IAEA and Brookhaven National Laboratory (BNL). The ORTEC version uses the DART-portable MCA. The measurements are performed on samples of arbitrary size, geometry, and physical and chemical composition, the only requirement being that the sample is "thick" to gamma rays from uranium (185 keV). The energy calibration is automatic (based on Am-doped NaI detectors). EMETER uses a single NaI detector.

FUNCTIONAL BLOCKS**SPECIFICATIONS****SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Software**HMS-III Holdup Software****MODEL: HMS-III holdup software****SUPPLIER: EG&G Instruments, Inc. ORTEC****USE CATEGORY:** Accounting**DEVICE TYPE:** Software**MEASUREMENT METHOD:** Gamma**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** Lockheed Martin Energy Systems Y-12 Plant**MANUFACTURER:** EG&G Instruments, Inc. ORTEC**104****DESCRIPTION****PURPOSE**

HMS-III performs and documents the holdup measurements using algorithms developed at Los Alamos National Laboratory, which provide the basis of the Holdup Assay course taught at LANL, as a part of the US DOE Safeguards Technology Program.

PRINCIPLES OF OPERATION

HMS-III operates under Windows 95 and supports a variety of MCA hardware, including the EG&G ORTEC microNOMAD and DART MCA's and the LANL M3CA.

FUNCTIONAL BLOCKS**SPECIFICATIONS****SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

S.E.Smith, K.A.Thompson and R.N.Ceo. Holdup Measurement System 3 (HMS3) user's guide", LMES report Y/DK-1104, November, 1996.

Accounting: Software**NaI Analysis Software****MODEL: ScintiVision A35-B32****SUPPLIER:** EG&G Instruments, Inc. ORTEC**USE CATEGORY:** Accounting**DEVICE TYPE:** Software**MEASUREMENT METHOD:** Gamma**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORATABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** EG&G Instruments, Inc. ORTEC**MANUFACTURER:** EG&G Instruments, Inc. ORTEC**105****DESCRIPTION****PURPOSE**

ScintiVision is a fully functional MCA Emulator and quantitative analysis software package, written specifically for analysis of gamma spectra from NaI detectors, and supports the EG&G ORTEC MCA hardware. It performs quantitative and qualitative analysis in real time with user-selective settings. ScintiVision is a 32-bit application for operation under Windows 95 or NT.

PRINCIPLES OF OPERATION**FUNCTIONAL BLOCKS****SPECIFICATIONS****SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Software

Nuclide Navigator
MODEL:

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SUPPLIER: *EG&G Instruments, Inc. ORTEC*

USE CATEGORY: Accounting

DEVICE TYPE: Software

MEASUREMENT METHOD:

MEASURED PROPERTIES:

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY:

ENVIRONMENT OF USE:

DEVELOPER: Pacific Northwest National Laboratory

MANUFACTURER: EG&G Instruments, Inc. ORTEC

DESCRIPTION

PURPOSE

An interactive Windows program to view, query, and extract gamma- and alpha and beta-ray radionuclide data. Analysis libraries may easily be built from the certified databases included.

PRINCIPLES OF OPERATION

The Segre chart can be scrolled in any direction or a specific nuclide can be accessed directly by entering its chemical symbol. Multiple database search constraints, based on sample origin (e.g., thermal neutron activation, fission product, or naturally-occurring isotope), may be employed for speedy and accurate gamma ray identification. Input and output data may be written in Microsoft Access format. Nuclear Navigator is totally compatible with any gamma analysis software.

FUNCTIONAL BLOCKS

- instant-access code
- on-line Nuclide Database Manager
- complete "Erdtmann and Soyka" nuclide database

SPECIFICATIONS

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Software**107*****Program ISOTOPIC******MODEL: ISO-BI V1.0*****SUPPLIER:** *EG&G Instruments, Inc. ORTEC***USE CATEGORY:** Accounting**DEVICE TYPE:** Software**MEASUREMENT METHOD:** Gamma**MEASURED PROPERTIES:** Isotopic Composition**NUCLEAR MATERIAL(S):** U**PHYSICAL FORM(S) OF NM:** Waste, Holdup**STATUS:** Serial Production**PORATABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** Lockheed Martin K-25 Facility**MANUFACTURER:** EG&G Instruments, Inc. ORTEC**DESCRIPTION****PURPOSE**

The Program ISOTOPIC is used for analyzing poorly characterized material such as found in nuclear facility waste streams or in "holdup" measurements of special nuclear material: using only a single point source, it can generate any needed calibration for a HPGe detector, accounting for geometry, container wall thickness, and matrix absorption.

PRINCIPLES OF OPERATION

Isotopic reads a peak report generated by GammaVision and then continues the analysis. The user selects the measurement: point, box, or cylinder; enters the dimensions, thickness, and material of the container along with the predominate matrix material.

Using the peak list and the input data, a plot is generated that shows the percentage difference (in energy order) between the corrected measured activity and the activity calculated for the "reference peak" for that nuclide. (The user chooses the reference peak.) If uranium is present, "AUTO slope" can calculate the effects of the container and matrix by fitting the U-238 lines to a zero slope. The user then guides the analysis interactively - adjusting the container, matrix, and weight fraction of uranium to refine the results further.

Homogeneous and inhomogeneous samples may be analyzed by this method. (A good indication of a container with an inhomogeneous distribution of materials may be the fact that the user can obtain a combination of parameters which render the activity plot flat for some but not all nuclides.) When the fine tuning is finished, the user may select a report for each isotope showing the activity and weight. These results can then be printed and/or archived, with the file written in either of two different formats: a database summary or a complete report showing all input and correction information. This information provides the starting point for the next container, thereby minimizing input entry.

Either English or metric units may be used and reported. The only reference standard needed is a point source. Monte-Carlo detector characterizations are not needed. Different detectors may be substituted by simply remaking the point source calibration: if a detector must be replaced, no time or money is lost, remaking Monte Carlo measurements.

FUNCTIONAL BLOCKS**SPECIFICATIONS****SOFTWARE****ADDITIONAL INFORMATION**

ISOTOPIC can be run on any PC operating under Windows 3.x or Windows 95, which is currently running GammaVision (A66-B1 V2.4 or later) or GammaVision-32 (A66-B32 V4.0 or later).

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Software**Spectroscopy Software for Germanium Detector Gamma-Ray Analysis****108****MODEL: GammaVision-32****SUPPLIER: EG&G Instruments, Inc. ORTEC****USE CATEGORY:** Accounting**DEVICE TYPE:** Software**MEASUREMENT METHOD:****MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** EG&G Instruments, Inc. ORTEC**MANUFACTURER:** EG&G Instruments, Inc. ORTEC**DESCRIPTION****PURPOSE**

GammaVision is an integrated product providing acquisition control, spectral display and quantitative analysis of data acquired on ORTEC MCA hardware from a HPGe detector. It is a full 32-bit Windows application, operating under Windows 95 or Windows NT.

PRINCIPLES OF OPERATION

The GammaVision Quantitative Analysis has an automatic total analysis mode, which allows launching an analysis and then proceeding to your next task; interactive analysis modes allow reanalyzing part or all of the spectrum, with visual inspection of deconvolution results; a suspected nuclides feature marks the most likely candidate for peaks found in the spectrum, but not in the library; simultaneous library and peak search directed analysis for the lowest possible detection limits; deconvolution of up to 22 components within a single multiplet is done with automatically chosen background-fitting technique, chosen from straight line, stepped, and parabolic functions. The program provides interactive graphically displayed calibration with single function efficiency curve fitting and peaked background correction. 15 MDA methodologies can be chosen for specific regulatory adherence.

Both library-directed and Mariscotti peak finders are used to locate and quantize the spectrum peaks. The library-directed method gives the most accurate peak areas in low level spectra and in complicated spectra. The Mariscotti method locates all the other peaks in the spectrum -- ensuring that no peaks are ignored in the analysis report.

All peaks ultimately used for the calculation of activity are validated by passing a user-set sensitivity criterion, passing a shape test to determine if interference is present, and passing a test to make sure that the centroid matches the library energy. Valid peaks have their activities rolled into a running, weighted average to produce reported activities of the best precision available. Invalid peaks are disqualified from activity calculation and are reported along with an explanation for their disqualification. Built in geometry correction and materials absorption data are included, along with QA according to ANSI N13.30 and a configurable report writer.

FUNCTIONAL BLOCKS**SPECIFICATIONS****SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Software**Spectroscopy Software with CONNECTIONS****109****MODEL:****SUPPLIER:** *EG&G Instruments, Inc. ORTEC***USE CATEGORY:** Accounting**DEVICE TYPE:** Software**MEASUREMENT METHOD:****MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** EG&G Instruments, Inc. ORTEC**MANUFACTURER:** EG&G Instruments, Inc. ORTEC**DESCRIPTION****PURPOSE**

CONNECTIONS is the ORTEC architecture for spectroscopy systems in the Windows/NT environment. CONNECTIONS provides support for different configurations, from a standalone PC workstation and single spectrometer to a full network configuration.

PRINCIPLES OF OPERATION

CONNECTIONS has system-wide detector access and control from any workstation and detector-locking password security. It has live spectral display from remote detectors and multiple, simultaneous access to detector data. This device has direct connect of DSPEC TM, 92X-II, OCTETE PC TM, and 921 MCBs via integral Ethernet adapter, and ORSIM II for easy interfacing of MCBs without integral Ethernet.

AUTOMATIC system configuration can be easily added to existing installations and there is an identical user interface for local and remote detectors. CONNECTIONS capabilities are built into all current versions of EG&G ORTEC Applications software, including MAESTRO TM, GammaVision TM, ScintilVision, AlphaVision TM, Renaissance TM, PC/FRAM, and MGA++.

CONNECTIONS-32 products provide smoother operation with truly preemptive multitasking and a Class C2 system security under Windows NT 4.0.

FUNCTIONAL BLOCKS**SPECIFICATIONS****SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Software

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CZTU SoftwareMODEL:**SUPPLIER:** Lawrence Livermore National Laboratory**USE CATEGORY:** Accounting**DEVICE TYPE:** Software**MEASUREMENT METHOD:****MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):** LEU, HEU**PHYSICAL FORM(S) OF NM:****STATUS:** Prototype**PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** Lawrence Livermore National Laboratory**MANUFACTURER:** Lawrence Livermore National Laboratory**DESCRIPTION****PURPOSE**

Uranium enrichment analysis program: covers range of 88-100 KeV. Spectrum type: Cadmium-Zinc-Telluride. Can be used with ORTEC and CANBERRA instrumentation; can use data in ASCII format.

PRINCIPLES OF OPERATION

Cadmium -zinc-telluride (CdZnTe) detectors with energy resolution performance reaching 2.0% at 122 keV may complement HPGe detectors for certain safeguards measurements where portable or unattended measurement equipment is needed.

CZTU Software has been developed especially for the CdZnTe detector spectra process to determine U235 enrichments. This software uses the main idea of the algorithm developed before for the same goal for HPGe (with energy resolution performance reaching 0.5% at 122 keV) detector spectrum [2]. The idea consists of analyzing the gamma- and X-ray peaks in the 88- to 100-keV region of uranium spectrum where U235 and U238 photon emissions are located and detected with comparable efficiencies. This analysis approach eliminates the need for calibration and allows U235 enrichment measurements in arbitrary samples. This region of uranium spectrum has a complex structure with closely overlapping peaks. In the case of CdZnTe detector spectra there is a stronger overlapping of peaks which leads to difficulties in spectra fitting. To overcome these difficulties, the algorithms of the CZTU software use a "response function" method that allows peaks belonging to a given isotopic component to have their energies and heights to be fixed relative to each other in the fitting spectra process. It also fixes other peak parameters which describe the low-energy exponential tail in the models of gamma- and X-ray peaks. These parameters are predetermined from other isolated peaks in the spectrum. This algorithm provides accuracies on the order of 10% on U235 enrichments from 3% to 50% using CdZnTe detectors.

FUNCTIONAL BLOCKS**SPECIFICATIONS**

Accuracy about 10% known value

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

1. W.D. Ruhter and R. Gunnink, Application of Cadmium-Zinc-Telluride Detectors in U-235 Enrichment Measurements, Nuclear Instruments & Methods in Physics Research, Section 353, pp. 716-718, 1994
2. R. Gunnink, W.D. Ruhter, P. Miller et al., MGAU: A New Analysis Code for Measuring U-235 Enrichments in Arbitrary Samples, Lawrence National Laboratory, UCRL-JC-114713 (1994).

Accounting: Software**Plutonium Gamma-Ray Measurement Program****111****MODEL: Pu600****SUPPLIER: Lawrence Livermore National Laboratory****USE CATEGORY:** Accounting**DEVICE TYPE:** Software**MEASUREMENT METHOD:****MEASURED PROPERTIES:** Isotopic Composition**NUCLEAR MATERIAL(S):** Plutonium**PHYSICAL FORM(S) OF NM:****STATUS:****PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** Lawrence Livermore National Laboratory**MANUFACTURER:** Lawrence Livermore National Laboratory**DESCRIPTION****PURPOSE**

The program is designed for instrument control and analysis to calculate Pu-240/Pu-239 ratio consistent with weapons-grade material.

PRINCIPLES OF OPERATION

The battery-operated gamma-ray spectrometer was assembled from commercially available equipment: portable, N-type, coaxial, high-purity germanium gamma-ray detector of 50% efficiency and a multi-channel analyzer with an integral amplifier and bias supply. The analyzer is controlled by a notebook computer running OS-2 operating system.

The code analyzes only 630- to 670-keV energy region of a high-purity germanium detector spectrum. From the analysis, the code calculates the Pu240/Pu239 isotopic ratio and a lower-bound estimate of total Pu239 in the sample. Pu600 makes numerous validity checks on the spectral data and statistical checks on the analysis process.

Isotopic ratios are derived from a ratio of peaks: the 642.48 keV peak from Pu240 and 645.969-keV peak from Pu239. The 658.929-keV peak used to determine the lower-bounder estimate of total Pu239. To compute these peak areas, Pu600 performs a response-function analysis of entire energy region between 630 and 670 keV. Local energy calibration is performed using the 619.00-keV and 662.42-keV peaks from Am241 as part of the response-function analysis.

Before the peaks can be analyzed, the underlying continuum has to be determined and removed.

To correctly calculate the individual peak areas requires a rigorous technique for unfolding the overlapping peaks. The code technique uses the peak model, which consists of a Gaussian component with two tailing terms on the low-energy side of the peak.

A fit of the peak group models to the data is accomplished by nonlinear minimization of weighted residual sum of squares. The isotopic contributions and mass estimate are derived from the fitting coefficients.

FUNCTIONAL BLOCKS**SPECIFICATIONS****Energy band:** 630-670 keV**SOFTWARE****ADDITIONAL INFORMATION****PC OS-2 implementation****REFERENCES**

Z.M. Koenig, J.B. Carlson, D. Clark, and T. B. Gosnell, Plutonium Gamma-Ray Measurements for Mutual Reciprocal Inspections of Dismantled Nuclear Weapons, INMM 36th Annual Meeting, Palm Desert, CA, July 9-12, 1995, UCRL-JC-121105. (D. Clark is the author of the programm support for the CZT Probe.)

Accounting: Software**Uranium Analysis Software (U235)****112****MODEL:****SUPPLIER:** *Lawrence Livermore National Laboratory***USE CATEGORY:** Accounting**DEVICE TYPE:** Software**MEASUREMENT METHOD:****MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:****PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** Lawrence Livermore National Laboratory**MANUFACTURER:** Lawrence Livermore National Laboratory**DESCRIPTION****PURPOSE***Evaluation of the percentage of U234, U235, U236 and U238 in a uranium sample from analysis of emitted gamma rays.***PRINCIPLES OF OPERATION**

Uranium Analysis Code (UAC) can non-destructively evaluate the percentage of U234, U235, U236 and U238 in a uranium sample from analysis of emitted gamma rays. Typical analyzer settings are 4096 channels with the gain set at 0.75 eV/channel. Typical counting times are 1-3 hours at 10-20 % deadtime or till roughly 2.10E+7 total counts are obtained.

Analyzer gain and zero are obtained by calibrating U-Ka1 peak (98.434 keV) and U235 peak (185.715 keV). Peak shape data, used to fit the peaks, are obtained from the 185.715 keV peak and peaks from 85-102 data region.

The U235 and U238 concentration are found by analyzing and least square fitting the 23 gamma and x-rays between 86 and 102 keV. Absorbers between the source and the detector have to be thin enough to allow these energy photons into the detector. Counting data are corrected for detector efficiency and source attenuation by utilizing the observed U-Ka1/U-Kb1 intensity ratio at 98.434 and 111.300 keV respectively. One of the limitations on using this photon energy range for isotopic analysis are that at both high (>95 %) and low (<0.5 %) U235 concentrations the signals of either the U235 peaks or the U238 peaks get too small to be accurately determined.

The U234 concentration is found from the measured 120.9 keV and 53.2 keV intensities after making attenuation and transmission corrections. The intensity at 120.9 keV peak has to be corrected for the U-K-edge at 115.6 keV.

The U236 concentration is found from the intensity of the 49.37 keV line making attenuation and transmission corrections.

FUNCTIONAL BLOCKS

HPGe detector and supporting electronics

SPECIFICATIONS**SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Software**Gamma-Ray Spectrum Analysis Code****MODEL: AnGamma.exe****113****SUPPLIER: SPC Aspect****USE CATEGORY:** Accounting**DEVICE TYPE:** Software**MEASUREMENT METHOD:** Gamma**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** SPC Aspect**MANUFACTURER:** SPC Aspect**DESCRIPTION****PURPOSE**

- Quantitative and qualitative analyzes;
- Control the analyzer and the spectrum collection parameters;
- Calibrate by energy, half width and efficiency;
- Calculate the activities and errors;
- Provide the user's graphical interface.

PRINCIPLES OF OPERATION

The code performs rapid quantitative and qualitative gamma spectra analysis of the known radionuclide content. The code runs in the user-friendly interactive mode through menu and windows. Either keyboard or "mouse" can be used.

A spectrum for processing can be read from the ADC or disc. A detailed set of scaling functions is provided for the spectrum observation. Information about the sample parameters is provided for each spectrum. This information is saved together with the spectrum when it is recorded on a disc.

The code includes the system calibration procedures. The energy and half width calibrations are fitted to a polynomial of order up to 3. The calibration points can be set manually by using the marker position or automatically (for the half-width calibration) on the last full-energy peak search results. The calibration of the efficiency can be performed using the calibration curves recommended by VNIINM (Bochvar Institute, Moscow, RF) or polynomial of order up to 5. The code can perform the calibration using several different spectra. In such case the calibration points obtained from the previous spectrum are saved together with the new points and used in the calculations. The calibration quality can be monitored visually on the curve plot.

The algorithm of the automatic peak search finds peaks whose statistical significance exceeds the user-defined limit. The algorithm excludes the Compton and false peaks. The user can mark or eliminate peaks manually. Background peak areas can be subtracted. To identify the nuclides the energy calibration and the nuclide library are used. The user can set the identification criteria. The nuclide activities are calculated by the method of least squares, assigning mutual contributions of the different nuclides to the unresolved peaks.

The activity errors are estimated for each nuclide. The activity values can be normalized to the sample weight or volume. The units of the activity are set by the user. The code provides correction for decay during the sample cooling time.

Based on the analysis results the code creates a report which consists of: the table of the peaks found, the table of the identified lines and the table of the nuclide activities. The table and report formats can be set by the user. The report can be displayed, printed or saved in the file. The spectrum graph can be printed with the designation of peaks found. The code allows one to create, enter (from a disc), save (on a disc) and edit the nuclide library in a suitable user interactive mode.

The code requires memory of 640K, a flexible or hard disk, the EGA, and VGA graphical adapter.

FUNCTIONAL BLOCKS

SPECIFICATIONS

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Software**PROGRESS-Gamma (SCD) Software**
MODEL:**114****SUPPLIER:** VNIIFTRI, SPA DOZA**USE CATEGORY:** Accounting**DEVICE TYPE:** Software**MEASUREMENT METHOD:** Gamma**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:****PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** VNIIFTRI, SPA DOZA**MANUFACTURER:** VNIIFTRI, SPA DOZA**DESCRIPTION****PURPOSE**

Control of the gamma-spectrometric channel, determination of the isotopic composition, and processing spectra of samples over wide ranges of isotopic composition. Software supports data reporting and storage of the system "Progress".

PRINCIPLES OF OPERATION

Program performs:

- automatic accounting of sample density;
- multi- factor control of the measuring channel serviceability and stability of the channel metrological characteristics;
- automatic radionuclide identification in samples of any isotopic composition;
- storage of measurement results in data base;
- adjusting measurement protocol form;
- operation with any Russian ADC plate (or pulse height analyzer);
- user access to built-in help;
- automatic measurement error calculation.

FUNCTIONAL BLOCKS**SPECIFICATIONS****SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Software

PROGRESS-Gamma Software
MODEL:

115

SUPPLIER: VNIIFTRI, SPA DOZA

USE CATEGORY: Accounting

DEVICE TYPE: Software

MEASUREMENT METHOD: Gamma

MEASURED PROPERTIES:

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS:

PORTABILITY:

ENVIRONMENT OF USE:

DEVELOPER: VNIIFTRI, SPA DOZA

MANUFACTURER: VNIIFTRI, SPA DOZA

DESCRIPTION

PURPOSE

Control of the gamma-spectrometric channel; processing spectra of bio-samples; building materials and samples with miscellaneous isotopic composition. Software supports the data reporting and storage of the system "Progress".

PRINCIPLES OF OPERATION

Program realizes the following capabilities:

- automatic accounting of a sample density;
- multi-factor control of the measuring channel serviceability and stability of the channel metrological characteristics;
- matrix technique of the spectra processing allows achievement of high precision for processing of the samples with an ordinary isotopic composition;
- spectrum processing by the generator method which allows determination of the activity of a limited number of radionuclides (up to 12) in the samples with a non-standard isotopic composition;
- storage of measurement results in data base;
- adjusting measurement protocol form,
- operation with any Russian ADC board (digital pulse height analyzer);
- user access to built-in program help;
- automatic measurement error calculation;
- can be installed on detector with low energy resolution (up to 15%).

FUNCTIONAL BLOCKS

SPECIFICATIONS

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer**116****InSpector Multichannel Analyzer**
MODEL: IMCA**SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Spectrometer**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):** HEU, LEU**PHYSICAL FORM(S) OF NM:** Oxide**STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Canberra Industries, Inc.**MANUFACTURER:** Canberra Industries, Inc.**DESCRIPTION****PURPOSE**

The IMCA is a portable gamma-ray spectrometer designed to measure the enrichment of uranium using the uranium enrichment meter method. Both NaI and HPGe low energy detectors can be used. The IMCA is designed to be operated by safeguards inspectors outside the laboratory environment. Methodology was developed by LANL.

PRINCIPLES OF OPERATION

The InSpector is modified to accept 1- or 2- microsecond shaping times and accepts a signal from a thermistor from an optional Am-241-seeded NaI detector. The spectra are automatically acquired, stored, and analyzed with special uranium enrichment software. The enrichment software is integrated with dedicated, application specific measurement and analysis procedures. Procedures were designed to replicate and automate manual procedures used by IAEA inspectors.

The IMCA supports both high and low resolution system requirements operating from the same software by allowing quick changes between NaI or LGE detector types.

It offers support of any number of sodium iodide or germanium detectors in a variety of configurations between any number of IMCAs. The rapid exchange and setup of different detectors is quick and easy between individual IMCA units and detectors is easy. Widely differing calibration and sample types are supported. Reliable operation under conditions affecting NaI detector performance (age of NaI crystal, temperature drifts) is provided regardless of the presence of enriched uranium. There is minimal operator interaction; personnel with varying degrees of training and experience can easily use the measurement system; it has built-in performance monitoring; it is designed to monitor and troubleshoot the systems performance after actual use.

FUNCTIONAL BLOCKS

- a modified Canberra InSpector Multichannel Analyzer
- a notebook computer
- NaI or a LGE detector
- special application software.

An IMCA/NaI system is known as the PMCN (Portable Multichannel Analyzer with NaI Detector) whereas an IMCA/LGE detector is known as the PMCG (Portable Multichannel Analyzer with a Ge Detector).

SPECIFICATIONS

Weight	3.2 kg (including batteries)
Notebook computer weight	1.5 to 3 kg

SOFTWARE

The specially designed IMCA counting procedure software combines all of the separate features of the system into a user interface that is both comprehensive and simple to operate. It is based on the Genie-PC software environment using the custom tools to create a fully interactive and proceduralized, graphical user interface.

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer**117****U-Pu InSpector
MODEL:****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Spectrometer**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):** U, Pu, Np, Am**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Canberra Industries, Inc.**MANUFACTURER:** Canberra Industries, Inc.**DESCRIPTION****PURPOSE**

The U-Pu InSpector is a portable instrument that can measure the isotopic composition of samples containing uranium and/or plutonium without tedious efficiency calibration and without the need for skilled operators.

PRINCIPLES OF OPERATION

The spectra are automatically acquired, analyzed and stored with the help of MGA software which has been integrated with dedicated, application specific measurement and analysis procedures. This shield reduces the intensity of the background gamma rays in the important 100 keV region by 23 orders of magnitude. At 200 keV, the attenuation is still four orders of magnitude.

FUNCTIONAL BLOCKS

- shielded Low Energy Germanium (LEG_e) detector
- Multi-Altitude Cryostat (MAC)
- InSpector portable spectroscopic station
- notebook computer
- Multi-Group Analysis (MGA)
- rugged metal carrying case
- collimator insert

SPECIFICATIONS

Energy region	84 keV to 130 keV (for uranium) below 210 keV (for plutonium)
Detector active surface area	5 cm ²
Resolution (FWHM) at 122 keV	(550-600 eV) at rates up to 50,000 counts per second
Measurement time	few minutes
Accuracy	within 1%

SOFTWARE

The Multi-Group Analysis software for plutonium (MGA) has been developed by Ray Gunnink [1] to analyze plutonium gamma-ray spectra to accurately determine the relative abundances of plutonium and other actinides in a sample. It requires only energy calibration and can be used to measure virtually any size and type of plutonium sample. The masses of other actinides in the sample, like Am-241, Np-237 and U-235 are given relative to the total plutonium mass. MGA also calculates the total uranium to plutonium (tot U/Pu) ratio. The specially designed U-Pu InSpector counting procedure software combines all of the separate features of the system into a user interface that is both comprehensive and simple to operate. It is based on Canberra's Genie-PC software environment which offers extensive customization. These tools were used to create the U-Pu counting procedures software - a fully implemented turnkey application for making uranium and plutonium isotopic measurements.

ADDITIONAL INFORMATION**REFERENCES**

R. Gunnink: MGA: A Gamma-Ray Spectrum Analysis code for Determining Plutonium Isotopic Abundances.

LLNL report: UCRL-LR-103220, April 1990.

Accounting: Spectrometer

DART Portable High-Performance Multichannel Analyzer

118

MODEL: DART

SUPPLIER: EG&G Instruments, Inc. ORTEC

USE CATEGORY: Accounting

DEVICE TYPE: Spectrometer

MEASUREMENT METHOD: Gamma

Active, Passive

MEASURED PROPERTIES: Isotopic Composition

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Portable

ENVIRONMENT OF USE: Field

DEVELOPER: EG&G Instruments, Inc. ORTEC

MANUFACTURER: EG&G Instruments, Inc. ORTEC

DESCRIPTION

PURPOSE

DART is battery-operated MCA for performing high quality laboratory-grade gamma spectroscopy in the field.

PRINCIPLES OF OPERATION

Accompanied by a germanium detector in the field, DART will typically provide 7 hours of operation without a battery change. "Field mode" operations allows DART, without a PC, to acquire MULTIPLE spectra in the field, each at the push of a button, and then to retain them in flash memory for later processing. DART, powered from mains, may be used in a fixed location for unattended monitoring applications; the internal batteries provide uninterruptable power supply (UPS) data acquisition protection.

FUNCTIONAL BLOCKS

SPECIFICATIONS

Power supply	6 Volt NiCd
Continuous operation	7 Hours without a battery change in typical operation at 50% duty cycle
Overall size	5-1/2 hours at 100% duty cycle
Weight	9.2 cm x 14 cm x 29.8 cm
	5-1/4 pounds with batteries

SOFTWARE

MAESTRO for Windows; MGA-BI VO1.1 (LLNL) and PC/FRAM-BI V2.3 (LANL): actinide isotopic ratio analysis codes, licensed by ORTEC HMS-III hold up software, GammaVision, and Program ISOTOPIC.

ADDITIONAL INFORMATION

REFERENCES

R.M.Ketser, T.R.Twomey. "Development in High-Performance Spectrometer System for Safeguard Applications". 38-th INMM Annual Meeting Proceedings, July 20-24, 1997, Phoenix Arizona

Accounting: Spectrometer

DSPEC Digital Gamma-Spectrometer
MODEL: DSPEC

119

SUPPLIER: EG&G Instruments, Inc. ORTEC

USE CATEGORY: Accounting

DEVICE TYPE: Spectrometer

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Portable

ENVIRONMENT OF USE: Industrial

DEVELOPER: EG&G Instruments, Inc. ORTEC

MANUFACTURER: EG&G Instruments, Inc. ORTEC

DESCRIPTION

PURPOSE

DSPEC incorporates digital Signal technology, and achieves the optimum resolution from each HPGe detector, even when ultra high throughput is required. It solves the ballistic deficit problem associated with large Ge detectors, and achieves high stability of resolution and peak shape over a wide range of count rates and operating conditions. DSPEC allows one to precisely match the instrument settings to a specific detector, via an "infinitely" variable integration-time selection. Vital system functions can be continuously observed by the new InSight virtual oscilloscope.

PRINCIPLES OF OPERATION

State-of-the-Art signal processing for HPGe gamma spectroscopy.

FUNCTIONAL BLOCKS

SPECIFICATIONS

Power supply	External Power
Overall size	31 cm x 35 cm x 14 cm
Weight	7.7 kg

SOFTWARE

Maestro TM, MGA-B1 vol.1 (LLNL) and PC/FRAM-B1 (LANL), GammaVision, and Program ISOTOPIC.

ADDITIONAL INFORMATION

REFERENCES

R.M.Keyser, T.R.Twomey. "Development in High-Performance Spectrometer System for Safeguard Applications," 38-th INMM Annual Meeting Proceedings, July 20-24, 1997, Phoenix, Arizona

Accounting: Spectrometer**Gamma-Ray Spectrometer****MODEL: 92X-II****120****SUPPLIER:** EG&G Instruments, Inc. ORTEC**USE CATEGORY:** Accounting**DEVICE TYPE:** Spectrometer**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Field, Industrial**DEVELOPER:** EG&G Instruments, Inc. ORTEC**MANUFACTURER:** EG&G Instruments, Inc. ORTEC**DESCRIPTION****PURPOSE**

This device is an improvement over the previous model, Spectrum Master™: Gamma Spectroscopy Workstations (92X-W3) described in this catalog.

PRINCIPLES OF OPERATION

The device allows a direct connect to Ethernet Local Area Networks, computer control of all major functions, triangular filter, computer controlled gain amplifier with patented automatic Pole-Zero circuit. The advanced features include Mariscotti fast peak search, with nuclide identification by library look-up, activity, net and gross areas (with uncertainty), centroid and shape for peaks, data protection with "detector locking" by name and not workstation, comprehensive JOB STREAMING with on-line editing, and integrated LAN support (CONNECTIONS).

FUNCTIONAL BLOCKS

- digital Spectrum Stabilizer,
- sample changer port, and
- detector bias supply (0-5 kV for Ge detectors, 0-2 kV for NaI detectors)

SPECIFICATIONS

A nonvolatile data memory	for 16,384 channels of 31 counts per channel
Operation temperature range	16 to 32 degrees C
Power input	110/220 v ac, 50/60 Hz
Power consumption	100 watts
Overall size	31 cm X 35 cm X 14 cm
Weight	7.7 kg

SOFTWARE

MAESTRO for Windows.

MGA-B1 vol.1 (LLNL) and PC/FRAM-B1 (LANL), GammaVision, and Program ISOTOPIC.

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer**MatchMaker EtherNim Acquisition Interface Module****121****MODEL:****SUPPLIER:** *EG&G Instruments, Inc. ORTEC***USE CATEGORY:** Accounting**DEVICE TYPE:** Spectrometer**MEASUREMENT METHOD:** Gamma

Active, Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** EG&G Instruments, Inc. ORTEC**MANUFACTURER:** EG&G Instruments, Inc. ORTEC**DESCRIPTION****PURPOSE**

MatchMaker is a cost-effective way to interface a variety of commercial vendor's ADC's into the ORTEC CONNECTIONS Software Environment, and to applications such as PC/FRAM, MGA, Program Isotopic, GammaVision, ScintiVision, Maestro etc.

PRINCIPLES OF OPERATION

The ADC is connected directly to the NIM MatchMaker, which then connects to the PC or PC network by the built-in Ethernet Interface.

FUNCTIONAL BLOCKS**SPECIFICATIONS****SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer**MicroNOMAD Portable, Miniature MCA for Use with NaI(Tl), CZT,
and Other Moderate-Resolution Detectors****122****MODEL: MicroNOMAD****SUPPLIER: EG&G Instruments, Inc. ORTEC****USE CATEGORY:** Accounting**DEVICE TYPE:** Spectrometer**MEASUREMENT METHOD:** Gamma

Active, Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Field, Industrial**DEVELOPER:** EG&G Instruments, Inc. ORTEC**MANUFACTURER:** EG&G Instruments, Inc. ORTEC**DESCRIPTION****PURPOSE**

Hardware/Software System to perform gamma spectroscopy. Can be used to collect large amounts of data in the field in a short time. If line powered, ideal for in-situ networks covering large areas.

PRINCIPLES OF OPERATION

The MicroNOMAD MCA, for NaI-based gamma spectroscopy can store 50 512-channel spectra with bar codes, out in the field.

FUNCTIONAL BLOCKS

- quality amplifier,
- 2k ADC,
- digital stabilizer

SPECIFICATIONS

Storage capacity	50 512-channel spectra with bar codes
Power supply	AA batteries
Continuous time	8 hours of field operation.
Overall size	7.1 cm x 7.1 cm x 21.3 cm
Weight	0.7 kg

SOFTWARE

MAESTRO, ScintiVision, HMS-III hold-up software, CZTU.

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer

Spectrum MasterTM: Gamma Spectroscopy Workstations**MODEL: 92X-W3****123****SUPPLIER: EG&G Instruments, Inc. ORTEC****USE CATEGORY:** Accounting**DEVICE TYPE:** Spectrometer**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Field, Industrial**DEVELOPER:** EG&G Instruments, Inc. ORTEC**MANUFACTURER:** EG&G Instruments, Inc. ORTEC**DESCRIPTION****PURPOSE***Designed for Gamma Ray Spectrometry with germanium detectors.***PRINCIPLES OF OPERATION**

The 92X-W3 SPECTRUM MASTER is computer controlled. Distributed processors allow eight 92X-W3 SPECTRUM MASTER or other ORTEC multi-channel buffers to be controlled from a single PC with no overhead on its resources. It can be integrated into a network environment.

FUNCTIONAL BLOCKS

- Triangular filter,
- computer controlled game amplifier with patented AUTO-PZ circuit,
- computer controlled Digital Spectrum Stabilizer.
- 16k ADC
- 16 k memory,
- detector Bias Supply (0-5 kV for Ge detectors with warmup protection interlock, 0-2 kV for NaI detectors).

SPECIFICATIONS

Power supply	External Power
Overall size	31 cm x 35 cm x 14 cm
Weight	8.5 kg

SOFTWARE

MAESTRO TM for Windows 3.1

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer**124****Pu-238 Isotopic Analysis System*****MODEL:*****SUPPLIER:** *Lawrence Livermore National Laboratory***USE CATEGORY:** Accounting**DEVICE TYPE:** Spectrometer**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):** Pu-238**PHYSICAL FORM(S) OF NM:** Oxide**STATUS:** Limited Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Lawrence Livermore National Laboratory**MANUFACTURER:** Lawrence Livermore National Laboratory**DESCRIPTION****PURPOSE***Designed to measure relative plutonium isotopic abundances of plutonium oxide enriched in Pu-238.***PRINCIPLES OF OPERATION**

HPGe detector views the sample from a distance of about 28 cm through a 7-cm diameter window in the sample-shielded enclosure.

FUNCTIONAL BLOCKS

- spectrometer with 20% efficient, coaxial, high-purity germanium (HPGe) detector
- sample-shielded enclosure.

SPECIFICATIONS

Measurement time	about 50 minutes
Accuracy	better than 1% accuracy for 200 g of plutonium oxide

SOFTWARE

GRPANL code developed at LLNL using twelve selected gamma rays from 152 to 860 keV. MGA code methodology is used to determine the effects of plutonium self-absorption and the relative plutonium isotopic abundances.

ADDITIONAL INFORMATION

Tested for Pu-238 enrichments ranging from 20% to 85%. Currently is used at the Westinghouse Savannah River Company and Los Alamos National Laboratory in US.

Accuracy and precision values were taken from measurements conducted with plutonium oxide residing in cylindrically-shaped, stainless steel containers (EP60/61).

REFERENCES

1. W.D. Ruhter and D.C. Camp, An Isotopic Analysis System for Plutonium Samples Enriched in Pu-238, American Nuclear Society Topical Conference, 4th International Conference on Facility Operations, Safeguards Interface, Albuquerque, New Mexico, September 29 - October 4, 1991
2. R. Gunnink, MGA: A Gamma-Ray Spectrum Analysis Code for Determining Plutonium Isotopic Abundances, V.1, Methods and Algorithms, UCRL-LR-103220, LLNL, Livermore, 1990
3. R. Gunnink, W.D. Ruhter, and B. Niday, GRPANL: A Suite of Computer Programs for Analyzing Complex Ge and Alpha-Particle Detector Spectra, V.1, UCRL-53861, LLNL, 1988

Accounting: Spectrometer**Generalized-Geometry Gamma-Ray Holdup Assay**
MODEL:**125****SUPPLIER:** *Los Alamos National Laboratory***USE CATEGORY:** Accounting**DEVICE TYPE:** Spectrometer**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Element Concentration**NUCLEAR MATERIAL(S):** U**PHYSICAL FORM(S) OF NM:** Holdup**STATUS:** Limited Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Field, Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Los Alamos National Laboratory**DESCRIPTION****PURPOSE***U holdup detection in three generalized geometries based on the gamma ray spectroscopy.***PRINCIPLES OF OPERATION**

A cylindrically collimated gamma-ray detector connected to a portable spectroscopy system automated by a palm-size controller measures nuclear material in three generalized geometries: a) a small deposit centered in a relatively large circular field of view, (FOV) b) a narrow, uniform deposit centered in a relatively wide FOV, and c) a uniform deposit that fills a circular FOV.

FUNCTIONAL BLOCKS

- compact, collimated, shielded NaI(Tl) detector, manufactured by Bicron Corp., is a 1-in.-diameter by 0.5- or 2-in.-thick NaI(Tl) crystal.
- Intermec 9440, manufactured by Intermec Corp., is a programmable, digital, control-and-data-storage unit that is equipped with a bar-code reader.
- PMCA or M3CA: portable multi-channel analyzer.

SPECIFICATIONS

Weight 2-3 kg

SOFTWARE

Holdup Measurement System II (HMSII) software is written for the controller and PC.

ADDITIONAL INFORMATION**REFERENCES**

Generalized-Geometry Gamma-Ray Holdup Assay, LANL Application Note, LALP-94-172, February 1995.

Accounting: Spectrometer**Plutonium Isotopic Analysis System****MODEL: FRAM****126****SUPPLIER:** *Los Alamos National Laboratory***USE CATEGORY:** Accounting**DEVICE TYPE:** Spectrometer**MEASUREMENT METHOD:** Gamma**MEASURED PROPERTIES:** Isotopic Composition**NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:****STATUS:** Limited Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Los Alamos National Laboratory**DESCRIPTION****PURPOSE**

Used primarily to determine isotopic composition of plutonium in SNM. Allows measurement of ratios and distributions of isotopes other than plutonium in arbitrary bulk items. No dependency on sample size, shape, physical or chemical composition, measurement geometry, and container characteristics.

PRINCIPLES OF OPERATION

FRAM analyzes photopeaks from the plutonium isotopes Pu238-241, Am241 and other isotopes such as U235 or Np237, Cr244. Does not require calibration.

FUNCTIONAL BLOCKS

- detector
- data acquisition hardware.

SPECIFICATIONS

Measurement range	100 mg to many kg (limited by criticality)
Measurement time	20 min to 1 hour
Accuracy	0.2% to 3%
Bias	less than 1%

SOFTWARE

Designed to analyze pulse-height spectra generated by high-resolution gamma-ray high-purity germanium detectors.

ADDITIONAL INFORMATION**REFERENCES**

Application Note, FRAM Plutonium Isotopic Analysis System, LALP-93-86, November 1993.

Accounting: Spectrometer

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Gamma-Spectrometric Unit

MODEL: CTA-2G

SUPPLIER: PNPI, St-Petersburg Nuclear Physics Institute

USE CATEGORY: Accounting

DEVICE TYPE: Spectrometer

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS:

PORTABILITY:

ENVIRONMENT OF USE: Industrial

DEVELOPER: PNPI, St-Petersburg Nuclear Physics Institute

MANUFACTURER: PNPI, St-Petersburg Nuclear Physics Institute

DESCRIPTION

PURPOSE

In-process nuclear fuel control (IAEA).

PRINCIPLES OF OPERATION

FUNCTIONAL BLOCKS

- gamma radiation detection unit based on cadmium telluride P-I-N detector with the thermoelectric microcooler and amplitude corrector;
- spectrometric amplifier/pulse shaping unit.

SPECIFICATIONS

Energy resolution:

for 122 keV line (Co-57)	1.5 keV - 2.0 keV
for 662 keV line (Cs-137)	2.5 keV - 3.5 keV

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer**128****Scout Nuclear Material ID Kit****MODEL:****SUPPLIER:** *Quantrad Sensor Division, Applied Electron Corp.***USE CATEGORY:** Accounting**DEVICE TYPE:** Spectrometer**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):** Pu, U, Medical and Industrial Isotopes**PHYSICAL FORM(S) OF NM:** Metal, Oxide, Solution**STATUS:** Serial Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Industrial, Field**DEVELOPER:** Lawrence Livermore National Laboratory**MANUFACTURER:** Quantrad Sensor Division, Applied Electron Corp.**DESCRIPTION****PURPOSE***Simple quantitative enrichment measurement device which can be used for inventory verification measurements.**Best for materials with uniform properties.***PRINCIPLES OF OPERATION****FUNCTIONAL BLOCKS**

NaI detector

SPECIFICATIONS

Proximity of the object

up to 6"

Enrichment range

high, medium, or low

Sensitivity

<50 g U behind 0.5" steel;

1 g Pu behind 0.5" steel.

Accuracy

Pu: 1.0E-5 PFA.

Weight

5 - 7 kg

SOFTWARE

DOS software was developed by Lawrence Livermore National Laboratory (LLNL).

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer

Gamma SpectrometerMODEL: СИНАПА-01

SUPPLIER: RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics

USE CATEGORY: Accounting

DEVICE TYPE: Spectrometer

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition

NUCLEAR MATERIAL(S): Pu, U

PHYSICAL FORM(S) OF NM:

STATUS: Prototype

PORTABILITY:

ENVIRONMENT OF USE: Industrial

DEVELOPER: RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics

MANUFACTURER: RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics

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DESCRIPTION**PURPOSE**

Production of the pulse height distribution from the gamma detection unit.

PRINCIPLES OF OPERATION**FUNCTIONAL BLOCKS**

- NaI detection unit combined with the photoelectric multiplier tube (PMT);
- multichannel analyzer P52-1Л965 (СИНАПА-01) made as an IBM PC plate.

IBM PC plate consists of:

- peak detector;
- analog-to- digital converter (ADC);
- accumulation counter;
- amplifier with the program-controlled-gain-factor;
- low frequency filter with pulse-shaping time of 1 mks;
- program-controlled-discriminator of lower detection level;
- disconnecting unit of the "zero- pole" compensation;
- unit for recovering the constant component;
- program-controlled-unit for setting and stabilization of PMT high voltage. (HV transformer of PMT power can be mounted on the analyzer plate, or built-in the detection unit.)

SPECIFICATIONS

Channel number	1024
Channel capacity in RAM plate	65536 pulses
Channel capacity with applied software	4294967295 pulses
Input resistance	1 kOhm
Gain factor range (factor is equal to the gain production of two amplifier stages)	
first stage	1; 2; 4; 8
second stage	0,512-1,022 (with step of 0,002)
Input ADC voltage range	0-2.5 V
Integral non-linearity	no more than 0,1%
Differential non-linearity	no more than 1%

SOFTWARE

Specialized software.

ADDITIONAL INFORMATION

Foreign analog: card ACCUSPEC NaI Plus, Canberra.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer**Spectrometric Device for the Gamma Energy Analysis and Flux Density Control****130****MODEL: ССГИ2****SUPPLIER: RIPT, Research Institute of Pulse Technique****USE CATEGORY:** Accounting**DEVICE TYPE:** Spectrometer**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Field**DEVELOPER:** RIPT, Research Institute of Pulse Technique**MANUFACTURER:** RIPT, Research Institute of Pulse Technique**DESCRIPTION****PURPOSE**

Detection of gamma sources that create a particle flux density close to natural background; detection of a level exceeding some predetermined level triggers alarm signal; gamma energy analysis; automatic identification of a number of radioisotops, and evaluation of the nuclide gamma activity.

PRINCIPLES OF OPERATION**FUNCTIONAL BLOCKS**

- detector
- ADC

SPECIFICATIONS

NaI(Tl) detector	D40 mm x 40 mm
Gamma sensitivity for energy 100кэВ-1,2МэВ	10cm ²
ADC digit number	8
Transformation time	30 ms
Exposure time	1-999 sec
Power supply	=20-24В
with a charge device	220V, 50Hz
Max. input rate	3E+4 cps
Overall size	290 mm x 330 mm x 140 mm
Weight	8 kg

Interface for the coordinate plotter

Interface for the cassette recorder

SOFTWARE

Program compatible with RT-11.

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика (Каталог продукции НИИИТ)

Accounting: Spectrometer**Spectrometric Device for Gamma Energy Analysis****131****MODEL: СМИ2****SUPPLIER: RIPT, Research Institute of Pulse Technique****USE CATEGORY:** Accounting**DEVICE TYPE:** Spectrometer**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Field**DEVELOPER:** RIPT, Research Institute of Pulse Technique**MANUFACTURER:** RIPT, Research Institute of Pulse Technique**DESCRIPTION****PURPOSE***Gamma energy analysis.***PRINCIPLES OF OPERATION****FUNCTIONAL BLOCKS**

- NaI(Tl) detector

- recorder with ADC

Supplied with NoteBook PC

SPECIFICATIONS**Detector**

NaI (Tl) crystal

Gamma sensitivity for 100keV-1,2 MeV

D63 mm x 63 mm
24 cm²**Recorder**

ADC digit number

10

Max. number of counts per channel

2¹⁶ - 1

Transformation time

40 mks

Exposure

1-9999 sec

Max. input rate

1E+5 cps

Power supply

=10-12 V

with recharge device

220B, 50 Hz

Overall size

190 mm x 300 mm x 300 mm

Weight

8 kg

Storage capacity

for 15 spectra

Interface

RS-232

SOFTWARE**ADDITIONAL INFORMATION**

Program compatible with MS-DOS 6.00 or later versions.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика (Каталог продукции НИИИТ)

Accounting: Spectrometer**132*****Hand-Held All-Weather Spectrometer of the Nuclear Radiation*****MODEL: ПРОСПЕКТ-НС (со сцинтиляционным БД), ПРОСПЕКТ-НП (с полупроводниковым БД)****SUPPLIER: SNIIP- Green Star, Ltd.**

USE CATEGORY: Accounting
DEVICE TYPE: Spectrometer
MEASUREMENT METHOD: Gamma
 Passive
MEASURED PROPERTIES: Isotopic Composition
NUCLEAR MATERIAL(S): Pu, U
PHYSICAL FORM(S) OF NM:
STATUS: Serial Production
PORTABILITY: Hand-held
ENVIRONMENT OF USE: Field
DEVELOPER: SNIIP- Green Star, Ltd.
MANUFACTURER: SNIIP- Green Star, Ltd.

DESCRIPTION**PURPOSE**

Precise measurements under field conditions for the determination of the isotopic composition and the surface or specific activity and the exposure dose rate.

PRINCIPLES OF OPERATION**FUNCTIONAL BLOCKS**

Delivery set includes:

- "ПроСпект-Н"- Analyzer
- detector
- Power supply providing the operation from AC V=220 V, f=50 Hz, and also battery recharge.

SPECIFICATIONS

Number of channels	1024, 2048, 4096
Channel capacity	2 ²⁴
Number of quantization levels	512-4096
Conversion frequency	100 MHz
Integral non-linearity	0.05%
Differential non-linearity	1%
Gain factor:	
the first range	5-80
the second range	50-800
High voltage (power supply of ionizing radiation detectors):	
the first stage	4.5 KV (1 mKA)
the second range	1.5 KV (500 mKA)
High voltage polarity	any
Power supply	from built-in rechargeable batteries; from AC 220 V, 50 Hz through an external power supply (a recharge device)
Independent continuous operation	16 hours
Operation temperature range	from -30°C to +50°C
Overall size	250 mm x 115 mm x 260 mm
Weight	2.5 kg
with rechargeable battery unit	5 kg

SOFTWARE

Provided with software

ADDITIONAL INFORMATION

ADDITIONAL INFORMATION

Storage up to 160 spectra for 1024 channels per each
Spectrometers are provided (on demand) with miniprinters with the independent power supply and the floppy disc drivers.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer

Installation for the X-Ray Fluorescent Analysis

MODEL: СИРВТ-50

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SUPPLIER: SNIIP- Green Star, Ltd.

USE CATEGORY: Accounting

DEVICE TYPE: Spectrometer

MEASUREMENT METHOD: XRF

Passive

MEASURED PROPERTIES: Element Concentration

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY:

ENVIRONMENT OF USE:

DEVELOPER: SNIIP- Green Star, Ltd.

MANUFACTURER: SNIIP- Green Star, Ltd.

DESCRIPTION

PURPOSE

Rapid automatic determination of the element mass concentration (from ultra low concentrations of micro admixtures to macro contents) in the analyzed substance.

PRINCIPLES OF OPERATION

FUNCTIONAL BLOCKS

SPECIFICATIONS

Determined elements range	from Na to U
Simultaneous determination	up to 18 elements
Sample preparation time	5 min - 10 min.
Analysis time	5 min - 15 min.
Detection limit	
in solutions	1E-5%
in solid samples	5E-3%

SOFTWARE

Software is included.

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer**Laboratory Spectrometric System****MODEL: LSPS-50****134****SUPPLIER:** SNIIP- Green Star, Ltd.**USE CATEGORY:** Accounting**DEVICE TYPE:** Spectrometer**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):** Pu, U**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Laboratory**DEVELOPER:** SNIIP- Green Star, Ltd.**MANUFACTURER:** SNIIP- Green Star, Ltd.**DESCRIPTION****PURPOSE**

Precise nuclear spectrometric measurement in laboratories. Device provides the specific and volume activity of gamma emitting nuclides with high precision.

PRINCIPLES OF OPERATION**FUNCTIONAL BLOCKS**

- IBM-PC;
- SBS-50 single board spectrometer (installed in PC);
- semiconductor detection unit;
- 50 mm or 100 mm Pb low background shield with Cd and Cu absorbing liners of 400 kg and 800 kg weight , respectively;
- a set of the spectrometer emulation and spectrum process codes.

Complex can be provided with Ge(Li) semiconductor detectors of the own production or with the following types of EG&G ORTEC(USA) HPGe detectors :

- GEM series (p-type germanium for 40 keV - 10 MeV energy range);
- GMX series (n-type germanium for 3 keV - 10 MeV energy range);
- LoAX series for the nuclear fuel cycle material spectrometry (lanthanide series, actinides in 3 keV - 400 keV energy range)

SPECIFICATIONS**SOFTWARE**

Integrated set of the spectrometer control software, the nuclide library, the spectrum processing program.

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer

Multichannel Spectrometer

MODEL: Колибрю

135

SUPPLIER: SNIIP- Green Star, Ltd.

USE CATEGORY: Accounting

DEVICE TYPE: Spectrometer

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition

NUCLEAR MATERIAL(S): Pu, U

PHYSICAL FORM(S) OF NM:

STATUS: Prototype

PORTABILITY: Hand-held

ENVIRONMENT OF USE: Field

DEVELOPER: SNIIP- Green Star, Ltd.

MANUFACTURER: SNIIP- Green Star, Ltd.

DESCRIPTION

PURPOSE

Determination of U-235 enrichment, plutonium isotope composition, radionuclide analysis and elemental analysis.

PRINCIPLES OF OPERATION

FUNCTIONAL BLOCKS

Built-in display and keypad (16 keys).

Operates with NaI(Tl), Cs(Tl), Ge and Si detectors.

SPECIFICATIONS

Number of channels	up 512 to 2048
Integral non-linearity	0,05%
Differential non-linearity	1%
Storage capacity	up to 100 spectra
Continuous operation time	
with AA type batteries	20 hours
with accumulators	8 hours
Overall size	30 mm x 85 mm x 150 mm
Weight	300 kg

SOFTWARE

Programs are fed in through the standard RS infrared - wireless interface from PC.

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer**Portable Spectrometric System Based on Scintillation Detector****MODEL: MSPS-50Sc****136****SUPPLIER: SNIIP- Green Star, Ltd.****USE CATEGORY:** Accounting**DEVICE TYPE:** Spectrometer**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):** Pu, U**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Field**DEVELOPER:** SNIIP- Green Star, Ltd.**MANUFACTURER:** SNIIP- Green Star, Ltd.**DESCRIPTION****PURPOSE**

Determination of the volume, specific or surface activity of radionuclides and dose rate from the radiation of each radio nuclide in the most common source-detector configurations.

PRINCIPLES OF OPERATION**FUNCTIONAL BLOCKS**

- Notebook PC;
- SBS-50 single board spectrometer;
- NaI or CsI scintillation detector of own production of any sizes and configurations.

Can be provided with Notebook PC and rechargeable batteries (up to 20 hours of continuous operation), battery adapters, recharge devices, tripods for operation in field conditions, shock resistant cases for transportation, special mini printers, devices for filling detectors with nitrogen and so on.

SPECIFICATIONS**SOFTWARE**

Carries out the control of all functions and parameters of the spectrometer and processes the spectrometric data obtained to determine the volume, specific and surface activity of radionuclides and radiation dose rate from each radionuclide in most common source-detector configurations.

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer**Portable Spectrometric System Based on Semiconductor Detector****137****MODEL: MSPS-50Ge****SUPPLIER: SNIIP- Green Star, Ltd.****USE CATEGORY:** Accounting**DEVICE TYPE:** Spectrometer**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):** Pu, U**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Field**DEVELOPER:** SNIIP- Green Star, Ltd.**MANUFACTURER:** SNIIP- Green Star, Ltd.**DESCRIPTION****PURPOSE***Determination of the volume, specific or surface activity of radionuclides and dose rate from radiation of each radionuclide in the most common source-detector configurations.***PRINCIPLES OF OPERATION****FUNCTIONAL BLOCKS**

- Notebook PC ;
- SBS-50 single board spectrometer;
- semiconductor detectors Ge(Li) of own production or with the following types of EG&G ORTEC(USA) HPGe detectors:
 - GEM series (p-type germanium for 40 keV - 10 MeV energy range);
 - GMX series (n-type germanium for 3 keV - 10 MeV energy range);
 - LoAX series for the nuclear fuel cycle material spectrometry (lanthanide series, actinides in 3 keV - 400 keV energy range)

Can be provided with Notebook PC and also with rechargeable batteries (up to 20 hours of continuous operation), battery adapters, recharge devices, tripods for operation in field conditions, shock resistant cases for transportation, special mini printers, devices for filling detectors with nitrogen and so on.

SPECIFICATIONS**SOFTWARE**

Carries out the control of all functions and parameters of spectrometer and provides the processing of the spectrometric data to determine the volume, specific and surface activity of radionuclides and dose rate from radiation of each radionuclide in the most used source-detector configurations.

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer**Scintillation Spectrometric Installation****MODEL: SSPU-57****SUPPLIER:** SNIIP- Green Star, Ltd.

USE CATEGORY:	Accounting
DEVICE TYPE:	Spectrometer
MEASUREMENT METHOD:	Gamma
	Passive
MEASURED PROPERTIES:	Isotopic Composition
NUCLEAR MATERIAL(S):	Pu, U
PHYSICAL FORM(S) OF NM:	
STATUS:	Serial Production
PORTABILITY:	Stationary
ENVIRONMENT OF USE:	Laboratory
DEVELOPER:	SNIIP- Green Star, Ltd.
MANUFACTURER:	SNIIP- Green Star, Ltd.

138**DESCRIPTION****PURPOSE***Determination of the specific activity of gamma emitting nuclides***PRINCIPLES OF OPERATION****FUNCTIONAL BLOCKS**

- IBM-PC;
- SBS-50 single board spectrometer (built-in in PC);
- CsI(Tl) 2"x2" detector assembly;
- Pb shield of 50 mm thickness on the special stand;
- a set of programs of the spectrometer emulsion and spectrum processing.

SPECIFICATIONS

Sensitivity limit	1-3 Bq
Resolution	7% on 662 keV line of Cs-137
Shield weight	less than 80 kg

SOFTWARE

Integrated set of the spectrometer control codes, nuclide library, a program for the spectrum processing by two algorithms: the full-energy peak analysis and correlation spectrum analysis by using standard samples ensuring the highest precision and reliability of the results. Ensures the determination of individual nuclides in the presence of other nuclides, and measurement of the activity of each nuclide present.

ADDITIONAL INFORMATION

CsI spectrometric scintillator developed by SNIIP Green Star has the energy resolution comparable to the best of NaI(Tl) crystals with higher density (4.51 g/sm³) and higher atomic number.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer

Single Board Spectrometer
MODEL: SBS-50

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SUPPLIER: SNIIP- Green Star, Ltd.

USE CATEGORY: Accounting
 DEVICE TYPE: Spectrometer
 MEASUREMENT METHOD: Gamma
 Passive
 MEASURED PROPERTIES: Isotopic Composition
 NUCLEAR MATERIAL(S): Pu, U
 PHYSICAL FORM(S) OF NM:
 STATUS: Serial Production
 PORTABILITY: Stationary
 ENVIRONMENT OF USE:
 DEVELOPER: SNIIP- Green Star, Ltd.
 MANUFACTURER: SNIIP- Green Star, Ltd.

DESCRIPTION

PURPOSE

This single board spectrometer serves for the determination of the gamma emitting nuclide specific activity as part of a spectrometric system.

PRINCIPLES OF OPERATION

FUNCTIONAL BLOCKS

- amplifier channel,
- ADC,
- power supply for preamplifier,
- high voltage power supply for the detection unit

SPECIFICATIONS

(Typical values are in brackets):

Number of channels	8192; 4096; 2048
Conversion frequency	100 MHz
Integral non-linearity	0.05% (0,02)
Differential non-linearity	1% (0.5)
Amplifier pulse-shaping time constant	2 mks; 4 mks; 8 mks
Gain factor:	
the first range	5-80
the second range	50-800
High voltage:	
the first range	1.5 kV (300 mKA)
the second range	4.5 kV (1 mKA)
High voltage polarity	negative, positive
Power consumption	0.7 Wt
Board length	136 mm
Board weight	200 g

SOFTWARE

Computer code for the spectrum processing uses the original algorithms to search and identify nuclides and elements, performs the quantity analysis of the activity and element content.

ADDITIONAL INFORMATION

SBS-50 (modifications: ST-standard, SC - for scintillation detectors, LP - for the low power consumption for the portable Notebook, Laptop PC)

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer

Spectrometric Rate Meter, "Kynol"

MODEL: РИГ-09II

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SUPPLIER: SNIIP-Automatics

USE CATEGORY: Accounting

DEVICE TYPE: Spectrometer

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition

NUCLEAR MATERIAL(S): U

PHYSICAL FORM(S) OF NM:

STATUS: Limited Production

PORTABILITY: Hand-held

ENVIRONMENT OF USE: Field, Industrial

DEVELOPER: SNIIP-Automatics

MANUFACTURER: SNIIP-Automatics

DESCRIPTION

PURPOSE

Detection, identification, quality and quantity control of fissile and radioactive materials, uranium enrichment control in samples and in containers, with wall thickness correction, as well as preliminary control of materials of unknown origin.

PRINCIPLES OF OPERATION

Gamma radiation spectra are collected in 256 channels. Data obtained are processed at measurement location by using of algorithms written in the device memory. For uranium enrichment control two techniques are used: 1) two regions of detected spectrum are selected - around 186 keV energy line and in the higher energy spectrum region. The second energy window is used for accounting of background in 186 keV window. To determine constants used by algorithm it is necessary to perform a preliminary calibration using two known samples;

2) the spectrum region near line 186 keV is fitted by Gauss curve. One sample is needed for the device calibration.

Operation ability testing is carried out by internal programs and using of standard radioactive sources.

FUNCTIONAL BLOCKS

Delivery set consists of:

-РИГ-09II console

-external scintillation detection unit on base of NaI(Tl) crystal (crystal sizes can be chosen for specific task; typical unit has crystal with size 25 mm x 25 mm) or CsI(Tl)

-recharging unit

-accumulator set

-main power unit

-collimator (on demand)

-software diskette

-communication cables

-documentation

SPECIFICATIONS

Channel number (quantum levels)	256
Gamma radiation energy range detected	from 30 keV to 3000 keV
Maximum integral count rate	up to 3E+4, cps
Integral non-linearity	no more than 2%
General own error	no more than 2%
Relative error (on two sigma level)	4-5% of uranium enrichment in samples
Energy resolution on line 662 keV	8-10%
Interface	RS-232
Console weight (with accumulators)	0,6 kg
Overall size	200 mm x 100 mm x 40 mm
Detection unit weight (crystal 25x25mm)	no more than 0,4 kg

Detection unit length (crystal 25x25 mm)	220 mm
Cable length (can be increased)	1 m
Power supply requirements:	
-nominal voltage (4 built-in accumulators, size AA)	5V
-continuous operation time without accumulator recharging	24 hours
-supply power at 1E+3 cps input rate	no more than 250mW
-main power supply unit	220V/5V
Operation conditions (depending on the display type)	-5°C(-10°C) to +50°C
Device transportation is produced in a package at temperature of	-10°C to +50°C

SOFTWARE

Software includes:

- typical operation modes of multichannel analyzer (spectrum and its parts scaling, cursor movement along a spectrum with the indication of a channel number and counts numbers in it, calibration of energy device scale by two gamma lines, the energy resolution determination of chosen spectrum line, adjusting of energy windows and calculation of total pulse number in them);
- program of the uranium enrichment determination on two and one window techniques with the estimation of statistical error (on two sigma level). Accounting of the wall thickness and materials to work with containers is provided;
- program for rdetermination of counts and their relation in chosen energy windows (from 1 to 4);
- program for spectrum archivation and extract from archive;
- program for identifying of unknown radioactive materials (by the spectrum library (15-20));
- program for data transferring to an external computer;
- program for device operation by external computer control.

ADDITIONAL INFORMATION

Warranty - 18 months from the beginning of operation or after warranty storage time.

Warranty storage time - 6 months.

Preservation of device for a long term storage - 3 years.

Delivery time - from 1 to 6 months.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

PC with ADC module and printer	no more than 30 kg
Power supply	220 V, 50 Hz
Power consumption	no more than 250 W

SOFTWARE

The software ensures has the following capabilities:

- spectrum measurement with the display in "live" and real time;
- calibration in terms of energy, efficiency and peak shape;
- automatic spectral analysis, including peak search, the nuclide identification, the nuclide activity calculation, the spectrum and storage results on flexible and/or hard disks;
- the visual representation of spectra and results of their processing on the PC display;
- the possibility of spectrum and results printing in the graphical mode;
- the possibility of combining the spectrum collection process and PC running for the other tasks.

Spectrometer can be used with other software.

ADDITIONAL INFORMATION

The possibility of including as spectrometers parts of any additional units such as fax-modem.

Warranty operation - 12 months

Life time - no less 8 years.

Possible delivery time - from 3 to 6 months.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer

Gamma Spectrometer with Semiconductor Detector

MODEL: Гамма-1II

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SUPPLIER: SPC Aspect

USE CATEGORY: Accounting

DEVICE TYPE: Spectrometer

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Stationary

ENVIRONMENT OF USE: Laboratory

DEVELOPER: SPC Aspect

MANUFACTURER: SPC Aspect

DESCRIPTION

PURPOSE

Intended for the quantitative and qualitative analysis of various types of samples (radioactive materials, food, building materials, raw materials and so on) for gamma emitting nuclides content. The device can be used for nondestructive NM control.

PRINCIPLES OF OPERATION

Gamma energy transformation to electrical pulses of proportional amplitude, and their subsequent detection and analysis by a multichannel analyzer.

FUNCTIONAL BLOCKS

Delivery set includes:

- semiconductor detector: high purity germanium or Ge(Li) (on demand) with preamplifier;
- АЦП-8К ADC;
- spectrometric chain in the NIM constructive or in the modular design;
- combined Pb screen-shield;
- IBM PC, printer;
- applied software.

SPECIFICATIONS

Energy range	50 - 3000 keV
Integral non-linearity	±0.05%
Max. input statistical rate	no less than 50000 cps
Energy resolution on the line of 1.33 MeV	1.8 keV - 3.5 keV
Continuous operation	no less than 24 hours
Operation state settling time	no less than 30 min
Min. measured activity at the external gamma background level of 16 mR/hour, in 1 hour, on the line of 661,66keV	0.5 Bq
Power supply	220 V, 50 Hz
Power consumption	no more than 250 W
Overall size:	
Pb screen-shield	no more than 570 mm x 570 mm x 1100 mm
PC	no more than 400 mm x 400 mm x 60 mm
printer	no more than 400 mm x 400 mm x 200 mm
Weight:	
Pb screen-shield	no more than 600 kg
detector	no more than 20 kg
PC with ADC module and printer	no more than 30 kg

SOFTWARE

The software has the following capabilities:

- spectrum measurement with the display in "live" and real time;
- calibration in terms of energy, efficiency and peak shape;

- automatic spectral analysis, including peak search, the nuclide identification, the nuclide activity calculation, the spectrum and storage results on flexible and (or) hard discs;
- the visual representation of spectra and results of their processing on the PC display;
- the possibility of spectrum and results printing in the graphical mode;
- the possibility of combining the spectrum collection process and PC running for the other tasks.

Spectrometer can be used with other software.

ADDITIONAL INFORMATION

Warranty operation - 12 months

Life time - no less 8 years.

Possible delivery time - from 3 to 6 months.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer**Portable Scintillation Gamma-Spectrometer****MODEL: Гамма-1С/НВ1****143****SUPPLIER: SPC Aspect****USE CATEGORY:** Accounting**DEVICE TYPE:** Spectrometer**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Field, Laboratory**DEVELOPER:** SPC Aspect**MANUFACTURER:** SPC Aspect**DESCRIPTION****PURPOSE**

Quantitative and qualitative analysis of different samples for gamma emitting nuclides content under harsh conditions. Spectrometer can be used for the nondestructive NM control.

PRINCIPLES OF OPERATION

Gamma energy transformation to electrical pulses of proportional amplitude, and their subsequent detection and analysis by a multichannel analyzer.

FUNCTIONAL BLOCKS

Delivery set includes:

- БДС-Г5 scintillation detection unit with 63x63 NaI(Tl) crystal;
- portable multichannel pulse height analyzer, AI-8K/NB;
- Pb collimator;
- NoteBook computer;
- applied software.

SPECIFICATIONS

Detected energy range	50 keV - 3000 keV
Integral non-linearity	±1%
Maximum input pulse rate	50000 pulses/s
Relative energy resolution on 661 keV line	no more than 8%
Continuous operation time:	
main 220 V, 50 Hz	no less than 24 h
from built-in accumulators	no less than 6 h
Operation state setting time	no more than 30 min
Time instability during continuous operation	no more than 1%
Overall size:	
detection unit БДС-Г5	90 mm x 90 mm x 310 mm
analyzer	2600 mm x 160 mm x 57 mm
Weight:	
detection unit БДС-Г5	no more than 2 kg
analyzer	no more than 2 kg

SOFTWARE

The software has the following capabilities:

- spectrum measurement with the display in "live" and real time;
- calibration in terms of energy, efficiency and peak shape;
- automatic spectral analysis, including peak search, the nuclide identification, the nuclide activity calculation, the spectrum and storage results on flexible and (or) hard discs;
- the visual representation of spectra and results of their processing on the PC display;
- the possibility of spectrum and results printing in the graphical mode;
- the possibility of combining the spectrum collection process and PC running for the other tasks.

Spectrometer can be used with other software.

ADDITIONAL INFORMATION

Spectrometer has all interfaces of standard IBM PC.

Warranty - 12 months.

Life time - no less than 8 years.

Spectrometer is provided with the post-warranty and software support.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer

Semiconductor Alpha Spectrometer
MODEL: СЭА-13П

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SUPPLIER: *SPC Aspect*

USE CATEGORY: Accounting

DEVICE TYPE: Spectrometer

MEASUREMENT METHOD: Alpha
Passive

MEASURED PROPERTIES:

NUCLEAR MATERIAL(S): Pu

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Stationary

ENVIRONMENT OF USE: Laboratory

DEVELOPER: SPC Aspect

MANUFACTURER: SPC Aspect

DESCRIPTION**PURPOSE**

Designed to measure the alpha particle energy distribution. Can be used for the quantitative and qualitative analysis from different environment samples.

Spectrometer can be used for:

- non-destructive NM control;
- process control in plant radiochemical laboratories;
- monitoring environment objects, foods, agricultural and cattle-breeding products ;
- fast control of aerosol emissions in the atmosphere and air from the radiation dose monitoring facility (sampling is performed by АФА-РСII-20 filters, no sample preparing is maded;
- medicine laboratories.

PRINCIPLES OF OPERATION

Transformation of alpha particle energy in the sensitive volume of a semiconductor detector to electrical pulses of the proportional amplitude with subsequent processing by multichannel analyzer.

FUNCTIONAL BLOCKS

Delivery set includes:

- minicrate "VECTOR";
- low voltage power unit, БПН-01;
- alpha spectrometer unit, СЭА-13П;
- АЦП-1К ADC;
- HBP-1.25Д vacuum pump;
- IBM PC ;
- printer;
- applied software;
- operational documentation;
- interface parallel cable.

Detection unit - semiconductor Si ion-implanted detector.

Delivery set can also include additional detectors of different size as well as the procedures for sample preparation.

SPECIFICATIONS

Detected energy range 3 Mev - 9 MeV

Detector area (chosen on demand) 3000 mm², 1000 mm², 400 mm²

Absolute spectrometer energy resolution for 5.15 MeV line and detection efficiency for source Pu-239:

semiconductor detector area mm ²	detection efficiency from a distance of 5 mm to detector, %	resolution from a distance of 25 mm, keV
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3000	no less than 35	no more than 90
1000	no less than 25	no more than 60
400	no less than 20	no more than 40
Analyzer channel number	1024	
Integral non-linearity		no more than 10 keV
Time instability for 24 hours of continuous operation		no more than 10 keV
Temperature instability		no more than 2 keV/°C
Maximum statistical pulse rate		no less than 10000 pulses/sec
Overall size:		
mini-crate with units СЭА-13П and БНН-01 vacuum pump НВР-1.25Д	360 mm x 410 mm x 250 mm 136 mm x 340 mm x 190 mm	
Weight:		
mini-crate with units СЭА-13П and БНН-01 vacuum pump НВР-1.25Д	15 kg 10 kg	

SOFTWARE

The software has the following capabilities:

- spectrum measurement with the display in "live" and real time;
- calibration in terms of energy, efficiency and peak shape;
- automatic spectral analysis, including peak search, the nuclide identification, the nuclide activity calculation, the spectrum and storage results on flexible and (or) hard discs;
- the visual representation of spectra and results of their processing on the PC display;
- the possibility of spectrum and results printing in the graphical mode;
- the possibility of combining the spectrum collection process and PC running for the other tasks.

Spectrometer can be used with other software.

ADDITIONAL INFORMATION

Warranty - 12 months.

Life time - no less than 8 years.

Approximate delivery time - from 3 to 6 months.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Weight of laboratory system version
(including Dewar) 30 kg

SOFTWARE

Software set includes:

- spectra acquisition program;
- programs for writing-reading spectrum files, processing spectra and quantity determination of the sample element content;
- program for displaying spectra with information on specific elements present in the sample.

ADDITIONAL INFORMATION

Heavy elements (for example, Au, Pb, W and others) including radioactive ones (for example Pu, U and other) can be detected not only on the sample surface, but under shielding.

Warranty - 1 year.

Installation has passed the State Metrological Certification.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer**PROGRESS-Gamma (SCD) Semiconductor Gamma Spectrometer****146****MODEL:****SUPPLIER: VNIIFTRI, SPA DOZA****USE CATEGORY:** Accounting**DEVICE TYPE:** Spectrometer**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:****PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** VNIIFTRI, SPA DOZA**MANUFACTURER:** VNIIFTRI, SPA DOZA**DESCRIPTION****PURPOSE**

Determination of the isotopic composition and activity of the gamma-emitting radionuclides, including radionuclides with a complex or previously unknown isotopic composition.

PRINCIPLES OF OPERATION**FUNCTIONAL BLOCKS**

- detection unit of ДГДК type on the base of Ge(Li) detector of various sensitivity (from ДГДК-63 to ДГДК-200) or HPGe detector with efficiency of 10% to 60% and more (manufactured by EG&G ORTEC or Canberra) with preamplifier and Dewar;
- power supply and pulse amplification units;
- Pb shield (thickness of 5 or 10 cm);
- ADC board (4K or 8K) or a separate analyzer unit;
- "PROGRESS-Gamma (ППД)" software;
- PC with printer;
- reference activity volume measure (on demand);
- 5 - 10 Marinelli (semiconductor detector) - volume of 1 l or other measuring vessels.

SPECIFICATIONS

Relative energy resolution
on 1332 keV line no more than:

for ДГДК	3 %
for high purity germanium detector	2 %
Detected energy range	0,05-3 MeV
Integral non-linearity	no more than 0,1 %
General measurement error	no more than 10 %
Shield weight	350-900 kg

SOFTWARE

"PROGRESS-Gamma (ППД)" software.

ADDITIONAL INFORMATION

Warranty - 1 year.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Spectrometer

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X-Ray Fluorescent Spectrometer

MODEL: СПЕКТРОСКАН

SUPPLIER: VNIIIFTRI, SPA DOZA

USE CATEGORY: Accounting

DEVICE TYPE: Spectrometer

MEASUREMENT METHOD: XRF

Active

MEASURED PROPERTIES: Element Concentration

NUCLEAR MATERIAL(S): U

PHYSICAL FORM(S) OF NM: Powder, Solution

STATUS:

PORTABILITY:

ENVIRONMENT OF USE: Laboratory

DEVELOPER: VNIIIFTRI, SPA DOZA

MANUFACTURER: VNIIIFTRI, SPA DOZA

DESCRIPTION

PURPOSE

Determination of toxic element content (over the background values).

PRINCIPLES OF OPERATION

X-ray fluorescence analysis.

The device can operate both independently and complete with PC.

FUNCTIONAL BLOCKS

The spectrometer and a set of procedures for sample preparation, and measurement (quality and quantity analysis), codes for the processing of measurement results.

SPECIFICATIONS

Detected element range	from Ca (Z=20) to U (Z=92)
Measurement time	2 min - 15 min
Analyzed sample type	solid, liquid, powder
Detection limit for 100 sec:	
without sample enrichment	0.00001% - 0.01% (1 mg/l - 100 mg/l)
with standard enrichment	up to 0.000001% (10 mkg/l)
Relative error (using the sample concentrating by the method of the inherent standard)	
in range of 0,3-30 mkg/mm ²	no more than 30%
Energy resolution	60 eV
Power consumption	100 W
X-ray tube power (Mo anode, 40 kV)	5 VA
Overall size:	
scanning unit	210 mm x 390 mm x 430 mm
control board	260 mm x 130 mm x 330 mm
Weight:	
scanning unit	18 kg
control board	6 kg

SOFTWARE

Software for the measurement processing.

ADDITIONAL INFORMATION

Warranty - 1 year.

All procedures and techniques are certificated by "Gosstandard" of RF and approved by environmental protection agencies.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System

Packet Monitor

MODEL: G34, G35

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SUPPLIER: AEA Technology plc, Harwell Instruments

USE CATEGORY: Accounting

DEVICE TYPE: Waste Measurement System

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: NM Type

NUCLEAR MATERIAL(S): Pu, U, Fission & Activation Products

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Stationary

ENVIRONMENT OF USE: Industrial

DEVELOPER: AEA Technology plc, Harwell Instruments

MANUFACTURER: AEA Technology plc, Harwell Instruments

DESCRIPTION

PURPOSE

The G35 Packet Monitor measures and qualifies packages of LLW and free release waste of up to 90 litres in volume in measurement times of only a few minutes. Alternative configurations (Model G34) can handle containers up to 200 litres in volume. The G35 offers users a compact, cost effective solution for measuring light and medium density wastes. It also offers a means of qualifying uncontaminated materials as free release waste, which can lead to substantial savings in the cost of disposal.

PRINCIPLES OF OPERATION

FUNCTIONAL BLOCKS

- multiple sodium iodide detectors

SPECIFICATIONS

For G35:

Cavity dimension 600 mm x 440 mm

Measurement time 300 s

Sensitivity for a matrix density 0.3 g/ml: <1.7 mg Pu-240 (reactor grade)
<7.5 mg U-235
<490 Bq Am-241
<290 Bq Cs-137
<240 Bq Co-60

Accuracy 5-20 %

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System

Passive Neutron Coincidence CounterMODEL: N94SUPPLIER: *AEA Technology plc, Harwell Instruments*

USE CATEGORY: Accounting
 DEVICE TYPE: Waste Measurement System
 MEASUREMENT METHOD: Neutron Coincidence Counting
 Passive
 MEASURED PROPERTIES: Effective Isotope Mass
 NUCLEAR MATERIAL(S): Pu-240 + SF isotopes
 PHYSICAL FORM(S) OF NM: Waste
 STATUS: Serial Production
 PORTABILITY: Stationary
 ENVIRONMENT OF USE: Industrial
 DEVELOPER: AEA Technology plc, Harwell Instruments
 MANUFACTURER: AEA Technology plc, Harwell Instruments

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DESCRIPTION**PURPOSE**

The Model 94 Passive Neutron Coincidence Counter is used for the assay of plutonium in waste drums of up to 200 liter capacity; a similar system is available which will accommodate 500 liter waste drums.

PRINCIPLES OF OPERATION

Neutron coincidence counting to determine Pu-240 effective mass. For plutonium masses below the detection limit for coincidence counting, the N94 can be used in total count mode to give an upper limit on the plutonium mass. This value is based on the worst case calibration constant, which neglects the contribution of (α, n) events and thus leads to a fail-safe estimation of plutonium mass. However, if the chemical composition of the waste stream is known, the total count mode can be used as a quantitative measure of the plutonium content.

FUNCTIONAL BLOCKS**SPECIFICATIONS**

Measurement time	1000 s
Sensitivity	< 2 mg Pu-240
Accuracy	5-10 %
Cavity dimension	fits 200 liter drums (available up to 500 liter drums)

SOFTWARE

DOS/Windows

ADDITIONAL INFORMATION**REFERENCES**

P.M.J.Chart et al. Characterization and Optimization of the Harwell Model N94 Passive Neutron Coincidence Counter for the Assay of Plutonium Contaminated Waste Drums up to 208 Liters. Proc of INMM 35-th Annual Meeting, pp.1271-1276

Accounting: Waste Measurement System**Segmented Gamma Scanner****150****MODEL: G20****SUPPLIER:** *AEA Technology plc, Harwell Instruments***USE CATEGORY:** Accounting**DEVICE TYPE:** Waste Measurement System**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):** Pu, U, Fission & Activation Products**PHYSICAL FORM(S) OF NM:** Waste**STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** AEA Technology plc, Harwell Instruments**MANUFACTURER:** AEA Technology plc, Harwell Instruments**DESCRIPTION****PURPOSE**

The Harwell/EG&G ORTEC G20 Modular Segmented Gamma Scanner (MSGs) is designed for accurate, reliable determination of the activities of gamma-emitting radionuclides present in drums of intermediate and low-level radioactive waste, and uses a standardized modular design.

PRINCIPLES OF OPERATION

The drum to be measured is loaded on a fixed-height turntable. Alongside the turntable, a liquid-nitrogen-cooled HPGe detector views the drum through a specially-designed, slot-shaped lead collimator. Under computer control, a lead-screw-operated platform lifts the detector in fixed vertical increments (segments). At each measurement point, the drum is rotated at 10 RPM, while spectral data are taken for that segment. The segments are analyzed in turn to produce an assay of the drum's total radioactive material inventory.

FUNCTIONAL BLOCKS

- turntable
- lifting platform
- spectrometer with HPGe detector with slot-shaped lead collimator
- computer

SPECIFICATIONS

Rotate rate	10 RPM
Measurement time	1800 s
Sensitivity (for matrix density 0.2g/ml)	<0.2 g Pu-240 (15-20%) <5-10 kBq Cs-137 (15-20%) <5-10 kBq Co-60 (10-15%)
Cavity dimension	fits up to 200 liters drums

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System**Versatile Passive Neutron Monitor****MODEL: N93****SUPPLIER:** *AEA Technology plc, Harwell Instruments***USE CATEGORY:** Accounting**DEVICE TYPE:** Waste Measurement System**MEASUREMENT METHOD:** Neutron Coincidence Counting
Passive**MEASURED PROPERTIES:** Effective Isotope Mass**NUCLEAR MATERIAL(S):** Pu-240 + SF isotopes**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** *AEA Technology plc, Harwell Instruments***MANUFACTURER:** *AEA Technology plc, Harwell Instruments***151****DESCRIPTION****PURPOSE**

N93 Versatile Passive Neutron Monitor is a series of identical neutron counting modules, which can be used individually or in any reconfigurable combination of up to eight modules.

Measurements can be made on mg to kg quantities depending on the number of counting modules used and the chemical and isotopic composition of the Pu.

PRINCIPLES OF OPERATION

The flexible positioning of the counting modules allows the Pu content of almost any waste container to be assayed, provided that a calibration can be made under similar geometrical conditions. The standard eight module system can be expanded by the addition of further modules to suit user requirements.

FUNCTIONAL BLOCKS

- 8 neutron counting modules mounted on a wheeled base on fixing plates (alternatively)
- Model N97 neutron coincidence analyzer

SPECIFICATIONS

Measurement time	1000 s
Sensitivity (for eight slabs around a 200 l drum)	<4 mg Pu-240
Accuracy	1-25 %
Cavity dimension	up to 200 liter drums

SOFTWARE

DOS/Windows

ADDITIONAL INFORMATION**REFERENCES**

B.H.Armitage et al., "A scan a source matrix correction technique for use with a reconfigurable passive neutron Plutonium assay system," Nucl. Instrum. & Meth. in Physics Research, 1995, A354, pp. 522-526

Accounting: Waste Measurement System**TRU Drum Monitor**
MODEL:**152****SUPPLIER:** BNFL Instruments**USE CATEGORY:** Accounting**DEVICE TYPE:** Waste Measurement System**MEASUREMENT METHOD:** Gamma, Neutron Coincidence Counting
Passive**MEASURED PROPERTIES:** Weight**NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:** Waste**STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** BNFL Instruments**MANUFACTURER:** BNFL Instruments**DESCRIPTION****PURPOSE***TRU waste assay for safeguards, criticality, transport and disposal purposes.***PRINCIPLES OF OPERATION**

Passive neutron coincidence counting combined with high resolution gamma spectrometry. Advanced and approved matrix correction techniques. Measurement control, including automatic regular self checking of both gamma and neutron counting systems. Large dynamic range - fully deadtime corrected. Loading and unloading of drums via roller conveyor or directly onto turntable.

System boot-up, test and background determination is automatic. In normal operation the system prompts the operator to load and unload drums. Once loaded the drum is rotated during the measurement to allow a better all round view of the drum by the mechanically integrated high resolution gamma spectrometry (HRGS) detector. On-screen outputs drum identification (configuration), weight, Pu mass and overall error and Pu isotopic composition.

FUNCTIONAL BLOCKS

- Turntable to accommodate 200 liter and 500 liter drums.
- Detectors:
 - 30-60 He3 neutron detectors in 4 p configuration;
 - 1 high purity germanium detector.
- Measurement chamber made of stainless steel.
- Control computer PC based. Optional optical disk drive.

SPECIFICATIONS

Detection limit: 20 mg total plutonium,
in 1000 second count.

Dynamic range: 20 mg - 850 g

Accuracy: $\pm 15\%$

SOFTWARE**ADDITIONAL INFORMATION**

The monitor can be supplied with an additional module which uses the gamma spectrum to identify and quantify other gamma emitters within the drum.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System**153****Automated Waste Assay System****MODEL: WM2211****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Waste Measurement System**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):** TRU**PHYSICAL FORM(S) OF NM:** Waste**STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** *Canberra Industries, Inc.***MANUFACTURER:** *Canberra Industries, Inc.***DESCRIPTION****PURPOSE***The Automated Waste Assay System is designed to quantify transuranic and fission product waste.***PRINCIPLES OF OPERATION**

The system features a multiple matrix correction techniques including (optional) transmission correction hardware and software. It includes a PLC based mechanism control system and optional dose measurement modules.

FUNCTIONAL BLOCKS

- a conveyor rotator module for interface to automated conveyor line
- an automated batch processing software
- bar code reader and dosimeter(s) are optional

SPECIFICATIONS

Drum capacity 200 L (55 gallon) and 300 L (85 gallon)

SOFTWARE**ADDITIONAL INFORMATION**

Complete conveyor lines are available.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System**Box Assay Counters****MODEL: WM-2500****154****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Waste Measurement System**MEASUREMENT METHOD:** Gamma
Passive**MEASURED PROPERTIES:** Isotopic Composition**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:** Отходы**STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Canberra Industries, Inc.**MANUFACTURER:** Canberra Industries, Inc.**DESCRIPTION****PURPOSE**

The WM-2500 Series Box counters assay boxes and other containers too large for traditional systems. While the primary intent of the systems is to measure B25 containers and standard waste boxes, the same systems can be used to measure even larger containers such as half-height and full-height ISO containers.

PRINCIPLES OF OPERATION

The WM-2500 Series ranges from very simple manually-controlled systems up to multiple-detector, full-automated systems. Their modular design can be configured in various ways, depending upon the size of the sample container and the desired level of detection, manpower and sample throughput. Modular components provide flexibility for different applications and this device has manual or fully automated sample movement and radionuclide-specific results.

The system includes bi-lateral measurements and density correction for best accuracy and multiple horizontal segments for non-homogeneity identification. It also eliminates need to repackage waste into smaller containers.

FUNCTIONAL BLOCKS

Ge or NaI(Tl) detectors

SPECIFICATIONS**SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System**Combined Thermal Epithermal Neutron Counter****MODEL: WM-3600 (CTEN)****155****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Waste Measurement System**MEASUREMENT METHOD:** Neutron

Active, Passive

MEASURED PROPERTIES: Effective Isotope Mass**NUCLEAR MATERIAL(S):** Pu, U**PHYSICAL FORM(S) OF NM:** Waste**STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Canberra Industries, Inc.**DESCRIPTION****PURPOSE**

The WM3600 Combined Thermal Epithermal Neutron Counter (CTEN) is designed for quantification of plutonium and uranium.

PRINCIPLES OF OPERATION

Device uses active interrogation of fissile isotopes in 200 L drums and passive measurement of even isotopes of plutonium. The counter supports traditional differential die-away analysis and has thermal interrogation for improved sensitivity. It features epithermal interrogation for reduced self shielding effects.

FUNCTIONAL BLOCKS**SPECIFICATIONS****SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System**Curved Passive Neutron Slab Counters****MODEL: WM-3500****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Waste Measurement System**MEASUREMENT METHOD:** Neutron

Passive

MEASURED PROPERTIES: Effective Isotope Mass**NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:** Waste**STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Canberra Industries, Inc.**MANUFACTURER:** Canberra Industries, Inc.**156****DESCRIPTION****PURPOSE***The WM-3500 Series Curved Passive Neutron Slab Counters measure the plutonium content in drums.***PRINCIPLES OF OPERATION**

The slabs can be configured closely around a drum or separated and placed on opposite sides of a crate. The high-density polyethylene moderator slabs have a welded stainless steel skin for easy decontamination and fire protection. The units are transportable to allow easy repositioning around a drum or crate.

FUNCTIONAL BLOCKS

- four high-density polyethylene moderator slabs
- welded stainless steel skin

SPECIFICATIONS**SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System**Flat-Squared Canister Counters****MODEL: WM-3300****157****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Waste Measurement System**MEASUREMENT METHOD:** Neutron

Passive

MEASURED PROPERTIES: Effective Isotope Mass**NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:** Waste**STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** *Canberra Industries, Inc.***MANUFACTURER:** *Canberra Industries, Inc.***DESCRIPTION****PURPOSE**

The WM-3300 Series Flat Squared Canister Counters measure the Pu-240 effective mass in waste samples in canisters. The counters provide quantification of plutonium mass in waste in small canisters, perform transuranic/low-level waste classification.

PRINCIPLES OF OPERATION

The counters are designed with graphite end plugs and a polyethylene/cadmium sleeve to flatten axial and energy response. They are designed for in-plant measurements of large plutonium samples but also can be used to measure scrap waste containing milligram quantities of plutonium.

FUNCTIONAL BLOCKS

- graphite end plugs
- polyethylene/cadmium sleeve
- a hoist lifting mechanism

SPECIFICATIONS

Sensitivity milligrams of Pu-240
Sample size up to 24 cm diameter x 41 cm tall

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System**Large-Volume Decommissioning Counter****MODEL: WM-2400****158****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Waste Measurement System**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:** Waste**STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** *Canberra Industries, Inc.***MANUFACTURER:** *Canberra Industries, Inc.***DESCRIPTION****PURPOSE**

The WM-2400 Large-Volume Decommissioning Counters are designed to automatically separate radioactive from nonradioactive waste.

PRINCIPLES OF OPERATION

The WM-2400 Series has multiple Ge and/or NaI detectors for qualitative and quantitative analysis, allowing radionuclide-specific release limits. Detectors and samples are totally enclosed in a low-background steel shield. A weight-sensing sample turntable rotates during an assay. Software corrects for sample density and correlates gamma emitters to non-gamma emitters based on waste stream type.

The system features free-release measurement of decommissioning material including thermal insulation, steel pipes, electrical wiring and concrete. It also has automatic "clean/contaminated" decision, automated operation for high throughput applications, large sample volume-1 m³ (250 gallon), energy and density calibration, and uses Ge or NaI(Tl) detectors.

FUNCTIONAL BLOCKS

- Ge and/or NaI detectors
- low-background steel shield
- sample turntable
- software

SPECIFICATIONS**SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System**Low Level Passive Neutron Counter for 200 Liter Drums**
MODEL: JCC-21**159****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Waste Measurement System**MEASUREMENT METHOD:** Neutron Coincidence Counting
Passive**MEASURED PROPERTIES:** Effective Isotope Mass**NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:** Waste**STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Canberra Industries, Inc.**DESCRIPTION****PURPOSE**

The JCC-21 Passive Neutron Coincidence Counter with the "add-a-source" option is designed for assay of the plutonium content in 200 liter (55 gal) waste drums.

PRINCIPLES OF OPERATION

High counting efficiency is obtained by multiple He-3 detectors in a 4pi geometry, and a high-density polyethylene moderator provides relative insensitivity to the effects of scattering reactions in the matrix. To facilitate drum loading and unloading, aluminum rollers are built into the loading platform and in the base of the counting chamber. Once the drum is loaded, the motor-driven door is closed and counting can begin. The door control circuitry includes safety interlocks to prevent the door from closing on an object that may be in its path. All sides of the counting chamber, including the door, have in excess of 10 cm (4 in.) of high density polyethylene shielding to reduce background and improve the detection limit of the system.

A control and indicator panel is used by the operator to open and close the door of the counting chamber. As a safety precaution, two pushbuttons - Door Enable plus Open Door or Close Door - must be simultaneously depressed to activate the automatic door mechanism. Indicators are provided for both the normal Opened and Closed limit switches as well as the Emergency Stop safety interlock switch.

Fast Amptek JAB-01 Amplifier/Discriminator modules are used to process the signals from the detectors. A total of 10 JAB-01s are used: two for each of the four side detector banks and one channel each for the top and bottom detector banks.

The "add-a-source" option, which was developed by Los Alamos National Laboratory (LANL) and available from Canberra, provides a significant improvement in accounting for the matrix effects by actually measuring the matrix absorption of neutrons from a small Cf-252 source and correcting the detected flux for the matrix absorption. The source is housed in a polyethylene shield and includes a cable transfer mechanism and stepping motor to move the source between the shield and the counting chamber. Measurements performed during certification at the Power Reactor Nuclear Fuel Development Corporation/Plutonium Fuel Production Fuel Facility (PNC/PFPF) in Japan demonstrated reduction in errors from matrix effects by an order of magnitude using the "add-a-source" option. [2]

FUNCTIONAL BLOCKS

- 60 He-3 filled proportional counting tubes (10 in each of the six sides of the chamber) embedded in high density polyethylene
- 10 fast Amptek JAB-01 Amplifier/Discriminator modules (two for each of the four side detector banks and one channel each for the top and bottom detector banks)
- Neutron Coincidence Analyzer JSR-12

SPECIFICATIONS

Detector active length	91.4 cm (36 in)
Sensitivity	53.3 cm (21 in) (in the top and bottom) less than 15 mg of Pu-240-eff within a 200 liter barrel
Counting time	less than 20 minutes

Cavity dimension 71 cm x 71 cm x 107 cm (28 in x 28 in x 42 in)

SOFTWARE

The overall control of the systems handled from the PC by the neutron coincidence applications software, which provides a convenient menu-driven interface to all system functions. The software is based upon analysis algorithms developed at Los Alamos National Laboratory [1]. The software also includes functions for setting the JSR-12s acquisition parameters and for report generation. A separate password-protected Supervisor option is provided for setting and verifying those system parameters which are critical to proper system operation.

ADDITIONAL INFORMATION

The results of the measurements made at LANL, which were performed with a 1000 second counting time are summarized as follows: with the 0.06 counts/second ambient background, a minimum detectable activity of less than 0.002 g Pu-240-eff was achieved. A detection limit of 0.73 mg Pu-240-eff was measured for coincidence counts at PNC/PFPF where the coincident background was 0.006 cps. A detection limit of 0.4 mg Pu-240-eff was measured for total counts at Los Alamos National Laboratory, demonstrating a lower detection limit for screening waste where the (alpha,n) component is known.

REFERENCES

1. M.S. Krick, Algorithms and Software for Data Acquisition and Analysis Using Thermal Neutron Coincidence Counters within the IAEA's IFSS/NCC System, Los Alamos National Laboratory Document LA-UR-88-1301.
2. H.O. Menlove, et al., WDAS Operation Manual Including the Add-A-Source function, Los Alamos National Laboratory Report LA-12292-M, April 1992.

Accounting: Waste Measurement System

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Low Level Waste Assay System

MODEL: WM-2100 Series Q2

SUPPLIER: *Canberra Industries, Inc.*

USE CATEGORY: Accounting
 DEVICE TYPE: Waste Measurement System
 MEASUREMENT METHOD: Gamma
 Passive
 MEASURED PROPERTIES: Isotopic Composition
 NUCLEAR MATERIAL(S): Cs, Co, Th, U, Pu, Np
 PHYSICAL FORM(S) OF NM: Waste
 STATUS: Serial Production
 PORTABILITY: Stationary
 ENVIRONMENT OF USE: Industrial
 DEVELOPER: *Canberra Industries, Inc.*
 MANUFACTURER: *Canberra Industries, Inc.*

DESCRIPTION

PURPOSE

The WM-2100 Series Q2 low-level waste assay systems provides qualitative and quantitative analysis, allowing radionuclide-specific release limits for individual isotopes.

PRINCIPLES OF OPERATION

The detectors and samples are totally enclosed in a thick low-background steel shield. The weight-sensing sample turntable is mounted on the door and rotates during an assay. Software corrects for sample density and correlates gamma emitters to non-gamma emitters based on waste stream type.

The WM-2100 Series meets 1 Bq/g for free-release of waste and certifies low-level waste classification and TRU waste classification. It discriminates between natural and man-made radionuclides and classifies mixed waste as hazardous only. This device provides legally defensible verification of results and calculates alpha/beta emitters that cannot be measured directly using customer-provided correlations. It also calculates the plutonium and uranium isotopes using optional Multi-Group Analysis (MGA) Code.

FUNCTIONAL BLOCKS

- three 20% Germanium detectors
- low-background steel shield
- sample turntable

SPECIFICATIONS

Thickness of steel shield	10 cm (4 in.) or 15 cm (6 in.)
Measurement time	10 minutes

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System**Passive Neutron Coincidence Drum Counters****MODEL: WM-3100/HENC****161****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Waste Measurement System**MEASUREMENT METHOD:** Neutron Coincidence Counting
Passive**MEASURED PROPERTIES:** Effective Isotope Mass**NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:** Waste**STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Canberra Industries, Inc.**MANUFACTURER:** Canberra Industries, Inc.**DESCRIPTION****PURPOSE***The systems assays plutonium in low-level waste.***PRINCIPLES OF OPERATION**

The WM-3100 Series Passive Neutron Drum Counter with He-3 detectors arranged on all sides provides accurate, precise and sensitive assay of plutonium content in 118 L (32 gallon) to 200 L (55 gallon) drums. The add-a-source option improves the accuracy of the measurement for matrices with a high hydrogen content.

High Efficiency Neutron Counter (HENC) has all the design features of WM-3100; further, 32% efficiency for Pu results in a lower MDA and correction for matrix effects on localized Pu sources, using the advanced multiplicity technique.

FUNCTIONAL BLOCKS**SPECIFICATIONS**

Count time	1000 sec
Sensitivity:	0.73 mg Pu-240-effective with 0.006 cps coincidence background
	2.74 mg Pu-240-effective with 0.02 cps coincidence background
	0.4 mg Pu-240-effective with 2.6 cps coincidence background

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System

Passive Neutron Slab Counters

MODEL: WM-3400

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SUPPLIER: *Canberra Industries, Inc.*

USE CATEGORY: Accounting
DEVICE TYPE: Waste Measurement System
MEASUREMENT METHOD: Neutron
Passive
MEASURED PROPERTIES: Effective Isotope Mass
NUCLEAR MATERIAL(S): Pu
PHYSICAL FORM(S) OF NM: Waste
STATUS: Serial Production
PORTABILITY: Portable
ENVIRONMENT OF USE: Industrial
DEVELOPER: *Canberra Industries, Inc.*
MANUFACTURER: *Canberra Industries, Inc.*

DESCRIPTION

PURPOSE

The WM-3400 Series Passive Neutron Drum Slab Counters perform a go/no-go measurement of the plutonium content in drums up to 200 L (55 gallons).

PRINCIPLES OF OPERATION

A drum-positioning fixture is attached to the front of the counter for repeatable positioning near 200 L drums. The 200 L counter is attached to a cart for easy mobility. This device is transportable to allow positioning in front of a drum.

FUNCTIONAL BLOCKS

- a single slab of high-density polyethylene with multiple He-3 tubes
- drum-positioning fixture
- cart
- portable computer
- printer

SPECIFICATIONS

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System

Segmented Gamma Ray Scanner

MODEL: SGS

163

SUPPLIER: *Canberra Industries, Inc.*

USE CATEGORY: Accounting

DEVICE TYPE: Waste Measurement System

MEASUREMENT METHOD: Gamma

Active

MEASURED PROPERTIES: Isotopic Composition

NUCLEAR MATERIAL(S): U, Pu

PHYSICAL FORM(S) OF NM: Waste, Scrap

STATUS: Limited Production

PORTABILITY: Portable

ENVIRONMENT OF USE: Industrial

DEVELOPER: Los Alamos National Laboratory

MANUFACTURER: *Canberra Industries, Inc.*

DESCRIPTION

PURPOSE

Used to quantify the radioisotope content of low-density scrap and waste containers (principally isotopes of uranium and plutonium). Constructed in various configurations allowing measurements on items ranging from small vials to 200-liter drums.

PRINCIPLES OF OPERATION

Segments of the sample are scanned by the transmission source as the sample is raised by the elevator and turned about the vertical axis by the rotator. Gamma radiation from the sample and the source is detected with a collimated germanium detector cooled with liquid nitrogen from a cryostat. Combining the results from each segment yields the assayed isotope mass in the sample.

The SGS measures gamma radiation arising from natural radioactive decay. Correction factors and refinements are then applied to the measurement to improve its accuracy. These enhancements fall into three categories: gamma-ray attenuation and absorption corrections, sample rotation and vertical scanning, and rate-loss corrections.

Calibration is usually accomplished with samples consisting dilute mixtures of SNM in oxide form mixed with sand or graphite (no chemical match with the measured material is required).

FUNCTIONAL BLOCKS

- transmission source S-75
- collimated HPGe (LN2-cooled)
- elevator
- rotator

SPECIFICATIONS

Measurement range	0.2 gal cans to 55 gal barrels
Measurement time	20 minutes per item
Source activity	12 mCi
Detector efficiency	25%

Accuracy (in 2 gal cans):

up to 10 g	1-5%
10 to 100 g	5-10%
100-500 g	10-25%
homogeneous items	1%

Overall size	75 cm x 200 cm x 200 cm
Weight	few hundred kilograms

SOFTWARE

ADDITIONAL INFORMATION

Some materials cannot be processed by this device: dense items whose transmission cannot be measured, short items (height less than half the diameter), items for which the matrix or SNM is extremely lumpy or heterogeneous, and large items such as 55- gallon drums containing isotopes emitting low-energy gamma rays

(for example, the 185-ke-V gamma ray from U235).

REFERENCES

LANL Application Note, Segmented Gamma-Ray Scanner, LALP-91-011, March 1991.

Accounting: Waste Measurement System**164****Segmented Waste Assay System****MODEL: WM-2200 Series****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Accounting**DEVICE TYPE:** Waste Measurement System**MEASUREMENT METHOD:** Beta, Gamma

Passive

MEASURED PROPERTIES: Isotopic Composition**NUCLEAR MATERIAL(S):** Cs, Co, Ba, Eu, U, Pu**PHYSICAL FORM(S) OF NM:** Waste**STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** *Canberra Industries, Inc.***MANUFACTURER:** *Canberra Industries, Inc.***DESCRIPTION****PURPOSE**

Segmented waste assay systems measure transuranic radionuclides and fission/activation products in containers of low-density waste. This device quantifies TRU and beta/gamma waste.

PRINCIPLES OF OPERATION

Multiple correction techniques for matrix attenuation and lump correction algorithms for self-absorption are available. Optional pseudo-tomography for detecting non-uniform source distributions is available. Also available are a horizontal detector movement to optimize sample and detector geometry and a surface dose rate meter.

Versions of the system handle from 20 L (5 gal) to 320 L (85 gal) drums.

FUNCTIONAL BLOCKS

- high-resolution Ge detector
- LN2 Dewar or cryoelectric (LN2-free, electrically-cooled)
- manual or automatic rotator platform
- transmission source

SPECIFICATIONS

Measurement time	one minute per segment
Sensitivity:	
Cs, Co	0.1 mCi
Ba	0.2 mCi
Eu	0.4 mCi
U-235	0.2 mCi
U-238	20 mCi
Pu-238	12 mCi in low-density drum wastes (0.1 - 0.2 g/cm ³)

SOFTWARE

Analysis and control software include the latest algorithms for improved accuracy and is designed for a semi-skilled operator performing routine assay functions. This device calculates the plutonium and uranium isotopes using optional Multi-Group Analysis (MGA) Code.

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System**Waste Activity Monitor****MODEL: WAM-10****165****SUPPLIER:** *Canberra Industries, Inc.*

USE CATEGORY:	Accounting
DEVICE TYPE:	Waste Measurement System
MEASUREMENT METHOD:	Gamma Passive
MEASURED PROPERTIES:	Radiation Intensity
NUCLEAR MATERIAL(S):	
PHYSICAL FORM(S) OF NM:	Waste
STATUS:	Serial Production
PORTABILITY:	Stationary
ENVIRONMENT OF USE:	Industrial
DEVELOPER:	Canberra Industries, Inc.
MANUFACTURER:	Canberra Industries, Inc.

DESCRIPTION**PURPOSE**

The monitor is designed for high sensitivity waste measurements in short count time.

PRINCIPLES OF OPERATION

Allows for user-defined operating parameters and alarms. Uses large area plastic scintillator detectors in 4-pi geometry for optimum sensitivity. Allows for optional through-holes in side detectors for monitoring long items. Count time can be automatically determined based upon the counting statistics.

FUNCTIONAL BLOCKS

- 6 plastic scintillator detectors
- weighing platform (0-45.5 kg)
- Cd-109 and Co-60 calibration sources
- NaI detector
- low background shield

SPECIFICATIONS

Operation environment	0°C to 40°C, humidity 0-95%, non-condensing
Measurement time	2 minutes
Sensitivity:	
3.8 thick detectors	2 nCi Co-60
7.6 thick detectors	400 pCi Co-60
(at 90% confidence level	
with 15% error in 2 minutes	
with 20 mR/hr background)	
Cavity dimension	60.1 cm x 68.6 cm x 73.6 cm (HxLxW)
Detector size	48.3 cm x 63.5 cm x 3.8 cm (HxLxW)
Overall size	179.1 cm x 89.5 cm x 109.2 cm (HxLxW)
Weight	3,402 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System***Waste Curie Monitor*****MODEL: WCM-10PC****166****SUPPLIER:** *National Nuclear Corporation***USE CATEGORY:** Accounting**DEVICE TYPE:** Waste Measurement System**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:** Waste**STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** National Nuclear Corporation**MANUFACTURER:** National Nuclear Corporation**DESCRIPTION****PURPOSE***Radiation monitor used to assay bagged waste, tools, drums, and other items prior to disposal.***PRINCIPLES OF OPERATION**

Each detector is supported by an independent microprocessor which controls all data acquisition and detector parameters. System controls and electronics are modular for easy removal during transport and maintenance. Results are displayed as as total activity or specific activity. Alarms: total or specific activity; audible; red status bar.

FUNCTIONAL BLOCKS

- six plastic scintillation detectors, 1.5" thick on six sides arranged in a 4-Pi geometry
- 1.5" of lead surrounds detectors
- six independent microprocessors
- housed PC

Options and accessories include:

- a weight scale; 1000 lb capacity;
- NaI detector with integrated MCA for isotopic analysis;
- printer and network capability;
- 3" thick scintillators;
- 2.5" lead shielding;

SPECIFICATIONS

Measurement time	automatic or on demand
Sensitivity	< 2 nCi Co-60 with a one minute count time and 20 mR/hr background
Operating temperature	-18C to +40C
Power supply	220 V VAC power.
Cavity dimension	27"D x 24"W x 29"H
Overall size	40"D x 34"W x 62"H
Weight	2948 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System**Active-Passive Neutron Examination and Assay System****MODEL: APNEA****167****SUPPLIER: Oak Ridge National Laboratory**

USE CATEGORY: Accounting
DEVICE TYPE: Waste Measurement System
MEASUREMENT METHOD: Neutron
 Active, Passive
MEASURED PROPERTIES: Effective Isotope Mass
NUCLEAR MATERIAL(S): Pu, U
PHYSICAL FORM(S) OF NM: Waste, Solution
STATUS: One-of-a-kind
PORTABILITY: Stationary
ENVIRONMENT OF USE: Industrial
DEVELOPER: Oak Ridge National Laboratory
MANUFACTURER: Oak Ridge National Laboratory

DESCRIPTION**PURPOSE**

Determines the spacial disposition of TRU material within a drum. In addition, the passive measurement of neutron activity from the drum yields a crude but confirmatory measure of the position of any material which spontaneously generates neutrons.

PRINCIPLES OF OPERATION

Differential Dieaway Method utilizes thermal neutrons as its probe and fission neutrons as its signal. The APNEA utilizes a 4 pi neutron detection system incorporating shielded (cadmium-wrapped) and bare He-3 detector tubes positioned both inside and outside the assay chamber walls. The system is capable of two scans: active and passive. The active scan uses a deuterium-tritium neutron generator which emits approximately $1E+6$ 14-MeV neutrons per pulse and can be pulsed up to a maximum rate of 100 times per second. After thermalization, the interrogating neutrons are then absorbed by any fissile nuclides (e.g., U-235 and Pu-239) contained in the drum. The resulting fast-fission neutrons are detected by the cadmium-wrapped He-3 detector tubes. The passive scan detects any spontaneous fission and (α, n) neutrons. The combined assay yields the total TRU content of the waste drum.

FUNCTIONAL BLOCKS

- cadmium-wrapped He-3 detector tubes
- bare He-3 detector tubes
- deuterium-tritium neutron generator ($1E+6$ n/sec, 14-MeV, 100pulses/sec)

SPECIFICATIONS

Sensitivity less than 1 mg of Pu-239 in a 55-gal waste drum.

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Internet site <<http://www.ornl.gov/armd/ndande.htm>>

Accounting: Waste Measurement System**Container Assay Systems****MODEL: CAS****168****SUPPLIER:** *Pajarito Scientific Corporation***USE CATEGORY:** Accounting**DEVICE TYPE:** Waste Measurement System**MEASUREMENT METHOD:** Gamma, Neutron Multiplicity Counting
Active, Passive**MEASURED PROPERTIES:** Effective Isotope Mass**NUCLEAR MATERIAL(S):** U-235, SRU, LLW**PHYSICAL FORM(S) OF NM:** Waste**STATUS:** Serial Production**PORATABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Pajarito Scientific Corporation**MANUFACTURER:** Pajarito Scientific Corporation**DESCRIPTION****PURPOSE**

Systems are designed for transuranic and uranium content waste packages: 2.5m x 2.5m x 6.5m. The system is similar to the IPAN/GEA Crate System (Imaging Passive-Active Neutron/Gamma Energy Assay Crate System) manufactured by PSC.

PRINCIPLES OF OPERATION

The physical principle is active and passive neutron multiplicity counting using PSC PMCCM electronics. Used pulsed D-T source. Both low resolution NaI and high resolution HPGe gamma analysis options are available. Systems range from simple passive neutron counters to complex Imaging Passive Active Neutron systems with High Resolution Gamma Spectroscopy.

FUNCTIONAL BLOCKS**SPECIFICATIONS**

Measurement range	1 mg to 1 kg Pu
Lower level wastes detection limit	10 nCi/g

SOFTWARE

Windows NT and Windows 95 and network compatible. PLC systems compatible.

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System**Drum Assay Systems****169*****MODEL:*****SUPPLIER:** *Pajarito Scientific Corporation***USE CATEGORY:** Accounting**DEVICE TYPE:** Waste Measurement System**MEASUREMENT METHOD:** Gamma, Neutron Multiplicity Counting
Active, Passive**MEASURED PROPERTIES:** Isotopic Composition, Effective Isotope Mass**NUCLEAR MATERIAL(S):** U-235, SRU, LLW, Pu**PHYSICAL FORM(S) OF NM:** Waste**STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Pajarito Scientific Corporation**MANUFACTURER:** Pajarito Scientific Corporation**DESCRIPTION****PURPOSE**

Systems range from simple passive neutron counters to complex Imaging Passive Active Neutron systems with High Resolution Gamma Spectroscopy. Systems are designed for transuranic and uranium content waste packages: 28 litre cans to 400 litre drums. Similar to IPAN/GEA Drum System (Imaging Passive-Active Neutron/Gamma Energy Assay Drum System) manufactured by PSC.

PRINCIPLES OF OPERATION

The physical principle is an active and passive neutron multiplicity counting using PSC PMCCM electronics, with active neutron imaging using pulsed D-T source and differential dieaway analysis. Both low resolution NaI and high resolution HPGe gamma analysis options are available.

FUNCTIONAL BLOCKS**SPECIFICATIONS**

Container size 28 litre cans to 400 litre drums

SOFTWARE

Windows NT and Windows 95 and network compatible. PLC systems compatible.

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System

Imaging Area Neutron Coincidence Counter**MODEL: IANCC****170****SUPPLIER:** Pajarito Scientific Corporation**USE CATEGORY:** Accounting**DEVICE TYPE:** Waste Measurement System**MEASUREMENT METHOD:** Neutron

Passive

MEASURED PROPERTIES: Effective Isotope Mass**NUCLEAR MATERIAL(S):** Pu-238, Pu-240, Pu-239, Am-241, Cm-244**PHYSICAL FORM(S) OF NM:** Waste**STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Pajarito Scientific Corporation**MANUFACTURER:** Pajarito Scientific Corporation**DESCRIPTION****PURPOSE***IANCC is a self-contained passive neutron instrument that can be used to assay plutonium contaminated vessels and areas.***PRINCIPLES OF OPERATION**

Optional programmable multi-coincidence counter module is available to distinguish spontaneous fission neutron sources from alpha, neutron sources.

Three dimensional images can be used to reduce waste volume disposal, to assist in criticality assessment, and to provide more accurate positional accountability of the material.

FUNCTIONAL BLOCKS

Array of He-3 proportional counters

SPECIFICATIONS

Measurement time	5 minutes
Sensitivity	<0.1 g (single mode, total Pu content); < 10 g (coincidence mode, total Pu content)
Overall size	1 m ² to 4 m ² x 0.15 m
Weight	250 to 1000 pounds

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System

Mobile Assay SystemMODEL:

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SUPPLIER: Pajarito Scientific Corporation

USE CATEGORY: Accounting
DEVICE TYPE: Waste Measurement System
MEASUREMENT METHOD: Neutron, Gamma
 Active, Passive
MEASURED PROPERTIES: Isotopic Composition, Effective Isotope Mass
NUCLEAR MATERIAL(S): Pu, U, LLRW, TRU
PHYSICAL FORM(S) OF NM: Waste
STATUS: Serial Production
PORTABILITY: Portable, Stationary
ENVIRONMENT OF USE: Industrial
DEVELOPER: Pajarito Scientific Corporation
MANUFACTURER: Pajarito Scientific Corporation

DESCRIPTION**PURPOSE***Measurement of wide range of different waste matrices and Pu or U isotopic compositions.***PRINCIPLES OF OPERATION**

High sensitive active neutron measurement is performed using pulsed D-T neutron source and imaged differential dieaway analysis. Imaging analysis is performed during both passive and active mode neutron analysis.

FUNCTIONAL BLOCKS**SPECIFICATIONS**

Measurement range	< 1 mg - 1000 grams Pu-239 or U-235
Measurement time	15 - 30 minutes per drum
Sensitivity	< 1 mg total Pu
Accuracy	< 15%
Overall size	10' x 40' trailer
Container size	55 -85 gal drums, up to 1000 pounds

SOFTWARE

Windows NT and Windows 95 and network compatible. PLC systems compatible.

ADDITIONAL INFORMATION

Measurement systems are protected against mechanical and electrical interferences.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System**Plutonium Container Assay Monitor****MODEL: P-CAM****172****SUPPLIER:** *Pajarito Scientific Corporation***USE CATEGORY:** Accounting**DEVICE TYPE:** Waste Measurement System**MEASUREMENT METHOD:** Gamma, Neutron Multiplicity Counting
Active, Passive**MEASURED PROPERTIES:** Isotopic Composition, Effective Isotope Mass**NUCLEAR MATERIAL(S):** Plutonium-239, Americium-241, TRU**PHYSICAL FORM(S) OF NM:** Oxide, Metal, Salts**STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Pajarito Scientific Corporation**MANUFACTURER:** Pajarito Scientific Corporation**DESCRIPTION****PURPOSE***Plutonium Container Assay Monitor (P-CAM) performs measurements of residues and waste packages contained within processing glove boxes.***PRINCIPLES OF OPERATION**

Fully integrated passive neutron multiplicity measurement and high resolution gamma-ray analysis of plutonium isotopic composition.

FUNCTIONAL BLOCKS

- He-3 proportional counters;
- HPGe detector.

SPECIFICATIONS

Measurement time	10 minutes
Sensitivity	less than 0.1 g Pu
Dimensions of assayed cans	up to 6.5" diam x 13" high.
Accuracy	< 10% for most applications
Overall size	3' x 3' x 4'
Weight	500 pounds

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System**Low Level Waste System for FM Mass Determination**
MODEL:**173****SUPPLIER:** *VNIIA, All-Russian Research Institute of Automatics*

USE CATEGORY: Accounting
DEVICE TYPE: Waste Measurement System
MEASUREMENT METHOD: Neutron
 Active
MEASURED PROPERTIES: Effective Isotope Mass
NUCLEAR MATERIAL(S): Pu, U, MOX
PHYSICAL FORM(S) OF NM: Waste
STATUS: Prototype
PORTABILITY: Stationary
ENVIRONMENT OF USE: Field
DEVELOPER: VNIIA, All-Russian Research Institute of Automatics
MANUFACTURER: VNIIA, All-Russian Research Institute of Automatics

DESCRIPTION**PURPOSE**

Determination of U-235, plutonium or their mixtures in low level wastes packed in standard containers of capacity no greater than 100 l. A pulsed neutron generator is used.

PRINCIPLES OF OPERATION

Irradiating samples by neutrons from pulse neutron generator, and detection of the secondary neutrons of the fission.

FUNCTIONAL BLOCKS

- measurement chamber (moderator, pulse neutron generator, detection units)
- control and processing unit (control panel, electronics)
- turntable for standard container
- replacement complect
- connection cables
- software (system, testing, and applied programs, PC)

SPECIFICATIONS

FM detection limit for 85 l standard container	100 mg
Measurement time	100 sec
Operation state settling time	5 min
Accuracy	30%
Capacity of measured containers	no more than 100 l
Environment of use:	
storage	+5°C to +40°C (80% humidity)
transportation	-50°C to +50°C (95% humidity)

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System

Fissile Nuclides Concentration Meter for Solutions

174

MODEL: *Смальта*

SUPPLIER: VNIITFA, All-Russian Research Institute of Technical Physics and Automatization

USE CATEGORY: Accounting

DEVICE TYPE: Waste Measurement System

MEASUREMENT METHOD: Neutron

Active

MEASURED PROPERTIES: Element Concentration

NUCLEAR MATERIAL(S): U

PHYSICAL FORM(S) OF NM: Solution

STATUS: One-of-a-kind

PORTABILITY: Stationary

ENVIRONMENT OF USE: Industrial

DEVELOPER: VNIITFA, All-Russian Research Institute of Technical Physics and Automatization

MANUFACTURER: VNIITFA, All-Russian Research Institute of Technical Physics and Automatization

DESCRIPTION

PURPOSE

Determination of fissile nuclide concentrations in solutions.

PRINCIPLES OF OPERATION

Detection of delayed neutrons from fissions induced by pneumatically moving Cf-252 neutron source.

FUNCTIONAL BLOCKS

SPECIFICATIONS

Measured concentration range (of U-235)	1 - 500 mg /l
Measurement time	15 min
Pneumatic-system pressure	0.4-0.6 MPa
Source moving time (of 5m)	0.5 s
Operation frequency	0.083 Hz
Passage diameter	45 mm
Equivalent dose rate in solution	no more than 500 R/hr

SOFTWARE

ADDITIONAL INFORMATION

The concentration meter provides compensation of the error caused by fission products neutron absorption.

Analog - Liquid Sample Shuffler Device (Los Alamos, USA)

Electronics can be updated on preliminary demand. Cf-252 source can be supplied and recharged on demand.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: Waste Measurement System**Indicator of the Transuranium Nuclide Content****MODEL: Салют****SUPPLIER: VNIITFA, All-Russian Research Institute of Technical Physics and Automatization**

USE CATEGORY:	Accounting
DEVICE TYPE:	Waste Measurement System
MEASUREMENT METHOD:	Neutron Coincidence Counting
	Passive
MEASURED PROPERTIES:	Effective Isotope Mass
NUCLEAR MATERIAL(S):	Pu
PHYSICAL FORM(S) OF NM:	Waste
STATUS:	One-of-a-kind
PORTABILITY:	Stationary
ENVIRONMENT OF USE:	Industrial
DEVELOPER:	VNIITFA, All-Russian Research Institute of Technical Physics and Automatization
MANUFACTURER:	VNIITFA, All-Russian Research Institute of Technical Physics and Automatization

175**DESCRIPTION****PURPOSE**

Determination of spontaneous fissile nuclides contents in solid, low and medium active wastes, both dry and moist.

PRINCIPLES OF OPERATION

Measurement of the neutron flux and selection of time-correlated-fission-neutrons.

FUNCTIONAL BLOCKS**SPECIFICATIONS**

Error of the eff.Pu mass determination in the range of 0.05 - 5 g	2 - 7%
Internal cavity size	16 and 64 l
Operation mode	periodic
Life time	6 years

SOFTWARE**ADDITIONAL INFORMATION**

Developed on the base of the installation "Салют" measurement techniques for the neutron distribution per effective fission. Electronics is updated on demand.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: XRF System**Transmission-Corrected X-Ray Fluorescence Analysis System****176****MODEL: XRA****SUPPLIER: Lawrence Livermore National Laboratory****USE CATEGORY:** Accounting**DEVICE TYPE:** XRF System**MEASUREMENT METHOD:** XRF**MEASURED PROPERTIES:** Passive, Active**NUCLEAR MATERIAL(S):** Element Concentration**NUCLEAR MATERIAL(S):** U, Pu**PHYSICAL FORM(S) OF NM:** Solution**STATUS:** Prototype**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Lawrence Livermore National Laboratory**MANUFACTURER:** Lawrence Livermore National Laboratory**DESCRIPTION****PURPOSE**

The method is designed for determining plutonium and uranium concentrations in solutions at nuclear facilities to avoid difficult and time-consuming transport of samples to analytical laboratories.

PRINCIPLES OF OPERATION

Two radioactive Co-57 sources are used to excite the uranium and plutonium K x-rays. A combined Co-57 and Gd-153 transmission source is used to measure attenuation affects of the solution. Transmitted gamma-ray and fluorescent x-ray intensities are measured with HPGe detector. Exciter source shutter is used for passive and active measurements.

FUNCTIONAL BLOCKS

- two Co-57 sources (10 mCi each)
- a combined Co-57 and Gd-153 (2 mCi each) transmission source
- HPGe detector and supporting electronics
- exciter source shutter

SPECIFICATIONS

Measurement range	0.5 to 400 grams/L
Accuracy	within 1 %

SOFTWARE

Spectrum analysis software to determine x-ray and transmission gamma-ray intensities.

ADDITIONAL INFORMATION**REFERENCES**

W. Ruhter, Transmission-Corrected X-Ray Fluorescence Analysis, Colloquium on MPC&A Technologies, LLNL, Livermore, CA, February 13-15, 1995 (UCRL-MI-119836).

Accounting: XRF System

Portable CdTe XFA-Spectrometer for Fast Analysis of Element Analysis
on-Situ

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MODEL: AMTK-21

SUPPLIER: PNPI, St-Petersburg Nuclear Physics Institute

USE CATEGORY: Accounting
 DEVICE TYPE: XRF System
 MEASUREMENT METHOD: Gamma, XRF
 Active
 MEASURED PROPERTIES: Weight
 NUCLEAR MATERIAL(S): U
 PHYSICAL FORM(S) OF NM:
 STATUS: Serial Production
 PORTABILITY: Portable
 ENVIRONMENT OF USE: Industrial
 DEVELOPER: PNPI, St-Petersburg Nuclear Physics Institute
 MANUFACTURER: PNPI, St-Petersburg Nuclear Physics Institute

DESCRIPTION

PURPOSE

XFA directly at the points of contacts the device probe with explore surface. Detection of U shielded by a package.

PRINCIPLES OF OPERATION

With assistance of a telluride-cadmium detector the detection of the sample x-ray fluorescent intensity induced by radioisotopic sources and simultaneous processing, decoding, registration and accumulation of measured spectrum.

FUNCTIONAL BLOCKS

- CdTe probe;
- Source -Co57 (Am241, Cd109 - on demand);
- Miniature terminal with liquid crystal display;
- Built-in computer

SPECIFICATIONS

Operation energy range:	from 6 keV to 140 keV
Energy resolution:	from 0.8 keV to 1.5 keV
*Detection limit of elements with Z>50	
at confidence level of 99%,	
with measurement time in 15 s	
(depends on compound content and	
matrix):	from 0.01% to 0.1%
*The thickness of a steel wall,	
through which can be detect U, Pu, Hg	
Au and other material:	up to 6 mm
*Measured thickness range of Au, Pt surfaces:	
Size of input probe window:	from 0.1 mkm to 40 mkm
Probe size:	16 mm x 24 mm
Electronics unit weight with accumulator:	1 kg
Independent operation time:	3 kg
	8 hr

*Note: data reference to Co57.

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: XRF system**Device for the X-Ray Fluorescent Material Content Determination****178****MODEL: IIPIIM-1****SUPPLIER: VNIITEA, All-Russian Research Institute of Technical Physics and Automatization****USE CATEGORY:** Accounting**DEVICE TYPE:** XRF system**MEASUREMENT METHOD:** XRF

Active

MEASURED PROPERTIES: Element Concentration**NUCLEAR MATERIAL(S):** Pu, U, Th**PHYSICAL FORM(S) OF NM:** Metal, Solution, Powder**STATUS:****PORTABILITY:** Portable**ENVIRONMENT OF USE:** Field, Laboratory**DEVELOPER:** VNIITFA, All-Russian Research Institute of Technical Physics and Automatization**MANUFACTURER:** VNIITFA, All-Russian Research Institute of Technical Physics and Automatization**DESCRIPTION****PURPOSE***The qualitative analysis and elemental quantity estimation of solid, liquid, and gas samples.***PRINCIPLES OF OPERATION**

With assistance of a telluride-cadmium detector the detection of the sample x-ray fluorescent intensity induced by radioisotopic (Am-241, Pu-238) sources and simultaneous processing, decoding, registration and accumulation of measured spectrum.

FUNCTIONAL BLOCKS

- CdTe detector

- Am-241, Pu-238 sources

SPECIFICATIONS

Atomic numer range of defined elements	20- 92
Number of simultaneously defined elements	15
Element-estimated-concentration-range	0.5-100%
Measurement time	10 sec - 200 sec
Storage capacity	up to 200 spectra with 1024 channels of each, with up to 10 mln. pulses per channel

Exposure dose rate:on the detector surface
from a distance of 1 m to detector

Operation temperature range

Power supply

Power consumption

Weight with the independent power supply

no more than 10mR/hr
the natural background

from -10°C to +40°C

main or batteries

no more than 10 W

8.5 kg

SOFTWARE

Provides capability to process complex gamma spectra, perform calculations of concentration and metrologic characteristics, and to archive the results of analysis.

ADDITIONAL INFORMATION

The device has been developed on demand of the State Customs Committee of Russian Federation. Now more than 150 devices are used by enterprises of this Committee.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Accounting: XRF system

X-Ray Radiometric Uranium Concentratometer

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MODEL: РФА - 1М

SUPPLIER: VNIITFA, All-Russian Research Institute of Technical Physics and Automatization

USE CATEGORY: Accounting
 DEVICE TYPE: XRF system
 MEASUREMENT METHOD: XRF
 Active
 MEASURED PROPERTIES: Element Concentration
 NUCLEAR MATERIAL(S): U
 PHYSICAL FORM(S) OF NM: Solution
 STATUS: One-of-a-kind
 PORTABILITY: Stationary
 ENVIRONMENT OF USE: Industrial
 DEVELOPER: VNIITFA, All-Russian Research Institute of Technical Physics and Automatization
 MANUFACTURER: VNIITFA, All-Russian Research Institute of Technical Physics and Automatization

DESCRIPTION

PURPOSE

Determination of the uranium content in solutions at the nuclear fuel production and reprocessing facilities. The device has capability to determine the content of elements with atomic numbers of $Z > 20$ in different materials.

PRINCIPLES OF OPERATION

Operation modes:

- analysis of the samples by facility laboratories;
- continuous automatic production process monitoring.

FUNCTIONAL BLOCKS

SPECIFICATIONS

Measured concentration range	0.005 - 300 g/l
Analysis error	0.1- 5%
Measurement time	1- 3 min

SOFTWARE

ADDITIONAL INFORMATION

Foreign analog: X-MET analyzer produced by METOREX.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Detector**Alpha Probe****MODEL: SC-AP750****SUPPLIER:** *Quantrad Sensor Division, Applied Electron Corp.***USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** Alpha
Passive**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):** Pu**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Field**DEVELOPER:** Quantrad Sensor Division, Applied Electron Corp.**MANUFACTURER:** Quantrad Sensor Division, Applied Electron Corp.**180****DESCRIPTION****PURPOSE**

Designed for quick verification of alpha emitting isotopes, detection of weapons grade materials using alpha spectroscopy, testing swipe samples, testing surfaces for alpha contamination, identification of alpha emitting isotopes on clothing, verification of alpha contamination on filter papers.

PRINCIPLES OF OPERATION**FUNCTIONAL BLOCKS**

- 750 mm² solid state silicon detector with light tight film.
- coiled 4' cable to Scout multichannel analyzer.

SPECIFICATIONS

Covered alpha particles energy range	0 to 15 Mev.
Weight	1.2 pounds

SOFTWARE

ScoutMaster program.

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Detector

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Detection Unit (БДИГ-28Н)
MODEL: БДИГ-28Н**SUPPLIER:** SNIIP-Konvel**USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** Beta, Gamma, Neutron
Passive**MEASURED PROPERTIES:** Radiation Intensity**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Field**DEVELOPER:** SNIIP-Konvel**MANUFACTURER:** SNIIP-Konvel**DESCRIPTION****PURPOSE***Used as a part of stationary installations for monitoring radiation background at entrance-exit posts for measurements of beta, gamma and neutron radiation.***PRINCIPLES OF OPERATION****FUNCTIONAL BLOCKS**

can be supplied with:

- built-in microprocessor controller,
- trunk amplifier,
- radio transmitter.

SPECIFICATIONS

Detector type	scintillation plastic
Energy range	
beta radiation	from 0.2 MeV
gamma radiation	0.04 - 3.0 Mev
Sensitivity	
for Cs - 137	25 cps (mkR/hour)
for fast neutrons	100 pulse x cm ² /neutron
Measurement limit	
beta active nuclides	200 pulse/min x cm ²
Overall size	370x145x75 mm
Weight	no more than 2.0 kg
Operation conditions:	
operation temperature range	from - 40°C to + 50°C
relative humidity	95% at 25°C
vibration stresses	in range from 10 to 35 Hz with 0.35 mm displacement amplitude

SOFTWARE

Connections to computer networks are provided through RS-232

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Detector

*Detection Unit (БДИГ-29Н)**MODEL: БДИГ-29Н*

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SUPPLIER: SNIIP-Konvel**USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Detector**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:****ENVIRONMENT OF USE:** Field**DEVELOPER:** SNIIP-Konvel**MANUFACTURER:** SNIIP-Konvel**DESCRIPTION****PURPOSE***Used as a part of portable radiometer-dosimeters and stationary installations for monitoring radiation background at entrance-exit posts for measurements of X and gamma radiation.***PRINCIPLES OF OPERATION****FUNCTIONAL BLOCKS**

can be supplied with:

- built-in microprocessor controller,
- trunk amplifier,
- radio transmitter

SPECIFICATIONS

Energy range	0.004 - 3 MeV
Equivalent dose rate measurement range	0.005 - 5E+3 mkZv/hour
X- and gamma quantum flux range	0.3 - 1.5E+4 quant/(s * sm^2)
General allowable error limit	no more than 20 %
Sensitivity to Am-241	40 (pulses/s) / (mkR/hour)
Detector type	scintillation film detector
Sensitive detection surface area	150 cm^2

SOFTWARE

Connections to computer networks are provided through RS-232

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Hand-held Monitor**Hand-Held Monitors****MODEL: JHH-31, JHH-41, JHH-50****SUPPLIER: *Canberra Industries, Inc.*****USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Hand-held Monitor**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Field**DEVELOPER:** *Canberra Industries, Inc.***MANUFACTURER:** *Canberra Industries, Inc.***183****DESCRIPTION****PURPOSE***Detection and tracing of NM and other radioactive material both on subjects and persons.***PRINCIPLES OF OPERATION**

The Hand-held Monitor is microcomputer controlled. It has a simple SCA adjustment using on-board display. This device uses a crystal-controlled count interval and stabilized sodium iodide detector which eliminates the need for recalibration with a reference spectrum before each verification.

FUNCTIONAL BLOCKS

- LED gain stabilization
- lower level discriminator (LLD)
- three single channel analyzers (SCAs)
- 4-digit LCD display
- sodium iodide detector

SPECIFICATIONS

Continuous operation time	16 hours per charge
Overall size	9 x 13 x 20 cm
Weight	1.8 kg

SOFTWARE**ADDITIONAL INFORMATION**

Model JHH-31 has an internal detector, JHH-41 used with external NaI probe, and JHH-50 used with JSP-12 SNAP detector

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Hand-held Monitor**Source Monitor****MODEL: Model 520A****184****SUPPLIER:** *National Nuclear Corporation***USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Hand-held Monitor**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Field**DEVELOPER:** National Nuclear Corporation**MANUFACTURER:** National Nuclear Corporation**DESCRIPTION****PURPOSE**

Gamma radiation field monitor providing continuous visual indication of whether or not an exposed radiation source is present.

PRINCIPLES OF OPERATION

Alarm threshold is continuously adjustable from 2 mR/h to 20 mR/h. Operates reliably to 1000 R/h. Detects radiation with an external GM tube on a 4-foot cable.

FUNCTIONAL BLOCKS

Detector: halogen-quenched GM tube.

SPECIFICATIONS

Operating temperature from -20C to +50C

Overall size 6" x 4" x 5"

Weight 3 pounds

SOFTWARE

Has built-in diagnostic tests

ADDITIONAL INFORMATION

Manufactured by XETEX, a Division of NNC.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Hand-held Monitor

NaI Area MonitorMODEL:**SUPPLIER:** Pajarito Scientific Corporation

USE CATEGORY:	Containment and Surveillance
DEVICE TYPE:	Hand-held Monitor
MEASUREMENT METHOD:	Gamma
	Passive
MEASURED PROPERTIES:	Isotopic Composition
NUCLEAR MATERIAL(S):	Pu-239, Cs-197, Co-60, U-235
PHYSICAL FORM(S) OF NM:	Holdup
STATUS:	Serial Production
PORTABILITY:	Hand-held
ENVIRONMENT OF USE:	Industrial
DEVELOPER:	Pajarito Scientific Corporation
MANUFACTURER:	Pajarito Scientific Corporation

185**DESCRIPTION****PURPOSE**

This device can be used inside or outside of a glove box to rapidly measure Pu or U holdup in pipes, ducts and processing equipment.

PRINCIPLES OF OPERATION

Detection and/or semi-quantitative measurement of specific gamma rays emitted by Pu-239 and U-235, using a hand-held NaI scintillation detector. Automatic diagnostic checks are done to monitor instrument performance. Can be integrated with plant control systems. Alarm levels can be preset.

FUNCTIONAL BLOCKS

2" x 2" NaI detector

SPECIFICATIONS

Measurement time	2 minutes
Sensitivity	< 1g of Plutonium
Overall size	2.5 inches by 7 inches
Weight	less than 12 pounds

SOFTWARE

Allows all data to be printed and saved to disk. All parameters can be accessed either on disk or a video monitor.

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Hand-held Monitor

Device for Radioactive Material Searching (ДОГ-2)

MODEL: ДОГ-2

SUPPLIER: RFNC VNIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Hand-held Monitor

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S): Pu, HEU

PHYSICAL FORM(S) OF NM:

STATUS:

PORTABILITY: Hand-held

ENVIRONMENT OF USE: Field

DEVELOPER: RFNC VNIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics

MANUFACTURER: RFNC VNIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics

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DESCRIPTION

PURPOSE

Searching for nuclear materials by using their gamma radiation.

PRINCIPLES OF OPERATION

Detection of object gamma radiation close to natural background. After switching on and self testing the device performs a background analysis and determines a limit value. If it is exceeded, a radiation signal indicating presence of an object is produced. The analysis is executed in "slipping" time mode, duration of which is optimized by the microprocessor with respect to sensitivity.

FUNCTIONAL BLOCKS

Cylindrical body contains:

- NaI detector
- Microprocessor controller
- Sound alarm unit
- LED indicator.

SPECIFICATIONS

Sensitivity few kg of Pu or HEU from
a distance of few dozens of meters

Operation time no less than 10 hours

with built-in accumulator

D180 mm x 280 mm

Overall size

6 kg

Weight

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Hand-held Monitor

Device for Radioactive Material Searching (ДОН-2)

MODEL: ДОН-2

SUPPLIER: RFNC VNIIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Hand-held Monitor

MEASUREMENT METHOD: Neutron

Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S): Pu

PHYSICAL FORM(S) OF NM:

STATUS:

PORTABILITY: Hand-held

ENVIRONMENT OF USE: Field

DEVELOPER: RFNC VNIIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics

MANUFACTURER: RFNC VNIIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics

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DESCRIPTION

PURPOSE

Searching for nuclear materials by using their neutron radiation. The device can detect neutron emitting materials under a metal shielding

PRINCIPLES OF OPERATION

Detection of neutron radiation emitted by an object close to natural background. After switching on and self testing the device begins a background analysis, and as a result, it determines a limit value; if this is exceeded a signal is produced.

In operation mode DON-2 is carried as a cartridge belt leaving the operator's hands free. Such construction gives the same sensitivity with a lighter device weight using the neutron moderation ability of a human body. Operation mode - monitoring, localization.

The analysis is executed in "slipping" time mode duration of which is optimized by the microprocessor with respect to sensitivity.

FUNCTIONAL BLOCKS

Device is made as a part of a hollow thin-wall cylinder inside which are situated:

- He-3 neutron counters
- Microprocessor controller.
- Sound signal unit.
- Digital LED indicator in a watch form.
- Accumulator.

SPECIFICATIONS

Sensitivity	few kg of PU from a distance of few dozen of meters
Overall size	350 mm x 200 mm x 120 mm
Weight	1.8 kg
Interface	RS-232

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Hand-held Monitor

Hand-Held Radiation Monitor (БИРК-2)

MODEL: БИРК-2

SUPPLIER: RFNC VNIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Hand-held Monitor

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Limited Production

PORTABILITY: Hand-held

ENVIRONMENT OF USE: Field

DEVELOPER: RFNC VNIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics

MANUFACTURER: RFNC VNIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics

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DESCRIPTION

PURPOSE

Searching for radioactive materials by using gamma radiation.

PRINCIPLES OF OPERATION

Operation modes:

- Automatic background testing by automatic setting of a triggering-alarm-signal-limit;
- The radiation situation analysis is executed in "sliding" time mode when registered pulses counts are summarized in a few measurement intervals of 0.1 sec duration. A parameter determining the false alarm probability (confidence level) Z=3; 4; 5; 6 is adjusted. The default parameter is Z=4.

FUNCTIONAL BLOCKS

- NaI(Tl) or CsI(Tl) detector
- photoelectric electron-multiplier tube with stabilized power source
- amplifier-discriminator,
- microcontroller
- digital indicator
- sound signal unit
- 8 small accumulators

SPECIFICATIONS

Scintillation crystal size	30 mm x70 mm
Sensitive (side) surface	21 cm ²
Background count time	30sec
Adjusted measurement intervals sec	0.5; 1.0; 2.0; 4.0 sec with step 0.1
Confidence level	2; 3; 4; 5 (without adjustment = 4)
Sensitivity in 0.5 sec from a distance of 15 cm, with probability no less than 0.5, with 20 mR/h background, with 0.5 m/s relative movement speed, with false alarm frequency no more than 2 /1000	0.1 g of weapon Pu 5g of U (enrichment > 90%) no less than 10 hours from 10° C to 35°C
Continuous operation time	230 mm x 50(80) mm x 100 mm
Operation temperature range	<=1.3 kg
Overall size	
Weight	

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Hand-held Monitor

Hand-Held Radiation Monitor (PIM-2)**MODEL: PIM-2**

SUPPLIER: RFNC VNIIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Hand-held Monitor

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS:

PORTABILITY: Hand-held

ENVIRONMENT OF USE: Field

DEVELOPER: RFNC VNIIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics

MANUFACTURER: RFNC VNIIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics

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DESCRIPTION**PURPOSE**

Searching for radioactive materials.

PRINCIPLES OF OPERATION

Detection of gamma radiation

Operation modes:

- automatic background testing and automatic alarm level setting;
- microprocessor optimization of "sliding" measurement time duration

FUNCTIONAL BLOCKS

- NaI(Tl) scintillator
- Photoelectric electron-multiplier tube
- Amplifier
- Discriminator
- High voltage source;
- Microprocessor controller with a LID-five-digit-indication and an independent power supply.

SPECIFICATIONS

Sensitive volume	71cm ³
Detection limit	0.05 g of weapon Pu and 0.5 g of HEU with 50% probability from a distance of 15 cm, in 1 sec
False alarm rate	no less than 1 /1000
Operation temperature range	from 0'C to +30'C
Overall size	210 mm x 210 mm x 60 mm
Weight	1.5 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Hand-held Monitor

Hand-Held Radiation Monitor (PIM-3H)

MODEL: PIM-3H

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SUPPLIER: RFNC VNIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics**USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Hand-held Monitor**MEASUREMENT METHOD:** Neutron, Gamma
Passive**MEASURED PROPERTIES:** Radiation Intensity**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:****PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Field**DEVELOPER:** RFNC VNIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics**MANUFACTURER:** RFNC VNIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics**DESCRIPTION****PURPOSE***Searching for radioactive materials***PRINCIPLES OF OPERATION**

Detection of a neutron radiation

Operation modes:

- automatic background testing and automatic alarm signal level setting;
- microprocessor optimization of "slipping" measurement time duration with respect to sensitivity

FUNCTIONAL BLOCKS

Monitor has rectangular body. Inside it there are:

- organic plastic scintillator
- photoelectric electron-multiplier tube
- amplifier
- discriminator
- HV supply;
- microprocessor controller with a LED-five-digit-indication and an independent power supply..

SPECIFICATIONS

Sensitive detector volume

600cm³

Detection limit

0.05 g of weapon Pu and

0.5 g of HEU with

50% probability, from a distance of 15 cm,
in 1 sec

no less than 1 /1000

False alarm rate

from -30°C to +30°C

Operation temperature range

250 mm x 130 mm x 80 mm

Overall size

2 kg

Weight

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Hand-held Monitor

Gamma and Neutron Rate Meter for Flux Density Control (CPIIC7)

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MODEL: CPIIC7

SUPPLIER: RIPT, Research Institute of Pulse Technique

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Hand-held Monitor

MEASUREMENT METHOD: Neutron, Gamma
Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S): Pu, U

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Portable

ENVIRONMENT OF USE: Field

DEVELOPER: RIPT, Research Institute of Pulse Technique

MANUFACTURER: RIPT, Research Institute of Pulse Technique

DESCRIPTION

PURPOSE

Detection of gamma and neutron sources that create a particle flux density comparable to natural background; mapping of neutron and gamma fields; measurement of radioactive surface contaminations.

PRINCIPLES OF OPERATION

FUNCTIONAL BLOCKS

- fast neutron detector;
- gamma detector;
- recorder.

SPECIFICATIONS

Fast neutron detector

8 thermal neutron He-3 counters	СИ-19Н
Neutron sensitivity for $E > 100\text{keV}$	$50 \pm 5 \text{ cm}^2$
Dead time	30 mks
Overall size	350 mm x 130 mm x 70 mm
Weight	15 kg

Gamma detector

NaI(Tl)crystal	D40 mm x 40 mm
Gamma sensitivity for energy of 100-1200keV	$10 \pm 3 \text{ cm}^2$
Dead time	15 mks
Overall size	D70 mm x 320 mm
Weight	1.5 kg

Recorder

Exposure time	1-9999 sec
Delay after exposure	1-999 ms
Input pulse amplitude (TTL)	5±10% V
Input resistance	300 Ohm
Max. input rate	upto 5E+5 cps
Power supply	=10-12V

Overall size	260 mm x 90 mm x 320 mm
Weight	6 kg

Storage capacity

for 120 results
(exposure time + counts)

RS-232

Interface

SOFTWARE

ADDITIONAL INFORMATION

Possibilities:

- Usage of active methods to detect transuranium elements

- independent usage of different detectors

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика (Каталог продукции НИИИТ)

Containment and Surveillance: Hand-held Monitor

Hand-Held Gamma Monitor

MODEL: СМГИ6

SUPPLIER: RIPT, Research Institute of Pulse Technique

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Hand-held Monitor

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S): HEU, Pu

PHYSICAL FORM(S) OF NM:

STATUS: Experienced sample

PORtABILITY: Hand-held

ENVIRONMENT OF USE:

RIPT Research Institute of Pulse Technique

MANUFACTURER: RIPT, Research Institute of Pulse Technique

DESCRIPTION

PURPOSE

Detection and localization of NM and other radioactive materials both on objects and persons.

PRINCIPLES OF OPERATION

FRENCH EYES OF OPERATION
Detection of gamma radiation in the energy range of 60 - 500 keV with the following light and sound alarm signals

FUNCTIONAL BLOCKS

FUNCTIONAL SPECIFICATIONS

SPECIFICATIONS	
Detection limit	
U-235 (90% enrichment)	0.5 g
weapon Pu-239	0.03 g
Detection time	no more than 0.5 sec
"Detection" distance from the subject surface	no less than 0.1 m
Detection Probability	no less than 0.95
False alarm rate	no more than 1/1000
Power supply	internal batteries during 24 hours
Operation temperature	-30°C to +35°C
Overall size	220 mm x 150 mm x 55 mm
Weight	800 g
Control	automatic by internal
microprocessor	
Alarm	light and sound (with external display - digital)

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Hand-held Monitor

Hand-Held Gamma Monitor-Spectrometer

MODEL: CMTU3.02

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SUPPLIER: RIPT, Research Institute of Pulse Technique

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Hand-held Monitor

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S): U-235

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Hand-held

ENVIRONMENT OF USE: Field

DEVELOPER: RIPT, Research Institute of Pulse Technique

MANUFACTURER: RIPT, Research Institute of Pulse Technique

DESCRIPTION

PURPOSE

Detection of gamma radiation sources and identification of U-235.

PRINCIPLES OF OPERATION

Detection of gamma radiation sources and identification of the gamma radiation from U-235 using the pulse-height distribution shape of the detector in real time

FUNCTIONAL BLOCKS

- NaI(Tl) detector,
- recorder

SPECIFICATIONS

Detector

NaI(Tl) crystal	D25 mm x 25 mm
Integral gamma sensitivity for the 60-250 keV energy region	no less than 0.7 cm ²
Sensitivity for the full-energy peak	no less than 0.5 cm ²
Overall size	D40 mm x 440 mm
Weight	1.5 kg

Recorder

Max. input rate	no more than 1E+4 cps
Overall size	140 mm x 175 mm x 205 mm
Weight	2.5 kg
Power supply	=10-12V

Detection probability

from a distance of 10 cm 0.95

Detection limit

U-235 (90% enrichment) 1g

from a distance of 10 cm in 1 second 1g

U-235 (3,6% enrichment)

from a distance of 10 cm

in 15 seconds 20 g

Interface

RS-232

SOFTWARE

ADDITIONAL INFORMATION

Intelligent interface for user. Device has its own metrological, software, and methodical support, and independent power supply.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика (Каталог НИИИТ)

Containment and Surveillance: Hand-held Monitor

Hand-Held Gamma-Neutron Rate Meter

MODEL: PIIC-06II

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SUPPLIER: SNIIP-Automatics**USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Hand-held Monitor**MEASUREMENT METHOD:** Gamma, Neutron

Passive

MEASURED PROPERTIES: Radiation Intensity**NUCLEAR MATERIAL(S):** Pu, U**PHYSICAL FORM(S) OF NM:****STATUS:** One-of-a-kind**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Field**DEVELOPER:** SNIIP-Automatics**MANUFACTURER:** SNIIP-Automatics**DESCRIPTION****PURPOSE***The meter is used for surreptitious detection of gamma and neutron sources.***PRINCIPLES OF OPERATION**

Gamma radiation is detected by Geiger counters.

Neutron radiation is detected by CHM-18 neutron counters in moderator.

Radiometer device informs operator on arising situation when radiation intensity exceeds the setpoint.

Data processing is performed by internal micro computer.

FUNCTIONAL BLOCKS

- 2 neutron counter units
- 2 Geiger counter units
- internal micro computer for data processing
- liquid crystal display (LCD)

Device is housed in the case. Can be provided with the main power supply unit.

SPECIFICATIONS

Number of neutron counters in one detection unit (with pulse summing)	up to 4
Number of Geiger counters in one detection unit (with pulse summing)	up to 5
Number of independent counting inputs on device console	4
Communication channel with external computer	RS-232
Temperature range	from -10°C to +50°C
Time of recording measurement results	every 2 sec during 8 hours
Continuous operation time	no less than 8 hours
Overall size of console	no more than 200 mm x 100mm x 40 mm
Console weight with accumulator (without detector units)	no more than 1 kg
Case weight: with complete set of the detection units lightened set (1 cassette of neutron and Geiger counters)	about 6 kg about 4 kg
Data storage with switching off power supply.	
Sound, light, sensor signals if radiation intensity exceeds installed limit	

SOFTWARE**ADDITIONAL INFORMATION**

The closest analogs (with the exception of detectors type) are HHD-440A and PRM-470A from TSA System Ltd.

An individual devices can be delivered per request.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Hand-held Monitor

Portable Neutron Monitor

MODEL: PXH-01

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SUPPLIER: SNIIP-Konvel

USE CATEGORY: Containment and Surveillance
DEVICE TYPE: Hand-held Monitor
MEASUREMENT METHOD: Neutron
 Passive
MEASURED PROPERTIES: Radiation Intensity
NUCLEAR MATERIAL(S): Pu, U
PHYSICAL FORM(S) OF NM:
STATUS: Limited Production
PORTABILITY: Portable
ENVIRONMENT OF USE: Industrial, Field
DEVELOPER: SNIIP-Konvel
MANUFACTURER: SNIIP-Konvel

DESCRIPTION**PURPOSE***Detects and locates fissile materials in baggage, loads and vehicles.***PRINCIPLES OF OPERATION****FUNCTIONAL BLOCKS**

- detection unit with scintillation detector
- control board

SPECIFICATIONS

Sensitivity to thermal neutrons	100 pulse/(neutrons/cm ²)
Sensitivity to fast neutrons	12 pulse/(neutrons/cm ²)
Sensitivity to gamma radiation	<0.016 cps (mR/hour).
Own background	<1.5 cps
Power supply	accumulators or main 220 V, 50 Hz
Operation without recharging	120 hours
Overall size:	
control board	165 mm x 107 mm x 33 mm
detector unit	D160 mm x 320 mm
Weight:	
control board	0.5 kg
detector unit	2.5 kg
Interface	RS-232
Transportation	by any closed transport type at temperature from -30°C to +50°C in storehouse conditions in a manufacture
Storage package	at air temperature from 0°C to +40°C at up to 80% relative humidity at +20°C

SOFTWARE

Allows determination of the neutron flux density.

ADDITIONAL INFORMATION

Possibility of the nuclear material quantity measurement
 Testing the operation ability is carried out with a test source
 Warranty - 18 months
 The after-warranty-service is carried out by manufacturer.
 Delivery time on individual demand - no more than 3 months

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Hand-held Monitor

X-Ray Rate Meter-Dosimeter

MODEL: P3C-10HP

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SUPPLIER: SNIIP-Konvel

USE CATEGORY: Containment and Surveillance
 DEVICE TYPE: Hand-held Monitor
 MEASUREMENT METHOD: Gamma
 Passive
 MEASURED PROPERTIES: Radiation Intensity
 NUCLEAR MATERIAL(S):
 PHYSICAL FORM(S) OF NM:
 STATUS: Limited Production
 PORTABILITY: Portable
 ENVIRONMENT OF USE: Field
 DEVELOPER: SNIIP-Konvel
 MANUFACTURER: SNIIP-Konvel

DESCRIPTION

PURPOSE

For detection of X and gamma radiation over a wide energy range, searching and localizing of radioactive sources. Device is used for the determination of NM activity and quantity.

PRINCIPLES OF OPERATION

FUNCTIONAL BLOCKS

- measurement board
- detection unit on the base of scintillation detector

SPECIFICATIONS

Energy range	0.0059-3.0 MeV
Measurement range for:	
equivalent dose	0.005-100 mR/hour,
exposure dose	0.5-10000mR/hour,
flux density	0.03-2000quantum/(cm ² *sec)
Limit of the general relative error	20%
Measurement time	1; 10; 100 sec
Sensitive detector surface area	150cm ²
Power supply	from built-in accumulators.
Continuous operation time	8 hours
Overall size:	
measurement board (with handle)	no more than 85 mm x 85 mm x 85 mm
detection unit	no more than D160 mm x 400 mm
Weight:	
measurement board	no more than 0.6 kg
detection unit	no more than 1.5 kg
Interface	RS-232
Operation temperature range	from -15°C to +40°C
Relative humidity	95±3% at temperature 25±3°C.
Mechanical stresses of vibration	
with frequency (25±2)Hz, at	
acceleration (19,6±3,9)m/cm ²	during 30 min
Transportation in package by any	
closed transport type	
at the temperature	from -30°C to +50°C
Storage in storehouse conditions	
in manufacturer package	
at the air temperature	from 0°C to +40°C

SOFTWARE

Specialized software

ADDITIONAL INFORMATION

Warranty - 18 months.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Hand-held Monitor

Radiation MonitorMODEL: PM-2

SUPPLIER: *SSC IPPE, State Scientific Center of Russian Federation, Institute of Physics and Power Engineering*

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Hand-held Monitor

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: One-of-a-kind

PORTABILITY:

ENVIRONMENT OF USE:

DEVELOPER: *SSC IPPE, State Scientific Center of Russian Federation, Institute of Physics and Power Engineering*

MANUFACTURER: *SSC IPPE, State Scientific Center of Russian Federation, Institute of Physics and Power Engineering*

DESCRIPTION**PURPOSE**

Control of radioactive material movements.

PRINCIPLES OF OPERATION

This is a threshold device detecting gamma radiation and generating alarm signals when the preset limits are exceeded. The monitor provides sound, light, and electric signals when radioactive materials are removed. Can be used at locations with changeable background.

The monitor can be used both as a part of a complex access control system, and as an independent device. The monitor has the following operation modes:

- continuous background monitoring;
- external control - by external signal (from infrared sensor, controller of the access system isolation chamber, electric lock and others) the monitor is switched from the background monitoring mode to the mode of the current count comparison with the most recent alarm setting.

FUNCTIONAL BLOCKS

- four detection units БДЕГ-01Р
- remote control board
- data processing unit
- connection cables

SPECIFICATIONS

Number of connected detectors	from 1 to 4
NaJ(Tl) crystal size	63 mm x 63 mm
Average count rate range	0-9999 pulses/sec
Measured energy range	50 keV - 3 MeV
Alarm level	5 and 7 sigma
Initial exposure time	16 sec
Measurement time of the current background	2 sec
False alarm frequency:	
in continuous mode	1/ 1700
in external control mode	1/ 2000
Detection probability of 8,5 g U (90% enrichment)	70%
Power supply	220 V, 50 Hz
Operation temperature range	from 5°C to 35°C
Overall size:	
detection unit	90 mm x 250 mm
processing unit	440 mm x 300 mm x 200 mm

SOFTWARE

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ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Hand-held Monitor

Hand-Held Personal Radiation Monitor
MODEL: PRM-470B

198

SUPPLIER: *TSA Systems Ltd.*

USE CATEGORY: Containment and Surveillance
DEVICE TYPE: Hand-held Monitor
MEASUREMENT METHOD: Gamma
 Passive
MEASURED PROPERTIES: Radiation Intensity
NUCLEAR MATERIAL(S):
PHYSICAL FORM(S) OF NM:
STATUS: Serial Production
PORTABILITY: Hand-held
ENVIRONMENT OF USE: Industrial
DEVELOPER: TSA Systems Ltd.
MANUFACTURER: TSA Systems Ltd.

DESCRIPTION

PURPOSE

This device is designed for vehicular or pedestrian monitoring where high sensitivity is critical, continuous search requires a lightweight instrument or frequent recharging is unavailable.

PRINCIPLES OF OPERATION

The PRM-470B automatically acquires a 20 second background when it is turned on. After the background it is ready to scan. The scan function can be started manually by pressing a front panel switch, or automatically by an internal motion switch. A front panel LED, and an audio annunciator signal alarms.

FUNCTIONAL BLOCKS

- circuit card assemblies or modular subassemblies contained all major electronics
- plastic scintillation detector

SPECIFICATIONS

Measurement time:	
search mode	0.4 s count moving average with 0.05 s intervals.
background time	10 sec.
Operation temperature	0 to 38 C
Power supply	Ni-Cd battery pack
battery charger	from 90 - 250 volt, 47- 63 Hz power
Operation on a full charge	60 hours
Overall size	12.5 x 10 x 20 cm^3
Weight	1.4 kg

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Hand-held Monitor

Hand-Held Radiation Monitor for NM Detection "Gnome"

199

MODEL: "Гном"

SUPPLIER: VNIIA, All-Russian Research Institute of Automatics

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Hand-held Monitor

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S): U, Pu

PHYSICAL FORM(S) OF NM:

STATUS: Limited Production

PORTABILITY: Hand-held

ENVIRONMENT OF USE: Field

DEVELOPER: VNIIA, All-Russian Research Institute of Automatics

MANUFACTURER: VNIIA, All-Russian Research Institute of Automatics

DESCRIPTION

PURPOSE

Timely detection of NM movements.

PRINCIPLES OF OPERATION

Detection of gamma-radiation in the single energy window of 40-210 keV for U-235 detection, and in two energy windows: 40-140 keV and 312-450 keV for plutonium detection. Device has digital visual and sound indication. Sound alarm is generated when radiation count goes over an established limit. Sound changes its tone with changes in the gamma-radiation counts rate. Radiation background can be compensated manually or automatically. Device can operate in a mode of selective uranium detection.

FUNCTIONAL BLOCKS

Two individual blocks:

- remote telescopic detector, and
- signal processing unit

SPECIFICATIONS

Sensitivity from a distance up to 15 cm
and scanning speed up to 0,5 m/s

4g of U; 0.4g of Pu

False alarm frequency at 20mR/hr background

1 - 2 per minute

Measurement time

8 - 16 sec

Environment of use:

temperature

from -10°C to +40°C

humidity

up to 75% at +30°C

Power supply

two 9 V Ni-Cd batteries

Overall size (without holder)

85 mm x 60 mm x 165 mm

Weight (with batteries, without holder)

0.96 kg

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Hand-held Monitor

Hand-Held Radiation Monitor for NM Detection "Guard"

200

MODEL: "Страж-2", "Страж-3"

SUPPLIER: VNIIA, All-Russian Research Institute of Automatics

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Hand-held Monitor

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S): U, Pu

PHYSICAL FORM(S) OF NM:

STATUS: Limited Production

PORTABILITY: Hand-held

ENVIRONMENT OF USE: Field

DEVELOPER: VNIIA, All-Russian Research Institute of Automatics

MANUFACTURER: VNIIA, All-Russian Research Institute of Automatics

DESCRIPTION

PURPOSE

Timely detection of NM movements.

PRINCIPLES OF OPERATION

Detection of NM spontaneous radiation in excess of background. Device has sound and visual indication signals.

It has capability for the automatic remote data transfer to the control station.

Device performs a self-control testing during 2 s after power switches on.

FUNCTIONAL BLOCKS

- NaI(Tl) detector
- photoelectric electron-multiplier tube (PHT)
- PHT signal amplifier
- PHT power unit
- analog-to-digital converter
- liquid crystal indicator
- processor

SPECIFICATIONS

Sensitivity at 5-15 sm	0.3 g of U; 0.03 g of Pu
Measurement cycle	8 - 16 sec
Power supply	5 V built-in Ni-Cd battery
Continuous operation without recharge	20 hours
False alarm frequency: (1/12min)	can be changeable from 10/1 min to
Environment of use: temperature	from - 30°C to + 50° C
humidity	100% for +30° C
atmosphere pressure	> 225 mm
mechanic vibration	10-55 Hz
Transportation conditions in packing: temperature	from - 60°C to + 50° C
humidity	95% for + 30° C
Capacity testing method:	built-in photodiodes
Average time before fault:	5000 hours
Life time:	5 years
Overall size "Страж-2"	252 mm x 96 mm x 125 mm
"Страж-3"	238 mm x 123 mm x 156 mm
Weight (including battery) "Страж-2"	2.2 kg
"Страж-3"	1.9 kg

SOFTWARE

ADDITIONAL INFORMATION

Device can be adjusted to detect other NM types.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Portal Monitor

Neutron Vehicle Portal Monitors

MODEL: JPM-31A

201

SUPPLIER: *Canberra Industries, Inc.*

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Portal Monitor

MEASUREMENT METHOD: Neutron

Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Stationary

ENVIRONMENT OF USE: Industrial

DEVELOPER: *Canberra Industries, Inc.*MANUFACTURER: *Canberra Industries, Inc.*

DESCRIPTION

PURPOSE

JPM-31A SNM Neutron Vehicle Portal Monitor is an intelligent detection system used to detect shielded SNM which cannot be detected by gamma-based portals due to attenuation of the gamma rays. It is also used in areas where the gamma ray background varies.

PRINCIPLES OF OPERATION

FUNCTIONAL BLOCKS

waterproof detector cabinet:

- eight He-3 proportional detectors
- polyethylene chambers
- portal controller
- amplifier/SCA
- high voltage power supply

SPECIFICATIONS

Detector dimensions 182.9 cm long x 5.08 cm diameter

Chamber dimensions 122 x 244 x 15 cm³

Distance between chambers 6 m

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Portal Monitor**Neutron/Gamma Portal Monitor****MODEL: JPM-32A****202****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Portal Monitor**MEASUREMENT METHOD:** Neutron, Gamma
Passive**MEASURED PROPERTIES:** Radiation Intensity**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Canberra Industries, Inc.**DESCRIPTION****PURPOSE**

JPM-32A is an integrated neutron and gamma-ray vehicle portal monitor for detecting gram masses of shielded plutonium. Lower detection limits are possible for unshielded plutonium and HEU using gamma detectors.

PRINCIPLES OF OPERATION

The JPM-32A Neutron/Gamma Vehicle Portal Monitor is a combination system that includes both neutron and gamma detectors, similar to those used in the JPM-12A and JPM-31A. Combination neutron and gamma portals allow detection of SNM even if it is shielded with a high-Z material such as lead. This combination is very effective for vehicle monitors. If not adequately shielded, the gamma portion will also detect the SNM.

FUNCTIONAL BLOCKS**SPECIFICATIONS****SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Portal Monitor**Pedestrian Portal Monitor (neutron)****MODEL: JPM-41A****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Portal Monitor**MEASUREMENT METHOD:** Neutron

Passive

MEASURED PROPERTIES: Radiation Intensity**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORATABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** *Canberra Industries, Inc.***MANUFACTURER:** *Canberra Industries, Inc.***203****DESCRIPTION****PURPOSE**

The JPM-41A Neutron Pedestrian Portal detects gram masses of shielded SNM that cannot be detected by gamma-ray based monitors. It is also used where the gamma-ray background varies.

PRINCIPLES OF OPERATION**FUNCTIONAL BLOCKS**

The portal configuration is identical to the JPM-31A Neutron Vehicle Monitor with fewer He-3 detectors. Pillars are smaller and closer together: 66 cm vs 6 m.

SPECIFICATIONS**SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Portal Monitor

SNM Pedestrian Portal Gamma Monitors**MODEL: JPM-21A, JPM-22A****204****SUPPLIER:** *Canberra Industries, Inc.***USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Portal Monitor**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity**NUCLEAR MATERIAL(S):** Pu, HEU**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** Los Alamos National Laboratory**MANUFACTURER:** Canberra Industries, Inc.**DESCRIPTION****PURPOSE**

Special Nuclear Material (SNM) Portals prevent unauthorized removal of fissile material such as U-235 and Pu-239.

PRINCIPLES OF OPERATION

The portal monitor JPM-21A features gamma-ray detection only, while the JPM-22A has gamma-ray and metal detection capability. The monitors can be operated in walk-through or wait-in modes. The microprocessor controller allows complete automatic operation and the visual/audio displays and alarms continuously inform operator of portal status. Occupancy sensors automatically determine presence of subjects and their direction of travel. The detectors are housed in protective enclosures rated for indoor-outdoor use (NEMA 3R). Heavy duty outdoor enclosures (NEMA 3) are available as an option.

The JPM-21A's programmable controller provides automatic operation of the monitor. To ensure the proper operation of the monitor, the controller performs a series of self diagnostic tests at system start up and master reset. Operating parameters and diagnostic functions are accessed with a simple terminal through an RS-232 port. Operating parameters like "walk through" or "wait in" mode, passage speed, the number and duration of monitoring measurements, and the amount of pre-occupancy data used in the monitoring can be entered using the optionally supplied terminal or computer. High and low background alarms can also be set. The result of the statistical analysis of the signals, and the number of alarms and occupancies can be printed or stored on file during operation. In wait in mode an alarm sounds if the occupant leaves early.

The controller uses the Sequential Probability Ratio Test (SPRT)[1] algorithm to determine the presence of SNM over background. This is a sequential hypothesis test that performs a sequence of short monitoring measurements during both background and occupied states. When the portal is unoccupied, the background events are counted by the portal controller. Each background is checked against the selectable high and low extreme values and is tested for statistical variance. The background is continually monitored until triggered by a person entering the portal by an active infra-red sensor pair located in the detector cabinets. When the monitor is occupied a series of short duration counting intervals is examined. Each short interval is analyzed, and a decision is made whether the signal is background, SNM, or undetermined. If neither a background nor an alarm decision can be made, monitoring continues with another short measurement until the user selectable maximum total monitoring time is reached. If no decision is reached, the signal is determined to be background and the monitoring repeats until the occupant has left the monitor. The SPRT technique was selected for the JPM series monitors (over traditional moving average background subtraction techniques) due to its lower sensitivity to the effects of varying passage speeds in the walk through mode.

The signal conditioning and analysis hardware are located within the pillars of the monitor. Access to all system electronics and the master reset are protected by keyed latches. A Remote Control panel is supplied to indicate system status to an operator located nearby. There is provision for a remote alarm. Tamper Indication Devices (TID) are optional.

The JPM-22A is the JPM-21A described above but with the addition of a metal detector similar to the kind used in airports. It is used in detecting the presence of metal objects or shielding that can attenuate gamma-rays sufficiently from the SNM, thereby defeating detection. The JPM-22A is offered in one or two way traffic

modes. With this option, the controller automatically sets the sensitivity level for the metal detector portal based on the direction of traffic, allowing different detection levels for metal coming into an area than that going out.

FUNCTIONAL BLOCKS

- four plastic scintillation detectors, shielded and collimated by lead sheets
- low-noise photomultiplier tubes (PMTs)
- spectroscopy-grade signal processing electronics NIM:
 - portal controller
 - amplifier/SCA
 - high voltage power supply
- metal detector (JPM-22A)

SPECIFICATIONS

Sensitivity:

walk-through mode (1.3 m/s)	0.3 g for low burnup plutonium 10 g of HEU 0.05 reactor grade Pu
wait mode:	0.08 g for low burnup plutonium 3 g of HEU 0.01 reactor grade Pu
False alarm rate	1/2100
Power supply	optional Battery Backup for eight hours
Overall size	height is 213 cm; width - 117 cm; spacing between pillars 74 cm
Weight	181 kg (3mm lead shield)

SOFTWARE

ADDITIONAL INFORMATION

The JPM-21A is compatible with the Canberra's JPM-41A neutron monitor in that the two can be placed together to provide the maximum detection capability.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Portal Monitor

SNM Vehicle Portal Gamma-MonitorMODEL: JPM-12A

205

SUPPLIER: *Canberra Industries, Inc.*

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Portal Monitor

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S): HEU, Pu

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Stationary

ENVIRONMENT OF USE: Industrial

DEVELOPER: Los Alamos National Laboratory

MANUFACTURER: *Canberra Industries, Inc.***DESCRIPTION****PURPOSE***Model JPM-12A SNM Vehicle Portal Gamma-Monitor is designed for the detection of SNM in moving vehicles.***PRINCIPLES OF OPERATION**

The monitor is operated in single or dual traffic mode.

FUNCTIONAL BLOCKS

Similar in design to JPM-11A (see JPM-11A detail description).

SPECIFICATIONS

Sensitivity:

HEU	1 kg
low burnup plutonium	10 gm
reactor grade plutonium	1.2 gm
False alarm rate	1/2100
Operation temperature	-40 C to +40 C
Power supply	optional battery backup for 8 hours operation (at 20'C) Uninterruptable power supply (UPS) lines (harsh climates)

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Fehlau, P.E., Coop K.L., and Nixon, K.V., Sequential Probability Ratio Controllers for Safeguards Radiation Monitors, Proceedings of the 6th ESARDA Symposium on Safeguards and Nuclear Material Management, Venice, Italy, 1984.

Containment and Surveillance: Portal Monitor

SNM Vehicle Portal Gamma-Monitoring Station

MODEL: JPM-11A

206

SUPPLIER: *Canberra Industries, Inc.*

USE CATEGORY: Containment and Surveillance
 DEVICE TYPE: Portal Monitor
 MEASUREMENT METHOD: Gamma
 Passive
 MEASURED PROPERTIES: Radiation Intensity
 NUCLEAR MATERIAL(S): HEU, Pu
 PHYSICAL FORM(S) OF NM:
 STATUS: Serial Production
 PORTABILITY: Stationary
 ENVIRONMENT OF USE: Industrial
 DEVELOPER: Los Alamos National Laboratory
 MANUFACTURER: *Canberra Industries, Inc.*

DESCRIPTION

PURPOSE

Special Nuclear Material (SNM) Portals prevent unauthorized removal of fissile material such as U-235 and Pu-239. The JPM-11A is an intelligent gamma-radiation detection system that was jointly developed by Canberra and Los Alamos National Laboratory. It provides a rapid means of searching vehicles leaving a material access area by detecting emitted gamma-radiation.

PRINCIPLES OF OPERATION

It is operated in wait-in mode only. The microprocessor controller allows completely automatic operation. The visual/audio displays and alarms continuously inform the operator of portal status and occupancy sensors automatically determine presence of vehicle. The detectors are housed in heavy duty protective enclosures rated for outdoor use (NEMA 3). The internal and external RS-232 ports are provided for setting operating parameters and printing/storing data to external devices.

The vehicle waits in the station for periods up to a minute, thereby maximizing sensitivity to SNM. In addition, 16 large plastic scintillator detectors are placed above and below the vehicle, profiling large detection areas. The detectors are organized in four independent monitoring groups. Three of the detector groups are buried below the vehicle in trenches spaced 1.2 m (4ft) apart. Each trench holds two detectors and is covered with an aluminum plate. The remaining group is above the vehicle in a rack attached to a canopy. Each overhead detector is in an individual cabinet. Each monitoring group has its own individual amplifier, SCA, and high voltage supply. Special low-noise photomultiplier tubes (PMTs) are used with each detector to further improve sensitivity.

The monitoring station also uses a controller similar to the portal monitors, but has four data channels, one for each group. The controller uses the four data channels, one for each group. The controller uses the Sequential Probability Ratio Test (SPRT) [1] algorithm. This is a sequential hypothesis test that makes a sequence of short monitoring measurements. When the portal is unoccupied, the background events are counted by the portal controller. Each background is checked against selectable high and low extreme values and is tested for statistical variance. The background is continually monitored until triggered by the occupancy sensors buried in the roadway. When the station is occupied, it waits a few moments until the vehicle is parked and begins to analyze the signals. Each short interval is analyzed, and a decision is made whether the signal is background, SNM, or undetermined. If neither a background nor an alarm decision can be made, monitoring continues with another short measurement until a user selectable maximum total monitoring time is reached (usually one minute). A single decision that SNM is present causes an alarm. Alternatively, all four groups must reach decisions that no SNM is present to complete the monitoring.

The controller is provided with self diagnostic tests that are performed at system start up and master reset. Operating parameters and diagnostics are accessed with a terminal via a RS-232 port. The signal conditioning and analysis hardware are located in temperature controlled enclosures. Access to all system electronics and the master reset are protected by keyed latches. A Remote control Panel is supplied to indicate system status to the operator in a building or other enclosure. A similar module is located out of doors near the vehicle being monitored.

FUNCTIONAL BLOCKS

- 16 large plastic scintillator detectors
- amplifiers
- SCAs
- high voltage supply
- low-noise photomultiplier tubes (PMTs)
- portal controller

SPECIFICATIONS

Sensitivity:

HEU	40 gm
low burnup plutonium	0.3 gm
False alarm rate	3/1000
Operational temperature range	-40° C to +40° C

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Fehlau, P.E., Coop K.L., and K.V. Nixon, K.V., Sequential Probability Ratio Controllers for Safeguards Radiation Monitors, Proceedings of the 6th ESARDA Symposium on Safeguards and Nuclear Material Management, Venice, Italy, 1984.

Containment and Surveillance: Portal Monitor

Vehicle Contamination Monitors

MODEL: JPM-13, JPM-14

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SUPPLIER: *Canberra Industries, Inc.*

USE CATEGORY:	Containment and Surveillance
DEVICE TYPE:	Portal Monitor
MEASUREMENT METHOD:	Gamma
	Passive
MEASURED PROPERTIES:	Radiation Intensity
NUCLEAR MATERIAL(S):	U
PHYSICAL FORM(S) OF NM:	
STATUS:	Serial Production
PORTABILITY:	Stationary
ENVIRONMENT OF USE:	Industrial
DEVELOPER:	Canberra Industries, Inc.
MANUFACTURER:	Canberra Industries, Inc.

DESCRIPTION

PURPOSE

The JPM-13 and JPM-14 Vehicle Contamination Monitors are designed to provide reliable and easy monitoring of vehicles to detect contaminated scrap metal or slag, and detect contaminated waste leaving a facility or entering a landfill. Intelligent radiation detection systems detect gamma rays from shielded and unshielded radioactive sources such as Co-60, Cs-137, Ra-226, U-235, and Th-232.

PRINCIPLES OF OPERATION

Models JPM-13 and JPM-14 are operated in drive-through mode and feature an automatic operation through use of a microprocessor-based intelligent controller.

Vehicle Portal Monitors are designed for rapid monitoring. The monitor is located in a vehicle trap or near a rail or truck scale, on either side of a single lane of traffic. The JPM-13, 14 sense an entering vehicle with an occupancy sensor. As the vehicle slows down, it is monitored by plastic scintillator detectors located in rugged, weathertight enclosures on both sides of the roadway. For harsh environments, the enclosures can be heated and/or cooled. The amp/SCA boards are located close to the detectors to minimize noise pickup. Multiple SCAs allow detection of the position of the radioactivity in the vehicle.

When the monitor is unoccupied, the background events are counted by the controller. Each background is checked against selectable high and low extremes, and tested for statistical variance, any of which will cause an alarm. The background is continually monitored until occupancy is sensed. When the portal is occupied, it begins to look at very small count intervals. Each of these time intervals is analyzed using the Sequential Probability Ratio Test (SPRT) and compared to the background average. For a vehicle traveling 8 km/h through the Portal Monitor, five or six monitoring decisions may be made.

The portal controllers include a variance analyzer that operates continuously to analyze variations in the background and to facilitate system setup. If variations are larger than statistically expected, the deviation is displayed. The portal will also alarm when the background exceeds an upper limit or drops below a lower limit. The purpose of the variance check is to detect efforts to compromise the detectability of the portal by someone trying to "fool" its background measurement. An RS-232 communication port allows authorized personnel to set algorithm parameter, background limits, and operational parameter which are stored in non-volatile RAM, and are entered via an external terminal or computer. This serial port makes the unit more versatile because parameters are field-adjustable instead of requiring factory adjustment.

FUNCTIONAL BLOCKS

- microprocessor-based intelligent controller
- high voltage power supply
- Remote Control Panel with status indicator lights and alarm reset

- detectors:

JPM-13 - four plastic scintillators, active volume approximately 4572 cm³ each

JPM-14 - two plastic scintillators, active volume approximately 24,500 cm³ each

- preamplifier/ amplifier/single channel analyzer (SCA) boards

SPECIFICATIONS

Sensitivity:

JPM-13 (for 1 ton van at 8 km/hr)	9 mCi Cs-137 in a 20 mR/hr background
JPM-14 (with thickness of scrap between the source and vehicle wall less than 91 cm and speed < 6.5 km/hr)	> 300 mCi unshielded Cs-137

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

P.E. Fehlau, K.L. Coop, and K.V. Nixon, Sequential Probability Ratio Controllers for Safeguards Radiation Monitors, Proceedings of the 6th ESARDA Symposium on Safeguards and Nuclear Material Management, Venice, Italy, May 14-18, 1984.

Containment and Surveillance: Portal Monitor

Radiation Control System
MODEL: PM-5000

208

SUPPLIER: JV Polimaster

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Portal Monitor

MEASUREMENT METHOD: Neutron, Gamma
Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS:

PORTABILITY: Stationary

ENVIRONMENT OF USE: Field

DEVELOPER: JV Polimaster

MANUFACTURER: JV Polimaster

DESCRIPTION

PURPOSE

NM movement control at facility entrance/exit posts.

PRINCIPLES OF OPERATION

FUNCTIONAL BLOCKS

The system is a set of independent modules from which 8 types of radiation monitors can be assembled.

Two modules are the base of the system:

- gamma radiation plastic scintillator detector;
- neutron radiation detector baseB or He-3 counters.

The following devices can be created from these modules:

- 1 - Vehicle Monitor with 4 gamma radiation detectors (2 in each pillar) and 2 neutron detectors (1 in each pillar) - for vehicles.
- 2 - Vehicle Monitor with 4 gamma radiation detectors (2 in each pillar) - for vehicles.
- 3 - Vehicle Monitor with 2 gamma radiation detectors (1 in each pillar) and 2 neutron radiation detectors (1 in each pillar) - for cars .
- 4 - Vehicle Monitor for a car transport with 2 gamma radiation detectors (1 in each pillar) - for cars.
- 5 - Pedestrian Monitor with 4 gamma radiation detectors (2 in each pillar).
- 6 - Pedestrian Monitor with 2 gamma radiation detectors (1 in each pillar).
- 7 - Pedestrian Monitor with 1 gamma radiation detector (1 pillar).
- 8 - Mail - Luggage Monitor with 1 gamma-radiation detector and 1 neutron detector (1 pillar).

SPECIFICATIONS

Distance between pillars:

1, 2, 3, 4 models	6 m
5, 6 models	1.5 m
7, 8 models	1.5 m (source-detector)

Source velocity through monitor

1, 2, 3, 4 models	15 km/hr
5, 6, 7, 8 models	5 km/hr

Sensitivity at 20 mR/hr background:

material	model	1	2	3	4	5	6	7	8
Pu-239, g		4.3	4.3	4.19	4.19	0.6	0.6	1.2	1.2
U-235, g		298	298	248	248	9.9	9.9	35	35
U-238, g		2700	2700	2000	2000	123	123	976	976
Cs-137, mCi		9	9	9	9	1-2	1-2	1-2	1-2
Pu-239, g (at a distance of 3 m from source) (in 4 cm lead shield)		50.3	-	50.3	-	-	-	-	50.3

Operating conditions:

Temperature:	from -30°C to +50°C
Humidity:	upto 95%
Power supply	90 V - 250 V, 50±2 Hz
Interface	RS-232

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Portal Monitor

Radiation Monitoring System for Vehicles and Loads (Scrap Monitor)

MODEL: SD-975, SM-1, SM-1B

210

SUPPLIER: *National Nuclear Corporation*

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Portal Monitor

MEASUREMENT METHOD: Neutron, Gamma
Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Stationary

ENVIRONMENT OF USE: Field

DEVELOPER: Lawrence Livermore National Laboratory

MANUFACTURER: National Nuclear Corporation

DESCRIPTION

PURPOSE

Monitoring gamma and neutron radiation from scraps in vehicles.

PRINCIPLES OF OPERATION

Detects gamma and neutron radiation.

FUNCTIONAL BLOCKS

SD975 weatherproof NEMA-type enclosure containing:

- large plastic scintillation detector,
- 3/8" thick lead shielding,
- electronic interface board.

Readout units contain:

- signal processing electronics
- power supply.

SPECIFICATIONS

Efficiency	0.35% at 5 feet in a low background area is 1000 cps
Measurement time	3 seconds
Detectable activity	1 mCi (at confidence level of 90%) placed 5' from the detector assembly.
False alarm rate	less than 0.0001%, or approximately 1 every 6 months (using sigma factor of 5)
Operation temperature:	
SD-975 Detector	-30F to 120F
Readout Unit	10F to 120F
Overall size:	
Detector	42"W x 30"H x 9"D
Readout Unit	18"W x 10.5"H x 5.5"D, indoor enclosure
Weight:	
SD-975	500 pounds
Readout Unit	10 pounds

SOFTWARE

ADDITIONAL INFORMATION

Model SD-975 is supplied with Detector Assembly and SM-1 or SM-1B with readout units.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Portal Monitor**Asphalt Panel, Portal Monitor**
MODEL:**211****SUPPLIER:** *Pacific Northwest National Laboratory***USE CATEGORY:** Containment and Surveillance
DEVICE TYPE: Portal Monitor**MEASUREMENT METHOD:** Neutron
Passive**MEASURED PROPERTIES:** Radiation Intensity**NUCLEAR MATERIAL(S):** U, Pu**PHYSICAL FORM(S) OF NM:****STATUS:** One-of-a-kind**PORATABILITY:** Portable**ENVIRONMENT OF USE:** Field**DEVELOPER:** Pacific Northwest National Laboratory**MANUFACTURER:** Pacific Northwest National Laboratory**DESCRIPTION****PURPOSE**

A neutron detector was constructed for the purpose of making fast, high sensitivity measurements of neutron emitters in portal applications including entrances and exits of nuclear facilities.

PRINCIPLES OF OPERATION

The system is based on upon glass fiber optic scintillators loaded with lithium-6 and operated to detect thermal neutrons. The electronics package is placed in 20 cm x 25 cm x 2 cm space.

FUNCTIONAL BLOCKS**SPECIFICATIONS**

Power supply	can be run on a car battery.
Overall size	200 cm x 28 cm x 2.54 cm - panel
Weight	16 kg per panel

SOFTWARE

Can be operated remotely and transmit measurement data periodically by commercial satellite.

ADDITIONAL INFORMATION**REFERENCES**

Harry S. Miley, et.al., High Sensitivity, Low Profile Neutron Detector for Safeguards Measurements, PNNL publication

Containment and Surveillance: Portal Monitor

Pedestrian Radiation Monitor, Post KPRM

212

MODEL: KIIPM-III A0413-P975

SUPPLIER: RFNC VNIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Portal Monitor

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Limited Production

PORTABILITY: Stationary

ENVIRONMENT OF USE:

DEVELOPER: RFNC VNIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics

MANUFACTURER: RFNC VNIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics

DESCRIPTION

PURPOSE

Designed for NM removal control through continuous monitoring of the radiation background; creates setpoints and makes enunciation when a preset alammand alarm value limit is exceeded.

PRINCIPLES OF OPERATION

Operation modes:

- monitor self testing;
- background analysis
- RM test on "carrying" a radioactive object;
- test by "throwing" a radioactive object through the area controlled by the monitor;
- testing an unauthorized access to the monitor installation.

Indication of operation modes of the monitor and self-testing results is performed.

FUNCTIONAL BLOCKS

- pillars for passage;
- detector units - 4 pieces (2 per pillar), total detection area - 5500cm²;
- sound and light signalization units;
- infrared detector indicating a controlled area "occupancy";
- interface RS-232 or RS-485.

SPECIFICATIONS

Sensitivity with 25mkR/h background, at detection probability of more than 50% and 0,95 confidence level, with a passage speed of (1±0,2)m/s: 0.3g of Pu (a low burned level)
10 g of HEU (>90% U-235) for the minimal configuration (sphere)

Sensitivity in "waiting" mode from 1 s to 10 s 0.1g of Pu (a low burned level)
3 g of HEU (>90% U-235) for the minimal configuration (sphere)

False alarm rate:

in "walk-through" mode no more than 1 per 1000 passages
in continuous control mode no more than 1 per 8 hours operation

Operation setting

no more than 15 min.

Post and PC communication

interface RS-232 or RS-485

Maximum external background

50 mkR/h

Power supply

220B - continuous, 24 hours a day

Power consumption

no more than 100VA

Operation temperature range

from +5°C to +50°C at 80% relative humidity at 35°C

Overall size 2287 mm x 1020 mm x 1130 mm
Weight 150 kg without a Pb shielding

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Portal Monitor

Gamma and Neutron Rate Meter for Flux Density Control (CPIIC2)

213

MODEL: CPIIC2

SUPPLIER: RIPT, Research Institute of Pulse Technique**USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Portal Monitor**MEASUREMENT METHOD:** Gamma, Neutron, X-Ray
Passive**MEASURED PROPERTIES:** Radiation Intensity**NUCLEAR MATERIAL(S):** Pu, U**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Field**DEVELOPER:** MOLNIA Plant**MANUFACTURER:** RIPT, Research Institute of Pulse Technique

DESCRIPTION

PURPOSE

Detection of gamma and neutron sources that create a particle flux density close to the natural background at the point of observation; evaluation of the neutron and gamma equivalent dose rate; detection of gamma and neutron sources within moving vehicles.

PRINCIPLES OF OPERATION**FUNCTIONAL BLOCKS**

- neutron detector unit;
- gamma NaI(Tl) detector ;
- two channel recorder.

SPECIFICATIONS

Neutron Detection Unit

15 thermal neutron counters	СИ-19Н
Neutron sensitivity for $E < 100$ keV	100cm^2
	$E < 5\text{MeV}$
Dead time	100...50 cm^2
Overall size	15 mks
Weight	620 mm x 500 mm x 110 mm

Gamma detector

NaI (Tl) crystal	D63 mm x 63 mm
Sensitivity for 100-1200 keV range	25cm^2
Dead time	15 mks
Overall size	D120 mm x 550 mm
Weight	3.5 kg

Recorder

Exposure time	0,5; 5; 50 seconds
Detection limit	4; 8 standard deviations
Input signal amplitude (TTL)	$5\pm 10\text{V}$
Input resistance	75 Ohm
Max. input rate	up to $8\text{E}+5$ cps
Power supply	=24-27V or 220V, 50Hz

SOFTWARE**ADDITIONAL INFORMATION**

Possibilities:

- independent usage of different detectors,
- carrying on searching operations in continuous moving mode,
- operation under harsh climatic and mechanical conditions.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика (Каталог продукции НИИИТ)

Containment and Surveillance: Portal Monitor

Portal Gamma Monitor (CMTИ3.01)

MODEL: CMTИ3.01

214

SUPPLIER: RIPT, Research Institute of Pulse Technique

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Portal Monitor

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S): HEU

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Stationary

ENVIRONMENT OF USE: Field

DEVELOPER: RIPT, Research Institute of Pulse Technique

MANUFACTURER: RIPT, Research Institute of Pulse Technique

DESCRIPTION

PURPOSE

Detection of fissile materials and their products.

PRINCIPLES OF OPERATION

Designed for detection of gamma radiation in continuous mode with background control at the location being monitored. The device provides light and sound alarms and the monitor's status directly in-situ and to the remote control stations by RS-232 and on the "dry" contacts.

FUNCTIONAL BLOCKS

Two pillars with detectors (2 detectors per one pillar)

SPECIFICATIONS

Polystyrene gamma detector	800 mm x 250 mm x 50 mm
gamma sensitivity	800cm^2
for the 150-210 keV energy range	
Detection limit for uranium dioxide	3 g of U-235 (90% enrichment) 100 g of U-235 (3,36% enrichment)
Detection probability	0.95
False alarm probability	10^-6
Measurement time	no more than 1 second
Background level	10-20 mR/h
Overall size	2130 mm x 1100 mm x 580 mm
Spacing between pillars	2070 mm x 800 mm
Weight	no more than 320 kg
Power supply	220V, 50 Hz from internal power supply no more than 12 hours

SOFTWARE

ADDITIONAL INFORMATION

Warranty 12 months

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика (Каталог НИИИТ)

Containment and Surveillance: Portal Monitor

Portal Gamma Monitor (СМГИ5)

215

MODEL: СМГИ5

SUPPLIER: RIPT, Research Institute of Pulse Technique

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Portal Monitor

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S): HEU, LEU

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Stationary

ENVIRONMENT OF USE: Industrial

DEVELOPER: RIPT, Research Institute of Pulse Technique

MANUFACTURER: RIPT, Research Institute of Pulse Technique

DESCRIPTION

PURPOSE

Detection of gamma radiation of fissile materials and their products

PRINCIPLES OF OPERATION

Designed for detection of gamma radiation in continuous mode with background control at the location being monitored. The device provides light and sound alarms and the monitor's status directly in-situ and to the remote control stations by RS-232 and on the "dry" contacts.

FUNCTIONAL BLOCKS

two pillars with detectors (2 detectors per one pillar)

SPECIFICATIONS

NaI(Tl) gamma detector

D150 mm x 25 mm

Gamma sensitivity

600cm²

for the 150-210 keV energy range

Detection time

no more than 1 sec

Detection limit for uranium dioxide

3 g of U-235 (90% enrichment)

100 g of U-235 (3,36% enrichment)

0.95

10⁻⁵

Detection probability

no more than 1 second

False alarm probability

10-20 mR/h

Measurement time

2130 mm x 1540 mm x 580 mm

Background level

2070 mm x 800 mm

Overall size

no more than 250 kg

Spacing between pillars

220V, 50 Hz

Weight

from internal power supply

Power supply

no more than 12 hours

SOFTWARE

ADDITIONAL INFORMATION

Warranty 12 months

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика (Каталог продукции НИИИТ)

Containment and Surveillance: Portal Monitor

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Vehicle Gamma Monitor**MODEL: CMII 7.01, 7.02, and 7.03****SUPPLIER: RIPT, Research Institute of Pulse Technique****USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Portal Monitor**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity**NUCLEAR MATERIAL(S):** HEU**PHYSICAL FORM(S) OF NM:****STATUS:** Prototype**PORATABILITY:** Stationary**ENVIRONMENT OF USE:** Field**DEVELOPER:** RIPT, Research Institute of Pulse Technique**MANUFACTURER:** RIPT, Research Institute of Pulse Technique**DESCRIPTION****PURPOSE***Control of nuclear and radioactive material removal.***PRINCIPLES OF OPERATION**

Gamma detection of radioactive materials is executed in automatic "drive through" mode. Controlled by the built-in microprocessor with RS-232 for the connection to an external PC.

FUNCTIONAL BLOCKS

- two pillars with gamma detectors,
- additional units with sensitive elements on the ground of the passage and overhead (3.5 m).

SPECIFICATIONS

Gamma detector number	from 4 to 8
Detection limit	200 to 1000 g of U-235 (90% enrichment)
False alarm probability	1/4000
Power supply	220V, 50Hz
Operation temperature range	from -40°C to +40°C
Power supply	220V, 50Hz
	independent supply mode with built-in accumulator for 8 hours
Side pillar height	3 m
Distance between pillars	5 m
Alarm signal	light and sound

SOFTWARE**ADDITIONAL INFORMATION**

Warranty for 12 months.

Time between failures - no less than 4000 hours.

Life time - no less than 6 years

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Portal Monitor

Pedestrian Portal Monitor (ППМ КИ-01S)

MODEL: ППМ КИ-01S

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SUPPLIER: RSC Kurchatov Institute

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Portal Monitor

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Prototype

PORTABILITY: Stationary

ENVIRONMENT OF USE:

DEVELOPER: RSC Kurchatov Institute

MANUFACTURER: RSC Kurchatov Institute

DESCRIPTION

PURPOSE

Detection of unauthorized NM movements through the entrance/exit facility posts.

PRINCIPLES OF OPERATION

Detection of the gamma-radiation.

After the system is switched-on a self-diagnostic test is executed and the technical parameters are set-up. Then the system goes to the gamma background measurement mode. When an occupancy sensor is triggered the system goes to the measurement mode. In case of the set limit is exceeded the system generates the sound and light alarm signal. Also system controls so-called the "background gate" (upper and lower background levels) from an unauthorized radioactive contamination or the system shielding.

FUNCTIONAL BLOCKS

Monitor consists of two pillars, each pillar includes two plastic scintillation detectors, and one of the pillars contains a microprocessor unit of data processing with RS-232 port and internal power supply. The occupancy sensor and signal system are located on the top span of the portal.

SPECIFICATIONS

Detected gamma energy range	0,03-3,0 MeV
Pulse sensitivity with a gamma background level of 20 mR/hr	no more than 4000 pulses/sec
Background measurement time	no less than 0.5 sec
Object measurement time	no less than 0.2 sec
Sensitivity:	10 g of U-235 3 g of Pu-239 from 2 to 8 sigmas above the
Alarm limit setting	less than 1 per 3000 passages
background	accumulator 12 V, 30 A/hr
False alarm frequency	main 220 V, 50 Hz
Power supply	no less than 12 hr no more than 150 VA no more than 30 sec 24-hours a day
Continuous operation time	21000 mm x 560 mm x 200 mm
Power consumption	1000 mm x 250 mm x 50 mm
Operation state settling time	2100 mm x 850 mm
Operation mode	
Overall size:	
pillar	
scintillation detectors	
passage	

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Portal Monitor

Neutron and Neutron/Gamma Detectors

MODEL: CDN 002, CDM 001, DGN 001

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SUPPLIER: SAPHYMO

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Portal Monitor

MEASUREMENT METHOD: Neutron, Gamma
Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Stationary

ENVIRONMENT OF USE: Industrial

DEVELOPER: SAPHYMO

MANUFACTURER: SAPHYMO

DESCRIPTION

PURPOSE

The CDN 002 neutron and CDM 001 and DGN 001 neutron/gamma detector are designed for nuclear materials control. Other models DSP010, CDG007, BDG005 are used for gamma-radiation detection for trucks, cars, pedestrians

PRINCIPLES OF OPERATION

FUNCTIONAL BLOCKS

CDN 002 consists of:

- 3 He-3 tubes (1m)
- polyethylene moderator (12 cm thick)
- housing made of fiber glass coated polyester

CDM 001 consists of:

- gamma/neutron plastic scintillation detector (also used as a moderator)
- photomultiplier
- 3 He-3 tubes (1m)
- housing made of fiber glass coated polyester

DGN 001 consists of:

- gamma/neutrons plastic scintillation detector (also used as a moderator)
- photomultiplier
- 6 He-3 tubes (0.5 m)
- housing made of aluminum

SPECIFICATIONS

CDN 002:

neutron sensitivity	450 cps/(n/cm ² *s)
operating temperature range	-10 to +50 °C (14 to 122 degrees F)
overall dimensions	2000 mm x 350 mm x 440 mm
weight	60 kg (about 132 lbs)
watertightness	IP56

CDM 001:

gamma detection limits at 1 m (in 1 second, background 70 nGy/h, 5 sigma)	Cs-137, 30 kBq
neutron sensitivity	450 cps/(n/cm ² *s)
operating temperature range	-10 to +50 °C (14 to 122 degrees F)
size of the gamma detector	100 cm x 25 cm x 5 cm
overall dimensions	2000 mm x 350 mm x 440 mm
weight	170 kg (about 371 lbs)
watertightness	IP56

DGN 001:

gamma detection limits at 1 m (in 1 second, background 70 nGy/h, 5 sigma)	Cs-137, 40 kBq 400 cps/(n/cm ² *s)
neutron sensitivity	-10 to +50 °C (14 to 122 degrees F)
operating temperature range	50 cm x 50 cm x 5 cm
size of the gamma detector	1000 mm x 700 mm x 180 mm
overall dimensions	170 kg (about 374 lbs)
weight	IP56
watertightness	

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

COGEMA, CEA (France Atomic Energy Comission), GDF (French NPP Corp.), Hydro Quebec

Containment and Surveillance: Portal Monitor

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Portal Pedestrian Radiation Monitor**MODEL: KCP1U.03 "ДОЗОР" (МИ-01П)****SUPPLIER: Scientific Engineering Center "Nuclear Physical Research"****USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Portal Monitor**MEASUREMENT METHOD:** Gamma, Neutron
Passive**MEASURED PROPERTIES:** Radiation Intensity**NUCLEAR MATERIAL(S):** Pu, U**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORABILITY:** Stationary**ENVIRONMENT OF USE:** Field**DEVELOPER:** Scientific Engineering Center "Nuclear Physical Research"**MANUFACTURER:** EMZ "Avangard"**DESCRIPTION****PURPOSE***Control of nuclear material (NM) movements at the facility entrance/exit gates.***PRINCIPLES OF OPERATION**

Detection of the gamma- and neutron radiation.

The monitor can operate in two modes: "wait-in" and "walk through".

In "wait-in" mode the monitor performs counting during a fixed period and then compares these counts with preselected level limits. When NM is detected by the gamma-radiation the monitor generates a message on the possible radiation source location and transfers it to the operator control board. If a controlled object leaves the portal before the measurement time is up, the monitor generates a signal indicating interruption of monitoring mode.

In "walk-through" mode the monitor performs count analysis during a fixed period starting from the sensor triggering. If the preset limit is exceeded the device generates the alarm signal. Continuous background data updating is performed when the portal is unoccupied.

The monitor is connected to an external PC through RS-232 port. This connection allows performing:

- control of the current monitor status by remote PC;
- setting operation monitor parameters such as detection limits and a measurement time.

FUNCTIONAL BLOCKS

Each portal pillar contains:

- 3 scintillation plastic detectors of 2640cm², each with low noise PMT at the ends;
- 2 He-3 counters CHM-76.

On the outside of the pillar - control board.

In the portal span:

- traffic lights for passage, detection lights and a siren
- micro-computer, executive unit

On the top of the portal:

- signal processing unit - micro-computer, amplifier, PMT power sources.

SPECIFICATIONS

Measurement time:

"wait-in" mode	5 sec
"walk-through" mode	0.8 sec

Sensitivity limit at background level of 20 mR/h and false alarm frequency of no more than 1/1000:

for gamma channel	
"wait-in" mode (5 sec)	0.03 g of Pu-239
	1.0 g of U-235;
"walk-through" mode	0.1 g of Pu-239
	3 g of U-235

for neutron channel

"wait-in" mode	30 g of Pu-239
"walk-through" mode	50 g of Pu-239
Operation temperature range	+5 °C to +45 °C at humidity of 80% at 35 °C, and at a lower temperature without humidity condensation
Power consumption	200 W
Overall size	2210 mm x 740 mm x 196 mm
Passage dimension	2000 mm x 800 mm
Weight	no more than 150 kg without Pb shield

SOFTWARE**ADDITIONAL INFORMATION**

- in "wait-in" mode the monitor belongs to the IV category, of the high sensitive monitors according to the ASTM C1169;
- in "walk-through" mode the monitor belongs to the III category of the monitors of the improved sensitivity according to the ASTM C1169;
- for neutron channel the monitor belongs to the III category, of the high sensitive monitors according to the ASTM C1169.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Portal Monitor

*Vehicle Portal Radiation Monitor**MODEL: KCAP1Y.04 "Рубеж" (МН-01Т)**SUPPLIER: Scientific Engineering Center "Nuclear Physical Research"***220**

USE CATEGORY: Containment and Surveillance
DEVICE TYPE: Portal Monitor
MEASUREMENT METHOD: Gamma, Neutron
 Passive
MEASURED PROPERTIES: Radiation Intensity
NUCLEAR MATERIAL(S): Pu, U
PHYSICAL FORM(S) OF NM:
STATUS: Serial Production
PORABILITY: Stationary
ENVIRONMENT OF USE: Field
DEVELOPER: Scientific Engineering Center "Nuclear Physical Research"
MANUFACTURER: EMZ "Avangard"

DESCRIPTION**PURPOSE***Control of nuclear material (NM) movements at the entrance/exit gates of facilities in vehicles.***PRINCIPLES OF OPERATION**

Detection of the neutron and gamma radiation.

When the portal is not occupied the monitor performs continuous updating of the background data. When vehicle enters the portal the occupancy sensors switch-on and the analysis of counts from detectors in the established time begins. When the natural background level is exceeded, presence of SNM is indicated. Alarm signal is generated after the vehicle exits a portal.

The following functions are also available:

- control of the current monitor status;
- set-up of the monitor operation parameters.

Monitor operates in "drive-through" mode.

FUNCTIONAL BLOCKS

- two detection pillars;
- electronic processing system;
- operator control board.

Each pillar contains:

- 8 gamma radiation detectors on base of the plastic scintillator with the volume of 26400 cm³ for each of them,
- photomultiplier tube (PMT),
- He-3 neutron radiation detectors CHM-76 (8 detectors in each pillar),
- portal occupation sensors.

SPECIFICATIONS

Measurement time

2 c with the average speed
of vehicle of 8 km/hr

Sensitivity limit with the natural background of 20 mR/hr and false alarm frequency of no more 1/4000 for gamma-channel

7 g of Pu-239
800 g of U-235

for neutron channel
Operation temperature range

60 g of Pu-239
from -50°C to +50°C with humidity of 100% at temperature +40°C

Power consumption

100 W

Interface

RS-232 or modem communication

Overall size:

pillar

electronic signal processing unit

3100 mm x 710 mm x 210 mm
1000 mm x 470 mm x 404 mm

Weight:

pillar	250 kg
electronic unit	25 kg

SOFTWARE

ADDITIONAL INFORMATION

The possibility of the radiation source location estimation alongs the length and height of the car.
Back-up reserve power.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Portal Monitor

Device for Searching Hidden Radioactive/Fissile Materials
MODEL:

221

SUPPLIER: SNIIP-Konvel**USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Portal Monitor**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity**NUCLEAR MATERIAL(S):** Pu, U**PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Portable**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** SNIIP-Konvel**MANUFACTURER:** SNIIP-Konvel**DESCRIPTION****PURPOSE***For continuous monitoring for the gamma radiation background level and signaling any abrupt change. Used to control removal of gamma active material.***PRINCIPLES OF OPERATION**Information on background level (in $\mu\text{kR}/\text{hour}$ at $E = 0,66 \text{ MeV}$) is displayed as output on digital screen, and background increase triggers alarm and closes "dry" relay contacts.**FUNCTIONAL BLOCKS**

- control board
- a set of scintillation spectrometric detection units with two channels for gamma detection per each detector.

SPECIFICATIONS

NaI (Tl) detector	D63 mm x 250 mm
Detection channel number	up to 12
Sensitivity limit for one detection channel ($E = 0.66 \text{ MeV}$)	less than 1 $\mu\text{kR}/\text{hour}$
Measurement time	3 sec
Number of failures	no more than 4 per hour
Power supply	220 V +10%, -15% (50 Hz)
Operation conditions	from -10°C to +40°C
temperature	up to 98%
relative humidity at temperature of 25°C	

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика (Рекламный проспект "Научно-инженерный центр "СНИИП," 1995 г"). Advertisement by Science-Engineering Center SNIIP, 1995

Containment and Surveillance: Portal Monitor

High Sensitivity Radiation Monitors

222

MODEL: РИГ-08II-X-XX (X-число блоков, XX-исполнение)

SUPPLIER: SNIIP-Konvel

USE CATEGORY: Containment and Surveillance
 DEVICE TYPE: Portal Monitor
 MEASUREMENT METHOD: Gamma, Neutron
 Passive
 MEASURED PROPERTIES: Radiation Intensity
 NUCLEAR MATERIAL(S): Pu, U-235
 PHYSICAL FORM(S) OF NM:
 STATUS: One-of-a-kind
 PORTABILITY: Stationary
 ENVIRONMENT OF USE: Industrial, Laboratory
 DEVELOPER: SNIIP-Konvel
 MANUFACTURER: SNIIP-Konvel

DESCRIPTION

PURPOSE

Detection of NM removal through control points.

PRINCIPLES OF OPERATION

FUNCTIONAL BLOCKS

- accumulation and processing unit (УНО-172II)
- scintillation detection units

Detection units can be installed at key points on the object or on vertical rectangular pillars.

SPECIFICATIONS

Gamma energy range	from 6 to 3000 keV								
Number of detection units connected to control board	from 1 to 6								
Typical monitors sensitivity: pedestrian monitor	<table border="0"> <tbody> <tr> <td>Pu</td><td><0.025 g;</td> </tr> <tr> <td>U-235</td><td><2.5 g;</td> </tr> <tr> <td>Cs-137</td><td><25 kBq;</td> </tr> <tr> <td>Co-60</td><td><7k Bq.</td> </tr> </tbody> </table>	Pu	<0.025 g;	U-235	<2.5 g;	Cs-137	<25 kBq;	Co-60	<7k Bq.
Pu	<0.025 g;								
U-235	<2.5 g;								
Cs-137	<25 kBq;								
Co-60	<7k Bq.								
vehicle monitor	<table border="0"> <tbody> <tr> <td>Pu</td><td><0.2 g;</td> </tr> <tr> <td>U-235</td><td><60 g;</td> </tr> <tr> <td>Cs-137</td><td><300 kBq;</td> </tr> <tr> <td>Co-60</td><td><90 kBq</td> </tr> </tbody> </table> <p>(using four detection units per pillar the U-235 detection limit can be decreased to 0.5 g at the distance of 60 cm between pillars)</p>	Pu	<0.2 g;	U-235	<60 g;	Cs-137	<300 kBq;	Co-60	<90 kBq
Pu	<0.2 g;								
U-235	<60 g;								
Cs-137	<300 kBq;								
Co-60	<90 kBq								
Operation temperature range	from -40°C to +50°C.								
Power supply	=12 V								
Continuous operation time with accumulator	~220 V, 50 Hz no less than 24 hours								
Overall size:									
detection unit	D160 mm x 220 mm								
typical УНО-172II	185 mm x 213 mm x 105 mm								
pillars	250 mm x 250 mm x 2500 mm								
Weight:									
detection unit	2.3 kg								
УНО-172II	3 kg								
pillars	15 kg								
Power supply									

УНО-172П
БДИГ-30

Interface
Operation ability test

3 Wt
0.6 Wt
RS-232
Ba-133 source

SOFTWARE

Responsible for turning on the sound and light alarm signals once an abrupt change in background near the detectors takes place at the place or there is an increase in radiation background over the preset value.

ADDITIONAL INFORMATION

- detection of X, gamma and beta radiation.
- detection of neutron radiation
- possibility of the hidden detector unit location
- maintaining control functions under a partial damage of detector units.

Warranty - 18 months

Service time- 15 years

Delivery time on individual demands - no more than 4 months

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Portal Monitor

Stationary Custom System for the Detection of Fissile and Radioactive Materials

223

MODEL: Янтарь-1A, Янтарь-1П, Янтарь-1Ж.**SUPPLIER: SPC Aspect****USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Portal Monitor**MEASUREMENT METHOD:** Gamma, Neutron

Passive

MEASURED PROPERTIES: Radiation Intensity**NUCLEAR MATERIAL(S):** Pu, U**PHYSICAL FORM(S) OF NM:****STATUS:** Limited Production**PORTABILITY:** Stationary**ENVIRONMENT OF USE:** Field**DEVELOPER:** SPC Aspect**MANUFACTURER:** SPC Aspect**DESCRIPTION****PURPOSE**

Systems are designed to detect nuclear and radioactive material removal through facility entrance/exit posts (vehicle: Янтарь-1A, pedestrian: Янтарь-1П, railroad: Янтарь-1Ж).

PRINCIPLES OF OPERATION

After the self-diagnostics test is completed the system goes into background measurement mode. When the preset low and upper background limits are exceeded, the system outputs the information to the control board. When a controlled subject is inside the portal the controller switches from the background monitoring mode to the measurement mode of subject. The measurement result is compared with the preset limit which was determined from of the most recently measured background value. The system produces sound and light signals when the limit is exceeded.

FUNCTIONAL BLOCKS

Two built-in channels for the nuclear radiation detection:

- gamma channel: plastic scintillators with sensitive volume of 4000 cm³ each;
- neutron channel: He-3 neutron counters with volume of 800 cm³ each.

Built-in accumulator.

Delivery set includes:

- pillars ("Янтарь-1A" - 2 pillars
"Янтарь-1П" - 1 pillar
"Янтарь-2П" - 1 pillars
"Янтарь-1Ж" - 2 pillars)
- control board
- operational documentation.

Gamma detectors number:

"Янтарь-1A"	14
"Янтарь-1П"	1
"Янтарь-2П"	4
"Янтарь-1Ж"	3

Neutron counters number:

"Янтарь-1A"	12
"Янтарь-1П"	2
"Янтарь-2П"	4
"Янтарь-1Ж"	12

SPECIFICATIONS

Detected amounts of nuclear materials:

	material mass, g
Pu-239	
U-235	
U-238	
Pu-239	

system	weapon	with shield of 4cm Pb		
"Янтарь-1А" for car of 3 ton weight and 10 km/h speed, with a distance of 6 m between pillars, with background level of 20 mR/h	10	1000	6000	50
"Янтарь-1П" for moving a pedestrian with a stop in the controlled zone from a distance no more than 1,5 m from the system, with a background level of 20 mR/h	1	10	100	40
"Янтарь-1Ж" for the railway car of 3 tons moving with speed of 15-20 km/h, with 1 m iron shielding, with a background level of 20 mR/h	10	1000	6000	
False alarm frequency		no more than 1/1000 continuous, 24 hours a day		
Operation mode				
Number of systems connected to a single control board	16			
Maximum distance between the control board and pillars	2000 m			
Operation temperature range	from -50°C to +50°C			
Power supply	220 V, 50 Hz			
Main power consumption	no more than 60 VA			
Continuous operation time with a built-in accumulator	10 hours			
Overall size:				
"Янтарь-1А"	370 mm x 600 mm x 2987 mm			
"Янтарь-1П"	250 mm x 520 mm x 1670 mm			
Weight:				
"Янтарь-1А"	700 kg			
"Янтарь-1П"	200 kg			
Interface	RS-485 and parallel interface for the information printing			

SOFTWARE**ADDITIONAL INFORMATION**

External devices (printer, PC, video surveillance systems, additional alarm devices) can be connected.

Warranty - 18 months.

Approximate delivery time - from 3 to 6 months.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Portal Monitor

Device for Radioactive Material Removal Control

224

MODEL: KIIPM**SUPPLIER:** *SSC IPPE, State Scientific Center of Russian Federation, Institute of Physics and Power Engineering***USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Portal Monitor**MEASUREMENT METHOD:** Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Limited Production**PORATABILITY:** Portable**ENVIRONMENT OF USE:****DEVELOPER:** *SSC IPPE, State Scientific Center of Russian Federation, Institute of Physics and Power Engineering***MANUFACTURER:** *SSC IPPE, State Scientific Center of Russian Federation, Institute of Physics and Power Engineering***DESCRIPTION****PURPOSE***Gamma-radiation detection of radioactive materials removal.***PRINCIPLES OF OPERATION**

When the current background level is exceeded, the device produces a light and sound alarm. The sensitivity limit is established from mean-square error values.

FUNCTIONAL BLOCKS

- Main module:

- recording unit
- logical unit
- signalization unit

- Detection units (from 1 to 4) with NaI (Tl) crystal

SPECIFICATIONS

NM detection alarm signal	sound, light, electrical
Alarm switch on time	0.5 sec
Operation setting time	<15 min
Continuous operation time	unlimited
Power supply	(220±15V), (50±2)Hz
Maximum distance between the detector and the main module	30 m
Overall size:	
detection unit	90 mm x 90 mm x 250 mm
main module	440 mm x 300 mm x 200 mm
Weight (with one detection unit)	8 kg

SOFTWARE**ADDITIONAL INFORMATION**

Time between failures - 10 000 h.

Life time - 6 years.

Warranty - 1 year.

Device can be supplied with the independent power block on demand.

Device is produced from unified modules of the "УТК" system.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Portal Monitor

Pedestrian Portal Monitor (PM-700/701)

MODEL: PM-700/701

225

SUPPLIER: *TSA Systems Ltd.*

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Portal Monitor

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Stationary

ENVIRONMENT OF USE: Industrial

DEVELOPER: *TSA Systems Ltd.*MANUFACTURER: *TSA Systems Ltd.*

DESCRIPTION

PURPOSE

These monitors are designed to automatically scan pedestrian traffic without the need for frequent calibration. They are intended for applications where the relatively low energy emissions from U-235 and Pu-239 are the main concern. They are currently in use at uranium enrichment plants, weapons manufacturing plants, weapons storage sites, nuclear laboratories, and nuclear waste disposal and storage sites where protection of SNM is essential.

PRINCIPLES OF OPERATION

After the initial site preparation is completed, the systems can be installed and operating in less than an hour. When the system is powered up, it acquires an initial background. This process takes twenty seconds. The background is continually updated until the system is occupied.

When the infra-red detector senses occupancy, the system starts comparing the current count to the most recent background data. Alarm comparisons are made every 200 ms. If the count exceeds the alarm level, both audible and visual alarms will be triggered. The system monitors itself and indicates low and high background conditions. A closed circuit tamper output is available for connection to an AM-255 or site security system.

System status is continuously updated on the SC-755 display.

FUNCTIONAL BLOCKS

- radiation detectors

PM-700: two 25 cm x 90 cm x 3.8 cm organic plastic scintillator detectors
per pillar (35.4 l of detector volume)

PM-701: two 15 cm x 76 cm x 3.8 cm organic plastic scintillator detectors
per pillar (17.6 l detector volume)

- controllers

- occupancy detector

- internal battery

- model SC-755 controller in the master pillar

- model SCA-725 single channel analyzer in the slave pillar

SPECIFICATIONS

Sensitivity:

PM-700	3 gm HEU or 0.08 gm Pu (ASTM 1169-92 Category III)
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PM-701	10 gm HEU or 0.29 gm Pu (ASTM 1169-92 Category II)
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Operation time

> 24 hours

Operation temperature

-34 to 50 degrees C

Overall size:

20 x 56 x 214 cm³;

PM-700	20 x 20 x 203 cm ³
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PM-701	
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Weight:

PM-700	182 kg per pillar
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PM-701

136 kg per pillar

SOFTWARE

ADDITIONAL INFORMATION

TSA's expert engineering staff can adapt monitors to meet special requirements, if necessary.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Portal Monitor

Vehicle Portal Monitor

MODEL: VM-250/375

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SUPPLIER: *TSA Systems Ltd.*

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Portal Monitor

MEASUREMENT METHOD: Gamma

Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Stationary

ENVIRONMENT OF USE: Industrial

DEVELOPER: *TSA Systems Ltd.*MANUFACTURER: *TSA Systems Ltd.*

DESCRIPTION

PURPOSE

These monitors are designed to automatically scan vehicular traffic without the need for frequent calibration. They are intended for applications where the relatively low energy emissions from U-235 and Pu-239 are the main concern. They are currently in use in installations such as uranium enrichment plants, weapons manufacturing and storage plants, nuclear laboratories, and nuclear waste disposal and storage sites where protection of SNM is essential.

PRINCIPLES OF OPERATION

The pillars are usually bolted to a concrete footing, with the interconnecting conduits installed under the roadway. The system requires two conduits, one to provide ac power to the battery charger, and one for the inter-pillar connections. A third conduit may be required to route signals to an AM-255 or an on site alarm system. When the system is powered up, it acquires an initial background. This process takes twenty seconds. The background is continually updated until the system is occupied.

When the infrared detector senses occupancy, the system starts comparing the current count to the most recent background data. Alarm comparisons are made every 200 ms. If the count exceeds the alarm level, both audible and visual alarms will be triggered. The system monitors itself and indicates low and high background conditions. A closed circuit tamper output is available for connection to an AM-255 or site security system. System status is continuously updated on the SC-755 display.

FUNCTIONAL BLOCKS

VM-250 system:

- two, self contained, weather resistant pillars (on either side of the entrance) consist of:
 - two 15 cm x 76 cm x 3.8 cm organic plastic scintillator detectors
(17.6 l of detector volume)
 - occupancy detector
 - amplifier/controller
 - battery (master pillar)
 - power supply/battery charger (master pillar)

VM-375 system is essentially a VM-250

- + third pillar positioned horizontally between the two upright pillars

SPECIFICATIONS

The pillar spacing

from 10 feet (3m) to 32 feet (10m)

Operation time

greater than 24 hours

Operation temperature

from -34°C to 50°C

Overall size

25 cm x 25 cm x 244 cm or 305 cm per pillar

Weight

136 kg per pillar

SOFTWARE

ADDITIONAL INFORMATION

The units can be insulated, heated and/or cooled for use in severe environmental conditions.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Position Control System
Authenticated Item Monitoring System

227

MODEL: AIMS

SUPPLIER: *Sandia National Laboratories*

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Position Control System

MEASUREMENT METHOD:

MEASURED PROPERTIES:

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Limited Production

PORTABILITY: Stationary

ENVIRONMENT OF USE: Industrial

DEVELOPER: Sandia National Laboratories

MANUFACTURER: Sandia National Laboratories

DESCRIPTION

PURPOSE

The objective of the system is to monitor, in a secure and authenticated fashion, the status of selected items, including six canisters, two doors, an overhead crane, a storage cabinet, and a secure container within a glove box.

PRINCIPLES OF OPERATION

To protect against tampering with the data, the Authenticated Sensor Transmitter employs a multi-burst, frequency-hopping transmission technique and data authentication. A RF receiver demodulates and filters incoming messages and ignores messages that are not assigned to its group of ASTXs. The Receiver Processing Unit (RPU) authenticates incoming messages, stores up to 10,000 events, reports chronological events in real-time or remotely, and provides programming for all ASTXs.

FUNCTIONAL BLOCKS

- Authenticated Sensor Transmitter (ASTX) packs,
- radio frequency (RF) receiver,
- portable Receiver Processing Unit (RPU) sealed in a tamper-indicating enclosure,
- PC interface.

SPECIFICATIONS

Power supply AC or battery-operated
Continuous operation time of RPU up to 8 hours (backup mode)

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

The Cooperative Monitoring Center (CMC), SNL publication

Containment and Surveillance: Position Control System**Authenticated Tracking and Monitoring System****MODEL: ATMS****228****SUPPLIER:** *Sandia National Laboratories***USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Position Control System**MEASUREMENT METHOD:****MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Limited Production**PORTABILITY:** Stationary, Portable**ENVIRONMENT OF USE:** Field**DEVELOPER:** Sandia National Laboratories**MANUFACTURER:** Sandia National Laboratories**DESCRIPTION****PURPOSE**

ATMS is designed for global monitoring of the status and location of sensitive items: arms control verification, non-proliferation treaty verification, and military asset control.

PRINCIPLES OF OPERATION

Uses sensor packs to monitor items and environmental conditions, collects a variety of event data through a sensor processing unit, and transmits the data to the INMARST satellite system, which sends the data to ground stations. Authentication and encryption are incorporated to secure the data during all transmissions.

ATMS can monitor virtually any shipment in continuing, near-real time, world-wide coverage. Incorporates state-of-the-art mapping and tracking software, and uses tamper-resistant/tamper-indicating technologies.

FUNCTIONAL BLOCKS

- sensor packs
- sensor processing unit,
- INMARST satellite system

SPECIFICATIONS**SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

The Cooperative Monitoring Center (CMC), SNL publication

Containment and Surveillance: Radiation Control System

229

Neutron Slab MonitorMODEL: N50SUPPLIER: *AEA Technology plc, Harwell Instruments*

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Radiation Control System

MEASUREMENT METHOD: Neutron

Passive

MEASURED PROPERTIES: Radiation Intensity

NUCLEAR MATERIAL(S): Pu-240 + SF isotopes + (alpha,n)

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Stationary

ENVIRONMENT OF USE: Industrial

DEVELOPER: AEA Technology plc, Harwell Instruments

MANUFACTURER: AEA Technology plc, Harwell Instruments

DESCRIPTION

PURPOSE

The N50 Compact Fast Neutron Monitor is designed to provide information on the location and movements of fissile material in different areas of Pu, PuO₂ and MOX handling facilities, required by plant operators for nuclear materials accountancy and criticality control.

PRINCIPLES OF OPERATION

It is intended to be permanently installed in nuclear installations and to be operated unattended in a continuous mode. It is compact and portable and may be readily mounted on walls or ceilings at a facility. The important considerations which were included in the design were efficiency, HV and signal redundancy, and driving long cable lengths. In addition, several monitors can be used in conjunction configured around particular items for quantitative measurements.

FUNCTIONAL BLOCKS

SPECIFICATIONS

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

S. Croft, et.al., Design and Performance of the Model N50 Neutron Slab Monitor System, 19th Annual Symposium on Safeguards and Nuclear Material Management, Le Corum, Montpellier, France, 13-15 May, 1997

Containment and Surveillance: Radiation Control System**Remote Scanning Gamma Spectrometer****MODEL: ДСГ-7****SUPPLIER: RSC Kurchatov Institute, SPC REKOM****USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Radiation Control System**MEASUREMENT METHOD:** Gamma**MEASURED PROPERTIES:** Radiation Intensity**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Prototype**PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** RSC Kurchatov Institute, SPC REKOM**MANUFACTURER:** RSC Kurchatov Institute, SPC REKOM**230****DESCRIPTION****PURPOSE**

Remote radiation monitoring of the rooms and objects of different designation. Can be used as a TV-surveillance system with the function of image displaying on the computer display.

PRINCIPLES OF OPERATION

The head rotating part of the spectrometer with two freedom degrees is placed in the measurement zone. TV-camera operates in the optical range in TV-standard, the image processing and correction are performed by computer.

The spectrometer can:

- detect radioactive objects and their location by match of the measured radiation image with the optical object image;
- identify the radiation emitted nuclides by the measured spectra;
- calculate the equivalent dose rate distribution in the volume of the controlled room;
- automatically measure the effective surface activity density for different surfaces;
- display graphical and digital data;
- transfer data to external registration units.

FUNCTIONAL BLOCKS

- the head part of this spectrometer contains:

- gamma detector ДСФ-1-2 (CsI(Tl) scintillator + silicon photodiode wrapped in the lead shield with collimator and spectrometric amplifier),
- TV- camera,
- laser range finder;

- main module on the PC base.

SPECIFICATIONS

Energy resolution for 662 keV line

7-10% (depending on the scintillator size)

Energy range

60 keV to 3 MeV

Sensitivity limit

250 Bq/cm² (for 20 mm collimator)

Laser range finder: range
resolution

1E+7 Bq from a distance of 10 m

to the "hot" spot

up to 100 m

no worse than 1 m

Overall size of the head part

500 mm x 400 mm x 400 mm

Weight of the head part

30 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Radiation Control System

CTM Data Processing Unit
MODEL: CTM 304, CTM 303-11

231

SUPPLIER: SAPHYMO

USE CATEGORY: Containment and Surveillance
DEVICE TYPE: Radiation Control System
MEASUREMENT METHOD: Gamma, Neutron

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:**

STATUS: Serial Production
PORTABILITY: Portable
ENVIRONMENT OF USE: Industrial
DEVELOPER: SAPHYMO
MANUFACTURER: SAPHYMO

DESCRIPTION**PURPOSE**

CTM type processing units can operate using all Saphymo gamma and neutron detectors. The processing unit provides the power for the detectors, counts the pulses and checks out the alarms and faults.

PRINCIPLES OF OPERATION

The CTM units do not need any special service by the staff in normal use. The operator is only warned by the system in case of an alarm or a fault. In case of a power supply problem, the battery provides the power to continue the measurement and warn the staff.

The processing units can communicate with external equipment (printer, computer systems, alarm devices, traffic lights, gates, etc.) through the RS 232 (or RS 422) port and the relay outputs.

The CTM processing units are fully programmable. All the measurement parameters can be adjusted by the user to fit the characteristics of the site and specific requirements.

FUNCTIONAL BLOCKS**SPECIFICATIONS**

CTM 304 manages	2 independent counting channels
CTM 303-11 manages	4 independent counting channels.
(Other types of processing units with more channels are also available.)	

SOFTWARE

The standard RAC software allows data storage on disk, graphical display of alarms or faults, permanent checking of detector status, etc. The software exists in English and French. Other languages, and more options can be added.

ADDITIONAL INFORMATION**REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Radiation Control System

Installation for the Radiation Control

MODEL: РИГ-08Н-2, -08Н-4, -08Н-8

232

SUPPLIER: SNIIP-Konvel

USE CATEGORY:	Containment and Surveillance
DEVICE TYPE:	Radiation Control System
MEASUREMENT METHOD:	Gamma, Neutron, Beta Passive
MEASURED PROPERTIES:	Radiation Intensity
NUCLEAR MATERIAL(S):	
PHYSICAL FORM(S) OF NM:	
STATUS:	Serial Production
PORTABILITY:	Stationary
ENVIRONMENT OF USE:	Industrial
DEVELOPER:	SNIIP-Konvel
MANUFACTURER:	SNIIP-Konvel

DESCRIPTION

PURPOSE

Continuous monitoring of gamma, beta and neutron radiation level.

PRINCIPLES OF OPERATION

Detection of gamma quanta, beta particles and neutrons in the detector is accompanied by light flash which is transformed into a pulse of current in PMT. The pulse amplitude of the current is a parameter serving for the selection of useful signals. The accumulation and processing unit is responsible for the calculation of the average pulse count rate of each detection unit and records sharp changes of the count rate in any channel. If count rates exceed the preset limits, the alarm indicator lights up and the internal sound signal switches on an alarm channel. Simultaneously the signal "dry closed contact" is sent to external devices. The accumulation and processing unit estimates the absolute background value for each detector zone and generates an alarm signal upon reaching 60 mR/hour.

FUNCTIONAL BLOCKS

Accumulation and processing unit

УНО-172Н - 1

- Detection units

- 2 (for -08N-2),
- 4 (for -08N-4),
- 8 (for -08N-8),

БДИГ-28Н, detection unit

from 0 to 2, 4, 8

(depending on model and delivery)

БДИГ-29Н, detection unit

from 0 to 2, 4, 8

(depending on model and delivery)

Detection units have detector, photoelectric multiplier tube (PMT), PMT power supply, unit for amplification and selection of signals from PMT.

- 2RM18K7GIV1 slot

2, 4, 8 (depending on model)

- a kit of mounting parts

SPECIFICATIONS

БДИГ-28Н detection unit

main part

scintillation plastic with special agents

overall size

no more than 370 mm x 150 mm x 80 mm

weight

no more than 2.0 kg

БДИГ-29Н detector unit

main part

film detector

overall size

no more than D160 mm x 220 mm

weight

no more than 1.5 kg

Accumulation and processing unit

overall size

no more than 145 mm x 185 mm x 115mm

weight

no more than 3.0 kg (4.0 kg for БДИГ-08Н-8)

Measurement time

1 sec

False detection frequency

no more than 1 per 10000 measurements

	at $K = 4$, where K is a factor adjusted by switches from a number of values: 3, 4, 5
Power supply	220 V +20-30V, 50±1 Hz frequency or = 12±0.6 V
Operation conditions:	
Environment temperature for:	
accumulation and processing unit	from +5°C to + 35°C
detection units	from -30°C to + 50°C
Power consumption	no more than 15 Wt (AC main)
Vibration stresses	in range from 10 to 55 Hz with amplitude of 0.35 mm
Transportation conditions	in package by any closed transport type at the temperature from -30°C to +50°C. The packed device must be transported by air in the a hermetic part of an air transport.
Storage	in manufacturer's package and storage conditions at air temperatures from 0°C to +40°C and with relative humidity up to 80% at 20°C.

SOFTWARE**ADDITIONAL INFORMATION**

Warranty - 12 months

REFERENCES

Паспорта на установки: (1996 г.):
РИГ-08Н-2, РИГ-08Н-4, РИГ-08Н-8

Passports on installations (1996):
RIG-08N-2, RIG-08N-4, RIG-08N-8

Containment and Surveillance: Seal

COBRA Seal

MODEL:

233

SUPPLIER: *AQUILA Technologies Group, Inc.*

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Seal

MEASUREMENT METHOD:

Passive

MEASURED PROPERTIES:

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Hand-held

ENVIRONMENT OF USE: Field

DEVELOPER: Sandia National Laboratories

MANUFACTURER: AQUILA Technologies Group, Inc.

DESCRIPTION

PURPOSE

The Cobra Seal is a passive, fiber-optic loop seal designed to efficiently provide accountability and control of material or items regulated by treaty or agreement

PRINCIPLES OF OPERATION

The seal is installed by looping the fiber-optic cable through the item that is to be sealed and then feeding the cable ends into the seal body. Two clamping pins secure the cable in the seal body and a specially designed cutting blade cuts the fiber-optic cable in a random manner, thereby creating a unique pattern on the seal face. This pattern is recorded photographically for future comparison with subsequent inspection images. The COBRA III Seal Imaging System, developed by Aquila Technologies Group, is used to photograph the fiber optic cable ends. These images may then be downloaded to a computer or printed and a manual review performed to verify seal integrity.

FUNCTIONAL BLOCKS

polycarbonate seal body:

- two clamping pins
- one cutting blade

The fiber-optic cable:

- 64 plastic fibers within a black polyethylene jacket.

SPECIFICATIONS

Seal dimensions: 2 in x 1 in x .5 in (5 cm x 2.5 cm x 1.5 cm)

Fiber diameter x numbers: 0.265 in x 64

Fiber cable tensile strength: 650 dB/km

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

The Cooperative Monitoring Center (CMC), Sandia National Laboratory publication

Containment and Surveillance: Seal

Digital Camera Module 14

234

MODEL:

SUPPLIER: *AQUILA Technologies Group, Inc.*

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Seal

MEASUREMENT METHOD:

MEASURED PROPERTIES:

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY:

ENVIRONMENT OF USE:

DEVELOPER: *AQUILA Technologies Group, Inc.*MANUFACTURER: *AQUILA Technologies Group, Inc.*

DESCRIPTION

PURPOSE

The Digital Camera Module 14 (DCM-14) is a complete autonomous surveillance system for safeguards applications. By combining a CCD camera to the DCM-14, Dr. Neumann GmbH has designed a surveillance device with authentication and encryption, external triggers, scene change detection, and VACOSS-S seals. The DCM-14 is manufactured and distributed in the U.S. under license from the German government.

PRINCIPLES OF OPERATION

The DCM-14 is a powerful, but compact tool that combines the capabilities of digitizing, image compression, authentication, a flexible trigger engine, and power management all into a design that fits into a standard IAEA camera housing. Images are taken by the CCD camera and are then collected by the DCM-14. Images collected by the heartbeat trigger of the camera are compressed and stored in the ring-buffer memory. The compression algorithm, a modified JPEG algorithm implemented in the software, has three different qualifications which result in a low, medium, and high resolution image. A variety of trigger configurations are available and can be set during installation. These sources can come from outside the camera, or the camera itself can be set to reduce the number of unnecessary images, thereby focusing the manual review on only those images deemed critical. The DCM-14 operates as a server for images and is equipped with an exchangeable PC-Card for local storage of the compressed images. Generally, sixty compressed medium resolution images fit on a 1 MB memory chip of the PC-Card. The PC-card can be reviewed and analyzed using a notebook PC with a PC-Card slot. An image can be compared with the previous image to detect a scene change. The scene change algorithm corrects for global lighting changes and allows for trigger level adjustments. The algorithm either operates on the whole image without setting regions of interest or sets a maximum of twenty regions of interest in one image. The authentication algorithm is a complex formula based on triple DES algorithm with a changing key every twenty four hours. A key set can be generated inside the module using a real random number generator. The DCM-14 will only reuse a key approximately once every five years. The encryption algorithm is based on an implementation of the DES cipher and on a key set generated and changed by the DCM-14 module. Utilizing a communications server and the Aquila GENERAL Advanced Review Software (GARS), a complete safeguards review of DCM-14 surveillance images from a remote location may be performed. Images from one or multiple cameras are downloaded from the PC-Card of each DCM-14 to the communications server via one of two available RS-232 communication ports. The images can then be downloaded from the server to a remote computer using the GARS software. Additional capabilities of the GARS software include back-end motion detection and authentication verification of the DCM-14 surveillance data.

FUNCTIONAL BLOCKS

- Exchangeable PC-Card
- Flexible Trigger Engine
- Ring Buffer Memory

SPECIFICATIONS

Controller:

System Memory - 2 MB SRAM (battery buffered)
 Memory - 512 KB FLASH EPROM
 Memory - 256 KB

CPU - DSP TMX320LC31 running at 20 MHz
Interface:

Serial Ports - RS-485 isolated interface for party-line Firmware operation or
isolated single
ended coaxial interface. Also RS-232 serial interface for service, setup and
external triggering

PC-Card Interface - Type III
Seal Interface - VACOSS-S

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Seal

235

Fiber Optic SealMODEL: VACOSS-SSUPPLIER: *AQUILA Technologies Group, Inc.*

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Seal

MEASUREMENT METHOD: Active

MEASURED PROPERTIES:

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Hand-held

ENVIRONMENT OF USE: Industrial

DEVELOPER: *AQUILA Technologies Group, Inc.*MANUFACTURER: *AQUILA Technologies Group, Inc.*

DESCRIPTION

PURPOSE

The VACOSS-S seal is intended for high reliability and long duration surveillance in those applications that require periodic access.

PRINCIPLES OF OPERATION

The VACOSS-S seal is comprised of two major components: the seal itself and the fiber-optic cable. At each end of the fiber optic cable is a terminating connector which inserts into two fiber optic receptors located on the top of the seal. The fiber terminators pass through a 0.250" opening. Captive nuts lock the connectors in place. One end of the fiber is typically prepared in advance and the other end is terminated to length in the field. Two LEMO connectors are also located at the top of the seal for communication with an external computer with reader software.

The fiber optic loop is interrogated with an encoded digital pulse stream every 250 milliseconds for continuity. Without any redesign, the interval could be changed to 125 milliseconds, although this will reduce the battery life by half. Continuity of light transmission through the fiber optic loop is monitored electronically by the seal. Opening the fiber loop requires approximately 3 seconds without gloves, and the fiber termination cannot be removed from the connector without indicating an open condition. Dates and times, opening or closing of the loop, tampering, and interrogations are stored in the seal and can be reviewed at a later time with the Aquila VACOSS reader. The fiber itself is glass with a plastic index layer and kevlar strength members inside a thermoplastic sheath. There is no known method of splicing the fiber in the interval between interrogations. The seal's design is rugged and resistant to tampering. The electronic circuitry (including the light emitting diode and detector) is potted in an X-ray resistant compound of epoxy and ceramic particles to deter attempts at reverse engineering. A tamper switch detects any opening of the seal housing, and all openings are recorded as tamper events. The seal has the option of an external power supply using the LEMO connectors. The internal batteries are disconnected when the seal is powered by an external supply but will immediately switch to the internal batteries if external power is interrupted. No loss of surveillance will occur during the transition. The internal batteries will provide backup protection for over 10 years if external power is continuous.

For installations with multiple seals in proximity, the seals may be daisy chained using the LEMO connectors in the "Party Line Mode." All seals connected in this fashion can be read by the adapter box in sequence without changing the connection. A real-time external alarm indication could be implemented for externally-powered seals.

FUNCTIONAL BLOCKS

Vacoss seal

Fiber optic cable

Communications cable

SPECIFICATIONS

Duration of surveillance
on the internal battery

1 years

Interrogation interval

250 millisec

Time to open the fiber loop

(could be changed to 125 millisec)

3 sec

Overall size 5 cm x 3.5 cm x 10.4 cm
Weight 0.43 kg

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Seal

236

Fiber-Electric Seal

MODEL: ARGUS

SUPPLIER: AQUILA Technologies Group, Inc.

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Seal

MEASUREMENT METHOD:

Passive

MEASURED PROPERTIES:

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS:

PORTABILITY: Hand-held

ENVIRONMENT OF USE: Field

DEVELOPER: AQUILA Technologies Group, Inc.

MANUFACTURER: AQUILA Technologies Group, Inc.

DESCRIPTION

PURPOSE

The family of Argus seals are electronic seals whose recorded data can be read remotely. The user is instantly given detailed verification information, eliminating the need for a complicated and thorough human visual inspection.

PRINCIPLES OF OPERATION

Once applied, the sealing wire creates a unique resistance pattern which cannot be replicated. This resistivity measurement is coupled with the seal's serial number to make a unique identification number for the seal. The construction of the sealing wire is such that it is not possible to measure the wire resistance from the outside of the seal. Depending on the requirements of the user, the Argus family offers the following: Argus passive tag, Argus passive seal, Argus active seal and Argus star seal. The seal data can be read via RF with a small, hand-held computer such as the HP200 Palmtop.

FUNCTIONAL BLOCKS

SPECIFICATIONS

Environment of use:

Reader:	0°C to 50°C;
Seal:	-20°C to 60°C

Device size:

Reader	245 mm x 95 mm x 30 mm;
Seal	45 mm x 20 mm x 45 mm

	Argus passive tag	Argus passive seal	Argus active seal	Argus star seal
Reading distance	10 cm	10 cm	1 m	10 - 30 cm
Lifetime	Unlimited	Unlimited	4-5 years	4-5 years
Power supply	No battery	No battery	Li - battery 500 mA/hr	Li - battery 500 mA/hr
Battery lifetime			1 year at 20 readings per day	1 year at 20 readings per day
Seal Engagement	-	One time	Re-usable	Re-usable
Advantage	Low cost tag for asset tracking & inventory control	Low cost seal to replace copper-brass seal	Records 10 events Option to read 100 events	Seals can be polled simultaneously at long range Records 10

events

SOFTWARE

Argus Seal Reader software

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Seal

237

Mechanical Seal**MODEL: E-Tag****SUPPLIER:** *AQUILA Technologies Group, Inc.***USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Seal**MEASUREMENT METHOD:**

Passive

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Field**DEVELOPER:** *AQUILA Technologies Group, Inc.***MANUFACTURER:** *AQUILA Technologies Group, Inc.***DESCRIPTION****PURPOSE***The E-Tag Mechanical Seal is an inexpensive solution to the issue of seal validation.***PRINCIPLES OF OPERATION**

The E-Tag contains a unique electronic serial number that is written in ROM at the time of manufacture. E-Tag Mechanical Seals are easily and instantly read by a variety of hand-held devices without the need to remove the seal from the container. This makes random validation of seals possible at any time.

FUNCTIONAL BLOCKS

- a standard metal (copper-brass) seal
- small E-Tag implanted in the case.

SPECIFICATIONS**SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Seal

Paper Tape E-Tag Seal**MODEL:****238****SUPPLIER:** AQUILA Technologies Group, Inc.**USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Seal**MEASUREMENT METHOD:**

Passive

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Industrial**DEVELOPER:** AQUILA Technologies Group, Inc.**MANUFACTURER:** AQUILA Technologies Group, Inc.**DESCRIPTION****PURPOSE**

Designed to address the issue of seal validation, the Paper tape E-Tag Seal is a tamper indicating device (ID) containing an electronically verifiable identification signature in its read-only memory. The electronic ID signature prevents counterfeiting attempts which traditional Paper Tamper seals are susceptible to because they do not have any form of unique identification to prove that the original tape is authentic.

PRINCIPLES OF OPERATION

Placing the seal is simple. The E-Tag, measuring 1/8" thick by a little over 1/2" in diameter, is placed in a hole in the metal retainer ring. The retainer ring is self-adhesive on one side. The adhesive attaches the E-Tag to the surface of the container being sealed. Then a circular paper tamper tape with a hole in the center that allows access to the E-Tag is placed over the retainer ring and completely covers and overlaps the edges of the retainer ring. The E-Tag is read by making touch contact with the tag and the metal side of the container. In fact, a fixture may be built into the container holder (whether it is an instrument or a storage shelf) that can be used to verify that the tag is in place.

FUNCTIONAL BLOCKS

- sandwich containing a thin E-Tag
- thin metal retaining ring
- Advertape paper tamper tape

SPECIFICATIONS**SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Seal

239

Seal Imaging SystemMODEL: Cobra IIISUPPLIER: *AQUILA Technologies Group, Inc.*

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Seal

MEASUREMENT METHOD:

MEASURED PROPERTIES:

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Portable

ENVIRONMENT OF USE: Industrial

DEVELOPER: *AQUILA Technologies Group, Inc.*MANUFACTURER: *AQUILA Technologies Group, Inc.*

DESCRIPTION

PURPOSE

Cobra III Seal Imaging System is a portable seal inspection station suitable for on-site inspections. The Cobra III Seal Imaging System is designed to photograph, view and print images of seals for review and tamper inspection.

PRINCIPLES OF OPERATION

The seal review process involves the following. A seal is inserted into the CobraspaceIII's seal receptacle and a photograph of the fiber optic cable ends is taken using the QV-30 digital camera. The camera comes with its own built-in liquid crystal color monitor to use as a viewfinder when photographing seal images and can also be used to display stored images. The QV-30 camera can digitally store up to 96 seal images, which may be archived using the included DP-8000 printer or transferred to a PC (not included) using a MS Windows based user interface program (included). The printer is a dye sublimation type printer which produces full color, non-fading, near photographic resolution prints. Once the captured images are downloaded to PC or printed using DP-8000 printer, the seals images can then be manually reviewed for physical differences by comparing the photographs taken of the seals fiber optic cable ends. Any differences found may indicate that the seal has been tampered with.

FUNCTIONAL BLOCKS

- Casio QV-30 digital camera
- DP-8000 video scanner
- Aquila proprietary optics
- an illumination and alignment accessory
- a portable power pack.
- "QuickStart Sheet" (includes brief instructions for operations most common to inspection applications)
- Factory instruction manuals for the QV-30 and DP-8000

SPECIFICATIONS

Environment of use:

camera	0°C to 40°C
printer	5°C to 35°C

Power supply "D" size alkaline batteries

Continuous operation time (or standard carbon-zinc cells)
Weight full working day of heavy usage.

1.8 kg

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Seal

Video Tape Sealing System

MODEL: TRAM-1000

240

SUPPLIER: AQUILA Technologies Group, Inc.

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Seal

MEASUREMENT METHOD:

MEASURED PROPERTIES:

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Hand-held

ENVIRONMENT OF USE: Industrial

DEVELOPER: AQUILA Technologies Group, Inc.

MANUFACTURER: AQUILA Technologies Group, Inc.

DESCRIPTION

PURPOSE

The Tamper-Resistant Analog Media (TRAM-1000) system is designed to provide standard VHS surveillance video tapes with an enhanced tamper-indication capability.

PRINCIPLES OF OPERATION

The access panel on the enclosure contains a tamper switch connected to the VACOSS-S seal contained within. Any attempt to open the enclosure will be registered in the VACOSS-S seal as a physical tamper. The unit provides the capability to disclose any tamper attempt while the tape is being recorded, shipped, or reviewed. The HP-200 reader records and validates information from both the seal and the E-Tag reader within the tamper detection unit.

The VHS video tape has been augmented by drilling two small holes into the back of the tape case to allow permanent fixture of a flexible fiber optic cable into the case. The unterminated cable is threaded through the holes and the tape case is reassembled. Epoxy permanently fixed the cable to the tape case and the cable is terminated with fiber optic mechanical connectors. The cable is attached in such a way that the tape may be loaded into a front or a top loading VCR with ease.

The video tapes are stored in a Tamper Bag sealed with a fiber optic cable permanently affixed to the tape. The cable is also attached to the connectors on the Tamper Detection Unit completing the seal. The Tamper Bag is a double-stitched, durable bag made of fiber-reinforced plastic. The open end of the bag contains two metal strips with eight eyelets to accommodate the fiber optic cable. The bag readily discloses any attempts to physically tamper with it. The internally stitched seam construction makes it virtually impossible to open a seam on the bag and repair it, as the seam of a sealed bag would have to be repaired internally.

FUNCTIONAL BLOCKS

the tamper detection unit:

- VACOSS-S active fiber-optic seal
- electronic identification tag (E-Tag)

- a specially augmented VHS video tape

- an HP-200 reader:

- standard serial cable and
- VACOSS-S adapter box

- Tamper Bag sealed with a fiber optic cable

SPECIFICATIONS

Reader dimensions 150 x 100 x 75 mm³

SOFTWARE

The VACOSS-S seal reader software is installed on the reader to read the inside of the Tamper Detection Unit. The HP-200's standard serial communications software is used to communicate with the Aquila Remote (E-Tag) Reader, also found inside of the Tamper Detection Unit.

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Seal

Auto Cobra Seal Verifier**MODEL:**

241

SUPPLIER: Mitsubishi Heavy Industries, Ltd.**USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Seal**MEASUREMENT METHOD:****MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Field**DEVELOPER:** Mitsubishi Heavy Industries, Ltd.**MANUFACTURER:** Mitsubishi Heavy Industries, Ltd.**DESCRIPTION****PURPOSE***The Auto COBRA Seal Verifier is designed to read the seal data, store the data, compare two sets of data, and display a verification conclusion.***PRINCIPLES OF OPERATION**

Reads the seal number automatically. The verifier operates on a built-in rechargeable battery, or on AC power. If necessary, a personal computer can be used to perform a detailed analysis, or to print out verification results and seal-data results.

A CCD camera built into the Auto COBRA Seal Verifier records the optical-fibre seal pattern as an image. It stores the image as digital information. At the time of verification, the pattern stored in memory is compared with a freshly read in image, and the verifier calculates a concordance ratio that shows the degree of similarity between the two images. If the concordance ratio is higher than a predetermined value, the seal is pronounced "OK". If the ratio is lower than the predetermined value, the seal is pronounced "NG" (no good).

An optical-fibre seal is comprised of a polyethylene-coated bundle of optical fibres with both ends fixed in the main seal body. At the time of sealing a cutting blade severs some of fibres at random and the transmitted light forms a pattern which, like a fingerprint, is unique to each seal. An inspector judges whether or not the seal pattern is satisfactory by comparing a new image of the pattern with the original pattern.

FUNCTIONAL BLOCKS

- CCD built-in camera
- built-in rechargeable battery
- RAM card

SPECIFICATIONS

RAM card	2MB
Storage capacity	data on up to 100 seals.
Power supply	built-in rechargeable battery/AC (100-240V)
Overall size	120W x 200L x 45/55H (mm)
Weight	1 kg

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Seal**Tag-Seal for Containers with NM**
MODEL:**242****SUPPLIER:** RFNC VNIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics**USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Seal**MEASUREMENT METHOD:**

Passive

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Prototype**PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** RFNC VNIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics**MANUFACTURER:** RFNC VNIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics**DESCRIPTION****PURPOSE***Detection of unauthorized access to the containers with NM.***PRINCIPLES OF OPERATION**

The tag-seal system provides:

- storage of the seal information and information on container and its content;
- possibility of reading the seal information (seal function);
- possibility of reading-in and reading-out the information on the container and its content (tag function);
- control of access to the information contained in the tag-seal;
- high reliability elimination of label-seal falsification in order to cover up a fact of unauthorized tamper inside of the container by means of container lid removal.

When the seal is removed from the container the electronic module is destroyed and the stored information is deleted.

FUNCTIONAL BLOCKS

- Tag-seal itself is a body with built-in:
 - locking unit,
 - electronic module;
- Adapter for a seal and PC connection;
- Communication cables for connection of an adapter with a seal and PC.

SPECIFICATIONS

Overall size:

max. diameter	27 mm
length	36 mm
Weight	80 g

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Seal

Autonomic Device for the Automatic Identification of the Optical Seals

243

MODEL: APIP-1M

SUPPLIER: RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Seal

MEASUREMENT METHOD: Symbol Reading

MEASURED PROPERTIES:

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: One-of-a-kind

PORTABILITY: Hand-held

ENVIRONMENT OF USE: Field

DEVELOPER: RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics

MANUFACTURER: RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics

DESCRIPTION

PURPOSE

Automatic registration of optical images of the optical seals (produced by VNIITF) and their following automatic identification; the long-time data storage and data exchange through the digital transmission channel. Device is proposed to be used as a component of automated control and accountancy systems. Its purpose in the field of nuclear materials control and accounting is the development of a completely automated system based on it.

PRINCIPLES OF OPERATION

Registration of unique optical image created when an adhesive seal body is installed and destroyed when seal removal attempts take place.

FUNCTIONAL BLOCKS

- unit APIP-1M;
- optical packing;
- infrared port (IR-port);
- standard charger for accumulators;
- diskette with PC software;
- operational documentation.

SPECIFICATIONS

Transportation and store conditions

according to store conditions 3
of the state standard ГОСТ 15150-69

"+" 4.8...5.6 V

no more than 35 mA

no more than 20 mA

no less than 10 hours

Overall size:

52 mm x 80 mm x 156 mm

26 mm x 50 mm x 70 mm

50 mm x 70 mm x 85 mm

unit APIP-1M

optical packing

IR-port

unit APIP-1M

optical packing

IR-port

Weight:

800 g

150 g

100 g

IR-port

unit APIP-1M

optical packing

IR-port

unit APIP-1M

optical packing

IR-port

Weight:

unit APIP-1M

unauthorized access by the password; seal quality control. Program ARP1M-PC-V2.0 provides interaction of АПР-1М and PC in DOS. 3.0 or higher version. Program ARP1M-IK-W01 provides interaction of АПР-1М and PC in Windows 95.

ADDITIONAL INFORMATION

Delivery with standard software - during 3 months.

Delivery with individual software - during 6 months.

Warranty - 12 months.

Storage time - 12 months.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика (Факс от 10.07.97 № 280-08/373)

Data received from RFNC-VNIITF . Fax from 10.07.97 № 280-08/373

Containment and Surveillance: Seal

Lock - Sealing Device

MODEL: 3II-1

244

SUPPLIER: RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Seal

MEASUREMENT METHOD: Passive

MEASURED PROPERTIES:

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Limited Production

PORTABILITY:

ENVIRONMENT OF USE: Field

DEVELOPER: RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics

MANUFACTURER: RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics

DESCRIPTION

PURPOSE

It is a passive reusable seal for the detection of an unauthorized access with the possibility of the automatic identification of the unique optical characteristics of the seal by means of a specially designed instrumentation. Seal provides controlled bolt-connection of parts of the sealed object.

PRINCIPLES OF OPERATION

The registration of the unique optical image created when the seal is installed and destroyed when there is a seal removal attempt.

To install/assemble a seal there is the possibility of the additional delivery of the auxiliary unit.

The seal integrity is monitored by the automatic seal registration and identification by means of autonomic devices like APII-1M.

FUNCTIONAL BLOCKS

- metal body;
- support plastic window;
- shield plastic window;
- lock washer;
- connection bolt with the special hole at the thread edge;
- wire of D 0.4 mm - 0.5 mm

SPECIFICATIONS

Size:

seal body	no more than D24 mm x 20 mm
connection bolt with the special hole at the thread edge	

Weight of the seal body	M8, M10, M12
	no more than 20 g

SOFTWARE

ADDITIONAL INFORMATION

The possible device damage before a reuse doesn't influence its serviceability.

Delivery - during 1 month.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика (Данные получены из РФЯЦ-ВНИИТФ. Факс от 10.07.97 № 280-08/373)

Data received from RFNC-VNIITF. Fax from 10.07.97 № 280-08/373

Containment and Surveillance: Seal

245

Loop Optical Seal**MODEL: ОПП-1М****SUPPLIER: RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics****USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Seal**MEASUREMENT METHOD:**

Passive

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Limited Production**PORTABILITY:****ENVIRONMENT OF USE:** Field**DEVELOPER:** RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics**MANUFACTURER:** RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics**DESCRIPTION****PURPOSE***It is a passive reusable seal for the detection of an unauthorized access with the possibility of the automatic identification of its unique optical characteristics by means of a special designed instrument.***PRINCIPLES OF OPERATION**

The registration of the unique optical image created, when the seal connection body (loop) is installed, and destroyed, when the seal removal attempt takes place.

To install/assemble seal there is the possibility of additional delivery of the auxiliary unit.

The seal integrity is monitored by the automatic seal registration and identification by means of autonomic devices like АРП-1М.

FUNCTIONAL BLOCKS

- metal body;
- support plastic window;
- shield plastic window;
- lock washer;
- connection body - wire of D 0.5 mm

SPECIFICATIONS

Storage and transportation conditions

according to the store condition 3
of the state standard ГОСТ 15150-68

Size

D 24 mm x 10 mm

Weight

5 g

SOFTWARE**ADDITIONAL INFORMATION**

The possible seal damage before a reuse doesn't influence its serviceability.

Delivery - within 1 month.

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика (Данные получены из РФЯЦ-ВНИИТФ . Факс от10.07.97№ 280-08/373)

Data received from RFNC-VNIITF . Fax from 10.07.97№ 280-08/373

Containment and Surveillance: Seal**Second-Generation Reflective Particle Tag**
MODEL: RPT-2**246****SUPPLIER:** *Sandia National Laboratories***USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Seal**MEASUREMENT METHOD:**

Passive

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Serial Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Field**DEVELOPER:** Sandia National Laboratories**MANUFACTURER:** Sandia National Laboratories**DESCRIPTION****PURPOSE**

The tag can be used to uniquely identify an item with a very low probability of a false decision. It is extremely tamper-resistant, with a high degree of confidence that attempted tampering will be detected.

PRINCIPLES OF OPERATION

Multifaceted micaceous hematite particles reflect light. When the Reflective Particle Tag (RPT) is illuminated and photographed from multiple angles, the reflections from the suspended micaceous hematite particles create a set of images that uniquely identifies the tag and the object to which the tag is applied. A numbered fiducial embedded in the tag identifies the tag and serves as a reference for the tag reader. A computer-based reader automatically illuminates and records images from 20 different angles each time a RPT reading is made. These images are recorded by the reader and automatically compared to the tag reference images recorded when the RPT is initially applied.

FUNCTIONAL BLOCKS

- portable kit containing all the materials necessary for surface preparation and application of RPT-2 under field conditions
- computer-based reader

SPECIFICATIONS**SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

1. The Cooperative Monitoring Center (CMC), SNL publication
2. K.M. Tolk, Reflective Particle Technology for Identification of Critical Items, Proceedings of the 33rd INMM Annual Meeting, Orlando, Florida, 1992, pp. 648-652

Containment and Surveillance: Seal**247****Tamper-Evident Shrink-Wrap Seal****MODEL:****SUPPLIER:** *Sandia National Laboratories***USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Seal**MEASUREMENT METHOD:**

Passive

MEASURED PROPERTIES:**NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** Limited Production**PORTABILITY:** Hand-held**ENVIRONMENT OF USE:** Field**DEVELOPER:** Sandia National Laboratories**MANUFACTURER:** Sandia National Laboratories**DESCRIPTION****PURPOSE**

Shrink-wrap seals were proposed as a method of securing strategic elements (valves, flanges, etc.) of a shut down chemical weapons facility to assure that chemical weapon could not be resumed. However, the Sandia version of a shrink-wrap seal is versatile enough for a variety of verification applications, including:

- Monitoring chemical production facilities;
- Nuclear material shipment scenarios;
- A layer of protection in multi-layer security design.

PRINCIPLES OF OPERATION

The shrink-wrap seal is formed by continuously wrapping at least two layers of shrink film (polyvinyl chloride or polyvinylidene chloride) with differing ink patterns around the object to be protected. When heat is applied, the film layers randomly shrink, producing an overlapping pattern that forms a unique fingerprint for the seal. Documentation and subsequent verification can be done using a modified Polaroid camera, a modified Canon still video camera system, and a camcorder.

FUNCTIONAL BLOCKS**SPECIFICATIONS****SOFTWARE****ADDITIONAL INFORMATION****REFERENCES**

The Cooperative Monitoring Center (CMC), SNL publication

Containment and Surveillance: Software

GENERAL Advanced Review Software

MODEL: GARS

SUPPLIER: *AQUILA Technologies Group, Inc.*

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Software

MEASUREMENT METHOD:

MEASURED PROPERTIES:

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY:

ENVIRONMENT OF USE:

DEVELOPER: *AQUILA Technologies Group, Inc.*

MANUFACTURER: *AQUILA Technologies Group, Inc.*

248

DESCRIPTION

PURPOSE

The GENERAL Advanced Review Software (GARS) is responsible for performing an efficient review of digital images which are created on a number of supported surveillance systems

PRINCIPLES OF OPERATION

Utilizing surveillance plug-in modules implemented via Windows Dynamic Link Libraries (DLLs), GARS currently supports three surveillance systems: the GEMINI and MOX/MUX systems from Aquila and the DCM-14 system by Guenter Neumann. Presently, the GARS is a cross-platform application available for the X86 Win95 and WinNT platforms and Digital Equipment Corporation (DEC) Alpha RISC processor based WinNT RISC platform. The program implements a rapidly executing motion detection algorithm that analyzes adjacent images to detect potential changes in user-defined areas in the images. The GARS functions handled by the DLLs are: the creation of all review files, image verification (authentication), image decompression, selection of surveillance preferences, and the creation of reports. The GARS provides an intuitive, highly flexible, and very simple to use interface. The current GARS performs image decompression, motion detection analysis, and image display "on-the-fly". The "on-the-fly" approach efficiently combines these processes into a single step/task, thereby greatly decreasing the overall time it takes to perform a review. It also provides a powerful and simple user interface due to the integration of multiple procedures into one operation.

FUNCTIONAL BLOCKS

SPECIFICATIONS

SOFTWARE

Windows 95, Windows NT, DEC Alpha RISC processor based WinNT RISC platform

ADDITIONAL INFORMATION

REFERENCES

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Software**Radioactive Material Inventory System**
MODEL: RMIS**249****SUPPLIER:** *Oak Ridge National Laboratory***USE CATEGORY:** Containment and Surveillance**DEVICE TYPE:** Software**MEASUREMENT METHOD:****MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:** One-of-a-kind**PORTABILITY:****ENVIRONMENT OF USE:****DEVELOPER:** Oak Ridge National Laboratory**MANUFACTURER:** Oak Ridge National Laboratory**DESCRIPTION****PURPOSE***RMIS is a PC-based system for tracking radioactive material.***PRINCIPLES OF OPERATION**

The system employs the latest GUI properties available in the MS Windows environment using MS FoxPro for Windows. The system includes "point and click" usability, bar-coding, extensive table look-up capabilities, a viewer for displaying graphic files of radioactive sources, and all features commonly associated with the accountability of nuclear material. The system is PC-network ready ; measures have been taken to assure the integrity of records in multi-user environment. The system can be provided in machine-ready executable code, or in the source-code.

FUNCTIONAL BLOCKS**SPECIFICATIONS****SOFTWARE****ADDITIONAL INFORMATION**

The system was validated in accordance with ORNL procedure.

REFERENCES

Internet site <<http://www.ornl.gov/armd/ndande.htm>>

Containment and Surveillance: Video Surveillance System**GEMINI Surveillance System****MODEL: GEMINI****SUPPLIER:** *AQUILA Technologies Group, Inc.***USE CATEGORY:**

Containment and Surveillance

DEVICE TYPE:

Video Surveillance System

MEASUREMENT METHOD:**MEASURED PROPERTIES:****NUCLEAR MATERIAL(S):****PHYSICAL FORM(S) OF NM:****STATUS:**

Serial Production

PORTABILITY:

Stationary

ENVIRONMENT OF USE:

Industrial

DEVELOPER:

AQUILA Technologies Group, Inc.

MANUFACTURER:

AQUILA Technologies Group, Inc.

250**DESCRIPTION****PURPOSE***Gemini is a modular, digital network-capable system for secure, unattended, visual surveillance.***PRINCIPLES OF OPERATION**

Activation causes a picture to be taken immediately and the trigger event is noted and recorded along with the time and date of the trigger.

GEMINI can also automatically dial a preset modem number to remotely announce the occurrence of an event or simply report its "state of health" on a regular basis. Stored images are reviewed on a separate review station. The GEMINI Review Station is a high-speed RISC-based computer optimized for high bandwidth video display and high computational throughput. The review software, GENERAL Advanced Review Software (GARS) performs unattended technical review and provides extensive support tools for manual safeguards review.

FUNCTIONAL BLOCKS

two fully independent surveillance units images housed within a tamper-proof enclosure:

- a camera unit capture
- system control unit that processes and stores acquired data
- a power management unit
- 4 inputs for external trigger devices.

SPECIFICATIONS

Surveillance interval	random
External triggers	4 inputs
Storage capacity	3 months of video data
Recording media	digital
Power supply	5 days of battery back-up on board

SOFTWARE**ADDITIONAL INFORMATION****REFERENCES**

Supplier/Developer Data - Информация от поставщика/разработчика

Containment and Surveillance: Video Surveillance System

Modular Integrated Video System

MODEL: MIVS

251

SUPPLIER: *AQUILA Technologies Group, Inc.*

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Video Surveillance System

MEASUREMENT METHOD:

MEASURED PROPERTIES:

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Stationary

ENVIRONMENT OF USE: Industrial

DEVELOPER: Sandia National Laboratories

MANUFACTURER: *AQUILA Technologies Group, Inc.*

DESCRIPTION

PURPOSE

Developed to provide surveillance in an unattended mode.

PRINCIPLES OF OPERATION

Photographs of images are taken by camera and are then recorded on an 8 mm video tape. The tape can be inspected and reviewed. The camera and data recording devices are sealed in tamper resistant enclosures.

FUNCTIONAL BLOCKS

Microprocessor-controlled CCTV system

SPECIFICATIONS

Surveillance interval 1-99 minutes

SOFTWARE

ADDITIONAL INFORMATION

REFERENCES

ESARDA, Working Group on Containment and Surveillance, Issue #2, October 21, 1994

Containment and Surveillance: Video Surveillance System

Portable Surveillance Unit

MODEL: PSU

252

SUPPLIER: *Sandia National Laboratories*

USE CATEGORY: Containment and Surveillance

DEVICE TYPE: Video Surveillance System

MEASUREMENT METHOD:

Passive

MEASURED PROPERTIES:

NUCLEAR MATERIAL(S):

PHYSICAL FORM(S) OF NM:

STATUS: Serial Production

PORTABILITY: Portable

ENVIRONMENT OF USE: Industrial

DEVELOPER: Sandia National Laboratories

MANUFACTURER: Sandia National Laboratories

DESCRIPTION

PURPOSE

Portable microprocessor-controlled CCTV system is designed for situations where quick setup of an optical surveillance device is required. PSU was developed based on technologies used for MIVS.

PRINCIPLES OF OPERATION

FUNCTIONAL BLOCKS

SPECIFICATIONS

Surveillance interval	1 - 99 minutes
Storage capacity	26,000 scenes
Recording media	DUAL 8mm Video Tape Recorders
Power supply	universal power supply with battery backup

SOFTWARE

ADDITIONAL INFORMATION

Commercially available through Miletus Associates, Inc., Albuquerque, NM.

REFERENCES

ESARDA, Working Group on Containment and Surveillance, Issue #2, October 21, 1994

8. LIST OF COMPANIES / СПИСОК КОМПАНИЙ

A list of equipment developers, manufacturers, and suppliers is presented below. Each company has a unique ID (shown on the left) so that it can be easily identified in section 9 of Catalog providing detailed company information.

Ниже приведен список разработчиков, производителей, и поставщиков. Каждой компании присвоен уникальный идентификатор (показанный слева), так что компании могут быть легко найдены в Разделе 9, где приведена детальная информация по компаниям.

20	AEA Technology plc, Harwell Instruments	AEA Технолоджи, Харвел Инструментс (AEA Technology plc, Harwell Instruments)
00	AQUILA Technologies Group, Inc.	Акила Технолоджи Групп, Инкорпорейшен (AQUILA Technologies Group, Inc.)
26	BNFL Instruments	BNFL Инструментс (BNFL Instruments)
08	Brookhaven National Laboratory	Брукхевенская национальная лаборатория (Brookhaven National Laboratory)
11	Canberra Industries, Inc.	Канбера Инд., Инкорпорейшен (Canberra Industries, Inc.)
13	Davidson Co. Inc.	Корпорация Дэвидсон (Davidson Co. Inc.)
25	Dr. I.R.Gunnink, consultant	Др. И.Р. Гунник, консультант (Dr. I.R.Gunnink, consultant)
12	EG&G Instruments, Inc. ORTEC	EG&G Инструментс, Инкорпорейшен, ОРТЕК (EG&G Instruments, Inc. ORTEC)
68	EMZ "Avangard"	ЭМЗ "Авангард"
15	GBS Elektronik GmbH im Technologie-Zentrum	GBS Электроник в Технологическом Центре (GBS Elektronik GmbH im Technologie-Zentrum)
52	IFTP, Institute of Physical & Technical Problems	ИФТП, Институт Физико-Технических Проблем
63	JV Polimaster	СП "Полимастер"
05	Lawrence Livermore National Laboratory	Ливерморская Национальная Лаборатория им.Лоуренса (Lawrence Livermore National Laboratory)
24	Lockheed Martin Energy Systems Y-12 Plant	Завод энергетических систем Y-12 Локхилда Мартина (Lockheed Martin Energy Systems Y-12 Plant)
23	Lockheed Martin K-25 Facility	Завод K-25 Локхилда Мартина (Lockheed Martin K-25 Facility)
01	Los Alamos National Laboratory	Лос-Аламосская Национальная лаборатория (Los Alamos National Laboratory)
21	MF Physics Corporation	Физическая Корпорация MF (MF Physics Corporation)
22	Mitsubishi Heavy Industries, Ltd.	ТОО "Мицубиси - тяжелая промышленность" (Mitsubishi Heavy Industries, Ltd.)
69	MOLNIA Plant	Машиностроительный завод "Молния"
03	National Nuclear Corporation	Национальная Ядерная Корпорация (National Nuclear Corporation)
14	Oak Ridge National Laboratory	Оук-Риджская Национальная Лаборатория (Oak Ridge National Laboratory)
70	PA MAYAK, Production Association MAYAK	ПО МАЯК, Производственное Объединение МАЯК
10	Pacific Northwest National Laboratory	Тихоокеанская Северо-западная Национальная Лаборатория (Pacific Northwest National Laboratory)
04	Pajarito Scientific Corporation	Научная Корпорация Пайарито (Pajarito Scientific Corporation)
61	PNPI, St-Petersburg Nuclear Physics Institute	ПИЯФ, ГНЦ Петербургский институт ядерной физики им.Б.П.Константинова Российской Академии Наук

06	Quantrad Sensor Division, Applied Electron Corp.	Отделение "Квантрад Сенсор", Корпорация Прикладной электроники (Quantrad Sensor Division, Applied Electron Corp.)
60	RFNC VNIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics	РФЯЦ ВНИИЭФ, Российский федеральный ядерный центр Всероссийский научно-исследовательский институт экспериментальной физики
53	RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics	РФЯЦ ВНИИТФ, Российский Федеральный Ядерный Центр Всероссийский Научно-Исследовательский Институт Технической Физики
58	RIPT, Research Institute of Pulse Technique	НИИИТ, Научно-исследовательский институт импульсной техники
18	RITEC Ltd.	ТОО "РИТЭК" (RITEC Ltd.)
62	RSC Kurchatov Institute	РНЦ "Курчатовский институт"
67	RSC Kurchatov Institute, SPC REKOM	РНЦ "Курчатовский институт" НПП "РЭКОМ"
02	Sandia National Laboratories	Сандийские Национальные Лаборатории (Sandia National Laboratories)
19	SAPHYMO	САФИМО (SAPHYMO)
64	Scientific Engineering Center "Nuclear Physical Research"	НТЦ "ЯФИ", Государственное унитарное предприятие Научно-технический центр "Ядерно-физические исследования" - дочернее предприятие государственного предприятия Научно-производственное объединение "Радиевый институт им В.Г. Хлопина"
55	SNIIP- Green Star, Ltd.	СНИИП - ТОО "Грин Стар"
66	SNIIP-ASCUR	СНИИП - АСКУР
56	SNIIP-Automatics	СНИИП - АВТОМАТИКА
57	SNIIP-Konvel	СНИИП-КОНВЭЛ
54	SPC Aspect	НПЦ "АСПЕКТ"
59	SSC IPPE, State Scientific Center of Russian Federation, Institute of Physics and Power Engineering	ФЭИ, ГНЦ РФ Физико-энергетический институт
16	Technische Universitst Dresden	Дрезденский Технический Университет (Technische Universitst Dresden)
17	TSA Systems Ltd.	TSA Систем Лимитед (TSA Systems Ltd.)
50	VNIIA, All-Russian Research Institute of Automatics	ВНИИА, Всероссийский научно-исследовательский институт автоматики
65	VNIIFTRI, SPA DOZA	ГП "ВНИИФТРИ" НПП "ДОЗА"
51	VNIITFA, All-Russian Research Institute of Technical Physics and Automatization	ВНИИТФА, Всероссийский научно-исследовательский институт технической физики и автоматизации

9. DETAILED COMPANY INFORMATION / ДЕТАЛЬНАЯ ИНФОРМАЦИЯ ПО КОМПАНИЯМ

Detailed information on the companies includes addresses, contact information, and in most cases a brief description of the company's profile. In cases where contact information provided in Catalog is not sufficient, the users can obtain it directly from the equipment suppliers.

Детальная информация по компаниям включает в себя адрес, контакты и, в большинстве случаев, краткое описание профиля деятельности компаний. В случаях, когда полная информация по контактам не приведена, пользователи могут получить добавочную информацию от поставщиков приборов.

AQUILA Technologies Group, Inc.

Акила Технолоджи Групп, Инкорпорейшен (AQUILA Technologies Group, Inc.)

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2. *Scott Kraus, International Programs Manager tel. (505)-828-9100, ext. 361; e-mail: skraus@aquilagroup.com; Internet: <http://www.aquilagroup.com>; fax (505) 828-9115*

Aquila wholly owned subsidiary of Canberra Industries Inc., is engaged in the development, manufacture, sale, and maintenance of nuclear safeguards equipment for authenticated surveillance and containment, Non-Destructive Assay (NDA) instruments for safeguards, specialized computer systems, and computer networks. In association with the natural course of product development, Aquila is frequently contracted by its product customers to provide engineering support, training, software development, and maintenance and repair services.

Aquila Networking offers consulting, design, integration, development, training, and support services for data management with an emphasis on secure Internet and Intranet business solutions. Aquila's Networking group has the expertise in network integration to assist customers in the design, acquisition, implementation, and support of a new network or modification of an existing one.

Aquila is engaged in the design and manufacture of products and systems for distributed, real-time data acquisition and process control. Aquila products are utilized in aircraft design and simulation, manufacturing process control such as forming glass containers, nuclear fusion research, high-energy particle acceleration experimentation, nuclear energy applications, transportation, surveillance, and industrial testing laboratories.

Акила, полностью принадлежащая в качестве отделения фирме Канберре, занимается разработкой, производством, продажей и обслуживанием оборудования для ядерных гарантий, относящегося к наблюдению и сохранению, приборам неразрушающего анализа, специализированным компьютерным системам и компьютерным сетям. Наряду с разработкой продукции, Акила часто привлекается потребителями ее продукции к обеспечению технической поддержки, обучения, разработки программного обеспечения, а также текущего обслуживания и ремонта на контрактной основе.

Сетевое обеспечение Акилы предлагает консультации, разработку, интеграцию, дизайн, обучение и поддерживающее обслуживание для управления данными с фокусом на безопасные решения систем Интернет и ИнTRANет. Сетевая группа фирмы обладает достаточным опытом в интегрировании сетей для того, чтобы помочь пользователям в конструировании, получении, применении и поддержки новых сетей или изменений существующих.

Фирма Акила вовлечена в разработку и производство продукции и систем для распределенного получения данных в режиме реального времени и контроля технологических процессов. Продукция фирмы используется в конструировании и моделировании самолетов, контроле таких процессов производства, как создание стеклянных контейнеров, исследований ядерного синтеза, экспериментах по ускорению частиц до высоких энергий, ядерной энергетики, транспортировании, наблюдении и промышленных испытательных лабораториях.

01

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03

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04

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The Safeguard Technology Program develops advanced, nondestructive analysis (NDA) technology for accounting of fissile materials. Our work focuses on R&D relating to x-ray and gamma-ray spectrometry techniques and to the development of computer codes for interpreting the spectral data obtained by these techniques.

Программа по технологии гарантий разрабатывает передовую технологию неразрушающего анализа для учета делящихся материалов. Наша работа сконцентрирована на разработке и исследованиях в области спектрометрических приборов для рентгеновского и гамма-излучений, а также на разработке компьютерных программ по интерпретации спектральных данных, полученных этими приборами.

06

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EG&G Instruments, Inc. ORTEC

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Davidson Co. Inc.

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Since 1960, Davidson has been engaged in the design, production, sale, and maintenance of portable nuclear instruments. These instruments have been mainly Multi-Channel Analyzers of various sizes and performance capabilities. The current Model 2056-C is a main field operational unit for enrichment measurements by safeguards inspectors. Also, produced by Davidson is the GRAND-3 electronics unit which can be configured for spent fuel burn-up measurements or core discharge monitor for refueling operations. Davidson has worked closely with national and international laboratories to develop new products and refine prototypes for commercial manufacture for use in safeguards applications.

Начиная с 1960 года, Дэвидсон занимался разработкой, производством, продажей и обслуживанием переносных приборов ядерной физики. В основном это были многоканальные анализаторы различных размеров и характеристик. Современная Модель 2056-С предназначена главным образом для полевых работ при измерениях обогащения инспекторами. Аналогично, выпускаемый Дэвидсоном модуль электроники GRAND-3 может быть скомплексирован для измерений отработанных топливных стержней или для мониторинга разборки зоны при перезагрузке топлива. Дэвидсон работал в тесном контакте с национальными и международными лабораториями при разработке новых образцов и уникальных макетов для коммерческого производства в интересах применения гарантий.

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GBS Elektronik GmbH im Technologie-Zentrum

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TSA Systems, Ltd. was created in 1987 by the merger of TSA Systems, Inc. and Geoscience Associates, Inc.

TSA specializes in the design and manufacture of both pedestrian and vehicle portal monitors and hand-held detectors for the protection of Special Nuclear Material (SNM). The company has worked closely with the Los Alamos National Laboratory to advance SNM monitoring technology.

TSA also produces a comprehensive family of bag, box, and barrel monitors, as well as custom designed systems for a variety of applications including security and waste management.

Компания TSA была создана в 1987г. в результате объединения TSA Systems, Inc. и Geoscience Associates, Inc.

Компания специализируется на разработке и производстве пешеходных и транспортных портальных мониторов, а также ручных радиационных мониторов для целей защиты специальных ядерных материалов (СЯМ). Компания работала в тесном сотрудничестве с Лос-Аламосской Национальной Лабораторией по усовершенствованию технологии мониторирования СЯМ.

Также компания производит практически полный набор различных мониторов для сумок, коробок, контейнеров, а также других традиционных систем различного применения, в том числе для обеспечения безопасности и управления отходами.

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RITEC Ltd.

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SAPHYMO

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Web site: WWW.essone-hightech.tm.Fr/saphymo*

Saphymo was founded in 1952 is based in Massy (near Paris, France) and employs 56 people/ Saphymo is ISO 9002 certified since 1956. Production includes both portable and fixed instruments of radioactivity in industrial environment or in field conditions. Production is divided in 4 types of products: expose monitoring, dosimetry, environment monitoring and radiological access control systems.

The customers include Nuclear Power Plants, Research centers, nuclear fuel processing plants, Army, Navy, and Civil Defense organizations in France, Switzerland, Germany, Sweden, Belgium and United States, as well as IAEA.

Saphymo была основана в 1952 году и расположена в Масси (около Парижа, Франция), и на ней работают 56 человек. С 1956 года Saphymo сертифицирована по ISO 9002.

В выпускаемую продукцию входят как переносные, так и стационарные приборы для измерения радиоактивности в производственных условиях и на местности. Продукция делится на 4 категории: мониторинг облучения, дозиметрия, мониторинг окружающей среды и системы контроля за доступом к радиоактивности.

Потребителями являются: атомные станции, исследовательские центры, заводы по переработке ядерного топлива, армия, морской флот и организации гражданской обороны во Франции, Швейцарии, Германии, Швеции, Бельгии и США, а также МАГАТЭ.

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AEA Technology plc, Harwell Instruments

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MF Physics Corporation

Физическая Корпорация MF (MF Physics Corporation)

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MF Physics Corporation manufactures a comprehensive line of neutron generators which are used in university, industrial and government laboratories throughout the world. Several MF Physics neutron generators are of specific interest for applications in the management of nuclear materials. Our Model A-211, which utilizes the Zetatron neutron tube, is widely used in a number of government and private facilities for the active assay of trans -uranic materials. The Model A-325 is a very versatile machine which is well suited to a number of analytical applications. The Models A-910/920 are specialized instruments for imaging individual elements utilizing the associated particle, time of flight technique. These instruments are particularly useful for analysis and imaging of facilities and devices which are not amenable to inspection by more conventional techniques.

MF Physics' laboratory and production facilities occupy a 20,000 square foot building which was completed in 1990. The facility meets all state and NRC requirements for handling tritium and testing neutron generators and is licensed by the state of Colorado.

Корпорация MF Physics изготавливает всевозможный набор нейтронных генераторов, которые используются в учебных, промышленных и государственных лабораториях всего мира. Ряд нейтронных генераторов нашей корпорации представляет особый интерес для применения при работе с ядерными материалами. Наша модель А-211, которая использует нейтронную трубку Zetatron, широко используется на государственных и частных установках для активного анализа трансурановых материалов. Модель А-325 является многосторонней установкой, которая хорошо подходит для ряда аналитических применений. Модели А-910/920 являются специализированными приборами для наблюдения отдельных элементов методом сопутствующих частиц и времени пролетной методикой. Эти приборы особенно полезны для анализа и наблюдения установок и устройств, которые не поддаются инспекции более традиционными методами. Лаборатория и производственные установки MF Physics занимают здание площадью в 20.000 квадратных футов, которое было построено в 1990 году. Производство удовлетворяет всем государственным и NRC требованиям при работах с тритием и при испытаниях нейтронных генераторов и лицензировано в штате Колумбия.

Mitsubishi Heavy Industries, Ltd.

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BNFL Instruments has developed a comprehensive range of innovative products and services designed to cover every materials assay need in modern day nuclear environment for: waste management, spent fuel monitoring, safeguards.

Компания BNFL Instruments разработала обширный перечень новейших продуктов и услуг, которые способны покрыть любые нужды анализа материалов для: контроля отходов, мониторинга отработавшего топлива, гарантий.

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Помимо оборонных направлений, институт является головным в Минатоме РФ по ядерно-физической аппаратуре и производит ряд приборов для российской системы учета, контроля и физической защиты делящихся материалов. К числу такой аппаратуры относятся радиационные мониторы с повышенной чувствительностью к урану и плутонию, аппаратура обнаружения и идентификации изотопного состава и массы ДМ по нейтронному и гамма излучениям.

Beyond the defence direction the Institute is a head organization of Minatom responsible for nuclear-physical instrumentation and produces some devices for Russian nuclear materials control, accounting and physical protection system. Among these instrumentation are radiation monitors with improved sensitivity to uranium and plutonium, instrumentation of detection and identification of isotopic composition and mass of NM by neutron and gamma radiation.

VNIITFA, All-Russian Research Institute of Technical Physics and Automatization

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Институт является головной организацией по неразрушающим методам анализа, используемым в технологическом контроле топливного цикла.

Institute is a head Minatom organization in the area of non-destructive assay methods used for the process control in nuclear fuel cycle.

IFTP, Institute of Physical & Technical ProblemsИФТП, Институт Физико-Технических Проблем

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Разработка и производство: 1. Полупроводниковые детекторы (GeLi, Si, алмазные); 2. Блоки детектирования и спектрометрические тракты на основе разработанных детекторов; 3.

Радиоизотопные приборы: Уровнемеры жидкых и сыпучих сред в сосудах большого диаметра, Толщиномеры листовых и ленточных материалов (бетта и гамма абсорбционные), Плотномеры жидких сред и пульп (абсорбционные), Измерители массовой концентрации и поверхностной плотности аэрозолей; 4. Пожарные извещатели для атомной промышленности и АЭС.

Institute is engaged in development and manufacturing of the following: 1) semiconductor detectors (GeLi, Si, diamond); 2) detection blocks and spectrometric section on the base of developed detectors; 3) radio-isotopic devices: level gauges for liquid and free-flowing materials in vessels of large diameter, thickness gauges for sheet and strip materials (beta and gamma absorption), densitometers for liquid and pulp materials (absorption), aerosol mass concentration and surface density gauges; 4) fire signalizers for atomic industry and NPP.

RFNC VNIITF, Russian Federal Nuclear Center, All-Russian Research Institute of Technical Physics

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Основные направления деятельности: фундаментальные и прикладные исследования по ядерной физике, физике высоких давлений, гидродинамике, конструкторские и технологические работы по системам автоматики, средствам регистрации. В настоящее время организованы новые научные направления - научное медицинское оборудование, создание компонентов волоконно-оптической техники, гамма-установки народно-хозяйственного назначения, взрывные технологии промышленного применения.

Main activity directions: fundamental and applied investigations in nuclear physics, physics of high pressures, hydrodynamics, design and engineering works on automatic systems, registration means. Now there are opened a new scientific directions - medical equipment, creation of fiber-optic hardware components, gamma-installations of commercial designation, explosion technology for industry.

SPC Aspect

НПЦ "АСПЕКТ"

ГУС, а/я 62

г. Дубна Московской обл.

Россия

141980

Contacts:

*Директор - Недачин Юрий Константинович (Director)
тел. (09621) 65-808*

*По вопросам поставок и новых разработок:
For purchase and development information*

*зам. директора - Зайцев Евгений Ильич, Иванов Александр Иванович (Deputy Directors)
tel/tel. (09621) 65-292*

*технический отдел
technical department
tel/tel. (09621) 62-611*

*по вопросам пуско-наладки, обучения, аттестации и технического обслуживания:
for installation, training, sertification and maintenance information
tel/tel. (09621) 62-075*

fax/Факс: (09621) 65-108

Основным направлением деятельности НПЦ "Аспект" является разработка и выпуск спектрометрической аппаратуры, применяемой во всех отраслях промышленности, использующих ядерно-физические методы анализа.

The main direction of "Aspect" activity is a development and production of spectrometric instrumentation applied in all areas of industry which use nuclear-physical methods.

SNIIP- Green Star, Ltd.**СНИИП - ТОО "Грин Стар"**

Расплетина, 5

Москва

Россия

123060

Contacts:*Сельдяков Юрий Павлович - директор (Director)**Дорин Андрей Борисович - Технический директор (Technical director)**fax/tel, Факс/тел: (095) 198-9709**Fax/Факс: (095) 943-0063**Tel/Тел: (095) 307-2789*

Разрабатывает и производит: детекторы ионизирующего излучения, защиты, анализаторы, спектрометры, радиометры. Обеспечивает своих покупателей необходимым программным обеспечением, методиками измерений, аттестацией и сертификацией аппаратуры, эталонными источниками и т.д. Вся аппаратура обеспечивается сопровождением специалистами фирмы, включая обучение, пуско-наладочные работы, гарантийное и послегарантийное обслуживание.

Developes and produces: ionizing radiation detectors, radiation shields, analyzers, spectrometers, radiometers. It provides all customers with necessary software, measurement procedures, certification of instruments, reference sources and so on. All instrumentation is provided with assistance of firm staff, including training, set-up, warranty and post-warranty service.

SNIIP-Automatics**СНИИП - АВТОМАТИКА**

Расплетина, 5

Москва

Россия

123060

Contacts:*Л.Г. Титов - директор предприятия (director)**Tel/Tel: (095) 198-8443**Fax/Факс: (095) 943-0063**Л.А. Корытко - нач. отдела (head of department)**Tel/Tel: (095) 198-84-43*

Основные направления деятельности: проведение научно-исследовательских и конструкторских работ в области создания систем автоматизации технологических процессов, методическое и приборное обеспечение горно-добычающих и горно-перерабатывающих производств, создание систем радиационного контроля и т.п.

The main trends of activity: carrying out of scientific, research, construction and designing works in the field of developing systems for process control automation, methodical and instrumentation provision of mining and processing enterprises, creation of radiation monitoring systems, and so on.

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SNIIP-Konvel

СНИИП-КОНВЭЛ

Расплетина, 5

Москва

Россия

123060

Contacts:

Директор - Леонов Александр Федорович (Director)

Tel/Тел: (095) 192-79-47; 198-80-41

Fax/Факс: (095) 192-79-47; 943-00-63

Специализация фирмы заключается в исследовании, разработке и поставке интеллектуальных приборов и систем, предназначенных для решения контрольно-измерительных задач для медицины, экологии, атомной техники (радиометры, аппаратура контроля перемещения РМ и ДМ, дозиметрические приборы)

The company is specialized in investigation, development and delivery of intellectual instruments and systems intended for solving control-and-measuring tasks for medicine, ecology, nuclear equipment (radiometers, apparatus for RM and NM monitoring, dosimetric instruments).

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RIPT, Research Institute of Pulse Technique

НИИИТ, Научно-исследовательский институт импульсной техники

ул.Луганская, 9

Москва

Россия

115304

Contacts:

Игнатьев Георгий Николаевич

tel/тел. (095) 321-47-65

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e-mail: room519@ript.in.ru

Служба маркетинга/Marketing service:

tel/тел. (095) 321-35-01; 321-35-92; 321-48-10; 321-43-22

fax/факс: (095) 321-48-55

teletype/телефайп: 611362 "Фауна"

Ведущая организация по разработке методов, технических средств и автоматизированных систем для телеметрических измерений параметров электромагнитных, оптических, ионизирующих излучений и сейсмических волн в широком диапазоне интенсивностей.

Leading organization in development of methods, technical means and automation systems for telemetric measurements of electromagnetic, optical, ionizing radiation parameters and seismic waves in the wide range of intensities.

SSC IPPE, State Scientific Center of Russian Federation, Institute of Physics and Power Engineering

ФЭИ, ГНЦ РФ Физико-энергетический институт

пл. Бондаренко, 1
г. Обнинск Калужской обл.
Россия
249020

Contacts:

tel/тел. (08439) 96-354

Бежунов Геннадий Михайлович (установка "СПАНДЕМ"/"SPANDEM" device)
tel/тел. (09439) 97-644, 98-281

Марин Сергей Николаевич (калориметр/calorimeter)
tel/тел. (08439) 98-942

Fax/Факс: (095) 230-2326, 883-3112

Научно-технической направленностью работы института является проведение научных исследований в области создания атомных реакторов, охлаждаемых жидкими металлами. Институт проводит исследования в области ядерной физики, физики ядерных реакторов, теплофизики, материаловедения и т.п.

Main trends of the Institute scientific activity is development of liquid metal cooled nuclear reactors. Institute investigates the nuclear physics, nuclear reactor physics, thermal physics, material irradiation study, and so on.

RFNC VNIIEF, Russian Federal Nuclear Center, All-Russian Research Institute of Experimental Physics

РФЯЦ ВНИИЭФ, Российский федеральный ядерный центр Всероссийский научно-исследовательский институт экспериментальной физики

г. Саров Нижегородской обл.
Россия
607200

Contacts:

Скрипка Георгий Михайлович
tel/тел. (831-30) 4-51-96
fax/факс: (831-30) 4-45-69

Институт является головной организацией Минатома по научно-методическому руководству разработки систем учета и контроля ЯМ. Основными направлениями деятельности являются: оружейные разработки, различные фундаментальные и прикладные исследования, разработки мирной направленности.

Institute is a leading Minatom organization in scientific supervision of NM control and accounting systems development. The main lines of activities are: weapon development, various fundamental and applied research, technology development for civilian applications.

*PNPI, St-Petersburg Nuclear Physics Institute**ПИЯФ, ГНЦ Петербургский институт ядерной физики
им.Б.П.Константинова Российской Академии Наук*

Орлова роща
г.Гатчина Ленинградской обл.
Россия
188350

Contacts:

Хусаинов Абдурахман Хусаинович
Зав. Отдела полупроводниковых детекторов
тe/тeл.(812) 71 36247
fax/факс: (812) 71 21451
e-mail: khusain@hep486.pnpi.spb.ru

Основные направления - физика элементарных частиц, атомного ядра и ядерных реакций, нейтронная физика, физика конденсированных сред, теоретическая физика, физика и техника ядерных реакторов и ускорителей, молекулярная и радиационная биофизика, новые методы и аппаратура для научных исследований.

Main directions: physics of elementary particles, nuclei and nuclear reactions, neutron physics, condensed matter physics, theoretical physics, physics and technology of nuclear reactors and accelerators, molecular and radiation biophysics, new methods and research equipment.

*RSC Kurchatov Institute**РНП "Курчатовский институт"*

пл.Курчатова, 1
г.Москва
Россия
123182

Contacts:

tel/fax -тeл/факс: 196-90-63
tel/тeл. 196-75-17, 196-78-41

JV Polimaster**СП "Полимастер"**

ул. Жодинская, 21; 21, Zhodinskaya str.
г. Минск, Minsk
Республика Беларусь, Republic of Belarus
220141

Contacts:

*Генеральный директор-Managing director
Антоновский Александр Алексеевич
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Phone: (375 172) 638263, 638187
Telefax: (375 172) 638188*

Предприятие "Полимастер" разрабатывает и производит аппаратуру радиационного контроля - от персональных дозиметров до сложных систем контроля за несанкционированным перемещением радиоактивных и ядерных материалов через границы государств. За сравнительно короткий срок своего существования "Полимастером" выпущены десятки тысяч персональных дозиметров различных типов, в том числе в уникальном исполнении в виде наручных часов. На границах Республики Беларусь, Эстонии, на Чернобыльской и Игналинской АЭС установлены радиационные мониторы, разработанные и серийно выпускаемые предприятием. Приборы, выпускаемые "Полимастером", сертифицированы, успешно прошли испытания в крупнейших научно-промышленных центрах России и зарекомендовали себя надежными средствами измерения ионизирующих излучений, обнаружения и идентификации радиоактивных веществ и специальных ядерных материалов. Предприятие тесно сотрудничает с предприятиями России и США, в том числе с компанией TSA Systems.

"Polymaster" develops and manufactures radiation control equipment - from individual dosimeters to complicated systems for RM and NM unauthorized traffic control. During comparatively short period of its activity "Polymaster" has produced tens of thousand personal dosimeters constructed in a wrist watch format. Radiation monitors that are developed and produced by the enterprise were installed at the borders of Belarus, Estonia, at Chernobyl and Ignalinskaya power plants. Instruments manufactured by "Polymaster" were successfully tested at the famous scientific-industrial centers of Russia and recommended as reliable means for radiation measurement, RM and SNM detection, and identification. "Polimaster" co-operates with Russian and US enterprises, including TSA Systems.

Scientific Engineering Center "Nuclear Physical Research"

НТЦ "ЯФИ", Государственное унитарное предприятие Научно-технический центр "Ядерно-физические исследования" - дочернее предприятие государственного предприятия Научно-производственное объединение "Радиевый институт им В.Г. Хлопина"

2 Муринский пр., 28
г.Санкт-Петербург
Россия
194021

Contacts:

*tel/тел. (7-812) 247-82-44
fax/факс (7-812) 247-39-24
e-mail: yafi@atom.nw.ru*

Основным видом деятельности НТЦ "ЯФИ" является проведение научно-исследовательских и опытно-конструкторских работ в области создания новых типов детектирующих устройств, в том числе специального назначения, предназначенных для регистрации ионизирующих излучений.

The main direction of the Center activity is a scientific, research, construction and designing works in the area of development of new types of detection units, including ones of special designation for detection of ionizing radiation.

VNIIFTRI, SPA DOZA**ГП "ВНИИФТРИ" НПП "ДОЗА"**

п.Менделеево, Солнечногорский р-н, Московская обл.
Россия
141570

Contacts:

Нурлыбаев Кубейсин Нурылбаевич - директор
K. Nurylbaev - Director
tel/тел. 535-9389, 536-9426, 535-1249, 536-9427
fax/факс: 534-0256
e-mail: kubesh@dose.msk.ru
Internet: <http://www.dose.ru>

Предприятие организовано в 1991г. Основное направление деятельности предприятия- методическое, метрологическое и аппаратурное обеспечение измерений параметров ионизирующих излучений. Основные разработки: альфа-бета-гамма-спектрометрический комплекс "Прогресс", малофоновый альфа-бета-гамма-нейтронный радиометр-дозиметр ДКС-96, рентгеновский дозиметр "ДРИМ" для определения дозовой нагрузки на пациента при рентгенорадиологических процедурах и другие. Все разработки сопровождаются методическим и метрологическим обеспечением и поставляются вместе с методиками пробоподготовки, методиками измерения, образцовыми мерами, а также с методиками проверки. При предприятии есть свой учебный центр. Предприятие выпускает ежеквартальный журнал по радиологии "АНРИ". Предприятие обслуживает на основе долгосрочных договоров около 300 организаций России, Казахстана, Белоруссии и других стран СНГ: оснащает оборудованием, обучает персонал и обеспечивает методическими, нормативными и информационными материалами. The Enterprise was created in 1991.

The main field of its activity is the methodologic, metrologic, and instrumental support for measurement of ionizing irradiation performances. The main developed instruments are: alpha-beta-gamma-spectrometric system «Progress», low background alpha-beta-gamma-neutron radiometer-dosimeter ДКС-96, X-Ray dosimeter "ДРИМ" for the determination of dose rate on a patient during X-radiometric procedures, and other. All developed devices are provided together with the metrologic support and sample preparation, measurement, reference materials and testing techniques. The Enterprise has its own training center, issues «ANRY» magazine on Radiology, and has contracts with about 300 Enterprises of Russia, Kazakhstan, Belorussia and other countries: supplies instruments, teaches, and provides methodological, regulatory, and information materials.

SNIIP-ASCUR**СНИИП - АСКУР**

ул. Расплетина, 5

г.Москва

Россия

123060

Contacts:*Директор - Голованов Михаил Николаевич (Director)**tel/тел. (095) 943-00-62, 192-99-04**fax/факс: (095) 943-00-63**telex/телефакс 411-680 "АЗАР"*

Основные направления деятельности -

Разработка и/или модернизация следующих систем:

- сосредоточенных или распределенных автоматизированных систем управления технологическими процессами (АСУТП) АЭС и других производств;
- систем контроля и управления технологическими процессами химводоочистки и очистных сооружений засоленных стоков АЭС и других промышленных объектов;
- систем контроля состояния активной зоны энергетических реакторов;
- систем контроля целостности контейнера энергетических реакторов типа ВВЭР.

The main lines of activities:

Development and/or modernization of the following systems:

- lumped values or distributed automated process control systems (PCS) for NPPs and other production;
- enterprises monitoring and process control systems for chemical water treatment and NPP's;
- salty discharge purification facilities and other production objects energy reactors;
- core state monitoring systems WWER type energy reactors containment integrity monitoring systems.

RSC Kurchatov Institute, SPC REKOM**РНЦ "Курчатовский институт" НПТ "РЭКОМ"**

ул.Щукинская, 21, корп.1

г.Москва

Россия

123182

Contacts:*Директор Леонид Ирбекович Уруцкоев (director)**tel/тел. (095) 196-9090, 196-7425**fax/факс: (095) 196-1635**e-mail: chesnok@rec.msk.su**ivan@rec.msk.su*

Основная деятельность: исследование и разработка новых методов и приборов в области дистанционного дозиметрического и радиоактивного контроля, систем гамма- видения; измерения гамма-загрязнения почвы, создание карт радиационного загрязнения; моделирование радиоактивного распространения выбросов в окружающую среду, распространение гамма и бета загрязнения в средах, мощности дозы. Специалисты "РЭКОМа" имеют шестилетний опыт работы на 4-м блоке Чернобыльской АЭС и в зараженных областях.

Main activity: research and development of new methods and devices in field of remote dosimetry and radioactive contamination control, gamma-vision systems; gamma contamination measurements on soil, production of contamination maps; simulation of radioactive contamination spreading in environment, gamma and beta radiation spreading in matter and dose rate. Recom's staff has six years experience of work on Chernobyl NPP unit#4 and in regions of Chernobyl disaster.

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EMZ "Avangard"

ЭМЗ "Авангард"

г. Саров, Нижегородской обл.
Россия

Contacts:

69

MOLNIA Plant

Машиностроительный завод "Молния"

г. Москва
Россия

Contacts:

70

PA MAYAK, Production Association MAYAK

ПО МАЯК, Производственное Объединение МАЯК

пр. Ленинаб 31
Озерск, Челябинской обл.
Россия
456780

Contacts:

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Факс: (351-71) 2-38-26, (351-71) 2-38-26
