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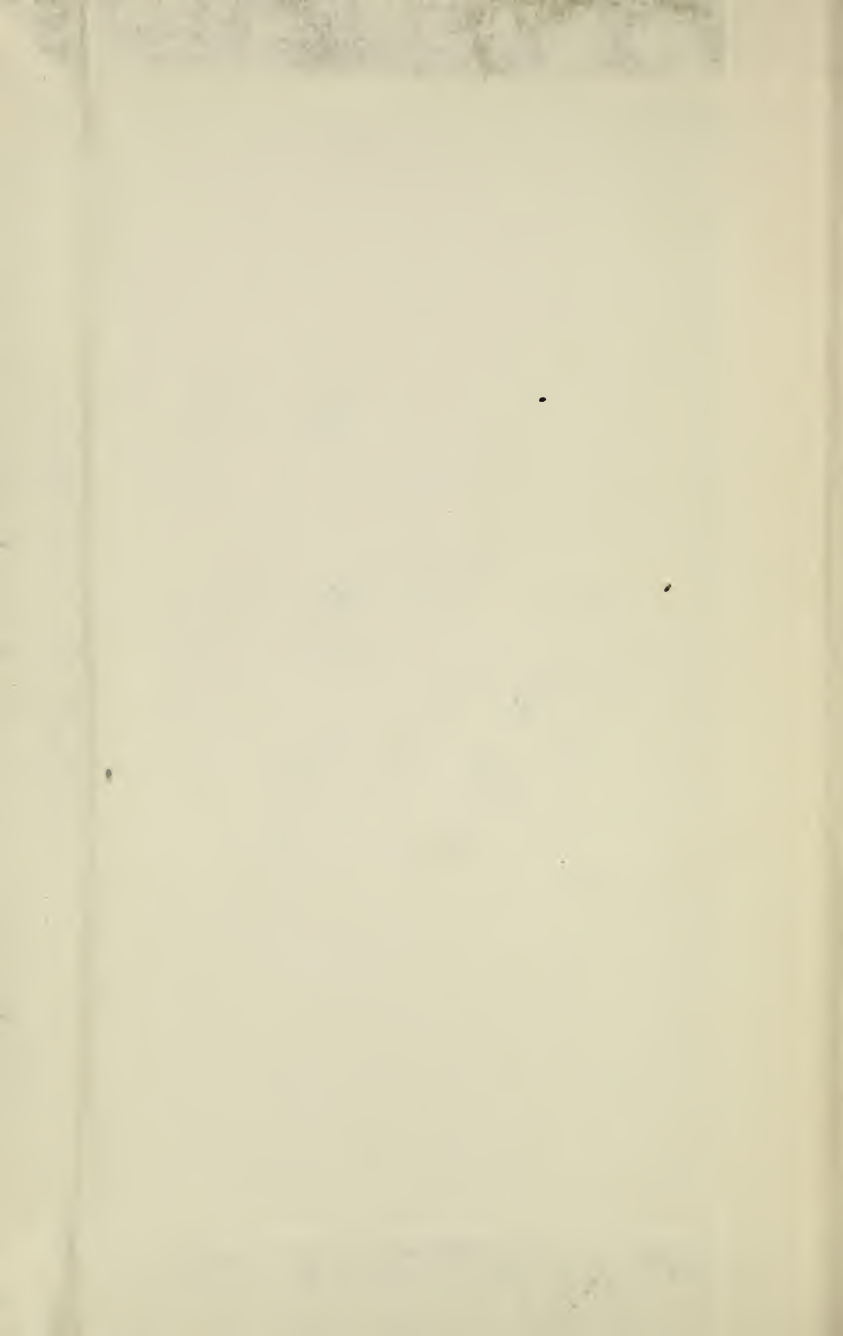
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U. S. DEPARTMENT OF COMMERCE  
NATIONAL BUREAU OF STANDARDS

SAFE HANDLING OF  
RADIOACTIVE LUMINOUS  
COMPOUND

NATIONAL BUREAU OF STANDARDS HANDBOOK H27

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WASHINGTON, D. C.

U. S. DEPARTMENT OF COMMERCE

JESSE H. JONES, Secretary

NATIONAL BUREAU OF STANDARDS

LYMAN J. BRIGGS, Director

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National Bureau of Standards Handbook H27

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**SAFE HANDLING OF  
RADIOACTIVE LUMINOUS  
COMPOUND**

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Issued May 2, 1941



UNITED STATES  
GOVERNMENT PRINTING OFFICE  
WASHINGTON : 1941





## PREFACE

The manufacture and application of radioactive luminous compound expose the technicians and painters engaged in this work to serious hazards. In the early days of the industry in this country, the nature of these hazards was not understood and cases of severe "radium poisoning" resulted. This led to several investigations which made clear the causes of radium poisoning and indicated protective measures by which it could be prevented. As a result of protective measures which were subsequently employed, no new cases of injury among workers in this field have come to light in recent years. It seems reasonable to conclude that the manufacture and application of radioactive luminous compound can be carried on without excessive risk to the individuals engaged in this work.

In recent months an increasing demand for luminous markings, principally on military equipment, has led to the expansion of existing dial painting plants and the opening of new plants, making it necessary to employ many additional workers in this industry. This situation has led organizations concerned with the dial-painting industry in this country to request the National Bureau of Standards to issue a handbook which would outline safe methods of handling radioactive luminous compound, similar to the handbooks on protection from X-rays and from radium, already published by this Bureau.

In preparing this handbook it was deemed advisable to follow a procedure somewhat similar to that employed in the preparation of earlier handbooks. An advisory committee, the members of which are listed below, was therefore invited to prepare the material for the handbook.

- L. F. CURTISS, chairman, representing National Bureau of Standards, Washington, D. C.
- R. D. EVANS, physicist, Massachusetts Institute of Technology, Cambridge, Mass.
- G. FAILLA, physicist, Memorial Hospital, New York, N. Y.

FREDERICK B. FLINN, director of Industrial Hygiene, Columbia University, New York, N. Y.

HARRISON S. MARTLAND, chief medical examiner of Essex County, Newark, N. J.

J. E. PAUL, representing U. S. Radium Corporation, New York, N. Y.

J. S. ROGERS, representing Division of Labor Standards, Department of Labor, Washington, D. C.

CAPT. CHARLES S. STEPHENSON (MC), representing Bureau of Medicine and Surgery, Navy Department, Washington, D. C.

G. T. TAYLOR, representing Radium Chemical Co., Inc., New York, N. Y.

The rules and suggestions regarding safe methods of manufacture and application of radioactive luminous compound set forth in the following pages are recommended by the above committee.

I express to the committee my sincere thanks for their cooperation in the preparation of this handbook.

LYMAN J. BRIGGS, *Director.*

# SAFE HANDLING OF RADIOACTIVE LUMINOUS COMPOUND

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## I. GENERAL CONSIDERATIONS

Ia. RADIOACTIVE LUMINOUS COMPOUND.—The material known as radioactive luminous compound or “luminous material” or “radium paint” is a mixture of phosphorescent zinc sulfide and radium,<sup>1</sup> mesothorium, or other similar radioactive substance. It is usually packed in small glass bottles holding 1 gram of the compound. It is used to make markings that are visible in total darkness by virtue of the light emitted by the zinc sulfide under bombardment from the radium. This compound is mixed with an adhesive to form a “paint” just before its actual application.

Ib. HAZARDS IN HANDLING RADIOACTIVE LUMINOUS COMPOUND.—It is well known that serious injury and even death may result from injudicious handling of this compound. The known hazards may be classified in the order of their importance as follows:

- (1) Ingestion or inhalation of solid radioactive luminous compound.

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<sup>1</sup> Wherever radium or radon is mentioned in this handbook, equivalent quantities of mesothorium or thoron may be substituted to refer to conditions arising from the use of mesothorium as a component of the radioactive luminous compound.

- (2) Inhalation of radon liberated from compound into the air, and
- (3) Exposure of whole body to gamma radiation from compound.

These hazards may be described briefly as follows:

- (1) The most serious injuries in the past have resulted when the compound was taken directly into the body through the mouth or by inhalation. Experience during the last 15 years has shown that when due precautions are taken to prevent the compound entering the mouth or lungs of the worker no detectable injury has resulted.

This can be understood when it is borne in mind that the radium in the compound is responsible for the injuries produced by the ingestion or inhalation of the compound and that the maximum destructive effects are produced after the radioactive material has deposited in the bones. Therefore, the radium must first find its way into the blood stream, which can only occur in appreciable quantity through the mouth and lungs. A small fraction of each amount of radium taken into the body is deposited in cumulative amounts in the bones. In this way, over a period of years, a dangerous amount of radium may be accumulated in the skeleton as the result of a small daily absorption of the radium.

This accumulation of radium is a slow process, even when appreciable amounts of compound are ingested daily. It is not surprising, therefore, that no immediate injury or illness appears from the ingestion of the compound. Even after a dangerous amount of radium has been accumulated in the skeleton, the effects are slow in becoming evident. It is now known that when deposits of radium are large the damage is chiefly to the skeleton, followed by damage to the white and red blood corpuscles, resulting in a leucopenia or anemia or both. This has happened with deposits of from 12 to 100 micrograms of radium. Such large deposits should never occur if the recommendations of this handbook are followed. An unfortunate feature of this situation is that the radium which has once been deposited in the bones remains there almost indefinitely and cannot be removed readily by medical treatment. Consequently, once this condition has been estab-

lished there is little chance of restoring a normal condition in time to prevent serious effects. When small amounts of radium are deposited in the bones over a long period of time the chief effect is on the bone-forming cells, producing destructive and crippling bone conditions which may progress and become malignant, resulting in bone sarcoma.

*It is therefore essential to avoid all ingestion or inhalation of radioactive luminous compound and to test workers periodically for exhaled radon in the breath.* By this test, small deposits of radium can be detected long before clinical symptoms have appeared.

It is recommended that any worker who shows a deposit of more than 0.1 microgram of radium, as revealed by the expired air test, change his occupation immediately and be treated by decalcification therapy, or any other modality which may have been developed for the purpose.

(2) The continued inhalation of radon or thoron may produce carcinoma of the lungs and may also be a contributing factor in the anemia resulting from radium poisoning. The radon concentration in the atmosphere of workrooms shall not exceed  $10^{-11}$  curie per liter, according to present knowledge.

(3) The whole-body exposure of the worker to gamma radiation shall not exceed 0.1 roentgen per working day, according to present knowledge. This general exposure to gamma radiation has been found to be safe, as far as any bodily injury is concerned.

In connection with the three types of hazards enumerated above, it is important to bear in mind that the tolerances have been determined under conditions where only one hazard was present. In the dial-painting industry all three hazards exist together, and this may reduce the tolerance on each. Insufficient information is available at present to determine to what extent this may occur. *It is therefore important to keep well below the tolerances stated, to insure safety.*

IC.—PRINCIPLE UNDERLYING PROTECTIVE MEASURES.—From the foregoing discussion of the general nature of radium poisoning resulting from the improper handling of radioactive luminous compound, it is clear that the fundamental purpose

of any protective measures is to prevent the ingestion or inhalation of the compound during its manipulation. However, this seemingly simple requirement *must be rigidly and continuously adhered to by all workers*. Furthermore, working conditions must be arranged to provide a generally safe environment for the workers and to encourage their cooperation in carrying out rules intended to preclude any known possibility of injury. It is now known that this end may be achieved without reducing the output of the worker or interfering seriously with a normal working procedure. The situation may be summed up by stating that in the main the essential requirement is neat and orderly "housekeeping" which, under proper supervision, results in better working conditions, increased productivity, and safety for the individual worker.

All workrooms or places usually inhabited by workers shall be equipped with such ventilation as will reduce the radon content to a concentration not exceeding  $10^{-11}$  curie per liter. Cleanliness with respect to the use of the compound will also help in removing possible sources of radon. Special attention shall be given to means for preventing the spilling of compound, especially in the dry form. If accidental spilling does occur, all traces of spilled compound shall be cleaned up immediately.

The gamma-ray exposure can be controlled by permitting only small amounts of compound, either before or after application, to be present in the workrooms and by storing the compound in a lead-lined cabinet at as great a distance from the workers as possible.

**Id. HAZARDS IN HANDLING RADIUM AND LARGE STOCKS OF RADIOACTIVE LUMINOUS COMPOUND.**—Whenever luminous compound is manufactured or stored in large quantities there is a possibility of general exposure to gamma radiation in excess of the tolerance dose. Special precautions shall be employed to protect workers engaged in this work. Rules for safe procedures in such instances are contained in the National Bureau of Standards Handbook H23, entitled "Radium Protection." Workers engaged in compounding, weighing, and packaging large quantities of radioactive

luminous compound should familiarize themselves with the contents of Handbook H23.<sup>2</sup>

## II. PERSONNEL

IIa. SELECTION AND INSTRUCTION OF PERSONNEL.—The handling and application of luminous compound requires great care and special training to secure satisfactory results. For this reason alone, personnel must be selected with care. From the point of view of reducing hazards, it is also important that only workers who are naturally neat and careful should be employed. Continued carelessness or untidiness in handling material during the preliminary training period shall be reason for dismissal. A rigid physical examination shall be made of all prospective workers. No applicant who is not in good health or who has shown a history of such diseases as anemia or tuberculosis shall be considered suitable for this work. Persons whose eyesight cannot be corrected properly by glasses are also unsuitable.

*Before an individual is employed he shall be informed in detail of all known dangers involved. He shall be instructed regarding rules and regulations which have been set up for his protection and he shall be directed to observe them in all details. It is suggested that those engaged in handling radioactive luminous compound familiarize themselves with the recommendations of this handbook.*

IIb. EFFECTS OF RADIUM POISONING.—Since radium taken into the human body is partly retained and stored mainly in the bones, the effects are chiefly injury to the bones. Characteristic results of radium poisoning are bone necrosis and osteogenic sarcoma. Accompanying these effects is a general lowering of vitality, so that resistance to ordinary diseases is lower. All of these conditions appear only after dangerous amounts of radium have been stored in the bones over a period of years. Therefore, there are no definite clinical symptoms which can be relied upon to guard against possible injury.

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<sup>2</sup> Obtainable from Superintendent of Documents, Washington, D. C., price, 10 cents.

### IIc. BLOOD COUNT.

IIc-1. It is important that a complete blood count be made by a skilled hematologist before any individual begins work involving the handling of radioactive luminous compound. No one shall be employed in this work who shows pertinent abnormalities in the blood count. The first blood count is also valuable to the hematologist as a reference index for subsequent blood counts.

IIc-2. Although blood counts cannot be relied upon to indicate the initial stages of radium poisoning, they shall be made a part of the regular physical examination of all workers. More attention must be given to the trend of successive counts on the same individual than to absolute values. For proper interpretation, all counts should be made by the same hematologist and under the same conditions. Any pertinent abnormality, particularly leucopenia, relative lymphocytosis, or beginning anemia, which is persistent or increasing should be reason for careful investigation and possible change of occupation of the individual concerned.

### IIId. PHYSICAL EXAMINATIONS.

IIId-1. A thorough medical and dental examination shall be made of each individual before employment and at least once each year, preferably twice a year, and more often if practicable, after entering upon dial painting. In this examination, particular attention should be paid to the teeth, jaws, and bones in general.

IIId-2. An examination for possible radioactivity by a person with special knowledge and equipment shall be given each applicant and form a part of the periodic physical examination. This radioactive test shall consist in, or include, a measurement of the radon content of the expired air. *No one shall be engaged as a dial painter who shows more than 0.1 microgram of deposited radium, as revealed by the expired air test.* This corresponds to 1 micro-microcurie of radon per liter of expired air. If, after employment, any operator shows a radon content of the exhaled air of this amount, a complete investigation shall be made at once to determine the cause. It requires several hours for the radon inhaled in the workroom to become dissipated. If radon is present in the breath after the worker has been away from the work-



room for at least 12 hours, it is most likely due to radium deposited in the body. If on investigation the concentration of radon in the exhaled air is equal to or greater than the amount stated above and is found to arise from radium deposited in the body, the operator shall change his occupation at once.

IIe. PERSONAL CLEANLINESS.—Radioactive luminous compound must be treated as any other poisonous substance. Therefore, the worker must develop habits of extreme personal cleanliness in the workroom. The compound must not be spilled or scattered, and it must not come in contact with the hands or clothing to any appreciable extent. At the end of the working period, the hands shall be carefully washed with the solvent for the particular adhesive used. This shall be done in such a way as to remove all traces of compound. When mixed with adhesive the compound is not readily removed by soap and water. No edibles of any kind, including chewing gum, candy, or beverages, shall be brought into the workroom, nor shall they be touched before removing all traces of compound from the hands. A convenient method of inspection to determine whether the hands and clothing are free of compound consists in viewing them in a darkroom by means of light from an argon bulb. The worker shall perform this inspection regularly under supervision, whenever leaving the workroom.

IIIf. NEATNESS IN THE WORKROOM.—The skill required for application of luminous compound demands neat and orderly methods of procedure. Therefore a skillful worker may be expected to keep all utensils and equipment in a neat and clean condition at all times. Compound shall not be permitted to accumulate, and all utensils shall be left clean at the end of each working period.

IIg. TIPPING OF BRUSHES.—In some cases very fine markings are coated with radioactive paint, requiring a fine tip on the brush. This should be achieved by the selection of a proper size and shape of brush and by manipulation of the brush in the container for the mixed paint. *At no time shall the brush be pointed by the lips or fingers.* It is essential that the adhesives contain solvents or a substance which are distasteful to prevent the habit of pointing brushes between

the lips. Experience has shown that the latter practice has been largely responsible for many of the fatalities which have occurred in the past.

III. SUPERVISION OF PERSONNEL.—Dial painters and others engaged in handling luminous compound shall be under constant and competent supervision to make sure that all recommended practices are strictly followed. It shall be the supervisor's duty to inspect utensils and equipment for neatness and cleanliness, and to examine the worker's hands at the end of working periods and after washing. This should be done under an argon bulb to see that all compound has been removed. Rules regarding bringing food, candy, chewing gum, or beverages into the workroom shall be strictly enforced. The supervisor shall also inspect, daily, rest rooms and lunchrooms (if available on the premises) to make certain that cleanliness is maintained and that no articles contaminated with luminous compound find their way into these rooms.

### III. WORKROOMS AND EQUIPMENT

IIIa. GENERAL WORKING CONDITIONS.—The application and handling of radioactive luminous compound require workrooms and equipment specially designed for the purpose. No work shall be undertaken in these rooms other than that strictly concerned with the application of the luminous compound. There shall be ample space (at least 12 square feet) for each worker. Overcrowding may readily lead to unsafe conditions. Natural daylight shall be used to the fullest extent for illumination and supplemented by artificial light when necessary.

IIIb. FLOORS.—The floors shall have smooth, continuous surfaces, as far as possible, such as painted concrete or linoleum. Wood floors, with inevitable cracks, should be avoided. Only in this way can luminous compound which has been accidentally spilled be prevented from accumulating in the floors to an extent where it may present a hazard. Floors shall be cleaned daily by wet mopping to remove dust without distributing it over the room. No dry sweeping shall be permitted in rooms where radioactive luminous compound is handled.

IIIc. WALLS, CEILING, AND WOODWORK.—Walls, ceiling, and woodwork should be well painted with a semigloss paint which may be washed occasionally to remove accumulation of dust.

IIIId. ILLUMINATION.—Artificial illumination shall be used to supplement natural daylight in order to provide a minimum of 50 foot candles of diffused light on the working plane.

IIIe. VENTILATION.—*General forced ventilation shall be provided for all workrooms and dark rooms, so that the radon content of the air does not exceed  $10^{-11}$  curie per liter at any place at any time.* The weighing, compounding, and bottling of luminous compound shall always be done under appropriately designed hoods with suction ventilation to the outside air. Operators engaged in weighing, compounding, and bottling of luminous compound shall wear respirators of the "supplied-air" type approved by the U. S. Bureau of Mines for such exposure. All ventilating fans shall be arranged so that they may be speeded up to three times their normal revolutions per minute for 20 minutes before and after each working period to remove dust and radon which may have accumulated in the ducts and in the air of workrooms.

IIIIf. DARK ROOMS.—Ventilated dark rooms for inspecting finished work shall be kept clean and free from scattered luminous compound. Painted objects shall be inspected in small lots. A weekly inspection with an argon lamp shall be made for the presence of possible accumulation of compound. Ventilation of dark rooms shall meet the requirements specified in section IIIe.

IIIg. CONTAINERS FOR MIXED PAINT.—Suitable containers shall be provided for mixing the luminous compound with the adhesive. They shall be of convenient form and have a capacity just large enough so that the contents of a 1-gram bottle of compound can be mixed without danger of spilling the compound. These containers shall have a broad base in order that they may not be easily upset, and they shall be heavy enough so that the compound and adhesive can be mixed without holding the container by hand. The form of the container shall provide convenient means for pointing the brush and removing excess paint before removing the

brush from the container. The inner surface shall be smooth, glazed, and with no sharp corners, to provide for ready cleaning.

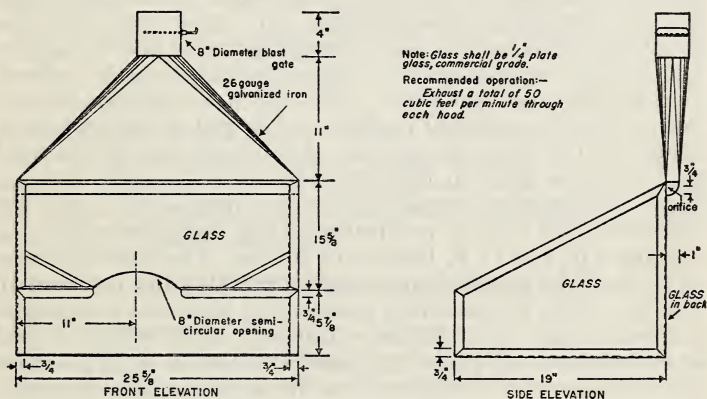
IIIh. METHOD OF APPLICATION.—Best results are obtained when brushes of suitable shape and size are used for applying the luminous paint. It is the consensus of the Committee which prepared this handbook that no dry method of application, such as dusting luminous powder on applied adhesive, has yet been devised which is safe. Therefore, none of the existing methods of dry application should be permitted in any application plant.

IIIi. BRUSHES.—A convenient rack shall be provided for brushes not in use at the moment so that they will not be placed on the table top, causing the bristle portion of the brush to come in contact with anything about the work table. Solvents in a suitable container and small wiping papers for cleaning the brushes shall be provided. These wiping papers shall be used only once and then be placed in covered containers. The containers for discarded wipers shall be removed at least once each day and the contents permanently disposed of, outside the workrooms, by burning or returning to the manufacturer of luminous compound for reclaiming the radium. *Cloth is not suitable for wiping and pointing brushes and shall not be used.*

IIIj. TABLES.—The tables used for dial painting, weighing, and other manipulations of luminous compound shall have a glazed porcelain surface or other smooth, continuous surface impervious to moisture and solvents used with the adhesive. There shall be no cracks, crevices, or sharp corners in which compound may accumulate. If provided with drawers, no luminous compound shall be stored in these drawers and no edibles of any kind placed in them. The drawers should be small to permit easy inspection, which should be made each week.

It is advisable to provide local ventilation at each work table. This removes radon and dust from radioactive luminous compound at the source and also serves to increase the general ventilation of the workroom. A convenient method of accomplishing this local ventilation at the work table is illustrated in figure 1, which is a detailed drawing of the

hood and accessory equipment. Other arrangements which will accomplish the same results undoubtedly are available, or can be devised. They should be given careful consideration in the design of any new installation for dial painting. *The installation of such arrangements as described does not of itself insure safety. If used, they shall be installed and operated in such a way that the concentration of radon in the air of the workroom does not exceed  $10^{-11}$  curie per liter at any place at any time.*



### RADIUM DIAL PAINTING HOOD

FIGURE 1.—Radium dial-painting hood.

IIIk. DIAL PAINTER'S EQUIPMENT.—On each individual painting table there shall be provided a porcelain or glass crucible and suitable holder for mixing compound with adhesive; a glass mixing rod; a small bottle or crucible of solvent for washing brushes and wiping any spilled particles of compound; wiping papers; the necessary brushes and suitable racks for holding them when not in use; and any other tools or devices designed specifically to facilitate the work. *No objects of any kind extraneous to the work shall be permitted on the work table.*

III. DRYING RACKS.—Racks for drying completed work, if painted work is to remain in the workrooms, shall be connected with a suction exhaust system to the outside air. This is to prevent the accumulation in the workroom of radon and of vapors from the drying adhesive. These vapors are unpleasant and under certain conditions may be toxic. Finished work shall be removed to drying racks promptly so that it does not accumulate near the painting table.

III<sub>m</sub>. REPAIR AND REPAINTING OF LUMINOUS ARTICLES.—Applied radioactive luminous compound is frequently removed preparatory to repainting. To avoid dust, luminous compound shall be removed by scraping under liquid. If this liquid is an organic solvent, gloves resistant to the solvent shall be provided and worn. This worn-out compound contains all of the original radium and is just as dangerous to handle as the fresh compound. Any operation of this kind that must be done in the dry state shall be done under a hood with suction ventilation to the outside air, and the operator shall wear a respirator of the "supplied-air" type approved by the U. S. Bureau of Mines. The recovered material shall be handled in accordance with rules outlined in this handbook for handling radioactive luminous compound. Containers, gloves, and other equipment used for the removal or reclamation of applied radioactive material shall be maintained in a clean condition, free from radioactive material when not in use.

III<sub>n</sub>. DISPOSAL OF EMPTY BOTTLES.—The 1-gram bottles in which the radioactive luminous compound is furnished to the dial painter shall be disposed of in a manner to preclude any possibility of harm to workers or other persons from the small amounts of compound which remain in the containers. If these bottles are to be returned to the manufacturer, they shall be carefully packed and returned at frequent intervals. They shall never be permitted to accumulate, and if they are to be destroyed, this shall be done under supervision to insure that this destruction is complete and is carried out at a spot remote from human habitation.

III<sub>o</sub>. STORAGE OF LUMINOUS MATERIAL.—Radioactive luminous compound shall be stored in a cabinet located at a sufficient distance from positions occupied by workers so that

the gamma-ray exposure for any worker does not exceed 0.1 roentgen per day. This cabinet shall be lined with lead at least  $\frac{1}{2}$  inch in thickness. All stock of luminous compound shall be stored in this cabinet and should be issued to the operators 1 gram at a time.

IIIp. **DRESSING ROOMS.**—Workers shall be provided with a dressing room where they may change from street clothes into working costume. Each worker shall be provided with two smocks so that one may be laundered, by the employer, each week. These are for use during working hours and shall not be worn or carried away from the plant by the workers. These smocks shall be left in the dressing room at the end of each day. Convenient facilities for washing, including solvent and hot water, shall be provided in the dressing room, and supervisors shall insist that the operators scrub their hands thoroughly at the end of each working period. Workers shall be provided with individual towels and soap. No working equipment of any kind shall be placed or stored in the dressing room.

#### IV. INSPECTION FOR HAZARDS

IVa. **SUPERVISOR.**—In every dial-painting plant or shop there shall be a well-trained supervisor whose duties and responsibilities include the inspection of personnel and equipment for possible hazards and the enforcement of safe practices. This supervisor should have available the handbook on Radium Protection, H23, published by the National Bureau of Standards, as well as the present handbook. The inspections outlined in the following paragraphs shall be made regularly by this supervisor at intervals as stated below.

IVb. **INSPECTION OF PERSONNEL.**—The hands, hair, and working costume of the personnel shall be examined at the end of each working period by means of an argon lamp in a darkroom for traces of luminous compound. This inspection is intended to reveal carelessness on the part of operators in removing compound at the end of working periods and to reveal any unsafe conditions which may result in compound accumulating on the hands, under fingernails, in the hair or clothing.

IVc. INSPECTION OF DRESSING ROOMS.—The dressing rooms, toilets, and washrooms shall be inspected every 6 months for traces of radioactive luminous compound, particular attention being given to lockers where work costumes are stored. Radon tests, as prescribed in section IIIe, shall be made in these rooms. If the radon content exceeds the adopted tolerance limit of  $10^{-11}$  curie per liter, a search shall be made by means of a Geiger-Müller counter to locate the contamination. This shall be removed at once.

IVd. INSPECTION FOR GAMMA-RAY EXPOSURE.—To determine the general gamma-ray exposure at points habitually occupied by workers a properly designed ionization or counter device shall be used, by a competent person. Such an instrument shall be sensitive enough and properly calibrated to measure gamma-ray intensities of the order of 0.1 roentgen per day. The exposure shall never exceed the rate of 0.1 roentgen per working day for any operator. In large plants where amounts of radioactive compound handled may vary rapidly, an automatic warning device which gives a visible and audible warning when the safe limit is reached, is helpful in controlling the gamma-ray exposure. The instrument should be tested and calibrated at least once every 6 months, to insure proper operation. In no case, however, should complete reliance be placed on any automatic device, for the protection of workers.

IVe. INSPECTION FOR RADIOACTIVE CONTAMINATION.—The radon content of the air in various workrooms of a dial-painting plant will give a general indication of the amount of contamination present. Test samples of air, taken by filling an evacuated glass bulb of about 1-liter volume and provided with glass stopcocks, shall be analyzed by a competent person at least every 6 months, and more frequently as conditions may indicate, such as accidental spillage of compound. If such tests reveal a radon content greater than  $10^{-11}$  curie per liter, a detailed inspection of the plant by means of a suitable Geiger-Müller counter, or other appropriate device, shall be made to locate the source of contamination. Floors, drying racks, work tables, and ventilation



ducts shall be given particular attention. Any accumulation of radioactive material thus revealed shall be removed at once.

## V. TRANSPORTATION

The shipment of radioactive luminous compound is restricted by common carrier because of the radium content. Postal regulations prohibit the shipment of radioactive material through the mails. Express companies will ship the compound when packaged and labeled in accordance with their regulations. Persons who desire to ship this compound are advised to consult the local representative of the express company regarding regulations imposed by the company for such shipments.

WASHINGTON, April 21, 1941.



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