MIL-HDBK-303

15 SEPTEMBER 1964

MILITARY STANDARDIZATION HANDBOOK

MICRO-REPRODUCTION

OF

ENGINEERING DOCUMENTS

FSC EDMS

DEPARTMENT OF DEFENSE
WASHINGTON 25, D. C.

MIL-HDBK-303

Micro-Reproduction of Engineering Documents

15 September 1964

1. This standardization handbook was developed by the Department of Defense with the assistance of various industry associations in accordance with established procedures.

2. This handbook was approved on 15 September 1964 for printing and inclusion in the military standardization handbook series.

3. This document provides basic and fundamental information related to the micro-reproduction of drawings, lists and related data. The handbook is not intended to be referenced in purchase specifications except for informational purposes, nor shall it supersede any specification requirements.

4. Every effort has been made to reflect the latest information on the micro-reproduction practices relating to engineering drawings, associated lists and related documents. References or pictures of any material, processes and equipment, are for informational purposes only and are not for authorization or restriction for procurement actions. The types of material, processes and equipment are those either covered by the referenced documents in 2.1 or those now in use by the various military activities. It is the intent to review this handbook periodically and, when applicable, revise to include the latest information regarding micro-reproduction methods.Users of this document are encouraged to report any errors discovered and any recommendations for changes or inclusions to Headquarters, DSA, Standardization Division, Washington 25, D. C.

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Contents

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1. SCOPE

1.1 Purpose. The purpose of this handbook is to provide guidance for Departments and Agencies of the Department of Defense and their contractors in the techniques required to obtain satisfactory micro-reproductions of engineering documents.

1.2 Scope. This handbook contains information regarding preparation and reproduction processes, practices and techniques which affect the quality, legibility, permanence and the interchange capabilities between military activities of all engineering documents in the form of microfilms or photographs and the reproductions thereof.

2. REFERENCED DOCUMENTS.

2.1 The current issues of the following documents form a part of this handbook with regards to information on the preparation and micro-reproduction of drawings, lists, specifications and other related engineering documents.

SPECIFICATIONS

MILITARY

MIL-M-9868 — Microfilming of Engineering Documents, 35MM, Requirements for.

MIL-C-9877 — Cards, Aperture.

MIL-C-9878 — Cards, Tabulating and Aperture for Engineering Data Micro-Reproduction System, Preparation of.

MIL-P-9879 — Photographing of Construction/Architectural Drawings, Maps and Related Documents, 105mm Requirements for .

MIL-C-9949 — Cards, Copy.

MIL-D-70327 — Drawings, Engineering and Associated Lists.

STANDARDS

MIL-STD-7 — Types of Engineering Drawings Definition and Requirements.

MIL-STD-24 — Revision of Drawings.

MIL-STD-804 — Formats and Coding, of Tabulating and Aperture Cards, for Engineering Data Micro-Reproduction System.

HANDBOOKS

MIL-HDBK-25 — Glossary of Photographic Terms Including Document Reproductions.

3. DEFINITIONS

3.1 Aperture Card. An aperture card is a tabulating card with a rectangular hole specifically prepared for the mounting or insertion of a frame of microfilm.

3.2 Control Activity. The control activity is the Department of Defense activity that holds the processed camera microfilm image of the document. It is responsible for answering requests from other Department of Defense activities for copies of the microfilm image.

3.3 Data Field. A data field consists of one or more columns, aperture, copy or tabulating card, reserved for specific information entered in a specified manner.

3.4 Engineering Data Micro-Reproduction System (EDMS). The EDMS is a Department of Defense (DOD) Program established to standardize and implement a common micro-reproduction system to be used throughout the Army, Navy, Air Force and industrial suppliers to DOD in the preparation of 35mm microfilm and 105mm film copies of engineering documents, preparation of tabulating and aperture cards, and the mounting of frames of 35mm microfilm in aperture cards.

3.5 Engineering Documents. "Engineering Documents" are specifications, drawings, sketches, lists, standards, pamphlets, reports and printed, typewritten, or other design, procurement, manufacture, test or inspection of items or services.

3.6 Frame. The frame is the total area of microfilm utilized in one exposure, regardless of whether or not the area is filled by the document image.

3.7 First Reproduction Microfilm. First reproduction microfilm is made from the camera microfilm.

3.8 Second Reproduction Microfilm. Second reproduction microfilm is made from first reproduction microfilm.

3.9 Single Frame Microfilming. Single frame microfilming is the utilization of one frame of microfilm to depict a single sheet of an engineering drawing or up to four sheets or pages of a complete engineering document.

3.10 Multiple Frame Microfilming. Multiple frame microfilming is the utilization of two or more frames of microfilm to depict a single sheet(s) or page(s) of an engineering document.

3.11 Reduction Ratio. The term Reduction Ratio means the ratio of the linear measurement of a document to the linear measurement of the micro-image of that same document. This ratio is expressed in abbreviated form as 16X, 24X, etc.

3.12 Revised. The term "revised" code-punched in a tabulating or aperture card means that there is a more recent issue of the document than shown in the original card.

3.13 Revision Notice. A revision notice is a separate document that describes a change to an engineering drawing in accordance with Standard MIL–STD–24.

3.14 **Tabulating Card.** A tabulating card is a card on which data are entered by use of punched holes or other means that can be sensed by a machine so that it can sort, collate, list, total, or otherwise manipulate the card or the data. Tabulating cards are used as a work deck to reproduce punch aperture and copy cards (see 5.7.3).

3.15 Other Definitions. Other definitions relating to engineering document preparation and reproduction are included in such documents as MIL–STD–7, MIL–D–70327, MIL–HDBK–25.

4. GENERAL INFORMATION

4.1 Establishment of the Engineering Data Micro-Reproduction Systems (EDMS). The Department of Defense Engineering Data Micro-Reproduction System (EDMS) is a program established for the microfilming, photographing, and recording of research, development and design information, including engineering and construction drawings, associated lists, specifications and related documents. Whether this program results in good products and contributes significantly to the working efficiency of the military departments and industry, depends largely upon the drafting effort, document preparation and Punched Card Accounting Machine (PCAM) services of military and industry.

4.2 Micro-Reproduction. Micro-Reproduction is a photographic filming process utilizing 35mm or 105mm film by which engineering documents are reduced to a fraction of their original size. The original 35mm negatives may be retained in roll form or individually mounted in PCAM Aperture Cards and placed in a permanent file. Duplicates of the original negatives may be supplied for optical viewing, making blowback prints or furnished to various locations in place of full-sized reproducibles. The 105mm filming system evolves around the use of a 4″ x 6″ film; full-scale and half-scale blowbacks from the film onto translucent paper linen or stable base film; and techniques developed in connection with the film and blowbacks. In some instances, the use of contact prints made from the 105mm film by diazo, blueprint or photographic processes are beneficial.

4.3 Micro-Reproduction Benefits. This program offers substantial savings in cost, manpower, file space and vastly improved service to all military and industrial activities. The use of 35mm microfilm, PCAM tabulating and aperture cards and 105mm film provides benefits such as reduced storage space, faster distribution, blowback prints direct from reduced size film; reduced handling and shipping cost, reduction of research time, and disposal of inactive original documents.

5. DETAIL INFORMATION

5.1 Preparation of Engineering Documents. The ever-increasing use of 35mm microfilm and 105 mm film as engineering document reproducibles for viewing various types of reproductions and record copies requires that appropriate attention be given in the preparation of all engineering documents. Conformance to the applicable specifications and standards (such as MIL–D–70327 and referenced documents contained therein) governing the preparation of engineering documents is one of the prime factors contributing to satisfactory micro-reproductions. Continuous control and proper care in the preparation and handling of original documents will insure more satisfactory micro-reproductions when these documents are to be photographed or microfilmed. To prevent possible redrawing or rehabilitation at a later date, all engineering documents should be prepared for eventual microfilming or photographing.

5.1.2 ***Limitation of Photo-reproductions.*** The finest cameras and the most carefully controlled processing will not produce optimum results unless the original engineering document to be microfilmed is of high quality. Frequently, new engineering document originals are photo-reproduced from complete or portions of existing documents. Documents so produced may be further used to generate additional copies to be used as original copies. The legibility of the microfilm and reduced-size reproductions prepared from such documents will decrease with each successive reproduction. The problem is further compounded in cases where original documents were not expressly prepared for microfilming. Therefore, the number of photo-reproductions should be kept to a minimum.

5.2 Inspection of Engineering Documents. Engineering documents should be inspected prior to microfilming operations. This inspection should be primarily concerned with the general quality, legibility, and similar physical characteristics of the document, rather than the technical accuracy of the content. The technical quality of the document should have been verified in the drafting and preparation stage of the document by technically qualified personnel. In some cases, it may be desirable to check the accuracy of the revision designator, drawing size designator, and page and sheet numbers.

5.2.1 The document should be inspected for the following characteristics:

a. All data are on the face of the document.

b. The document is positive in characteristics and right reading.

c. The document is generally legible,

i.e., lines and characters are large, clear and of sufficient contrast to produce legible microfilm.

d. The background of the document is clean and reasonably free of stains, smudges, correction areas, and similar characteristics that would produce a wide variation in the background density of the microfilm.

e. Sheets or pages of document to be microfilmed in multiples are similar in color, background, contrast, etc.

f. Tears, folds, holes and similar defects do not obliterate data.

5.3 Correction and Rehabilitation of Engineering Documents. Document discrepancies should be corrected prior to microfilming to eliminate expensive duplicate handling of the document in re-microfilming and the attendant delay in the rejection and correction of unacceptable microfilm images. Substandard document correction and rehabilitation need not require the expensive and time consuming redrawing of the original although in a few cases this step may be totally or partially necessary. Obviously, errors of omission by the draftsman must be manually corrected. In a very high percentage of cases of sub-standard documents, either contact or photographic reproduction processes, can be used to create a new original of adequate quality. (See section on 105mm.) Some original documents can be rehabilitated by such prosaic techniques as washing and ironing to correct a surface that is stained, creased, folded or crumpled.

5.4 Camera Equipment and Operations.

5.4.1 *Planetary Camera Characteristics.* Several satisfactory brands and models of planetary cameras are commercially available and in use in the EDMS. The major physical characteristics of most planetary cameras are:

a. The copy board and base on which the document is positioned for microfilming. The copy board is larger than the photographic field at the largest reduction ratio, i.e., 30X, or approximately 36" x 52". The copy board may incorporate one or more features such as backlighting, vacuum system, and glass or plastic document cover. The copy board should be flat and parallel to the film plane, white in color, and not subject to vibration.

b. The camera tower and camera bracket, which maintain the camera, film, and lens-systems in proper orientation, and reduction ratio to the document on the copy board. The camera tower and bracket should be free of vibration and properly oriented to the copy board to maintain a parallel film plane and document relationship. The tower may contain a reduction ratio indicator such as a scale or appropriate reduction stops, (microswitches, detents, etc.).

c. The camera (film magazine and lens systems), which contains the unexposed, and exposed portions of the microfilm. The lens may or may not be an integral part of the film magazine. The camera usually provides the functions of film supply and take-up, film advance, film immobilization, shutter actuation, and exposure spacing. It may contain alarms for exhausted film supply, improper take-up, loose film, loss of light-tight integrity and similar malfunctions. The lens assembly may incorporate the shutter mechanism or it may be part of the magazine assembly. Lens focus may be automatic (auto focus) or manual.

d. The exposure control system may be in several configurations, i.e., manual or automatic, light level, or shutter and lens controlled. The major function of the exposure control system is to permit the proper level of light reflected from the document to pass through the lens system to the film in order to achieve the exposure result desired.

e. The illumination system is the lighting method employed to provide the proper

degree and eveness of light to properly microfilm the document. The light sources may be incandescent or fluorescent, have a wide or narrow range of output, and must be directionally adjustable to provide for a higher level of illumination at the extremes of the copy board than in the center to compensate for lens absorption of light. Backlighting systems incorporated in the copy board are useful in optimizing the exposure of marginal contrast documents, and documents on polyester based film.

5.4.2 *Camera Operation—Error Detection and Correction.* Manufacturers of microfilm cameras provide an operating manual or the equivalent for operator use. This manual is generally brief, and may be illustrated to assist camera operator in basic operating steps such as, film loading, reduction setting, exposure control, film unloading, and alarm system. Cleaning and routine maintenance are generally described. Most manufacturers will furnish specialized instructions in training if requested. Some basic operations and frequently encountered errors are listed below:

Operational step	*Defects*
a. Film loading and takeup	Film roll partially fogged. Film threading incorrect. Film not attached to a takeup spool. Takeup spool bent. Film access door not secured. Insufficient takeup to clear fogged film from camera aperture.
b. Camera or magazine positioned.	Improper positioning—film tracking results in diagonal or incorrect image orientation. Magazine not seated and locked.
c. Select and adjust reduction.	Wrong reduction ratio selected for document.
d. Exposure setting	Incorrect exposure selected.
1. Manual	Meter incorrectly oriented.
2. Auto	
e. Target Setup ..... (Figure 11 of MIL-M-9868)..	Information on target incomplete.
	Resolution charts improperly positioned. Target not parallel to film. Index number omitted (if required).
f. Position, flatten and expose document.	Documents not flat.
	Document not centered horizontally or vertically.
	Index number, when required, is wrong or omitted.
	Document in motion during exposure.
	Operator hand or extraneous material in photographic field.
	Multiple exposures of document.
	Flattening bars or devices—Incorrect color.
g. Unload film	Insufficient takeup to clear camera aperture or provide trailer.
	Film fog due to film unwinding.

5.4.2.1 In addition to the above camera operator errors, some frequently encountered defects, due to equipment malfunction or adjustment or combinations of operator and equipment errors, are listed below:

Defect	*Causes*
a. Incorrect film advance and spacing.	Film drive slipping.
	Supply tension too tight.
	Incorrect film threading.
	Incorrect film advance setting.
	Takeup drive slipping.
	Film not connected to takeup spool.
b. Substandard Resolution at one or more reduction setting.	Auto focus system out of adjustment or non-operable at one setting.
	Operator failed to change focus when reduction changed (manual).
	Platen not seating properly.
	Vibration.
	Operator failed to change focus when reduction changed (manual).
	Auto focus system non-operable at all settings. Loose lens and/or magazine.
	Vibration during exposure.

Defect	*Causes*
	Film not tracked properly.
	Film in motion during exposure.
	Dirty or scratched lens surface.
	Incorrect lens-camera calibration.
	Defective lens.
c. Substandard Parallelisb	Incorrect film threading.
	Copy board askew.
	Copy board warped or bowed.
	Camera bracked loose and askew.
	Camera tower out of plumb.
	Camera magazine askew.
	Document improperly positioned.
	Automatic exposure system out of adjustment.
	Faulty exposure meter.
	Uneven illumination.
	Lamp out or askew.
	Extraneous light and/or reflection on document.
	Document not flat.
	Faulty shutter.
	Wide variations in background of document(s).

5.5 Microfilm Processing, Inspection and Reproduction.

5.5.1 *Microfilm Processor Characteristics.* Microfilm processing machines are commercially available in a wide range of sizes, speeds and types. Manual processing devices of the type requiring insertion of the film in a circular slot in a round metallic or plastic carrier are in limited use. These carriers, with the film inserted, are put through circular trays of developer, fixer and wash. After washing, the film is removed from the carrier and dried on a film rack.

5.5.1.1 *Manual Processing.* Manual processing requires skilled technical personnel and careful control of all processes and solutions; as a result the use of automatic processors have exceeded that of the manual types. Microfilm service companies and many suppliers of microfilm offer processing either as part of the film cost or on a separate charge basis. The major advantage of service processing is that the capital investment and related costs of processing equipment ere reduced. The major disadvantage is that usually extra time is required to transmit film to and from processing service installation. The major advantages of "in house" processing are:

a. The complete control of all operations "in house."

b. The reduction in time required between film exposure and film inspection.

5.5.1.2 *Automatic Film Processors.* Automatic film processors mechanically move the exposed film through tanks of developer, stop bath, fix, and wash water. The film is automatically dried and wound on the takeup mechanism as the final operations. Processing machines may use plastic "leader" to pull the film through the processes or may use "leaderless" mechanical means of accomplishing the same functions. Automatic processors usually have provisions for speed (time) control of film in the solution, temperature control of solutions, and chemical strength controls (replenishers). The image of the 50% and 6% reflectance patches, contained in the roll identification target described in MIL-M-9868, Figure 11, may be used as rough guides to the consistency and accuracy of the processing operation. If the exposure of target and test patches is consistent and accurate, then any significant variation in density of these patches from roll to roll, can usually be attributed to film processing.

5.5.2 *Microfilm Inspection.*

5.5.2.1 *Inspection Requirements.* The inspection requirements for roll microfilm are described in detail in Section 4 of MIL–M–9868. Certain items of equipment are necessary or desirable to properly inspect the microfilm. These include:

Equipment	*Purpose*
Rewinds, 35mm	Wind and rewind roll microfilm during inspection operations.
Light box and 8–20X magnifying glass or 8–20X microfilm reader.	Visual inspection of images for positioning, centering, spacing, etc.
Densitometer (Diffuse Transmission Type).	Density measuring device (see MIL–M–9868).
Microscope 50–100X	Read resolution targets for resolution test.
Rule, Caliper or similar measuring device –2″ — 2 1/16″.	Measure image spacing.
Rule, Caliper or similar measuring device — .5″ + .002″ — .010″.	Reduction ratio test measurement.
Residual Hypo test set	Measure residual hypo in processed microfilm.
Microfilm enlarger	Reproducibility and centering test.
Plier style punch with at least 1″ throat.	Punch hole in rejected frames.

5.5.2.2 *Inspection Records.* Inspection records must be prepared and retained for periodic checking by government inspectors. Proper use of the inspection records can be valuable in the administration of the microfilming operations. If microfilm service subcontractors are used the records can give early warning of potential camera and other equipment malfunctions and may provide a guide to the level of skill attained by camera and other equipment operators.

5.6 **Roll to Roll Microfilm Reproduction, Characteristics and Equipment.** Roll film duplication process information is included in 5.6.1 through 5.6.4.

5.6.1 *Silver Handle Emulsion on Acetate Base.* Although silver halide emulsion is coated on both acetate and nitrate film base, the use of the explosive nitrate base is excluded from consideration in microfilming. Acetate base films, or the so called safety base films are the only films acceptable for microfilming. The discussion will therefore be limited to acetate based on film. Silver halide duplicating film base is identical to that of the camera film (diacetate or triacetate). The emulsions employed in duplicating films (silver halide) are similar to camera microfilm to the extent that both use light sensitive silver compounds as the image forming medium. Camera microfilm emulsion is either panchromatic in response (sensitive to all colors) or orthochromatic in response (sensitive to ultra violet, blue, yellow, green, orange, but insensitive in the red and infrared ranges). Silver halide duplicating films are called color blind films. They are sensitive only to those colors, or that part of the spectrum in the ultra violet-blue range. This arrangement is practical because duplicating film is only required to duplicate shades of black and white from the reproduction master or camera film. The camera film has already reduced colors in the original copy to shades of grey due to its panchromatic or orthochromatic response. Duplicating films must be fine grained films to retain as much of the detail of the original as is possible. As a general rule, the finer the grain, the slower the film speed. Consequently, duplicating films are considerably slower in their reaction to light (exposure time) than camera film. Several excellent roll film printers, made and marketed by reputable manufacturing firms, are commercially available. These printers drive the unexposed duplicating film, in intimate contact with the processed master film, past a controlled light source. The exposure light passes through the processed master film first. The master film casts its shadow pattern on the film being duplicated, thus ac-

applications. Also an acronym for *light amplification*

complishing the exposure. An important item to remember when duplicating film is that the two films, master and unexposed duplicating film, must be so positioned that the emulsion of one film contacts the emulsion of the other film. Processing procedures for camera film and duplicating film are the same. The speed of processing will vary somewhat. Duplicating films can be processed at a greater speed due to their thinner coating of emulsion. The processing chemicals may vary due to a desire to increase or decrease image contrast. In the duplicating of silver film, the characteristics of alternate generations will reverse, i.e., positive to negative to positive. This is due to the fact that a silver halide emulsion darkens (accumulates density) when light strikes it. The portion of the film or image that is shadowed or protected from light appears as a clear area when the film is processed.

5.6.2 *Diazo Type Emulsions on Acetate Base.* Diazo type "Emulsion" is coated on both polyester and acetate film bases. Polyester base film is, as a general rule, used as a special requirement. Acetate base film is the generally accepted, general purpose film and as such will be the topic of discussion. Diazo dye coated film is generally discussed as having an emulsion side (sensitive side) and non-emulsion side similar to silver halide film. This terminology is used as a matter of convenience although it is erroneous. The sensitive dye coating is coated on the film base and is absorbed into the film base. Diazo dye microfilm is substantially different from silver halide microfilm. It differs in the type of sensitive coating; it differs in response to light; it differs in processing; and it differs in image contrast and sensitometry. The dye coating on the film base consists of a transparent diazo dye, a dye-coupler, and an inhibitor. The exposure of diazo film must be accomplished with a high intensity light source, generally of the mercury vapor type. Diazo dye is sensitive only in the ultra violet and near ultra violet range of the spectrum. The reaction of diazo dye to light is opposite to the reaction of silver halide film. The image forming ability of the dye coating is destroyed when struck by light and therefore alternate generations of diazo film will be identical in characteristic, i.e., positive to positive, negative to negative. The image of a diazo dye film is formed in the following manner. It was previously noted that the diazo coating contains the diazo dye, a dye coupler and an inhibitor. The inhibitor separates the coupler from the dye and prevents image or color formation until exposure has taken place. After the exposure, the film is subjected to an atmosphere of ammonia vapor. The ammonia vapor has the property of breaking down the inhibitor and allowing the coupler to combine with the diazo compound in those areas not exposed to light. The coupler and diazo dye combine to form a visible azo dye image. The areas of the film exposed to light emerge from the processor as areas of clear film. Diazo films are available which permite image formation in many colors, but in the microfilm trade the most satisfactory image color is black or essentially black. The black image film is almost universally employed in microfilm duplication. To the un-initiated, the black diazo film image is very difficult to distinguish from the metallic silver image of silver halide film. Some of the differences between diazo coated microfilm and silver halide coated microfilm are as follows:

Printing Speed:	Diazo substantially slower:
Image Resolution:	Diazo — Essentially grainless.
	Silver — Grain size varies with film speed.
Image Density:	Silver — Capable of much greater densities.
Image Characteristics:	Silver — Alternates from positive to negative between successive generations.
	Diazo — Retains characteristics of previous generation.
Color of Image:	Silver — Black or shades of grey.
	Diazo — Many colors.

Development of Image: Silver — Wet Processing in a solution of silver oxidizers.
Diazo — Dry processing in an atmosphere of ammonia vapor.

5.6.2.1 *Diazo Roll to Roll Printers.* Satisfactory commercially available diazo type type roll to roll printers are less profuse in make and model than comparable silver printers. It should be noted that most diazo roll to roll printers include the developing operation and unlike the silver process provide a finished roll of images in one machine operation. Exposure control is usually a combination of film drive speed and light intensity. Development by ammonia in a heated environment is usually automatic. The diazo process, unlike silver, retains the same gender through successive reproductions, i.e., negative to negative to negative.

5.6.3 *Heat Developing Emulsion on Polyester Base.* Satisfactory commercially available roll to roll heat developing printers are limited in make and model through some diazo printers have been modified to accept the heat developing material. The heat developing emulsion is chemically similar to diazo, but substantially different in reaction. The image is not a dye but crystaline in nature. The change of image character between film generations (reproductions) is normally analogous to that of silver halide film, i.e., negative to positive and vice versa. There is, however, a printer on the market that permits the operator to select the characteristics of the final product, regardless of type of printing master employed. Heat developing image structure is pale yellow in color. Heat developing film base is polyester plastic which is tougher than acetate and does not exhibit the tendency to curl, stretch and shrink with changes in temperature and humidity. Some of the differences in characteristics between heat developing film and silver and diazo include:

Emulsion exposure speed: heat film slightly faster than diazo but substantially slower than silver.
Light absorption (density): heat film does not absorb light, whereas silver and diazo do.
Color of image: heat developing film is pale yellow in color but projects as black and white.

5.6.4 *Microfilm Reproduction Defects.* Many defects in reproduced microfilm images are similar in cause to those encountered in the camera microfilm, particularly those caused by incorrect exposure and/or development. The cause(s) and correction of this type of defect is obvious. One frequently encountered defect in reproduced film is substandard resolution. The two visual causes for this defect are (1) operator error in loading film through printer with emulsion to emulsion contact not provided and (2) slippage in printer mechanism. The latter defect is readily detected since the resolution loss will be greater in one direction than in the other.

5.6.5 *Microfilm Handling Damage.*

5.6.5.1 *Film Inspection.* Properly exposed and processed microfilm may be damaged in performing inspection, mounting, packing and shipping operations either by mechanical devices or by operator carelessness. Operators should wear lint free cloth "photographic" gloves when handling film for inspection operations. Rolls of microfilm should not be "clinched" to tighten the roll since minute dust particles on the film can cause damage to images as the film is tightened by "clinching." Film rolls should be secured by pressure sensitive paper tape (masking tape) or by inserting a few inches of the outside loop between the rolled film and the flange of the reel.

5.6.5.2 *Care of Inspection Equipment.* The inspection mechanisms; densitometer, microscope, rewinds, film reels, viewing devices, etc., should be carefully inspected to detect and eliminate sharp or rough projections or areas that might contact and damage the film. Careful and periodic cleaning of these devices will minimize dust and grit damage

and the use of phonograph record cleaning brushes with anti-static capabilities may aid in reducing dust accumulation on film and inspection mechanisms due to static electricity. The proper application of commercially available cleaning and conditioning solutions may be useful in reducing film curl and stretch due to extreme temperature and humidity environments. Many of these solutions contain film lubricants.

5.7 Punched Card Accounting Machine (PCAM) Card Operations. The Department of Defense requirements for the PCAM card portion of the "Micro-reproduction" program are contained in Specifications MIL-C-9877, MIL-C-9878, MIL-C-9949 and Standard MIL-STD-804.

5.7.1 *PCAM Tabulating Card Preparation.* The preparation of a tabulating (PCAM) card work or microfilm frame deck should be an early operational step in the microfilming cycle if a PCAM deck or an aperture card is a requirement. Contractors with a PCAM "in house" operation may use punched cards as a drawing control document. If this condition exists, manual key punching of the "microfilm" deck can be minimized. The master deck can be sorted to retrive the cards pertaining to the microfilm drawings requirement, these cards therefor can be used to create the PCAM data into the aperture card. Tabulations from the PCAM card can be used as a shipping list, drawing retrieval list, and data list operations. If an in house PCAM operation is not available, there are PCAM service companies that may be used to accomplish the work on a contract basis. Other possibilities include, the purchase or rental of a key punch machine if the volume and length of the microfilm operation, lack of service facilities or other conditions justify this step. Commercially available tape producing devices that produce punched paper tape as a by-produce of a typing operation may be available. The paper tape by-product of typing the drawing list can be converted to PCAM cards by several machines.

5.7.2 *Work Deck Uses.* The work deck may be used to retrieve the drawings for microfilming or used to prepare a list for this purpose. In either operation, the deck can be machine arranged to optimize subsequent operations. Work deck cards representing security classified drawings can be sorted out for special security handling. The retrieval and microfilming operation sequence can be machine arranged by proper sorting of the work deck such as by drawing size and numerically therein, or by assembly breakdown if such data is contained in the cards.

5.7.2.1 *Common Errors.* Common errors encountered in the use of the work deck in retrieval and microfilming operations include: PCAM card but no drawing; data on card and that on drawing differs. These conditions may have several causes such as: drawing out of file for reproduction or revision, drawing may be misfiled, file clerk may have errored in retrieving or reading drawing number, revision to the drawing has not been reflected in the PCAM control deck, machine punch or interpretation is erroneous and many other causes. PCAM cards reflecting deficiencies can be machine listed, duplicated or set aside for "special handling."

5.7.2.2 *Master Work Deck.* During the microfilming operation, identification data, such as roll identification, multiple frame, and microfilm index number may be manually added to the card or list. When these data are punched into the card, the final or master work deck is complete. This master work deck, if properly prepared, is in microfilm image sequence and should contain cards for all frames including target frames, rejected images, etc. If subsequence listing, cross reference or data deck operations are required, the master work deck should be machine duplicated for these purposes. The duplicate deck(s) may be machine sorted or rearranged for list or data deck use. In any event, cards not necessary for list or data deck purposes, such as "target and reject cards" can be mechanically removed and the integrity of the master work deck

maintained.

5.7.3. *Reproducing Master Work Deck to Aperture Cards.* If aperture cards are required the Master Work Deck (MWD) in the roll film sequence must be reproduced to aperture cards. This operation is most rapidly accomplished by card reproducer machines, but may be accomplished by use of the automatic mechanism of some key puch machines. If a high speed card reproducer is used some defects or errors in the aperture cards will cause the machine to stop or possibly jam. If a key punch machine is used, the slower operation speed may permit an alert operator to visually detect some aperture card deficiencies and to take immediate corrective action.

5.7.4 *Interpreting (printing) Aperture and Work Deck Cards.* For "in house" use the printing feature of commercially available "printing" key punch machines may suffice. For EDMS aperture, data or work deck purposes, the type size and positioning are specified. In some EDMS operations, the large (approximately ¼") "end printing" feature of the special machines is required. Other requirements include the use of the optional fields of the DOD 1306 format for item or equipment nomenclature. Since the nomenclature poses many problems because of varying word lengths, and the frequent presence of special characters this operation should be carefully planned and inspected.

5.7.5 *PCAM Aperture Card Preparation.*

5.7.5.1 *Mounting Microfilm Images in Aperture Cards.* The EDMS aperture cards presently encompass two types—the adhesive card which has a pressure sensitive adhesive ledge around the aperture to hold the microfilm frame—and the jacket type which uses a plastic pocket to retain the film in the aperture. Machines for "mounting" the microfilm in either type card are commercially available. Mounters are categorized as manual, semi-automatic, and automatic. Only a few of the high speed automatic mounters are in use in the EDMS program, and in general the problems associated in mounting film with the automatic machine are due to the speed of operations which make quality control and verification more complex.

5.7.5.2 *Locating Deficiencies.* The defects in film mounting and the inspection requirements for the EDMS program are described in MIL-M-9878. The most frequent deficiencies encountered can be summarized as follows:

a. Information, depicted in the microfilm image, does not conform to that interpreted on the card — nonmatch of card and film image. This type of defect may range from the complete erroneous mounting of the wrong image in the aperture card to a single difference in a data field, such as revision letter.

b. Orientation of the microfilm image does not conform to specification. This type of defect may occur in many patterns — a frequent cause in the mounting of the emulsion side of the film to adhesive.

c. Microfilm frame overlaps edge of aperture. This type of defect may have several causes, such as, defective batch of aperture cards, mechanical malfunction of mounting machine, operator error, or a combination of errors.

5.7.6 *PCAM Card Sequence Errors.*

The condition of card and film not in proper sequence should be detected if the appropriate inspection procedures of MIL-M-9868 are coupled with a card sequence inspection. If the microfilm image contains a microfilm index number, and if the cards either aperture or non-aperture are punched and interpreted in the roll film sequence, a non-match condition is readily detected. Some frequently encountered defects are:

Defect	*Cause/Correction*
a. Film image on roll no card.	Create card and add in proper sequence.
b. Card — no film image	Check card for proper roll identification and accuracy of punch/interpret — delete from deck and add to proper sequence and/or deck.
c. Film image data do not match card data in one or more fields/columns.	Erroneous punch or interpret; punch and interpret correct card.

5.7.7 *PCAM Card Handling Damage.* Aperture and PCAM cards may be damaged either by machine operations or operator carelessness. Cards should be "conditioned" to the working area environment of temperature and humidity prior to their operational use. Card manufacturers usually provide instructions and guidance for this purpose. The card defects and damage of nicked, torn, warped, and bent cards are described, in the appropriate EDMS documents.

5.7.7.1 *Aperture Cards.* Aperture cards prior to the mounting of the frame of microfilm, have a definite shelf life and stocks of these cards should be properly scheduled for use to assure that they are used within the manufacturers specified time limit. Operator personnel should use care in "fanning" and "jogging" cards prior to machine operations to assure that cards are not nicked or bent in these operations. PCAM personnel should be aware of the cost of aperture cards compared to ordinary PCAM cards and the economic justification for careful handling of these cards.

5.8 **105mm Film System.** In contrast to the 35mm film system, the 105mm film system has been developed for low volume, large size and high quality reproductions. The projections can be made on translucent paper, linen or stable-base film. The quality of the projection can be superior to the original if the rehabilitation techniques which are possible by the use of the large size film are employed. The 105mm film is used in lieu of the original drawing in cases of quick reference due to the ability to read simple drawings directly from the film image without projection. The 105mm system is basically a manual system for those operations which require the rehabilitation of unusable originals or require photographing of large size maps and drawings. The 105mm film size offers a complete system consisting of cameras, combination camera-projectors, photographic and electrostatic projectors, a variety of viewers, view-printers, print processors, film processing equipment, specialized chemicals, film duplication equipment and film scanners. The 105mm film size offers the advantages of: drawing file condensation, high quality reproduction, ease of scale change from original size, rapid retrieval, and restoration of sub-standard originals. To a certain extent rehabilitation of opaquing can be done on the film directly where it is a matter of painting out areas. This is possible because of the large size of the film. A full scale rehabilitation involves filming the original, projecting the original, doctoring the projection, refilming the doctored projection and producing a better than an original or a new drawing. The foregoing can be accomplished by taking subordinate parts of other drawings and projecting them to scale (if required) using the 105mm process, and then cutting and pasting (scissors drafting) the desired parts onto the first projection, refilming the rehabilitated projection. A minimum of drafting effort will therefore be extended on the total product. Contractors throughout the United States as well as military establishments in coastal areas have 105mm capability. In many cases the desired end product could result by maintaining the basic file via the 35mm system and using the 105mm system to rehabilitate old drawings and to create new drawings, and maps. Half size drawings can be produced very economically through the use of the 105mm system by projecting directly to printing plates and using the offset method

for quantity reproduction. Half scale drawings are also produced through normal diazo methods.

5.8.1 *Film Size.* The 105mm film size yields a 4 inch by 6 inch negative. The applicable Military Specification is MIL–P–9879A. The 105mm film size is considered to be miniaturization photography as compared with microfilming. 105mm negatives are primarily designed for enlargement onto photographically sensitized materials at sizes up to (and often exceeding) the scale of the original copy. Among the broad applications for which the 105mm size is used are reduction and enlargement of: topographic and areonautical maps, engineering and construction drawings, architectural renderings, specification documents, electrical schematics; restoration of torn, discolored and faded originals; and multicolored matter.

5.8.2 *Film Processing.* The 105mm film is chemically processed to meet the archival quality standards established by the National Bureau of Standards. The film is placed in an indexed archival paper envelope of 5 x 8 inch size. A standard file cabinet with double eight inch drawers is used to store 105mm film files. Retrieval of selected data is accomplished manually.

5.8.3 *Characteristics of 105mm Cameras and Projectors.* There are two basic models of 105mm cameras. One model is used solely for photographing copy and producing 105mm negatives. A separate projector is used with this particular model. The other model combines the functions of a complete camera together with adaptability of performing as a projector.

5.8.3.1 *Camera, Planetary, 105mm.* The 105mm planetary camera is capable of photographing copies up to 40 inches by 50 inches. The copy is held flat during exposure by means of a thin acetate sheet drawn over it and held rigid by a suction device built into a plexiglass-topped subject holder. The camera has four separate light stands with individually reflectored fluorescent lamps for overhead illumination. A backlighting unit equipped with fluorescent lamps is built into the copyboard to provide transmitted light. The model 3C camera accepts a 350′ roll of 105mm film held in a detachable supply magazine on the left side of the camera. Exposed film is automatically transported to a take-up magazine on the right side of the camera. Any number of exposed frames can be cut from the supply roll by a knife mechanism in the take-up magazine and processed. Illumination for both overhead and backlights is continuously variable by rheostat control. Exposure is controlled by an electronic timer which varies the shutter speed. Reduction ratios from 4X to 10X are standard on this unit. In addition to the copy being held flat by a suction device, the film is also kept flat during exposure by a pressure plate with a vacuum control.

5.8.3.2 *Combination 105mm Camera, Planetary, and Projector.* This equipment has the capability for making both the 105mm negative and projecting it onto photographically sensitized material. This unit uses the same lens for both photographing the original and enlarging the negative. A copyboard capable of holding a 43″ x 63″ original flat under a vacuum held acetate sheet, also features built in fluorescent backlighting. Reduction (and enlargement) ratios from 4X to 11X allow for a wide range of size-changing capabilities. Overhead lighting is provided by two banks of reflectored fluorescent lamps on each side of the copyboard. Both the top lighting and back lighting in continuously variable by rheostat control. Top and lighting may be used individually, combined, or blended for exacting reproduction requirements. The camera and projector are calibrated for all reductions (4, 5, 6, 7, 8, 9, 10, 11). Movement of the optical head up or down is accomplished by a push-button actuated motor control. The film capacity of the camera is 350′. Exposed frames may be removed at any time, so that five or six exposures can be made, the film removed, processed, and ready for enlargement within

minutes. A control panel, with electronic time, exposure counter and all other electric controls is conveniently mounted on the right, front of the camera body. The projector magazine holds up to 25 105mm negatives individually enclosed in plastic holders. Moving each frame into enlarging position is accomplished by a push-button actuated motor drive mechanism. The light for enlarging is a point source high intensity lamp. This lamp is automatically focused with the varying focus change of the lens. A filter turret is positioned in front of the projector lamp allowing for the projection of both line and continuous tone film as well as a red filter for splice print registration. The combination 105mm camera-projector takes up approximately the same floor space as a separate camera unit. With planned workload programming, this unit efficiently meets production requirements.

5.8.4 *Camera Operation.* Exposure control on 105mm cameras is accomplished by varying the shutter speed which is actuated by an electronic timer, and by adjustment of either or both the top lighting and back lighting.

Operation of the camera is basically as follows:

a. Reduction ratio is selected and camera is calibrated for proper lens to film plane distance, and lens to copy plane distance. (These adjustments are semi-automatic and are obtained from a reduction ratio calibration card.)

b. Copy is placed on subject holder, vacuum is turned on, and a transparent acetate sheet is rolled over the copy holding it perfectly flat.

c. Shutter speed is selected, the electronic timer is set and the exposure is made.

Depending upon the nature of the camera copy (which may vary from small originals to roll length drawings) film production on the 105mm camera will vary from 300 to 1,200 negatives per eight hour day.

5.8.5 *Types of Film Used.*

5.8.5.1 *Line Film.* For general use in filming line drawings or maps, an orthochromatic, high contrast, litho-type emulsion film with an anti-halation back coating is used. This emulsion is coated on both a polyester base and a tri-acetate base. (Both bases are acceptable for use in conformance with MIL-P-9879). The developer recommended for use with this type film is of the D-11 formula type with special additives which produce a negative of medium contrast, and extreme clarity of line detail.

5.8.5.2 *Continuous Tone Film.* In photographing material such as aerial photographs, multi-colored or multi-toned maps for black and white reproduction, a medium contrast, continuous tone, panchromatic emulsion on an acetate base is used. A developer producing distinctive tone separation and fidelity is recommended.

5.8.5.3 *Color Film.* Film for producing both positive color transparencies and color negatives can be used in the 105mm camera. This type material finds application in photographing multi-colored architectural renderings, geological charts and other types of colored charts. The processing chemicals are those recommended by the film manufacturer.

5.8.6 *Film Processing, Inspection, Duplication and Retouching.*

5.8.6.1 *Processing.* In general, the processing of film is performed in-plant, that is, in the same area where the 105mm camera is located. Because the 105mm film size is predominantly used as a reproduction system, it is more advantageous to utilize in-plant processing for closer quality and production control. The 105mm film is processed on a spiral wound stainless steel reel designed to accommodate 80 feet of film. Round tanks containing the processing solutions are ar-

ranged in the proper sequence for processing, i.e., developer, short-stop, fixer, hypo neutralizer, wash and wetting agent. These solutions are generally required to achieve archival quality of processed film in accordance with referenced documents in Military Specification MIL-P-9879. It is only in rare instances that fewer chemicals may be used to achieve desirable quality results. When the volume of film processing dictates, an automatic film processor may be used. With this type of equipment, the exposed film is loaded in the processor and is automatically conveyed through the processing chemicals and is rewound onto a take-up spool fully processed and dried.

5.8.6.2 *Inspection*. Due to the comparatively large image obtained on the 105mm negative inspection of processed film may be accomplished using magnifying glasses of from ten to fifty magnifications. The negatives should be inspected over a light box designed to allow soft, even illumination. An X-ray viewing unit may be used. The use of a light box incorporating fluorescent lighting and a plexiglass surface for light diffusion is quite desirable. Through use of National Bureau of Standards resolution test charts and applicable Military Specification MIL-P-9879, a sharpness quality level can be established. Although specific background density requirements are not necessarily required of 105mm negatives, it is of definite value to quality and production control to maintain reasonable value to quality and production control to maintain reasonable ranges of acceptable negative density. The most widely used background density ranges from .9 to 1.3. Critical bacground density is of less importance than with smaller film sizes. This is because the 105mm negative must have the capability of print enlargement to intermediate scales as well as original scale, and also due to the varying quality condition of the original copy.

5.8.6.3 *Duplication*. When the original camera copy from which a 105mm negative has been made is not available and duplicate film copies are required, they can be made using the following processes: diazo, thermal-developing and silver halide sensitized.

a. Diazo. In this process the 4" x 6" 105mm negative is placed in contact with a sheet of diazo sensitized film, exposed either in a contact printing frame or through a diazo printing machine and developed by exposure to ammonia fumes. A negative diazo image is obtained from the 105mm negative.

b. Thermal-Developing. This process produces a positive image from the negative image on the 105mm film. The thermal developing material is placed in contact with the 105mm negative, inserted in a suitable device to maintain proper contact, exposed to an ultraviolet light source, and the image is developed by passing the exposed material through a chamber where heat of a specific temperature develops an image. The image is "fixed" or made permanent by a short exposure to an ultraviolet light source.

c. Silver-Halide (Photographic). This process produces a positive image from the negative image on the 105mm film. With a sheet of photographic film in contact with the 105mm negative, an exposure is made with a point-source light. The film is then processed through the regular photographic processing solutions. Where a volume requirement is in evidence, roll materiel rather than sheets may be used to expedite production of duplicates of 105mm negatives.

5.8.6.4 *Retouching*. One of the advantages in using the 105mm size film as a reproduction system tool is that negatives made from old, discolored, or torn camera copy can be retouched to improve projection print quality. Retouching can be accomplished using a thin liquid opaque solution. This solution may be either water or alcohol soluble, the alcohol-soluble opaquing solution being more desirable in that it can be applied more

smoothly, dries quickly and does not deteriorate appreciably in storage. The opaquing solution is applied with small brushes. Opaquing can be used to eliminate unwanted detail in the negative, cover clear spots in the negative caused by dirt, etc. on the camera copy and to improve the appearance of ragged or torn edges on the copy. Among other materials which can be used in retouching the 105mm negative is a red liquid solution which is applied to negatives made from poor quality originals. This solution is prepared by diluting with water a fine red powder to make a semi-transparent working mixture. This "red dye" as it is often referred to, is used primarily when extremely heavy lines or congested detail are found in a negative which also has a predominance of fine, light lines or detail. The dye solution is applied to the negative with a fine brush or a cotton swab. It is applied to the more congested detail so as to add a "filter" to these heavy areas so that the transmission of light is lessened thus providing better overall balance with the fine line detail areas. The preparation and application of the red dye solution must be carefully controlled as too much applied solution or too concentrated a mixture can cause too little light to be transmitted through the treated area of the negative resulting in a light image on the projection print. The correct use of the red dye solution can result in improved quality of projection prints, higher print production and finds particular value in the restoration of old or damaged drawings or maps.

5.8.7 *Projectors.* For use in conjunction with the 105mm planetary camera is a variable enlargement projector. This unit consists of three basic components, i.e., the projector assembly, the sensitive material easel and the track assembly upon which the projector unit rides. The enlargement capability is matched with the camera unit in that projection prints can be made in a continuous range from 4X to 10X. The film holder of the projector will accept up to four 105mm negatives and is easy and fast to reload. A point source enlarging lamp, automatically focused with the movement of the lens, is used in the unit. An electronic timer is housed in a panel unit which includes a rheostat for reducing the intensity of the projection lamp. The easel upon which the photographically sensitive material is positioned has a suction device to hold such material flat during exposure. The projector unit rides smoothly on a two rail track for positioning for the various enlargements. A second projector model widely in use in Government facilities is the two position (fixed focus) 105mm projector. This unit is designed to project a 105mm negative at both a four and eight diameter enlargement. This projector consists of three basic components: projector assembly with electronic timer control, sensitive material easel, and track stand. The projector assembly is so designed that it is rolled on the track to either of the two enlargement lock positions. For the optical focusing operation, a control is provided for both the lens adjustment and the light source positioning. A tray attached to the projector unit will hold negatives prior to being projected. The electronic timer attached to the projector also has a rheostat for reducing the intensity of the projection lamp. The easel assembly is composed of a sheet of optically clear glass in a frame and a metal pressure back assembly. The sensitized projection material is held flat between the glass and the pressure back during the exposure. The track stand supports the easel assembly and the projector unit. Six rubber-bottomed leveling feet allow for ease of alignment of the entire projector assembly.

5.8.8 *Viewers.*

5.8.8.1 *105mm Viewer-Scanner.* This is a completely portable unit for scanning detail areas from a 105mm film. This unit uses fluorescent lamps to provide smooth, even illumination for a plexiglass topped surface. A three power magnifying glass mounted on a swivel arm allows for positioning in any area of the 105mm film.

5.8.8.2 *105mm Drafting and Reference*

Viewer. This is a projection viewer accommodating 105mm negatives. It projects an 8 times image of the information contained in the negative onto a plate glass surface (covered with translucent material) which forms the top of the drafting table viewer. The unit consists of a drafting-type table with projector attached parallel to the right end of the table. The projector unit may be removed from the table and used for wall screen projection film. Projection lamps between 750 and 1,000 watts may be used in the unit. The film holder can rotate 360°. At the left side of the table is a compartment to hold a roll of tracing paper.

5.8.9 *4X 105mm Viewer-Printer.* This 105mm viewer-printer is a compact, efficient unit which will project or print from 105mm negatives at 4X magnification. The 16" x 24" viewing screen is recessed in a frame for good visual contrast and provides crisp, clear images. Prints made on this viewer-printer are excellent for reference purposes. The viewer-printer fits conveniently on any table or stand of appropriate size. A stand is also available as an optional accessory. No darkroom is necessary. The basic features of this model are:

a. The film holder facilities quick, accurate positioning of the negative and slips easily into the machine. The holder is simple to clean and may be completely removed from the machine. An extra film holder is provided to assist in speedy loading and changing. A take-up magazine that attaches quickly to the right sides of the unit can be obtained as an accessory item. When multiple frames are to be viewed they can be collected automatically in this magazine, which holds five negatives in a holder.

b. A "paper-safe" compartment at the top of the viewer-printer offers safe, convenient storage space for the sensitized paper sheets.

c. Sensitized can be taken from the "paper-safe" compartment and quickly loaded from the top between glass pressure plates at the viewing plane. After setting the timer, a push-button control exposes the paper which is then ready for processing in a single solution print processor.

d. A sectionalized carrier shelf, directly below the viewing screen, provides space within easy reach for extra negatives and film holders.

5.8.10 *3X 105mm Viewer-Printer.* This 105mm viewer-printer is a compact efficient unit which projects or prints from 105mm negatives at 3X magnification. The projected image can either be viewed or quick, sharp, reference prints may be made. The basic features of this unit are:

a. Ease of Film Loading. The film holding mechanism consists of a sheet of optically clear plexiglass, which when pulled forward allows the 105mm film to be easily dropped into place. No separate film holder need be loaded and there is no critical positioning of the film in the built-in holder. SIMPLIFIED FILM LOADING is accomplished by merely pulling the plexiglass plate forward and dropping the 105mm negative into the holder.

b. Sharp, Brilliant Image. Because the image is projected directly to an opaque viewing surface, the resultant image is extremely bright and clear. Thus, this unit may be readily used in areas with a high level of illumination, such as drafting room . . . and the image is still brilliant and clear.

c. Convenient Placement. The unit is compact in size and when not in use may be swung out of the projecting position to increase space usage The surface required is only 20 x 30 inches.

d. Print Quality and Operation. The optics of this unit have been especially designed to provide crisp, needle-sharp prints regardless of the most common adverse lighting conditions. Printing time

may vary slightly from 5 to 15 seconds due to negative density and ambient light. In the printing operation, the No. 650 One Solution Paper merely lays flat on the viewing surface — minor curling of the paper will not adversely affect print quality. Exposure time is easily controlled on-off toggle switch. (An accessory timer can be factory-installed at additional cost.)

e. Optional Enlargement. The basic unit, as indicated by the specified dimensions shown, will provide an enlargement of 3 times. On special quantity orders, an enlargement ratio of 4 times can be provided at additional cost.

5.8.11 *Print Processor.* This unit is used with the 4X viewer-printer to process reference prints exposed on that printer from 105mm film. The print processor uses one solution to develop and stabilize the print image. The paper may be processed in subdued light — no darkroom is required. This processor has a 27″ throat and will readily accept the 16″ x 24″ prints exposed on the viewer-printer. The paper is fed into the front opening until it engages two motor driven squeegee rollers which transport the print through the processing solution and squeegee the print dry.

5.9 Preservation, Packaging and Marking. The applicable preservation, packaging and marking requirements for all 35mm microfilm, 105mm film and aperture, copy and tabulating cards are contained in Section 5 of the following specifications:

5.9.1 *Specification MIL-M-9868 for 35mm microfilm.*

5.9.2 *Specification MIL-C-9879 for 105mm film.*

5.9.3 *Specification MIL-C-9877 for aperture cards.*

5.9.4 *Specification MIL-C-9949 for copy cards.*

5.9.5 *Specification MIL-C-9878 for tabulating cards.*

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Navy—WP; YD; SH; CG

Air Force—26

User:

Navy—MC

Preparing Activity:

Air Force—26

Project MISC-0055

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

OMB Approval
No. 22-R255

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