

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

ARMY EQUIPMENT: MANUFACTURE OF DATA PLATES

Headquarters, Department of the Army, Washington 25, D.C.

15 July 1963

TB ORD 1024, 10 October 1961, is changed as follows:

Change title to read as shown above.

**1. Purpose.** This bulletin provides information and instructions on the process used and the equipment required to fabricate photosensitive anodized aluminum data plates for **use on Army equipment.**

**3. General.**

d. Metalphoto is manufactured \* \* \* sizes and thicknesses. The 0.020-inch thick material is considered the most practical and economical for **Army equipment** data plate use. The size recommended \* \* \* are given below.

**5. Obtaining Negative.**

d. In the absence \* \* \* multiple image negative.

(5) After the required \* \* \* for future use. If the data plate has no FSN, use the **plate drawing** number or assign an interim number.

**6. Processing Photosensitive Anodized Aluminum Material.**

d. Satisfactory results can \* \* \* are as follows:

(4) Acid shortstop bath

*Formula for Acid Shortstop Solution*

		<i>Avoirdupois</i>	<i>Metric</i>
Acetic acid (28%) .....	1.5 ounces	45 cc	
Water .....	32.0 ounces	1. liter	
*	*	*	*

**7. Depletion of Current Data Plate Stocks.**  
Rescinded.

**8. Supply of Data Plates.** (Superseded)

a. The following facilities are the primary supply points for data plates:

- (1) Anniston Army Depot, Anniston, Ala.
- (2) Granite City Army Depot, Granite, City, Ill.
- (3) Pueblo Army Depot, Pueblo, Colo.
- (4) Red River Army Depot, Texarkana, Tex.
- (5) Tooele Army Depot, Tooele, Utah.
- (6) USA Aeronautical Depot Maintenance Center, Corpus Christi, Tex.

b. Replacement data plates will be obtained through normal supply channels. Federal stock numbers listed in applicable technical manual parts list or supply manuals will be used.

c. Overseas depots and CONUS depots other than those mentioned above are also authorized to fabricate data plates locally to support their depot maintenance operation. However, as indicated in paragraph 2, local production of data plates is dependent on ready availability of photographic laboratory skills and facilities. Those installations which are not in a position to fabricate their own plates will requisition them through normal supply channels.

By Order of the Secretary of the Army:

**EARLE G. WHEELER,**  
*General, United States Army,*  
*Chief of Staff.*

Official:

**J. C. LAMBERT, Major General,**  
*United States Army,*  
*The Adjutant General.*

Distribution:

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DCSLOG (1)  
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    Sixth US Army (1)  
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Div (2)  
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USAWECOM (2)  
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Instl (1) except  
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    Ft Sill (6) Ft Meade (3)  
    Ft Bliss (9) Ft Hood (7)  
    Ft Sam Houston (7)  
Svc Colleges (2)  
Br Svc Sch (2) except  
    USA Ord Sch (50)  
USA Tk Autmv Cen (105)  
GENDEP (OS) (2)  
Ord Sec. GENDEP (5)  
A Dep (1) except  
    Black Hills (5) Rossford (10)  
    Savanna (5) Sierra (3)  
    Sioux (2) Tooele (4)  
    Umatilla (3)  
    Wingate (3)  
POE (2)  
Ord PG (10)  
Trans Tml Comd (2)

Army Tml (2)  
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    Benicia (15)  
    Frankford (10)  
    Joliet (3)  
    Raritan (10)  
Springfield Armory (2)  
Proc Dist (Ord) (1) except  
    Cleveland (2)  
    New York (3)  
    Philadelphia  
    St Louis  
Ord Plants (5) except  
    Lake City (2)  
    Kingsbury, Pantex (none)  
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    29-55

NG: State AG (3); units-same as Active Army except allowance is one copy each.

USAR: Same as Active Army except allowance is one (1) copy each unit.

For explanation of abbreviations used see AR 320-50.

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**AGO 5620A**

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DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

ORDNANCE VEHICLES: MANUFACTURE OF DATA PLATES

Headquarters, Department of the Army, Washington 25, D. C.  
10 October 1961

**1. Purpose.** This bulletin provides information and instructions on the processes used and the equipment required to fabricate photosensitive anodized aluminum data plates for ordnance vehicles.

**2. Scope.** a. These instructions are limited to depot maintenance personnel.

b. Manufacture of data plates below depot level is not authorized unless an emergency, shortages, or circumstances prevent logistical support through normal supply channels. In these instances only major commanders overseas may authorize the manufacture of data plates below depot level.

Note, This bulletin does not authorize the purchase of equipment to fabricate data plates. Data plate fabrication, in accordance with these instructions, must be accomplished with existing facilities and equipment.

**3. General.** a. Data plates fabricated from photosensitive anodized aluminum have been wear and weather tested. Legibility and quality of the plates were not adversely affected under salt atmosphere, moisture, light, abrasion, cleaning and painting solvents, up to 950°F. heat or general atmospheric exposure.

b. Photosensitive anodized plates are photographically processed in a manner almost identical to that used for ordinary photographic paper.

c. Photosensitive anodized aluminum material is covered by Military Specification MIL-P-514. It is available through the General Services Administration Federal Supply Schedule under FSC Class 6750, Photographic Sensitized and Chemical Supplies. The material is listed under the trade name "Metalphoto."

d. Metalphoto is manufactured in several sizes and thicknesses. The 0.020-inch thick material is considered the most practical and economical for Ordnance data

plate use. The size recommended is 10 x 12. Federal stock numbers for common sizes 0.020-inch thick, one side printable, are given below.

Table I. Metalphoto, One Side Printable, in. 0.020-Inch Thickness

Per stock No.	Size	Federal stock No. Box		Plates Mfgs
	10 X 12	6750-720-5375	U-1012-24(100)	100
	12 X 20	6750-720-5408	U-1220-24(100)	100
	18 X 24	6750-720-0615	U-1824-25(50)	50
	20 X 24	6750-720-5315	U-2024-24(50)	50
	22 X 26	6750-720-5329	U-2226-24(50)	50

**4. Preparing Data Plate Art Work.**

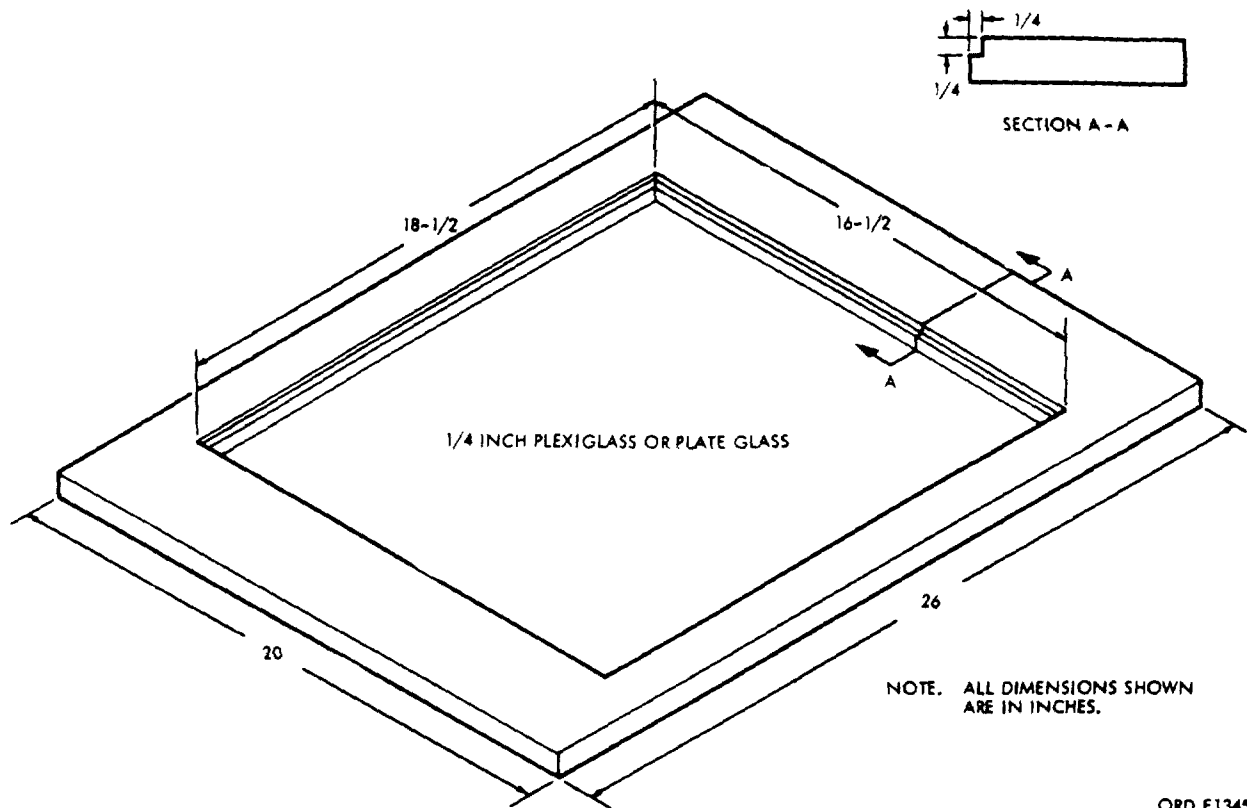
*Note.* When original artwork is not on file or data plate reproduction cannot be found in pertinent technical manuals, it will be necessary to prepare drafting board art containing necessary data for photographing. A lithographic negative (plain negative without screen) is necessary for transferring the artwork image to the "Metalphoto."

a. When an art or visual aids facility is available, the artwork for the required data plate is best handled through them.

b. When it is necessary to prepare original art without an art or visual aid facility, the data plate information can be drawn on a regular drafting board, using professional drafting and lettering techniques. A drawing board, modified as shown in figure 1, may be used for retouching negatives. tracing, viewing, etc.

TAGO 2093A - October

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**Figure 1. Modified 20 x 26 drawing board converted into art and photo view screen.**

- (1) THIS LINE IS SET IN ARTYPE NO. 1165
- (2) THIS LINE IS SET IN CRAF-TYPE NO. M-2-3-14
- (3) THIS LINE IS SET IN LE ROY GOTHIC NO. 3240-120C

ORD E1346

**Figure 2. Sample lettering faces.**

c. Artwork should be prepared 1 1/2 to 2 times the size required for reproduction.

d. In the interest of quality reproduction, lettering for data plates should be sharp and clear and proportionately spaced. For samples of readily available lettering faces, refer to figure 2.

**5. Obtaining Negative.** a. Photograph the finished art work (fig. 3) to obtain lithographic negative.

b. In exposing Metalphoto, time can be saved if a multiple image reverse negative is used. Use a step-and-repeat easel to produce the multiple

image reverse negative (fig. 4) A series of accurately-spaced images on a film is produced by using the step-and-repeat easel (fig. 5).

c. Operating a step-and-repeat easel.

- (1) Attach the negative produced from the art work to movable platen and mask off the balance of the platen area.
- (2) Attach a strip of film to the platen, and make a series of exposures lengthwise thus providing an evenly-spaced series of images. This series of images should be of the same length as the printable area of the Metalphoto plate being used. Each exposure should be timed 2 seconds under a 150-watt lamp approximately 3 feet away.
- (3) Using the strip negative thus produced, repeat the procedure in (1) and (2) above, this time moving across the platen to produce the final reverse negative of approximately the same size as the printable area of the Metalphoto plate being used.
- (4) The easel adjusting screws may be set by using an inside-outside caliper. When the starting position has been deter

**TRUCK UTILITY 1/4 TON 4X4 M-151**  
**FEDERAL STOCK NO. 2320-542-4783**  
 MFD. BY [REDACTED]  
 CONTRACT NO. [REDACTED]  
 MFR. MODEL M-151 PARTS LIST [REDACTED]  
 MFR. SERIAL NO. [REDACTED]  
 MAINTENANCE MANUALS [REDACTED]  
 DATE OF DELIVERY [REDACTED] INSPECTED [REDACTED]  
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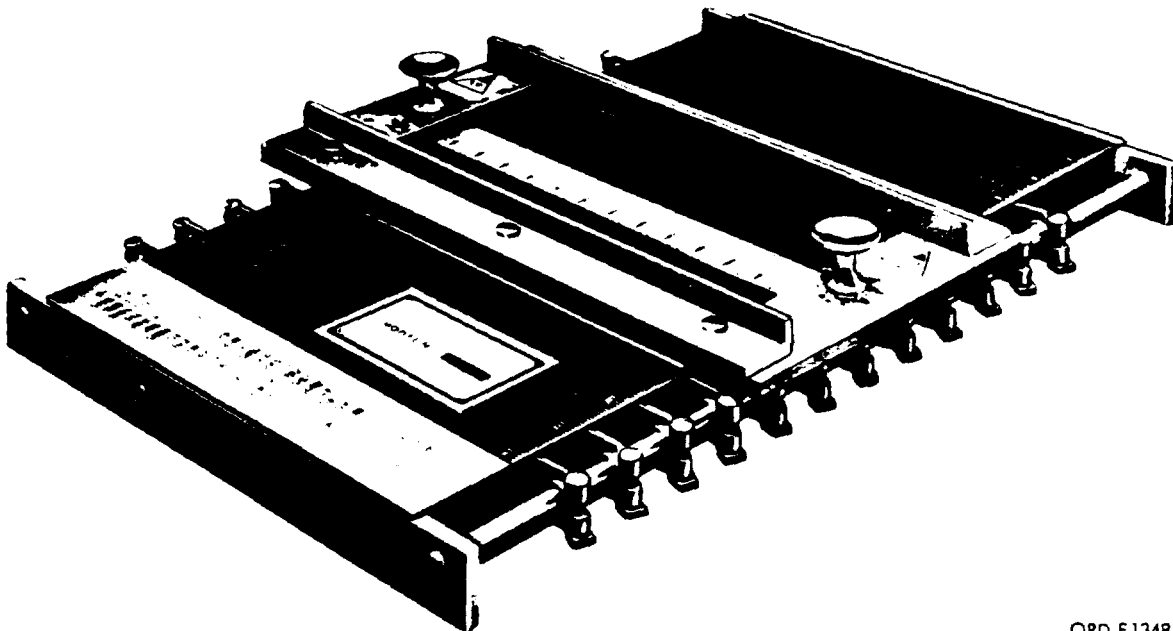
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**WEIGHT AND DIMENSIONAL DATA**

VEHICLE PAYLOAD	EMPTY	CROSS COUNTRY	HIGHWAY
PAYLOAD		800 LBS.	1200 LBS.
FRONT AXLE	1303 LBS.	1389 LBS.	1433 LBS.
REAR AXLE	970 LBS.	1684 LBS.	2040 LBS.
TOTAL LBS.	2273 LBS.	3073 LBS.	3473 LBS.
MAX. TOWED LOAD		1500 LBS.	2000 LBS.
SHIPPING CUBAGE EM 346 CU. FT. REDUCED TO 255 CU. FT. SHIPPING WEIGHT (DRY) 2136 LBS.			

ORD E1347

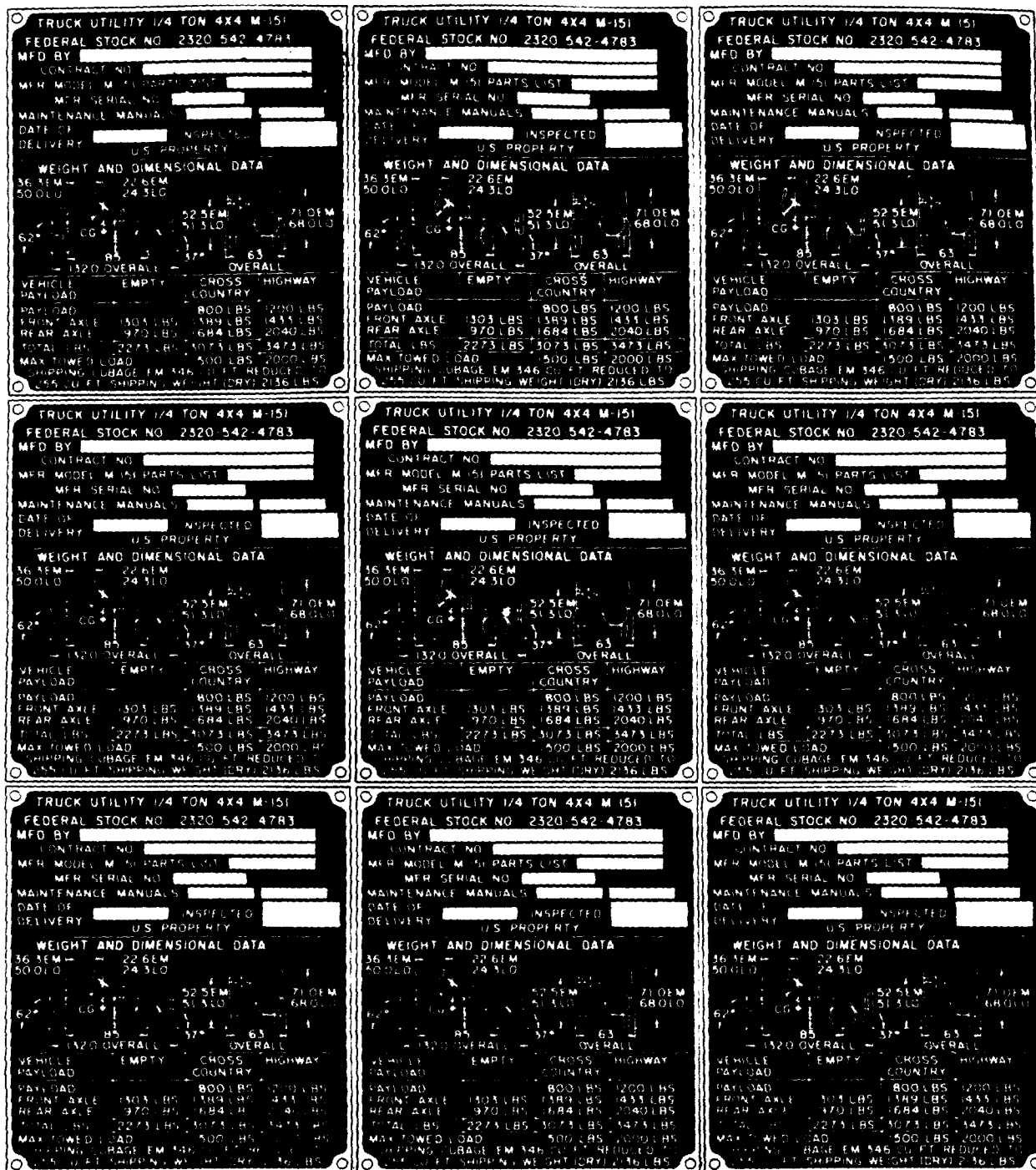
Figure 3. Completed art work.



ORD E1348

Figure 4. Step-and-repeat easel.

AGO 2093A



ORD E1349

Figure 5. Plates printed on 10 x 12 sheet of Metalphoto from a multiple image negative.

AGO 2098A

mined, the caliper is set to allow for size of the image plus the border. Then, using the inside measuring jaws, each lock screw is moved up to the correct position. This method is faster and more accurate than adjusting the screws by reading easel scales.

d. In the absence of a step-and-repeat easel, use the following procedure for making the multiple image negative:

- (1 ) Using the negative produced from the art work, make a contact reverse print on film.
- (2) Using the full size reverse negative thus produced, make as many contact prints on photographic paper as are necessary to make a multiple image negative.
- (3) Carefully trim and mount the paper contact prints as shown in figure 5, making sure to maintain accurate alignment.
- (4) Place the layout on the copy board, and make a one-to-one negative. Use this negative to make contact exposures on Metalphoto.
- (5) After the required number of plates have been exposed, assign the negative the data plate Federal stock number, catalog the film and file for future use. If the data plate has no FSN, use the Ordnance number or assign an interim number.

**6. Processing Photosensitive Anodized Aluminum Material.**

a. Working with Metalphoto is essentially the same as working with photographic printing paper, but one must become familiar with and compensate for its characteristics.

b. The only equipment needed is that of a conventional photographic laboratory, plus a means of boiling water (for the sealing operation).

c. Safelight can be bright red. Basically, any light safe for chloride paper is safe for Metalphoto. All operations through fixing must be done under darkroom conditions.

d. Satisfactory results can be obtained if recommended formulas are adhered to and distilled or deionized water is used. It is advisable to use certain prepared solutions in photographic work to save time, labor, and money. Suggested solutions and formulas are as follows:

- (1) Developers such as Eastman s Kodak D-19, metalphoto DM1- or DM-2, or equal.
- (2) Standard fixers such as Eastman's Kodak Rapid Fixer, or equal.
- (3) Toners such as Ansco 231 Toner, or equal.

Formula for Ansco 231 Toner (To Make 1 Quart)

	Avoirdupois	Metric
Hot water (125° F. or 52°C.)	24 ounces	760 cc
Ammonium Thiocyanate.	3.5 ounces	105 grams
Gold Chloride, 1 % solution	.2 ounces	60 cc
Distilled water to make.	32 ounces	1 liter

**Note. To prepare a 1 percent gold chloride solution, dissolve 15 grains of gold chloride in 3 1/4 ounces of water, or 1 ounce of gold chloride in 100 ounces of water.**

(4) Acid shortstop bath.

Formula for Acid Shortstop Solution

	Avoirdupois	Metric
Acetic acid (28%)	1.5 ounces	45 cc
Water	32.0 ounces	1 liter

**Note. To prepare a 28 percent acetic acid solution, mix 3 parts of glacial acetic acid in 8 parts of water.**

e. The Metalphoto processing requires a 13-step procedure as follows:

- (1) Step 1. Exposing. Expose Metalphoto plates for 14 to 15 seconds in a contact printer with a 1000-watt light. Normally, Metalphoto plates are contact printed. Projection printing is possible, but it is not considered applicable to data plate fabrication. In copying line work, from good density negatives, it is difficult to over expose. For best results, give line work plenty of exposure. In all Metalphoto work, good contact between the negative and the Metalphoto plate is of the utmost importance. Fuzziness of the image on Metalphoto plates, unless the fuzziness is in the negative, is always due to improper contact.

**Caution: Handle plates by the edges until the sealing operation is completed. If tongs are used, they must be clean and must have plastic grip faces. Until the surface is sealed, the anodized layer on the plate surface is porous. Smudges and fingerprints penetrate the pores and are impossible to remove. Before sealing, the plates are also subject to scratching. Exercise due care to keep plates from rubbing against each other. Econopak plates have a tab end for convenience in handling.**

- (2) Step 2. Rinsing. Dip plates in bath of tap water long enough to wet completely

the entire surface. This provides positive contact between the developer and the light-sensitive chemicals embedded in the pores of the anodized layer.

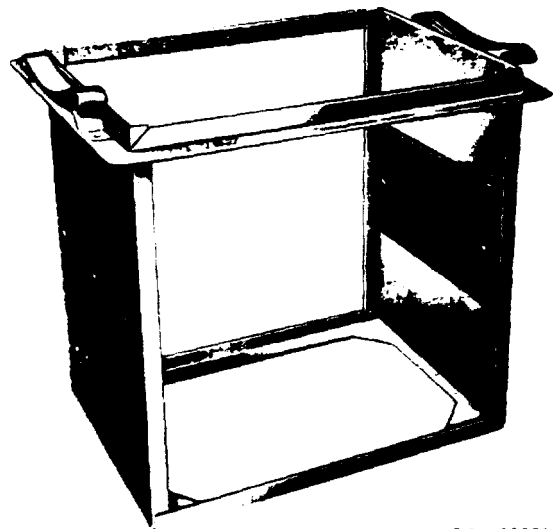
- (3) Step 3. Developing. Immerse the plates 6 to 8 minutes into appropriate developer (d(1) above) and agitate intermittently. If the image is not dark enough, an additional minute or two should bring the image to the desired density. The ideal practice is to suspend the plates vertically in the developer to minimize agitation requirements.

**Caution: Extreme periods of time in the developer may cause plate background fogging. Recommended temperature for developer is 68°F. Higher temperatures are likely to cause background fogging. Use glass, hard rubber, plastic, or stainless steel trays or tanks for developing solution.**

- (4) Step 4. Washing. Rinse plates under an open tap. During this rinsing operation, wipe the plates with a clean, damp sponge for approximately 30 seconds.
- (5) Step 5. Shortstopping. Immerse the plates into the shortstop solution (d(4) above) for 30 seconds, and agitate gently.
- (6) Step 6. Rinsing. Rinse in water bath approximately 15 to 30 seconds to wash away the shortstop chemicals.
- (7) Step 7. Fixing. Immerse plates in solution (d(2) above) for 2 minutes. Vertical plate immersion is the most practical. Use glass, plastic, hard rubber, or stainless steel trays or tanks for fixing solutions.
- (8) Step 8. Washing. Immerse plates vertically in running tap water for 2 to 3 minutes. Plates may now be exposed to the light.
- (9) Step 9. Image toning. Immerse plates vertically into the image toning solution (d(3) above) from 30 to 60 seconds longer than it takes to turn the image black. This operation normally takes from 1 to 5 minutes. If the image does not turn black within the time indicated, prepare a fresh toner solution. Before toning, the image is brownish black or dark sepia.

The gold chloride-thiocyanate toner converts the image to dense black. If the plates are toned too long, the image will turn blue black, or may bleach out completely, and the background may develop a blue haze. If the plates are not toned, the image will turn sepia during the sealing operation. Use only glass, hard rubber, or plastic trays or tanks for toning. If stainless steel hangers are used, remove them from the plates for toning, or have the hangers coated with plastic.

- (10) Step 10. Rinsing. After toning, rinse the plates for 3 minutes in running tap water.
- (11) Step 11. Sealing. Immerse plates vertically in boiling water for 30 minutes. If a tray is used for this operation, place the plates face down, and do not allow the plates to overlap. An aluminum rack may be used to hold plates vertically (fig. 6).
  - (a) When plates have been processed this far, the photographic image has been developed through the pores of the anodized layer. At this point, the pores are open. To insure permanence, these pores are sealed by boiling. Sealing may also be accomplished by using steam or an acetate solution. Sealing with steam takes 5 minutes, and acetate solution takes approximately 15 minutes. Steam sealing, however, does not provide the abrasion



ORD E1350

Figure 6. Locally fabricated plate holding rack for sealing operation.



resistance quality desired. So, this method is not recommended for Ordnance use. Abrasion and corrosion resistance is improved by acetate solution sealing. Accordingly, this method is optional. If this method should be used, immerse the plates in hot acetate solution (200° to 205°F. Or 95°C.) for approximately 15 minutes. Using distilled or deionized water, mix the solution as follows:

Nickel acetate-5 grams per liter

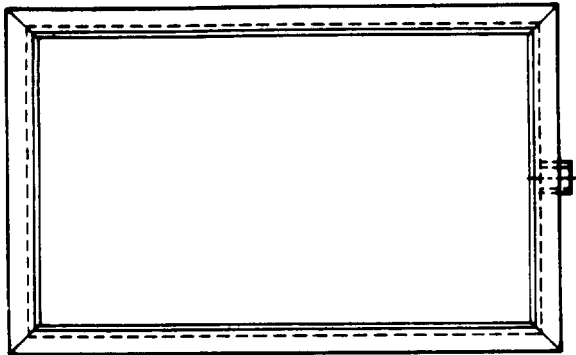
Cobalt acetate-1 gram per liter

Boric acid-8 grams per liter

(b) Use distilled or deionized water for the boiling operation, otherwise, impurities in the water can prevent sealing, no matter how long the plates are boiled. Use glass, stainless steel, or aluminum containers for boiling operation.

(c) Caution and warning plates will be tinted or colored red. The coloring operation is performed after the rinse following the toning, and before the sealing operation, steps 10 and 11, respectively. Red chemical color No. ZR-130, 6750-720-3490, is used for this purpose.

NOTE: ALL DIMENSIONS SHOWN ARE IN INCHES.



**TEN TANKS ARE REQUIRED**

THREE (3) TANKS TO HAVE A 1/2" STAINLESS STEEL VALVE LOCATED ONE INCH UP FROM BOTTOM (NO OTHER FITTINGS TO BE USED FOR DEVELOPER SHORT-STOP, AND FIXER SOLUTIONS).

FOUR (4) TANKS TO HAVE TWO 3/4" STAINLESS STEEL THREADED COUPLINGS WELDED IN PLACES SHOWN, (FOR WASH AND RINSE.)

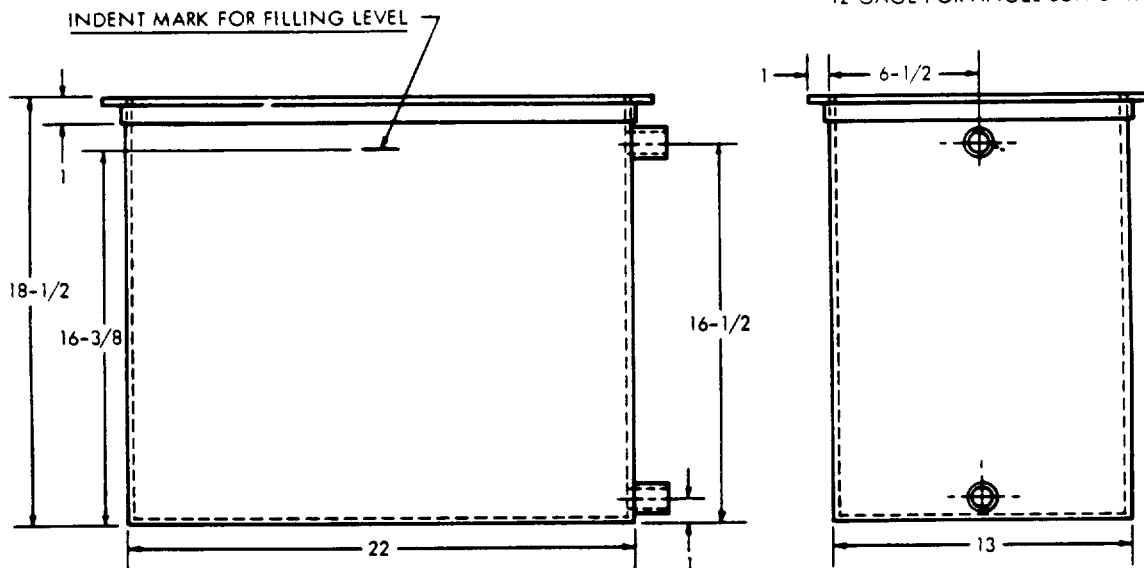
ONE (1) TANK (WITHOUT FITTINGS) TO BE SLUSH-COATED WITH POLYVINYL CHLORIDE OVER INTERIOR SURFACE. (THIS TANK TO BE USED FOR TONING.)

TWO (2) TANKS (WITHOUT FITTINGS) FOR TINTING AND BOILING (SEALING) OPERATIONS.

ALL WELDS TO BE HELIARC WELDED AND MUST BE WATER-TIGHT.

LIQUID CAPACITY WHEN FILLED TO INDENT MARK IS TO BE 20 GALLONS.

MATERIAL: TYPE 316 STAINLESS STEEL OR FIBER GLASS.  
18 GAGE FOR TANK.  
12 GAGE FOR ANGLE SUPPORT.



ORD E1351

Figure 7. Construction of processing tanks (for 12 x 20 plates).

AGO 2098A

1. Dissolve the contents of a color package in approximately 1 pint of distilled or deionized water. Dilute this concentrated solution in distilled or deionized water to make 1 gallon.
2. Test the solution on test strips of Metalphoto to obtain uniformity of color intensity. The color intensity may be maintained by adjusting the solution concentration and the coloring time. The color may be intensified by diluting the solution to less than a gallon.
3. Maintaining the color solution at a temperature between 125° and 150°F. (50° and 65°C.), immerse the plates in the solution for 5 minutes or more if required. (Darker color is obtained by longer immersion.) It is possible to color plates at room temperature with longer immersion.

(12) Step 12. Polishing. After taking the plates out of the sealing tank, allow them to dry thoroughly. If the acetate sealing method is used, rinse the plates in running water immediately after removing them from the solution, then dry. Use a soft cloth or buffer and floor, furniture. or automotive wax to polish the plates.

(13) Step 13. Trimming, punching, stamping. Use available equipment and cut, trim, drill holes,

and stamp serial numbers, registration numbers, dates, and other information as required.

*Note.* Manual office paper cutter may be used for cutting or trimming Metalphoto plates. However, due caution must be exercised when using an office paper cutter to cut unexposed Metalphoto. Always use a sheet of black paper between cutter surface and unexposed Metalphoto. If sheared edge is rough, bent, or distorted, place the plate on the cutter and make a narrow cut (Approximately 1/32 of an inch) from the distorted edge. This operation restores the straight edge, and assures better contact during exposing.

**Caution: Stamping must be accomplished in a manner that will neither cut through the plate metal, nor bend or distort the back surface.**

f. For processing Metalphoto data plates, ten tanks are required. If tanks are not available, they can be locally constructed by coordinating with the Post Engineers. Tanks should be made of fiber glass or stainless steel. When stainless steel is used, the tank for the toning operation should be lined (slush coated) with polyvinyl chloride. Tank construction is illustrated in figure 7.

g. For problems that may arise in processing Metalphoto, troubleshooting information and corrective measures are given in table II.

Table II. Troubleshooting

Problem	Probable cause	Corrective action
Lack of full density black in image	Insufficient exposure Insufficient developing time	Increase exposure time. Increase developing time (minimum of 5 min. in D19).
Fogged background	Insufficient light intensity Stray light Spent developer  Developer temperature too high Image toner improperly prepared Insufficient or improper sponging and rinsing between developer and fixer.	Increase light intensity. Check for and correct light leaks. Check for and prepare fresh developer.  Correct temperature to 68°F. Properly prepare fresh toner. Make certain plates are properly sponged during rinse between developer and fixer. If tank developing is used, the shortstop may be used in place of the sponging.
	Insufficient density in negative. When held to the light, if the black areas transmit any light the negative is not dense enough.	Check the negative. If negative lacks density, retouch or make a new negative.

Table II.-Continued

Problem	Probable Cause	Corrective action
Fuzzy image	Plates left standing in open air for an hour or longer. If this is so, chemical fog is likely to develop. Improper contact	Keep the plates in box until ready for exposure. Reseal any unused plates, return to box, and tape edges of box. Make sure there is proper contact between negative and plate.
Blocked in white lines	Poor contact Lack of negative density	Insure proper negative contact. Retouch negative or make a new one.
Yellow cast to background	Incomplete sealing Distilled or deionized water not used for sealing.	Boil sufficiently to insure proper sealing. Use distilled or deionized water for sealing.
Blue-black image Bleached image Spots, fingerprints, etc. in unexposed areas.	Too long in toning solution Improper handling	Do not tone longer than required. Remove spots, fingerprints, etc. From background with Farmer's Reducer or ordinary household iodine. If iodine is used, follow with a rinse in fresh hypo.
Brown image	Image toner is spent or insufficient toning	Make fresh toner and/or insure proper toning.
Bleaching of background during	Contamination of sealing water sealing.	Use clean distilled or deionized water In proper sealing container or tank.

#### 7. Depletion of Current Data Plate Stocks. a.

Current stocks of brass vehicular data plates at Red River Arsenal will be used to satisfy all current requirements until such stocks are depleted.

b. Effective immediately, Red River Arsenal will discontinue fabrication of data plates by the photo engraving (etchings) brass process. except to utilize existing stocks of sheet brass for which there is no other use. In this instance, the quantity of sheet brass on hand and the date by which it will be exhausted will be reported to the Chief of Ordnance, ATTN: ORDFM.

c. As stock of a particular brass data plate is exhausted. Red River Arsenal will fulfill all subsequent requirements for that plate with data plates produced by the photosensitive anodized aluminum process.

8. Supply of Data Plates. a. Red River Arsenal, Texarkana, Texas, is the primary supply point for data plates. However, replacement data plates will be obtained through normal supply channels.

b. Under certain circumstances. it may become necessary for Ordnance overhaul installations other than Red River Arsenal to manufacture data plates locally to support their depot maintenance operations. As indicated in paragraph 2, local production of data plates is dependent on ready availability of photographic laboratory skills and facilities. Further, all local manufacture of data plates in CONUS is subject to approval by the Chief of Ordnance.

**BY ORDER OF THE SECRETARY OF THE ARMY:**

G. H. DECKER  
*General, United States Army,  
Chief of Staff.*

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J. C. LAMBERT,  
*Major General, United States Army,  
The Adjutant General.*

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USCONARC (3)	Army Hosp (2)
ARADCOM (2)	Ord Arsenal (5) except
ARADCOM Rgn (2)	Benicia (15), Frankford (10),
OS Maj Comd (2)	Joliet (3), Lake City (2),
OS Base Comd (2)	Ravanna, Radford (1),
LOGCOMD (2)	Raritan (25), Watervliet
Armies (3)	Ord Arsenal (None)
Corps (2)	Kingsbury Ord Plant (None)
Div (2)	Springfield Armory (2)
Instls (1) except	Ord Dist (1) except
Ft Bliss (9), Ft Hood,	Cleveland (2), New York,
Ft Sam Houston, Ft Belvoir (7),	(3), Phila (4), St Louis
Ft Bragg (2), Ft Sill (6)	Ord Dist (3)
Svc College (2)	Mil Msn (1)
Br Svc Sch (2) except	MAAG (1)
USA Ord Sch (50)	Units org under fol TOE:
Ord Tk Autmv Comd (105)	Two copies to each unit:
Ord Ammo Comd (1)	9-9
Ord Wpns Comd (10)	9-12
GENDEP (2)	9-137
Ord Sec. GENDEP (5)	9-167
Ord Dep (1) except	9-197
Black Hills, Savanna (5),	9-500, CC
Sierra, Umatilla,	29-55
Wingate (3), Sioux (2),	

NG: State AG (3); units-same as Active Army except allowance is one copy to each unit.

USAR: Units-same as Active Army except allowance is one copy to each unit.

For explanation of abbreviations used, see AR 320-50.

U.S. GOVERNMENT PRINTING OFFICE 828 268

**AGO 2093A**

**10**

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

 <div style="border: 1px solid black; border-radius: 15px; padding: 5px; display: inline-block; margin-left: 20px;"> <p style="font-size: small; margin: 0;">THEN...JOT DOWN THE DOPE ABOUT IT ON THIS FORM. CAREFULLY TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL.</p> </div>		SOMETHING WRONG WITH PUBLICATION	
		FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)	
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PUBLICATION NUMBER		PUBLICATION DATE	PUBLICATION TITLE
IN THIS SPACE, TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT.			
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BE EXACT PIN-POINT WHERE IT IS			
PAGE NO.	PARA- GRAPH	FIGURE NO.	TABLE NO.
PRINTED NAME, GRADE OR TITLE AND TELEPHONE NUMBER		SIGN HERE	

## The Metric System and Equivalents

### Linear Measure

1 centimeter = 10 millimeters = .39 inch  
 1 decimeter = 10 centimeters = 3.94 inches  
 1 meter = 10 decimeters = 39.37 inches  
 1 dekameter = 10 meters = 32.8 feet  
 1 hectometer = 10 dekameters = 328.08 feet  
 1 kilometer = 10 hectometers = 3,280.8 feet

### Weights

1 centigram = 10 milligrams = .15 grain  
 1 decigram = 10 centigrams = 1.54 grains  
 1 gram = 10 decigrams = .035 ounce  
 1 decagram = 10 grams = .35 ounce  
 1 hectogram = 10 decagrams = 3.52 ounces  
 1 kilogram = 10 hectograms = 2.2 pounds  
 1 quintal = 100 kilograms = 220.46 pounds  
 1 metric ton = 10 quintals = 1.1 short tons

### Liquid Measure

1 centiliter = 10 milliliters = .34 fl. ounce  
 1 deciliter = 10 centiliters = 3.38 fl. ounces  
 1 liter = 10 deciliters = 33.81 fl. ounces  
 1 dekaliter = 10 liters = 2.64 gallons  
 1 hectoliter = 10 dekaliters = 26.42 gallons  
 1 kiloliter = 10 hectoliters = 264.18 gallons

### Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch  
 1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches  
 1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet  
 1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet  
 1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres  
 1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

### Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch  
 1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches  
 1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

## Approximate Conversion Factors

To change	To	Multiply by	To change	To	Multiply by
inches	centimeters	2.540	ounce-inches	Newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29.573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	Newton-meters	1.356	metric tons	short tons	1.102
pound-inches	Newton-meters	.11296			

## Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C
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