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SINCLAIR RESEARCH LABORATORIES, INC.
400 E. Sibley Boulevard
Harvey, Illinois

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RADIATION LABORATORY BUILDING

Sinclair's new Radiation Laboratory provides facilities for conducting research on the effect of gamma radiation on petroleum processes and products and the application of radioactive tracers in the petroleum industry. Sinclair Research engineers developed the overall planning, design, and shielding requirements with consultation from outside experts in the field.

The building layout was selected on the basis of flexibility and recognition was given to basic nuclear laboratory considerations such as surface treatment, waste disposal, radioactive material storage, monitoring, shielding, and air handling treatment and flow.

The building is approximately 42 feet wide by 54 feet long. It is designed to provide the maximum in safe working conditions for a staff of six research workers. Entrance into the building is through the office area permitting complete surveillance to insure that no unauthorized persons enter the building. All workers in the building and visitors to areas containing radioactive materials are issued film badges or direct reading pocket dosimeters.

The building is divided into two sections for research involving radioactive materials; a radioactive tracer section which contains a tracer laboratory, a counting room and a dark room, and a radiation section which contains a radiation laboratory and the hot cave. A general area consists of an office, shower room, wash room, and locker room.

The radiation source consists of four spent MTR fuel elements. The purpose of the radiation laboratory section is to investigate the effects of high levels of gamma irradiation on petroleum processes and products. The purpose of the tracer laboratory is to have adequate facilities available for preparing labelled compounds safely and measuring the radioactivity level of various radioisotopes. Tracer uses will cover many phases of petroleum research.

The architecture of the building essentially matches that of the other buildings on the site. The building is a single story structure of masonry construction, except for the hot cave which is constructed of reinforced monolithic concrete. The concrete slab floor of the building is designed for 150 pounds per square foot loading and that of the hot cave is of 600 pounds per square foot design. These design floor loads permit the placing of concentrated loads of shielding materials.

Exposed surfaces throughout the interior of the building are designed to be smooth and free of cracks. Strippable wall linings are provided in the tracer laboratory where "spills" of radioactive materials might cause contamination requiring replacement in certain areas. The floors throughout the building are of sheet vinyl plastic which provides an impervious surface which resists contamination. In the event of contamination of the floor surface it will be a relatively simple job to remove and replace the contaminated section.

The building is air conditioned to obtain clean air and nearly constant temperature conditions which provide for better laboratory test data, better working conditions, and reduced building maintenance.

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In order to comply with A.E.C. requirements all air discharged from the building is filtered through absolute (A.E.C. type) filters. The filter housings are designed to provide for safe handling of contaminated filters from the housing to a disposable container insuring that radioactive material fall out from the filters during transfer will be held to a minimum. The filter is installed in the duct in a vertical position down stream of the exhaust blower so that the unit is under negative pressure at all times insuring air infiltration and thus precluding escape of radioactive materials through the ducting. The filter edge has a continuous neoprene gasket which seals against a heavy steel frame with a cam loading device providing the sealing pressure on the unit. The filter is raised and lowered from its duct position with a chain mechanism through a sheave mounted directly above. Clearance is provided below the filter housing for the shipping box from which the new filter is taken and into which the contaminated filter is deposited for transfer and disposal.

Air from the building is discharged through ventilating ducts. Discharge vent stacks have rain hoods as well as weep holes in the lower end of the vertical stack. Discharge ventilators extend above the building coping to insure proper distribution and diffusion with no pocketing of the discharged air in the roof area. The hot cave exhaust stack extends 12 ft. above the roof. This affords diffusion of the discharge air from the high level area for all possible wind conditions.

Air flow is from the operating section into the radiation cave in the radiation laboratory and from the counting room into the tracer laboratory to minimize building-wide dispersal of possible airborne radioactivity.

Shower and locker facilities are provided for employees working in the building to insure that no radioactive contaminants are carried out of the building.

Radiation Section

The radiation section of the laboratory building consists of a radiation laboratory and a hot cave. The radiation laboratory has a large open area that is used for setting-up the equipment necessary for process installations. Control panels designed to handle many functions, standard laboratory furniture with stainless steel work surface and a fume hood are provided in this area.

The hot cave is designed to handle four spent MTR fuel elements having a combined emission of approximately 2.5×10^6 roentgens per hour measured through 3 inches of water.

The radiation laboratory and the hot cave have a common wall. In this wall are located the pipe labyrinth for servicing the process vessel to be irradiated, an observation window for viewing the equipment in the cave, and Argonne National Laboratories Model 8 master-slave manipulators for remote handling of material within the cave. Other items such as the fuel element radiation source hoist hand wheels and a cave interlock-radiation detecting device are located on or operated from the laboratory face of this wall.

The working area in the cave is 8 feet wide by 13 feet long and 13 feet high. A 6 ft. wide by 7 ft. long corridor provides access to the cave. A shielded door is provided which is interlocked with the source handling mechanism providing protection against opening the door with the fuel elements exposed.

The hot cave-laboratory wall is 5 feet thick and is made of magnetite concrete which was selected to reduce its thickness thus reducing the length of the penetrations and increasing the viewing area of the window. The thickness of the remaining walls and roof were not critical from an engineering standpoint thus regular concrete was used. The minimum regular concrete wall thickness excluding brick facing is 6 feet - 7 inches and the roof thickness is 6 feet - 4 inches.

The cave is serviced through the outside access door which is a reinforced steel box filled with magnetite ore compacted in place. The door is 55 inches thick and contains bulk shielding steel to reduce linear radiation and radiation scatter. It is suspended from and travels on a monorail extending parallel with the cave wall. A source-cave door interlocking device incorporates a keyed door locking component which is mounted on the door and affixed to the building wall.

Bulk steel shielding is also incorporated in the cave wall to reduce the radiation level at certain points. The openings in the cave wall create a reduction in the wall thickness and provide portals for escape of scatter radiation. At these points shielding steel is imbedded in the concrete and oriented as required by the cave geometry to provide essentially a constant level of protection throughout the cave wall surface area.

The entire interior of the cave is lined with steel plate which was used as the concrete form. The purpose of the steel liner is to provide a smooth cave interior for decontamination and also to provide a surface for anchoring shielding steel as well as other cave internals.

A ceramic tile lined water well 6 feet by 8 feet in cross section and 18 feet deep is located inside the cave. This well was provided to accommodate the source shipping container which is immersed in the well during transfer of the MTR fuel elements. It is also used for storage of the fuel elements during normal operation.

An open grating with a clear plastic sheet backing is provided over the well to keep out foreign material. The well water is run continuously through a filter and de-ionizing unit to remove contaminants and to prevent the well water from becoming turbid.

A pipe labyrinth and dry materials port through the cave wall provide access to the cave from the radiation laboratory. The pipe labyrinth is a 1 ft. wide x 3 ft. high continuous mazed port located at floor level through which service pipes pass to the interior of the cave and through which ventilating air passes from the laboratory to be discharged through the cave exhaust system. A dry materials port is provided in the cave wall for exposing bulk items to short term radiations. It permits the insertion of materials into the radiation field within the cave from the lab side of the cave, thus eliminating the need of putting the source back in the well and entering the cave for each irradiation.

The cave is equipped with an all glass viewing window which permits observation of the apparatus and measuring devices located within the cave. The window is approximately 64 inches thick and measured 59 inches wide by 40 inches high on the hot side and 41 inches wide by 22 inches high on the cold side. The window is of stepped design with a steel case and wall liner. Its shielding capacity is equal to that of the magnetite concrete cave wall in which it is mounted.

One pair of master-slave manipulators are installed directly over the viewing window. These are used for light duty manipulating tasks within the cave when the source is in the exposed position. Provisions were made for removing the manipulators from the cave during long time radiation exposures which might effect the manipulator lubrication thus necessitating excessive maintenance.

Monorails with large hoists are used for unloading and transporting the container to the cave well where it is immersed during unloading of the fuel elements. The elements are stored in the cave well and brought up into position during radiation periods by a remote operated hoist.

An interlock system insures the safe operation of the cave. With the source in the down position in the well the hoist operating mechanism is locked out and the key removed to open the cave access door if the radiation within the cave is below a prescribed safe limit. An electronic instrument measures the radiation within the cave and locks-in the access door key if the radiation is unsafe or releases the key allowing the door to be opened when a safe level of radiation is reached.

An emergency access plug is provided in the center of the roof for handling the radioactive source in the event of use of standard handling equipment.

Although the major purpose of the radiation cave is to provide facilities for research on the effects of high levels of gamma irradiation on petroleum processes and products it can quite easily be used for high level radioisotope tracer work or radiography, if desirable or necessary, due to its construction because of the viewing window, master-slave manipulators, direction of air flow, ease of decontamination and heavy radiation shielding.

Radioactive Tracer Section

The radioactive tracer section is composed of the counting room and the tracer laboratory. The counting room houses all the electronic equipment used in tracer work and also the monitoring equipment used for checking contamination.

The tracer laboratory is equipped with standard laboratory furniture with stainless steel work surfaces. Stainless steel fume hoods are the radio-chemical-type with air foil entrances. Hoods consist of a California type hood for preparation of materials containing beta activity or small amounts of gamma and two vertically operating sash type hoods for higher level work. Hood bases are of extra sturdy construction which permit loading with heavy shielding material. The hood services are arranged for control from the outside. Removable pans of stainless steel cover the entire work surface inside each hood. These permit the removal of spilled radioactive materials for deposit in the waste sink which is connected to a 3000 gallon storage tank for radioactive waste materials which is buried adjacent to the building. The waste sink dumps into this tank with no trap, thus eliminating hold up of radioactive materials. Further disposal of radioactive wastes will be made through the facilities of AEC or an authorized private disposal agency after suitable concentration by distillation or ion exchange.

The strippable laboratory wall lining is constructed of pressed wood attached to furring strips anchored to the masonry wall. All wall joints are masked with tape, and the entire surface is painted with a suitable wall finish.

A storage vault for radioactive materials is located in the laboratory floor. This vault consists of a cluster of pipe sleeves imbedded in a block of concrete. The sleeves are covered with concrete plugs which act as the vertical shielding for the vault. The vault is placed independent of the laboratory floor to permit replacement with a revised unit if required.

Four additional pipe sleeves are imbedded in the radiation cave floor for additional storage of radioactive materials. The storage well in the radiation cave can also be used as a safe storage area for suitably contained radioisotopes.

Three plan views of the Radiation Laboratory building are attached to this description.