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THE MARTIN COMPANY

Refer to:
PRG:W729

Baltimore 3, Maryland

August 26, 1959

Radiography licenses

Mr. W. O. Miller
Division of Licensing and Regulation
U. S. Atomic Energy Commission
Washington 25, D. C.

Dear Bill:

Enclosed please find two copies each of the following manuals:

MND 2078 - "A General Outline of the Martin Health Physics Program"

MND 2109 - "Health Physics Procedures During the Use of Radiography Sources"

Manual 2078 is intended as an official outline of our Health Physics Program. It will serve as a guide for all of our projects that involve materials or equipment that emit ionizing radiation. You will note that the manual has been approved by the responsible managers. We believe this manual gives a good picture of our program here.

Manual 2109 is the one you requested several months ago. We incorporated several suggestions by some of your people as well as those received from various Martin personnel. We certainly hope this fulfills your request.

I appreciate your many helpful suggestions during the past two years. If you are down Oak Ridge way be sure to stop by to see me.

Sincerely yours,

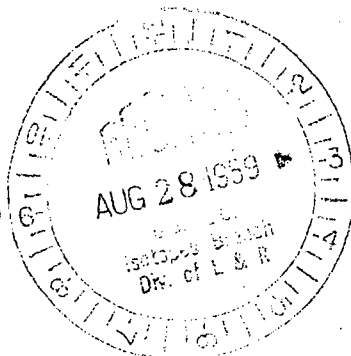
THE MARTIN COMPANY

Paul R. Guinn

Paul R. Guinn
Chief, Health Physics

PRG:mnh

Encl: (4)



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HEALTH PHYSICS PROCEDURES

DURING THE USE OF

RADIOGRAPHY SOURCES

Prepared by

Paul R. Guinn

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Chief, Health Physics

MND 2109

AUGUST 1959

DUPLICATED
FOR DAY OF USE

HEALTH PHYSICS PROCEDURES
during the use of
RADIOGRAPHY SOURCES

I Introduction

This manual contains a general outline of the controls necessary to provide maximum protection to personnel during the use of radiography sources and to assure compliance with all Federal, State and local laws pertaining to the use of radioactive materials. All personnel using radiography sources shall be cognizant of the contents of this manual and comply fully with all provisions.*

*Other manuals which may be consulted for additional information are MND 2078 "A General Outline of the Martin Health Physics Program" and MND 2108 "Health Physics Handbook for the Radioisotopes Facility".

II General Information

A. Individuals Responsible for use of Sealed Sources

George Samos

C. E. Hollens

B. Name of the Person Directly Responsible for Over-all Radiation Protection

~~Paul R. Guinn~~

Richard H. Boutelle

C. Instructions of Personnel

All personnel handling radioactive materials shall be instructed as to the hazards of ionizing radiation and the procedures to follow to prevent overexposures. Each person shall be instructed to maintain total body exposures within the permissible limits of 5 rems per year. All work with radioactive materials shall be under the supervision of experienced personnel who are expected to instruct less experienced personnel on the job as to safe handling procedures. At periodic intervals Health Physics will meet with personnel to discuss handling procedures, emergency procedures, and other topics pertaining to radiation protection.

III Security of Sources During Use and Storage

During the use and storage of sources maximum precautions must be taken to assure that only authorized personnel have access to the sources.

A. Storage

1. Radioactive materials, including sealed sources, must never be left unattended in an unlocked room, vault, or cell, except as approved by Health Physics. Access to these areas is by permission of the responsible supervisor or a Martin Health Physicist.
2. Under normal conditions sources are stored in a specially designed shielded room in the Radioisotopes Laboratory which is locked during off-duty hours. Another door through which access to the storage room is gained is also locked during off duty hours.
3. All areas containing radioactive materials, including sealed sources, are clearly identified by magenta and yellow radiation and/or radioactive material signs.

B. In Use

During the use of radiography sources, qualified personnel are in attendance except where it is possible to perform the work in a locked room where unauthorized personnel would not be able to gain entrance without approval. During open air radiography (i.e. work outside the Radioisotopes Laboratory) a responsible person shall be present at all times.

IV Exposure Equipment and Safe Handling Procedures

Exposure equipment is available which makes it possible to use radiography sources with a minimum of exposure to personnel.

A. Description

The exposure equipment used in "open air" radiography consists of a Model 412-Iridium 192 and a Model 402-Co 60 projector mechanism as manufactured by the Technical Operations Company. Attachment 1 and 2 are operational manuals for these projectors.

B. Open Air Radiography

- (1) The Responsible Supervisor, in the area in which radiography work is to be conducted, is notified of the location, time and date the work is to be performed.
- (2) The equipment is moved into position and the two cables are attached.
- (3) The source cable is placed in the desired position and all except operating personnel are moved to a distance of 50 feet or more from the source.
- (4) The Health Physics representative stands with the operator who operates the crank mechanism which moves the source through the cable to the desired exposure point. At this point the flashing light on the control box should be in operation.
- (5) With the source in the desired position the Health Physics representative makes a quick radiation survey of all work areas to determine what areas, if any, exceed an average of 2 mr/hr. After the Health Physics survey, the operator turns the crank which moves the source back into the container. At this point the flashing light should not be showing. As an added precaution, the Health Physics representative always walks along the cable to the exposure point to determine that the source has, in fact, been returned to the shielded container. No deviation is permitted from this procedure.

- (6) All areas above an average of 2 mr/hr are now roped off and tagged. Personnel are also placed in positions to observe the entire radiography area. This is to prevent anyone from entering the roped off area while the source is "out". It should be emphasized that all personnel entering an area where the radiation levels exceed 2 milliroentgens per hour must wear a film badge.
- (7) With the area roped off and the cables in position, the photographic film is mounted in position for the first shot.
- (8) During radiography work the operators and the Health Physics representative wear film badges, two pocket chambers and a self-reading dosimeter. The latter is checked frequently during the operations.

On special occasions sealed sources may be used without benefit of a remote handling device. In work of this kind the source would be handled with a remote tool of sufficient length to insure that personnel would not receive an over-exposure. Careful monitoring of the radiation levels and, in some instances, adjustments of working times are made to prevent over-exposures.

C. Radiography in the Radioisotopes Laboratory

- (1) The same procedures are followed as in "open air" work with the exception that a Health Physics representative will "spot check" the work instead of being continuously present.
- (2) The crank mechanism is activated at the entrance to the specially shielded room. At this point the operator is shielded by approximately 23" of concrete. (See Attachment No. 4.)
- (3) A Nuclear Chicago Laboratory Monitor with visual and audible indicator is in operation in the laboratory at the entrance to the shielded room. This serves as a warning to personnel whenever the source is out of the shield and is also used to monitor for personal contamination.
- (4) A chain with a sign reading: "CAUTION: RADIATION AREA - NO ADMITTANCE" is placed across the entrance door whenever a source is "out" in the specially shielded room. This sign also contains the magenta and yellow radiation symbol.
- (5) A remote monitoring system is installed in the Nuclear facilities. One detector unit, complete with warning light and buzzer is located in the Radioisotopes Laboratory. The light and buzzer are activated when the gamma radiation levels exceed 10 mr/hr. The light is mounted above the door into the shielded room.

- (6) All radiography work is performed within the area outlined by painted lines on the floor in the specially shielded room. Health Physics surveys show that radiography work performed within the area outlined by the painted lines on the floor does not result in a radiation level exceeding 1 mr/hr in adjacent areas where other personnel are working. The latter was determined by placing a 3 curie cobalt 60 source in the specially shielded room and then making measurements of the radiation levels in all adjacent areas.
- (7) After each "shot" the crank mechanism is activated to return the source to the container. At this point the operator enters the shielded room with a "Cutie Pie" to insure that the source has in fact been returned to the shield.

V Use of Radiation Survey Equipment

All personnel engaged in radiography operations are required to familiarize themselves with the use and operation of various types of radiation survey equipment by studying the Instrument Handbooks and by personal instructions from experienced personnel, usually a Health Physicist. The Martin Radioisotopes Laboratory has the following instruments permanently assigned to the facility:

- 1 - Nuclear Chicago "cutie pie" - reads up to 2.5 r/hr
- 1 - Nuclear Chicago Survey Meter -- reads up to 20 mr/hr.
- 2 - Nuclear Chicago Laboratory Monitors - read up to 20 mr/hr.

In addition to the above, Health Physics has numerous types of survey instruments as well as air samplers and counters available for use.

VI Survey and Restriction of Radiographic Areas

Areas in which sources are used are thoroughly monitored to assure that exposures to personnel do not exceed permissible levels.

A. Permanent Radiography Area

At the present time the Radioisotope Laboratory is sufficiently shielded to handle up to 5 curies of CO 60. This was verified by measuring the radiation levels in the areas adjacent to the Radioisotopes Laboratory while a 3 curie Cobalt 60 source was mounted in various locations in the specially shielded room. By referring to the attached diagram covering this survey (Attachment No. 4) it will be observed that in all unrestricted areas (i.e. areas in which personnel do not normally wear film badges) the radiation levels did not exceed 1 mr/hr.

As previously mentioned, during the time that a radiography source is "out" in the specially shielded room, a chain must be placed across the entrance door with a sign reading: "CAUTION: RADIATION AREA - NO ADMITTANCE". The door to the specially shielded room and the main entrance door to the facility are both locked whenever facility personnel are absent. A gamma detector with warning light and buzzer are also installed.

B. Source Changing Procedure

Sources are usually changed by means of source changing devices such as the "Model 414 Iridium 192 Source Changer" (See Attachment 3) as manufactured by the Technical Operations Company. This also serves as a shipping container. The source is replaced remotely without exposing personnel to radiation above permissible limits. If necessary to change sources by other methods, Health Physics approval is required.

C. Temporary Radiography Area

Whenever radiography sources are used outside the permanent radiography area they may be stored temporarily in a locked room provided Health Physics has determined that no serious health hazard would result and that the sources would not be disturbed by unqualified personnel. Radiography sources are used at the Martin Middle River Plant, and on rare occasions at Cape Canaveral, Florida. All storage containers are tagged with radiation warning signs.

D. Leak Testing of Sealed Sources

All sealed sources (except as approved by the AEC) are leak tested each 30 days. This consists of rubbing the surface of the source capsule with a filter disc (smear) and counting in a gas-flow proportional counter. Leaking sources will be sealed in a suitable container and held for decay or returned to the manufacturer for encapsulation.

VII Personnel Monitoring Equipment

All personnel engaged in radiography work are required to wear a film badge and two pocket chambers. Personnel temporarily assigned to work in the radiography areas and personnel who will observe radiography work in areas exceeding an average of 2 milliroentgen per hour will also wear a film badge and two pocket chambers. Personnel who perform the actual radiography work are also required to wear a self-reading dosimeter which is read several times during the radiography operations.

A. Determination of Exposure Totals

Pocket chambers are read daily while film badges are developed routinely each thirteen weeks but will also be developed and read any-time one or more of the following conditions exist:

- (1) The two pocket chambers both read "off scale".
- (2) The two pocket chambers are damaged or lost.
- (3) During any given week that the daily pocket chamber totals reach 100 milliroentgens or more.
- (4) At anytime during the 13 week period that the daily pocket chamber totals reaches 500 milliroentgens or more.
- (5) Personnel are involved in a significant incident such as a spill, air contamination, high radiation level, etc.

Permanent records are maintained of radiation exposures and resumes are submitted to all individuals annually as required by the U. S. Atomic Energy Commission.

B. Visitor Monitoring

Visitors* to the Radioisotopes Laboratory are required to wear film badges and pocket chambers when entering any area where the radiation levels exceed 2 milliroentgens per hour and/or where an exposure in excess of 100 millirems is likely to be received in any seven consecutive days.

*For the purposes of this manual a visitor is defined as anyone not permanently assigned to work in the Radioisotopes Laboratory.

VIII Transportation of Sources to
Field Locations

Radiography sources are moved within the Martin Middle River Plant in approved source containers. These are usually the same shielded containers in which the sources were originally shipped from the supplier. Generally, the radiation levels do not exceed 20 mr/hr on the surface of the container. However, each container has a radiation sign attached with the radiation level reading and a statement of the contents of the container.

Sources transported from the Martin Middle River Plant are packaged and labeled to comply with all ICC Regulations. The radiation levels on the surface of the containers must not exceed 200 milliroentgens per hour at contact and/or 10 milliroentgens per hour at one meter. All source containers are monitored by Health Physics before removal from the Plant. Generally, the containers will be carried to Cape Canaveral, Florida in a company owned plane. However, it may be necessary in the future to send the source via air or railway express. Upon arrival, the sources are picked up by Martin Baltimore radiography personnel.

The sources in transport would be under surveillance of Martin personnel and/or Air-Railway Express personnel and will be shipped in full compliance with all ICC regulations. The sources will be stored in a locked room or vault at the temporary radiography site.

IX Radiation Surveys

The Martin Health Physics Section has the responsibility for monitoring all areas where radioactive materials are used or stored to evaluate the radiation hazards present. Permanent records are maintained of survey results.

A. Survey Methods

- (1) The air in all work areas is sampled periodically as deemed necessary by Health Physics, to determine the air concentration in microcuries per milliliter of air. This is accomplished by means of small portable air samplers and/or continuous air monitors.
- (2) Radiation surveys are conducted in all areas on a routine schedule to determine the external radiation levels. This is accomplished by means of portable type instruments and fixed monitoring systems.
- (3) "Smear" surveys are conducted in all work areas to determine the levels of surface contamination. "Smears" are made on floors, equipment, table tops, etc. and counted in sensitive counters.
- (4) Corrective measures must be taken, as directed by Health Physics, to eliminate sources of air contamination, surface contamination and/or direct radiation readings above permissible limits.

B. Posting of Radiation and/or Radioactive Material Areas

All areas in which radioactive materials are used or stored will be posted with a radiation warning sign in accordance with the following:

- (1) A radiation symbol and sign with the words: CAUTION-RADIOACTIVE MATERIALS. This sign is used in all low radiation level areas.
- (2) A radiation symbol and sign with the words: CAUTION-RADIATION AREA. This sign is used in areas where a dose in excess of 5 mrem/hr or 100 mrem in 5 consecutive days could be received.
- (3) A radiation symbol and sign with words: CAUTION: HIGH RADIATION AREA. This sign is used in areas where a dose could be received in excess of 100 mrem/hr.

X Emergency Procedures

The following is a brief outline of procedures to follow in the event of emergencies involving radiography sources. It is an absolute requirement that Health Physics be notified immediately of all emergencies involving radioactive materials.

A. Persons to be Notified of Emergencies

1. Richard H. Boutelle LYric 2-9874 Baltimore, Md.
2. George Samos - VA 5-8756 - " "
3. C. E. Hollens - Franklin 4-4735 " "

B. Procedures

1. Fires

- (a) Remove all people from vicinity of the source.
- (b) Take radiation level readings to determine whether fire fighters can safely approach vicinity of source. Avoid breathing of smoke or fumes. Use extreme caution to avoid exposing personnel to radioactive fumes or dusts.
- (c) After fire is out, approach source with survey instrument to determine that source container is undamaged. If container is damaged, secure a replacement.
- (d) Investigate to determine whether personnel may have exceeded exposure limits.

2. Damaged container:

- (a) Remove all personnel from the vicinity of the source container.
- (b) Make survey of area to determine whether source is still in the container. If not, find source and rope off area and keep personnel away from the source.
- (c) Determine if source is damaged. If it appears that source is damaged make a survey to determine if contamination is present in the area. Be especially careful to avoid spreading of contamination.
- (d) Secure a suitable source container and replace source by means of remote handling tool. Place contaminated equipment, soil, etc. (if any) in containers.

- (e) Investigate to determine whether personnel may have exceeded exposure limits.

3. Lost Source (Plant Area)

- (a) Evacuate all people from all areas in which source was used or through which source was moved.
- (b) Make an immediate survey to find source by walking through all areas with a survey instrument.
- (c) If this fails, notify plant security to alert all personnel immediately that source is missing.
- (d) After source is located, immediately isolate the site, move container to site and replace source.
- (e) Check area for contamination.
- (f) Investigate to determine whether personnel may have exceeded exposure limits.

4. Lost Source - Off Plant

- (a) If high level source, notify local police and health department to aid in finding source.
- (b) Use radiation survey instrument to attempt to find source. Carefully check all areas in which source was used.
- (c) When found, place source in container and determine possible exposure level to personnel. If necessary, initiate immediate medical attention.
- (d) Check area in which source was found for contamination.

5. Source Out of Container - Exposure Device Will Not Return Source To Shield.

- (a) Keep personnel away from source until plan of action is determined.

- (b) Use long pipe or extension to attempt to shake source loose by tapping on cable.
- (c) If above fails, disconnect cap on end of cable and shield "hot" spot on cable in which source is lodged. Use flexible wire in attempt to push source back into the container.
- (d) If above fails, disconnect cable from source container and attempt to shake source loose.
- (e) If above fails, transport to a shielded area in which source can be removed by cutting cable.
- (f) Determine if source is damaged. If so, place in proper container for return to supplier to be re-encapsulated. Monitor all areas for contamination.

XI Compliance with Federal Regulations

All work involving radioactive materials, including sealed radiography sources, will be conducted in full compliance with all sections of Title 10, Part 20 of the Code of Federal Regulations.

A. Waste Disposal

Disposal of all radioactive wastes are conducted in full compliance with all Federal, State and local regulations.

B. Reporting of Incidents

AEC will be notified of any significant incident or loss of licensed materials as required in Title 10, Part 20, Code of Federal Regulations.

ATTACHMENT 1

OPERATION MANUAL FOR
MODEL 402 GAMMA RAY PROJECTOR



TECHNICAL

OPERATIONS

INCORPORATED

SOUTH AVENUE • BURLINGTON • MASSACHUSETTS

TELEPHONE BURLINGTON 7-2261

OPERATION MANUAL FOR
MODEL 402
GAMMA RAY PROJECTOR

NOTE

Do NOT attempt to set up or operate this machine
without reading this Operation Manual.

DESCRIPTION

The Technical Operations' Model 402 Gamma Ray Projector consists of three basic assemblies:

1. The cabinet contains a lead filled steel shell to shield the gamma ray emitting source and provides storage space for the control cable, source tube and control unit. Wheels and lifting eyes are provided for easy transport. The door of the cabinet has a lock to prevent unauthorized use.

2. The control unit consists of a source cable control unit and a battery-operated electrical signal system to indicate source position. It is connected to the source storage shield with three parallel cables. One is an electrical cable connected to the source position switches. The other two are housings for the flexible cable. The flexible cable engages a hobbled wheel in the control unit and is actuated by rotating a crank.

3. The source tube is a flexible metallic hose consisting of three sections. One section (7 feet) is attached to the source storage shield. Two extension sections may be coupled to this to extend the range of the source from the cabinet to 21 feet. The source position switch (Part No. 40205) is used on the extreme end of the source tube. This source position switch must be used in all machine applications. It contains electrical contacts which are closed when the source is correctly positioned within it. Refer to Figure 1 to identify the parts of this unit and to Figure 2 which is a schematic diagram of the Gamma Ray Projector.

UNCRATING

The unit is shipped in a wooden crate on skids. Remove the crating and lift the unit off the skid.

Open the door of the cabinet. Keys will be found with the packing slip. Remove the packing material and the control unit. Examine carefully for any damage that may have occurred in shipment. Check material against packing

list. Use Figure 1 of this Manual to identify parts. Any shortages or damaged material should be reported to Technical Operations immediately.

PREPARATION FOR USE

This unit is shipped with the source tube removed and a shipping plug is installed in its place. This shipping plug is fastened in place with two screws and sealed with a tamperproof seal. To prepare the unit for use, first remove the source control unit from the cabinet. The shipping plug should then be removed by cutting the wire of the tamperproof seal and removing the two bolts which hold it in place. Install the flanged source tube over the exit tube of the shield in place of the shipping plug. Socket head cap screws and wrench are provided. Couple to this first section of source tube one or two source tubes as required. Affix the source position switch to the end of the source tube and connect the source position switch lead (red wire) at the switch, at each source tube section junction and at the shield. Test this by pulling the tip of the source position switch. This closes the contacts in the switch and should cause the "ON" light on the control unit to flash.

Do not operate the unit without the source tube or without the source position switch in place. Failure to observe this may permit the source and source cable to be completely ejected from the unit.

OPERATION

Do not attempt to operate this machine without a radiation measuring instrument. We recommend a gamma survey meter of the ionization chamber type that has a full scale range of at least 500 MR/HR. Geiger counters are, as a rule, unsatisfactory for this purpose.

Place the cabinet conveniently near the radiograph location. Place the conical tip of the source position switch at the position the source should occupy during exposure. The source position switch should be clamped or supported in this position so that it cannot move during exposure. Locate the control box as far from the cabinet as is practicable. Easiest operation will be obtained if the

connecting cables and source tube are laid in straight lines without twist or with the longest practicable radius bends.

The source is actuated by turning the crank in a counter clockwise direction. Turn steadily at about 60 R. P. M. If undue resistance is encountered, reverse direction of cranking until the unit operates smoothly. DO NOT FORCE THE CRANK.

When the source reaches the source position switch, it enters the tip of the switch, pushing it outward and indicating that the unit is "ON". An "OPEN" indication means that the source has started to leave the safely stored position. "SAFE" indication means that the source is fully retracted within the storage container.

When the exposure is completed, retract the source by turning the crank clockwise until indication of safe storage is obtained.

The operator should use a survey meter or other rate indicating devices to measure the radiation when the unit is "ON" or in "OPEN" position.

Normally the radiation level 25 feet from the unshielded, exposed source will be about 22 milliroentgens per hour per curie of cobalt 60.

Absorbing or scattering materials will affect this reading. It may be necessary for the operator to move away from the unit when exposures are made so as not to exceed the maximum prescribed operating dose of 300 milliroentgens per week.

The operating dose should be determined by a personnel monitoring film badge or pocket dosimeter.

MAINTENANCE

The Technical Operations' Model 402 Gamma Ray Projector is designed to operate with a minimum of maintenance. Regular inspection of the unit for signs of damage to the connecting cables and source tube is recommended. Do not attempt to operate the unit if cables or tubes should become crushed or cut.

LUBRICATION

The Model 402 Gamma Ray Projector has been lubricated with a Texaco uni-temperature grease. Should further lubrication be necessary, use either the uni-temperature grease or a three-in-one spray oil. DO NOT USE GRAPHITE.

INDICATOR CIRCUIT

The indicator circuit is shown in Figure 3. It consists of a battery power supply and a relaxation oscillator circuit that causes the indicator lights to flash approximately twice per second. This type of circuit requires very little power and batteries should last about one year. The batteries may fail sooner if the unit is used in extreme cold. Replacement batteries (Burgess XX45 or equivalent) are available at all radio stores.

The lamps (type NE-51) are also available at most radio and appliance stores. Batteries may be changed by removing the cover of the control box located beneath the handle. See Figure 4. Note position of the batteries and their connections before removing. The replacement batteries should be placed in the same position. NOTE: Avoid touching the battery terminals as a moderate shock hazard exists.

SAFETY

Do not attempt to operate the unit without adequate distance from the exposed source to areas where personnel have access. Determine, with a survey meter of the ionization chamber type, the areas that must be denied during exposures. Personnel should not be exposed to fields greater than 7-1/2 mr/hr on a continuous basis (40 hour week) OR more than 300 mr in a week.

Typical radiation rates from a 4 curie cobalt 60 source are given below. These figures are for a source exposed in open space and do not include the reinforcing effect of scattering or the diminishing effect of absorbers that may be noticed when walls or structures are near the source.

<u>Distance from Source</u>	<u>Radiation in MR/HR</u>
5 feet	2200
10 feet	560
25 feet	88
50 feet	22

Personnel using the equipment or working near it should wear a film badge to provide a continual record of the radiation they receive.

"Pocket Dosimeters" allow exposed personnel to read at any time the total dose received.

The film badge service and monitoring instruments are described in the general catalog of Technical Operations, Incorporated.

WARRANTY

Technical Operations guarantees this equipment to be free of defects in material and workmanship for a period of one year from the date the equipment was received.

In the event the equipment described above proves, during the guarantee period, to be defective in material or workmanship Technical Operations will undertake to repair or replace the parts which prove defective.

Technical Operations does not assume any liability or responsibility for usage of the Cobalt 60. Any use of the Cobalt 60 other than that described in the Atomic Energy Commission Authorization Form 374 is forbidden without specific Atomic Energy Commission authorization.

SHIPPING INSTRUCTIONS

If unit is shipped by carrier subject to Interstate Commerce Commission, it must have the shipping plug installed and be crated. The outside of the container should be labelled "RADIOACTIVE MATERIAL" and be plainly marked "BUREAU OF EXPLOSIVES PERMIT NO. 143".

Pages 26 through 30 redacted for the following reasons:

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ATTACHMENT 2

OPERATION MANUAL FOR
MODEL 412 GAMMA RAY PROJECTOR

OPERATION MANUAL

for the

MODEL 412

Panoramic GAMMA RAY PROJECTOR

NOTE

**Read these instructions carefully
before attempting to set up or
operate this equipment.**

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I. DESCRIPTION

A. General

The Model 412 Panoramic Gamma Ray Projector is an advanced isotope handling unit developed to provide safe storage and accurate remote positioning of industrial radiographic sources.

Designed for use with Iridium 192 sources, the Model 412 features maximum operator protection, together with unusual flexibility of application. In use, the equipment positions the radioactive source at the end of a long, flexible tube, where its 360° (panoramic) radiation pattern may be used to full advantage, either for multiple specimen work or for circumferential exposure techniques. Positive mechanical control of the source and visual indication of its location is maintained at all times.

The relatively light weight of the equipment (when stored in its compact cabinet it is easily carried by two men) plus a battery-operated indicator system, make the Model 412 well-suited for field work as well as for permanent and semi-permanent installation. Provisions for safe replacement of the source in the field by the user make it unnecessary to return the unit periodically to the manufacturer for this purpose.

B. Specifications

1. Source Data

- a. Isotope: Iridium 192
- b. Source Dimensions: 1/8" dia. x 1/8" long
- c. Maximum Source Strength: 50 curies
- d. Shielding: Adequate to limit surface radiation to 2 milliroentgens per hour per curie.

2. Operating Specifications

- a. Maximum distance, Source Shield to Control Unit: 25 ft.
- b. Distance, Source Shield to exposure position: 7, 14 or 21 ft.
- c. Source Position Reproducibility: $\pm 1/16$ "

3. Physical Specifications

a. Weight

- 1) Source Shield, Control Unit and Control Cable: 145 lbs.
- 2) Complete equipment, packed in storage cabinet: 205 lbs.
- 3) Shipping Weight: 258 lbs.

b. Dimensions

(Storage Cabinet): 34" long x 12" high x 17" deep

C. Equipment Supplied

1. Source Shield with Control Unit (complete with batteries) and Control Cable.
2. Three 7-foot Source Tube sections (Part No. A-40209).
3. Source Switch (Part No. 40205).
4. Clamp (Part No. 40201-7).
5. Clamp Holder (Part No. 40201-8).
6. Tripod Stand. (Part No. 40201-9).

D. Accessory Equipment (available on order)

1. Iridium 192 Sources

<u>Catalog Number</u>	<u>Strength</u>
RS-1	1 curie
RS-2	2 curies
RS-4	4 curies
RS-10	10 curies
RS-20	20 curies
RS-40	40 curies

2. Dose Rate Meter (Victoreen Model 592). Ranges: 0-10, 0-100, 0-1000 mr/hr.
3. Dosimeter (Victoreen Model 541A). Range: 0-200 mr/hr.
4. Dosimeter Charger (Victoreen Model 561A).
5. Film Badge Service (T.O. No. FB-20).
6. Exposure Calculator (Catalog No. 426).

E. Construction Details

The Model 412 Gamma Ray Projector consists of three basic assemblies:

1. The Source Shield is a welded shell of 1/4" steel, containing approximately 115 lbs of lead. A curved channel through the center of the shield, which may be sealed by a metal plug for shipment or storage, houses the radioactive source. When the source is fully retracted into the shield it actuates a microswitch which causes the "SAFE" lamp on the control panel to flash. Built-in connectors at each end of the unit provide for attaching the Source and Control Tubes and electric cable.

2. The Control Assembly consists of a Control Unit and a 25 ft. composite control cable. The Control Unit contains the batteries and circuitry for the signal system which indicates source position. A hand-operated crank on one side of the unit permits the operator to move the source from the shield to its exposure position and back, from a remote position.

The Control Cable consists of three parallel sections. One is an electric cable which connects the signal circuit to the source position switches. The other two serve as housings for the flexible Drive Cable which, when actuated by a hobbled wheel connected to the hand crank, mechanically positions the source.

Three neon lamps, mounted on the top of the unit, flash to indicate whether the source is safely stored in the shield ("SAFE"), is in transit through the Source Tube ("OPEN"), or is in exposure position ("ON").

3. The Source Tube is a flexible, metallic hose consisting of one, two or three 7-foot sections, through which the source is moved by the Drive Cable. One end of the tube is connected to the Source Shield. At the other end is connected the Source Switch. When the source enters this switch, at the end of its travel, it closes a set of contacts which cause the "ON" lamp to flash at the Control Unit, indicating that the exact exposure position has been reached. (CAUTION: At no time should this equipment be operated without the Source Switch attached, or with more than three sections (21 ft.) of Source Tube connected to the shield.)

Parallel with each section of the Source Tube is an electric cable which serves to connect the Source Switch to the signal circuit.

II. OPERATING INSTRUCTIONS

A. Unpacking

The Model 412 Gamma Ray Projector is shipped in a wooden crate. After inspection for external signs of possible damage in shipment, the crate should be opened and the locked storage cabinet removed. Keys for the padlock will be found in an envelope taped to the storage cabinet cover. NOTE: The cabinet should be unlocked only by authorized personnel, trained in the handling of radioactive isotopes.

Unfasten the canvas securing straps and remove the Control Unit and the Control and Source Tubes, extending the latter to their full length. Remove the Source Shield. Examine all items carefully for any damage that may have occurred in shipment. Check the material included against the packing list, Using Figure 1 of this manual to identify parts. Any shortages or damage should be reported to Technical Operations immediately.

B. Preparation for Use

Locate the Source Shield at the desired distance from the specimens to be radiographed. Remove the shipping plug by cutting the seal wire and unscrewing the plug from the connector. Attach one section of the Source Tube in place of the plug, and add one or two additional sections if needed. The red signal cables should be connected together at each junction, and to the Source Switch and Source Shield at either end.

Attach the Source Switch to the end of the last section. The Control Unit should be located at the maximum distance (25 ft.) from the Source Shield, with the Control Tubes laid out as straight as possible. (Too many bends or a bend of small radius in either Control or Source Tubes may restrict the movement of the Drive Cable). Where practicable, it is recommended that the operator and Control Unit be located behind a protective shield, such as a concrete wall.

Mount the Source Switch firmly (using the tripod stand and clamp, or a permanent mounting jig) with the tip of the switch in the exact exposure position.

As soon as the signal cables are connected, the "SAFE" lamp on the Control Unit should begin flashing. The operation of the "ON" lamp should be checked at this point by pulling outward on the Source Switch tip.

C. Operating Procedure

(NOTE: This equipment should be operated only when monitored by a suitable radiation measuring instrument, in accordance with standard isotope handling practice. Technical Operations recommends a gamma survey meter of the ionization chamber type, having a full-scale range of at least 500 mr/hr. Geiger Counters are, as a rule, unsatisfactory for this purpose).

Turn the hand crank steadily in a counter-clockwise direction to move the source out of the Source Shield toward the exposure position. If undue resistance is encountered, reverse direction of cranking until the unit operates smoothly. DO NOT FORCE THE CRANK. If, after several reversals, cranking is still difficult, return the source to the "SAFE" position (by cranking clockwise) and check the Source Tube and Control Cables for bends which may be too sharp.

When the source leaves the "SAFE" position in the Shield, the "OPEN" lamp flashes on the Control Unit. This lamp continues to flash until the source enters the tip of the Source Switch. As it reaches exposure position, the "ON" lamp will begin to flash.

The operator should monitor the activity with a survey meter at all times when the source is in "OPEN" or "ON" position. Normally the radiation level at a distance of 25 feet from the exposed source will be about 9.2 milliroentgens per hour per curie of Iridium 192, although absorption or scattering effects of nearby materials may affect this value. It may be necessary for the operator to move away from the Control Unit while exposures are being made, to avoid exceeding the maximum prescribed dose of 300 mr/week.

The exposure time required for a given specimen will be a function of the specimen material and thickness, the source-to-film distance, and the strength of the source in curies. The time may be computed (when the exposure factor is known) by the relation,

$$\text{Exposure time (minutes)} = \frac{\text{exposure factor} \times (\text{source-to-film dist.})^2}{\text{strength of source (millicuries)}}$$

where the source strength may be estimated from the Iridium 192 decay curve (Fig. 5). For rapid, convenient calculation of exposure time, Technical Operations offers a slide-rule-type calculator for radiography with Iridium 192 sources.

When the exposure is completed, retract the source by turning the crank clockwise until "SAFE" storage is indicated.

III. MAINTENANCE

A. General

The Model 412 is designed to operate with a minimum of maintenance. Regular inspection is recommended for signs of damage to the Control Cables and Source Tube. Do not attempt to operate the equipment if cables or tubes should become crushed or cut.

B. Source Replacement

The equipment is designed so that the source replacement may be safely accomplished by the user in the field. By arrangement with Technical Operations, renewal sources will be shipped, either at regular intervals (dictated by the half-life of the source) or on individual order.

Shipment of renewal sources is made in a specially-designed shielded container. This container has two separate source pockets, one containing the renewal source and the other empty. The old source is simply cranked through the Model 412's Source Tube into the empty pocket and decoupled from the Drive Tube (in accordance with instructions furnished with the container). The new source is coupled in its place and retracted into the Source Shield.

C. Lubrication

Lubricate the inside of each Source Tube section, as needed with no more than a pinch of dry graphite. Do not use oil or grease, which may break down into corrosive or tar-like compounds in the presence of the strong radiation field around the source. No other lubrication is required.

D. Signal Circuit

The Signal Circuit consists of a battery power supply and a relaxation oscillator circuit which causes the indicator lights to flash approximately twice a second. This type of circuit requires very little power, and batteries should last for about a year. Replacement batteries (Burgess XX45 or equivalent) are available at all radio stores.

The neon indicator lamps (type NE-51) are also available at most radio and appliance stores.

Access to the batteries may be obtained by removing the Control Unit cover, located beneath the handle. (See Fig. 4). Before removing the batteries, note their relative positions and the locations of the connecting leads. The new batteries should be replaced in an identical manner. (Note: avoid touching the battery terminals, as a moderate shock hazard exists.)

IV. SAFETY

The Model 412 is designed to afford the operator maximum protection from radiation. However, normal precautions, consistent with accepted isotope handling practices, must be observed at all times in operating this equipment.

1. Every precaution should be taken to insure adequate distance between the exposed source and areas accessible to personnel. Prohibited areas should be determined with a survey meter, and should be plainly marked.
2. Personnel should not be exposed to fields greater than 7-12 mr/hr on continuous basis (40-hour week) OR more than 300 mr in any one week.
3. Personnel using the equipment or working near it should wear a film badge to provide a permanent, running record of the radiation dosage received.
4. Pocket Dosimeters, which allow exposed personnel to read, at any time, the total dose received, are also recommended.

WARRANTY

The product is guaranteed by us to be free from defects of manufacture subject to the following:- Our responsibility under this warranty is limited solely to replacement of any or all defective parts for a period of one year after delivery. This warranty does not apply if the defect has been produced through misuse, alteration or abnormal conditions of operation. The warranty is limited solely to the workmanship and materials in the product and shall not extend in any way to the uses to which it may be put or as to its suitability for such uses.

WAIVER

By accepting delivery of the product, you agree that we shall not be liable to you or anyone claiming through you with respect to any claims for injuries alleged to be due to the use of the product. We sell the product on the condition that we shall not be liable for any claims for injuries alleged to be due to the use of the product whether or not such use is in accordance with instructions given by or referred to by us.

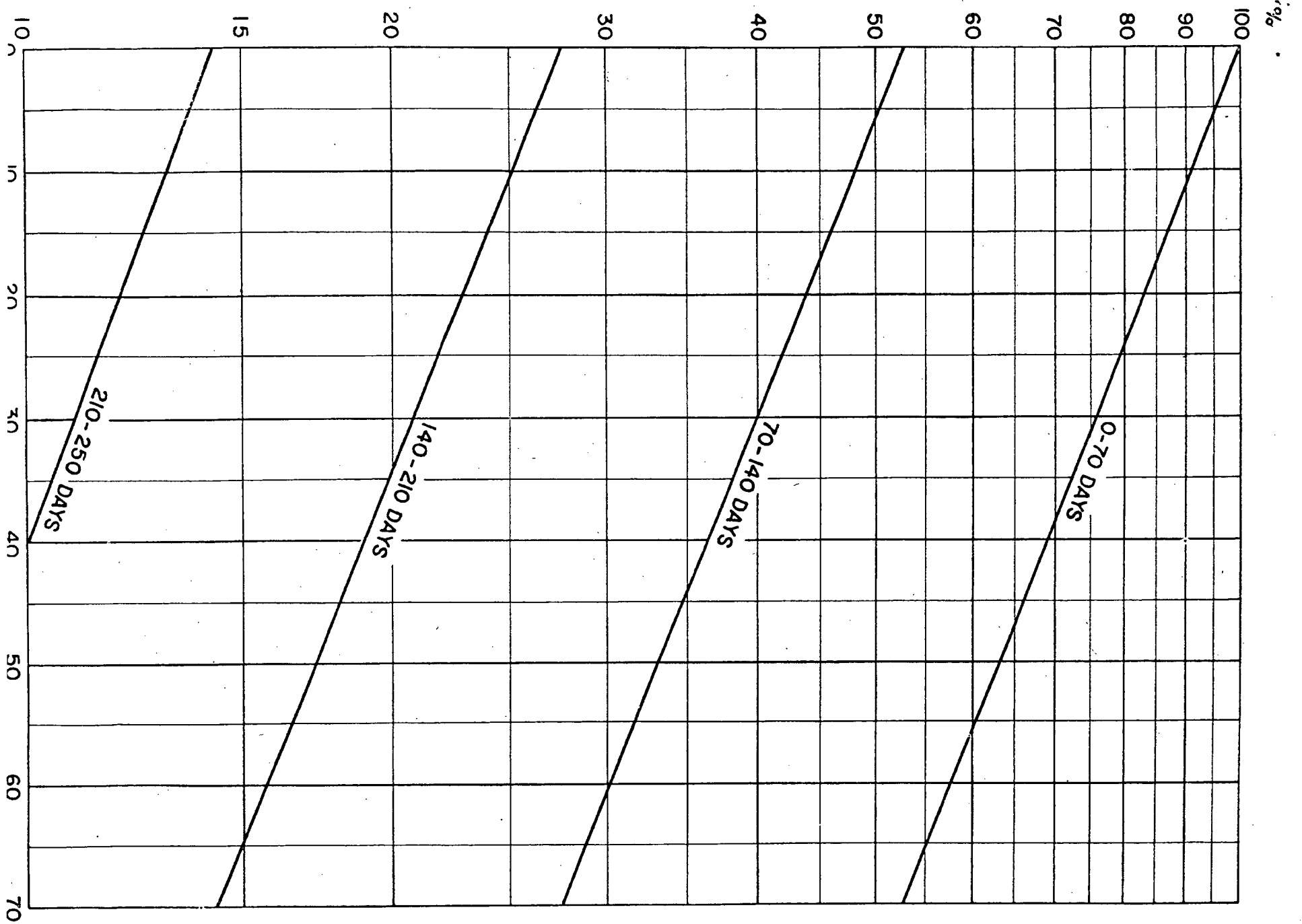
VI. SHIPPING INSTRUCTIONS

If this equipment is to be shipped by a carrier subject to Interstate Commerce Commission, it must have the shipping plug installed and must be crated. The outside of the container should be labelled "RADIOACTIVE MATERIAL" and be plainly marked "I.C.C. 55". Standard shipping labels are available for this purpose and it is recommended that they be used. The container or shield holding the source must be securely locked.

Pages 43 through 46 redacted for the following reasons:

(b)(4)

PERCENTAGE OF ORIGINAL STRENGTH



IRIDIUM DECAY CHART - BASED ON 75 DAY HALF LIFE

Pages 48 through 50 redacted for the following reasons:

(b)(4)

IMPORTANT

Observe these precautions when changing sources.

1. NEVER attempt to release coupling with any tool other than the release tool furnished. Release tool fits the grooves of the connector. Hold the release tool so that the index finger can press the connector against the release tool as shown in the illustration.
2. If the connector is clogged with dirt the spring may not engage the groove in the mating part. Clean, if necessary, with gasoline or carbon tetrachloride.
3. When source and connector are engaged be sure spring of connector has dropped into groove of the mating part. Test for proper engagement by pulling between source assembly and connector.

CAUTION Do not allow source assembly to be withdrawn more than $\frac{1}{2}$ inch from the storage container while testing for proper engagement.

ATTACHMENT 3

OPERATION MANUAL FOR THE
MODEL 414 IRIIDIUM 192 SOURCE CHANGER

ATTACHMENT 4

Co 60 SURVEY IN THE
RADIOISOTOPES LABORATORY

Page 54 redacted for the following reason:

(b)(4)

19-1398-19

Form AEC-313
(5-58)

ATOMIC ENERGY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE

Form approved.
Budget Bureau No. 38-R027.3.

INSTRUCTIONS.—Complete Items 1 through 16 if this is an initial application. If application is for renewal of a license, complete only Items 1 through 7 and indicate new information or changes in the program as requested in Items 8 through 15. Use supplemental sheets where necessary. Item 16 must be completed on all applications. Mail three copies to: U. S. Atomic Energy Commission, Washington 25, D. C. Attention: Isotopes Branch, Division of Licensing and Regulation. Upon approval of this application, the applicant will receive an AEC Byproduct Material License. An AEC Byproduct Material License is issued in accordance with the general requirements contained in Title 10, Code of Federal Regulations, Part 30 and the Licensee is subject to Title 10, Code of Federal Regulations, Part 20.

1. (a) NAME AND STREET ADDRESS OF APPLICANT. (Institution, firm, hospital, person, etc.)

THE MARTIN COMPANY
Baltimore 3, Maryland

Attn: Mr. R. G. Macaulay
Licensing Officer

(b) STREET ADDRESS(ES) AT WHICH BYPRODUCT MATERIAL WILL BE USED. (If different from 1 (a).)

Middle River Plant
Middle River, Maryland

2. DEPARTMENT TO USE BYPRODUCT MATERIAL

Isotope Power Department
Nuclear Division
The Martin Company

3. PREVIOUS LICENSE NUMBER(S). (If this is an application for renewal of a license, please indicate and give number.)

Twelve Byproduct Material Licenses are currently in effect.

4. INDIVIDUAL USER(S). (Name and title of individual(s) who will use or directly supervise use of byproduct material. Give training and experience in Items 8 and 9.)

Carie E. Hollens
Engineer

5. RADIATION PROTECTION OFFICER (Name of person designated as radiation protection officer if other than individual user. Attach resume of his training and experience as in Items 8 and 9.)

Paul R. Guinn - See Resume Submitted With Martin Application Dtd. 11/13/57
Re: License No. 19-1398-9, Amend. No. 2

6. (a) BYPRODUCT MATERIAL. (Elements and mass number of each.)

Any byproduct material having Atomic Number between 3 and 83, inclusive.

(b) CHEMICAL AND/OR PHYSICAL FORM AND MAXIMUM NUMBER OF MILLCURIES OF EACH CHEMICAL AND/OR PHYSICAL FORM THAT YOU WILL POSSESS AT ANY ONE TIME. (If sealed source(s), also state name of manufacturer, model number, number of sources and maximum activity per source.)

A maximum of 15 grams of irradiated Hastelloy C - 500 millicuries (See attachment for composition of Hastelloy C).

7. DESCRIBE PURPOSE FOR WHICH BYPRODUCT MATERIAL WILL BE USED. (If byproduct material is for "human use," supplement A (Form AEC-313a) must be completed in lieu of this item. If byproduct material is in the form of a sealed source, include the make and model number of the storage container and/or device in which the source will be stored and/or used.)

15 grams of Hastelloy C (consisting of three pieces @ approximately 4½ grams and one piece @ .1455 grams) will be shipped to Brookhaven National Laboratory, there to be irradiated in a reactor for a period of approximately nine days. After a cooling period of about fourteen days, the pieces will be returned to The Martin Company in a 2 inch lead pig. The pieces thus irradiated will then be immersed in beakers containing sea water in order to study the effects of corrosion on Hastelloy C.

DUPLICATED 20859

TRAINING AND EXPERIENCE OF EACH INDIVIDUAL NAMED IN ITEM 4 (Use supplemental sheets if necessary)

B. TYPE OF TRAINING	WHERE TRAINED	DURATION OF TRAINING	ON THE JOB (Circle answer)	FORMAL COURSE (Circle answer)
a. Principles and practices of radiation protection	See License Application dtd. 9/3/58 Re: Amendment No. 3 to Byproduct Material License No. 19-1398-10A60.		Yes No	Yes No
b. Radioactivity measurement standardization and monitoring techniques and instruments			Yes No	Yes No
c. Mathematics and calculations basic to the use and measurement of radioactivity			Yes No	Yes No
d. Biological effects of radiation			Yes No	Yes No

9. EXPERIENCE WITH RADIATION. (Actual use of radioisotopes or equivalent experience.)

ISOTOPE	MAXIMUM AMOUNT	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
		See License Application referred to in number 8 above.		

10. RADIATION DETECTION INSTRUMENTS. (Use supplemental sheets if necessary.)

TYPE OF INSTRUMENTS (Include make and model number of each)	NUMBER AVAILABLE	RADIATION DETECTED	SENSITIVITY RANGE (mv/hr)	WINDOW THICKNESS (mg/cm ²)	USE (Monitoring, surveying, measuring)
See list submitted with Martin Application dated September 22, 1958					

11. METHOD, FREQUENCY, AND STANDARDS USED IN CALIBRATING INSTRUMENTS LISTED ABOVE.

See Application referred to in number 10 above.

12. FILM BADGES, DOSIMETERS, AND BIO-ASSAY PROCEDURES USED. (For film badges, specify method of calibrating and processing, or name of supplier.)

See Application referred to in number 10 above.

INFORMATION TO BE SUBMITTED ON ADDITIONAL SHEETS

13. FACILITIES AND EQUIPMENT. Describe laboratory facilities and remote handling equipment, storage containers, shielding, fume hoods, etc. Explanatory sketch of facility is attached. (Circle answer) Yes No See Attachment

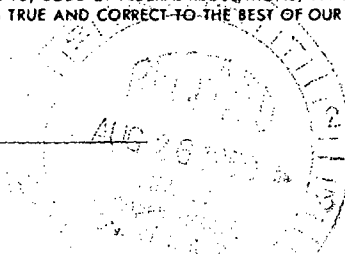
14. RADIATION PROTECTION PROGRAM. Describe the radiation protection program including control measures. If application covers sealed sources, submit leak testing procedures where applicable, name, training, and experience of person to perform leak tests, and arrangements for performing initial radiation survey, servicing, maintenance and repair of the source. See Application referred to in number 10 above.

15. WASTE DISPOSAL. If a commercial waste disposal service is employed, specify name of company. Otherwise, submit detailed description of methods which will be used for disposing of radioactive wastes and estimates of the type and amount of activity involved. Same as number 10 above.

CERTIFICATE (This item must be completed by applicant)

16. THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATE ON BEHALF OF THE APPLICANT NAMED IN ITEM 1, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PART 30, AND THAT ALL INFORMATION CONTAINED HEREIN, INCLUDING ANY SUPPLEMENTS ATTACHED HERETO, IS TRUE AND CORRECT TO THE BEST OF OUR KNOWLEDGE AND BELIEF.

Date August 25, 1959



THE MARTIN COMPANY

Applicant named in item 1

By: *Ross G. Macaulay*

Ross G. Macaulay
Licensing Officer

Title of certifying official

WARNING.—18 U. S. C., Section 1001; Act of June 25, 1948; 62 Stat. 749; makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

Attachment to Byproduct Material License Application Dated August 25, 1959

6.(b)

Composition of Hastelloy C

Ni	-	54%
Co	-	2.5%
Cr	-	14.5% - 16.5%
W	-	3.0% - 4.5%
Fe	-	4% - 7%
Si	-	1%
Mn	-	1%
C	-	.08%
Va	-	.35%
P	-	.04%
S	-	.03%

13. FACILITIES AND EQUIPMENT

Extension tongs will be used for transferring pieces of Hastelloy C from lead pigs to the beakers containing sea water. The beakers, in turn, will be shielded by 2 inch lead bricks.

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FOR DIV. OF INSP.

20859