1. Hammers, mauls and sledges.

2. Hatchets, axes, chisels.

3. Hand saws (rip and crosscut).

4. Lumberjack's (two man) crosscut saw.

5. Battens, wooden plugs, clamps.

6. Turnbuckles, chainfalls, jacks.

7. Mattresses, pillows, canvas and rope.

8. Bolts, nuts and washers.

9. Cutting and welding equipment.

10. Measuring battens, a six foot rule and carpenter's steel square.

11. Cement is also necessary for erection of a coffer dam.

C. Demonstrations.

1. Demonstrate the proper use of the measuring batten.

2. Demonstrate use of the carpenter's steel square to get correct angles on ends of shore.

3. Study diagrams in BUSHIPS Manual, Chapter 88, Section II, Part 13. Point out the principal types of shoring structures and how stresses are distributed. Give examples of poor and effective shoring techniques.

D. Preparation and Stowage of Shoring Material.

1. Keep full allowance of shoring material on hand. Use dunnage for instruction and drill purposes.

2. Never attempt to cut or prepare shores in advance of need.

3. Stow materials where easily accessible, in pockets between frames and girders and secured with lines or metal clips. Shoring must be secured so that it cannot break and must be easily removable when needed.

4. Wooden wedges should be made up into blocks by nailing a batten on their sides.

5. Plugs should be kept in a canvas bag secured to a beam or stanchion or stowed in metal boxes.

E. Emergency Shoring Material. In an emergency, any equipment aboard ship which will serve the purpose should be used to effect temporary repairs.

Metal plates, pipe, bars and I beams can be used for more semi-permanent shoring when there is time to weld it in place and a repair facility is not available. (See Section 7.7 USNS Marine carp for an example of temporary and semi-permanent repairs.)

V. SUMMARY.

A. Purpose of shoring - to support weakened structures, not to eliminate bulging.

B. Descriptive terms in shoring.

C. Rules for applying shoring.

D. Principal types of shoring structures.

E. Tools and equipment required for shoring.

F. Stowage and accessibility of shoring materials.

G. Emergency and semi-permanent repairs.

H. Reproduce and distribute the handout in VII or demonstrate the key points in the use of the carpenter's square in shoring.

VI. TEST AND APPLICATION.

A. Test. Use these and additional questions as an oral quiz:

1. Q. What is the purpose of shoring?
A. To offset metal fatigue, sagging or bulging; to strengthen weakened bulkheads and decks; and to support hatches, doors or equipment that has broken loose.

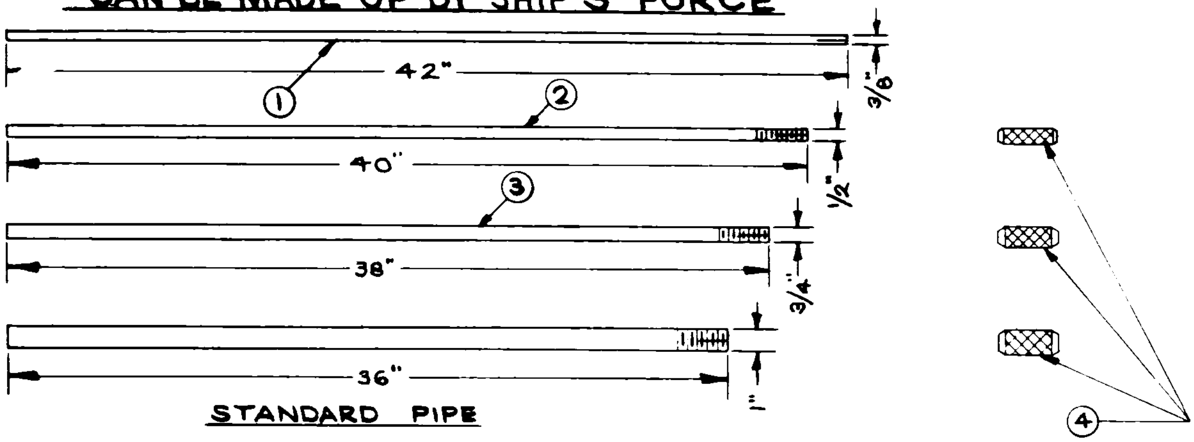
2. Q. How far in advance should shoring materials be prepared?
A. Never cut or prepare shoring timbers in advance. Since each situation is different, there would be too much waste in advance preparation.

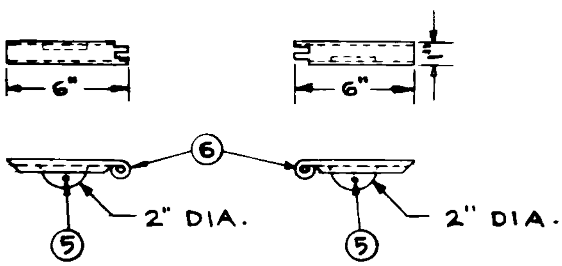
3. Q. Why are pillows unsatisfactory for use as patches?
A. When the feathers get wet, they collect in a lump and the patch collapses. If the casing rips, the feathers clog pumps and strainers.

4. Q. Why should shoring timbers, plugs and wedges be left unpainted?
A. The unpainted wood absorbs water and grips better. Paint would seal the pores of the wood, stopping or slowing down water absorption.

5. Q. How should wedges be set up and driven?
A. Set up two wedges, hypotemuse to hypotenuse, so they will form a shape like the block from which they were cut. Drive simultaneously against both wedge butts.

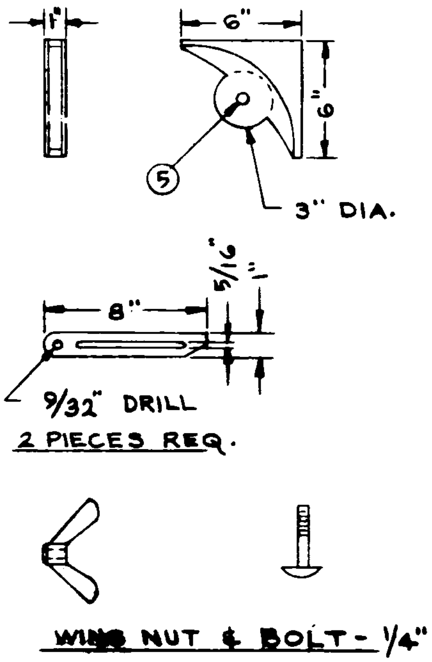
DETAILS OF MEASURING BATTEN WHICH CAN BE MADE UP BY SHIP'S FORCE





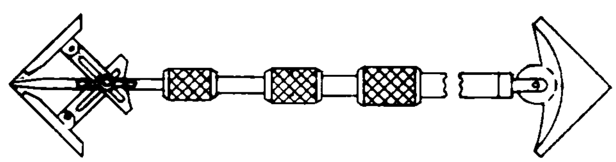
MATERIALS

Pipe to be steel.
Knurled nuts to be brass.
Angle measuring heads to be fabricated from galvanized sheet metal.



NOTES:

1. 3/8" D. PIPE MUST BE MACHINED APPROXIMATELY 1/16" TO FIT INSIDE 1/2" D. PIPE.
2. 1/2" D. PIPE MUST BE MACHINED APPROXIMATELY 1/32" TO FIT INSIDE 3/4" D. PIPE.
3. 3/4" D. PIPE MERELY REQUIRES A CLEAN SURFACE TO FIT INSIDE 1" D. PIPE.
4. BRASS STOCK DRILLED & KNURLED & THREADED TO SUIT RESPECTIVE PIPE.
5. DRILL TO PROVIDE FOR BOLT.
6. FOLD METAL FOR HINGE EFFECT - 1/4"
7. COMPLETED BATTEN IS AS SHOWN BELOW WHEN ASSEMBLED



STEEL DAMAGE CONTROL SHORES

(BUSHIPS Journal, November 1960)

The Bureau of Ships is taking steps to replace some of the wooden damage control shores, now used on surface ships, with adjustable steel shores. The change is expected to result in decreased cost as well as a number of other advantages.

The cost of steel shores initially will be higher than wood shores. A set costs about $80, but this figure will be reduced somewhat by the savings realized from the proposed reduction in the allowance of wooden shores. The difference will be offset over a period of years since the steel shore is reusable.

Since the large 11-foot size telescopes down to 6 feet, steel shores can be stowed in repair stations, where they are more readily available to repair personnel. They can be installed more rapidly than wood shores since no cutting or measuring is needed. The ones furnished the ships will have swivel tops and bottom plates so that they can be used vertically, horizontally, or at any angle. The plates can be secured by nails, screws, or tack welding and by wedging them against ship bulkhead or hatch coaming.

The steel shore requires less storage space than the wood shore and they are lighter weight. The 6-foot steel shore (which extends to 11 feet) weighs 40 pounds less than a 6-inch by 6-inch by 11-foot wood shore.

The steel shores have other advantages, they do not burn. They are not as bulky as wood shores, hence they are more easily handled, particularly in confined spaces. They can be used where pressure is required, as in driving plugs against water pressure. Their use makes it easy to adjust pressure without wedges, and less time is required to install the shores.

Benefits also will derive from using the steel shore for training, since they can be reused in shoring drills. Because their use eliminates cutting wood shores, they have greater training potential without increased cost. Their use elimates the loss of time and expensive material which results from mistaken measurements or cuts.

Since the steel shore will be stowed in repair stations in lieu of living spaces, habitability is improved. Maintenance of steel shores is easier also, since all they need is an occasional greasing of threads.

6. Q. What kinds of lumber are best for shoring?
A. Douglas fir or yellow pine.

7. Q. What should be the maximum length of a shoring timber?
A. Not more than 30 times its minimum width.

8. Q. How would you measure for the required length of a shoring timber and the angles the ends should be cut to?
A. By means of the measuring batten.

9. Q. Define the following: (a) shore, (b) wedge, (c) shole, (d) strongback.
A. (a) A shore is a portable beam.
(b) A wedge is a block, triangular on the sides and rectangular on the butt end.
(c) A shole is a flat plate which may be placed under the end of a shore to distribute weight or pressure.
(d) A strongback is a bar or beam used to distribute pressure.

10. Q. To what extent are nails used to secure shores?
A. Nails should be used only where necessary or to secure blocks behind wedges to prevent their slipping.

B. Application. Assume a practical shoring situation and have the group erect the proper shore.

VII. HANDOUT. Instructions for Use of Carpenter's Steel Square in Shoring. There may be times when a measuring batten is not available or, if it is, it may be too long or too short to measure for shores. In this event, the carpenter's steel square can be used to give flat, smug pressure surfaces.

A. Top Shore - One End (See Sketch A).

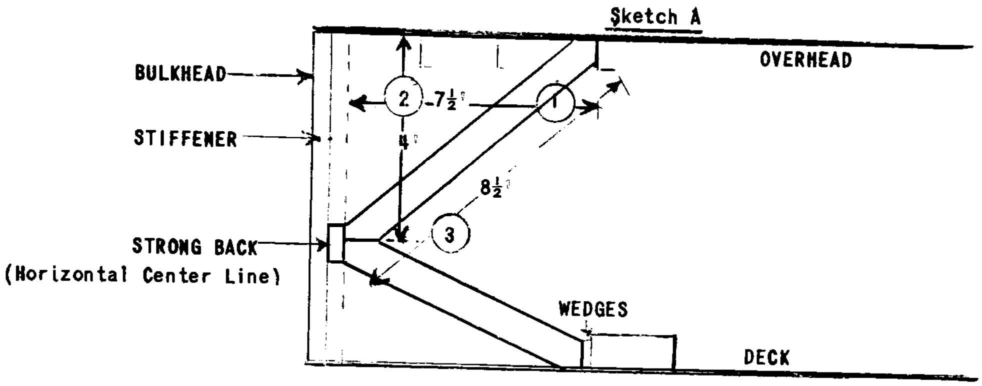
1. Measure in feet the horizontal distance from the bulkhead to be shored to the overhead support point. Deduct from this the distance from the bulkhead to the face of the strongback where pressure is to be applied. (In Sketch A., measurement 1 , the net measurement is $7\frac{1}{2}$'.)

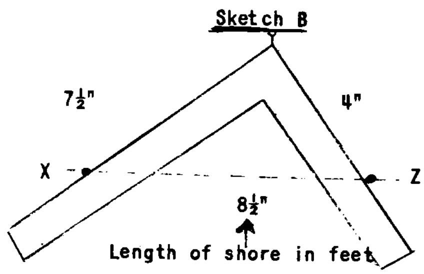
2. Measure in feet the vertical distance from the overhead deck plating to the horizontal centerline of the strongback. (This is 4' in measurement 2 .)

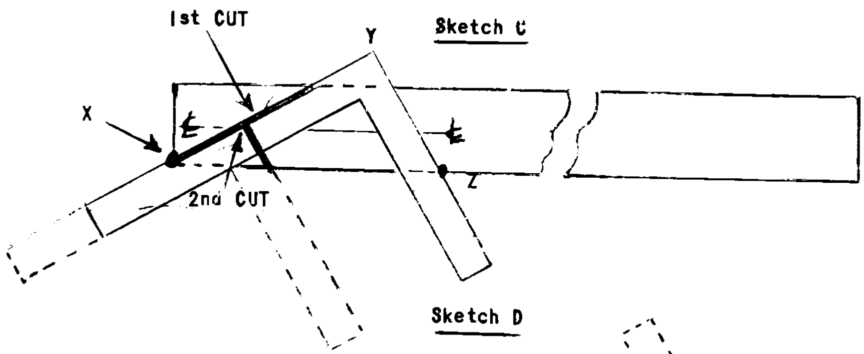
3. Using a scale of 1" = 1', reduce these measurements to inches. Thus, $7\frac{1}{2}$' becomes $7\frac{1}{2}$" and 4' becomes 4". Lay these two measurements off on the legs of the square from the outside corner or vertex, giving you points X and Z (see sketch B). With a straight edge, connect X and Z. This line (hypotemuse) will give you correct length of the shore. Thus an $8\frac{1}{2}$" hypotenuse means that the shore should be $8\frac{1}{2}$' long.

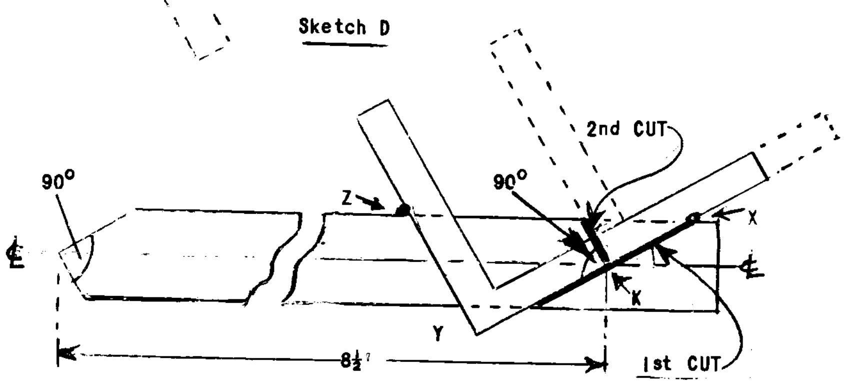
4. Now lay the square, vertex up, on the flat side (if any) of the timber so that points X and Z coincide with the edge (see sketch C). Slide the square along the edge until X is at the end of the timber. Then

OBTAINING CORRECT ANGLES IN SHORING









draw a line from X toward Y. This is the first cut. Where this cut line intersects the centerline, draw a perpendicular. This will be the second cut.

B. Top Shore - Other End (See Sketch D).

You have already determined that the shore should be $8\frac{1}{2}'$ long. Measure this off along its centerline and lay off a squared line at $8\frac{1}{2}'$. Where this square line intersects the centerline, mark it point K. Now reverse the square with the vertex (point Y) pointing downward. Once again, line up points X and Z with the edge (upper edge this time). Slide the square along the edge until side XY of square is flush with point K. Draw the first cut line. Then draw a perpendicular from point K. This will be the second cut line. Note that by reversing the square for the other end, the opposite beveled edges of the shore are exactly parallel.

C. Bottom Shore.

Repeat the above process except as follows: -

1. When laying off length of shore, deduct $\frac{1}{2}''$ from its over-all length in order to allow for wedges.

CHAPTER 3

ADVANCED DAMAGE CONTROL - For Deck and Engine Personnel (Lesson Plans)

Section 3.11

OXYGEN-ACETYLENE CUTTING UNIT

I. OBJECTIVES.

A. To familiarize repair party personnel with the operation, maintenance, and safety precautions for the oxygen-acetylene cutting unit.

B. To instruct personnel in the operation of the unit and its advantages and limitations.

II. MATERIAL.

A. Training Aids.

1. Cutting unit, including the manufacturer's instructions.

2. Film strip, SN 137, Oxyacetylene Cutting (for use with film strip projector).

B. References.

1. BUSHIPS Manual, Chapter 92, Sections IV and V, Welding and Allied Processes.

2. BUSHIPS Manual, Chapter 93, Firefighting, Ship.

3. NAVSHIPS 392-0003 - Instruction Manual for Operation of Pack-Type Oxy-acetylene Emergency Cutting Outfit.

4. NAVPERS 10571-E - Damage Controlman 3 & 2.

III. INTRODUCTION

A. Introduce self and subject (Oxygen-Acetylene Cutting Unit)

B. Uses of the Emergency Cutting Unit:

1. To cut holes in decks or bulkheads so that applicators equipped with fog heads may be inserted. The engine room fire in USNS ROSE in July 1952 when two applicators for fire fighting were inserted to overcome a serious fire after the CO_2 had failed to extinguish the fire is an example. (See Section 8.5)

2. To cut away debris. For example, the case of the woman in the ANDREA DORIA who was pinned in her bunk and lost, whereas she would have been freed if a cutting unit was available.

C. Advantages of the Unit.

1. Is comparatively light and can be carried by one man.

2. Regulators are pre-set and ready for use.

3. It will cut continuously for 25 minutes.

4. The torch will cut through up to 1" of steel.

D. Larger Unit. A large, two-man unit, is also available. This will weld as well as burn. It will not be covered in this lesson, though it could be used in an emergency.

IV. PRESENTATION. (Show the unit, its parts, and its operation while describing it.)

A. Location. The emergency cutting unit is stowed in the repair locker. It is kept in its fast-opening metal cabinet in an upright position.

B. Description. The pack contains two oxygen cylinders of 22 cubic feet capacity each and one acetylene cylinder of 10 cubic feet. Also, cylinder pressure gauges, working pressure gauges, a regulator for each gas, a cutting torch with two adjusting valves, a high pressure lever-type oxygen valve, a cutting tip, two five foot lengths of hose, a spark lighter, gloves, goggles, and a wrench. The unit is carried in a fire-resistant canvas carrying pack.

C. Preparation for Use.

1. Before strapping the carrying pack to operator's back, crack the oxygen cylinder valves slowly to permit high pressure to build up in the regulator; then open the valves wide.

2. Next open the acetylene cylinder valve slowly, about one quarter turn. Use the key attached to the regulator with a chain. Help

the operator adjust the pack on his back.

3. To ready the torch for use, open the preheating flame acetylene valve one quarter turn. Immediately, light the flame with the spark lighter. Never use a match. Next, open the preheating oxygen valve one quarter turn. Adjust the oxygen valve until you have individual clear, blue-white flames with sharp edges.

D. Cutting. The metal must be preheated with the above flame. Hold the burner tip at right angles to the surface. Heat to a bright cherry red at one point only. Then press the cutting lever, holding the torch so that the ends of the flame cones just touch the metal. After burning through, move to the adjoining point. Moving too fast will lose the cut; moving too slow will fuse the cut. To prevent slag from blowing toward you, tilt the torch to one side and back the torch off slightly from the plate.

E. Securing Torch.

1. Turn off the acetylene valve.

2. Turn off the preheating flame oxygen valve.

3. Close both oxygen and acetylene cylinder valves tightly.

4. Test cylinder valves for tightness.

F. Safety Precautions.

1. See that hose connections are tight and that there are no leaks. Test for leaks with soap and water.

2. Do not submerge the tip end of the torch into molten metal!

3. Do not let unburned acetylene gas accumulate in a confined space.

4. Keep oil and grease away from the cutting unit. These substances ignite violently in the presence of oxygen under pressure.

5. Always wear goggles, leather gloves and protective clothing when cutting.

6. Never depress the cutting oxygen lever unless actually cutting or adjusting the flame.

7. Do not undertake repair of any part of this unit. Send it ashore for proper repair.

G. Stowage. Remember that this is an emergency unit and must be ready for instant use. It will be ready for use if maintained as follows:

1. Determine the oxygen content.

a. Remove oxygen regulator from manifold.

b. Attach pressure test gauge in place of regulator.

c. Open both oxygen cylinder valves slowly, one at a time.

d. Read the pressure on the gauge. This will be for <u>both</u> cylinders. If the pressure is less than 500 lbs., replace all three cylinders.

e. If pressure is more than 500 lbs., close all cylinder valves tightly, remove the test gauge, and replace the oxygen regulator.

f. Acetylene content does not need to be determined because consumption is in proper ratio to the oxygen. The gauge in the bottom of the acetylene cylinder is not a true test of gas content (a full cylinder at 70 degrees will register 250 lbs.)

2. Test for leaks with soap and water.

3. The torch is carried in the torch holster on the right shoulder strap. Stow the unit in the repair locker in upright position away from any steam lines or other sources of heat.

4. If, on opening the locker, you smell acetylene gas, leave the door open, post a guard to prevent smoking, and notify the First Officer at once.

H. <u>Re-ordering Cylinders</u>.

1. Ignore directions for change-over appearing on page 18 of NAVSHIPS 392-0003, Instruction Manual.

2. Remove the manifold; remove all 3 cylinders from their cradle.

3. Turn in only the empty cylinders for credit, using the appropriate shipping form.

4. Order the following replacements, using the appropriate requisition form:

2 Oxygen cylinders
1 Acetylene cylinder
44 Cubic feet of oxygen
10 Cubic feet of acetylene

5. Indicate at the bottom of the requisition that empty cylinders are being turned in.

V. SUMMARY.

A. Give practical demonstrations of:

1. Breaking out the cutting unit.

2. Lighting.

3. Cutting.

4. Determining oxygen content.

5. Securing.

B. Review the key points of lesson.

C. Review safety features.

VI. TEST AND APPLICATION.

A. Test. Use these and additional questions as an oral quiz.

1. Q. Name the parts of the oxygen acetylene cutting unit.
A. a. One fire resistant canvas carrying pack and harness.
b. Two oxygen cylinders.
c. One acetylene cylinder.
d. Two 5' lengths of hose (one oxygen and one acetylene) with preset pressure regulators for each.
e. One type "E" hand cutting torch.
f. One oxygen cylinder manifold.

2. Q. What valves must be opened before the operator puts the oxygen-acetylene cutting unit on his back?
A. The valves on the oxygen and acetylene cylinders.

3. Q. What is the most important limitation placed on the use of the oxygen-acetylene cutting unit?
A. It is for emergency use only, and must be maintained in readiness for this purpose.

4. Q. Where is the oxygen-acetylene cutting unit stowed?
A. It is stowed in the repair locker.

5. Q. What is the gas capacity of the oxygen-acetylene cutting unit?
A. Gas capacity of the oxygen-acetylene cutting unit is 44 cubic feet of oxygen in two cylinders and a 10 cubic foot acetylene cylinder.

6. Q. When is the oxygen lever pressed down?
A. The lever is pressed down when ready to start cutting.

7. Q. What is the chief precaution that must be taken when cutting?
A. Do not submerge the tip of the torch into molten metal.

8. Q. Would you lubricate any part of the outfit? Give the reason for your answer.
A. No, it is dangerous to use oil or grease in the presence of oxygen under pressure.

9. Q. What is the pressure level under which all cylinders must be replaced?
A. 500 lbs.

10. Q. Why is it not necessary to check the acetylene pressure?
A. Because due to the pre-set regulators, both gases are used in the proper ratio.

11. Q. What is the procedure for securing the torch?
A. a. Turn off the preheating flame acetylene valve.
b. Turn off the preheating flame oxygen valve.
c. Close both oxygen and acetylene cylinder valves tightly.
d. Test the cylinder valves for tightness.

12. Q. What protective clothing is required with the oxygen-acetylene cutting unit?
A. Always wear goggles and leather gloves when using this equipment in addition to ordinary protective clothing.

B. Application. Have each man demonstrate his ability to break out, light, use and secure the cutting unit.


MAIN DECK

CHAPTER 3

ADVANCED DAMAGE CONTROL - For Deck and Engine Personnel (Lesson Plans)

Section 3.12

RADIAC INSTRUMENTS

I. OBJECTIVES.

A. To familiarize repair party personnel and members of monitoring teams with radiac instruments.

B. To show personnel how to operate radiac instruments.

C. To develop an understanding of the capabilities, limitations, maintenance, and safety precautions to be observed in handling radiac instruments.

II. MATERIAL.

A. Training Aids.

1. Film MN 8694, Radiac Equipment (film series).

2. Survey Meter, Gamma High Intensity - AN/PDR-18. + AN/PDR-43

3. Survey Meter, Beta-Gamma Low Intensity - AN/PDR-27.

4. Survey Meter, Alpha - AN/PDR-~~10~~ 56 (~~Passenger ships only~~).

5. Phosphor-Glass Dosimeter - DT-60/PD.

6. Pocket Dosimeter ~~IM-9/PD~~. IM-143/PD ch 3

7. Computer - Indicator - CP-95/PD.

B. References.

1. Radiological Defense, Volume IV.

2. ABC Warfare Defense, NAVPERS 10099.

III. INTRODUCTION.

A. Introduce self and subject (Radiac Instruments).

B. "Radiac" is the term given to all radiological detection instruments. It stands for Radiological Activity Detection, Identification and Computation.

C. AN/PDR is an abbreviation for "Army - Navy, Portable, D for radiac, Receiving". The number indicates the model. DT-60/PD stands for a "detecting portable radiac" and CP-95/PD is a "computer, portable radiac".

D. Nuclear radiation cannot be seen or felt. Nor can it be detected by any of the five natural senses. It is necessary to have special instruments for its detection, and for determination of the dosage rate.

E. Nuclear radiations given off by radioactive elements consist of 3 basic types - alpha particles, beta particles and gamma rays.

F. In monitoring for nuclear radiation, we must determine its presence, location, intensity, and the dose rate to which exposed personnel have been, or will be, subjected.

G. Improvement and development of new radiac equipment is a continuing project and progress is rapid in this field. Currently-available equipment is described herein. Improved equipment will be furnished ships when available, together with instructions regarding its use.

IV. PRESENTATION. Various instruments are required to determine the type, location and intensity of radiation, usually in the form of radioactive "fallout" material, after an atomic explosion. For this purpose "dose-rate" meters are used (similar to "miles per hour" on a speedometer). For determination of the amount of exposure to which personnel have been exposed, "dosimeters" are used (similar to "total mileage" on a speedometer). (Show each instrument as you describe it and explain its use).

A. Dose-Rate Meters (or Survey Meters). These come in three different types: Lo-Rate Survey Meter, Hi-Rate Survey Meter, and Alpha Survey Meter.

1. Lo-Rate Survey Meter - AN/PDR-27 Series (Geiger Counter). The AN/PDR-27 series radiac set is a portable, watertight survey instrument consisting of a low range Geiger-Mueller tube located in a probe, a higher range Geiger-Mueller tube located inside the case, an electronic amplifier, a battery power supply, a meter and earphones. This instrument is used

for low intensity surveys and all personnel monitoring.

a. This device is capable of detecting and measuring beta and gamma radiations together, or gamma radiation alone. (See Section 2.13 for definitions.)

b. The main unit of this radiac set, the radiac-meter, is equipped with a carrying handle and it may also be carried by its shoulder harness. The detector unit is contained in a probe which is attached to the meter by means of a flexible cable. The probe is normally carried in a "well" on the outside of the meter from which it can easily be removed. When measuring gamma radiation, the detector can be used in or out of the well; beta radiations, however, can be detected only when the detector is removed from the well and the beta shield on the probe is moved aside.

c. When the Geiger-Mueller tubes are exposed to gamma and beta radiation, they produce short voltage pulses at an average rate which depends upon the radiation intensity in the vicinity of the tubes. The meter gives a visual indication of the radiation; earphones in which a click is heard for each pulse received are also provided to give an audible indication.

d. Only the Geiger-Mueller tube in the probe is used for the two most sensitive ranges, 0 to 0.5 mr/hr and 0 to 5 mr/hr. Only the Geiger-Mueller tube in the case is used for the two least sensitive ranges, 0 to 50 mr/hr and 0 to 500 mr/hr.

e. This set has a six-position, rotary selector switch mechanically geared to the meter dial. Range scales are color coded.

f. Only gamma radiation field strengths can be measured on the two <u>less sensitive</u> ranges (0 to 50 mr/hr and 0 to 500 mr/hr).

g. The meter can be illuminated by tilting the radiac set case at an angle of about 45 degrees.

h. The following is a general description and operating instructions for the AN/PDR-27C, Lo-Rate Survey Meter.

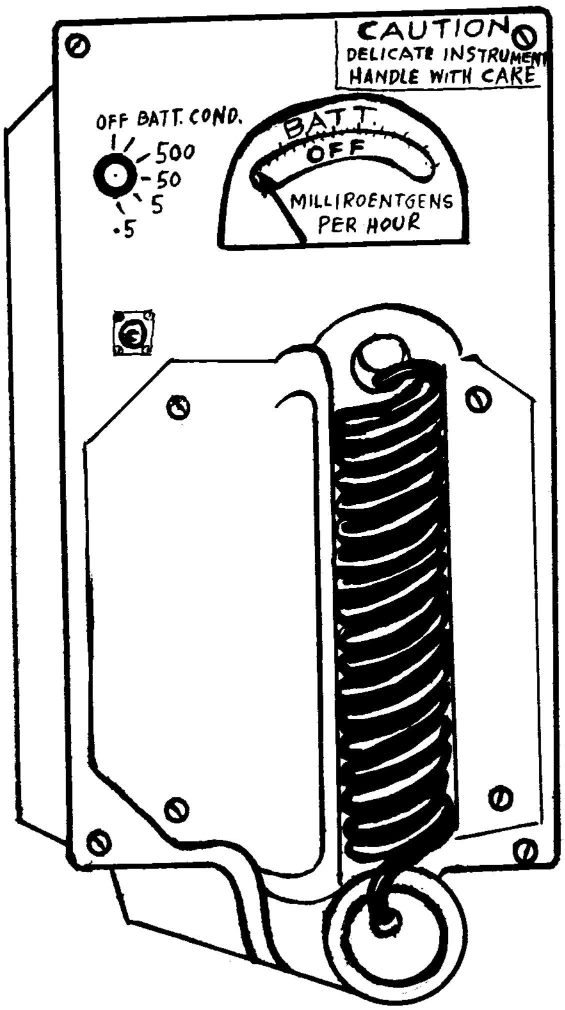
(1) General Description of the AN/PDR-27C. (See illustration).

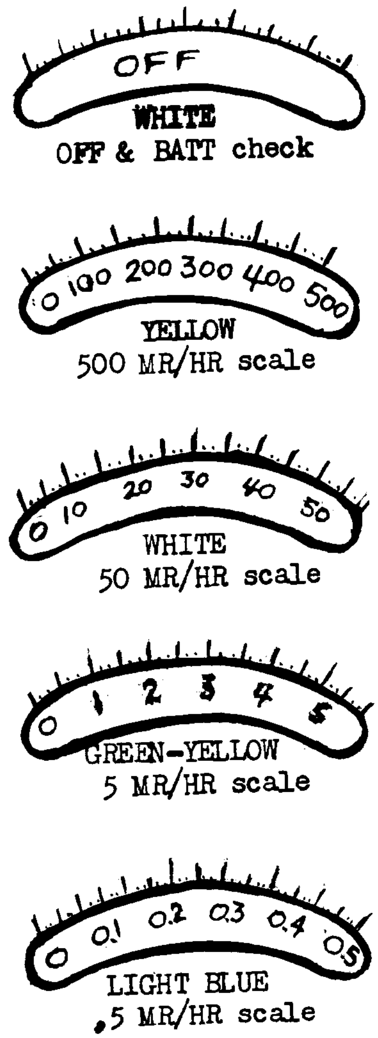
(a) Meter design.

(1) Lo-R. Geiger-Mueller type survey meter.

(a) Measures GAMMA rays for 0 to 500 mr/hr.

(b) Will detect BETA rays with shield off probe end. (Close to surface.)





LO-RATE SURVEY METER - AN/PDR - 27C
(BETA - GAMMA LOW INTENSITY)

(2) Color code and range scale.

(a) Yellow -- 0 to 500 mr/hr.

(b) White -- 0 to 50 mr/hr.

(c) Green-yellow -- 0 to 5 mr/hr.

(d) Light blue -- 0 to .5 mr/hr.

(3) Meter range selector (Six positions).

(a) OFF position - indicates batteries disconnected, set inoperative.

(b) BATT position - indicates condition of battery charge.

(c) 500 mr/hr position.

(d) 50 mr/hr position.

(e) 5 mr/hr position.

(f) .5 mr/hr position.

(4) Headset is provided for audible signals.

(a) To source of clicks.

(b) Rapidity of the clicks indicate increase in intensity.

(b) Power supply.

(1) One 135 volt battery.

(2) One 22.5 volt battery.

(3) Two 1½ volt batteries.

(c) Chassis design - portable battery operated. Batteries are contained beneath the handle casting in a separate chamber. They can be removed and replaced without exposing the circuit.

(1) Simplicity of reading.

(a) When ranges are changed, numerals and colors change.

(b) Meter is read directly in mr/hr.

(2) Smooth painted surfaces for easy decontamination. (Do not repaint).

(3) Shoulder strap lugs for carrying.

(2) Procedures for placing instrument into operation. Note: It should be checked out at least monthly, since it cannot be checked out in any area containing radio-activity.

(a) Turn switch to BATT COND position. The indicator should point to right of line marked BATT on meter dial. This line is the point below which operating voltage is insufficient.

(b) Check operation of the circuits, using the test sample.

(1)-On 500 scale, meter should read "0". (Chassis tube only on 500 scale.)

(a) Place colored end of test sample in dimple on bottom of chassis.

(b) Meter should read 10 to 30 mr/hr.

(2) Turn switch to 50 range scale.

(a) Place colored end of test sample in dimple on chassis bottom.

(b) Meter should read 5 to 15 mr/hr.

(3) On 50 and 500 ranges, tube in chassis is in use.

(a) Detects and measures GAMMA radiation only.

(b) For survey on these ranges, instrument is turned facing toward the source. Probe well should be against body of operator.

(4) Turn switch to 5 range. Use probe.

(a) Place colored end of test sample against the center of the probe.

(b) Meter should read 1 to 3 mr/hr.

(5) Turn switch to 0.5 range.

(a) Place clear end of test sample against probe to prevent overloading of the tube.

(b) Meter should read .1 to .3 mr/hr.

(c) Prior to use for monitoring:

(1) After check-out, put on 500 scale and allow to set for 5 minutes to warm up all electronic components.

(2) Put on harness.

(3) Connect the headset to its jack.

(4) Check BATT condition.

(5) Start survey readings on highest scale and work down. Stop at range scale where meter gives indication of radiation.

(6) For GAMMA survey, carry instrument at waist level.

(a) Maintain meter or its probe at same distance from surface.

(b) Turn instrument so tube in use is facing source or highest indication.

(7) For BETA indication (Food or food preparation areas mainly):

(a) Use probe with meter on 5 or .5 mr/hr range.

(b) Leave BETA shield in place for initial reading.

(c) Remove shield, take reading and calculate BETA contribution.

(8) To illuminate for use at night or in dark areas, tilt instrument to about 45 degrees and small lamp inside will illuminate dial.

(9) Calibration:

(a) Performed at authorized shore establishments only.

(b) Must be performed in an area free of large metallic objects to avoid inaccuracies.

(c) Instrument should be recalibrated whenever error is plus or minus ten percent.

(d) To secure instrument:

(1) Be sure instrument switch is OFF.

(2) Replace in case and secure fasteners.

(3) For prolonged storage, remove batteries.

(3) Maintenance. After six months of service aboard * ship, turn the instrument in to the nearest authorized shore radiac repair facility for test, repair, battery change, and recalibration in accordance with area command's instructions.

2. Hi-Rate Survey Meter - AN/PDR-18 Series (Scintillation Counters).

a. The AN/PDR-18 series radiac set is a portable survey instrument consisting of a detector with a sensitive phosphor crystal element which fluoresces, or scintillates, when exposed to gamma radiation, a photomultiplier tube which multiplies the extremely small current caused by the radiation, an electronic amplifier circuit, a rate meter and a combination battery and vibrator power supply. This device is designed to detect and measure gamma radiation only.

b. It measures high intensity gamma radiation over four ranges: 0 to .5r/hr, 0 to 5r/hr, 0 to 50r/hr, and 0 to 500r/hr.

c. It has a nine-position rotary selector switch mechanically geared to the meter dial. The position of the switch at any particular time shows through an opening in the meter face. The first five positions are from OFF through battery checks and calibrations; the background for these positions is white. The last four positions are for the range scales; their backgrounds are color coded according to the degree of danger represented by readings in each range.

d. A push-button illumination switch on the handle turns an internal lamp on to illuminate the meter face at night or in dark areas.

e. General description and operation of the AN/PDR-18A, Hi-R GAMMA survey meter (see illustration).

(1) Meter design.

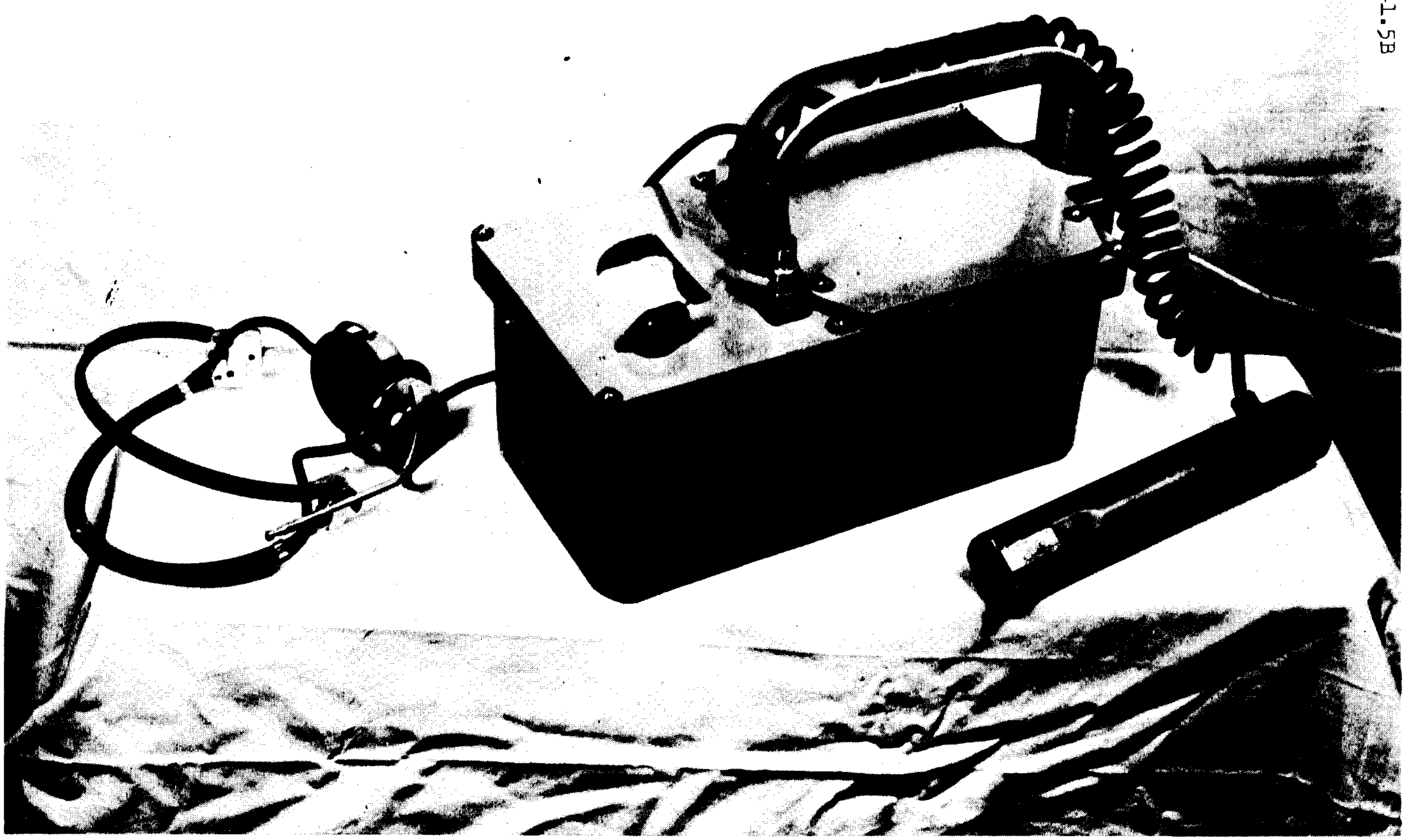
(a) High intensity scintillation counter.

(1) Gamma survey meter ONLY.

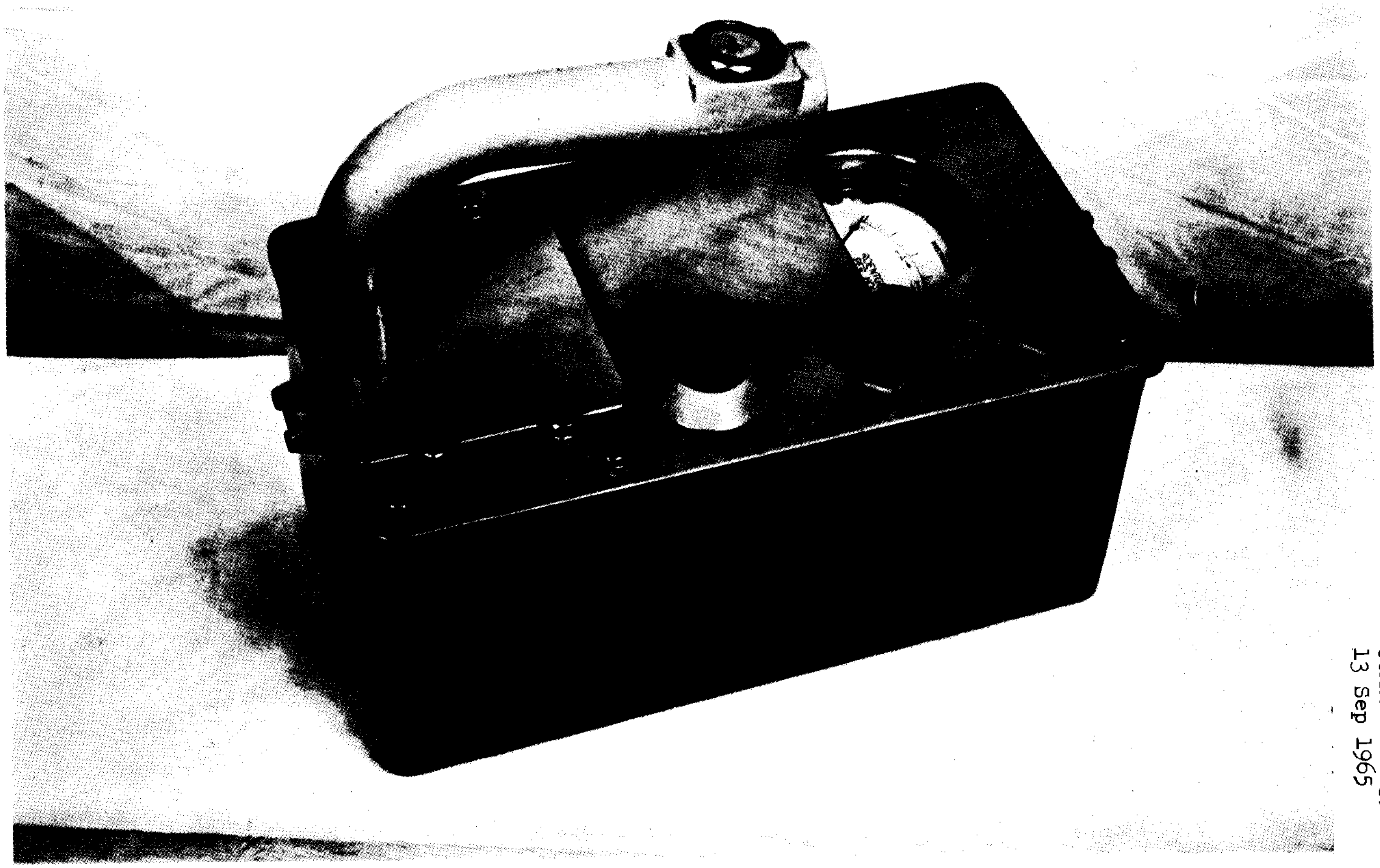
(2) Range 0 to 500 Roentgens per hour (r/hr).

(b) Range scale color code of the meter.

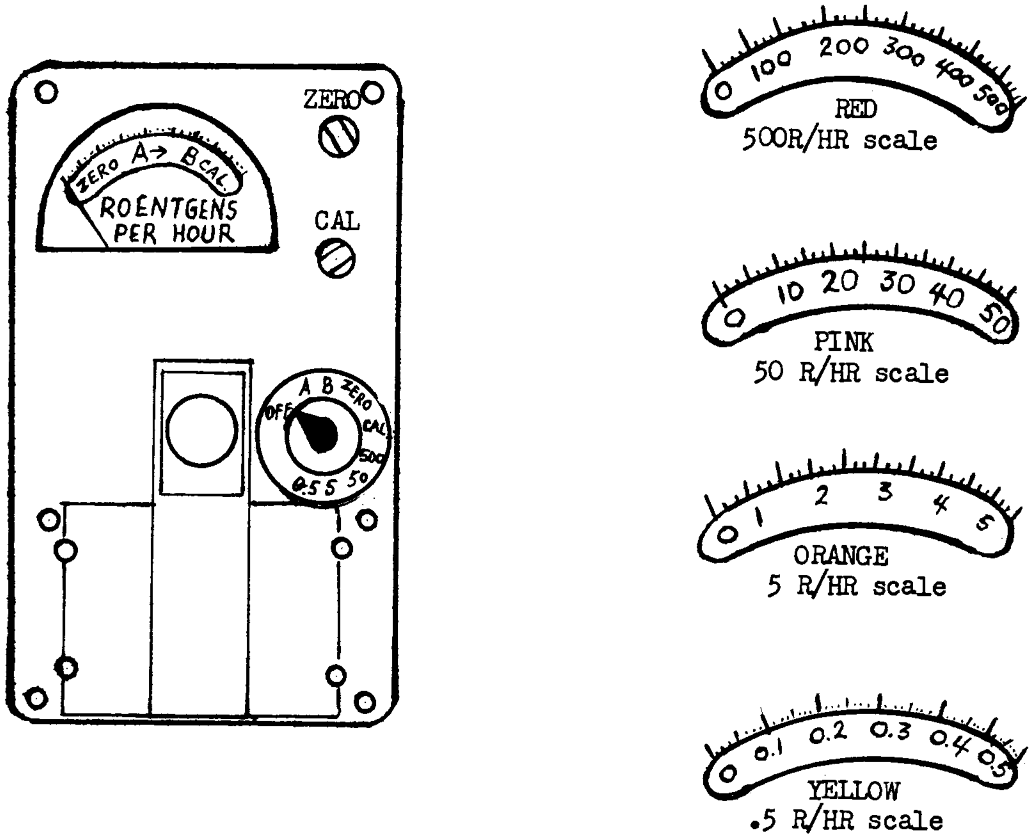
Color	Degree of danger	Range of scale
(1) Red	Mortally dangerous	0 to 500 r/hr
(2) Pink	Extreme danger	0 to 50 r/hr
(3) Orange	Slight danger	0 to 5 r/hr
(4) Yellow	Negligible	0 to .5 r/hr



AN/PDR-27 LOW-RANGE SURVEY METER



AN/PDR-18 HIGH RANGE SURVEY METER



HI-RATE SURVEY METER - AN/PDR-18A
(GAMMA HIGH INTENSITY)

(c) Meter range selector.

(1) Located to the right of the handle.

(2) The selector knob has nine positions.

OFF	Zero adjustment	50 r/hr
A-Batt check	Cal adjustment	5 r/hr
B-Batt check	500 r/hr	0.5 r/hr

(a) The above positions are printed on the dial.

(b) In the first five positions the dial background is white.

(c) The remaining four positions are for the range scales of the meter.

(d) Zero Adjustment Knob.

(1) It is used to set the instrument needle on zero prior to use.

(2) It must be set prior to calibration.

(e) Calibration Knob.

(1) Used to adjust the sensitivity of the instrument.

(2) The sensitive element is exposed to a source within the instrument.

(2) Power Supply.

(a) Six dry cell $1\frac{1}{2}$ volt batteries. (Do not use photo-flash batteries).

(b) Limited battery life requires zero and sensitivity checks.

(3) Chassis Design.

(a) Watertight.

(b) Portable.

(c) Smooth hard finish for easy decontamination. (Do not repaint.)

(d) Simple operation.

(e) Easily operated with gloves.

(f) Lugs on instrument for shoulder strap attachment.

(g) Push button on the handle for dial illumination at night.

(4) Operating Procedures.

(a) Routine check prior to using the instrument on a survey.

(1) Turn the range selector knob from "OFF" to "A" position.

(a) It should read on or to the right of "A" marker.

(b) This indicates proper functioning of the filament current supply.

(2) Turn the selector knob to "B" position.

(a) It should read on or to the right of "B" marker.

(b) This indicates an ample power supply.

(3) Turn the selector knob to "ZERO" position.

(a) Adjust needle to ZERO by means of the ZERO adjustment knob.

(b) Essential to check ZERO frequently, especially in the field.

(4) Turn selector knob to "CAL" position.

(a) Adjust needle to calibrate full scale deflection. (Needle must settle on scale division farthest to the right.)

(b) For detection and measurement:

(1) Assure yourself of instrument check.

(2) Attach harness.

(3) Adjust instrument for waist level survey carry.

(a) All readings must be taken at waist level.

(b) Maintaining the same distance from the surface being monitored will provide a true survey picture.

(4) Turn range selector to the highest range scale (0 - 500 r/hr).

(a) Always start at the highest range scale and work down.

(b) Turn down to the next range that will give an indication.

(5) To illuminate the dial at night, press the button on the handle.

(6) To secure the instrument:

(a) Be sure that the selector switch is in the "OFF" position.

(b) Spent batteries cause corrosion. Therefore, for prolonged storage remove the batteries.

(c) Replace the instrument in the case and return to storage place.

(5) Maintenance. Confine maintenance to operating checks on face of instrument.

(a) If the instrument does not satisfy check requirements, turn it in to an authorized shore repair facility at the first opportunity for repairs and recalibration.

(b) Take the instrument to an authorized shore repair facility once every six months for testing, overhaul and recalibration, if necessary, in accordance with area command's instructions.

Note: This Hi-Rate Survey Meter, AN/PDR-18 Series, is used only for surveying areas suspected of being contaminated, never for personnel monitoring.

3. Hi-Rate Survey Meter - AN/PDR-43 Series.

a. The AN/PDR-43 series radiac set is a portable survey instrument using a Geiger-Mueller detector, but employs a statistical sampling procedure to overcome the saturation problem associated with the Geiger-Mueller detector. The beta-gamma (or gamma only) radiation detection capability is available by means of a beta sampling port in the bottom of the instrument. In the earlier models, this port is controlled by manually rotating a round selector disc on the bottom of the instrument to beta, gamma, or check as desired. In later models the round selector disc has been replaced by a spring loaded control in the upper left corner on the face of the instrument. This control is normally in the gamma position and is manually rotated to either the beta or check positions. While in the beta position this instrument detects both beta and gamma, giving a composite reading. In the gamma position, gamma radiation only is detected and measured. In the check position, an 80 microcurie source of Krypton 85 is placed next to the Geiger-Mueller detector as a check to determine if the instrument is operating properly. It is not considered accurate for measurement of beta but gives an approximation of the amount of beta present. *

b. The AN/PDR-43 measures radiation over three ranges: 0 to 5r/hr., 0 to 50r/hr, and 0 to 500r/hr.

c. The power source is two 1-1/2 volt, D cell (JAN type BA-30/U) batteries. In addition to regular operational checks, the batteries should be checked visually every 60 days.

d. The AN/PDR-43 has three operational controls; the function selector control, the range switch, and a small button switch for dial illumination. A fourth control under the screw cap marked CAL is for the use of qualified maintenance personnel only.

e. To operate the set:

(1) Turn the range switch to the BATT position. The needle should move to the right of the BATT mark on the dial, indicating that the batteries are in good condition.

(2) Turn the range switch to the 50 and 5r/hr ranges and move the function selector to CHECK position on each range. The dial reading in the CHECK position should usually be about one to 1-1/2r/hr. This indicates the instrument is operating properly. It is now ready for survey use.

Note: The carrying handle can be raised or lowered by loosening the large nut which secures it to the instrument. When the handle is down, the range switch must be in the OFF position.

f. This instrument should be turned in to a Radiac Repair Facility for maintenance and calibration after six months use aboard ship - in accordance with area command's instructions.

4. Alpha Survey Meter - AN/PDR-56 Series

a. The AN/PDR-56 radiac set is a portable device to detect and measure the intensity of alpha radiation. It operates on the scintillation principle with four ranges marked in counts per minute from an area of 17 square centimeters, this being the actual exposed area of the Mylar windows on the probe face. The four ranges are: 0 to 1000 CPM/17cm2, 0 to 10,000, 0 to 100,000, and 0 to 1,000,000.

b. The power supply:

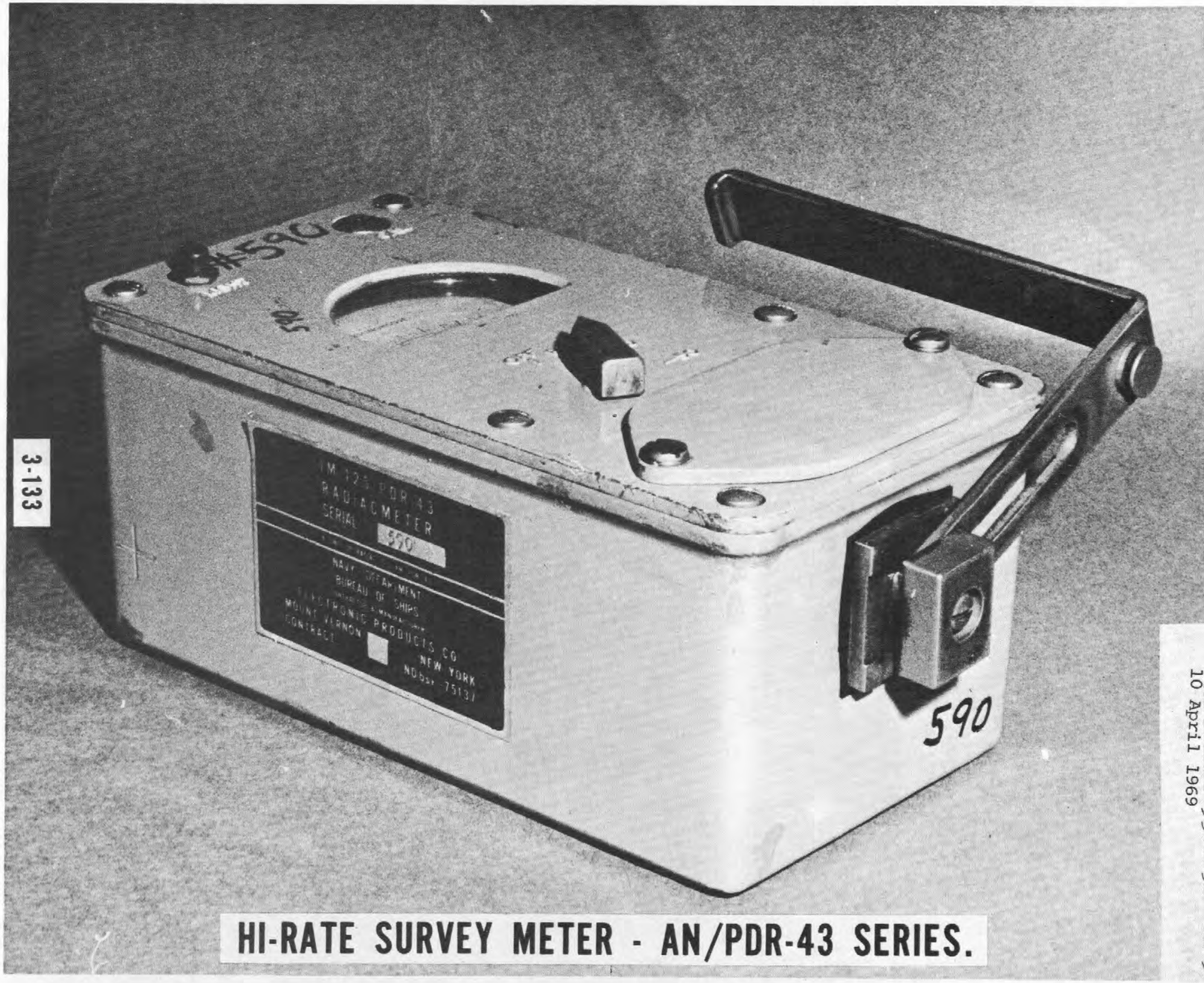
(1) Two 1-1/2 volt, D cell (JAN type BA-30/U batteries).

(2) Batteries should be visually checked every sixty days to prevent battery leakage into the battery compartment.

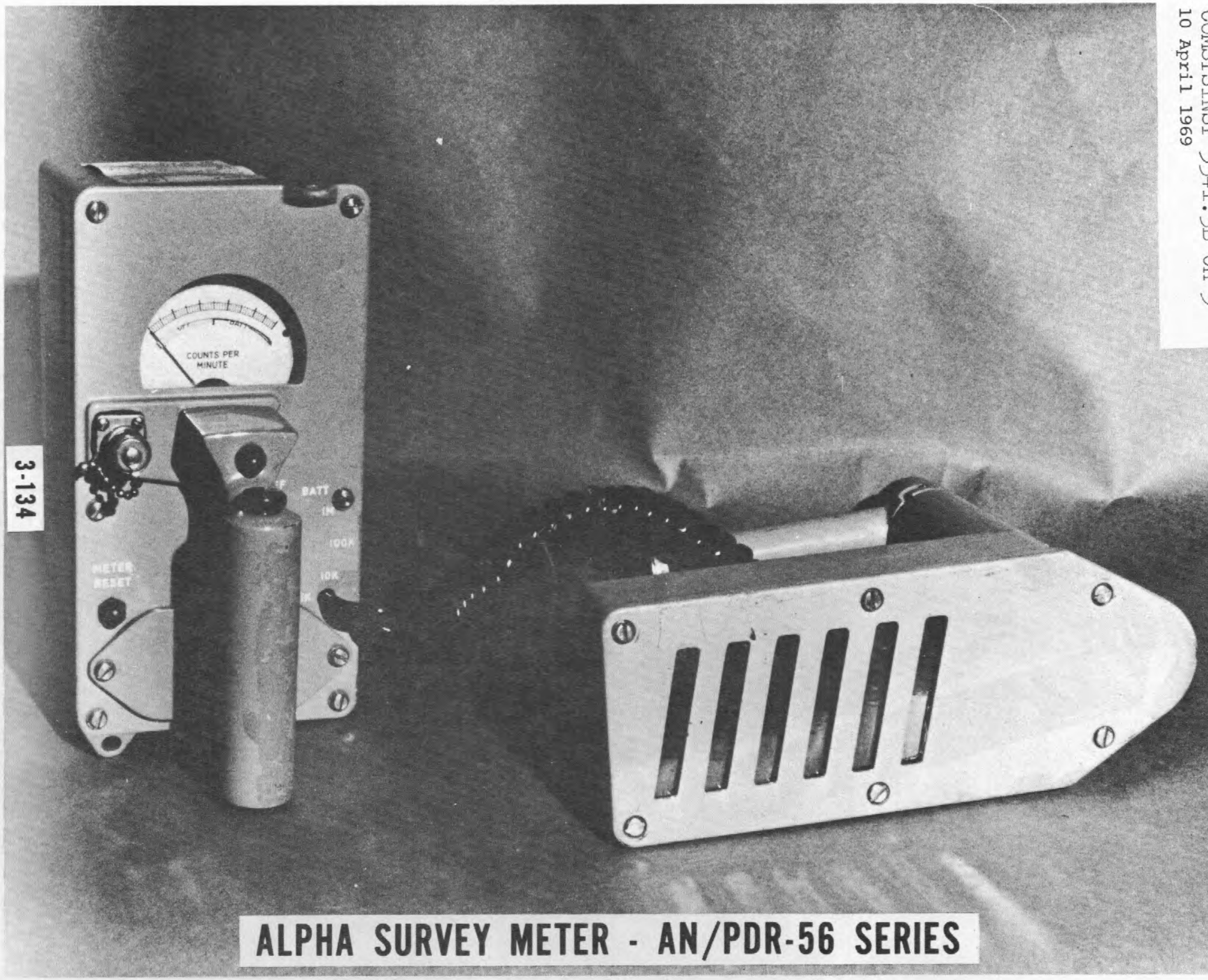
(3) The expected battery life is at least 50 hours.

c. The AN/PDR-56 is a completely transistorized instrument except for the photomultiplier tube located in the probe handle. It operates on the scintillation principle utilizing silver activated zinc sulfide crystals in the probe face. The crystals are attached to a lucite plaque and protected from outside light by a very thin (.00025 inches thick) aluminized Mylar on the probe face. If this Mylar is punctured it will cause a false meter indication from the light passing through to the photomultiplier tube. This aluminized Mylar is thick enough to block light but thin enough to allow alpha particles to pass through between the molecules of the Mylar. The light from the crystals scintillating, when struck by alpha particles, is transmitted by a lucite light pipe to the photomultiplier tube for conversion to an electronic signal.

d. The AN/PDR-56 has a handle extension so that the main probe can be used to survey floors and level surfaces without having to stoop to do it. It also has an auxiliary probe, smaller in size, for use in areas where the main probe is too bulky. Whenever the two probes are changed, make sure the instrument is turned off and do not make the change in a bright light. The photomultiplier tube is damaged by exposure to direct light.



HI-RATE SURVEY METER - AN/PDR-43 SERIES.



ALPHA SURVEY METER - AN/PDR-56 SERIES

e. The AN/PDR-56 has an external phone jack so that head phones can be used while monitoring. This facilitates watching the probe face, instead of having to watch the meter dial for changes in radiation level.

f. The AN/PDR-56 has three controls for the operator's use.

(1) A range selector switch.

(2) A meter reset switch which provides a means for rapidly returning the meter needle to zero in the event that a high alpha contamination causes the circuit to saturate with a consequent prolonged full scale deflection.

(3) A switch in the carrying handle to turn on the dial illuminating. light.

g. To operate the set:

(1) Turn the Range Selector to the BATT position. The meter needle should move to the right of the vertical mark on the meter scale marked BATT, to indicate the batteries are in good operating condition.

(2) Plug in the headphones and turn the range selector to the 1K position. In the absence of alpha radiation you should hear a high-pitched whine and an occasional click caused by background radiation.

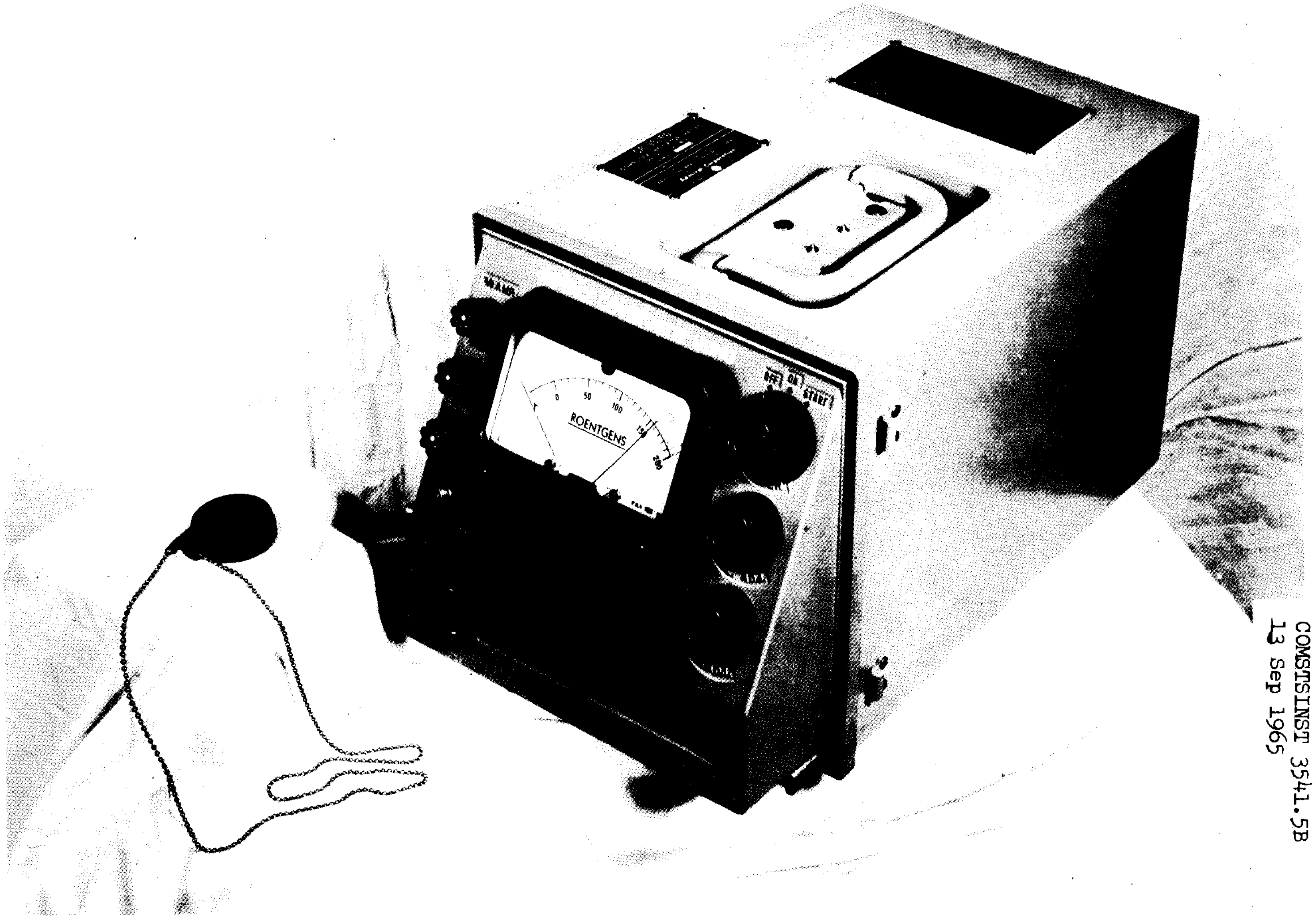
(3) Turn the range selector to the 100K position, invert the probe and place the slotted underface against the Thorium check source located on the bottom of the instrument. The meter should read approximately 24,000 CPM and the clicks in the headphones should be loud and fast. This is not a calibrating source but is used only to check the operation of the instrument. If a high reading is present in the absence of alpha radiation, most probably the Mylar covering on the probe face has been punctured and light is passing through. If the readings go up and down as more or less light is permitted to reach the probe face, the instrument probe will need repairs. DO NOT use a bright light to make this check. If all indications are normal, the instrument is ready for use.

(4) All readings should be made with the probe face not over 1/4 inch away from the contaminated surface due to the short range of alpha particles.

h. This instrument should be turned in to an authorized Radiac Repair Facility for maintenance and calibration after six months use aboard ship.

i. For additional information, refer to the manufacturer's instruction manual.

Note: No replacements provided for pages 3-136, 3-137 and 3-138. These pages are omitted for the present.



DT60/PD RADIAC DETECTOR

CP-95/PD RADIAC COMPUTER-INDICATOR

Ch 3-

(6) Maintenance.

(a) Confine maintenance to the routine checks described above.

(b) When the instrument fails to respond properly to these checks, turn it in to the nearest authorized radiac repair shop ashore at the first opportunity.

(c) Every six months, take the instrument to the nearest authorized shore radiac repair shop for test, repair, battery change and recalibration.

B. Dosimeters (Personnel Protective Devices) - The dosimeter is probably the most widely used instrument in the nuclear industry. It is an instrument designed to detect and measure an accumulated dose of radiation. There are two basic kinds of dosimeters -- self-indicating and non-self-indicating. Dosimeters are used to indicate the total radiation dosage to which an individual has been exposed.

1. Film Badges. Film badges, as the name indicates, consist of small packets containing photographic film sensitive to gamma radiation and beta particles. Each film is packaged in a light-proof envelope. An external metal shield fits over part of the packet. The unshielded portion will record both beta particles and gamma radiation while the shielded section will record only gamma radiation.

a. Non self-reading film badges have to be sent to a laboratory for developing and processing. This results in a considerable time lapse between exposure to radiation and the final evaluation of dosage.

b. Self-developing film dosimeters based on the principle of Polaroid-Land camera film have been developed.

c. An important requirement for all film dosimeters is that each batch of film should be standardized. Different lots from the same manufacturer differ sufficiently to make it unwise to use them without calibration. A control piece from each lot of film must be developed without exposure and used for comparison with each exposed piece of film in a "densitometer" to determine the dosage absorbed by the individual film badge, and its wearer.

2. Phosphor-Glass Dosimeter (DT-60/PD.) The phosphor glass dosimeter is a small bakelite case slightly larger than an identification tag, containing a specially prepared phosphor glass crystal. Exposure of the glass to gamma radiation produces changes in its internal structure so that when the glass is examined by certain special wave lengths of ultraviolet light, it will glow. The luminescence can be picked up with a photo-multiplier tube, and through an amplifier, can be made to indicate

the radiation exposure of the glass on a meter calibrated in roentgens. The special light source, photo-multiplier tube, meter, etc., required for reading the glass are contained in an auxiliary device called a "computer-indicator." The DT-60/PD is a cumulative device indicating up to 600/R.

3. Pocket Dosimeter (IM-143/PD). This is a high reading dosimeter shaped like a fountain pen and used for brief periods of exposure. Before wearing, the indicator should be set on zero with a radiac detector charger. It has its own self-contained direct reading scale. These dosimeters detect and measure total GAMMA dosage up to 600 R. The Pocket dosimeter is one of the most common applications of an ionization chamber. Accuracy is a major deficiency of pocket dosimeters if used for several days without recharging. If they are charged up to zero and allowed to stand for 24 hours they should not leak off more than 10% of their total range. If they do fall below tolerance, they should be sent to the nearest Radiac Repair Facility for testing and survey.

C. Radiac Computer-Indicator - CP-95/PD.

1. Description. The Radiac Computer-Indicator is a portable instrument designed for computing and indicating the total amount of X-ray and/or gamma radiation to which dosimeter DT-60/PD (and thus the wearer) has been exposed. The computer-indicator is operated from a 120 Volt, 60 cycle AC power source. Its function is to read the exposure registered by the DT-60/PD dosimeter, which contains a crystal of phosphor glass, coated with a special silver compound. The DT-60/PD is a cumulative recording device and readings indicate "total cumulative exposure."

2. Measuring Dosage. To measure the total accumulated exposure dosage of a DT-60/PD dosimeter, place the detector in the computer-indicator. It is exposed to a source of ultra-violet light which causes the silver coated phosphor glass to fluoresce, emitting an orange luminescence.

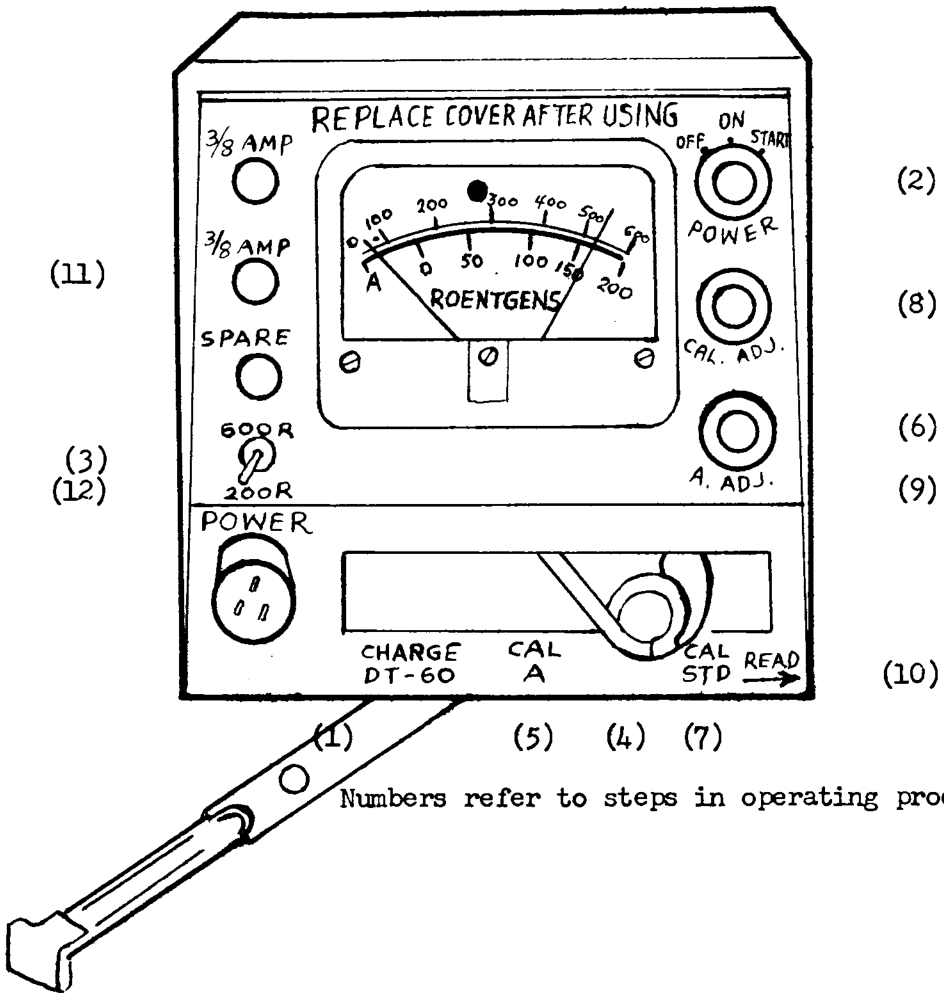
a. A standard crystal that has been exposed to a specified amount of radiation is contained in the skillet of the computer-indicator. The computer-indicator is calibrated to this standard and it compares the DT-60/PD being read with its standard to compute the reading.

b. The luminescence emitted by the DT-60/PD being read is measured by a photo-multiplier tube, fitted with a filter to eliminate passage of blue and green light. The photo-multiplier tube employs the principle of secondary emission to amplify the initial electron emission caused by the filtered orange luminescence illumination of the light sensitive cathode.

c. The output of the photo-multiplier tube is applied to an indicating circuit to indicate on a dial the accumulated total amount of radiation, to which the dosimeter (and thus the wearer) has been exposed.

4. Operation of Computer-Indicator CP-95/PD (see illustration).

a. Connect power cable to computer-indicator and screw connector sleeve up tight. Then plug into 110-120 Volt, 60 cycle AC outlet. Turn on the power switch and allow five minutes to warm up.



Numbers refer to steps in operating procedures.

COMPUTER - INDICATOR CP-95/PD

(1) Extend operating lever and move left to "Charge" DT-60 position.

(2) Turn "ON-OFF" switch to "ON" position and then further continue to "START" until the red light at the upper center of the dial shows, then release the switch.

(3) Flip the range selector toggle switch (lower left side) to the 200R position.

(4) Insert the DT-60 dosimeter into socket in the skillet.

(5) Move the operating lever to "CAL A" position.

(6) With the lower right side control knob, adjust the black needle to "A" on the dial.

(7) Move the operating lever to "CAL STD" position.

(8) With the center right side control knob, adjust the black needle to coincide with the red needle on the dial.

(9) Repeat (5), (6), (7) and (8) until the black needle coincides successively with "A" and red needle.

(10) Move operating lever to "READ" position.

(11) Read accumulated dose on dial of meter.

(12) If the needle registers past the 200R graduation on the lower (black) scale, throw the selector toggle switch to 600R and read the accumulated dose on the upper (green) scale.

NOTE 1: Operators must limit their maintenance to adjustments on the front panel, i.e., fuses, RED and BLACK pointer adjustments.

NOTE 2: 115 Volt AC power supply only is to be used. It requires about five minutes warm-up period with the selector toggle switch on the 200R setting. Before using a new instrument, remove the skillet stop, check value of STANDARD marked on top of STANDARD, and check to see that the setting of the RED pointer agrees with this value. If not, reset the RED pointer by means of the small screw just below the center of the meter. Move the skillet to the right and replace the skillet stop.

b. Calibration: Always calibrate with the toggle selector switch set on the 200R range scale.

(1) With the lower knob on the right side of the panel, adjust the needle to the "A" position - skillet in first position with shutter closed, marked CAL A.

(2) Move the skillet to closed position marked CAL STD and with center knob adjust the needle to coincide with the RED pointer. This pointer is preset to the correct value of STANDARD in the skillet.

(3) Repeat (1) and (2) above till the needle settles on A and the RED pointer when the skillet handle is shifted between these two positions. When using the CP 95 computer-indicator, check needle in A and CAL STANDARD at frequent intervals (about every tenth DT 60 reading) for accuracy.

c. Reading the DT-60 Dosimeter.

(1) Open the DT 60 with wrenches or opening studs on top of CP 95 case under the handle. Take care not to touch the surface of the phosphor glass crystal.

(2) Log the serial number of the DT 60

(3) Place the crystal bearing half of the DT-60 in the receiver socket of the skillet.

(4) Read first on the 600R scale, then, if the reading is below 200R, read on the 200R scale.

(a) On the BLACK scale (o to 200R), the value of each division of the scale is 10R.

(b) On the GREEN scale (0 to 600R), the value of each division is 20R.

(5) Log the reading obtained on the lowest scale.

(6) Open the reader by moving the skillet handle all the way to the left. Remove the DT-60, reassemble with wrenches or studs on the CP-95 case, and return the dosimeter to the wearer.

D. Demonstration of Operation.

1. Using the radioactive source, demonstrate the operation of each radiac instrument to the group.

2. Then permit each trainee to operate the equipment himself.

E. Film. Briefly introduce and show training film MA 6730A, An Introduction to Radiation Detection Instruments, or appropriate films from the MN 8694 series, Radiac Equipment.

F. Radiac Allowance. Radiac equipment in MSTS ships includes some or all of the following allowances:

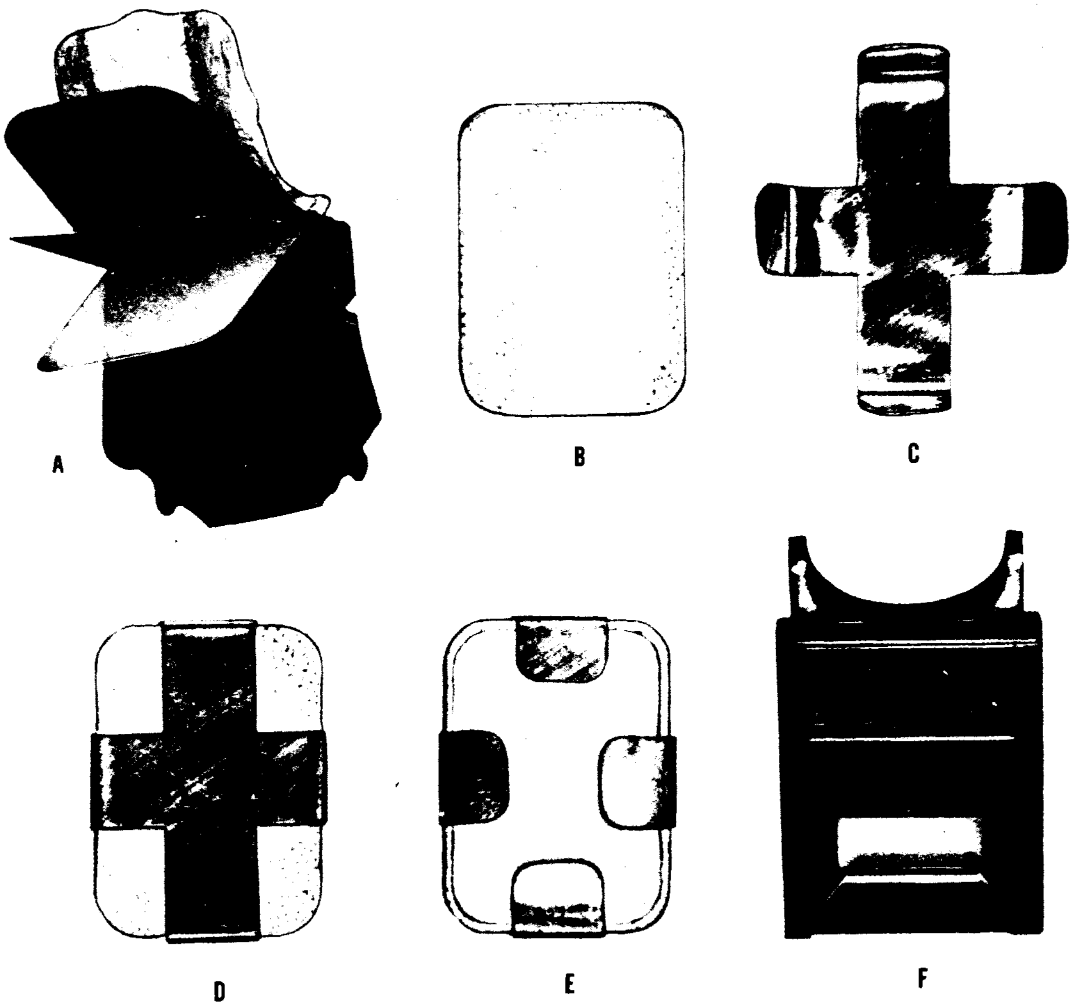
RADIAC EQUIPMENT IN MSTS SHIPS *

INSTRUMENT	PURPOSE	RANGE	POWER	REMARKS
RADIAC SET AN/PDR-43 Series (High Intensity Gamma Measurements) (AN/PDR-18 is interim until replaced.)	Survey	0 to .5 R/HR 0 to 5.0 R/HR 0 to 50 R/HR 0 to 500 R/HR	Battery	Must be checked every six months by authorized radiac repair facility in accordance with area command's instructions.
RADIAC SET AN/PDR-27 Series (Low Intensity Beta Gamma Measurements)	Survey	0 to .5 MR/HR 0 to 5.0 MR/HR 0 to 50 MR/HR 0 to 500 MR/HR	Battery	Must be checked every six months by authorized radiac repair facility in accordance with area command's instructions.
* SURVEY METER, ALPHA AN/PDR-56 Series for ships having nuclear weapons handling facilities	Survey	0 to 1,000,000 CPM/17 CM2	Battery	Must be checked every six months by authorized radiac repair facility in accordance with area command's instructions.
PHOSPHOR-GLASS DOSIMETER DT-60/PD Casualty dose, indicating	Personnel protection	To 600 R	None required	Non-indicating. Must be read with a "Computer-Indicator" CP-95/PD.
* POCKET DOSIMETER IM-143/PD	Personnel protection	Up to 600 R	Set on Zero by charger	Direct reading instrument.
POCKET DOSIMETER IM-94/PD, High dose, indicating	Personnel protection	0 to 100 R	Set on Zero by charger	Current but to be superseded by IM-143/PD.
RADIAC DETECTOR CHARGER, DOSIMETER PP-354/PD	Charging Pocket Dosimeters		Self-contained electrostatic generator	Used in charging: AN/PDR-17, IM-8/PD, IM-9A/PD, IM-19/PD, IM-21/PD, IM-22/PD, IM-94/PD, IM-143/PD.
COMPUTER INDICATOR CP-95/PD	For use with DT-60/PD	0 to 200 R 0 to 600 R	120 Volt AC	Reading is total radiation dosage to which the DT-60/PD has been exposed.

*Radiac equipment allowances for MSTS ships in-service are established by and contained in COMSTS INST. 9670.1B (Allowance of Electronic Equipment for MSTS ships in service; establishment of).

PP-354 E/PD CHARGER

IM-143/PD SELF-READING POCKET DOSIMETER



FILM BADGE AND HOLDER

A FILM BADGE CONSISTS OF A SMALL PACKET CONTAINING SEVERAL PHOTOGRAPHIC FILMS (A-B), A CROSS OF THIN SHEET LEAD (C) IS BENT AROUND THE FILM PACKET (D-E), THEN INSERTED IN A CLIP-ON HOLDER (F) FOR ATTACHMENT TO THE WEARER'S CLOTHING.

V. SUMMARY. - Show, describe and demonstrate the use of the following radiac instruments:

A. Hi-R Equipment. Portable survey equipment capable of detecting and indicating the presence of high intensity of gamma radiation, from 0 to 500 roentgens per hour.

B. Lo-R Equipment. Portable survey equipment capable of detecting and indicating the presence of low intensity (low roentgen) of beta-gamma radiation, from 0 to 500 milliroentgens per hour.

C. Phosphor-Glass Dosimeter. A badge used for personnel protection; has a range of 0 to 600 R/HR. No power such as batteries is required. It is non-indicating and must be read with a computer-indicator.

D. Radiac Computer-Indicator. Designed for computing and indicating the total amount of X-ray and gamma radiation to which dosimeter DT-60/PD has been exposed. Power required for operation is 120 volt AC. Range is 0 to 600 R/HR.

E. Radiac Detector Charger. Used for charging the pocket dosimeter. Power is supplied from a self-contained frictional electrostatic generator (currently, pocket dosimeters are unreliable but a reliable model is being developed).

NOTE: New, improved radiac equipment is under continual development, with a considerable time lag before its shipboard availability. In the meantime, older equipment becomes difficult to maintain and may be declared obsolete. Therefore, the list on page 3-145 is not necessarily up to date but does indicate the types of equipment generally available for training purposes. New equipment will be provided as developed and available.

VI. TEST AND APPLICATION.

A. Test -- Use these and additional questions as an oral quiz.

1. Q. Define a "dose rate" meter.
A. A "dose rate" meter is a device that measures the intensity of radiation in roentgens per hours, similar to a speedometer reading in "miles per hours".

2. Q. What is the purpose of a phosphor-glass dosimeter or badge?
A. A phosphor-glass dosimeter is a device used to indicate the accumulated dosage of radiation; it is similar to total miles driven on a speedometer.

3. Q. What is the difference between a high intensity meter and a low intensity meter?
A. High intensity devices read in roentgens (R) and low intensity devices read in milli-roentgens (MR).

4. Q. May shipboard personnel service radiac instruments?
A. No. Shipboard personnel are not permitted to service radiac equipment. These instruments are very delicate and sensitive and must be serviced only in authorized radiac repair shops.

5. Q. Can nuclear radiation be detected by any of the five natural senses?

A. No. It can be detected only with radiac instruments.

6. Q. How is the phosphor-glass dosimeter (DT-60) read?

A. It is read by the use of an auxiliary device called a "Computer-indicator".

7. Q. What radiac equipment is included in allowances of MSTS ships?

A. Radiac set (high intensity)
Radiac set (low intensity)
Phosphor-glass dosimeter, pocket dosimeter, radiac detector-charger, and computer-indicator.

8. Q. Define the term "radiac".

A. "Radiac" is the term given to all radio-activity detection instruments. It stands for Radiological Activity Detection, Identification, and Computation.

9. Q. Name the three basic types of nuclear radiation given off by radioactive elements.

A. Alpha particles, beta particles, gamma rays.

10. Q. Name the three main purposes of monitoring for nuclear radiation.

A. To determine location, intensity and dose rate of radiation to which exposed personnel have been subjected.

B. Application - Have each individual demonstrate his knowledge of and ability to take readings with the various radiac instruments.

R - Radiological
A - Activity
D - Detection
I - Identification
A - And
C - Computation

VII. HANDOUT. A convenient radiation dosage calculator has been placed aboard many ships (see illustration of next page). The following directions for its use may be reproduced as a handout and for reference purposes.

DIRECTIONS FOR USING THE RADIATION DOSAGE CALCULATOR

A. Radiation Hazard. After a nuclear explosion, there is danger of residual radioactivity caused by fallout in the case of an air burst, or by the base surge or radioactive rain in an underwater burst. After the fallout is over, the radioactivity decreases with time, rapidly at first, then more and more slowly, through natural decay.

B. What the Calculator Will Do. The radiation dosage calculator will solve three types of problems:

1. It will predict the dosage rate at any future time (or give the rate for any time past).

2. It will find the total dose accumulated by one person (or persons) up to the present time.

3. It will determine the stay time for any permissible dosage (the length of time one can remain exposed): Entry time, or exit time.

C. Background Information. The master, damage control officer and ABC defense officer should know or determine the following before using the calculator:

1. The units of measurement for DOSE and DOSE-RATE are roentgens (r) and milliroentgens (mr), or one-thousandth of a roentgen. "K" on the outer dial ("A" dial) means thousand, so 1K equals 1000 units. The "A" dial is the one on which all DOSE or DOSE-RATE readings in roentgens or milliroentgens are read. *

2. As in reading from a speedometer, the DOSE-RATE readings are in r/hr or mr/hr and the DOSE readings are in r or mr, as "miles traveled", or amounts of radiation exposure during a given time. *

3. The middle dial (red or "B" dial) is the "TIME after the detonation" dial. All times are measured from the TIME of the incident - the "H" hour. *

4. The inner dial (black - "C" dial) is the "TIME OF EXPOSURE" dial, which is used for all problems involving total DOSE received during any length of time in a contaminated area. *

5. The master must know the permissible whole body doses (if only a part of body is exposed, there is less danger):

a. In peacetime, 5 r is the highest permissible accumulated dose in a year.

b. An accidental or emergency dose of 25 r over the whole body is assumed to have no permanent effect, but this dosage should occur only once in a lifetime.

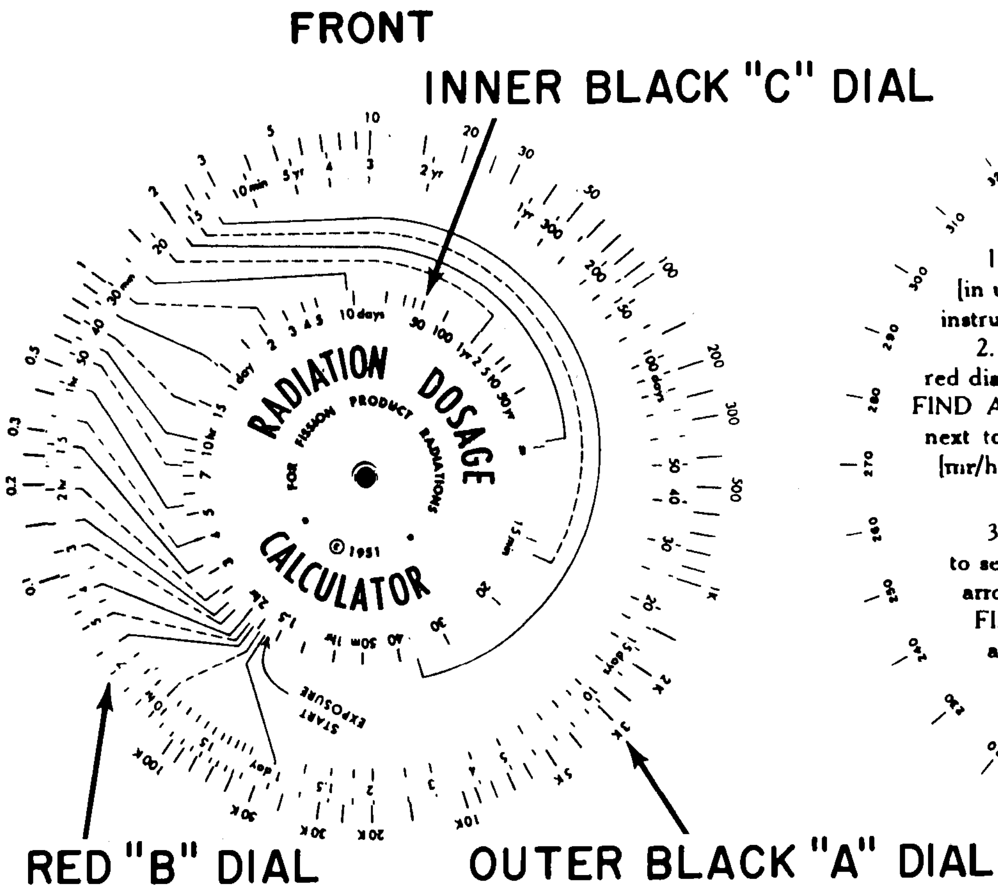
c. In wartime, military necessity may call for greater exposures than the above.

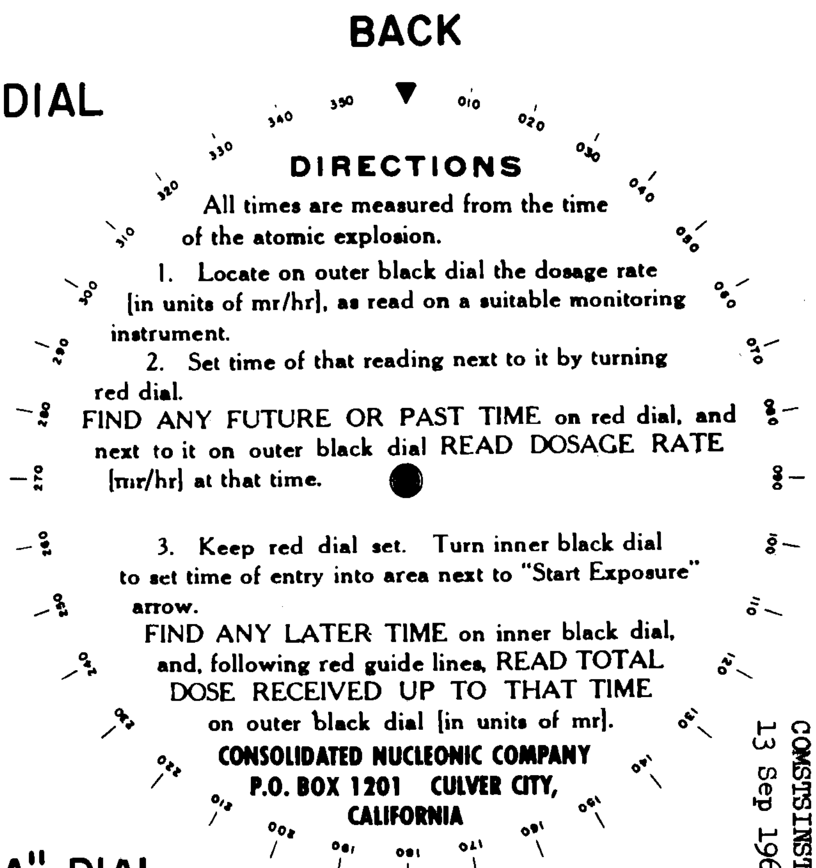
6. If readings taken through a door continue to rise, keep under cover, since fallout is continuing.

7. Constant, or decreasing, radiation level readings at a selected interior location will indicate when fallout has ceased.

D. Procedure in Solving Problems. *

1. Sample DOSE-RATE problem.


FRONT
INNER BLACK "C" DIAL
RADIATION DOSAGE
FOR FISSION PRODUCT RADIATIONS
CALCULATOR
©1951
START EXPOSURE
RED "B" DIAL
OUTER BLACK "A" DIAL


BACK
DIRECTIONS
All times are measured from the time of the atomic explosion.
1. Locate on outer black dial the dosage rate (in units of mr/hr), as read on a suitable monitoring instrument.
2. Set time of that reading next to it by turning red dial.
FIND ANY FUTURE OR PAST TIME on red dial, and next to it on outer black dial READ DOSAGE RATE (mr/hr) at that time.
3. Keep red dial set. Turn inner black dial to set time of entry into area next to "Start Exposure" arrow.
FIND ANY LATER TIME on inner black dial, and, following red guide lines, READ TOTAL DOSE RECEIVED UP TO THAT TIME on outer black dial (in units of mr).
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a. Facts given. Ten hours after the explosion (H + 10) a survey meter gives a reading of 200 mr/hr in a contaminated area.

b. To Find. What will be the DOSE-RATE reading at 1 day (24 hours) after the explosion (H + 1d)?

c. Procedure. Using the outer and middle dials only ("A" and "B" dials), rotate the red "B" dial until the 10 hour mark is directly opposite 200 (mr) on the black "A" dial. Then opposite the 1 day mark on the red "B" dial, read 70 as the answer on the black "A" dial. This is in mr/hr, since your original reading was given in mr/hr. If the original units were r/hr, the answer would be in r/hr. This same setting can be used for determining the predicted DOSE-RATES at any future time - or vice-versa, the time at which any specific dose-rate reading can be expected.

Example: To find the time at which the intensity would fall to 10 mr/hr, based on the same facts as in the previous problem, use the same basic setting, locate 10 on the outer black "A" dial and read 5 days on the red "B" dial as the answer.

2. Sample ACCUMULATED DOSE Problem.

a. Facts given. The dose-rate reading at H - 10 was 20 r/hr. A man was observed entering the area at H + 7.

b. To Find. What will be his accumulated dose to the present time - 10 hours after the explosion (H + 10)?

c. Procedure. The two outer dials are rotated so that 20 (r) on the outer black "A" dial is opposite 10 hrs on the red "B" dial. Rotate inner black dial ("C" dial) until the 7 hr mark is opposite the end of the START EXPOSURE arrow on the red "B" dial. Place the 7 hr mark opposite the end of the arrow, not the line next to it. Now locate the 10 hour mark on the "C" dial, follow the red guide line out to the outer black dial ("A" dial - DOSE reading dial) and read about 80 (80 r, since the original Dose Rate was in r/hr).

NOTE: Since the 10 hour mark on the inner black "C" dial is slightly "behind" the red guide line, a corresponding proportionate correction is made in reading the correct answer off the outer black "A" dial.

3. Sample STAY-TIME Problem.

a. Facts given. The Dose-Rate reading is 3r/hr at H + 5 hrs. The Master has set the MAXIMUM PERMISSIBLE EXPOSURE DOSE (MPE) at 20r.

b. To Find. STAY-TIME in the area for a man who enters at 5 hours after the blast (H + 5).

c. Procedure. Use same basic procedure for setting "A", "B", and "C" dials as for previous problem - except the initial readings and conditions are now 3 r/hr at H + 5. The new condition for which answer is needed is that the man should not be allowed to accumulate more than a dose of 20r, as set by the Master. How long can be STAY in the contaminated area?

After setting 3 (r) on the outer black "A" dial opposite 5 hrs on the "B" dial, and ENTRY time at 5 hrs on the "C" dial, find the maximum dose reading 20 (r) on the outer black "A" dial, follow the red guide line on the "B" dial down inward to the inner black "C" dial and read 1 day. This is TIME AFTER the blast - to determine the approximate number of hours the man should be allowed to STAY in the area after he entered, it would be necessary to subtract the 5 hours (he entered at H + 5) from 1 day. The STAY-TIME then would be:
1 day, or 24 hours, minus 5 hrs., equals 19 hrs. as the answer.

4. Variation. Often you are interested in determining when you can ENTER a contaminated area and STAY for a period of time without exceeding an established radiation exposure limit.

a. Facts given. The MPE is 25r and the original DOSE-RATE reading is 16r at H + 3 hrs.

b. To Find. When can you enter the area to perform rescue work estimated to require 4 hours STAY-TIME without exceeding the MPE of 25r?

c. Procedure. Set the 16 (r) DOSE-RATE on the outer black "A" dial opposite the 3 hr marker on the red "B" dial.

Note the 25(r) DOSE mark on the outer black "A" dial and follow the corresponding red GUIDE LINE down or in toward the "C" dial. This guide line and the "START EXPOSURE" marker now represent the two limits between which you want to place the earliest 4 hrs of STAY-TIME, as indicated on the inner "C" dial. By moving the various hour markers on the "C" dial back and forth so that a total of 4 hrs of elapsed time can be "compressed" between these two limits, it will be seen that the earliest time at which this can be done is with the space between the hour markers of 5 hrs ENTRY TIME and 9 hrs EXIT TIME.

It will be noted that if you place the 4 hr marker at START EXPOSURE, the next 4 hours of elapsed time would carry you beyond the 25r limit line. This, then, indicates that this would be too early as an entry time. In like manner, any trial after 5 hrs Entry Time would indicate that 4 hours elapsed time would fall well within the 25r limit.

Accordingly, the answer to your problem is: ENTRY TIME should be at H + 5.

5. Directions. The directions on the back of the calculator should also be studied and used in solving similar practice problems.

E. Stowage of Calculator. Recommended stowage of the calculator is in a conspicuous cloth pocket in damage control central.