RSD

ALDERSON PHANTOMS

THE LAWRENCE LIVERMORE REALISTIC PHANTOM

A WORLDWIDE REFERENCE STANDARD FOR IN-VIVO COUNTING

- And Alderson Fission-Product and Thyroid Phantoms

The Lawrence Livermore Realistic Phantom was developed under the direction of the U.S. Department of Energy, primarily as a reference standard for the in-vivo counting of emissions from low-energy transuranic nuclides.

The organs of interest are the lungs, liver and lymph nodes. Each of these may be radioactive or inert. These organs are accommodated in a male thorax generally similar to average adult males.

The Livermore phantom contains a synthetic bone skeleton molded within a soft-tissue-equivalent material. The organs are located in an internal cavity with a separate torso cover that closes the phantom. Anterior sections of ribs and the sternum are molded into this cover.

Soft-tissue-equivalent blocks are used to position the organs and fill significant air spaces, providing continuity of the soft-tissues throughout the phantom. The phantom is shipped assembled with inert organs. Any or all of these organs can be replaced with radioactive organs, which are shipped in separate packages.

Organs

All organs are made of soft-tissue equivalent materials. Lungs are available with the nuclides uniformly dispersed throughout the lung molding material. Optional organs (developed by RSD and not part of the original DOE specifications) are inert, but have holes in 2 cm^2 grids. These either can be filled with inert plugs or with active capsules to establish any desired distribution within the lungs.


Liver with Hole Matrix


Capsules

The liver has the same loading flexibility, but another option is available, designed for use with solutions having relatively short half-lives. This liver is a hollow shell with a fill/drain port.

If the liver is not required, it may be replaced with the Abdominal Contents, which are also available with a hole matrix, or active.

Lymph nodes are available as hollow shells or as active packets. Two are 8 mm in diameter by 17 mm long. A third is 13 mm in diameter by 25 mm long. They are positioned in recesses molded in a lymph node block.

Chest Overlay Plates

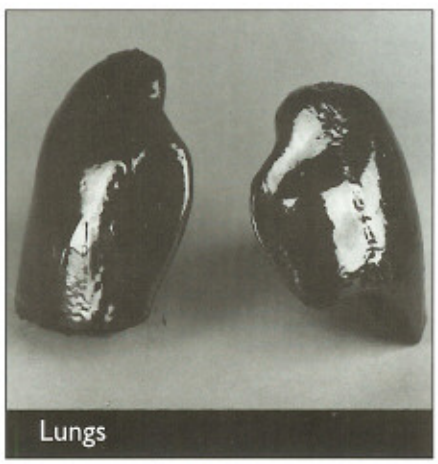
Transuranic emissions from individuals with varying amounts of muscle and/or adipose tissue may be so attenuated as to be undetectable. Chest overlay plates were developed to ensure the validity of in-vivo counting of such individuals.

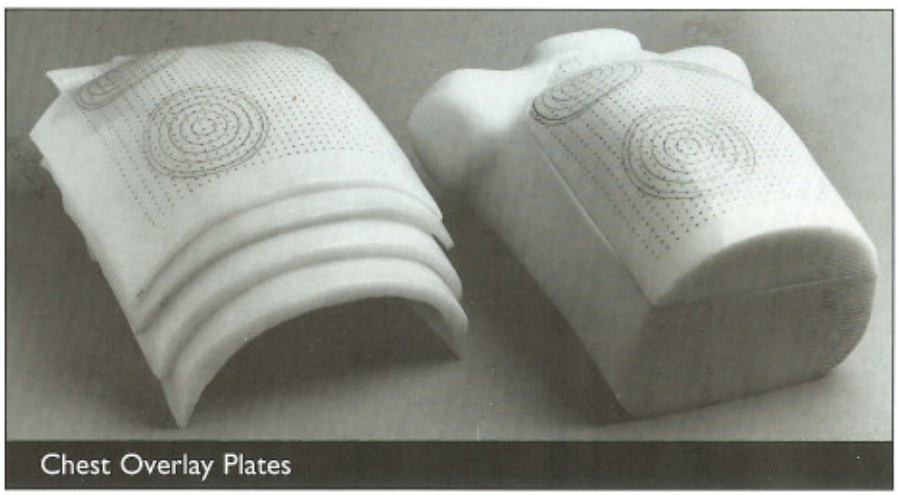
There are three sets of plates, each in four graded thicknesses. One set is equivalent to 87% adipose and 13% muscle, another is equivalent to 50% adipose and 50% muscle, and the third is equivalent to 100% muscle. Plates of each material and/or each thickness are available separately.

Targets

Three sets of concentric circles are drawn in permanent black ink over the torso cover and over each chest overlay plate. They range in 1 in. increments from 1 in. to 5 in. in diameter, with a 5.5 in. diameter outer circle. One set of circles is placed over each lung region, with the outer circle tangent to the inferior aspect of the clavicle and protruding over the sternum. The third set is placed over the liver.

A 2 cm^2 grid is projected in red ink over most of the chest surface by the same technique that is used for the circles. All targets are consistent among all phantoms.


Lungs


Chest Overlay Plates

THE FISSION-PRODUCT PHANTOM

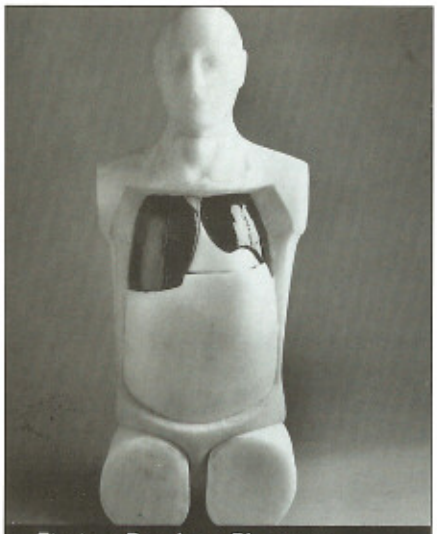
The Fission-Product Phantom is partially modeled after the Lawrence Livermore Realistic Phantom. It was developed by RSD to meet the needs of nuclear power stations and other facilities where more organs are needed than are provided by the Lawrence Livermore Realistic Phantom.

This phantom may be used on a couch, in a chair or standing. It includes the head and neck, the complete torso and stub legs articulated at the hips (which are also needed for the sitting position). The same access to the torso cavity is provided as in the Livermore Phantom.

The materials of construction are RSD multi-energetic formulations. The skeleton has been extended to include the head and full torso. The RSD "Superhuman Skeleton," which is multi-energetic, is used. RSD materials closely meet the standards of the International Commission on Radiation Units and Measurements (ICRU) Report No. 44 (Tissue Substitutes in Radiation Dosimetry and Measurement, 1989.)

Organs

The organs of the Lawrence Livermore Realistic Phantom fit exactly into the Fission-Product Phantom, but RSD has modified the internal construction to accommodate additional organs: thyroid, kidneys, stomach, spleen, pancreas, and small and large intestines.



Fission-Product Phantom

The Fission-Product Phantom system is shipped with inert organs. Any or all organs can be replaced by radioactive organs, which are shipped in separate packages.

The same choices of nuclide loadings are available for active organs as for the liver of the Livermore Phantom (uniformly dispersed in the molding materials, hollow shells or with hole grids).

Chest Overlay Plates

These are fitted specifically to the Fission-Product Phantom and are not interchangeable with the Livermore Phantom.

THE THYROID PHANTOM

The Thyroid Phantom is an integral part of the Fission-Product Phantom, but it can also be supplied separately (with or without a head). This phantom has the same contours as in the full Fission-Product Phantom.

The Thyroid Phantom contains a neck with corresponding "Superhuman Skeleton" vertebrae, a hollow-shell thyroid with filling and flushing ports, and a front cover of tissue-equivalent phantom material.

Thyroid Phantom

This assembly has been designed for rapid removal of the cover plate and thyroid, a quick fill with an isotope solution and an equally rapid reassembly. This permits work with iodines of very short half-lives. A portion of the clavicles and sternum are included to further enhance the realism of the phantom.

RADIONUCLIDES

RSD routinely manufactures active organs with isotopes to suit users' needs. Active capsules to fit into the gridded holes are available, or empty capsules can be supplied to be filled by the user.

RSD usually supplies the required isotopes, but users may furnish them if so desired.

Isotopes are most often received as calibrated solutions, traceable to the NIST. Organ loading is controlled by micropipetting aliquots from the calibrated solutions. Uraniums and plutoniums are traceable to the NIST by mass. Other isotopes are usually traceable by activity.

Some isotopes are manufactured only at intervals throughout the year, so delivery is subject to availability. In some cases, calibration costs from governmental sources are subject to wide fluctuations.

Model Number

RS-500 Lawrence Livermore Realistic Phantom System, includes: Torso and gridded torso cover, inert heart, lungs, lymph nodes, liver and liver envelope or abdominal contents. All blocks needed for organ location and soft-tissue continuity within torso. Documentation. Permanent shipping and storage case.

Livermore Organs

Organs	Inert, Hole Matrix	Solid, Active	Inert, Hollow
Lungs	N/A	RS-503A	N/A
Lymph Nodes (set of 3)	N/A	RS-506A	RS-506S
Liver & Liver Envelope	RS-507H	RS-508A (Liver only)	RS-519S (Liver only)
Abdominal Contents*	RS-510H	RS-511A	N/A

** Replaces Liver and Liver Envelope*

Model Number

RS-550 Fission-Product Phantom System, includes: Head, neck, neck cover plate for thyroid access, complete torso and gridded torso cover, inert heart, lungs, lymph nodes, thyroid, liver, kidneys, stomach, pancreas, spleen, small and large intestines. Stub legs with pivot bolts. Documentation. Permanent shipping and storage case.

Fission-Product Organs

Organs	Inert, Hole Matrix	Solid, Active	Inert, Hollow
Lungs	RS-502H	RS-503A	N/A
Lymph Nodes (set of 3)	N/A	RS-506A	RS-506S
Thyroid	N/A	RS-543A	RS-543S
Liver	RS-507H	RS-508A	RS-519S
Kidneys (pair)	RS-530H	RS-531A	RS-532S
Stomach	RS-533H	RS-534A	RS-535S
Pancreas	RS-536H	RS-537A	RS-538S
Spleen	RS-539H	RS-540A	RS-541S
Small Intestine	RS-544H	N/A	N/A
Large Intestine	RS-546H	N/A	N/A

Capsules

RS-520 Active Capsule (isotope and activity to be specified)

RS-521 Inert Capsule with sealing cap, to be filled by user.

Thyroid Phantom

RS-542 Thyroid Phantom without Head; consists of neck, hollow thyroid, thyroid cover, a portion of the cervical spine, sternum and clavicles

RS-545 Thyroid Phantom with Head; (same as RS-542 but with Head and full cervical spine)

RS-543A Thyroid, solid, active

RS-543S Thyroid, hollow, inert

Chest Overlay Plates

RS-513 Chest Overlay Plate (Any of 4 thicknesses)
(1,2,3,4) #1 - thinnest, #4 - thickest
(A,B,C) A) 87% adipose - 13% muscle
B) 50% adipose - 50% muscle
C) 100% muscle

RS-514 Chest Overlay Plates
(A,B,C) Set of 4, in materials A, B or C

RADIOLOGY SUPPORT DEVICES

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