NATIONAL BUREAU OF STANDARDS REPORT

6518

Development of Taxi Guidance Wands
for Carrier Deck Personnel

By
R. S. Rinkinen

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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Information on the Bureau's publications can be found in NBS Circular 460, Publications of the National Bureau of Standards ($1.25) and its Supplement ($0.75), available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

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NBS PROJECT		**NBS REPORT**
0201-20-02411	August 1959	6518

Development of Taxi Guidance Wands
for Carrier Deck Personnel

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For
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Bureau of Aeronautics Project TED NBS SI-5001

NBS

U. S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

Development of Taxi Guidance Wands for Carrier Deck Personnel

1. PROJECT OBJECTIVE

During daylight operations of aircraft carriers the flight-deck plane directors use hand signals for advising the pilot when to retract the aircraft tail hook and flaps, when to apply right or left brake, and when to apply full power for catapult launches, etc. For night operations the plane directors use illuminated wands to provide the same signals. The present wands are plastic cylinders designed for attachment to the type MX993U Navy flashlights. The wands are approximately 8 inches long with an outside diameter of 1 inch, except at the base, which is designed to replace the cover-glass retaining ring of the flashlight case. The wands now in use have low luminance along their length and tend to transmit light to and out of the end of the cylinder. Consequently the wands are not as visible to the pilot as they should be for ready identification of the signals. Further difficulty is encountered because the weight of the wand assembly and the high wind pressure on it quickly tire the arms of the directing personnel.

Accordingly, the Visual Landing Aids Branch of the Bureau of Aeronautics in Project Directive TED NBS SI-5001 dated 24 June 1958 requested the National Bureau of Standards to design and construct evaluation models of hand-held lighted wands which would be smaller and lighter than the present wands and would have a higher and a more uniform luminance.

2. DESIGN CONSIDERATIONS

2.1 Wand

Preliminary study and previous experience with snow extension rods for flush runway lights indicated that the most suitable shape for the wand was a truncated cone, the base of which was approximately the diameter of the flashlight reflector. Preliminary tests were made of a solid cone machined from methacrylate with the surface of the cone roughened to provide a diffusing finish. The luminance of this surface was much higher and more uniform than the luminance of the wands presently in use. The improvement in luminance was due principally to the nearly complete interception of the collimated beam from the flashlight reflector by the surface of the wand.

Further improvement and a reduction in weight were obtained by making a hollow, thin-walled methacrylate cone. Both the inside and the outside of the cone were frosted by dipping the cone in concentrated nitric acid. This produced a smooth diffusing finish but it was somewhat difficult to control the processing and subsequent washing procedures.

A further substantial improvement in performance and simplification in production were obtained by the use of polyethylene instead of the etched methacrylate. The polyethylene material has a waxy white translucent appearance and does not require etching. It is easily molded. It remains flexible over a wide range of temperature, thus eliminating breakage.

2.2 Wand-Flashlight Assembly

The efficiencies of both the methacrylate and the polyethylene wands were so much higher than the efficiency of the present wand that it was possible to use a two-cell, C-size flashlight in place of the present D-size flashlight, thus further decreasing the size and weight of the assembly. Details of the assembly are shown in figure 1. This design is based upon a commercially available metal-case flashlight. In this design the cone is held to the retaining ring by a force-fit adaptor ring as the type of thread on the flashlight case is not suitable for use in polyethylene. The color of the wand is obtained by a 1/32-inch-thick plastic filter placed between the cone and the flashlight reflector. To increase the uniformity of luminance, a small cup is attached to the center of the filter to shield the cone from direct light from the lamp.

2.2 Type of Battery

Consideration was given to the use of rechargeable nickel-cadmium cells in place of the conventional dry cells. One advantage in the use of the rechargeable batteries is that the batteries could be left on charge except when the wands were being used. A flashlight design was developed so that either dry cells or rechargeable batteries could be used. A small connector was installed in the end of the flashlight to permit the batteries to be charged without removal from the flashlight. Tests made of the electrical characteristics of the rechargeable batteries indicated that their performance would be satisfactory. Life tests were not made but manufacturers' data indicates a useful life of 100 to 200 charging cycles.

However, after the use of rechargeable batteries had been considered at several conferences between Bureau of Aeronautics and National Bureau of Standards personnel, the conclusion was reached that there would be no appreciable gain at present in the use of rechargeable batteries for taxi guidance wands. Factors considered were:

1) The complexities of the problems involved in providing charging facilities aboard carriers.

2) The difficulty of modifying flashlight cases or of providing external charging racks.

3) The relatively high cost of rechargeable cells. The cost is about $5.00 each for C-size cells in small lots as compared with $0.05 for a C-size dry cell. Since the average energy output per cycle of the rechargeable cell is about equal to the energy output of a dry cell of the same size, the cost of the rechargeable battery per cycle, neglecting cost of charging and costs due to damage and loss, is more than half the cost of a dry battery.

4) The relatively high possibility of loss or damage before the end of the useful life of the battery.

5) The weight of a rechargeable battery is about twice that of a dry battery of similar size.

2.4 Subsequent Development

Because of the complexities involved in supplying the fleet with the wands which would require C-size flashlight cases and cells which are not now readily available, the National Bureau of Standards was requested as an interim measure to design a polyethylene wand suitable for use with the type MX993U Navy flashlight now in use. Figure 2 is a drawing of this wand. Note that since the threads of this flashlight case are designed for use in plastics, it is possible to mold threads in the wand so that a retaining ring is not required.

3. PERFORMANCE

Day and night views of the present wand, the C-size cell wand, and the Navy flashlight with a polyethylene wand, are shown in figures 3 and 4 respectively. The exposure given the present wand in making figure 4 was approximately twice the exposure given the other two wands.

Table 1 gives the weight and luminance data of the three wands.

Table 1

	Weight Wand Only (Oz.)	Weight Wand & Flashlight & Battery (Oz.)	Average Luminance* (Footlamberts) (red light)	Ratio Maximum to Minimum Luminance*
Present Wand	3.5	15.5	0.11	6.9
C-Size Cell Polyethylene Wand	1	6.5 **	2.3	2.7
D-Size Cell Polyethylene Wand	2	13.5	4.5	8.9

* Perpendicular to axis of wand.
** With inexpensive commercial case. Weight with heavy-duty case would be greater.

Twenty C-size cell polyethylene wands on inexpensive commercial flashlights were supplied the Bureau of Aeronautics for service tests (of the wands only) aboard a carrier. Informal oral reports indicate that the performance of these wands was very satisfactory.

4. DISCUSSION

The use of a translucent instead of an opaque shield over the lamp of wand B, figure 4, would increase the luminance of the base of the wand and thus provide a more uniformly lighted wand.

No shield over the lamp was included in the design of wand C, figure 4, since this is an interim design. Use of such a shield would provide a more uniformly lighted wand.

5. RECOMMENDATIONS

The conical wand of polyethylene is a major improvement over the wands now used by the Navy. Its use is recommended.

As the luminance of the polyethylene wand on a C-size cell flashlight is sufficiently high, the use of this size flashlight is recommended since it is smaller and lighter than the D-size cell flashlight.

August 1959

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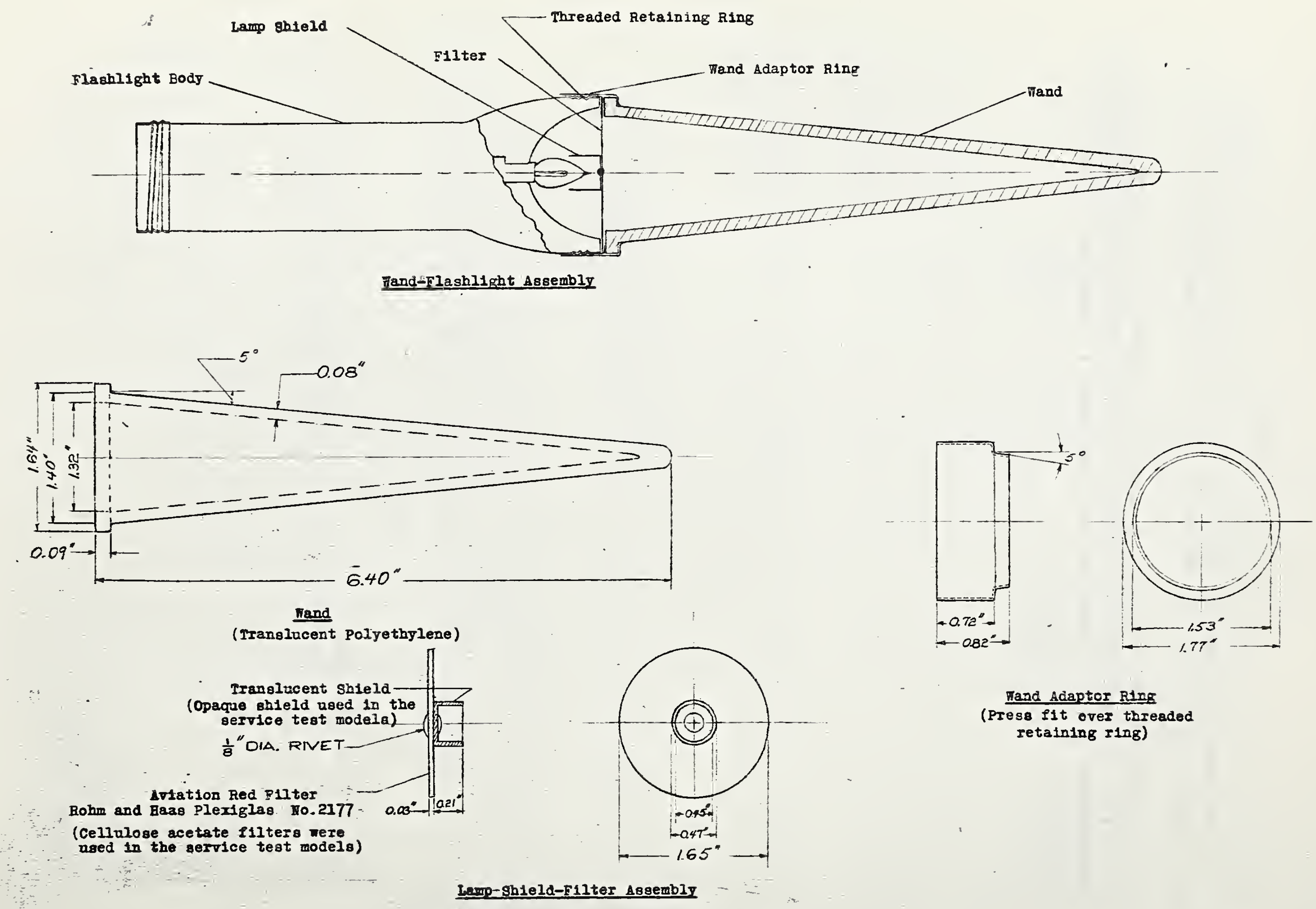
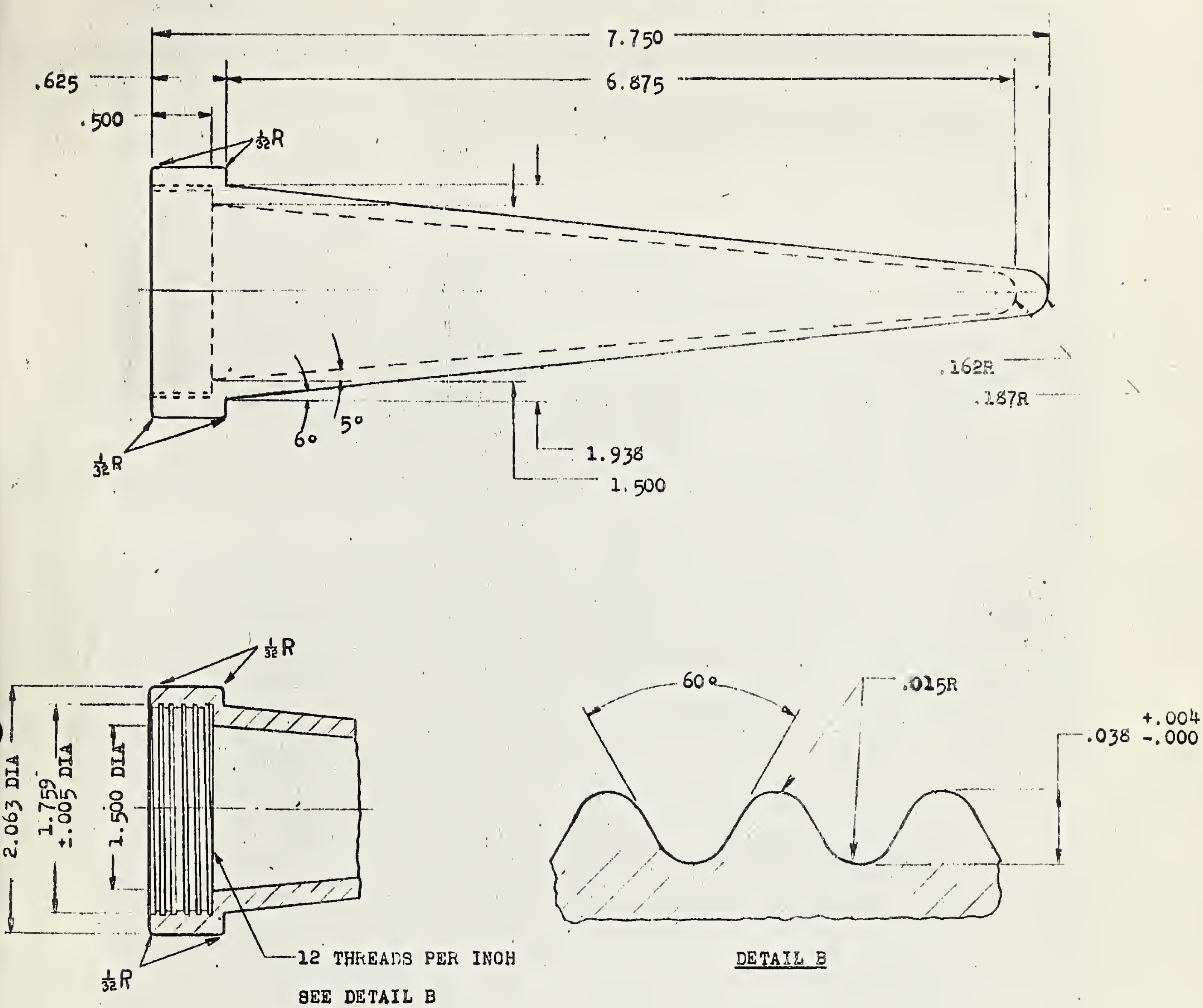


N.B.S. TAXI GUIDANCE WAND

Figure I.



MATERIAL - POLYETHYLENE

WAND, TAXI SIGNAL IS TO BE USED WITH MX-993/U FLASHLIGHT TO COMPLETE ASSEMBLY.

DIMENSIONS IN INCHES. UNLESS OTHERWISE SPECIFIED, TOLERANCES: ±.031

WEIGHT 2 OUNCES.

ONE EACH OF RED AND GREEN CELLULOSE ACETATE PLASTIC FILTERS $1.740 \begin{smallmatrix}-.005\\+.000\end{smallmatrix}$ DIA X .032 THICK SHALL BE PROVIDED WITH THE ASSEMBLY. FILTERS MAY BE DIE-CUT FROM SHEET STOCK. RED FILTER SHALL MEET THE TEST REQUIREMENTS OF SPECIFICATION MIL-F-3747. GREEN FILTER SHALL BE COMPARABLE TO COLOR NUMBER 34108 OF FEDERAL STANDARD 595.

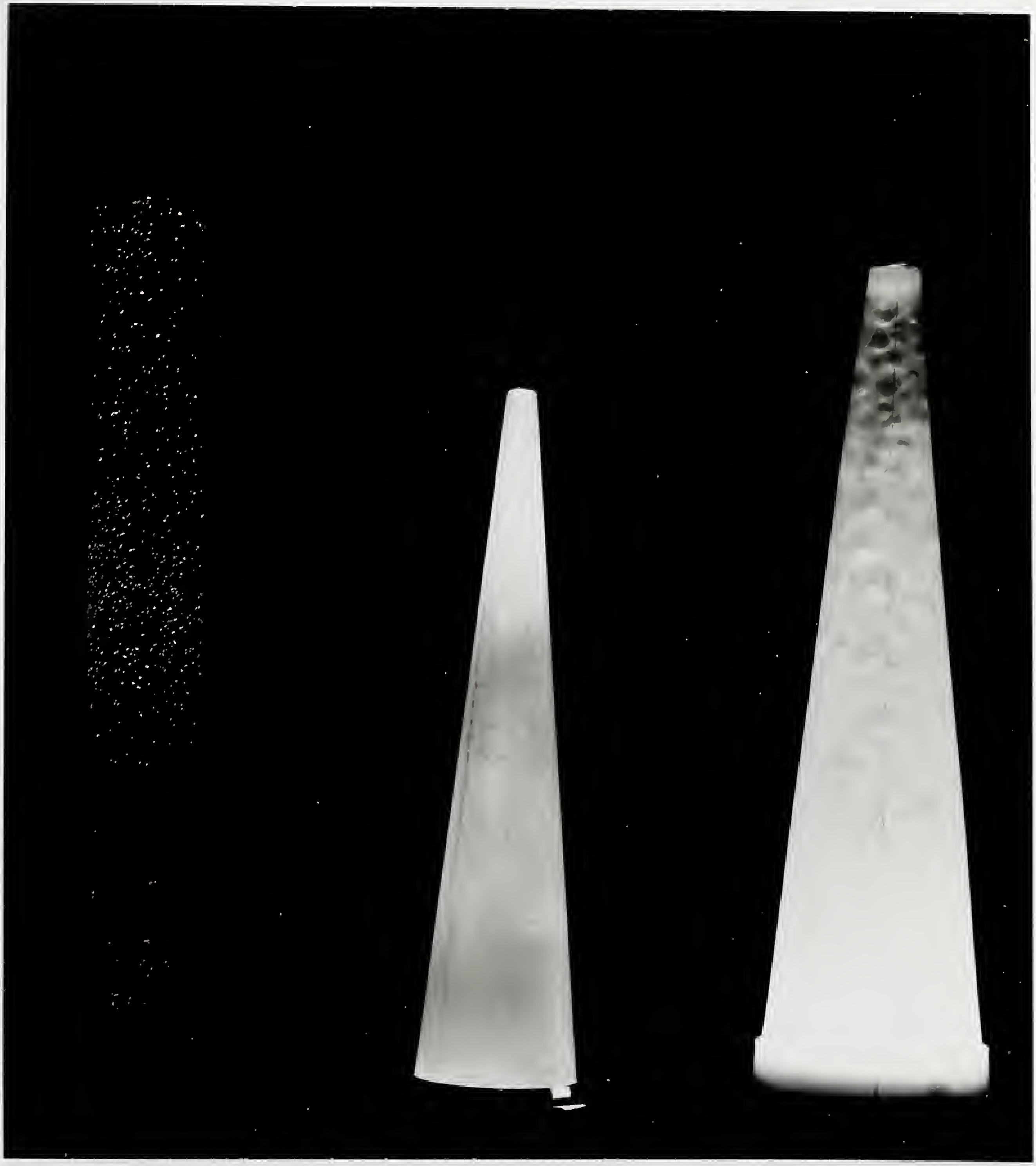
WAND FOR NAVY FLASHLIGHT MODEL MX 993U

Figure 2

A B C

Taxi Guidance Wands: A. Present model B. N.B.S. C-size cell model C. Polyethylene cone on Navy flashlight

Figure 3



A B C

Taxi Guidance Wands: A. Present model B. N.B.S. C-size cell model
C. Polyethylene cone on Navy flashlight

Figure 4

U.S. DEPARTMENT OF COMMERCE
Frederick H. Mueller, Secretary
NATIONAL BUREAU OF STANDARDS
A. V. Astin, *Director*

THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its headquarters in Washington, D.C., and its major laboratories in Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

WASHINGTON, D.C.

Electricity and Electronics. Resistance and Reactance. Electron Devices. Electrical Instruments. Magnetic Measurements. Dielectrics. Engineering Electronics. Electronic Instrumentation. Electrochemistry.

Optics and Metrology. Photometry and Colorimetry. Optical Instruments. Photographic Technology. Length. Engineering Metrology.

Heat. Temperature Physics. Thermodynamics. Cryogenic Physics. Rheology. Engine Fuels. Free Radicals Research.

Atomic and Radiation Physics. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics. Neutron Physics. Radiation Theory. Radioactivity. X-rays. High Energy Radiation. Nucleonic Instrumentation. Radiological Equipment.

Chemistry. Organic Coatings. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Molecular Structure and Properties of Gases. Physical Chemistry. Thermochemistry. Spectrochemistry. Pure Substances.

Mechanics. Sound. Mechanical Instruments. Fluid Mechanics. Engineering Mechanics. Mass and Scale. Capacity, Density, and Fluid Meters. Combustion Controls.

Organic and Fibrous Materials. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Plastics. Dental Research.

Metallurgy. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion. Metal Physics.

Mineral Products. Engineering Ceramics. Glass. Refractories. Enameled Metals. Concreting Materials. Constitution and Microstructure.

Building Technology. Structural Engineering. Fire Protection. Air Conditioning, Heating, and Refrigeration. Floor, Roof, and Wall Coverings. Codes and Safety Standards. Heat Transfer.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics.

Data Processing Systems. SEAC Engineering Group. Components and Techniques. Digital Circuitry. Digital Systems. Analog Systems. Application Engineering.

• Office of Basic Instrumentation.

• Office of Weights and Measures.

BOULDER, COLORADO

Cryogenic Engineering. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Gas Liquefaction.

Radio Propagation Physics. Upper Atmosphere Research. Ionospheric Research. Regular Propagation Services. Sun-Earth Relationships. VHF Research. Radio Warning Services. Airglow and Aurora. Radio Astronomy and Arctic Propagation.

Radio Propagation Engineering. Data Reduction Instrumentation. Modulation Systems. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Radio Systems Application Engineering. Radio-Meteorology. Lower Atmosphere Physics.

Radio Standards. High Frequency Electrical Standards. Radio Broadcast Service. High Frequency Impedance Standards. Electronic Calibration Center. Microwave Physics. Microwave Circuit Standards.

Radio Communication and Systems. Low Frequency and Very Low Frequency Research. High Frequency and Very High Frequency Research. Ultra High Frequency and Super High Frequency Research. Modulation Research. Antenna Research. Navigation Systems. Systems Analysis. Field Operations.

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