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FINAL TYPE REPORT (TECHNICAL)

Development of Dosimeter Calibration Attachment

For CDV-794X

OCD Contract No. OCD-OS-62-260

This report has been reviewed in the Office
of Civil Defense and approved for publication.

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ABSTRACT

- 1 - - - The requirements of the dosimeter calibrator are presented, and specific solutions to the design problems are given. Also described are a number of unsatisfactory attempts to meet the requirements.
- 2 - - - This report describes the necessary modifications to the GDV-794X calibrator, and a method to prepare existing calibrators for use with this attachment.
- 3 - - - The specifications for the attachment are tabulated. Test specifications and procedures are given.
- 4 - - - A summary of test data obtained from a series of repeated readings with the dosimeters provided by OCD under the subject contract shows the accuracy attainable in checking a dosimeter for proper operation. It is recommended that the calibrator be used to compare uncalibrated dosimeters with standards of known calibration.

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1. PURPOSE

- 1.1 - - - The purpose of this report is to describe the development of the electrically operated dosimeter calibration attachment for Calibrator CDV-794X.
- 1.2 - - - The scope of work outlined in contract OCD-OS-62-260 included the following specific requirements from Tracerlab:
 - a. Furnish a planetary gear drive and electric timer start-stop functions interconnected and compatible with CDV-794X control system.
 - b. Modify the Government furnished calibrator for use with the new attachment to accommodate CDV-138, CDV-730, CDV-736, CDV-740, CDV-742, and CDV-746 dosimeters.
 - c. Manufacture a complete dosimeter calibration attachment, make all necessary modifications to CDV-794X and perform laboratory tests.
- 1.3 - - - This report includes a description of how these requirements were met together with necessary specifications and production cost data.

2. GENERAL DESCRIPTION

- 2.1 - - - The attachment design consists of a single electro-mechanical unit which can be lowered to the base of the CDV-794X test chamber. Included in the unit are 8 chucks that accept the dosimeters to be calibrated, a timer-programmer, and a motor driven turntable. Power and control connections are made via a short cable and connector. Figure I shows the unit assembled. Figure II shows an exploded view.

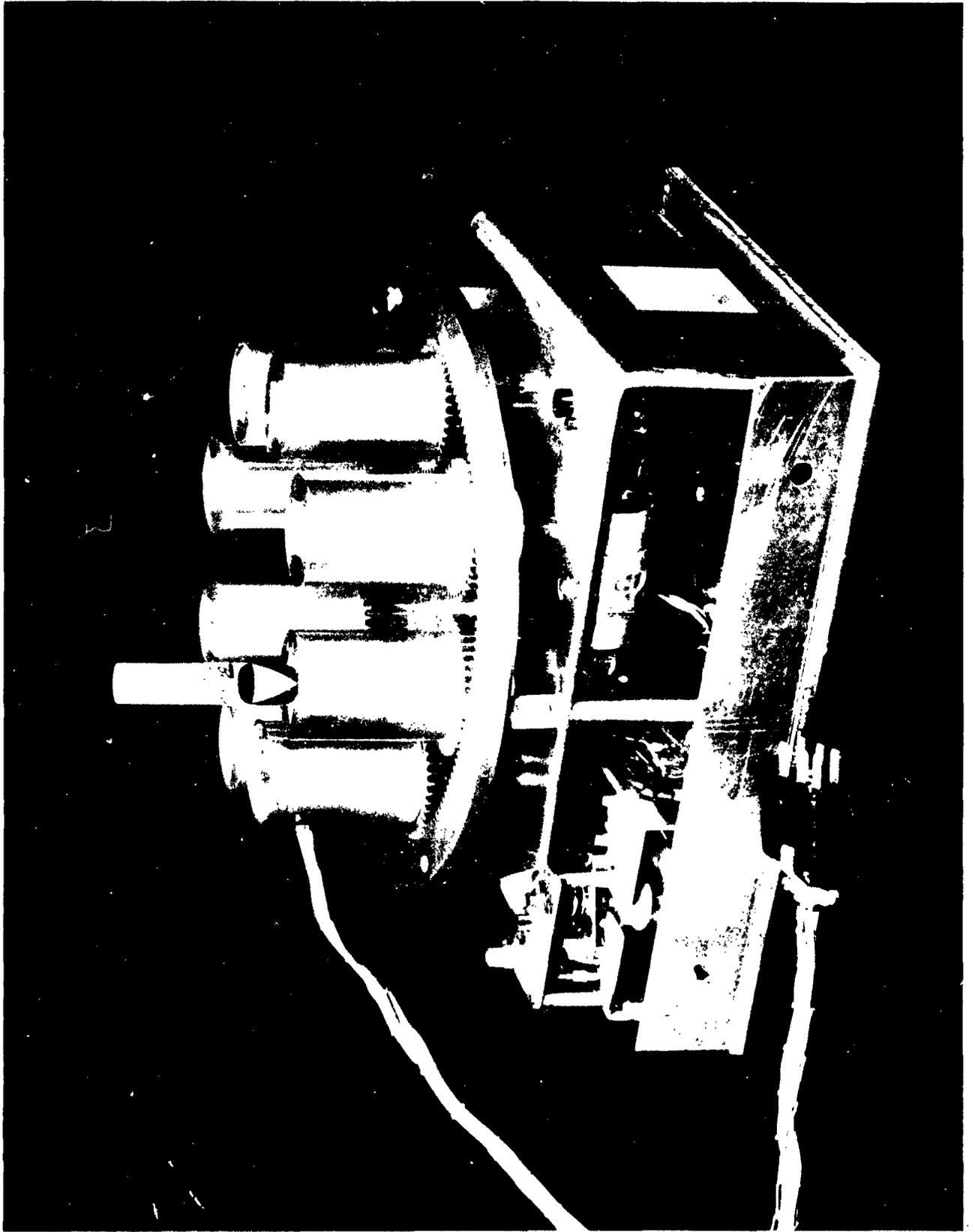


FIG. 1 Assembled Unit

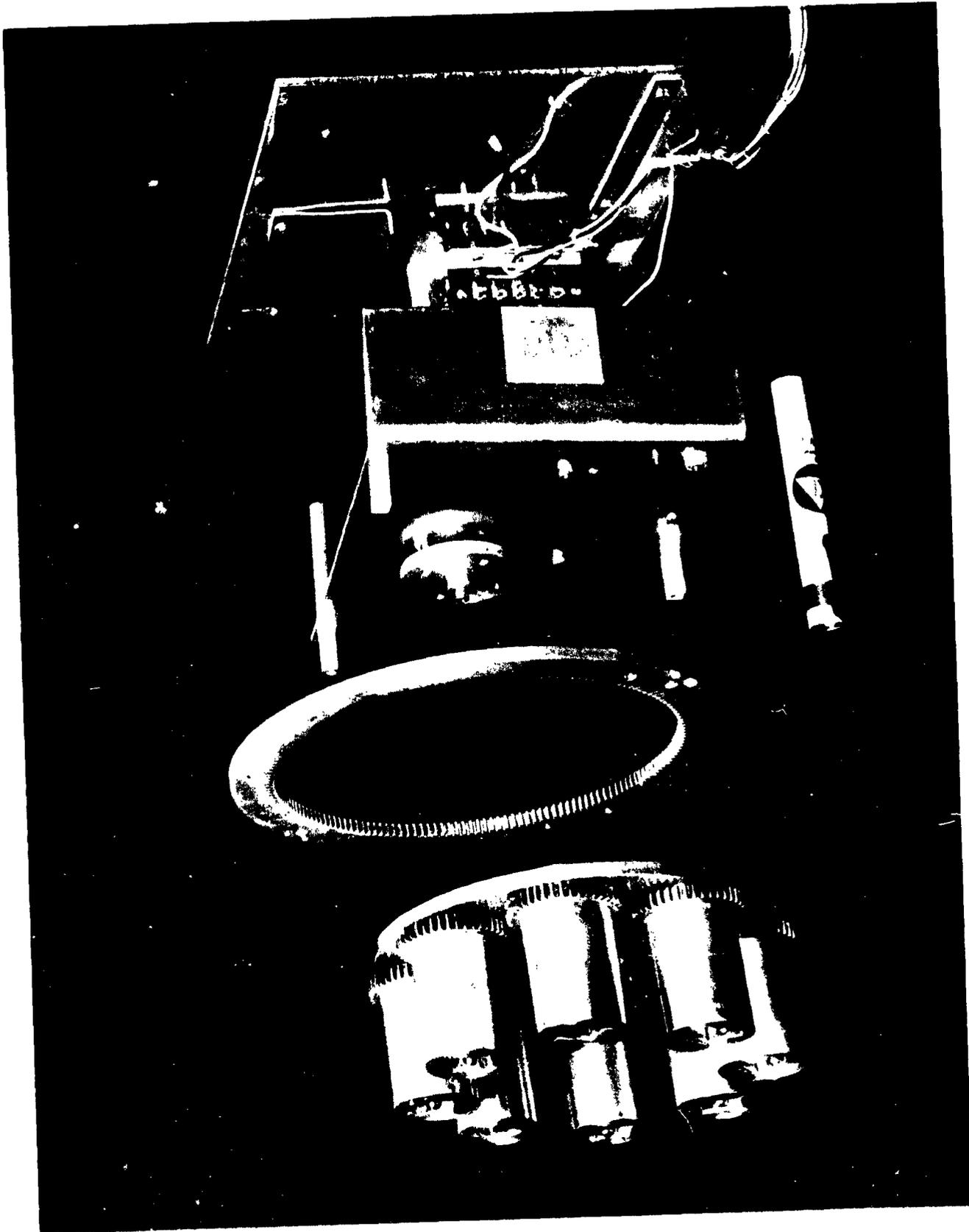


FIG. 11 Enclosed View

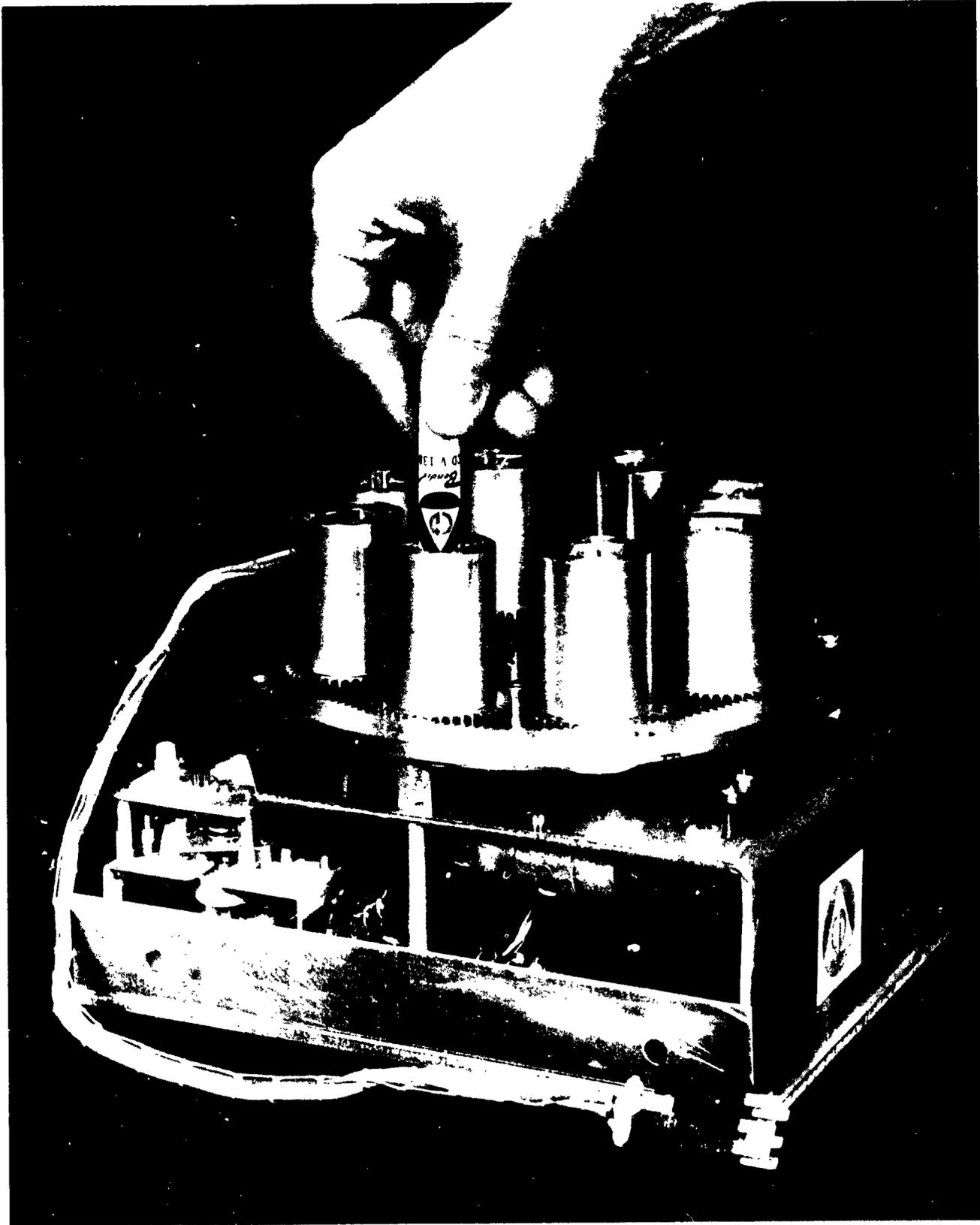


FIG. III

2.2 - - - Dosimeters to be tested are inserted lens down into the chucks as in Figure III. When the unit is loaded and chamber doors are closed, the CDV-794X can be operated by selecting the correct field intensity for the type of dosimeter being calibrated. The calibrator operation time will be controlled by the attachment programmer and the dosimeters receive a uniform, accurate exposure to the calibrator source of radioactivity.

3. BACKGROUND FOR DESIGN

The Dosimeter Calibration Attachment design has been based to some extent on the data in Final Type Report No. 1, Contract No. DA-36-039-SC-87320, USASRDL, Fort Monmouth, New Jersey. The basic requirements and final design of the calibrator resulted from technical discussions with Mr. Robert B. Martin, Project Coordinator - OCD, Washington, D. C., and Tracerlab personnel.

4. CALIBRATOR AND DOSIMETER DATA

4.1 - - - Data on the CDV-794X was obtained from OCD Standard Item Specification CDV-794, June 1, 1962, and from actual measurements performed on CDV-794X unit number 3, which was used at Tracerlab during the project. Data on dosimeters was obtained from measurements on representative samples of the following types:

<u>Item</u>	<u>Type Designation</u>	<u>Range</u>
1	CDV - 138	0-200 mr
2	CDV - 730	0-20 r
3	CDV - 736	0-2 r
4	CDV - 740	0-100 r
5	CDV - 742	0-200 r
6	CDV - 746	0-600 r

- 4.2 - - - Ten each of these dosimeters were used in tests. The "preliminary standard" units are the 730, 740, and 742 types, while the 736 and 746 are not so accurate. The 138 is accurate but used mainly for training purposes. These factors have been considered in the design and tests made on the units.
- 4.3 - - - Of major importance in the 794X data is the radiation zone pattern and intensity in the test chamber. The Standard Item Specification describes this zone as an approximately circular section with a 20° divergence. The source intensity with slides up is 400 r/hr. + 10% and - 5% at a point 10.42 inches or more from the reference center of a nominally 100 curie Cs-137 source. The vertical center of the zone is approximately $6 \frac{7}{8}$ inches from the chamber base.
- 4.4 - - - The adaptors used in the chamber have base dimensions not exceeding $9 \frac{13}{16} \times 8 \frac{1}{2}$ inches. Two locating pins for the adaptors are mounted .740 inches above the chamber base in the back (source side) wall, and their center to center distance is 7.000 inches. Clearance holes for these pins should be .281 dia. A latch on the chamber base secures the adaptors in place, and the stop for this latch should be $0.688 + .015, - .000$ up from the base, centrally located $8 \frac{1}{2}$ inches back from the two pin locating holes. Besides these dimensions, the complete assembly must clear the bottom door opening, and a mirror mounted on the chamber wall.
- 4.5 - - - The Test Chamber Dose rates could be reduced by selecting appropriate push buttons on the control panel. These were marked SAFE, 4, 40, 100, 400, 1, 4, 10, 40, 100, and 400 r/hr. The specification limits variances of the intensity at the reference point of + 10% and - 5% of that selected, except the 4 mr/hr. rate.

4.6 - - - All dosimeters supplied were approximately .537 inches in diameter, and the length was approximately 4 1/2 inches.

5. MODIFICATIONS TO CALIBRATOR

5.1 - - - The first attempts to provide a suitable attachment were based on application of the general shape of the existing adapters designed for USASRD calibrator AN/UDM-2 (XE-2). This unit was intended to have all components mounted on a chassis with approximately the dimensions given for one of these existing units. The mirror would not allow clearance during insertion into the test chamber, and a corner of the dosimeter adapter chassis was removed. Eventually it was realized that this design was too expensive and the chassis as such was eliminated, rather than attempt to modify the interior of the chamber.

5.2 - - - Control for the system was initially attempted by using power for the dosimeter adapter derived from the control panel, especially from the SLIDES UP and SLIDES DOWN lights. It was planned to select slides down by shorting out the momentary contacts on the selector switches. Of course, this merely set the slide lifting mechanism into an up and down motion. It was subsequently determined that the complete action of the SAFE switch had to be duplicated, at least electrically, by the dosimeter adapter control circuit. This included the operation on the zero and slide solenoids, since otherwise these solenoids might remain energized, and, if they were not rated for continuous duty, they might become destroyed. This could best be accomplished by locating another relay inside the calibrator, and providing control for this relay in the dosimeter attachment.

5.3 - - - Access for wiring to the dosimeter attachment could be made through an existing hole in the chamber wall, through which the leads for the test chamber lamp were passed. It would become necessary to enlarge this hole to allow room for a few more wires. A connector for the attachment was mounted on two standoffs which were inserted under the base of the test chamber lamp.

5.4 - - - In summary, the modifications to the CDV-794X will consist of the following steps:

- a. Provide suitable re-wiring of the control panel to enable inclusion of the new relay cable, and connector.
- b. Enlarge the hole in the chamber wall to allow clearance for more wires.
- c. Mount the new relay, standoffs with connector, and cable in the 794X at initial assembly or as a field modification, and wire these in according to an instruction sheet. These instructions and additional details are included in appendix A of this report.

6. ATTACHMENT DESIGN

6.1 - - - The requirements for a suitable dosimeter calibrator are as follows:

- a. A stable source of ionizing radiation whose energy and intensity are within the intended range of all dosimeters,
- b. A set of supports or chucks for a number of dosimeters,
- c. A means of allowing the radiation to enter all dosimeters identically, and
- d. A means of controlling the time exposure of all dosimeters to the radiation.

- 6.2 - - - The calibrator CDV-794 provides the means for satisfying the requirements of 6.1 a and partially satisfying 6.1 d. The source and slide assembly in the CDV-794X is used to supply a range of discreet field intensities over a wide enough zone to expose a number of dosimeters. The circuit of the 794X, with relatively minor modification, is controlled for correct time exposure.
- 6.3 - - - The modification to provide the means for controlling the exposure has been described briefly in paragraph 5.2. An added relay in the calibrator CDV-794X is used to electrically duplicate the operation of the SAFE selector button. This relay in its unenergized state has no effect on the normal operation of the CDV-794X. When the relay is energized, the circuits act to bring the slides down, inhibit any slides up, and release all solenoids.
- 6.4 - - - A timing device in the calibrator attachment controls the relay. The attachment has been designed to operate for a fixed (preset) time, nominally one hour. As the source decays, the timer can be re-adjusted to provide longer time exposures to the weaker source. At the end of one half-life of the source, in this case about 30 years, the time would be two hours. This device is a time-delay relay, operated by a solenoid clutch and a synchronous timing motor. A cam-operated switch closes a circuit to the relay in the 794X at the end of the preset time interval. Reset of the timer is automatically performed by a spring when power to the clutch solenoid is removed. Reset time takes 1/2 second and timing repeat accuracy is within 2%. Mechanical life expectancy is well in excess of one million operations, and switch life expectancy is

nearly one million operations. A dial on the top of the unit is used to set the time interval. This dial is calibrated in five minute divisions and can be set over a range of 12 minutes to 2 hours. The timer is a Cramer Controls Corporation type 471 direct clutch delay relay, with a modified circuit.

6.5 - - - In order to provide uniform exposure to a number of dosimeters, it is desirable to rotate the dosimeters in the radiation zone. During one rotation, each dosimeter will follow the same path as all the others, and the net dose accumulated will be identical for all. In addition, it is desirable to rotate each dosimeter in such a way that all sides are exposed to the radiation, to average out variations in wall thickness and uniformity of the ionchambers. This is accomplished by mounting the dosimeters vertically in several chucks on a turntable with a gear on each chuck that meshes with one fixed internal teeth ring gear. The turntable is rotated by an electric motor, and the gears cause each chuck to turn about its own axis. Motor speed must be fast enough so that, at start and stop the time taken for the dosimeter nearest the source is less than one tenth of one percent of the total time for the run. For a one hour exposure, a rotation speed of 8 rpm would serve. Many motors can be used, and the actual choice was based on economy and torque output. The motor must also support the vertical weight of the turntable plus the force used to push dosimeters into the chuck. A Merkle-Korf WF4209u-025 Model WF motor at 35 rpm was selected for this application. It has a 4.3 inch - pounds starting torque rating and will easily support the turntable. A fan provides some cooling.

- 6.6 - - - The chucks were designed to accommodate the OCD dosimeter units. A cylinder, with a diamond-shaped longitudinal hole, is mounted concentrically on a spur gear. One V of the diamond supports the body of the dosimeter. The other V is larger, and is provided with spring loaded steel balls. The balls bear against the dosimeter so that it is held against the smaller V, in such a way that the standard-shaped dosimeter is concentric with the cylinder body. Dosimeters with other diameters will, of course, be off-set somewhat, but the rotation of each dosimeter will provide some correction for this.
- 6.7 - - - Dosimeters are mounted with the lens end down. This insures that the ion chamber will be clear of the chuck body and, therefore, not shielded from the radiation-source. It was felt, with great confidence, that most dosimeter designers would use a substantial part of the lens end for the optical and scale-reading devices, so that the ion chamber would always be at or near the opposite or charging end. A recess in the bottom of the chuck was provided to receive the great variety of pocket clips on dosimeters.
- 6.8 - - - With the design chosen, a maximum of 8 dosimeters can be loaded into the attachment. Since a dosimeter is approximately 1/2 inch in diameter, and may be as much as 5/8" it was necessary to provide 1/8" adjustment by the steel balls. This requires a 9/32 inch ball (minimum). The cylinder wall behind the ball, therefore, requires 1/8 inch free travel, and room for the excess solid height of the spring, or another 1/64 minimum. A 1/32 inch thick sleeve holds the springs in place and the total cylinder diameter must be 1 7/16 inches for complete range capacity. A spur gear whose teeth clear this diameter would be approximately 1 3/4" P.D.

The largest diameter assembly that can be lowered easily into the test chamber is about 8 1/2 inches. With a ring gear of 3/4 inch width (1/4 inch face) for adequate flatness, the turntable diameter can be 7 inches. In order to clear each other the spur gears should be on at least 2 inch centers, so that the gear center circle is 5 inches diameter approximately. This represents a circumference of about 16 inches, and, when divided by the gear to gear distance, results in a maximum of 8 gears.

6.9 - - - Other designs were considered in an effort to increase the number of dosimeters, but all appeared to require more bearings or concentric shafts, or both. Furthermore, the overall height of the unit had to be kept to a minimum in order to (a) clear the doors, and (b) be less than the 6 7/8 inch distance of the source center line above the chamber base. The design height does not exceed 6 1/4 inches.

6.10 - - - The electrical connections for this system are made to the existing CDV-794X controls. The motor is energized from the Down Limit Switch, so that whenever the source is anything but "closed off", the motor will turn. The timer is energized from the Up Limit Switch, so that timing starts when the source is fully "open". The timer clutch is wired across the test chamber light so that it is energized whenever power to the calibrator is turned on, and can be reset by turning power off momentarily.

6.11 - - - If there were a power failure or interruption during a calibration run, the motor would, of course, stop turning, and the timer would be reset. This would result in errors for two reasons: (a) the dosimeters would no longer obtain equal exposure to the radiation, and (b) the timer would start the hour run over again

when power came on. For this reason, a relay was included in the attachment to "sense" a power interruption and stop the attachment from continuing the run. This relay is reset by a pushbutton on the attachment, and its condition ("in" or "out") is shown by a small indicator lamp. Whenever the operator sees the calibrator "SLIDES UP" lamp on and the attachment indicator lamp lit, he knows that the run was cancelled by a power interruption and has to be done over. The relay used is a Potter and Brumfield KASAY SPDT 115 VAC 60 cycle relay.

7. SPECIFICATIONS FOR ATTACHMENT:

7.1 - - - The Standard Item Specification CDV-794 is attached as Appendix B.

8. TEST DATA:

8.1 - - - Tests were made with the dosimeters and CDV-794X unit number 3 as supplied under the terms of the subject contract. Some tests were conducted before the calibrator attachment was constructed; most were made with the attachment.

8.2 - - - A mock-up jig was fabricated and used to test some of the basic ideas. It was observed that when dosimeters type CDV-794X were rotated in the field without rotating each dosimeter, the readings had a spread of plus or minus 13%. When the dosimeters were rotated in the field planetary fashion, using the attachment, the spread was plus or minus 9%.

8.3 - - - Each type of dosimeter supplied was "calibrated" repeatedly in the attachment, for 1 hour, except for the CDV-138. Unit #3 CDV-794X

did not seem to have the 100 mr/hr selector and slides circuits working, or built in. Manual timing for 15 minutes at 400 mr/hr and for 6 minutes at 1 R/hr was used.

8.4 - - - CDV-746 type dosimeters appeared to give the most reproducible data on the first runs, and so were used to check reproducibility (not true time) of the programmer. These tests included:

- a. Several runs with dosimeters in the same chuck each time.
- b. Several runs with dosimeters in different chucks each time.
- c. Several runs with a dosimeter in different chucks each time.
- d. The turntable was lowered 1/4 inch and one chuck was cut so that it was 21/32" shorter, and more of the dosimeter was exposed.
- e. The dosimeters were charged, then allowed to sit to check for drift.
- f. The dosimeters were charged, then inserted in and removed from the chucks several times to check for "jarring".
- g. The time was recorded for each of the runs.

8.5 Test Results

8.5.1 Results of different type tests:

R(ind) R(app)	Dosimeter Type	Intensity	Median	Average Reading	Deviation		
					% P.E.	Max.	Min.
123%	138	1R for 6 min	123 mr	123 mr	±2.0%	±4.9%	-3.3%
150%	138	400mr for 15 min	148 mr	151 mr	±2.1%	+5.0%	-3.2%
55%	730	10R	10.4 R	10.9 R	±6.2%	+26.5%	-14.6%
67%	740	100R	60 R	67 R	±12%	+36%	-22.4%
125%	736	1R	1.25 R	1.25 R	±9.3%	±20.0%	-5.5%

8.5.2 Results with one dosimeter in different chucks,
using CDV-746 for 4 runs in each chuck.

Ser.	Sequence	Mean	Max. Dev.	Min. Dev.
753	DAHG	286	+5%	-2%
555	EBGD	258	+0.8%	-2%
595	GDFE	280	+3.5%	-3.5%
717	CDEF	277	+1%	-4%
692	AHFB	277	+2.9%	-5.4%

- Notes:
- a. Out of 16 runs with ser. 717, it read 30% high twice, no explanation found.
 - b. Data indicates that A chuck produces readings that are about 2% high, H about 2% low. Others are $\pm 1\%$.
 - c. Sequence indicates the chuck designations into which each dosimeter was placed. For example #753 was in chuck D, then chuck A, then H, then G, while #555 was in chuck E, etc.

8.5.3 No observable difference was found when the turntable was lowered 1/4 inch. When the dosimeter chuck was cut back by 23/32 inch, the readings seemed to be 1% lower.

8.5.4 Tests made for drift and jarring showed no effect. One hour drift runs showed no readable change in the fiber position on the scale. Repeated insertions of a number of dosimeters in the chucks showed no noticeable change.

8.5.5 The time measured by the electric clock was 62.5 minutes +3% -2%. This result was obtained from 38 runs.

8.6 - - - The average reading for 120 observations on assorted type CDV-746 dosimeters in assorted positions was 281.6, with a P.E. of 0.48%. The maximum deviations were +35% and -10%, each of which occurred once but on different runs. There was also one deviation of +25%, and four deviations of +12 to +14%. All other readings were within $\pm 10\%$.

9. CONCLUSIONS AND RECOMMENDATIONS

9.1 - - - The urgent need for the combination CDV-794 and Dosimeter Calibration Attachment appears to manifest itself in the test data. From the data for any one dosimeter it is evident that the combination is quite accurate and well within the limits for the dosimeter. The dosimeters can be made to repeat to almost $\pm 4\%$ with this system. Different dosimeter types can be checked very easily and safely with either automatic or manual timing. The design center appears to be placed such that variations in height and position of dosimeters causes negligible differences in readings.

9.2 - - - It should be noted that this combination does not constitute a calibrator for dosimeters but rather a comparator. A primary standard should be used to establish the correct reading that should be observed, and other dosimeters compared with that standard. It would, of course, be possible to prepare tables showing what range of readings can be tolerated for each type of dosimeter in existence, but the range would be quite wide. If such tables were prepared for each calibrator and attachment combination the range would be substantial. A set of calibrated dosimeters, so marked, would provide a very satisfactory "primary" standard, and then dosimeters would be calibrated to a relatively narrow range of readings, possibly within the $\pm 4\%$.

9.3 - - - Some possible improvements in the design of the calibrator have been made evident during the course of the last few tests. For example, a single lighted push button switch could take the place of the present separate pushbutton switch and lamp on the attachment. Also, a small bar mounted under the ring gear could serve as a handle to facilitate lowering of the attachment into

the calibrator. Finally, it has been suggested by Mr. Robert B. Martin of OCD that the relay and wiring for the 794 modification be prepared in "kit" form, for easy inclusion in existing calibrators. This latter change is included in appendix A of this report.

APPENDIX A

Suggested Modifications to CD V 794 to Provide for
Dosimeter Calibration Attachment.

1. Mechanical Changes to CD V-794

- 1.1 Change hole size in chamber wall for test chamber lamp wiring to 1/4" diameter, no burrs on edges.
- 1.2 Maintain present (CD-V-794) dimensions for inner test chamber and for test chamber lamp socket and mounting holes.

2. Electrical Changes to CD V-794

- 2.1 Add wire from K-1 coil (contacts end) to pin MM of connector.
- 2.2 Add wire in cable to connect both connectors, pins MM.

3. Kit for Modification

3.1 Equipment Included:

- a. Dosimeter Adapter Assembly
- b. Relay and Bracket Assembly
- c. Receptacle, Standoffs, and Cable Assembly

3.2 Installation of Equipment

- 3.2.1 Remove the screws used to mount the lamp socket to the chamber wall. Pass the cable supplied with the kit through the hole in the chamber wall.
- 3.2.2 Connect the two short leads from pins 1 and 2 to the socket of the test chamber lamp. Mount the socket and standoffs, and the relay assembly on the test chamber wall, using the original screws.
- 3.2.3 Connect the cable leads to the relay as indicated in the wiring diagram. Route the cable to follow the test chamber leads, and wire the cable to the up and down limit switches and to pin MM on the connector.

3.2.4 Remove the wire from the NC contact of the up limit switch (S-9) and from pin X on the connector, and replace with the new cable wires.

3.2.5 This completes the modification, and makes it possible to use the Dosimeter Calibrator. When the calibrator is not plugged in, the CDV-794 will operate in its normal fashion.

APPENDIX B

DEPARTMENT OF DEFENSE

OFFICE OF CIVIL DEFENSE

STANDARD ITEM SPECIFICATION

1 March 1963

Item No. CD V

Nomenclature

Dosimeter Calibrator Attachment for the CD V-794

1. Scope

- 1.1 This is a specification for a dosimeter calibrator attachment which is to be used in conjunction with the CD V-794 calibrator.
- 1.2 This attachment, when in use, is positioned within the test chamber of the CD V-794.
- 1.3 The attachment shall be capable of calibrating Civil Defense Dosimeter types CD V-138; CD V-730; CD V-736; CD V-740; CD V-742 and CD V-746.
- 1.4 The primary purpose of the attachment is to check the calibration accuracy of these dosimeters.

2. General Performance Requirements

- 2.1 The calibrator attachment may be used by semi-professional personnel and, therefore, should incorporate maximum simplicity, ruggedness, and reliability within the following detailed requirements.
- 2.2 The attachment shall consist of eight chucks arranged in a circle. The chucks shall be driven by a planetary gear system such that all portions of the dosimeter ionization chamber shall be exposed to the radioactive source during the cycle - See Attachment B.
- 2.3 The test chamber dose rates shall be adjustable by use of the appropriate push button on the control panel of the CD V-794. The accuracy requirements of the CD V-794 shall apply in all cases to this dosimeter attachment.
- 2.4 This specification also includes the necessary modifications which must be made to the CD V-794 to make it compatible with the dosimeter attachment. Details of this modification are at Attachment A.

3. Detailed Performance Requirements

3.1 Relay

- 3.1.1 An additional relay in the CD V-794 shall be used to electrically duplicate the operation of the safe selector button. This relay, in its unenergized state shall have no effect on the normal operation of the CD V-794. When energized, this relay shall bring any slides down, inhibit any slides which are up and release all solenoids.

3.1.2 Relay should be as in Attachment A.1.4.

3.2 Timing Device

A timing device in the dosimeter attachment shall control the relay.

3.3 Timing

The attachment shall be designed to operate on a fixed preset time of one hour. Provision shall be made to vary this preset time up to two hours to accommodate the natural decay of the radioactive source (half life approximately 30 years.)

The timing sequence shall be provided by a time-delay relay, operated by a solenoid clutch and a synchronous timing motor. The timer shall be the Cramer Controls Corp. type 471 direct clutch delay relay, with modified circuit, or equal.

All timers shall be tested for proper circuit operation at the minimum setting of approximately 12 minutes. Sample tests shall be made in accordance with MILQ105C sampling plan level II, 15 AQL to determine repeatability of within 2% at 1 hour and 2 hour dial settings.

3.4 Turntable and Planetary Gear

The planetary gear for the dosimeter chucks shall be provided by a ring gear and eight chuck gears mounted on a turntable. The turntables shall be rotated by an electric motor. The rotation speed and torque of the motor shall be compatible with the requirements of the attachment. A fan will be included for cooling. The electric motor shall be the Merkle-Korf WF4200V - 025 Model WF at 35 rpm or equal.

Motors shall be sample inspected for dimensions in accordance with MILQ105C sampling plan level II, 4.0 AQL. All motors shall be tested at 115 UAC 60 cps for idle power consumption of 17 watts, idle speed of 35 rpm, and minimum starting torque of 4.3 lb. in.

3.5 The Dosimeter Chuck

The dosimeter chuck shall be designed so that the dosimeter can be held vertically ($\pm 5^\circ$). The dosimeter chuck shall provide for easy insertion and extraction of the dosimeter by hand. The dosimeter shall not be displaced from its "at rest" vertical position by the planetary motion of the system during operation. A recess in the bottom of the chuck shall be provided to accommodate all clips found in OCD dosimeters. All types of dosimeters made to OCD specifications CD V-138; CD V-730; CD V-736; CD V-740; CD V-742 and CD V-746, shall be accommodated in a single chuck without adjustment. The chuck shall be designed so that the dosimeters will be mounted with the lens end down, i.e. at the base of the chuck.

3.6 Accuracy

The accuracy of the measurement depends on the accuracy of the intensity and zone of the calibrator field and on the fabrication details of each dosimeter, so that accuracy specifications for the attachment are limited to reproducibility of readings on a standard dosimeter. Reproducibility of measurements shall be within $\pm 5\%$. For tests 6 calibrated dosimeters of the same CD V type shall be inserted into the chucks and exposed to the rated dose rate for that type for three cycles of the attachment operation. Repeatability of measurement of the mean of the 6 readings for each cycle shall be within 5%.

4. Physical Characteristics

4.1 Mounting Provision

The dosimeter attachment shall be mounted in the test chamber by a latch and two locating pins. The locating pins shall be mounted .740 inches above the chamber base in the back (source side) wall, center to center distance is 7.000 inches. The latch shall be attached to the chamber base and the latch step shall be $0.688 + .015 - .000$ up from the base, centrally located 8-1/2 inches back from the two pin locating holes.

4.2 Size

The base dimensions of the attachment shall not exceed 9-13/16 x 8-1/2 inches. The height of the attachment shall not exceed 6-1/4 inches. In addition, when assembled the complete attachment shall clear the bottom door opening and a mirror mounted on the chamber wall in order that the attachment may be mounted in the test chamber.

4.3 Weight

The weight of the attachment shall be a minimum, compatible with the requirement of this specification. It shall not weigh more than 13 lbs.

4.4 Material and Construction

4.4.1 Material

The gears shall be brass. Other parts shall be alloyed aluminum. All aluminum parts shall be anodized.

4.4.2 Form Factor

The form factor is shown in Attachment B. The general construction and form factor must be specifically approved by the contracting officer.

5. Environmental Requirements

5.1 Temperature

5.1.1 Operation

The attachment, when mounted in the Calibrator, shall operate over the temperature range of 0°F to plus 125°F. For tests, the calibrator shall be placed in an environment chamber at 0°F for the cold test and into an atmosphere of plus 125°F for the high-temperature test. Operation and safety, in accordance with specification CD V-794 paras. 2.3.3, 2.4.1, 2.4.2, 4.1.1, 4.2.4, 4.4.3, 4.5.2, 4.7.3, and the requirement of this specification, par. 3.6, shall be tested after a period of two hours.

5.1.2 Storage

The attachment shall be capable of operating within the requirements of this specification, following storage for 24 hours at minus 30°F and storage for 72 hours at plus 160°F (at the conclusion of this test and after reaching room temperature the attachment shall meet the requirement of the specification, par. 3.6).

5.2 Shock and Vibration

The dosimeter attachment shall withstand without damage the shock and vibration tests of MIL standard 167. Following these tests the attachment shall be capable of calibrating dosimeters within the requirements of par. 3.6 of the specification.

5.3 Tropicalization

It is not required that the instrument be moisture or fungus proof. However, if tropicalization is applied, it shall be done in accordance with the requirements of MIL-T-152S and MIL-V-173B.

5.4 Atmosphere Corrosion

Metal parts shall be able to withstand the 20-hour salt spray test conducted in accordance with Federal Standard 151. No evidence of corrosion shall be apparent at the conclusion of this test.

5.5 Atmosphere Pressure

The attachment shall withstand, without damage, transportation at the pressure equivalent of 50,000 feet above the sea level for a period of 20 hours. At the conclusion of this test the attachment shall meet the requirements of par. 3.6.

6. Components

6.1 Choice

New components shall be used. Only those components commercially available from at least two domestic manufacturers and meeting standard commercial or military tolerances shall be used unless otherwise noted in these specifications.

6.2 Selection

All components shall meet the applicable specifications and there shall be no selection.

6.3 Operation

Each component shall be operated only within its specified operational limits.

6.4 Markings

Electrical components, relays, capacitors, etc. shall be marked by standard commercial practices.

6.5 Timer

See par. 3.3

6.6 Motor

See par. 3.4

6.7 Relay

The relay shall be Potter and Brumfield KASAY, Single Pole, Double Throw or equal.

6.8 Connector

The connector shall be a 6 pin Cinch Jones P-306-CCT or equal.

6.9 All components shall be accessible and replaceable without the use of special tools.

7. Wiring and Cabling

7.1 General

Wiring and cabling shall be neat sturdy and as short as practicable, except that sufficient slack shall be provided (1) to prevent undue stress on cable forms, wires and connections; (2) to facilitate field repair of broken or cut wires; and (3) to enable parts to be removed and replaced during servicing without disconnecting other parts.

7.2 Wire and Cable Runs

Wires shall not be bent sharply around corners or edges that cut or abrade the insulation. Where wires run through holes in metal, the insulation shall be protected with suitable grommets or bushings.

7.3 Terminations

Wire terminations shall be soldered except that tinned, stranded wires may terminate in solderless connectors if approved by the contracting officer.

7.4 Grounding

Ground connections to shields and other mechanical parts shall be only made for the purpose of eliminating high-potential points and not for the purpose of completing electrical circuits. Ground connections to the circuit shall be made mechanically secure by soldering.

7.5 Color Code

As far as practicable, the wiring shall be color coded.

8. Attachment Identification

8.1 Marking

Each instrument furnished in accordance with this specification shall bear the following data "Dosimeter Attachment for OCD Item No. CD V-794" with a serial number. Serial numbers shall be supplied by the contracting officer. In addition, the contractor's name, city, and state shall appear. The name plate shall be approved by the contracting officer.

9. Tests

9.1 Conformance

Conformance with these specifications shall be determined according to the practices of the National Bureau of Standards. Unless otherwise stated, tests shall be performed at normal room temperatures, and pressure. Unless otherwise indicated, tests may be performed in any sequence.

9.2 Damage Resulting from Tests

Attachments damaged incident to test to determine their conformance with the requirements of the specification will not be accepted by the purchaser; except that when a sample has satisfactorily passed the test, the manufacturer may correct all damage that occurred during the test and resubmit the instrument.

9.3 Pre-Production Models

9.3.1 The successful contractor who is awarded a contract shall furnish three preproduction attachments which will be tested for conformance with these specifications. Test Data proving compliance shall accompany the instrument.

9.3.2 The preproduction models shall be subjected to any or all tests and measurements deemed necessary to prove operational and construction design conformance. The contractor may be required to perform these tests in his plant under the supervision of the government contract officer, or they may be performed by the government at the pleasure of the government.

9.3.3 The preproduction models shall be retained by the government inspector during the production period and will be returned to the manufacturer.

9.4 Production Testing

The required test procedure and test schedule is contained in Attachment C.

9.5 Test Costs

The manufacturer shall be responsible for the cost of tests conducted

on the preproduction models to prove their compliance with this specification. The cost of crating and shipping the preproduction models will be borne by the contractor if government testing is required.

9.6 Changes

The manufacturer shall obtain from the contracting officer written authorization to introduce into the production units any change from the approved preproduction model.

9.7 Conflicts

In the event there are conflicts between the dimensions and materials specified and the general performance requirements of this specification, the contractor shall resolve the conflicts and the performance characteristics shall govern. The written specification shall take precedence over the Attachments.

10. Instruction Manual

10.1 Manuals

Two instruction manuals conforming to Attachment D shall be supplied with each dosimeter attachment. The content, format and materials for these manuals shall be submitted to the contracting officer for approval before final printing.

11. Packing and Marking

11.1 Each dosimeter attachment shall be boxed individually. The individual container shall be constructed of double-faced corrugated fibre board, with a bursting strength of not less than 175 pounds, conforming to Federal Specifications PPP-B-636B. The manuals and modification kit for the CD V-794 shall be packed in the individual box with each instrument.

11.2 Ten individually boxed instruments shall be over packaged in a shipping container designed for that purpose. The shipping container will be for domestic use and shall be a standard commercial container of double-faced corrugated fiberboard with a bursting strength of not less than 275 pounds conforming to Federal Specification PPP-B-636B.

11.3 Each dosimeter attachment box and each shipping container shall be marked with the following information: "Dosimeter Attachment for OCD Item No. CD V-794" and the name of the contractor. In addition, each shipping container shall be marked with the contract number, the shipping weight, and the number of dosimeter attachments in the container.

12. Production Drawings and Specifications

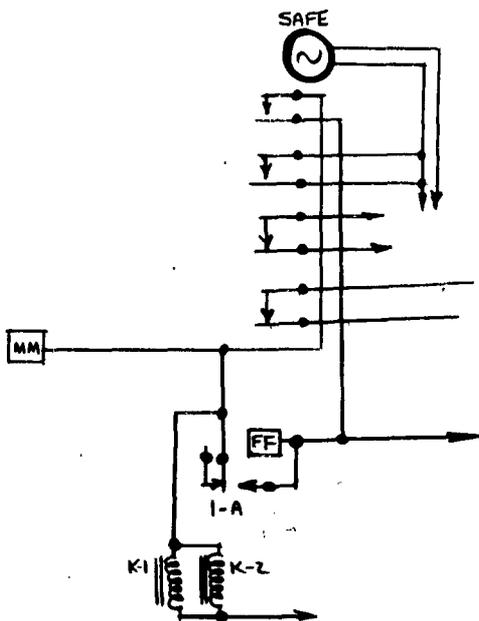
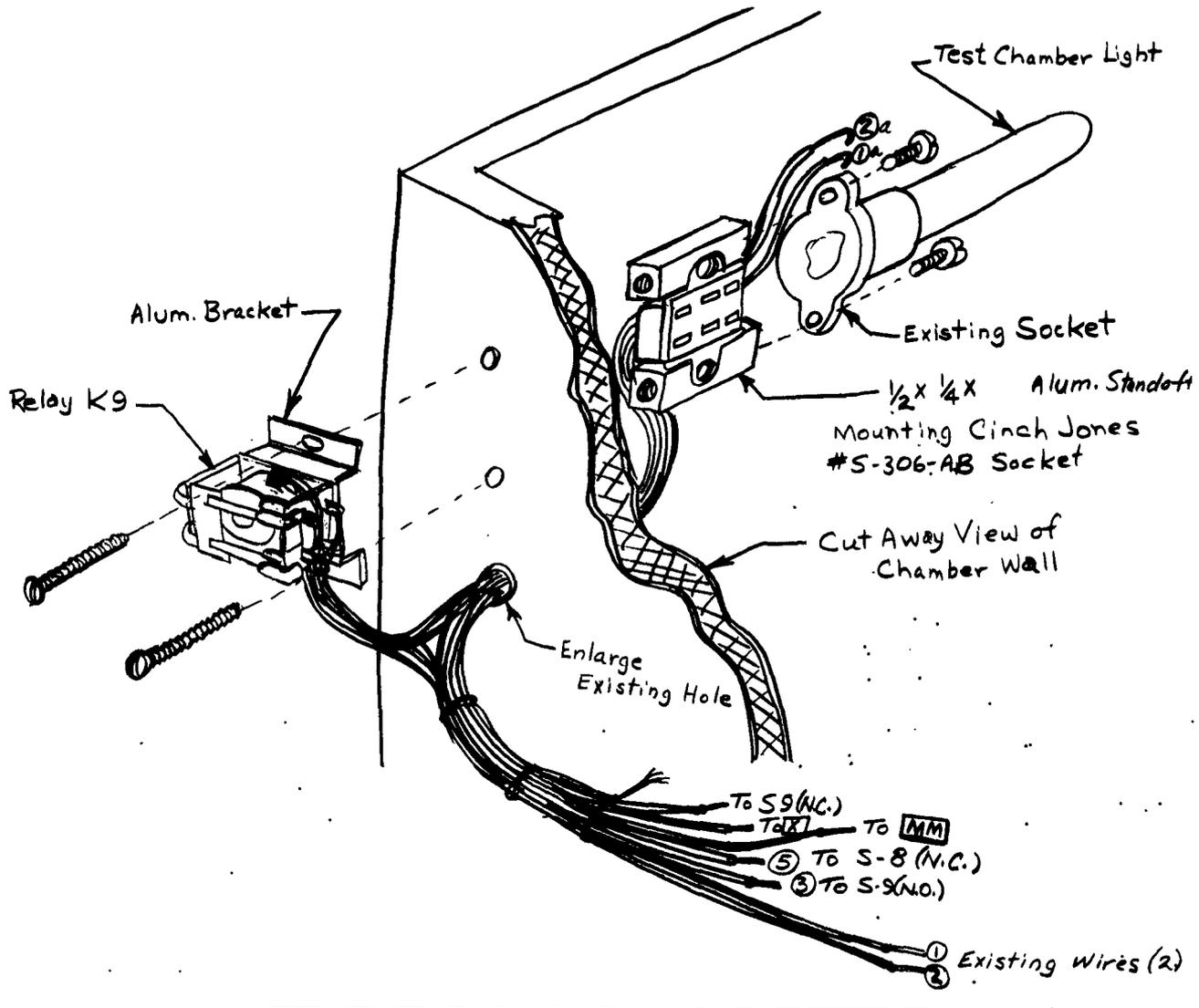
12.1 The contractor shall prepare and furnish, for the approval of the contracting officer, manufacturers layout and schematic drawings and specifications for all components and materials.

12.2 Drawings and specifications shall be in accordance with standard commercial practices. They shall include reproducible transparencies and five complete sets of prints. Final drawings and specifications shall be delivered within two months from the time of the initial shipment of production dosimeter attachments, or within four months after the time of notice of arrival, whichever is sooner.

ATTACHMENT A

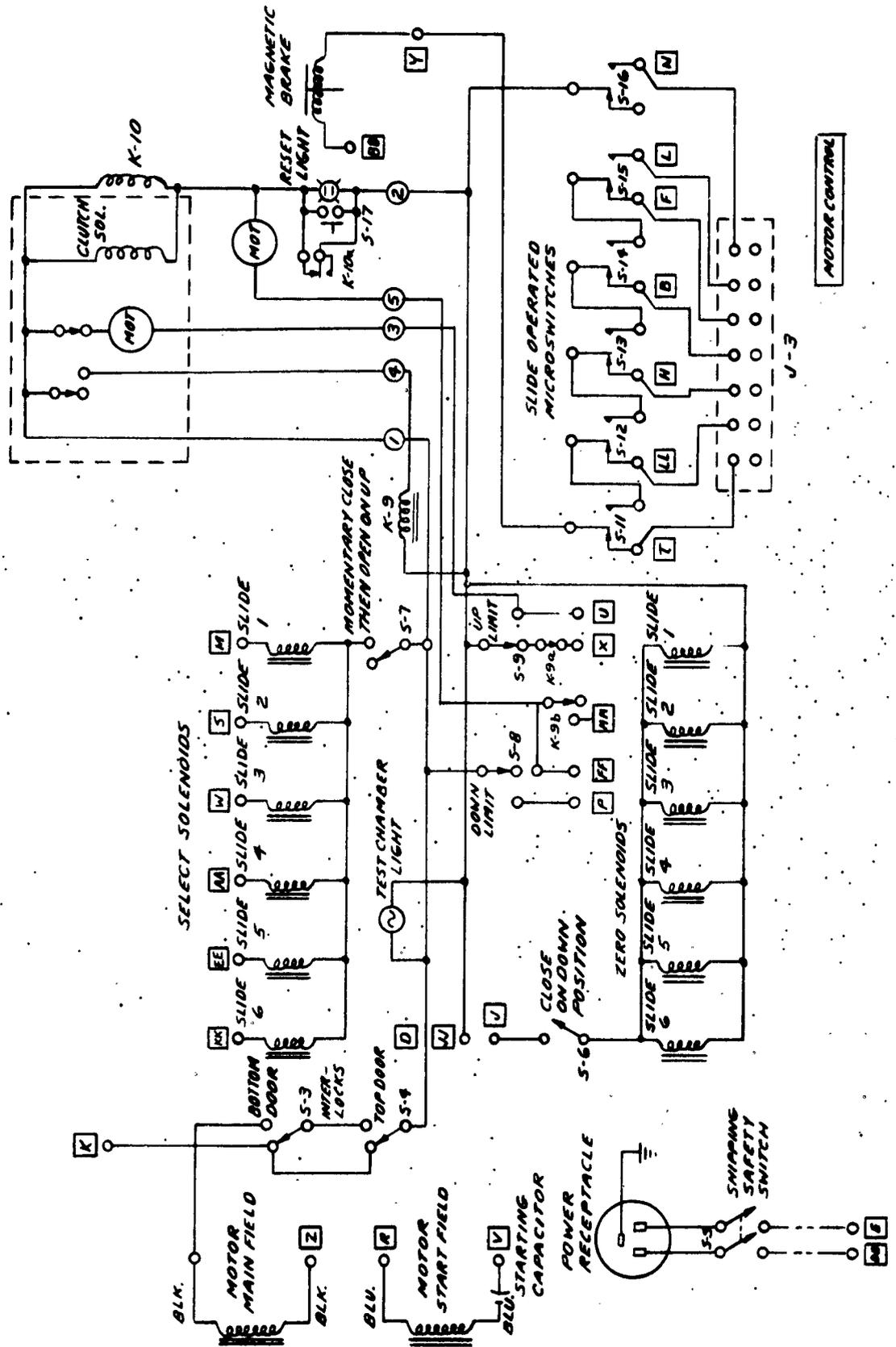
A1 Modifications to the Calibrator CD V-794 to make it compatible with the Desimeter Attachment.

- A1.1 The complete electrical action of the safe switch on the calibrator CD V-794 must be duplicated which includes the operation of the zero and slide solenoids. This is accomplished by locating another relay inside the calibrator and providing control for this relay in the desimeter attachment.
- A1.2 Access for the wiring of the desimeter attachment is made by enlarging the hole normally used for the test chamber lamp leads.
- A1.3 The modifications to the CD V-794 to accommodate the Desimeter attachment are:
 - A1.3.1 Rewiring of the control panel to enable the inclusion of the additional relay cable and connector.
 - A1.3.2 Enlarging of the hole in the chamber wall to allow clearance for more wires.
 - A1.3.3 Mounting of the new relay, standoffs with connector and cable in the CD V-794.
- A1.4 The additional relay shall be type Allied Control Corp. PO 49A or equal. The connector shall be type Cinch Jones S-306AB or equal.
- A1.5 Components and parts necessary to make this modification will be supplied in kit forms.
- A1.6 The rewiring schematic is shown at A-2 and A-3.



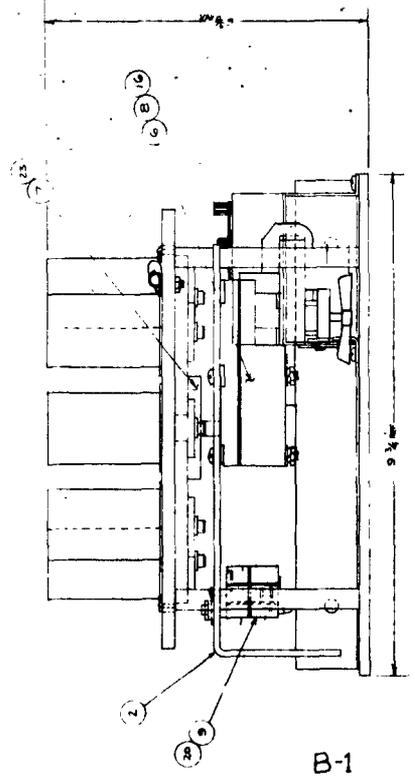
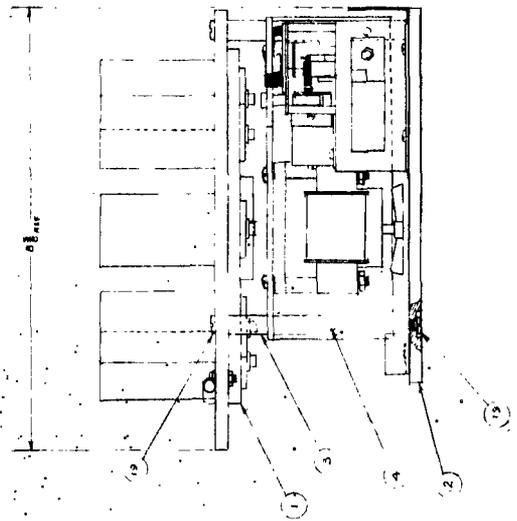
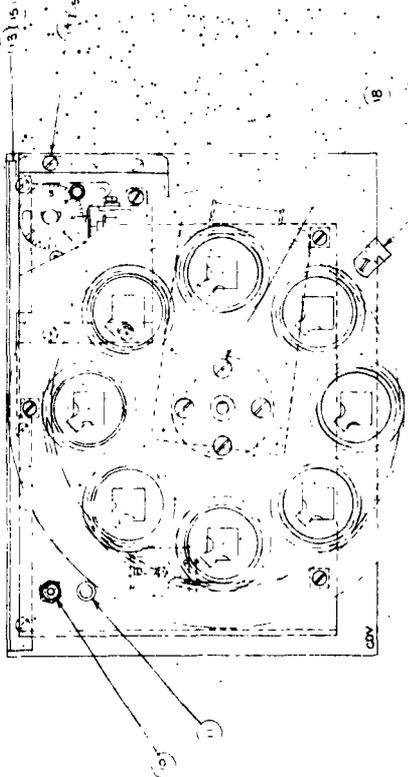
Note
 Schematic Change, Ref B-47,
 Std Item Spec. CDV-794, require
 addition of one wire connector
 from K-1 coil to pin MM of J

Wiring Detail & Schematic Change



MOTOR CONTROL

PARTS LIST	
QTY	DESCRIPTION
1	996418 TURNABLE ASSY
2	996416 CAMSHAFT
3	996417 STRAIGHT SHAFT
4	996419 STRAIGHT SHAFT
5	996420 RING GEAR
6	996421 MOTOR
7	996422 COIL
8	996423 SCREW, CS P. ST. 1/8" X 1/2"
9	237218 RELAY
10	996424 SWITCH
11	996425 INDICATOR LIGHT
12	996426 BASE
13	996427 GUIDE BRACKET
14	996428 THINER
15	996429 SCREW, CS P. ST. 1/8" X 1/2"
16	996430 NUT, CS P. ST. 1/8"
17	996431 SCREW, CS P. ST. 1/8" X 1/2"
18	996432 SCREW, CS P. ST. 1/8" X 1/2"
19	996433 SCREW, CS P. ST. 1/8" X 1/2"
20	996434 NUT, CS P. ST. 1/8"
21	996435 SCREW, CS P. ST. 1/8" X 1/2"
22	996436 CABLE CLAMP
23	996437 SCREW, CS P. ST. 1/8" X 1/2"

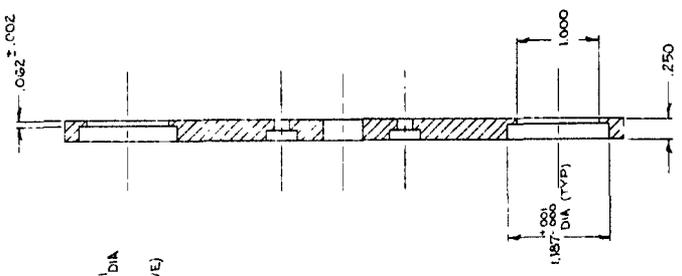
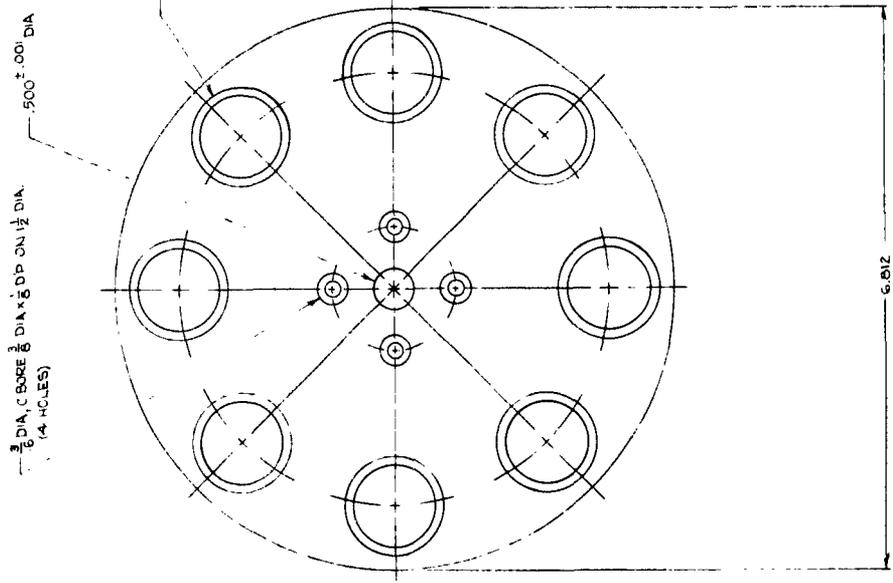


DCOM - WASHINGTON D.C.
 24-794

DOCKET NUMBER
 17-43
 PART ASSY
 996418
 A

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

PARTS LIST	
QTY	DESCRIPTION

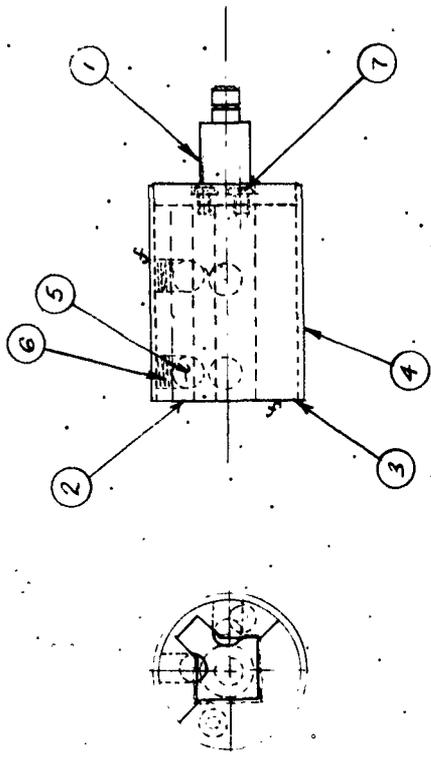


B-2

OCCM WASHINGTON, D.C.		996612	USED OR	MODEL
TOLERANCES UNLESS OTHERWISE SPECIFIED	FRACTIONAL	DECIMAL	ANGULAR	
	± 1/64	± .005	± 1/16°	
SCALE	AS SHOWN			
NATURAL SPECIFICATIONS				
MATERIAL	ALUM 3032-H32			
FINISH	YELLOW ANODIZE			
SIZE				
DRAWN	REL.	12-20-62		
CHECKED				
APPROVED				
REVISIONS		TURNABLE		
		PART NO. C 996614		
		REV. A		
DO NOT SCALE DRAWING				

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

PARTS LIST		
QTY	PART NUMBER	DESCRIPTION
1	996619	CHUCK JOURNAL
1	996620	CHUCK INSERT 'A'
1	996621	CHUCK INSERT 'B'
1	996622	CHUCK HOUSING
4	233785	STEEL BALL 3/32 DIA.
4	SEE SPEC.	SPRING
2		SCREW CO. AL. STZ 6MMX 6.32X 1/4



NOTES: 1. PRESS ITEMS 2&3 TOGETHER INTO ITEM 4. INSERT ITEMS 5&6 AS HOLES APPROACH ITEM 4. ITEM 6 SQUARE END TO BALL.
 2. ATTACH ITEM 1 WITH ITEM 7 AFTER PRESS.
 3. FINISH: SPRAY SURFACES MARKED WITH CLEAR LACQUER

SPRING: 1/4 OD, FACE HT. 1/16, SOLID HT 3/32, LEFT HAND 3 COILS COMPR. FORCE 10" PFG IN.; E.G. .024 WIRES, ONE END GROUND SQUARE, OTHER END PLAIN.

OCDM WASHINGTON, D.C.

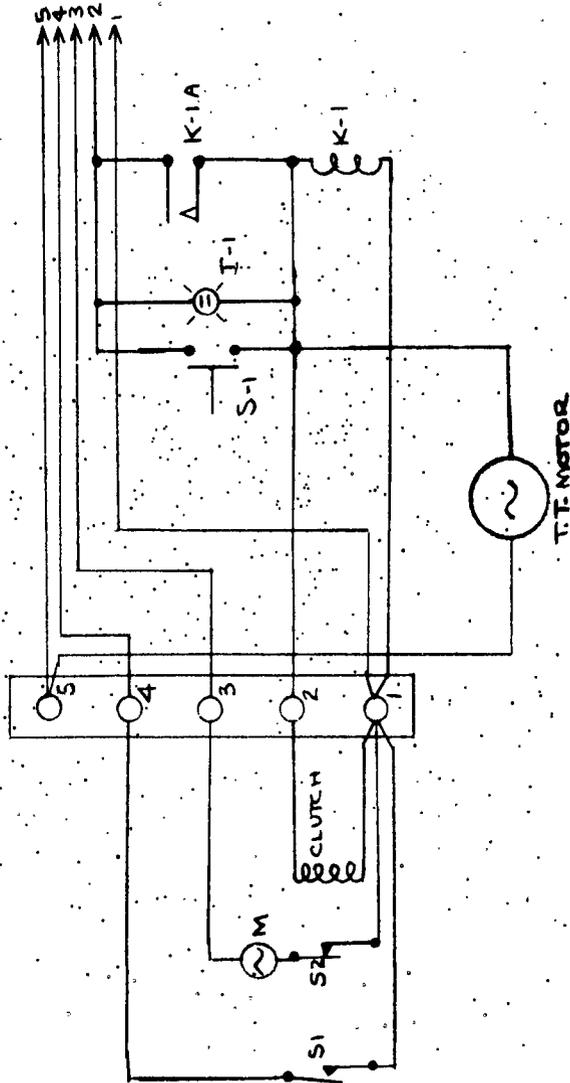
TOLERANCES UNLESS OTHERWISE SPECIFIED		996612	
FRACTIONAL	DECIMAL	ANGULAR	USED ON
		±1/2°	MODEL
SCALE			
MATERIAL SPECIFICATIONS			
KIND	NAME		
FINISH	DASIMETER CHUCK		
SIZE	ASSY		
DRAWN	DRAWING NO.		
CHECKED	B 9966 18		
APPROVED	REV. A		
DO NOT SCALE DRAWING			

REVISIONS

B-3

996657

B-4



ALL DIMENSIONS DO NOT INCLUDE PLATING

TOLERANCES UNLESS OTHERWISE SPECIFIED		996612		MODEL	
FRACTIONAL	DECIMAL	ANGULAR	USED ON		
± 1/64	± .005	± 1/2°			
SCALE					
MATERIAL SPECIFICATIONS					
KIND					
FINISH					
SIZE					
DRAWN	AMF 1-8-63				
CHECKED					
APPR'D					
					
Waltham 54, Mass.					
NAME					
SCHEMATIC					
DRAWING NO. A 996657					
REV. B					

THIS DRAWING HAS BEEN FURNISHED BY TRACERLAB, INC. OR KELEK X-RAY CORP. THE INFORMATION AND KNOW-HOW THEREON MAY NOT BE USED OR THE DRAWING REPRODUCED WITHOUT THE WRITTEN PERMISSION OF TRACERLAB, INC. OR KELEK X-RAY CORP. ALL REPRODUCTIONS IN WHOLE OR IN PART, INCLUDING VENDORS' SHOP DRAWINGS, MUST BEAR THIS STATEMENT OR MAKE REFERENCE TO IT.

REVISIONS		CHANGE MOTOR	
B			

B-4

ATTACHMENT C

**Production Sampling, Inspection and Testing for
Dosimeter Attachment for CD V-794**

C1 Production Sampling

All Inspections, Safety Tests and Operational Tests are to be performed on each dosimeter attachment. All defects must be corrected prior to acceptance.

C2 Inspections

C2.1 Inspections will be made for general workmanship and quality using the following list of defects.

- C2.1.1 Scratches or dented metalwork
- C2.1.2 Improperly aligned chuck (3.5)
- C2.1.3 Improperly aligned gears (3.4)
- C2.1.4 Incorrect soldering and wiring (Par. 7)
- C2.1.5 Incorrect Timer (3.3)
- C2.1.6 Incorrect Electric Motor (3.5)
- C2.1.7 Incorrect relay (6.7)
- C2.1.8 Incorrect connector (6.8)
- C2.1.9 Improper finish to metal parts (4.4.1)
- C2.1.10 Incorrect marking of components (6.4)
- C2.1.11 Incorrect marking of attachment (8.1)
- C2.1.12 Other visually apparent defects
- C2.1.13 Incorrect size, weight and dimensions (4.1, 4.2, 4.3)

C2.2 Inspections will be made for details of packaging, packing, and marking the attachment base and shipping container, using the list of defects below.

- C2.2.1 Damaged container
- C2.2.2 Incorrect marking (11.1)

- C2.2.3 Two manuals not present
- C2.2.4 CD V-794 modification kit not present (Attachment A)
- C2.2.5 Defective sealing
- C2.2.6 Use of improper or defective materials
- C2.2.7 Quantity of unit package not as specified (11.1 and 11.2)

C3 Tests

The contractor will be required to furnish all equipment and personnel necessary to perform the tests for the pre-production and production models specified herein.

C3.1 Operational

Each instrument shall meet the following requirements. These are 100% production run inspections.

- C3.1.1 Accuracy (3.6)
- C3.1.2 Repeatability (3.6)
- C3.1.3 Preset time variation (3.3)

C3.2 Initial Production

- C3.2.1 Three units selected at random by the inspector from the initial run shall be designated to pass the Environmental Tests of Par. 5 in addition to the tests indicated under Par. C3.1 above.
- C3.2.2 The contracting officer shall withhold authorization for delivery pending receipt of test data proving conformance with the above. The instrument serial numbers, date the tests were performed, name of the company and individuals responsible for the tests shall be furnished.
- C3.2.3 One of the production units tested shall become the property of OCD and shall be retained as reference. One of the production units test shall be retained by the government inspector during the production period and will be returned to the manufacturer.
- C3.2.4 Certification

The manufacturers will be required to certify compliance with 3.3, 3.4, 6.7, and 6.8.

C4 Failures

Disposition of rejected lots and defective sample units shall be in accordance with MIL-STD-105A. When resubmitted for acceptance, such lots will be suitably tagged or identified by equivalent means to indicate the cause of failure and means employed to correct the fault.

ATTACHMENT D
INSTRUCTION AND MAINTENANCE MANUALS FOR
CALIBRATOR

D.1 SCOPE

An instruction and maintenance manual for the dosimeter attachment shall be provided. It shall be written as far as practicable to enable an inexperienced, nontechnical operator to understand in general terms the attachment's use and theory of operation and to enable the operator, by following the instructions, to put the instrument in proper operating condition, operate it, and prevent failure or accidents. In addition, it shall include all necessary information to enable a reasonably competent technician to locate and repair electrical and mechanical malfunctions of the instrument.

D.2 CONTENTS OF THE MANUAL

D2.1 Table of Contents. The table of contents preceding the text of the manual shall list all sections, subsections, illustrations, photographs, drawings, and tables. The page number for each shall be shown.

D2.2 Illustrations. All illustrations, photographs, drawings, sketches, and tables shall be located in appropriate sequential order in the text.

D2.3 Text of Manual. The text of the manual shall include the sections listed below.

D2.3.1 Safety. This section shall detail all procedures required for the safe operation of the equipment. Safeguards and cautions shall be cited to warn of possible health hazard, and preventative attitudes and procedures shall be outlined. Wipe tests and contamination checks shall be given as well as procedures to be followed in the event of contamination. Appropriate reference material shall be cited for this important section of the manual.

D2.3.2 The General Description. This section shall include all basic information required to give a general understanding of the attachment and its use. Photographs and detailed drawings of the complete attachment shall be included to illustrate the relative size and location of the several components and how they fit together functionally. A simplified electrical control circuit block diagram shall be furnished and its several functions explained.

D2.3.3 The Theory of Operation. This section shall contain a detailed description and discussion of the theory of operation of the attachment. Elementary theory need not be covered in detail. However, all elements which are not generally understood, unusual or new arrangements and special mechanical arrangements not widely employed, shall be clearly explained, using sketches, photographs, and drawings to supplement the text.

- D2.3.4 Shipping and Transporting. This section shall discuss in detail the step by step procedures required to prepare the attachment for transporting and shipping. Appropriate regulations shall be explained and referenced. A check list of procedures for complete preparation for shipping shall be included.
- D2.3.5 Installation. This section shall contain all explanations and diagrams necessary to enable the operator to put the instrument in proper operating condition.
- D2.3.6 Operation. This section shall outline the operating procedure and shall be written particularly for the operator. It shall include a step-by-step description to enable the operator to operate the equipment. Reference to controls and adjustments shall be made by the control designation, or illustration reference symbols provided. Illustrations shall be in logical sequence.
- D2.3.7 Data.
- D2.3.7.1 The manual shall include a chart or table showing adjustments required for source decay. This shall list appropriate timer settings versus number of elapsed years from a calibration date. It shall be the same for all dosimeter attachments.
- D2.3.7.2 The manual shall include a set of tables showing typical readings for the various type dosimeters versus source intensity selected by the CDV-794X push buttons. These tables shall clearly indicate to the operator which control should be selected for each particular dosimeter type.
- D2.3.7.3 The manual shall describe the method of comparing dosimeters with a "standard" of the same type and the basis on which calibration shall be made.
- D2.3.8 Operator's Maintenance. This section shall include information on such maintenance procedures as can be performed by the operator.
- D2.3.9 Preventive Maintenance. This section shall include all maintenance procedures and adjustments which shall be performed periodically by a technician for the purpose of preventing failure or impairment of the equipment. Procedures shall be included for periodic adjustment of the timer to compensate for decaying source.

- D2.3.10 Corrective Maintenance. A complete mechanical functional diagram of the equipment shall be included. This section shall include all information necessary to permit a technician to locate troubles, and to make repairs or necessary adjustments to the equipment. This section shall be illustrated amply and shall include data on all adjustments, alignments, calibration, and test methods required for maximum performance. A drawing of the physical layout of the internal construction with appropriate marking shall be included. A complete schematic circuit diagram of the electrical circuit shall be furnished. Each component shall be identified by name and part number.
- D2.3.11 Parts List. This section shall include tables, listing by part number or schematic symbol designations, all mechanical parts and electrical components considered subject to replacement or maintenance during the normal life of the equipment. Complete information concerning tolerances, and other essential characteristics shall be given. In addition, component manufacturer's part numbers, complete information regarding manufacturer's name and address for all items, and appropriate drawing numbers and detailed references shall be listed for unique or modified items. Recommendations shall be made of each item considered necessary for plant maintenance for the instrument over a five year period.

D3 FORMAT AND MATERIALS

- D3.1 Size. The manuals furnished with the instrument shall be approximately 5-1/2 inches by 8-1/2 inches.
- D3.2 Cover.
- D3.2.1 The cover shall be printed in black on a field of yellow.
- D3.2.2 The cover shall be marked with the following information: "Instruction and Maintenance Manual, Dosimeter Attachment for OCD Item No. CD V-794, Model No. (to be furnished)" the contractor's name, city, and state.
- D3.2.3 A picture of the complete instrument shall appear on the cover.
- D3.2.4 The cover shall be made of material heavier than the inside pages.

PRODUCTION COST ANALYSIS

10 Units

LABOR

Engineering	122.55	
Manufacturing	<u>15.27</u>	
Subtotal		\$137.82

OVERHEAD

Engineering @ 150%	183.83	
Manufacturing @ 200%	<u>30.54</u>	
Subtotal		214.37
Material		222.27
Tooling		<u>25.00</u>
Subtotal		599.46
General & Administrative @ 16%		<u>95.91</u>
Total Est. Mfg. Cost		695.37

100 Units

LABOR

Engineering	12.26	
Manufacturing	<u>9.46</u>	
Subtotal		21.72

OVERHEAD

Engineering @ 150%	18.39	
Manufacturing @ 200%	<u>18.92</u>	
Subtotal		37.31
Material		197.61
Tooling		<u>25.00</u>
Subtotal		281.64
General & Administrative @ 16%		<u>45.06</u>
Total Est. Mfg. Cost		326.70

1000 Units

LABOR

Engineering	1.05	
Manufacturing	<u>7.97</u>	
Subtotal		9.02

OVERHEAD

Engineering @ 150%	1.58	
Manufacturing @ 200%	<u>15.94</u>	
Subtotal		17.52
Material		197.61
Tooling		<u>25.00</u>
Subtotal		249.15
General & Administrative @ 16%		<u>39.86</u>
Total Est. Mfg. Cost		289.01

<u>Material Cost for other Components</u>	<u>Number of Assemblies</u>	
1. <u>Turtable Assembly</u>	<u>10</u>	<u>100</u>
Bearing (8 per assembly)	2.25	1.80
2. <u>Desimeter Chuck</u>		
Gear	36.00	36.00
Washer	.60	.60
Retaining Ring	.12	.12
Steel Balls	.96	.96
Springs	.96	.96
Screws	.12	.12
3. <u>Chassis</u>		
Stand-off (short)	.45	.45
Ring Gear	18.00	15.00
Screw	.03	.03
Stand-off (long)	.45	.45
Meter	44.33	40.66
4. <u>Cellar</u>		
Screws	.20	.20
	.03	.03
5. <u>Base</u>		
Screws & Washer	.07	.07
<u>ELECTRICAL COMPONENTS</u>		
Relay	4.80	3.36
Switch	1.43	1.08
Indicator Light	.40	.40
Timer	34.20	30.60
Connector	.90	.75
Wire & Lugs	.27	.27
<u>SUMMARY</u>		
Material	222.27	197.61
Machine Shop	2.07	1.00
Assembly	1.00	1.00
Final Test	2.63	1.32

No Engineering and Drafting included, i.e., the above is straight manufacturing cost for assembly. All drawings final and all development finished.

Component (Manufactured Parts)	Probable Method of Manuf.	Tooling (if any)	Material \$	Setup Hours	Run Hours (each)	Remarks
1. Chuck Assembly	Investment Casting & Machining & Finish	\$250.	\$4.50 ea. casting	3 hours .04 each for tea	.12	8 per assembly \$4.50 for 80 each \$3.75 for 800 each
2. Turntable	Purchased	\$38.00				\$38.00 for 10 each \$32.00 for 100 each
3. Collar	Machined		.38	2.5	.13	
4. Chassis	Machined		.63	2.5	.08	
5. Base	Machined		.60	3.5	.45	
6. Guide Bracket	Machined		.09	3.5	.06	
7. Swivel Catch				3.5	.06	

Air Force Special Weapons Center
Att: Capt. C. E. Harris
Kirtland AFB
Albuquerque, New Mexico

Commanding Officer and Director
U. S. Naval Radiological Defense Lab.
San Francisco 24, California

Commander, Field Command
Defense Atomic Support Agency
Sandia Base
Albuquerque, New Mexico

Commanding Officer
U. S. Army Electronics
Research and Development Lab.
Fort Monmouth, New Jersey.

Chief of Research and Development
Department of the Army
Washington 25, D. C.

Chief of Naval Operations
Washington 25, D. C.

Chief, Defense Atomic Support Agency
Att: Radiac Panel Secretary
Washington 25, D. C.

Chief Bureau of Ships
Department of the Navy
Att: Code 685-C
Washington 25, D. C.

Director,
Defense Research and Engineering
Washington 25, D. C.

Defense Logistics Studies Information
Exchange
Washington 25, D. C.

St. Procopius College
Physical Sciences Division
Att: Dr. F. R. Shenka
Lisle, Illinois

C. J. Barkowski
Instruments and Controls
Oak Ridge National Laboratory
Oak Ridge, Tennessee

Division of Biology and Medicine
Atomic Energy Commission
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