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SPACE AND DEFENSE SYSTEMS

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FINAL ENGINEERING REPORT

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CAMERA AND FILM PROCESSOR
(Jet Propulsion Laboratory)

This work was performed for the Jet Propulsion Laboratory, California Institute of Technology, sponsored by the National Aeronautics and Space Administration under Contract NAS7-100.

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SECTION I

INTRODUCTION

A scientific instrumented spacecraft to orbit the planet Mars is possible for the early 1970's. A reconnaissance system for this mission is being considered capable of surveying 1/4 of the surface area of the planet and to provide details down to 1/2 km. This will require that the spacecraft send back to earth about 10^9 bits of information. The sending rate is expected to be about 2 x 10^3 bits of information. The sending rate is expected to be about 2 x 10^3 bits of information per second at the time of this mission. Primarily because of the slow sending rate, real time transmission of picture information is not practical and some form of data storage will be necessary.

Two schemes compatible with the mission are (1) a combined TV system and high volume storage device and (2) a photographic film system which acts as its own data storage system. A film type hotographic system would be capable of performing high resolution photographic reconnaissance of the Martian surface from an orbiting spacecraft and it offers a specific advantage in that it performs both the long term storage and the photo sensing function. The factors that will ultimately determine the practicability of such a system are:

1. Film expose, transport and processing mechanization

2. Film readout mechanization

3. Radiation damage versus sensitivity of available films.

SECTION II

SPECIFICATION

In order to implement the mechanization of the film expose, transport process portion of the system, a design specification was prepared by the Jet Propulsion Laboratory for a Camera and Film Processor. The specifications designated, GMO-50197-DSN-A was submitted to private industry for the purpose of requesting technical and price proposals. The design specification is reproduced in the following pages.

1. SCOPE

1.1 Scope. This specification covers the design requirements for a combination Camera and Film Processor in a self-contained package, for present laboratory use, which may later be easily redesigned to conform to a flight environment package.

1.2 Description. The following is a brief description of the combination camera and processor.

1.2.1 Camera. The camera will use 35 mm film. A 70 mm by 25 mm active area of SO-243 film will be exposed in a manner that will cause no greater degradation than 40 percent at 50 line pairs/mm on axis. The best commercial lens, with the largest field-of-view under 60 degrees, that will meet this requirement at 10 degrees off axis and $f/2$ capability, will be used. It is desired that the field-of-view be at least 25 degrees by 9 degrees. Focusing on targets at eight feet to infinity will be controlled to the accuracy dictated by the above 40 percent criteria. Shutter speed will be in steps to 1/500 second.

1.2.2 Film. One film loading will be 100 feet of 35 mm film. It will cover the range and be similar to Kodak SO-243 and Pan X types, with possible later implementation to Plus X.

1.2.3 Processor and dryer. The film processor and dryer will have the capability of processing a minimum of three feet to a maximum of twelve feet of film during one duty cycle.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on the date of invitation for bids, form a part of this specification to the extent specified herein:

SPECIFICATIONS

Jet Propulsion Laboratory

ZPP-02061-PPL	JPL Preferred Parts List
ZPO-20002-PRS	Process Specification, Identification Requirements, Parts and Assemblies
20014	General Specification, Soldering Process

Note: The above documents represent JPL accepted techniques and components. Deviations will be permitted, if the techniques and components are in good commercial practive and do not affect the completion of the contract. In case of doubt, the JPL cognizant engineer shall be contacted for approval. The JPL approved parts list should be used where parts costs do not exceed 10 percent over other acceptable parts.

2.2 Other publications. The following document forms a part of this specification to the extent specified herein.

MANUALS

Kodak

W-40	Manual of Physical Properties of Kodak Aerial and Special Sensitized Materials

3. REQUIREMENTS

3.1 Conflicting requirements. In case of conflict between the requirements of this specification and any document referenced herein, the requirements of this specification shall govern.

3.2 Materials, parts, and processes. Materials, parts, and processes used in the design, fabrication, and assembly of the item covered by this specification shall conform to the requirements of this specification. Any materials, parts, and processes that are not so covered shall be subject to the approval of the JPL cognizant engineer. In all events, the contractor's selection shall assure the highest uniform quality and condition of the item delivered.

3.2.1 Selection of parts. The selection of parts, where applicable, shall adhere to JPL Specification ZPP-2061-PPL. Components substituted shall be of proven equivalent quality.

3.2.2 Interchangeability of parts. All parts having the same part number shall be directly and completely interchangeable, with respect to function and installation.

3.3 Design.

3.3.1 General. A combination Camera and Film Processor shall be designed in a self-contained package. The camera shall use 35 mm film. The initial machine shall be used in a laboratory environment; however, during the design period, size and weight should be kept in mind for easy extension to a flight environment type package.

3.3.2 Film. The system shall use 100 feet of 35 mm film. The film types to be used in the system shall cover the range and be similar to Kodak's SO-243 and Pan X types. It is desirable, if possible, that PlusX capability be easily implemented.

3.3.3 Camera. The camera shall have the capability of exposing a 70 mm by 25 mm active area of film in a manner that shall cause no greater degradation than 40 percent at 50 line pairs/mm on axis. The best commercial lens, with the largest field-of-view under 60 degrees, that shall meet this requirement at 10 degrees off axis and $f/2$ capability, shall be used. It is desired that the field-of-view be at least 25 degrees by 9 degress. Focusing on targets at eight feet to infinity shall be controlled to the accuracy dictated by the above 40 percent criteria. Shutter speed shall be in steps to 1/500 second. A set up focus device is desirable but not mandatory. The shutter action shall be in reasonable steps to 1/500 second. An active frame area, 70 mm by 25 mm, shall be exposed every 15 seconds, with the film clearing the exposure station within two seconds. Spacing between frames shall not exceed 10 percent of the length used (70 mm plus the data block, see 3.4), and no frame overlap shall be permitted. Any amount of film exposure from three feet to twelve feet shall be considered as one duty cycle.

3.3.4 Processor and dryer. The processed film shall be used in a scan system that will measure the transmission through the film. In general, it is expected that the film be dried to good darkroom quality, within the closed form of the processor. Duty cycle repetition rates ahll be as high as once every four hours, and as low as once every three days. Maximum processor film necessary for leaders or run out shall be a minimum. In no case can the loss of an exposed area be tolerated. Processing shall be complete on all film used during a duty cucle within one hour of the final picture taking. The processed film shall be immediately wound on a take-up reel where storage up to thirty days shall be possible. It shall be required that the processing, and camera action, be available after an eight months shelf life. The capability for removal of an antihalation backing shall be considered. The following processor requirements shall be considered design objectives:

		Pan X	SO-243
a.	D_{min}	< 0.2 above base	< 0.2 above base
		Less than 0.1 is desired	
b.	γ_{range}	$0.8 \rightarrow 2.0$	$1.0 \rightarrow 2.5$
c.	D_{max}	> 2.3	> 2.3
		(capability at $\gamma > 1.8$)	

d. Film sensitivities equivalent to those given in Kodak handbook.

e. RMS granularity measured at D=1 with circular aper. = 24μ < 0.060 < 0.030

f. Modulation transfer function of the film alone

80%	25 c/mm	35 c/mm
50%	50 c/mm	80 c/mm
20%	125 c/mm	225 c/mm

(Maximum overmodulation permitted is 110%; D. C. = 100%)

Exposure conditions for sensitometric and image quality shall utilize daylight illumination as specified by ASA photographic standards. Testing light conditions for sensitometric and image quality shall use light composed principally of wavelengths between 3800 and 4700 angstrom units (Å). At any one time only one film type shall be in the processor camera. The chemicals can be adjusted for the particular film being used, but ease of change shall be implemented. The range of γ's are desired for investigation purposes and are not a primary design criteria.

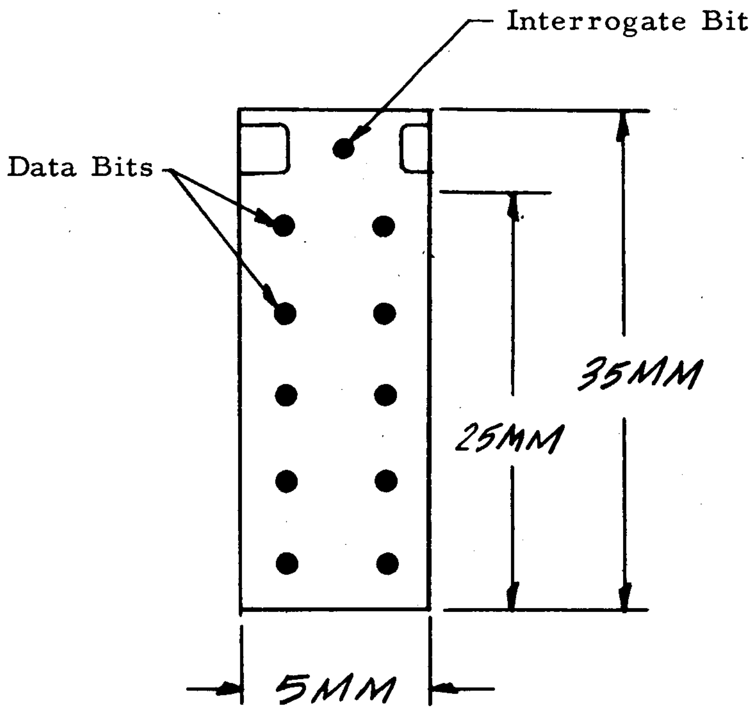
3.3.5 Drive mechanism. A slack box or accumulator (of 12 feet minimum) shall be used between the camera and film processor. The film drive mechanism, in addition to meeting the camera drive requirements, shall be capable of rewinding exposed and developed film out of the take-up cassette into the slack box or accumulator up to slack box capacity. Precautionary measures shall be taken to assure that neither unexposed or exposed film sections are damaged during the rewinding operation. The sequencer shall control the rewinding operation. It shall be possible to open the processor in daylight to remove the processed film, and to replace a new take-up reel without damaging more than two or three feet of unexposed film. A counter, indicating the amount of footage remaining in the supply cassette, shall be available.

3.3.6 Sequencer. A sequencer to control the required drive circuitry shall be provided to meet the range of possible film lengths to be used.

3.3.7 Environmental requirements. The machine shall be capable of working under a steady acceleration of two times gravity in any direction and also in the absence of gravity. Temperatures experienced within the processor shall not influence any camera processor functions. The optimum design temperature shall be between 70 and 90°F. Temperature stability for the processing mode shall be internally controlled to the accuracy dictated by design. It shall be considered for this proposal that a sink (air flow or metal surface) exists at 50°F nominally. If storage of raw film and chemicals at temperatures down to 40°F is needed to meet the shelf life criteria, it can be considered that for four of the eight months storage time, the system environment is 40°F.

The machine shall also be capable of producing a picture when at an internal temperature of from 50 to 20°F. No criteria is imposed on the quality of this picture. The internal pressure of the device and the particular gas inside shall be dictated by design. Capability to have the device exist in the vacuum of space shall be considered, but not necessarily implemented in this laboratory device. The camera processor shall be capable of loading and unloading of film and being made ready for use within one hour.

3.4 Data block. During a 70 mm by 25 mm film exposure, an adjacent 5 mm by 25 mm data block of 10 bits shall be exposed. An exposed bit shall give the highest possible density on the processed negative. In addition, an interrogate bit shall be exposed above the 25 mm width and centered in the 5 mm on all exposures. In the case of 35 mm film with a single sprocket, the layout might be as in the following sketch.



The time of the data block exposure and the maximum shutter opening shall be within 0.5 second. The number to be exposed shall be capable of being preset in, or free run starting from any preset number, and going through the number of exposures ($\approx$ 500). The diameter of the bits shall be between 0.030 and 0.060 inch.

3.5 Power, weight and size. Since size will be almost dictated by path length, it is believed that the laboratory system will be very close to the size of a final flight type package. Consideration shall be given to minimizing the package size. Size minimizations that are extremely costly in money or time shall not be a part of the contract, but is desired that they be documented in a proposal. A definite weight is not considered except as it will affect other design requirements. During operation, up to 30 watts of input power shall be available continuously, with a possible 50 watts being available for one out of four hours. The input voltages are restricted to 28 vdc and/or 115 volts 400 cycles. Power supplies shall be supplied to convert standard laboratory voltages to those necessary. All necessary drive and control circuitry shall be part of this specification.

3.6 Electronic components. All electronic components are conveniently mounted inside the camera processor shall be on 19 inch rack mounted panels.

3.7 Test requirements of storage capabilities of developing components. Since the method of adequately protecting the developing components to meet the eight month storage requirement is involved (during the contract), samples of the developing components shall be protected by the technique prior to placing into storage tests. Enough samples shall be prepared to allow tests to be conducted at one, two, four and eight month intervals. As the contract continues and as techniques are improved, new samples shall be prepared for testing.

3.8 Spare Parts. With the acceptance of the contract, the contractor agrees to supply the necessary materials for processing 500 feet of film in this system. Additional supplies will be obtained on a separate contract at the original rate plus normal additional costs. Spare parts shall be supplied at the original contract cost, less toolings required for the contract for this specification.

3.9 Waste products. Removal of waste products, cleaning of the machine, recharging of chemicals, desiccant, etc., shall not be necessary before 100 feet of film have been exposed as outlined in this specification.

3.10 Life and reliability. Five hundred hours is a desired goal without major component replacements. The machine shall be designed so that a single down time for repairs shall be no greater than eight hours.

3.11 Interlocks. Suitable interlocks shall be provided in control circuitry and/or internal to the processor, to prevent operations either by manual control or automatic operation, that would damage the device.

3.12 Identification The method of identification marking of parts and assemblies shall be in accordance with JPL Specification ZPO-20002-PRS. (See note in Section 2.)

3.13 Workmanship. Workmanship shall be in accordance with JPL Specification 20014. (See note in Section 2.)

4. QUALITY ASSURANCE PROVISIONS

4.1 Contractor inspection. The contractor shall be responsible for performing all necessary quality assurance control and inspections on all materials, components and products to assure compliance with the requirements specified herein.

4.1.1 Visual inspection. A visual inspection to assure compliance with applicable drawings and documents shall be performed on 100 percent of all materials, components, hardware, assemblies, etc., prior to, during, and after fabrication of each item produced. The method of inspection marking used shall be subject to the approval of JPL.

4.1.2 Electrical examination. Electrical examination and inspection shall be performed, visually and dynamically as appropriate, on all incoming parts, and on all assemblies during and after fabrication. This shall assure that electrical parameters shall meet requirements of applicable drawings and documents.

4.2 Performance testing. The contractor shall provide JPL with sufficient signed and dated documentation (test data and reports) to verify that the completed equipment meets all of the performance requirements of this specification under any environmental conditions specified, prior to, or upon delivery.

5. PREPARATION FOR DELIVERY

5.1 Packing and packaging. Each unit shall be packed for shipment in a manner conforming to the requirements of commercial transportation applicable to the mode of transportation employed and shipped at the lowest transportation rate.

6. NOTES

6.1 If it can be easily implemented, it is desired that the camera film drive mechanism and the processor section be separable and usable in combinations other than originally intended. This requirement is secondary to the requirement on size.

6.2 This system is to be part of a bench model of a photographic system. After extensive development a similar system may be used in planetary reconnaissance Although this device will not experience any flight environments, its design must show considerations of an easy transition in development to meet such a requirement. In cases where a particular size or power restriction would require a special design and it can be shown that an easy design transition can meet a lower size or power restraint, then the larger size or power will be accepted for the camera processor defined in this specifications. (Such an example might be a size 8 component that could do the job, but delivery in two or three months is not possible and there exists a size 15 component on hand.)

SECTION III

TECHNICAL PROPOSAL

In response to Request for Proposal No. 3284 from the Jet Propulsion Laboratory, Fairchild Camera and Instrument Corporation submitted the enclosed proposal No. SME-CF-117.

FAIRCHILD SPACE AND DEFENSE SYSTEMS
A Division of Fairchild Camera and Instrument Corporation
300 Robbins Lane, Syosset, New York

Proposal No. SME-CF-117
December 26, 1963

S. I. 450, 067 R-1

CAMERA AND FILM PROCESSOR

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SECTION 1
INTRODUCTION

1.1 Purpose of the Program

The purpose of this program is to design, develop and fabricate a laboratory model of a camera and film processor in accordance with the Jet Propulsion Laboratory design specification number GMO-50197-DSN. Design intentions will be directed toward the ultimate flight environment package requirements.

1.2 Proposed Technique

The technique to be used will employ a Flight Research camera and a saturated web processor with an intermediate slack box. A des-sicant drier, prior to the take-up station, will dry the damp processed film.

Fairchild's continuous PoroMat processing technique is the most advanced method in use today. This method has been utilized successfully in a number of processors for films of 16mm to 5 inch in width. The web technique provides rapid processing of continuous film lengths with quality results. Since there is no flow of the processing liquid from the web material, safe operation is assured in airborne systems.

Considerations of operation, convenience, and reliability in the proposed end equipment, evaluated against the broad background of Fairchild's in-flight processing experience, dictate the use of a monobath as unquestionably optimum for the prototype phase of this program. In the proposed technique the saturated PoroMat is mated to the exposed film emulsion where it remains until processing is completed. It is then stripped from the film and the damp film dried and taken-up.

SECTION 2

CAMERA SYSTEM

The camera to be used for the laboratory model will be a Model 207 Flight Research unit modified to meet the specification requirements. The basic unit has been designed and tested to the requirements of MIL-E-5400. Modifications included changes for the large aperture, data area, and variable focal plane shutter with separate clutch control. The camera, as shown in Figure 1, will be fitted with a special 100 foot supply cassette and house a 6" F/2 Schneider lens. Operation will be from 28 volts D. C. with cycling of up to three frames per second being accomplished in the pulsed mode. Data lamp control will be affected through a nine bit binary counter.

Because of the resolution required, 30 lines/mm minimum, no set up focus device is required of the system.

SECTION 3

SATURATED PROCESSING WEB

A photographic processing solution may be impregnated into a suitable carrier and contained within it. This mat, when brought into contact with a photographic emulsion, causes processing to take place. The technique does not require precision applicators or pumps; all that is necessary is a means for obtaining intimate contact between the two materials. The mat may be stripped from the film immediately upon completion of the processing to permit viewing, scanning, projection or drying. The mat may be retained in contact until it can be conveniently removed. Direct viewing, with the mat in contact, is another possibility of the system.

3.1 Characteristics of a Saturated Web

The performance criteria for design of an efficient web processing system are discussed in the paragraphs which follow. Since many of the system operating characteristics are inherently determined in the choice of the saturable material, the importance of selecting the optimum material must be strongly emphasized. Choice of web material is discussed fully in Section 3.2.

--- <u>Thickness and Flexibility</u> - The web must be sufficiently thin to be physically adaptable to equipments, yet it must be thick enough to hold sufficient liquid. It must also be flexible to permit convenient packaging, e.g. in a roll, and to permit proper sandwiching and take-up with the film.

--- Wettability - The material should be uniformly wettable and capable of holding sufficient solution to provide complete and uniform processing.

--- Solution Release and Diffusion - The web must be capable of releasing the adsorbed solution readily and uniformly to a receptor, such as gelatin. However, the liquid should not flow freely from the saturated mat. Diffusion of the fresh chemicals from the mat, and of the reaction by-products into the mat, should be as free as possible so that processing is complete within a reasonable period of time.

--- Chemical Stability - The material (s) of which the web is constructed must not react with the absorbed photo-chemicals to alter the balance of the solution. Monobaths are relatively sensitive to alkalinity (pH) and are also readily oxidized. The photochemical solution must not attack the web and alter the characteristics of the sheet.

--- Environmental Stability - The saturated web, within its protective package, must be capable of withstanding extremes of temperature and humidity.

--- Strength - The web material must be sufficiently strong, both dry and wet, to permit handling during preparation and to tolerate tension and acceleration during use.

--- Compressibility - The web should be reasonably incompressible so that the absorbed solution will not be forced out of it during handling, under sandwiching pressure, or when subjected to high gravitational load factors.

--- Marking - The mat structure should be sufficiently fine to avoid being reproduced during the photographic processing in such a way as to have a deleterious effect on the image quality.

--- Sheet Integrity - The mat should be so constructed that it does not decrepitate upon separation from the processed material, thereby leaving portions of it on the gelatin surface. The sheet must also be such that it unwinds properly, even after aging, and does not split the wetted carrier or adhere to itself or its support backing.

--- Adhesion to Emulsion - The basic characteristics of the material of which the mat is constructed should be such that there is no strong tendency for it to adhere to the softened gelatin emulsion. In the extreme case of prolonged contact, where the sandwich is completely dried out, it should still be possible to remove the mat intact, without deleterious effect on the image quality.

--- Cost - The price of web, chemicals, preparation and packaging must be consistent with the system operation expenses.

3.2 Choice of Saturated Web Material

There are three different types of mat materials available for processing. Each has desirable characteristics and limitations, as discussed below.

3.2.1 Paper

Paper is a mat of non-woven fibers which retains strength by use of proper binders. Avoidance of the superposition of the fibrous structure on the proposed film requires that fiber diameter be extremely small. Current technology limits the material to glass fibers, which is one of the most difficult types to bind into a high wet strength mat. Additionally, both binder and fiber are often attacked by alkaline processing solutions.

Processing uniformity is generally good with paper, but glass fibers usually remain on the processed film when the web is removed. As contact time is extended this difficulty increases. Softer emulsions also increase the problem.

Glass fiber paper is soft and compressible and extensive solution leakage is an inherent problem. Leakage can be minimized by limiting the absorbed liquids, but this places restrictions on processing variations and film types. Because of its low wet strength, glass paper must be laminated to a carrier material of sufficient strength to permit practical use. This carrier is generally a plastic, such as one mil polyethylene. A saturated web of this type has one surface suitable for processing, and no practical means for handling dye backed, thin base materials is available.

3.2.2 Gelatin

As noted above, the structure of the saturated material can reproduce on the processed film. Thus a film former, like gelatin, would appear to be ideal as a carrier since its structure is identical to that of the film coating. There are, unfortunately, some severe limitations to practical applicability.

--- Wettability and Releasability - Gelatin is capable of absorbing a relatively small quantity of solution, as compared with other carriers. With the use of extremely soft gelatin it is possible to get very high swelling and retain the approximate equivalent of a two mil layer of solution. However, not all of this solution can be absorbed by the film to be processed, since a state of equilibrium of diffusion between the two like gelatin layers must be reached. The slow rates of diffusion between the two gelatin layers results in rather extensive processing times, particularly for higher speed films such as Classes A and N.

--- Chemical Stability - Gelatin absorbs water by swelling. A carrier capable of being used for film processing swells to as much as three or four times its original thickness and becomes relatively soft. Storage life of a roll of gelatin saturated in such a manner is very limited, since the gelatin may flow, or may adhere to the back of its support. The consequences of storing a roll of wet film are well known. Since a saturated gelatin web cannot be stored for any significant period of time, it becomes necessary to prepare the material at or near the point of use. The immersion equipment used for such preparation is very similar to a standard processing machine. It would seem, therefore, that one might just as well use this equipment, rather than the web, for processing the exposed film.

--- Adhesion to Emulsion - The like layers of processed film and carrier mat will have strong cohesive properties if retained in contact for extended time periods or if processing is accomplished at higher than normal temperatures (probably at 100°F. or higher). There is no satisfactory means for separating the two materials once they are stuck together.

A gelatin carrier mat does have one distinct advantage over other materials. It is possible to produce, as a direct by-product of the negative process, a reasonably good positive transparency by a diffusion transfer type reaction. In this process, however, exposure must be very accurately controlled; latitude is limited as in any reversal process. In this type of transfer system, it is impossible to view the negative in contact with the web should it not be readily removable. However, it should be noted that a positive print may be obtained, on a porous plastic web in substantially the same manner, since the transfer process depends on the monobath chemistry and/or the use of additives to form the positive image.

3.2.3 Porous Plastic

Many plastics exhibit the necessary chemical stability to permit storage in contact with photographic processing solutions without detriment to either. Several of these may be formed into porous sheets which might appear to have characteristics suitable for use as a saturated web for film processing. However, in the development of PoroMat as the first plastic saturated web to be offered for film processing, it was learned that certain important web structural characteristics are needed to provide the necessary base for a liquid carrier.

Permeability, that characteristic which describes the ease with which liquid will flow through the web, from surface to surface, should be sufficiently high to permit proper impregnation and to afford good photographic processing characteristics. It is obvious that the best processing would be obtained by having a layer of solution uniformly placed on the emulsion. The higher the web permeability, the closer this process approaches the use of liquid alone.

The void volume of the porous plastic is another critical characteristic, since it determines the total amount of processing fluid which can be brought into contact with the emulsion for a given thickness of web. These two characteristics, permeability and void volume, must be compromised, for as they increase the web strength decreases.

A third characteristic upon which depends the ability of the web to process film uniformly is the size of the surface holes. Where inherent permeability is low, the hole sizes must be increased to provide sufficient liquid flow for complete processing. Where this hole size increases to excess, the hole pattern clearly reproduces in the processed film. This is noticeable principally after the saturated web roll has been thoroughly drained of excess surface liquid, as would occur after a day or two of storage.

3.2.4 PoroMat

The porous plastic used for PoroMat has been specifically developed for use as a film processing saturated web. It is not an adaptation of a material used for another purpose where quality compromises must be tolerated. PoroMat is virtually an ideal saturated mat processing material. It is a microporous, unplasticized polyvinyl chloride which will not be affected by, or affect, the photographic processing solutions. It is non-fibrous and flexible with approximately 80% of its 0.008 inch thickness being void volume. In the wetted condition it can withstand storage at 180°F. Thus storage conditions are limited by the solution and not the mat. Impregnated PoroMat has been stored at 0°F. at which temperature the solution freezes. Use after defrosting has shown no ill effects.

PoroMat is essentially non-compressible and therefore will not drip. Its tensile strength (same wet or dry) is sufficient for most requirements. Where greater strength is required a thin plastic support may be interleaved within the roll. This is similar to a film base support for gelatin, or a plastic laminate for paper.

PoroMat is microporous and will not adversely affect processing uniformity. It exhibits superb sheet integrity and thus will not decrepitate upon separation from the processed emulsion. It will not adhere to the emulsion unless allowed to dry completely while in contact. A simple rewetting provides complete separation.

It is perfectly feasible to view PoroMat processed film with the mat and emulsion in contact. The mat, facing downward on a viewing table, acts as an additional diffuser while examination is made through the base. No precipitates form on the carrier to block up the image, although it is possible to obtain a diffusion transfer type positive image onto PoroMat. This image is usable as a reflection type print. Positive transfer has been accomplished experimentally and would require additional laboratory effort.

3.2.5 Monobath Chemistry

Monobath processing, as the name implies, uses a single solution which simultaneously develops and fixes the film. Processing is carried to completion so that overdevelopment is impossible even if the minimum required processing time is vastly exceeded. In conventional, two solution processing, on the other hand, a constant development time must be maintained, so that it is necessary to maintain accurate film velocities, path lengths, and processing temperatures, in order to maintain sensitometry. No such problem is presented in a monobath system as long as minimum times and reasonable temperatures are assured.

Present state-of-the-art experience on rapid processing (five minutes or less) with the PoroMat technique indicates sensitometric results sufficiently close to those of the film manufacturer that no problem should exist in near-duplicating Eastman Kodak's results. (Reference - Manual of Physical Properties of Kodak Aerial and Special Sensitized Materials W-40) It may, indeed, be possible to accomplish the objective within considerably less time than the one hour total duty cycle allowed by the specification.

SECTION 4
PROPOSED PROCESSOR

4.1 Processing Equipment Design

As is clearly shown in the schematic of Figure 1, the overall design is extremely simple and compact and is characterized by great flexibility.

Referring to the schematic, film upon leaving the camera enters a slack box where it is stored until exposures are completed. It is then drawn into the processing area and mated by saturated PoroMat at a pair of specially fabricated mating rollers. The PoroMat supply, having been sealed by a double wall of edge-sealed thin plastic, Figure 2, is stripped of these coverings immediately prior to mating with the emulsion. In normal practice this protection is unrequired but, with the extended duty cycle and low pressure requirements of the specification, this precaution is considered necessary.

The sandwiched pair remain together until processing is completed whereupon the film and web are separated and the web taken up. The damp film proceeds through a dessicant drier to its take-up station. Drying is simplified by the fact that only one surface has been moistened. A second web may be used to remove an anti-halation backing in the production equipment.

4.2 Design Parameters

Utmost consideration must be given the proposed equipment in the areas of size, weight, power, and reliability for the ultimate system to be successful in the planetary reconnaissance vehicle. The laboratory model is, by the very nature of technique, simple, and will demonstrate complete feasibility of conformance to the design parameters required in the ultimate equipment.

4.2.1 Size and Configuration

The web processing technique, eliminating the need of fluid pumps, precision applicators, solution reservoirs and complicated drives occupies an absolute minimum size compared to other methods of airborne processing. The greatest configuration flexibility is also achieved with supply and take-up areas capable of a variety of positions conforming to the desired package.

4.2.2 Weight

In conjunction with the unusually few number of assemblies, unit weight is held to an absolute minimum.

4.2.3 Power

The specification requirements are of such nature as to allow conservation of power to the greatest degree possible.

System operation will proceed in sequenced fashion so as not to unnecessarily duplicate the consumption of power. Operation will consist of:

1. Camera cycling, during which time processor power is not consumed.

2. Processor drive and drying, during which time camera power is not consumed.

Processing will take place at the 50°F. sink temperature, eliminating the need of usually necessary controlled temperatures during processing.

The simple drying technique devised requires only a low velocity blower to circulate dry air around the film, effecting a moisture transfer to the dessicant crystals. Recharging of the dessicant will be accomplished during the three hour non operating period.

4.2.4 Reliability

Inherent to Fairchild's PoroMat Processing Technique, with its use of simple, proven components, is the critical feature required of all space age equipment - reliability. No unusual components are envisioned for use in the equipment to decrease the basic field-tested trustworthiness of not only the final system but the laboratory model as well.

SECTION 5

ENVIRONMENTAL CONSIDERATIONS

Full design consideration shall be given not only the acceleration and pressure requirements, but to shock and temperature as well. Unfortunately, because of the accelerated delivery requirements of the system, there will be no time allowed for full environmental testing. Scan tests will be conducted as time allows.

SECTION IV

CONTRACT

Fairchild's technical proposal SME-CF-117 was favorably received on April 13, 1964. A Cost-Plus-A-Fixed-Fee type Research and Development Contract No. 950794 was issued by Jet Propulsion Laboratory to Fairchild Camera and Instrument Corporation for a Camera and Film Processor. The estimated cost was $72,160.00 plus fee of $5,051.00 for a total amount allotted of $77,211.00. The statement of Work is reproduced below.

SCHEDULE

ARTICLE 1 STATEMENT OF WORK

(a) The Contractor shall:

(1) Design, develop, fabricate and test a laboratory model of a Camera and Film Processor for 35 mm film in accordance with JPL Specification GMO-50197-DSN-A, Camera and Film Processor Design Specification, dated 21 February 1964.

(i) Fabrication of the laboratory model shall begin upon written approval of the preliminary design by JPL.

(ii) Tests shall be performed at the Contractor's facility prior to the delivery of the laboratory model in accordance with the Contractor's test procedure as approved by JPL. Prior to the performance of any test, the Contractor shall prepare and submit, to JPL for approval, six (6) copies of its test procedure.

(2) Schedule Monthly-Progress-Summary meetings at the Contractor's facility for JPL's review. The meetings shall include, but not necessarily be limited to, the following:

(i) A verbal report of technical progress to date by the Contractor.

(ii) A brief discussion of how any technical problems were encountered and solved.

ARTICLE 1 STATEMENT OF WORK (cont.)

(iii) A brief discussion of activities planned for the ensuing month.

(iv) A report of the financial status and an estimate of the total final costs.

(3) Prepare and submit one (1) vellum and six (6) copies each of the following documentation:

(i) Monthly Status Report in accordance with EXHIBIT I of JPL Statement of Work, SW-3284, Monthly Status Report, dated 4 December 1963.

(ii) Final Engineering Report which shall include, but not necessarily be limited to, the following:

(A) Engineering sketches, drawings, diagrams, schematics, photographs and all other data necessary to technically describe the complete Camera and Film Processor.

(B) Test and operation procedure of the Camera and Film Processor.

(C) A Spare Parts List which shall include, but not necessarily be limited to, the following:

1. Estimated spare parts requirement to maintain the Camera and Film Processor 1500 operating hours.

2. Part number and nomenclature, including supplier's name and part number if applicable.

(D) Post design critique and recommendation.

SECTION V

MINUTES OF MEETING

During the course of the contract periodic meetings were held between the technical representative of the Jet Propulsion Laboratory and Fairchild Camera. Minutes of these meetings were kept, directing future action and reporting on previous action. In order to ensure against misinterpretation, representatives of both parties signed the minutes. Since many of the topics were a defining of the requirement of the contract, they are included in this report.

CAMERA AND FILM PROCESSOR

ENGINEERING LIAISON REPORT

Meeting No.	1
Minute No.	1 through 19
Job No.	1382
Contract No.	950794
Customer	J. P. L.
Meeting Place	FSDS Syosset, N. Y.
Date	May 27 & 28, 1964

<u>Present</u>

<u>Fairchild Camera and Instrument Corporation</u>

G. Haines, Principal Engineer, Photo Processing Section
R. Siegel, Principal Engineer, Photo Processing Section

<u>Jet Propulsion Laboratory</u>

A. Spitzak, Project Engineer
R. Wickelman, Engineer
R. Dearing, Consultant, Dearing Associates

Prepared By: ____________________
G. Haines, FSDS

Approved By: ____________________
A. Spitzak, JPL

MINUTE	TOPIC	ACTION
1	Specification - Paragraph 1.2.1 - The performance of the system will be determined with both SO-243 and Pan-X 5240 films. Square Wave targets will be recorded through the lens onto both films and half of the material will be processed by web and half by conventional means. Microdensitometer traces will be made of both samples.	FSDS to prepare acceptance test procedure for JPL approval.
2	Specification - Paragraph 1.2.1 - The preferred method of critical focusing will be ground glass, with an alternate choice of graduations on lens barrel.	FSDS to include requirement in camera specification.
3	Specification - Paragraph 1.2.1 - The shutter speed will be continuously variable over a range of 1/10 to 1/700 of a second. An accuracy of ± 10% will be maintained over the range of 1/10 to 1/250 of a second. The preferred method of determining shutter setting is a panel meter calibrated in time. An alternate method could be a nomograph. Exposures in excess of 1/2 second will be manually controlled; pulse for open-pulse for close. If possible a means for changing gear ratios to the shutter to provide 1/2 and two (2) times the shutter speeds should be provided.	FSDS to include requirement in camera specification and provide interlock to prevent film transport during exposures.
4	Specification - Paragraph 2.1 - Part marking may be omitted on camera parts if parts can be identified from call out in manual.	FSDS to include in camera requirements.

MINUTE	TOPIC	ACTION
5	Specification - Paragraph 3. 3. 1 Environmental testing of hardware shall be under normal laboratory conditions including a temperature range of from 50°F. to 120°F. The processing assembly i. e., PoroMat in the recommended package will be shelf tested in vacuum in addition to environment dictated by FSDS.	FSDS to prepare acceptance test procedure for JPL approval.
6	Specification - Paragraph 3. 3. 2 - The processor as proposed will not treat the base of the film, therefore, dye back film cannot be handled.	FSDS shall not consider dye back films.
7	Specification - Paragraph 3. 3. 3 - In the auto mode the cycling rate shall be variable from 1 every 5 seconds to 1 every minute. A manual mode will be provided for pulse operation.	FSDS to provide requisite controls.
8	Specification - Paragraph 3. 3. 4 - The processor shall have a variable speed drive.	FSDS to provide requisite controls.
9	Specification - Paragraph 3. 3. 4 - The processed film shall be tested for RMS granularity as a maximum requirement, or comparative photo micrographs of web processing and conventional processing shall be submitted. Uniformity test and criteria will be defined in acceptance test procedures.	FSDS to prepare acceptance test procedure for JPL approval.

MINUTE	TOPIC	ACTION
10	Specification - Paragraph 3.3.5 - The slack box shall be designed to preclude contamination of raw exposed film by processed film.	FSDS to provide a double slack box, each box to contain a minimum of 12 feet.
11	Specification - Paragraph 3.3.7 - The leads from the data lamps will be brought to a connector. JPL will supply power to these leads. A trip will be provided by the camera to pulse JPL control box.	FSDS to include in camera requirements.
12	Specification - Paragraph 3.5 - The preferred power shall be 115V 60 cycle AC. An alternate choice will be 28 VDC.	FSDS to consider the voltage requirements.
13	Specification - Paragraph 6.1 - No. Independent controls will be provided.	FSDS to provide single control panel.
14	Camera Procurement - Mounting compatibility will be considered for the Super Baltar series and the Ernst Leitz 3" and 6" lens.	FSDS investigate mounting.
15	Processor - Possible point of difficulty is the 12" unsupported path length.	FSDS to determine feasibility.

MINUTE	TOPIC	ACTION
16	Dryer - Means shall be provided for restricting dessicated air flow to vicinity of film and web.	FSDS to design dryer to restrict air.
17	Rewind - The option to rewind film from take-up to the slack box shall not be automatic, but shall be at operator discretion.	FSDS to provide manual control of rewind.
18	Processor - Possible point of difficulty is the separation of film and web at completion of processing cycle.	FSDS to determine feasibility and design accordingly.
19	Purchase Order - The purchase order for the camera will be forwarded to C. Chuh for approval; copy to R. Dearing.	FSDS to comply.

CAMERA AND FILM PROCESSOR

ENGINEERING LIAISON REPORT

Meeting No.	2
Minute No.	20 thru 30
Contract No.	950794
Customer	JPL
Meeting Place	FSDS Syosset, NY
Date	June 26, 1964

Present

Fairchild Camera and Instrument Corporation

G. Haines - Principal Engr. - Photo Processing Section
R. Siegel - Principal Engr. - Photo Processing Section
J. Bradley - Designer - Photo Processing Section
S. Davis - Eng. Techn. - Photo Processing Section

Jet Propulsion Laboratory

A. Spitzak - Project Engineer

Prepared By: G L Haines
G. L. Haines

Approved By: ______________
A. Spitzak

MINUTE	TOPIC	ACTION
20	JPL requested copies of camera drawings supplied by Giannini to FSDS.	FSDS to forward copies of camera drawings supplied by Giannini to JPL.
21	The method of setting shutter opening to obtain accuracy requested by JPL in Minute No. 3	FSDS to explore manual setting of shutter opening.
22	Monobath formulation efforts will be concentrated on Pan emulsion 5240 with secondary effort on SO-243. No chemical investigation will be conducted on Plus-X types.	FSDS to limit chemical investigation to 5240, SO-243.
23	Specification - Paragraph 3.3.5 Granularity	FSDS to process identical wedges of both 5240 and SO-243 with D - 19 and Poro-Mat and produce comparative microphotographs.
24	Specification - Paragraph 3.3.4 Testing light conditions. This is included in the specification to assure sensitometric quality with the scanning source which will radiate in the spectral range of 3800-4700A.	FSDS will determine the difference in sensitometric quality between daylight and the range 3800-4700A. If no difference exists all subsequent tests will be accomplished with normal daylight.
25	Specification - Paragraph 3.3.4 Film sensitivity - The exposure index listed in E. K Handbook W-40 are obtained by processing to a gamma higher than the gamma desired in this system. To determine any loss in film sensitivity the following procedure should be used. Identically exposed samples of both	

MINUTE	TOPIC	ACTION
25	Cont. - 5240 and SO-243 will be processed in D-19 and PoroMat, to a gamma of 1. The resultant density produced at step 11 shall not differ by more than 0.30 density units.	FSDS to test for difference in film sensitivity by the prescribed technique.
26	Specification - Paragraph 3.3.4 The gamma, to be selected by JPL, shall lie within the range of 0.8 to 1.3. Deliverable rolls of PoroMat shall process the film to the selected gamma ± 10%.	FSDS to investigate monobath formulations to produce gammas in the range of 0.8 to 1.3.
27	Specification - Paragraph 3.3.4 PoroMat processed samples to a gamma of 1 shall provide a usable Log E acceptance range of at least 1.5 and the minimum density above base shall not exceed 0.2.	FSDS to investigate monobath formulations to meet this criteria.
28	Program Schedule - The most recent Pert Chart was submitted and the delivery date as indicated at the meeting of May 27, 28 (i.e. camera processor delivery during week of 10/18/64) was reiterated.	FSDS to consider ways of accelerating delivery.
29	Exposure Time Indicator. JPL requested that FSDS investigate a method for supplying JPL with an indication of shutter open time.	FSDS to investigate and propose a change to supply an indication of shutter open time.
30	Shelf Life Testing - It was agreed that shelf life testing will be conducted under the following environmental conditions:	

MINUTE	TOPIC	ACTION
30	Shelf Life Testing - Cont.	
	1. 50°F. 9.3 mm of Hg in a nitrogen atmosphere. 2. 120°F. and as near absolute vacuum as the displacement pump can attain.	FSDS to conduct shelf life tests during the period of contract and to explore contractual means of continuing tests beyond contract end date.

Camera and Film Processor

Engineering Liaison Report

Telecon	
Minute No.	31 thru 32
Contract No.	950794
Customer	Jet Propulsion Laboratory
Date	September 14, 1964

Fairchild Camera and Instrument Corporation
G. Haines, Principal Engineer, Photo Processing Section

Jet Propulsion Laboratory
A. Spitzak, Project Engineer

Prepared By: G. Haines

G. Haines

Approved By: Albert Spitzak

A. Spitzak

Minute No.	Topic	Action
31	Specification - Paragraph 4.1.1 - Inspection marking subject to J.P.L. approval.	FSDS to maintain records of inspection on file and refrain from marking individual components.
32	Submission of manufacturing drawings of web sealer and **processor,** and drawings furnished by Giannini to FSDS.	FSDS to forward requested drawings to J.P.L.

SECTION VI

CAMERA SPECIFICATION

In order to implement the film exposure requirements of the basic design specification, a detailed specification defining the camera portion of the device was prepared by Fairchild Camera and Instrument Corporation. This specification SME-DI-22, dated 25 May 1964, was submitted to several private companies for quotation. The specification follows.

FAIRCHILD SPACE AND DEFENSE SYSTEMS

A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

SYOSSET, NEW YORK

ENGINEERING SPECIFICATION

TITLE: CAMERA, 70MM X25MM FORMAT

1. SCOPE

1.1 General

This specification covers the design requirements for a modified Model 207 Giannini Scientific Corporation Camera in a self contained package, for present laboratory use, which may later be easily redesigned to conform to a flight environment package.

1.2 Description

The camera will use 35mm double perforated film in roll lengths up to 100 ft., accepting a standard daylight loading film spool. A 70mm by 25mm active area of SO-243 film will be exposed in a manner that will cause no greater degradation than 40 percent at 50 line pairs/mm on axis. The best commercial lens, with the largest field-of-view under 60 degrees, that will meet this requirement at 10 degrees off axis and f/2 capability, such as 6" F.L. Schnieder, will be used. It is desired that the field-of-view be at least 25 degrees by 9 degrees. Focusing on targets at eight feet to infinity will be controlled to the accuracy dictated by the above 40 percent criteria. The shutter opening shall be capable of providing shutter speed of 1/10 to 1/700 of a second, and also be manually controlled for time exposure in excess of 1/2 second. A device will be provided to allow for focusing of the camera to meet the previously mentioned performance criteria.

2. APPLICABLE DOCUMENTS

The following document, of the issue in effect on the date of contract forms a part of this specification. Jet Propulsion Laboratory Specification No. GMO-50197-DSN-A.

If there are conflicting requirements between the referenced specification and this document, the requirements of this specification shall govern.

3. REQUIREMENTS

3.1 Materials, Parts and Processes

Materials, parts and processes used in the design, fabrication and assembly of the item covered by this specification shall conform to the requirements of this

Prepared By S. Frankel Date

Approved By Baum 5-25-64

FCI 10-276-1 (5-64)

specification. Any materials, parts, and processes that are not so covered shall be subject to the approval of the cognizant Fairchild engineer. In all events, the contractor's selection shall assure the highest uniform quality and condition of the item delivered.

3.2 Interchangeability of Parts

All parts having the same part number shall be directly and completely interchangeable, with respect to function and installation.

3.3 Design

3.3.1 General - The camera shall be confined to a self contained package. It shall use 35mm double perforated film in daylight loading spool lengths up to 100 feet.

3.3.2 Configuration and Mating Surface - Camera configuration shall be as depicted in Giannini Scientific Corporation Drawing No. RD-6324-002. Mating interface between camera and film processor shall be defined at a later date.

3.3.3 Design Requirements - The specifications of paragraph 1.2 of this document shall be acccomplished with a modified Model 207 Camera, exposing an active frame area, 70mm x 25mm at least once every 15 seconds, and a maximum rate of once every 5 seconds. Exposure rate less then once every 15 seconds will be manually controlled. Spacing between frames shall not exceed ten percent of the length used (70mm plus the data block, see paragraph 3.3.4), and no frame overlap shall be permitted. Any amount of film exposure from three feet to fifteen feet shall be considered as one duty cycle. Provision shall be made for transporting film through the camera without exposures being made. An indicator, showing the amount of film footage remaining in the supply cassette shall be provided. Accuracy shall be ± 1 foot.

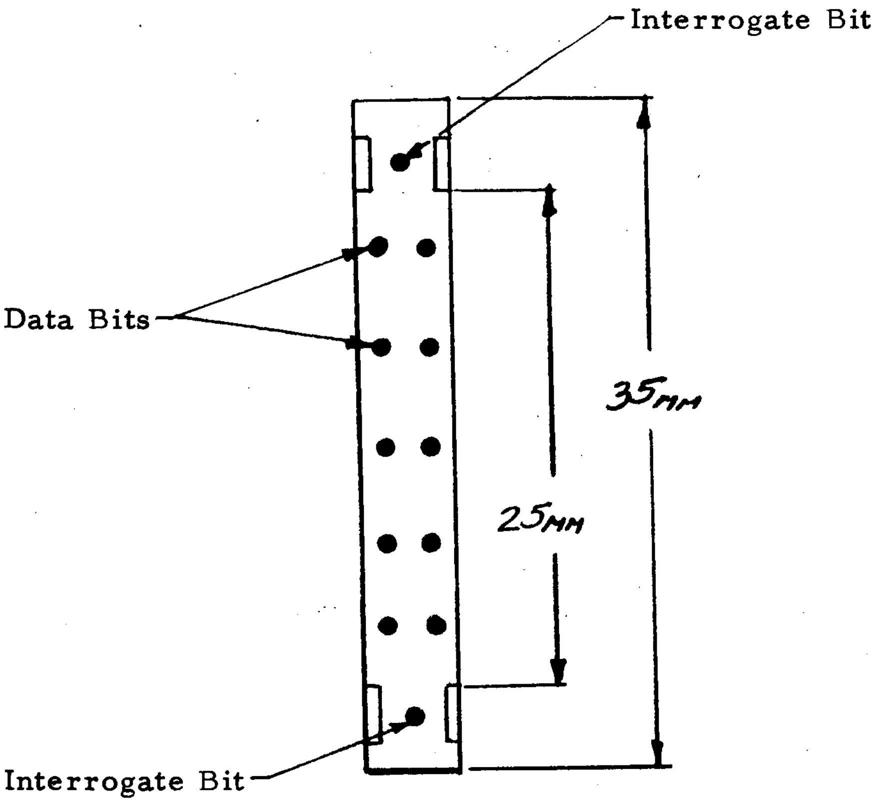
3.3.4 Data Block - During a 70mm by 25mm film exposure, an adjacent 5mm by 25mm data block of ten bits shall be exposed through control circuitry provided by Fairchild thru a Giannini supplied binary counter. Giannini shall provide each data light with an outgoing line to a connector terminal. An exposed bit shall give the highest possible density on the processed negative. In addition, two interrogate bits shall be exposed above the 25mm width and centered in the 5mm on all exposures. The layout will be as in the following sketch.

FAIRCHILD SPACE AND DEFENSE SYSTEMS
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
SYOSSET, NEW YORK

FCI 10-276 (7-63)

ENGINEERING SPECIFICATION

TITLE: CAMERA, 70MM X 25MM FORMAT



The time of the data block exposure shall be at mid point of format exposure. Bit diameter shall be between 0.030 and 0.060 inches.

3.3.5 Environmental Requirements - The camera shall be capable of working under a steady acceleration of two times gravity in any direction and also in the absence of gravity. Operation shall be at temperatures between 50 and 120°F.

PREPARED BY	DATE	REV LTR							
S. Frankel	3/11/64	ECN NO.							
APPROVED BY	DATE	BY							
Haines	5-25-64	DATE							
APPROVED BY	DATE	APPROVED							

3.4. Power, Weight and Size

Consideration shall be given to minimizing the package size and weight. Camera power shall not exceed 50 watts 28 VDC.

3.5 Spare Parts, Life and Reliability

Five hundred hours of running time is a desired goal without major component replacements. Spare parts list shall be provided for this period of operation. Design shall be such that a single down time for repairs shall be no greater than eight hours.

3.6 Workmanship

The workmanship shall be consistent with the best standard practices used in the manufacture of camera equipment.

4. QUALITY ASSURANCE

4.1 Contractor Responsibility

The contractor shall be responsible for camera conformance to all necessary inspection on materials, components, products to assure compliance with the requirements specified within this document.

4.1.1 Visual Inspection - A visual inspection to assure compliance with applicable drawings and documents shall be performed on 100 percent of all materials, hardware, components, assemblies, etc., prior to, during, and after fabrication of each item produced.

4.1.2 Electrical Examination - Electrical examination and inspection shall be performed, visually and dynamically as appropriate, on all incoming parts, and on all assemblies during and after fabrication. This shall assure that electrical parameters shall meet requirements of applicable drawings and documents.

4.1.3 Performance Testing - The contractor shall aid in verification that the camera meets all of the performance requirements of this specification under any environmental conditions specified.

5. PREPARATION FOR DELIVERY

Each unit shall be packed for shipment in a manner conforming to the requirements of commercial transportation applicable to the mode of transportation employed.

PREPARED BY S. Frankel	DATE 3/11/64	REV LTR						
APPROVED BY Haynes	DATE 5-25-64	ECN NO.						
APPROVED BY	DATE	BY						
		DATE						
		APPROVED						

SECTION VII

DESIGN ANALYSIS

The functioning of the device defined in the JPL specification for the Camera-Film Processor depends upon the successful solution of three (3) problems:

a. A method of packaging the PoroMat web to allow intermittent operation after an initial inactive period of eight months.

b. The formulation of a monobath, which when used to process film with a web carrier, will (1) approximate the sensitometric results attained in standard processing and, (2) will produce no degradation of image quality when the emulsion is dried without washing.

c. The integration of a camera and web processor with the requisite controls.

These problems will be dealt with separately in the following paragraphs.

Web Package

The unprotected PoroMat is subject to both oxidation and dessication. The developing portion of the monobath is a highly active reducing agent and is readily oxidized. In addition, the ingredients of the monobath are dissolved in water which will quickly evaporate in a reduced pressure environment. In order to protect the web from the hostile invironment, a vapor barrier must be introduced between the web and its surroundings.

The normal packaging of PoroMat consists of a flexible, heat sealable, plastic bag overpacked with a rigid hermetically can. The purpose of the plastic bag is to prevent the caustic monobath from attacking the can. Packed under these conditions PoroMat shows no aging after storage for 15 months at 70°F. The results of these tests clearly demonstrate there is nothing inherent in the PoroMat per se which would render it unsuitable for the application intended. If the PoroMat were packaged in an hermetically sealed can, this would satisfy the requirement for the initial inactive period of eight months. Rupturing the can after the eight months to make the PoroMat accessible for processing would expose it to the hostile environment, and it would not be available for intermittent use for an additional thirty days. Ideally, the web would be packaged in predetermined lengths, each in its separate can, which would be ruptured on demand. It is desirable to maintain the flexibility of post launch programming, which precludes the pre-packaging technique.

A technique was conceived which promised to satisfy the ideal situation. The technique was to seal the PoroMat in a continuous sheath of plastic, The plastic would protect the PoroMat from evaporation and oxidation and the sheath may be slit open on demand.

A literature search resulted in the availability of several plastic materials which showed promise. It was determined that no plastic is truly impermeable to vapor, as is a metal. The permeability is a function of the thickness of the plastic, the density of the plastic, the pressure differential across the membrane and time. The least permeable material which also exhibits the required flexibility is a commercially available material "Scotch-Pak" (i.e. it's an aluminized mylar sheet laminated with a sheet of polyethylene). The aluminum decreases the permeability of the mylar and the polyethylene renders it heat sealable. Tests were conducted on this material and it was decided to initiate the shelf life tests using this material.

As was indicated in the previous paragraph, the effectiveness of a vapor barrier is a function of the differential pressure across the barrier. If the plastic sheath were to be sealed at atmospheric pressure, and the vehicle, at any time lost pressurization, the maximum pressure differential would increase the rate of vapor transfer. In addition, the pressure differential would cause the roll of packaged PoroMat to unroll like a Bourdon tube.

The minimum pressure which can be attained within the plastic sheath is the vapor pressure of the solution within the PoroMat. The vapor pressure of the PoroMat solution is variable depending upon the temperature of the solution. The suggested temperature of the specification is 50°F. The vapor pressure of water at 50°F is 9.3 mm of Mercury. If the web is packaged in a pressure environment of 9.3 mm, the maximum pressure differential of complete depressurization of the vehicle is 9.3 mm of Mercury.

A device Figure 7 - 1 was designed and fabricated to enable the continuous heat sealing of a 35 mm 100 foot length of saturated PoroMat within a plastic sheath.

INTERIM REPORT OF POROMAT INVESTIGATION

An investigation was made to develop a suitable PoroMat processing material for use in the JPL Camera-Processor. Concurrent with the development of monobath chemistry for emulsions E. K. Panatomic-X, Type 5240 and E. K. Special High Definition Aerial, Type SO-243, a number of film evaluations were conducted.

PROCESS CONTROL FILM SAMPLES

Kodak emulsions Panatomic-X, Type 4240 and Special High Definition Aerial, Type SO-243 were exposed on the Edgerton, Germeshausen and Grier Sensitometer, Model VI using a Kodak No. 2 step tablet and processed in Kodak D-19 Developer. The rocking tray technique was used for development in order to obtain sensitometric curves for the two emulsions. Exposure and processing data were as follows:

Emulsion	5240	SO-243
Exposure Time	1/100 sec.	1/100 sec.
Neutral Density Filter	2.2	1.1
Developer	Kodak D-19	Kodak D-19
Developing Time	1, 2, 3, 4, 5 & 8 min.	1, 2, 3, 4, 5 & 8 min.
Developer Temperature	68°F.	68°F.
Rapid Fix	10 minutes	10 minutes

Figures I and II represent a series of processing curves for emulsions Panatomic-X, Type 5240 and Kodak SO-243. The immersion processing tests were conducted to prepare conventionally processed film for comparison with PoroMat web processed film. Since the desired gamma of 1.0 was not obtained for the high contrast Kodak SO-243 emulsion processed in Kodak D-19 Developer a second series of processing tests was run using D-76 Developer. Figure III represents the results of 1, 2, 3, 4 and 5 minutes development for SO-243 in D-76 Developer.

SENSITOMETRIC QUALITY

The exposure conditions for sensitometric and image quality as described in Paragraph 3.3.4 of JPL GMO-50197-DSN specifies the use of daylight illumination as described in ASA photographic standards. The testing light conditions for sensitometric and image quality shall use light composed principally of wavelengths between 3800 and 4700A°.

The Edgerton, Germeshausen and Grier, Model VI Sensitometer, using an electronic flash light source, was used to expose film. The flash tube, General Electric FT118, emits light approximating the color quality of daylight.

The Macbeth Quantilog Densitometer Model TD-102 was used to measure the sensitometric characteristics of the developed image. This instrument employs a tungsten light source and an optical system which meets the ASA Standard PH2-19-1959 for Measuring Diffuse Transmission Density. A Wratten Type 106 Filter is utilized for making visual density measurements.

Since it is required that image scanning of the processed film be accomplished with a light source radiating in the range of 3800-4700A°, an evaluation was conducted to determine what image quality differences, if any, are observed when the spectral range of the analyzing light is changed.

In order to evaluate changes in image quality that are related to the scanning light the following procedure was followed:

1. Film strips of Kodak Special High Definition Aerial Film, Type SO-243, containing sensitometric exposures were processed in Kodak D-76 Developer and also PoroMat processed with a typical monobath developer to a gamma of 1.

2. Film strips of Panatomic-X, Type 4240, containing sensitometric exposures were processed in Kodak D-19 Developer and also PoroMat processed with a typical monobath developer to a gamma of 1.

The processed film strips were then analyzed with a Macbeth Model TD-102 Densitometer to determine whether: (1) the PoroMat processed film samples differ in sensitometric and image quality when the standard light source, balanced with a Wratten Type 106 filter, is changed to a light source radiating in the spectral range of 3800 to 4700A°, (2) the behavior observed in (1) is similar to or differs from the film conventionally processed by immersion in Kodak D-19 or D-76 Developer, (3) there is any change in image quality for Kodak SO-243 proceed in Kodak D-19 Developer compared to Kodak D-76 processing.

The Macbeth TD-102 Densitometer used for sensitometric measurements has a selected 931A Photomultiplier tube. The Spectral Sensitivity curve for a typical tube is shown in Figure IV. According to the manufacturer (RCA) the peak response of this tube may change by as much as ± 50 millimicrons.

Wratten filters Type 106, used with the TD-102 for visual density measurements and Wratten filters Type 47, 48 and 98 which transmit between 3800-4700A°are shown in Figure V. This data was obtained from Kodak Publication No. B-3 entitled "Kodak Wratten Filters".

Since the sensitometric measurements obtained for Wratten filters 47 and 48 were almost identical only data obtained for Wratten filter 48 is presented in sensitometric comparison curves.

RESULTS OF IMAGE ANALYSIS

1. Panatomic-X, Type 5240

A. Figures VI and VII for PoroMat processing using monobaths 1936-71-1 and 1984-18-10 indicate no change in the shape of the characteristic curves with changes in the spectral range of scanning light source.

B. Figure VIII shows the results of 5240 processing with D-19 Developer when scanned with filters 106, 48, 98. Here again there is no general change in shape of the characteristic curves and the relationship of image quality as a function of scanning light is similar to PoroMat processed wedges in Figures VI and VII.

2. Kodak Special High Definition Aerial (SO-243)

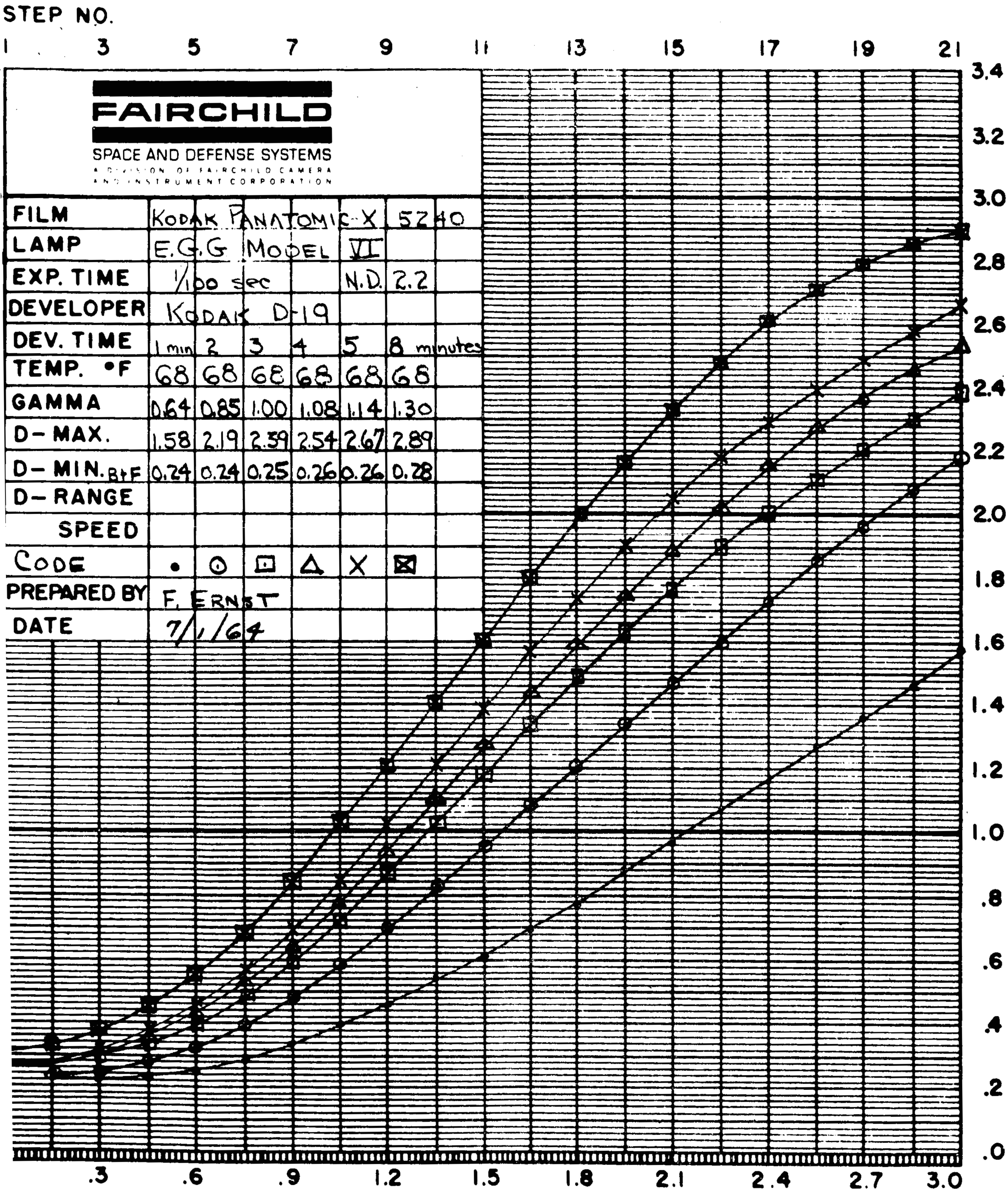
A. Figures IX and X for PoroMat processed film using monobaths 1984-6-4 and 1936-71-1 show a change in the shape of the characteristic curve with changes in the spectral range of the scanning light source.

B. Figure XI shows the results of SO-243 processing with D-76 Developer when scanned with filters 106, 48 and 98. Here again there is a change in the shape of the characteristic curve when the scanning light is changed. This is apparently not due to the chemistry of PoroMat processing since the same relationship exists with Kodak D-76 processing. Figure XII further supports the fact that the change in sensitometry, as measured by light sources of differing spectral ranges, is unrelated to the chemistry used for here D-19 Developer was used.

FAIRCHILD

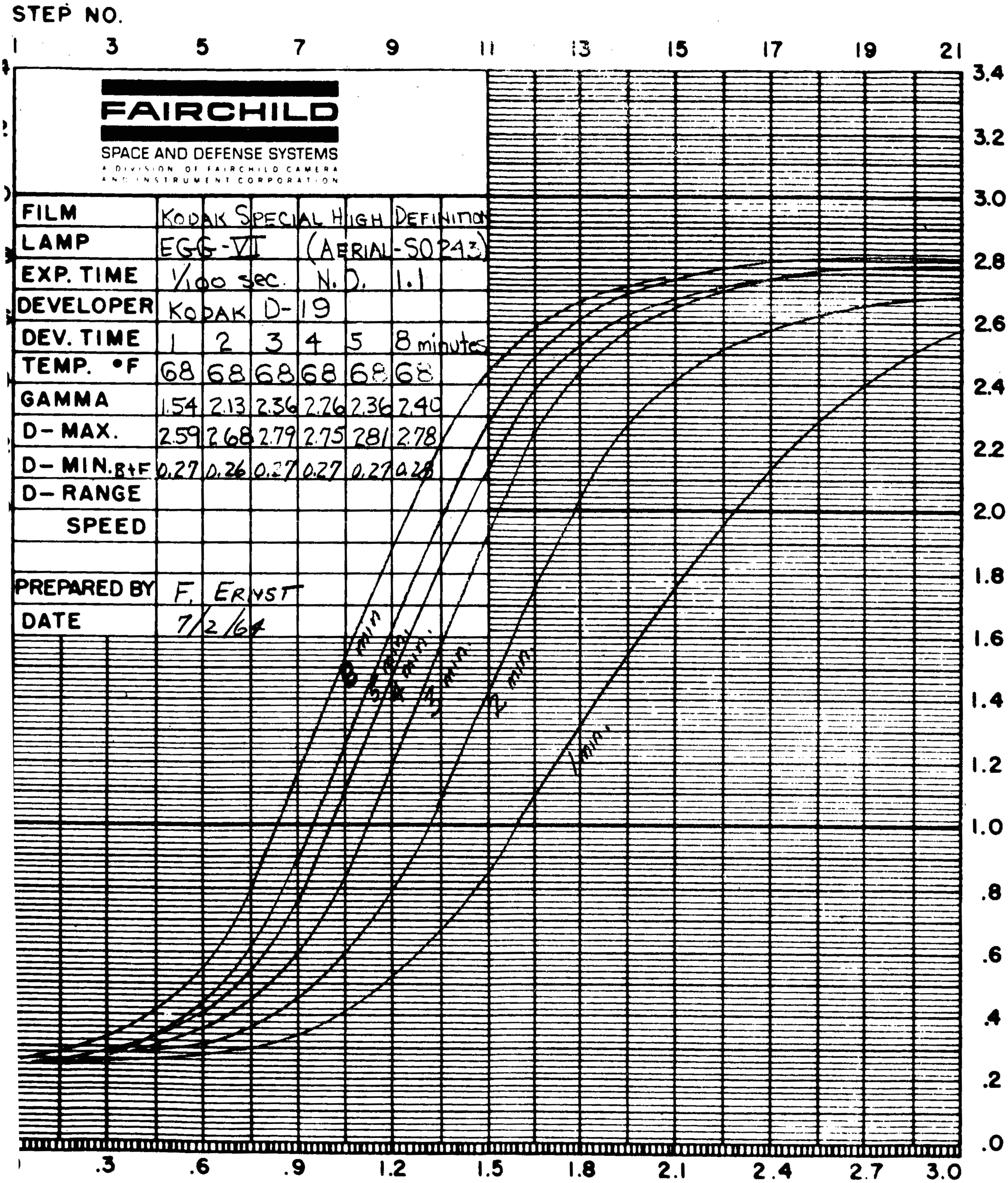
SPACE AND DEFENSE SYSTEMS
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

FILM	Kodak Panatomic-X 5240						
LAMP	E.G.G Model VI						
EXP. TIME	1/100 sec				N.D.	2.2	
DEVELOPER	Kodak D-19						
DEV. TIME	1 min	2	3	4	5	8 minutes	
TEMP. °F	68	68	68	68	68	68	
GAMMA	0.64	0.85	1.00	1.08	1.14	1.30	
D-MAX.	1.58	2.19	2.39	2.54	2.67	2.89	
D-MIN. B+F	0.24	0.24	0.25	0.26	0.26	0.28	
D-RANGE							
SPEED							
CODE	•	⊙	⊡	△	X	⊠	
PREPARED BY	F. Ernst						
DATE	7/1/64						



SENSITOMETRIC TEST CHART

FIG I

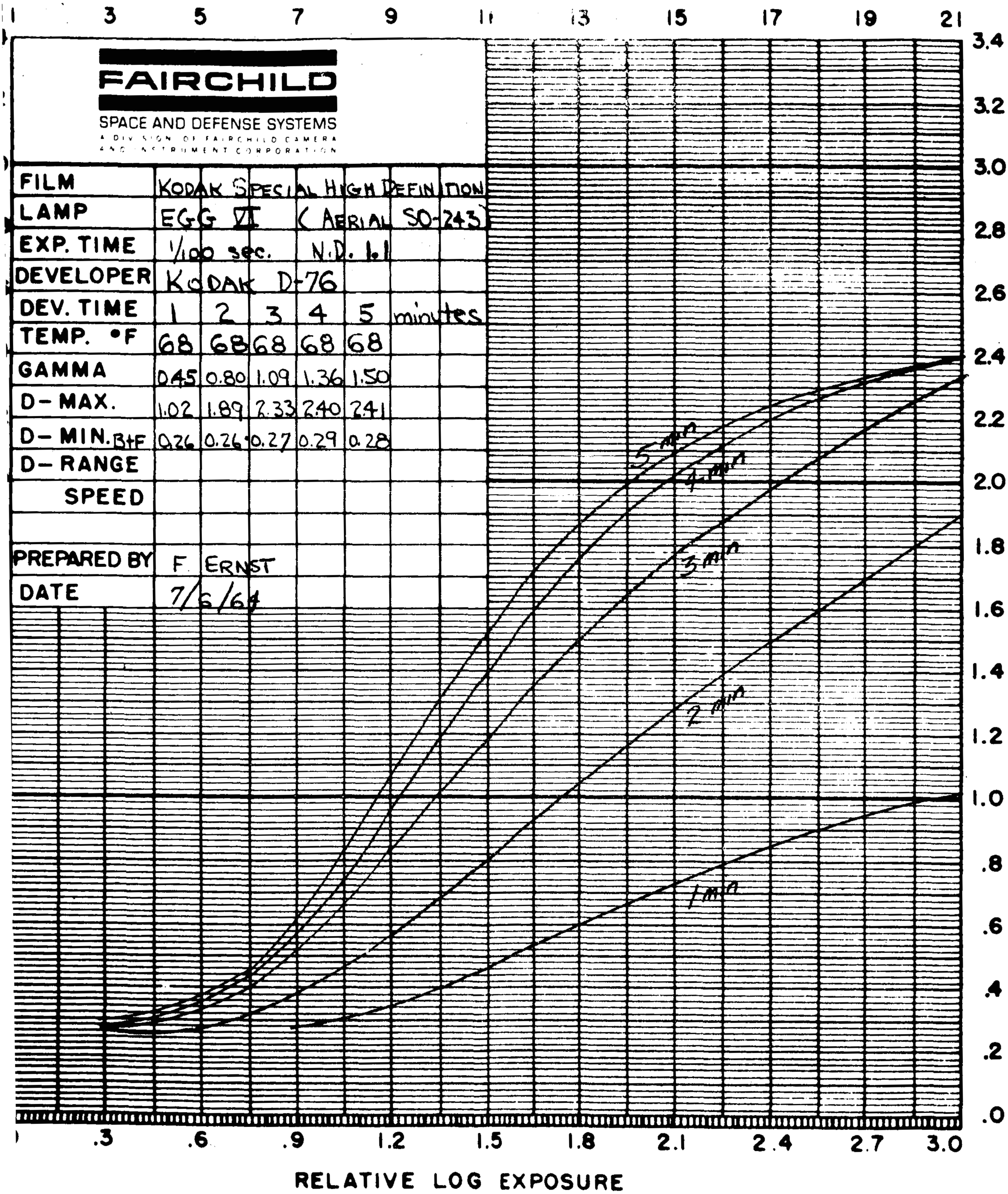


FILM	KODAK SPECIAL HIGH DEFINITION					
LAMP	EGG-VI (AERIAL-SO243)					
EXP. TIME	1/100 sec. N.D. 1.1					
DEVELOPER	KODAK D-19					
DEV. TIME	1	2	3	4	5	8 minutes
TEMP. °F	68	68	68	68	68	68
GAMMA	1.54	2.13	2.36	2.76	2.36	2.40
D-MAX.	2.59	2.68	2.79	2.75	2.81	2.78
D-MIN. B+F	0.27	0.26	0.27	0.27	0.27	0.28
D-RANGE						
SPEED						
PREPARED BY	F. ERNST					
DATE	7/2/64					

SENSITOMETRIC TEST CHART

FIG. II

STEP NO:

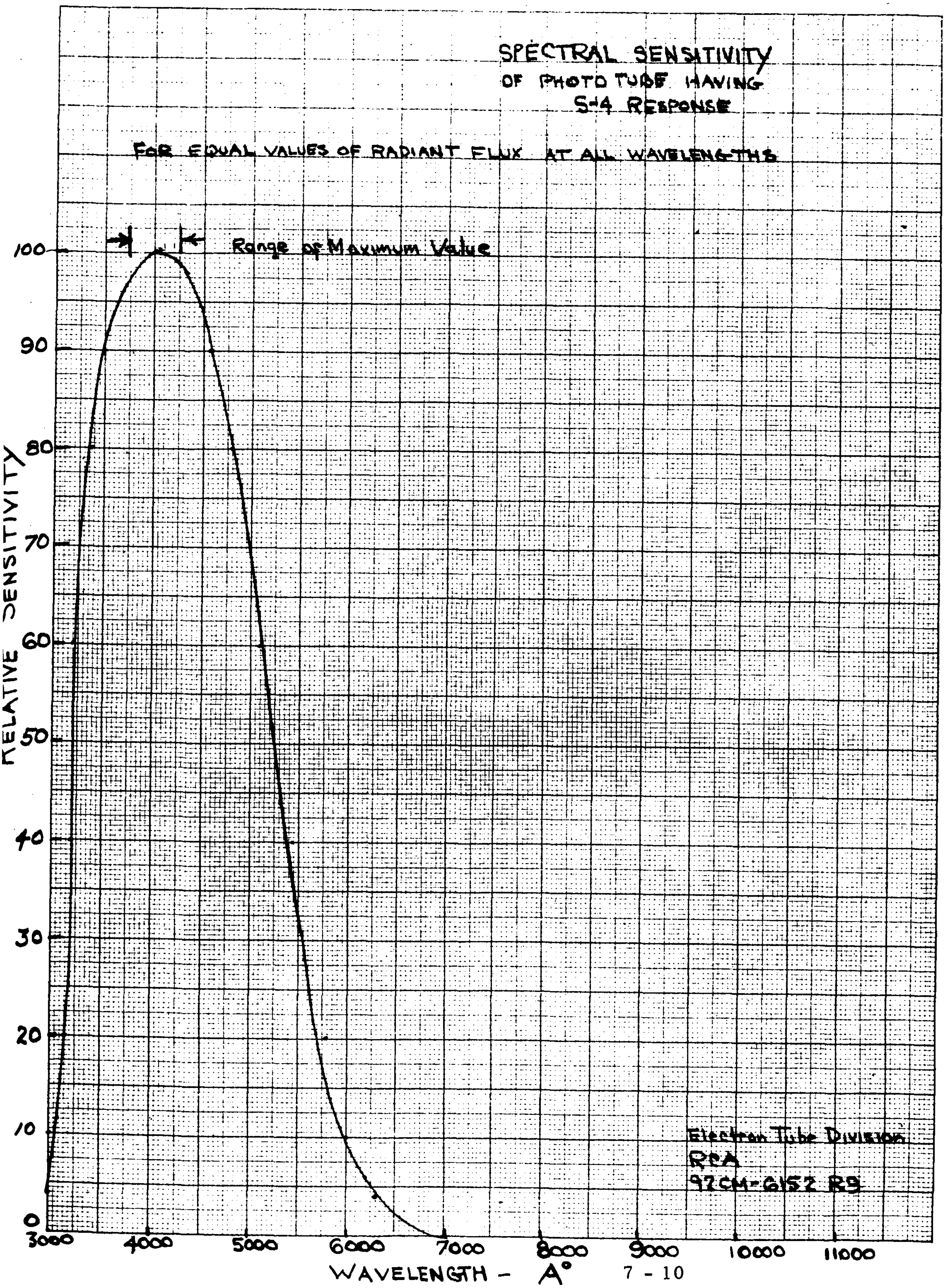


FILM	KODAK SPECIAL HIGH DEFINITION						
LAMP	EGG VI		(AERIAL SO-243)				
EXP. TIME	1/100 sec.		N.D. 1.1				
DEVELOPER	KODAK D-76						
DEV. TIME	1	2	3	4	5	minutes	
TEMP. °F	68	68	68	68	68		
GAMMA	0.45	0.80	1.09	1.36	1.50		
D-MAX.	1.02	1.89	2.33	2.40	2.41		
D-MIN. B+F	0.26	0.26	0.27	0.29	0.28		
D-RANGE							
SPEED							
PREPARED BY	F. ERNST						
DATE	7/6/64						

SENSITOMETRIC TEST CHART

FIG. III

FIG IV


SPECTRAL SENSITIVITY
OF PHOTOTUBE HAVING
S-4 RESPONSE
FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS
Range of Maximum Value
RELATIVE SENSITIVITY
100
90
80
70
60
50
40
30
20
10
0
3000
4000
5000
6000
7000
8000
9000
10000
11000
WAVELENGTH - A°
Electron Tube Division
RCA
92CM-6152 R3

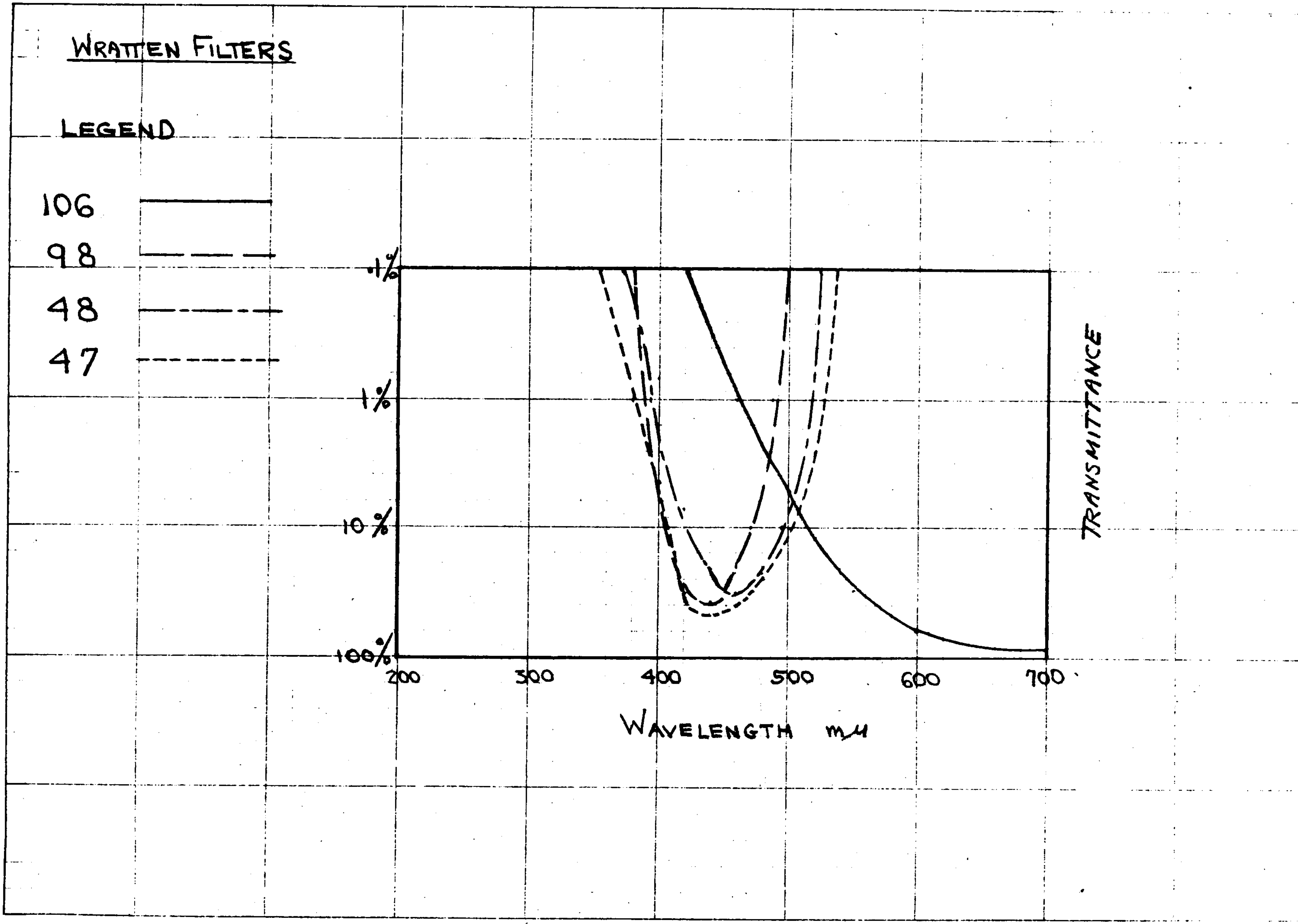
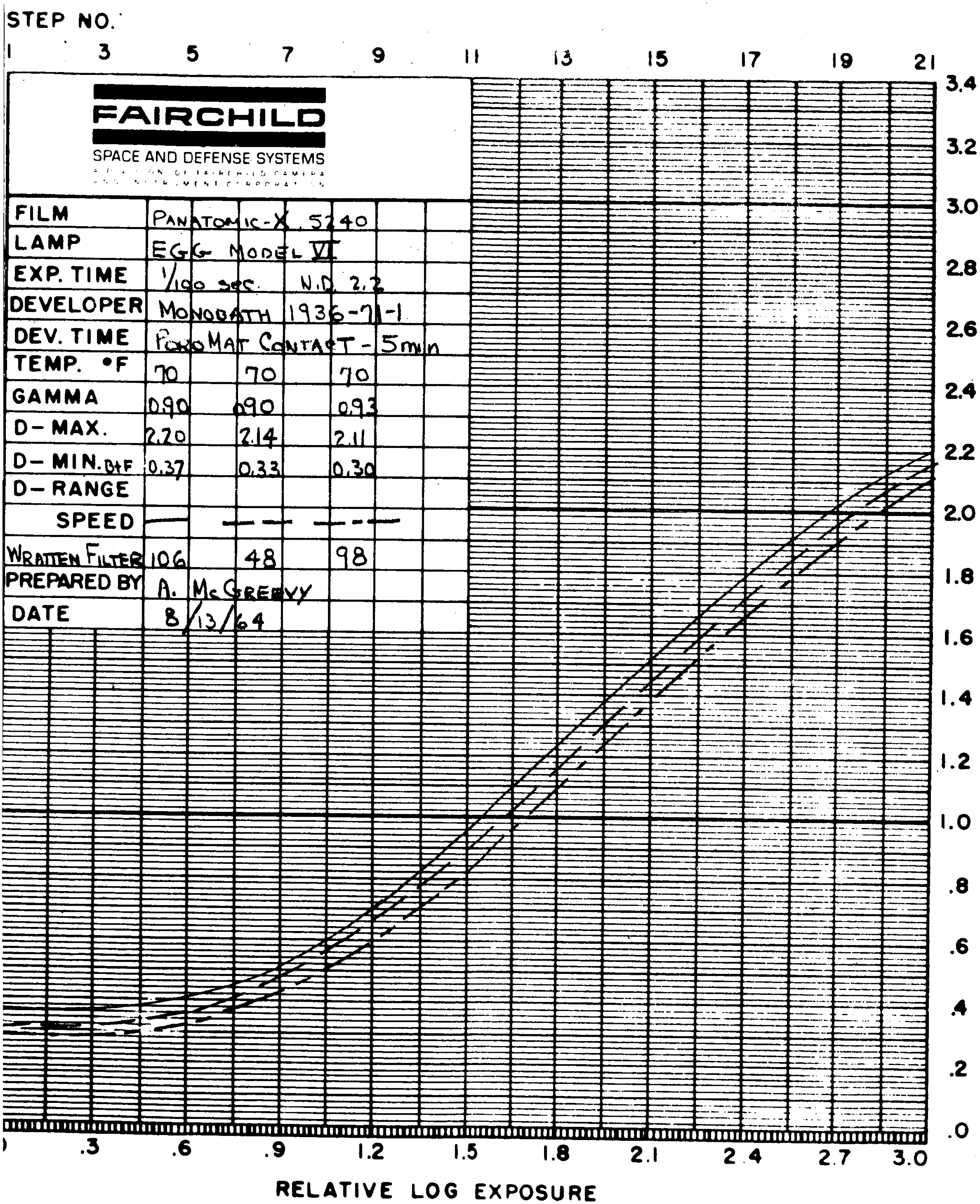
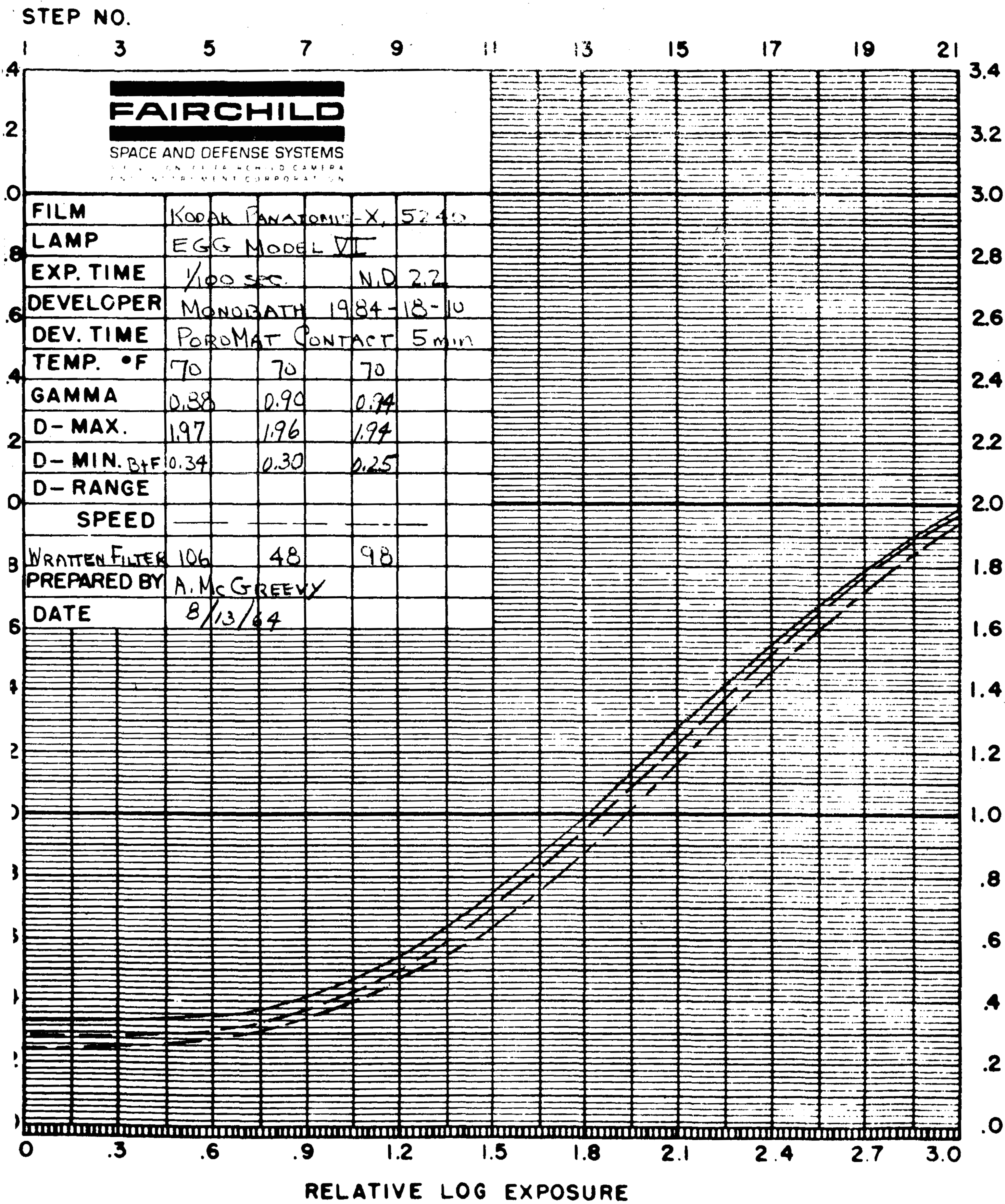

WRATTEN FILTERS
LEGEND
106
98
48
47
.1%
1%
10%
100%
200
300
400
500
600
700
WAVELENGTH mμ
TRANSMITTANCE

FIG. V



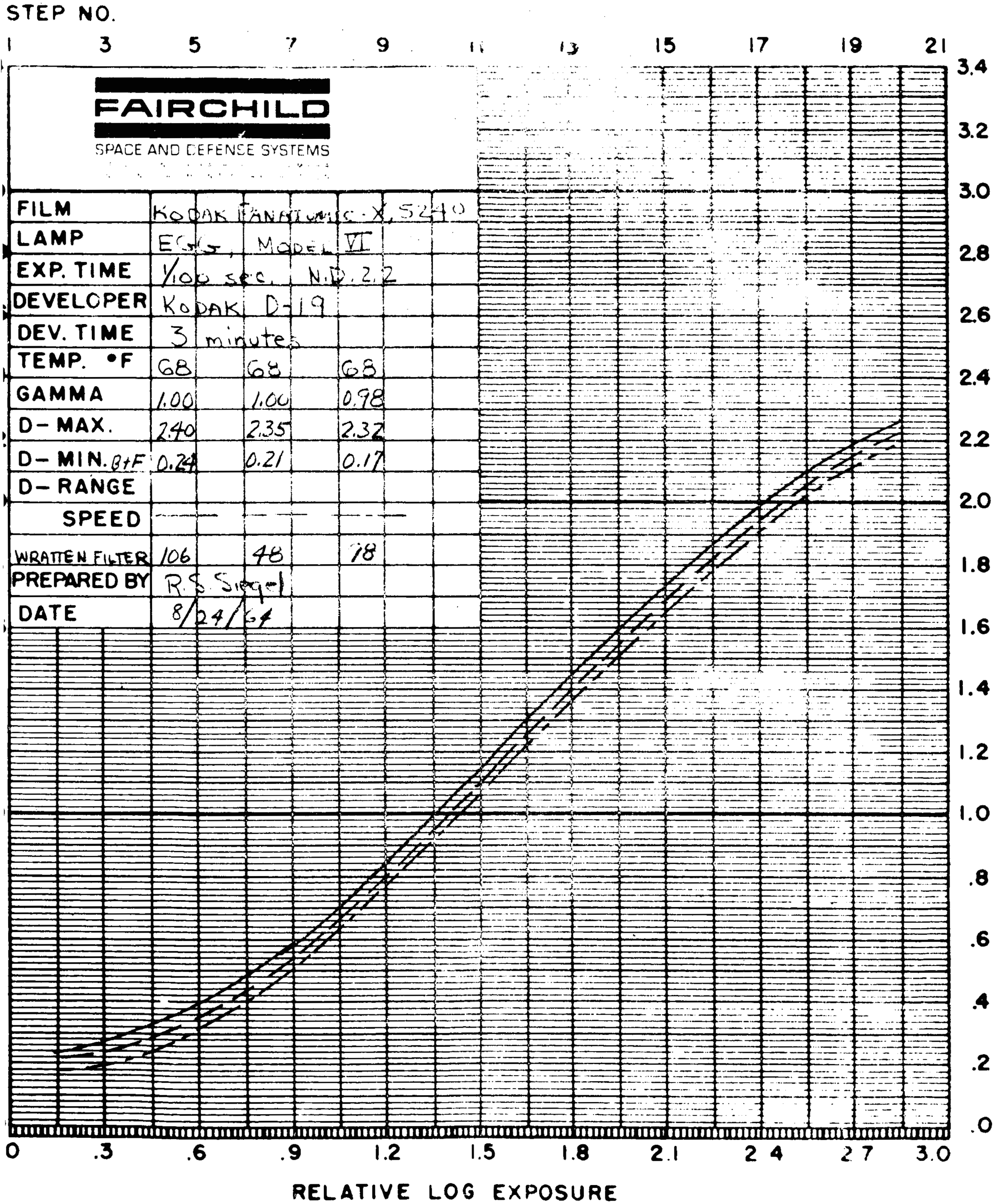
SENSITOMETRIC TEST CHART

FIG VI



SENSITOMETRIC TEST CHART

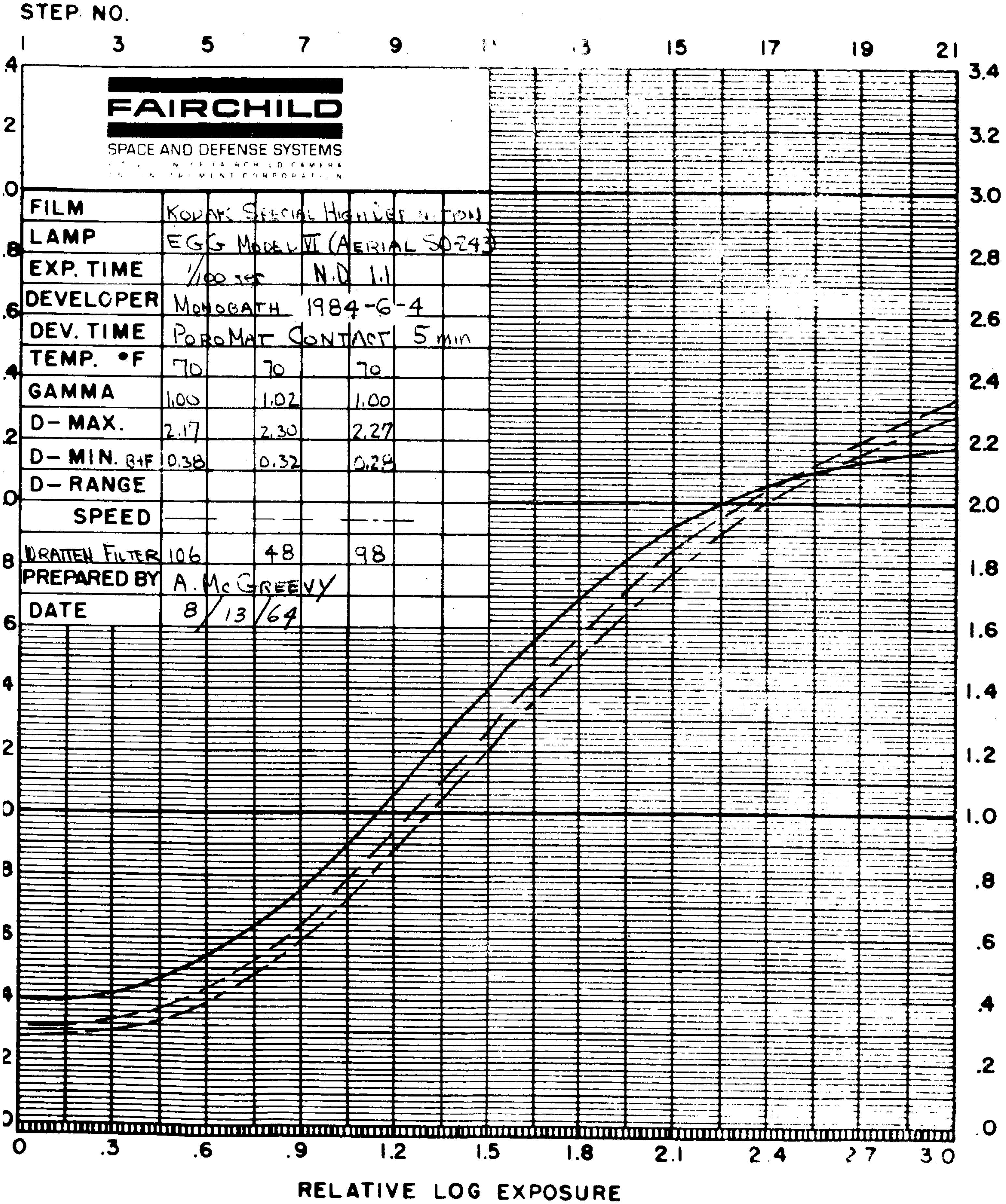
FIG VII



FILM	Kodak Panatomic-X, 5240		
LAMP	EG&G, Model VI		
EXP. TIME	1/100 sec. N.D. 2.2		
DEVELOPER	Kodak D-19		
DEV. TIME	3 minutes		
TEMP. °F	68	68	68
GAMMA	1.00	1.00	0.98
D-MAX.	2.40	2.35	2.32
D-MIN. B+F	0.24	0.21	0.17
D-RANGE			
SPEED	—	—	—
WRATTEN FILTER	106	48	78
PREPARED BY	R.S. Siegel		
DATE	8/24/64		

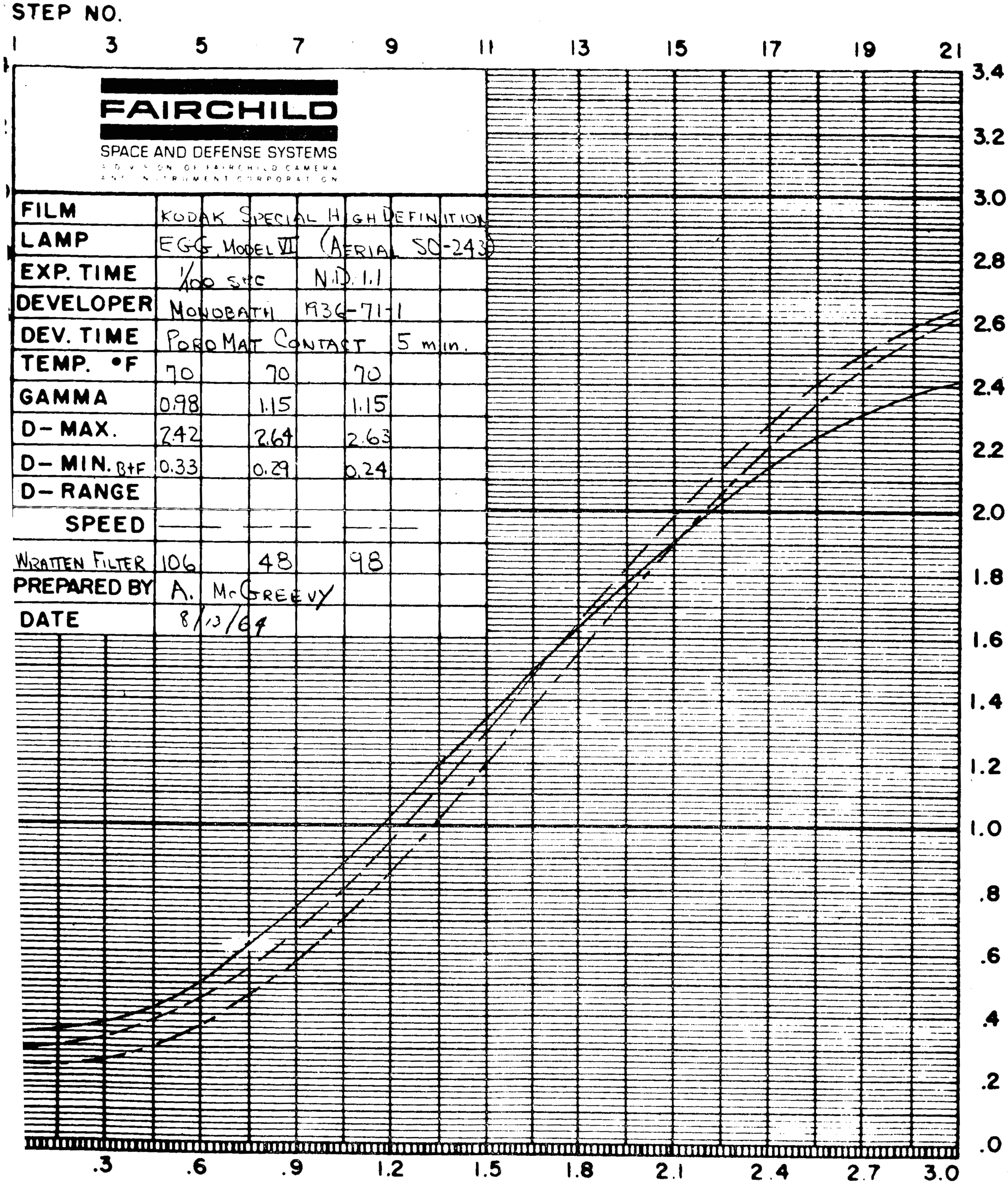
SENSITOMETRIC TEST CHART

FIG VIII



SENSITOMETRIC TEST CHART

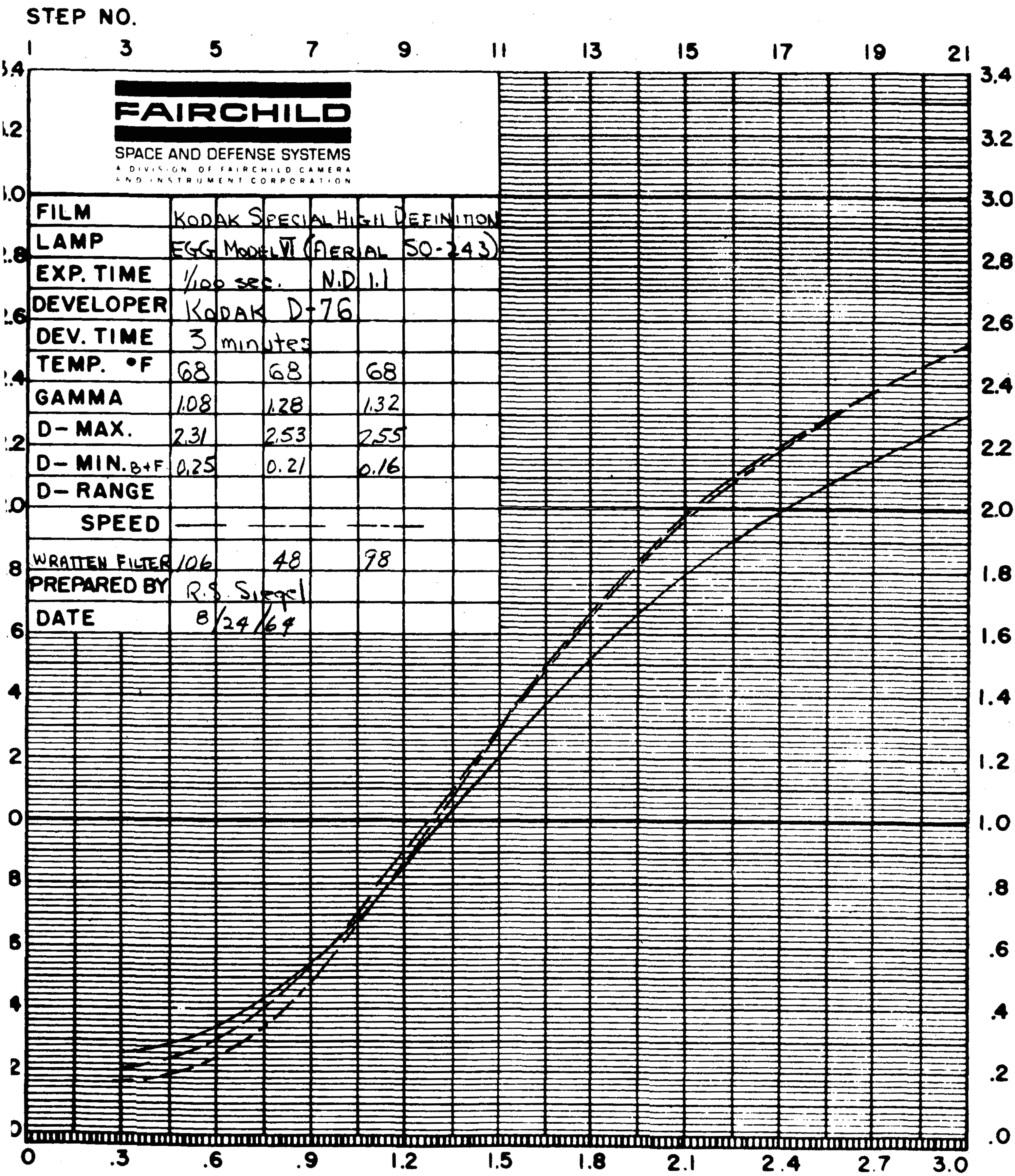
FIG IX



FILM	KODAK SPECIAL HIGH DEFINITION		
LAMP	EGG MODEL VII (AERIAL SO-243)		
EXP. TIME	1/100 sec N.D. 1.1		
DEVELOPER	MONOBATH 1936-71-1		
DEV. TIME	POROMAT CONTACT 5 min.		
TEMP. °F	70	70	70
GAMMA	0.98	1.15	1.15
D-MAX.	2.42	2.64	2.63
D-MIN. B+F	0.33	0.29	0.24
D-RANGE			
SPEED	——	— —	— - —
WRATTEN FILTER	106	48	98
PREPARED BY	A. McGREEVY		
DATE	8/13/64		

SENSITOMETRIC TEST CHART

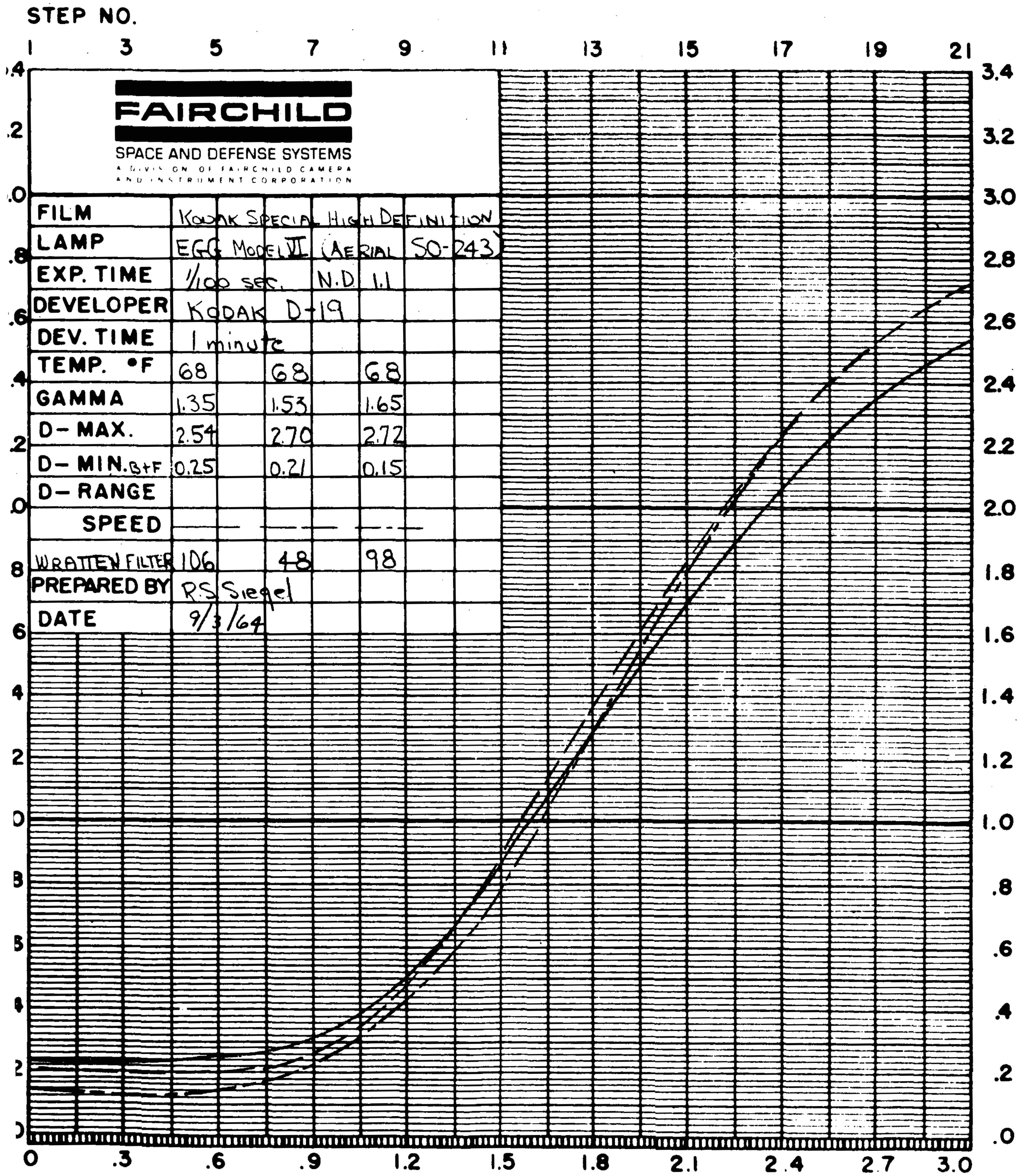
FIG X



FILM	Kodak Special High Definition		
LAMP	EGG Model VI (Aerial SO-243)		
EXP. TIME	1/100 sec.	N.D 1.1	
DEVELOPER	Kodak D-76		
DEV. TIME	3 minutes		
TEMP. °F	68	68	68
GAMMA	1.08	1.28	1.32
D-MAX.	2.31	2.53	2.55
D-MIN. B+F	0.25	0.21	0.16
D-RANGE			
SPEED	—	—	—
WRATTEN FILTER	106	48	98
PREPARED BY	R.S. Siegel		
DATE	8/24/64		

SENSITOMETRIC TEST CHART

FIG. XI



SENSITOMETRIC TEST CHART

FIG. XII

Camera-Processor

The problems posed by the design of the Camera-Processor resolve themselves into two groups. They are:

a. Camera problems
b. Processor problems

These problems will be considered separate in the following paragraphs.

Camera

The requirement for non-cini, variable rate, (both regular and irregular) dictates a pulse type camera. The Giannini Model 207 was selected as the basic camera. This particular unit is of a proven, reliable design, having been used in the photographic instrumentation field for a number of years. The normal 35mm frame is 18mm by 24mm and relates to four perforations per frame. A sixteen tooth sprocket is generally used in series with a one revolution device and a 4:1 reduction gear train. The frame requirements of the specification is 70mm x 25mm with an associated data block occupying a 5mm by 25mm area. The film to be advanced for each frame is therefore 76mm, or sixteen perforations. A one revolution device connected directly to the film advance sprocket satisfies the film metering. The gear plate of the Model 207 was completely redesigned to facilitate the direct coupling of the one revolution clutch and the film metering sprocket. The motor, which normally is transporting 18mm of film per pulse, must now transport 76mm in the same time period. The maximum pulse rate of the camera was reduced to one every five seconds. A larger motor would have exceeded the allowable power.

The extra long format precluded the use of a standard rotary shutter. A new shutter was designed which is of the constant velocity, variable opening type. The angular opening is variable from 90° to 0.9°; which at a rate of 2 revolutions per second provides exposure times of from 125 mille seconds to 1.25 mille seconds.

Processor

The processor configuration is determined by the processing path length and the power available. The processing path length is a function of the monobath completion time and the rate of film transport. The maximum rate of film transport is determined by the specification requirement for having the processed film available for scanning within an hour after exposure. The maximum exposed length of film, twelve feet plus the distance from the film gate to the scanning gate (approximately three feet), is a total of fifteen feet. Fifteen feet per hour is equal to three inches per minute. A monobath completion time of five minutes was considered as a design goal. The product of the film transport rate (3"/min.) and the processing time (5 min.) determines the processing path length of 15 inches.

The power available for operation of the unit precludes simultaneous exposure and processing. Since the camera and processor cannot be operated at the same time, a slack-box must be introduced between the exposure station and the processing station. The volume of the slack-box is such that it will accomodate fifteen feet.

The elevator rollers evident in the final design, evolved from the necessity for separating the web and film during periods of no processing to protect the web from adhering to the film. The electrio-mechanical clutches and cranks were used to obviate the necessity of reverse switching, and constant power demand.

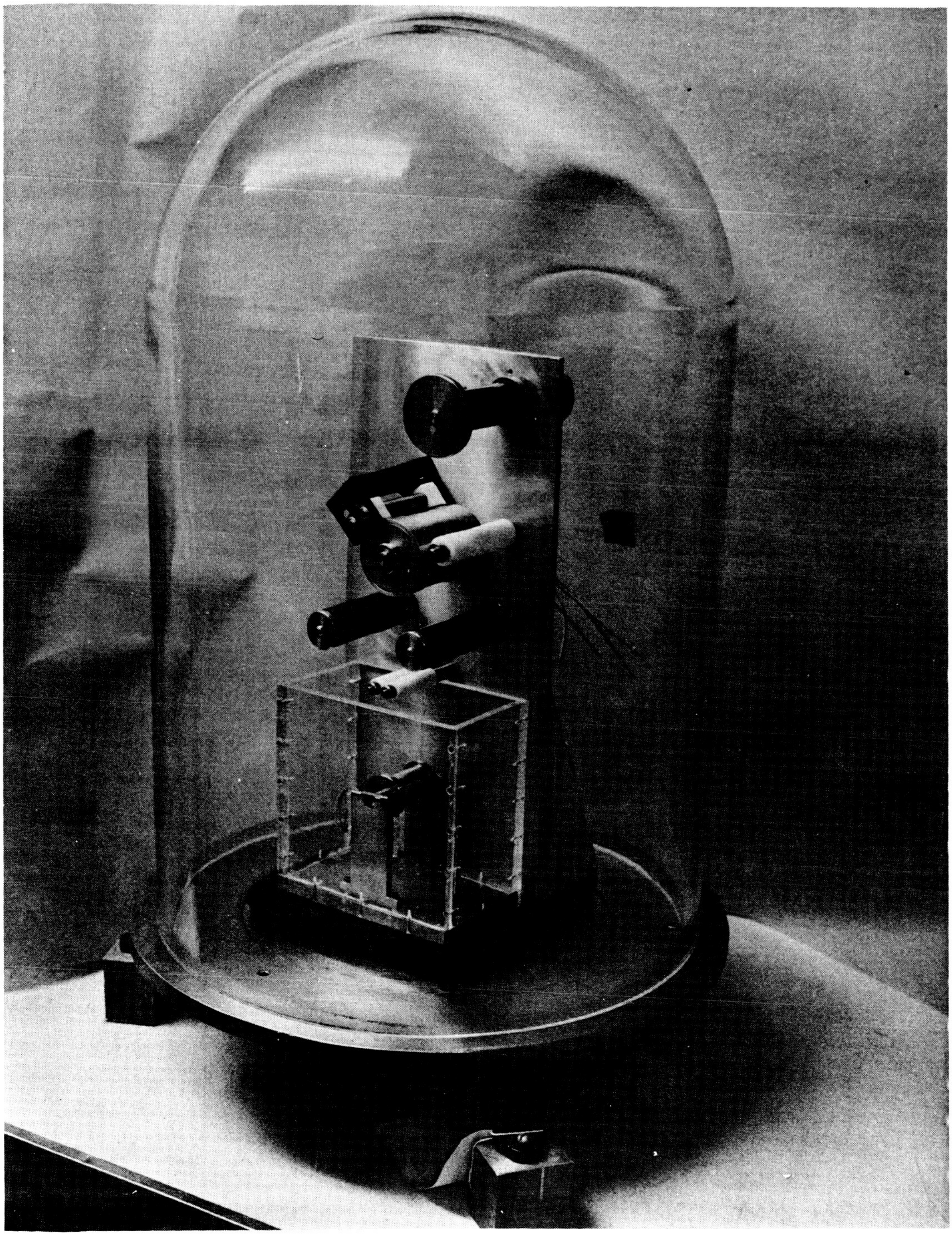


FIGURE 7-1. WEB SEALER

SECTION 8

OPERATION AND MAINTENANCE

PART 1

INTRODUCTION AND DESCRIPTION

1.1 Introduction

1.2 This section provides instructions for the installation, operation and maintenance of the Camera and Film Processor, hereafter referred to as the C. F. P. and shown in Figure 1-1.

1.3 The C. F. P. is manufactured by Fairchild Space and Defense Systems, a division of Fairchild Camera and Instrument Corporation, Syosset, New York.

1.4 Purpose of the Equipment

1.5 The C. F. P. automatically exposes varying lengths of 35mm film at various rates, and automatically processes and dries the exposed film.

1.6 Physical Description

1.7 C. F. P. is a single cabinet enclosing the processor, a camera attached to the left end of the cabinet, and a control panel attached to the top of the cabinet.

1.8 Two aluminum doors, fitted with two (2) flush mounted push button latches, each opening 180 degrees, provide access to the front compartment of the processor cabinet.

1.9 A single aluminum panel fitted with a threaded knob, and completely removable, provides access to the rear compartment of the processor cabinet.

1.10 The front compartment contains the slack box, the web processor and the film dryer.

1.11 The rear compartment contains the drive motor, dryer blower motor, dryer dessicant container and power transmitting components.

1.12 A completely removable aluminum plate with a knurled captive screw, provides access to the inside of the camera for threading.

1.13 A completely removable, threaded aluminum plate with two small knobs, provide access to the camera magazine for film loading.

1.14 A single aluminum plate, completely removable, secured with six (6) screws, provides access to the top of the control box.

1.15 Leading Particulars

1.16 The leading particulars of the C. F. P. are listed in Figure 1-2.

1.17 Functional Description

1.18 The C. F. P. consists basically of a camera, a processor and the requisite controls.

1.19 The camera portion of the C. F. P. is composed of the following:

a. Film supply magazine
b. Film transport mechanism
c. Shutter assembly
d. Motor and associated power transmitting components
e. Lens
f. Buckle trip switch

1.20 The processor portion of the C. F. P. is composed of the following:

a. Slack box
b. Metering sprocket
c. Laminating rollers
d. Elevator mechanisms
e. PoroMat web supply
f. Film dryer
g. Film take-up
h. PoroMat web take-up
i. Plastic sheath take-up
j. Slitting knives

1.21 The control box consists of the following:

a. Mode selector switch
b. Indicator lamps
c. Exposure mode selector
d. Power switch
e. Programming counters
f. Intervalometer
g. Manual shutter trip
h. Manual film advance button
i. Power supply
j. Associated relays

1.22 The film is transported from the film supply magazine to the aperture plate in an intermittent fashion. A one revolution clutch, activated by a short pulse from the intervalometer, engages the metering sprockets. One revolution of the metering sprockets advances a 75mm length of film through the camera.

1.23 A Schneider f2.8, 6" lens gathers the light and brings it to focus at the focal plane of the camera. The lens may be manually adjusted to focus on objects from 8 feet to infinity. Critical focus is attained through the use of boresight tool number 217. A manually adjustable iris is incorporated into the lens barrel which provides a range of exposure control of from f2.8 to f-22.

1.24 A rotating focal plane shutter controls the exposure by varying the period of incident light on the film. The shutter is of the constant speed, variable opening type. A one revolution clutch, activated by a short pulse from the control box, engages the shutter shaft with the motor. At the conclusion of one revolution the clutch disengages and the shutter is snubbed. The shutter opening may be manually adjusted from 90° to 1°, providing an effective shutter speed of from 1/10 to 1/1000 of a second. An electrical interlock prevents a pulse from reaching the shutter clutch while the film is being transported.

1.25 The aperture plate defines a format 25mm x 70mm, leaving a data area 25mm x 5mm.

1.26 The data lamp assembly consists of two reference lamps located on the center lines of the perforation and between the perforations and two (2) lines of five (5) lamps centrally located, within the 5mm x 25mm area. The leads to the data lamps are available through connector P CO2A-14-15P.

1.27 An end of film switch is actuated by the buckle trip. In the event of film failure or as the end of film is reached, the switch is actuated and power to the motor is interrupted.

1.28 The camera motor is a 28V DC gearhead motor which supplies power to the film transport and shutter assembly.

1.29 The slack box feed sprocket is chain driven from an extended shaft of the metering sprocket in the camera. The feed sprocket serves to push film into the slack box.

1.30 The slack box assembly, located inside the front compartment of the processor cabinet, provides an intermediate store for the exposed film until the camera portion of the program has been completed. The slack box assembly consists of the slack box feed sprocket (camera driven), a "slack-box-empty-sensor", a processor metering sprocket and the slack box.

1.31 The "slack-box-empty-sensor" is actuated when the metering sprocket has withdrawn all film from the slack box. The "slack-box-empty-sensor" activates a microswitch interrupting power to the processor drive motor.

1.32 The processor metering sprocket, driven by the processor drive motor, serves to withdraw film from the slack box and meter film into the processor. A cam on the processor metering sprocket shaft activates a microswitch which pulses the processor counter. The processor counter signals the elevator mechanism of the laminating rollers to descent.

1.33 The laminating roller assembly serves to bring the PoroMat processing web and the exposed film into intimate contact, excluding all air. The assembly consists of a stationary rubber covered roller, and a movable roller mounted to an elevator mechanism.

1.34 The elevator mechanism serves to move the lower roller of the laminating roller assembly up into contact with the stationary laminating roller, and to move the lower roller of the laminating assembly away from the stationary roller to separate the PoroMat processing web from the processed film at the conclusion of the processing cycle. The PoroMat and the film are separated after processing to prevent adhesion of the web in contact with the film, should drying occur.

1.35 The PoroMat support assembly provides support for the spool of PoroMat. The shaft of the assembly is attached to the rear wall of the front compartment through a mechanical brake, which applies the appropriate amount of drag to the shaft to maintain the proper tension in the PoroMat.

1.36 The slitting knife assembly serves to slit the plastic sheath on either side of the PoroMat web to allow the web to be exposed for processing. The slitting knife assembly consists of a stationary block supporting the two "razor-blade" type knives, and a rotating roller relieved in two places to match the knives.

1.37 The plastic take-up assembly serves to wind up the two edges, and one side of the plastic sheath enclosing the PoroMat. The take-up shaft is driven by the processor motor through a mechanical slip clutch which maintains the proper tension in the plastic.

1.38 The movable guide roller assembly serves to maintain the processing path during the processing portion of the program, and to effect separation of the processed film and PoroMat web at the conclusion of the processing cycle.

1.39 The elevator mechanism serves to move the movable guide roller assembly when required. The operation of this elevator assembly is identical to that of the laminating roller elevator mechanism described in 1.32.

1.40 The web dryer assembly serves to evaporate the unused liquid from the spent PoroMat web prior to take-up. The assembly consists of two small flat cans, slotted on one side and connected to either side of the dryer blower. In addition, two guide rollers define the web path between the two cans. Air from the dessicant reservoir is directed through the slots in one can against the active side of the web. Air is drawn through the slots of the other can and returned to the dryer reservoir.

1.41 The web take-up assembly serves to wind up the spent PoroMat web and its accompanying plastic strip. The take-up shaft is driven by the processor motor through a mechanical slip-clutch which maintains the proper tension in the web.

1.42 The film dryer serves to evaporate the processing solution from the film emulsion. The assembly consists of two (2) flat "L" shaped cans slotted in one face. In addition, two (2) guide rollers serve to define the film path through the dryer. An "L" shaped cover slips over the two (2) dryer cans to partially contain the moist air. Air from the dessicant reservoir is forced by the blower through the slots of one can against the emulsion side of the film. The air is drawn through the slots of the other can and returned to the dessicant reservoir.

1.43 The film take-up assembly serves to wind up the processed film. The film is wound up on a standard daylight loading 100' - 35mm spool. The take-up shaft is driven by the processor motor through a mechanical slip-clutch which maintains the proper tension in the film.

1.44 The dessicant reservoir and blower, located in the rear compartment of the processor cabinet serve to absorb the moisture from the air and to circulate the dry air through the dryer.

1.45 The control box located on top of the processor cabinet houses the various control components and provides a programming capability through digital pulse generators and counters.

PART II

THEORY OF OPERATIONS

2.1 Introduction

2.2 This part of the section describes the various modes of operation available and the theory of operation of the various components in each of the modes.

2.3 There are five (5) modes of operation available to the operator, they are:

a. Manual Camera
b. Automatic Camera
c. Automatic Camera-Processor
d. Processor
e. Scanner

2.4 The Manual Camera mode of operation provides for irregular cycling rates or cycling rates slower than one per minute as limited by the automatic intervalometer.

2.5 Operation in the manual camera mode requires the following:

a. Power switch S-1 in "on" position
b. Mode selector switch S-3 in the Manual Camera position
c. Footage counter indicating film in camera
d. Camera counter set to desired number of frames
e. Shutter mode selector in manual or automatic position

1. If in automatic, set shutter opening
2. If in manual, manual shutter switch must be pressed once to open shutter (shutter opens, lamp lights) and once to close (shutter closes and lamp extinguishes)

f. Set focus lens opening to desired aperture
g. Press start cycle S-2.

2.6 The start cycle switch S-2 activates relay K1 which applies power to the Manual Camera indicator DS2 and the camera motor.

2.7 Activating Manual Film Transport switch S-5 allows C10-R10 to discharge through the coil of K5. Closure of K5 allows C1-R1 to discharge through clutch coil in the camera, engaging the motor with the film transport sprocket for one revolution. If the shutter mode selector switch S-7 is in the automatic position, power will be applied to the shutter clutch coil allowing the shutter to make one revolution. If the shutter clutch mode selector is in the manual position the manual shutter switch must be depressed once to open and once to close.

2.8 Camera Counter CS2 is pulsed by a closure in the camera each time the film transport switch is activated. When the counter has accumulated enough pulses to equal the frames desired, contacts within the counter transfers allowing C9-R9 to discharge through the coil of K7. Power is applied through the normally open contact of K7 directly to the film transport clutch coil in the camera. This allows the film transport mechanism to continuously transport film until C9-R9 is fully discharged. This length of unexposed film is necessary to assure that the last exposed frame will pass completely through the processor. When C9-R9 is completely discharged, K-7 returns to an inactive state and C8-R8 is allowed to discharge through the release coil of latching relay K1. The transfer of K1 removes power from the camera motor and mode indicator lamp DS2.

2.9 The Automatic Camera Mode of operation provides completely automatic, unattended operation of the camera.

2.10 Operation in the Automatic Camera Mode requires the following:

a. Power switch S-1 in the "on" position.
b. Mode selector switch S-3 in the automatic camera position.
c. Footage counter CSl indicates film in the camera.
d. Camera counter CS2 set to desired number of frames.
e. Shutter Mode Selector switch S-6 set to Auto.
f. Set shutter opening to desired angle.
g. Set lens opening to desired aperture.
h. Focus lens.
i. Set Intervalometer to exposure interval desired.
j. Prèss start cycle switch S-2.

2.11 The Start Cycle switch S-2 activates latching relay K2, which applied power to the Automatic Camera indicator lamp DS5, to the camera motor, and to the intervalometer.

2.12 The pulse generated by the intervalometer activates the clutch coil in the camera engaging the motor with the film transport sprocket for one revaluation. The intervalometer simultaneously activates K5 allowing Cl-Rl to charge up. When the intervalometer pulse terminate K5 transfers, allowing Cl-Rl to discharge through pin E to the shutter clutch release coil.

2.13 A closure on the film transport shaft in the camera pulses the Camera Counter CS2. When the counter has accumulated enough pulses to equal the frames desired, contacts within the counter transfer allowing C9-R9 to discharge through the coil of K-7. Power is applied through the normally open contacts of K-7 directly to the film transport clutch coil in the camera. This allows the film transport mechanism to continuously transport film until C9-R9 is fully discharged. This length of unexposed film is necessary to assure that the last exposed frame will pass completely through the processor. When C9-R9 is completely discharged, K-7 returns to an inactive state and C8-R8 is allowed to discharge through the release coil of latching relay K-2. The transfer of K-2 removes power from the intervalometer, the camera motor and the Automatic Camera mode indicator lamp DS5.

2.14 The Automatic Camera-Processor Mode provides completely automatic, unattended operation of film exposure and film processing.

2.15 Operation in the Automatic Camera-Processor Mode requires the following:

a. Power switch S1 in the "on" position.
b. Mode selector switch S3 in the Automatic Camera-Processor position.
c. Footage counter indicates film in the camera.
d. PoroMat supply in the processor.
e. Dessicant supply in the dryer.
f. Camera counter set to desired frames.
g. Processor counter set to same frames as Camera counter.
h. Shutter mode selector set to automatic position.
i. Set shutter opening to desired angle.
j. Set lens opening to desired aperture.
k. Focus lens.
l. Set intervalometer to exposure interval desired.
m. Press start cycle switch S2.

2.16 The Start Cycle switch S2 activates latching relay K2 2hich applies power to the Automatic Camera indicator lamp DS5, camera motor, and the intervalometer.

2.17 The pulse generated by the intervalometer activates the film transport clutch coil in the camera, engaging the motor with the film transport sprocket for one revolution. The intervalometer simultaneously activates K5 allowing C1-R1 to charge up. When the intervalometer pulse terminates, K5 transfers, allowing C1-R1 to discharge through pin E to the shutter clutch release coil.

2.18 A closure on the film transport shaft in the camera pulses the Camera Counter CS2. When the counter has accumulated enough pulses to equal the frames desired, contacts within the counter transfer, allowing C9-R9 to discharge through the coil of K7. Power is applied through the normally open contacts of K7 directly to the film transport clutch coil in the camera. This allows the film transport mechanism to continuously transport film until C9-R9 is fully discharged. This length of unexposed film is necessary to assure that the last exposed frame will pass completely through the processor. When C9-R9 is fully discharged, K7 returns to an inactive state and C8-R8 is allowed to discharge through the release coil of latching relay K2 and relays K3 and K6.

2.19 The transfer of relay K2 removes power from the intervalometer, the camera motor and the Automatic Camera indicating lamp DS5.

2.20 The transfer of relay K3 applies power to the following components.

a. Processor indicator lamp DS3.
b. The common of S11, the common of the Processor Counter, the common of S18, the common of S14, the common of one pole of K9 through a capacitor.
c. The dryer blower B2.
d. The 4PDT switch S15 through the motor control package to the processor drive motor B1.

2.21 The initial pulse through the coil of K9 applies power through the normally open contact of one pole to the clutch coils L1 and L2. The actuation of L1 and L2 engage the processor motor to the elevator assemblies. As the elevators start to raise S12 and S14 transfer. Power is then applied through S11 to S12 to L1. Also, S16 and S18 transfer, applying power through S15 to S16 to L1. L1 continues to drive until elevator number 1 actuates S11 and S13. The transfer of S11 removes power from L1, disengaging the motor from elevator assembly number 1. L2 continues to drive until elevator number 2 actuates S15 and S16, the transfer of S15 removes power from L2, disengaging the motor from elevator number 2.

2.22 The Processor Counter accumulates pulses from S19 on the processor metering sprocket until the total pulses equals the number of frames desired. At this time a set of contacts in the counter transfers applying power through S13 to the coil of relay K10. As K10 transfers, power is applied through S11, through one pole of K10 to L1. Elevator number 1 starts to descent actuating S11 and S13. The transfer of S11 applies power through S12 to L1 and the elevator continues to descent although power is removed from K10 by the actuation of S13. At the bottom position elevator number 1 actuates S12 and S14. The transfer of S12 removes power from L1 and applies power through S17 to L2. Elevator number 2 starts to descent actuating S15 and S17. As S15 transfers power is applied through S15 to S16 to L2 and the elevator continues to descent although S17 has transferred. At the bottom position, elevator number 2 actuates S16 and S18. The transfer of S16 removes power from L2 and the elevator stops.

2.23 The processor motor continues to pull film from the slack box until the Slack Box Switch S4 is actuated, pulsing the release coil of latching relay K3. The transfer of K3 removes power from the Processor Indicator lamp DS3, the processor motor B1 and the blower motor B2.

2.24 The Processor Mode provides the completely automatic, unattended processing, drying and wrapping up of previously exposed film.

2.25 The Processor Mode of Operation requires the following:

a. Power switch S1 in the "on" position.
b. Mode Selector switch in the Processor position.
c. PoroMat supply in the processor.
d. Dessicant supply in the dryer.
e. Processor Counter set to desired number of frames.
f. Press start cycle.

2.26 The Start Cycle switch S2 activates latching relays K3, K6 and applies power to the normally open contact of the Scanner Counter CS4. The transfer of K3 and the ensuing operation is discussed in previous paragraphs 2.20 through 2.23.

2.27 The Scanner Mode of operation provides for the automatic recall of a pre-selected number of frames from the take-up spool and the return of these frames to the take-up at a simulated scanning rate.

2.28 Operation in the Scanner Mode requires the following:

a. Power switch S1 in the "on" position.
b. Mode selector switch in the Scanner position.
c. Scanner counter set to the desired number of frames.
d. Film threaded through the unit, and a sufficient number of frames on the take-up.
e. Press start cycle switch S2.

2.29 The Start cycle switch S2 activates latching relays K4 and K6. The transfer of K4 applies power to the Scanner Mode indicator lamp DS4, and to the normally closed position of the Scanner Counter CS4, charging C4-R4. The transfer of K6 applies power through S15, through the motor control package to the Processor-Scanner Motor B1.

2.30 The Scanner Counter accumulates pulses from the cam operated switch S20 until it reaches the desired number of frames. When the counter totals the desired number, contacts inside the counter transfer allowing C4-R4 to discharge through the release coil of latching relay K6, the release coil of latching relay K4, and the pull in coil of latching relay K3.

2.31 The transfer of K6 reverses the direction of the motor B1, and film is transferred from the slack box to the take-up reel. The transfer of K4 removes power from the Scanner Mode Indicator lamp DS4, and from the Scanner Counter CS4. The transfer of K3 applies power to Processor Indicator lamp DS3.

2.32 The film continues to wind-up on the take-up reel until the slack box switch S4 actuates. The actuation of S4 applies power to the release coil of latched relay K3. The transfer of K3 removes power from the Processor Indicator lamp DS3 and the motor B1.

PART 3

PREPARATION FOR USE

3.1 General

3.2 Operating instructions for the CFP given in this part includes threading the film, threading the PoroMat, and requisite controls for the unit.

3.3 The camera must be securely mounted to the pedestal bracket on the left of the processing cabinet. The camera is located by two small projecting dowels located in the horizontal surface of the pedestal bracket. These dowels fit into matching holes in the bottom of the camera casting. The camera is secured to the bracket by a single 3/8-16 knurled thumb screw. The camera must fit snugly against the mating surface of the processor cabinet to insure against light striking the film as it passes from the camera into the processor.

3.4 The extended shaft on the back plate of the camera casting must be coupled to the input sprocket of the processor with the 1/8" pitch rollerless chain. To achieve the coupling, the brass flywheel and chain sprocket should be removed from the camera shaft, and the chain sprocket should be removed from the shaft in the rear compartment of the processor cabinet. The chain may now be passed through the slot in the side wall of the processor cabinet and around each of the two chain sprockets. The two sprockets may then be slipped over their respective shafts and the set screws tightened. The brass flywheel should then be replaced.

3.5 The interconnecting cable should be attached to the mating plugs in the camera, the control box and the processor cabinet. If the data lamps are to be used the signal must be fed through plug number PCO2A - 14- 15P.

3.6 The supply magazine of the camera is designed to accept 100' of 35 mm film either wound on a Type 10 daylight spool, or a standard core. The magazine may be removed from the camera by pushing down on the "T" bar.

The threaded cover may be removed from the front of the magazine by grasping the two projecting knobs and rotating until the cover can be lifted off. If the daylight loading spool is used, no darkroom is necessary. The film must be threaded through the light trap emulsion side up. To open the light trap pull up on the "T" bar. After threading through the light trap, push down on the "T" bar to close the trap. If the film is supplied on core the above procedure must be performed in the dark. Approximately two (2) feet of film should extend from the magazine to allow for threading of the camera.

3.7 The magazine should be mounted onto the camera by threading the film from the magazine through the back wall of the camera, fitting the magazine to the back wall, and pulling up on the "T" bar.

3.8 A threading diagram is located on the inside of the camera cover. The directions should be followed implicitly. To attach film on sprockets it is necessary to pull up on film guards P/N 207-036 and 207-036-2, and to rotate them away from the sprockets. To thread film between the aperture plate and pressure plate, it is necessary to pull the top rail back to clear the opening. The film tension across the aperture should not be tight, but give slightly when depressed by finger. Close all film guards and push top rail in as far as it will go.

3.9 The buckletrip P/N 207-035 must be lifted off the micro switch when loading the film and also when running the camera with no film.

3.10 The film should now be threaded through the velvet covered rollers just to the right of the processor cabinet wall. From this point the film should pass over the slack box input sprocket, under the keepr, under the slack box empty sensor, under the keeper of the processor metering sprocket, over the metering sprocket. From there the film is threaded under the upper roller of the laminating roller assembly, straight across the upper roller of the dryer, down through the dryer, around the lower roller of the dryer and onto the take-up reel, emulsion in. The Camera cover should be replaced. Replace dryer cover.

3.11 The operation of the unit should now be checked before proceeding.

a. Attach the portable power cable to any 115V 60 cycle AC source.
b. Place the power switch in the "on" position. The power indicator light should be illuminated.
c. Set Footage remaining indicator to amount loaded into magazine.
d. Place mode selector switch to Manual Camera.
e. Place shutter mode selector switch to the manual position.
f. Set the Camera Counter to ten (10).
g. Press the Start Cycle button.

3.12 The Manual Camera indicator lamp will go on and the camera motor will start. Press the film transport button. The camera will transport a single frame into the slack box and the Camera Counter will indicate transport. Transport may be determined by observing the slack box with the processor cabinet doors open.

3.13 Before processing the film transport button again, the shutter must be tripped. In the manual shutter mode the button must be pushed once to open the shutter (notice the shutter indicator illuminates) and once to close the shutter. After tripping the shutter, the film may be advanced to the next frame by again depressing the film transport button.

3.14 Repeat this sequence for five frames then place the shutter selector mode switch in the automatic position. With the shutter selector in this position, the shutter operation is automatic and occurs at the end of each transport cycle.

3.15 Repeat the depressing of the film transport button until the Camera Counter reaches zero, at this time the camera will automatically transport approximately 48 inches of additional film. This amount of film is required to allow the last exposed frame to pass completely through the processor.

3.16 In order to clear the slack box, it is necessary to complete the following operation:

a. Set Mode Selector switch in the Processor position
b. Set Processor counter to ten (10).
c. Press Start cycle button.

3.17 The elevator rollers may be observed rising to the process position through the open doors of the processor cabinet. The film may be observed being transported from the slack box to the take-up reel. The Processor indicator lamp will illuminate. When the Processor Counter reaches zero, the laminating roller elevator (No. 1) lowers first followed by elevator No. 2.

3.18 When the slack box is completely empty the slack-box-empty-sensor will actuate a switch and the processor will stop and the Processor indicator lamp will go out.

3.19 The Camera may now be checked out for operation in the Automatic Mode by completing the following operations:

a. Set the Mode Selector switch to the Automatic Camera position.
b. Set the Camera counter to ten (10).
c. Set the Shutter Mode selector to automatic.
d. Set the Intervalometer to five (5).
e. Press the Start cycle button.

3.20 Upon initiation of the Start cycle the Automatic Camera indicator will illuminate and the camera motor will start. The intervalometer will send a pulse to the camera every 5 seconds calling for film transport. This sequence will continue until the camera counter reaches zero. The camera will automatically transport the requisite extra film and the cycle will be complete. To clear the slack box perform instructions given in paragraph 3-16 through 3-18.

3.21 Operation of the Processor requires the following:

a. Set the Mode Selector switch to Automatic Camera-Processor.
b. Set theCamera counter to ten (10).
c. Set the Processor counter to ten (10).
d. Set the Intervalometer to five (5).
e. Set the Shutter Mode Selector to automatic.
f. Loan PoroMat and Dessicant.

3.22 To load the PoroMat supply into unit, unscrew large knurled knob on PoroMat supply shaft. Slip PoroMat spool over shaft with the PoroMat feeding from the under side of the spool (i.e., pulling the PoroMat causes the spool to turn clockwise.) Replace large knurled knob on shaft.

3.23 Loosen the two (2) slot head screws in knife assembly and raise the knife back from the guide roller. Pull the PoroMat over the first guide roller, lower the knife assembly and secure with the two (2) screws.

3.24 Pulling the PoroMat through the knife assembly opens the PoroMat package. The two (2) edge strips, approximately 1/2" wide and the bottom half of the plastic sheath should be attached to a standard 70 mm core on the plastic take-up shaft. The shaft is driven counter-clockwise.

3.25 The 35 mm strip of PoroMat and its plastic backing should be threaded under the second guide roller, over the first elevator rollers, around the second elevator roller and down through the web dryer to the web take-up spool. This spool is driven counter-clockwise.

3.26 The dessicant reservoir is available in the rear compartment of the processor cabinet. The clear plastic reservoir may be removed by rotating it to the right to disengage it from the blower. The reservoir should be half full with fresh silica gel. Replace the reservoir and the back cover. The unit is ready to operate.

3.27 Press Start cycle button to initiate operation. The Automatic Camera indicator lamp will glow and the camera motor will start. The Intervalometer will generate a Camera operate pulse every five seconds until the Camera Counter reaches zero. The Camera will automatically turn itself off and turn the processor on to process the film collected in the slack box. The Processor indicator lamp will go out when the processor is finished. The doors may then be opened and the film inspected.

3.28 The Scanner Mode may be checked out by performing the following operations:

a. Set Mode Selector switch to the Scanner position.
b. Set the Scanner counter to ten (10).
c. Press start cycle.

3.29 The film may be observed being transported from the take-up spool back into the slack box. When the Scanner counter reaches zero the film drive will reverse and transport film from the slack box to the take-up spool. When the cycle is complete, the scanner indicator lamp will go out.

3.30 To adjust exposure the angle between the two shutter blades is varied. The relationship between shutter opening and exposure time is determined by consulting the nomograph figure 3 - 1. To adjust the angle, lift the semi-circular adjustment upward (i. e., perpendicular to the front plate, and rotate the indicator to the desired angle. See drawing number 247-009, P/N 247.150). As can be seen the connection between the blades is broken due to the cam action of the release arm. Due to the eccentricity of this cam the adjustment arm is secured by the self locking action. The rubber cushion action felt when adjusting the shutter in no way affects the setting. The cushion action is produced by a rubber coupling between the clutch and shutter drive and serves to absorb the high inertia shock of the shutter in starting and stopping.

3.31 A boresight and focusing tool is supplied with the unit. The transport cover must be removed and replaced by the focusing tool. Remove film from camera before installing boresight viewer.

NOTE: Before installing the tool, loosen the two thumb screws which secure the lens assembly to the cover and move the lens assembly back from the left edge. This prevents damage to the frosted glass. After the tool has been secured in place by the single knurled knob at the top, slide the lens assembly forward until it set against the aperture plate and tighten the two screws. Adjust the lens by rotating the lens until critical focus is achieved. Remove focusing tool, first moving lens assembly back and replace transport cover.

3.32 The iris adjustment is accessible on the indicating knurled ring on the lens itself.

3.33 Two interchangeable processor motors are supplied with the CFP: A fixed speed 115V 60 cycle AC motor and a variable speed 28 VDC motor. Each motor is supplied with its respective sprocket and appropriate chain. Electrical connection requires plugging in the motor and placing the 4 PDT switch S-15 to the appropriate position. The variable speed motor control is accessible through a hole (covered by a plug button) in the top of the control box.

3.34 There are two release buttons on the camera body. One release button, located on the top of the camera body, serves to engage the motor with the shutter shaft. Another release button, located on the back of the camera, serves to engage the motor with the film transport shaft.

3.35 When intermixing films of different performation types, it is necessary to adjust the location of the film stop position relative to the data lamps. This operation is performed by adjustment of the film tension arms shown on drawing number 207-005-7. The holddown screws should be loosened. The adjusting screws P/N 207-328 rotated until the desired position is attained, then the holddown screws secured.

3.36 A small lamp and photocell are located on either side of the shutter blade just on top of the aperture plate. The readout on pins "H" and "J" of plug number PCO2A-16-26P will provide an accurate indication of shutter open-shutter close.

PART IV

MAINTENANCE INSTRUCTIONS

4.1 Preventive Maintenance

4.2 Preventive maintenance should be performed each time the CFP is not in use. Such tasks should include checking of fuzes, lamps, visual inspection to detect any foreign material inside of cabinet and camera.

4.3 Film emulsion and dust that accumulates should be removed frequently. A soft camel hair brush is recommended for removing dust, while a lintless cloth dampened with water is best for removing emulsion. Should emulsion clog the data lamp holes, it is necessary to insert a piece of wood, such as a toothpick into the holes. Do not insert the toothpick into the aperture over 1/16 inch for fear of damaging the lamps. The inside of the processor cabinet and slack box should be wiped clean with water damped cloth.

4.4 Periodic Maintenance

4.5 The dessicant reservoir must be refilled after each 100 feet of film has been processed. The silica gel may be restored to active use by baking in an oven a 212°F. for 4 hours.

4.6 In normal use the CFP should be lubricated every six months or every 10,000 feet of film whichever occurs first. The camera bearings and clutch chamois should be lubricated with a high grade instrument lubricant such as Anderol L-401D. Anderol 795 should be used for the gear teeth on the gear block assembly P/N 207-087-3. All oilites should be lubricated with a drop of Anderol L-465. See drawing number 207-005-7 for location of parts.

4.7 To remove the data lamps, it is necessary to remove the lens, lens adaptor, and shutter front plate. When the front plate is removed, the shutters come apart as an assembly with the front plate. The data lamp assembly is secured with two (2) number 0-80 fillister head screws. To pull the lamp assembly away from the aperture plate, it is necessary to loosen the screws retaining the aperture plate. When removing the lamp assembly, take care not to lift the assembly as damage to the lamps may occur. When replacing individual lamps take care that the soldering iron tip not touch the lamp.

4.8 Removal of the motor assembly is effected by removing the three number 8-32 fillister head screws and withdrawing the motor. Quick disconnects are used on the motor leads.

4.9 Access to the shutter is available by removing the front plate assembly and is carried out in the following sequence.

a. Remove lens.
b. Remove lens adaptor.
c. Adjust shutter opening to 90°.
d. Rotate shutter blades until they clear the photocell assembly. If shutter resists rotation, depress shutter release button on the top of camera.
e. Remove the five (5) cover retaining screws.
f. Slowly remove the front plate being careful not to damage the blades.

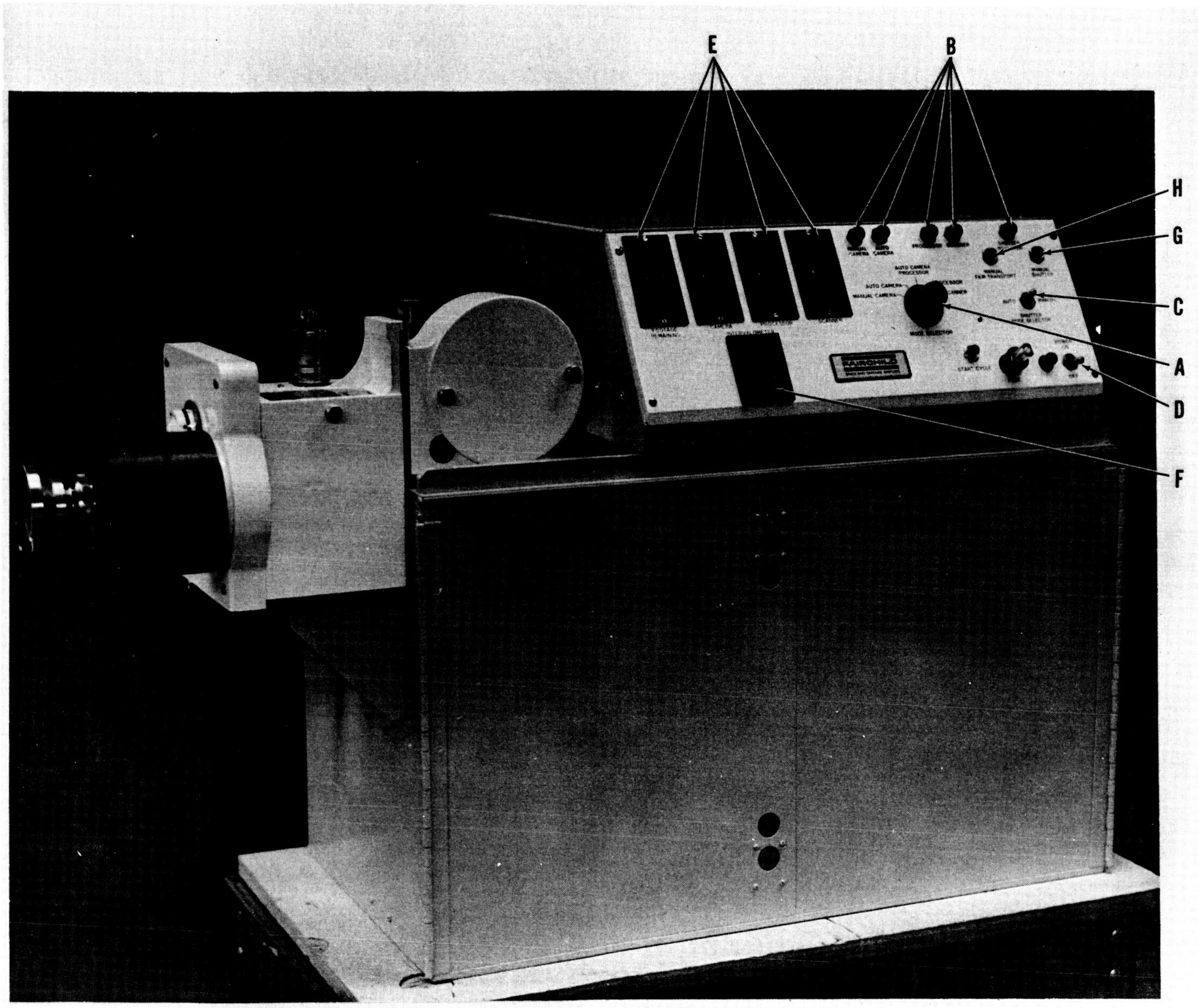
Replacement of the shutter assembly is carried out in reverse sequence. It is recommended that a damage shutter is returned to the factory for repair.

4.10 All chains and sprockets should be lubricated every six months or every 10,000 feet of film with MIL-6-3278 using a fine camel hair brush.

4.11 Check that the processor drive motor and blower motor cups are filled to the required level. If required add MIL-L-6085.

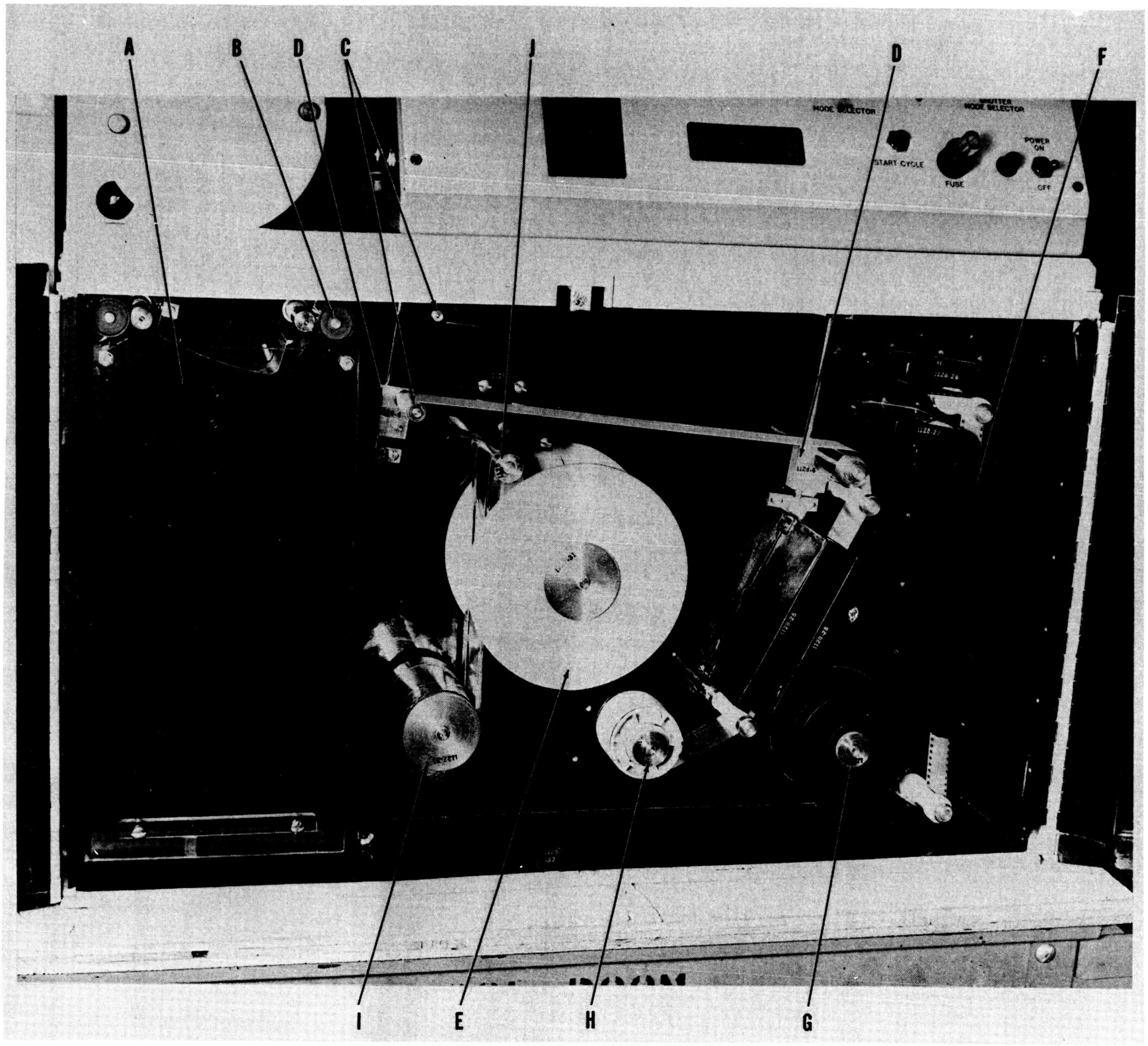
4.12 Lubricate elevator assemblies with MIL-L-6085.

4.13 Caution: DO NOT OVER LUBRICATE AS OILY FILM WILL NOT PROCESS.



A. MODE SELECTOR SWITCH
B. INDICATOR LAMPS
C. EXPOSURE MODE SELECTOR
D. POWER SWITCH
E. PROGRAMMING COUNTERS
F. INTERVALOMETER
G. MANUAL SHUTTER TRIP
H. MANUAL FILM ADVANCE BUTTON
I. POWER SUPPLY
J. ASSOCIATED RELAYS

FIGURE 8-1. CAMERA FILM PROCESSOR



A. SLACK BOX
B. METERING SPROCKET
C. LAMINATING ROLLERS
D. ELEVATOR MECHANISMS
E. POROMAT WEB SUPPLY
F. FILM DRYER
G. FILM TAKE-UP
H. POROMAT WEB TAKE-UP
I. PLASTIC SHEATH TAKE-UP
J. SLITTING KNIVES

FIGURE 8-2. PROCESSOR SECTION FRONT VIEW

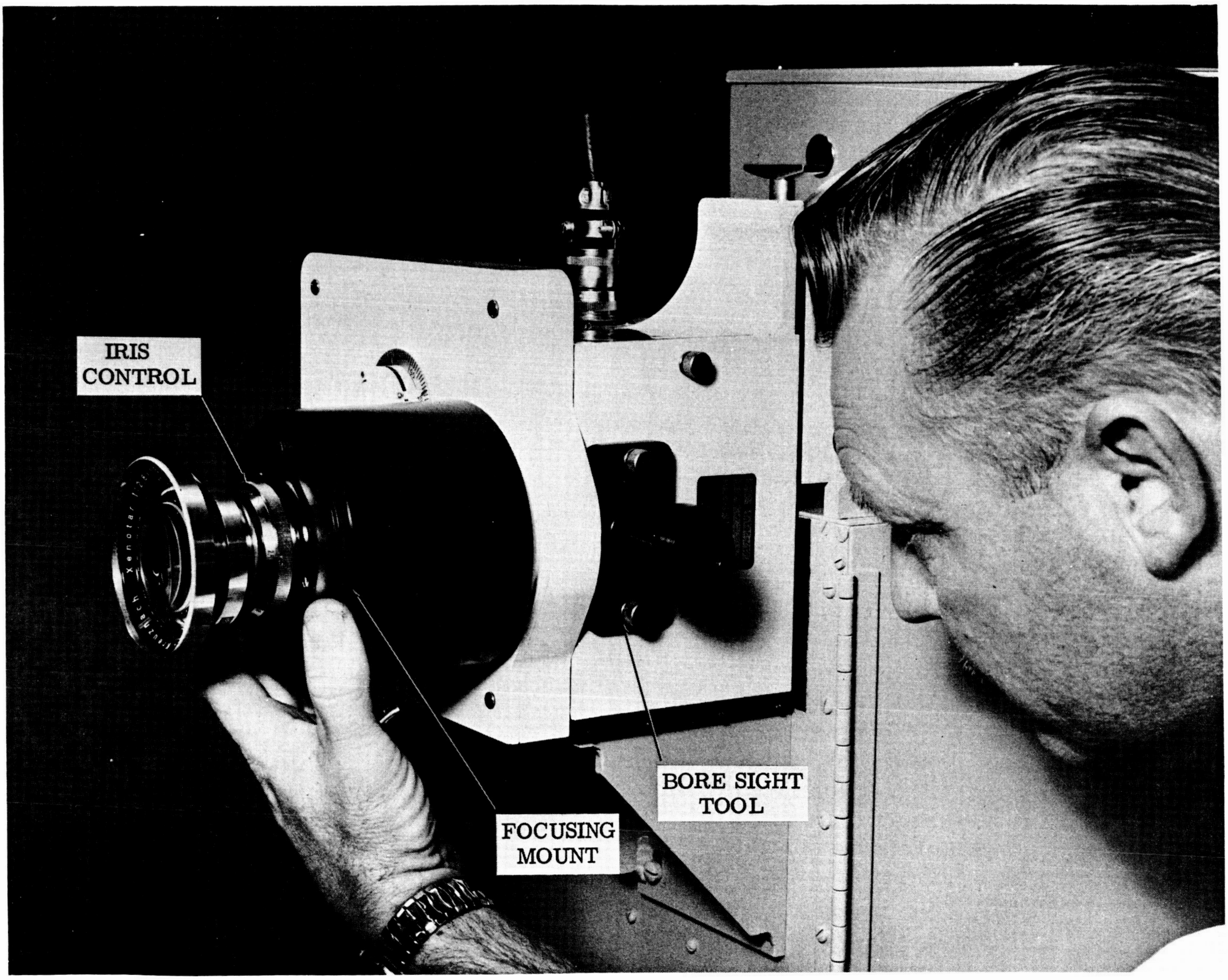


FIGURE 8-3. CAMERA FILM PROCESSOR CAMERA SECTION

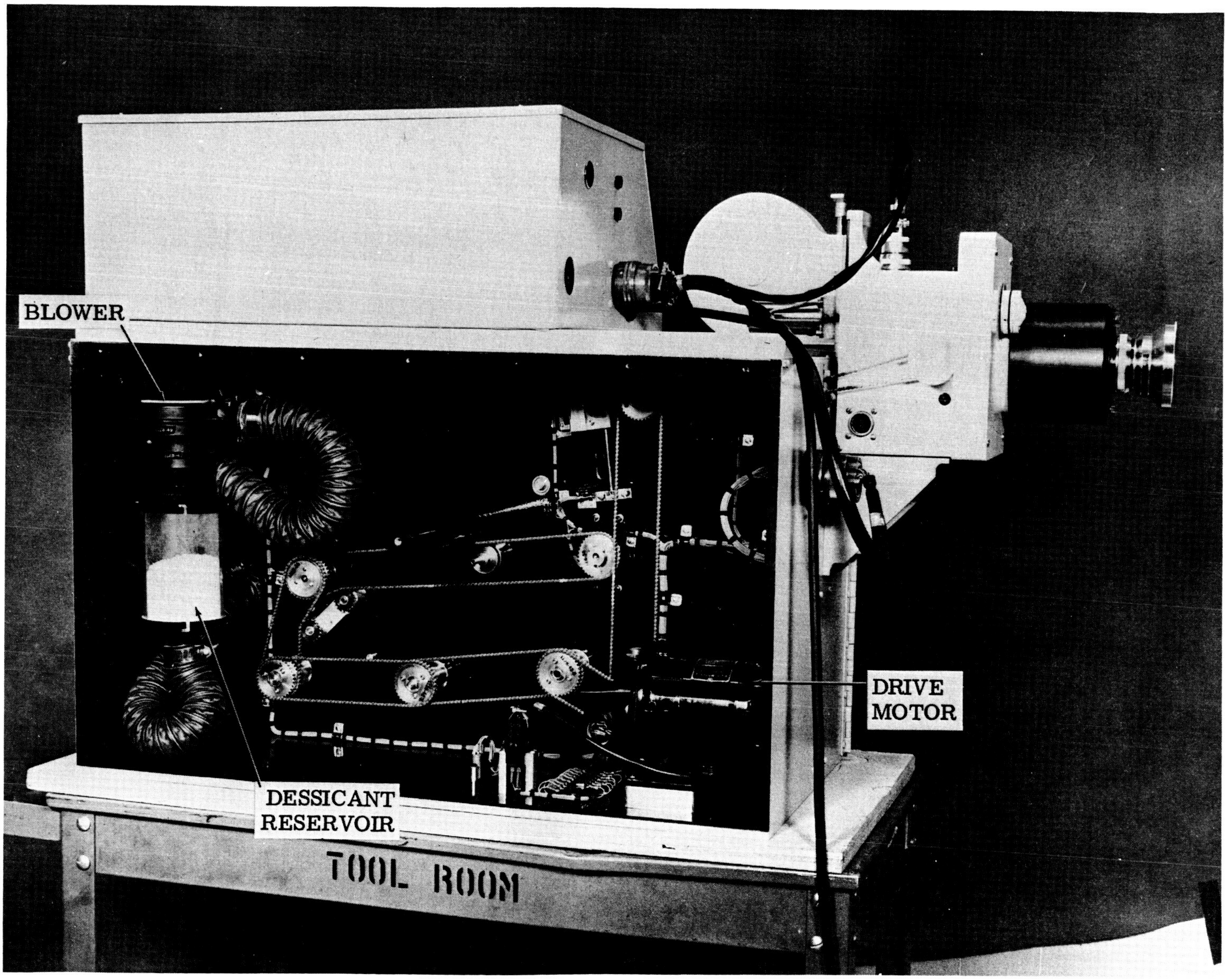


FIGURE 8-4. PROCESSOR SECTION REAR VIEW

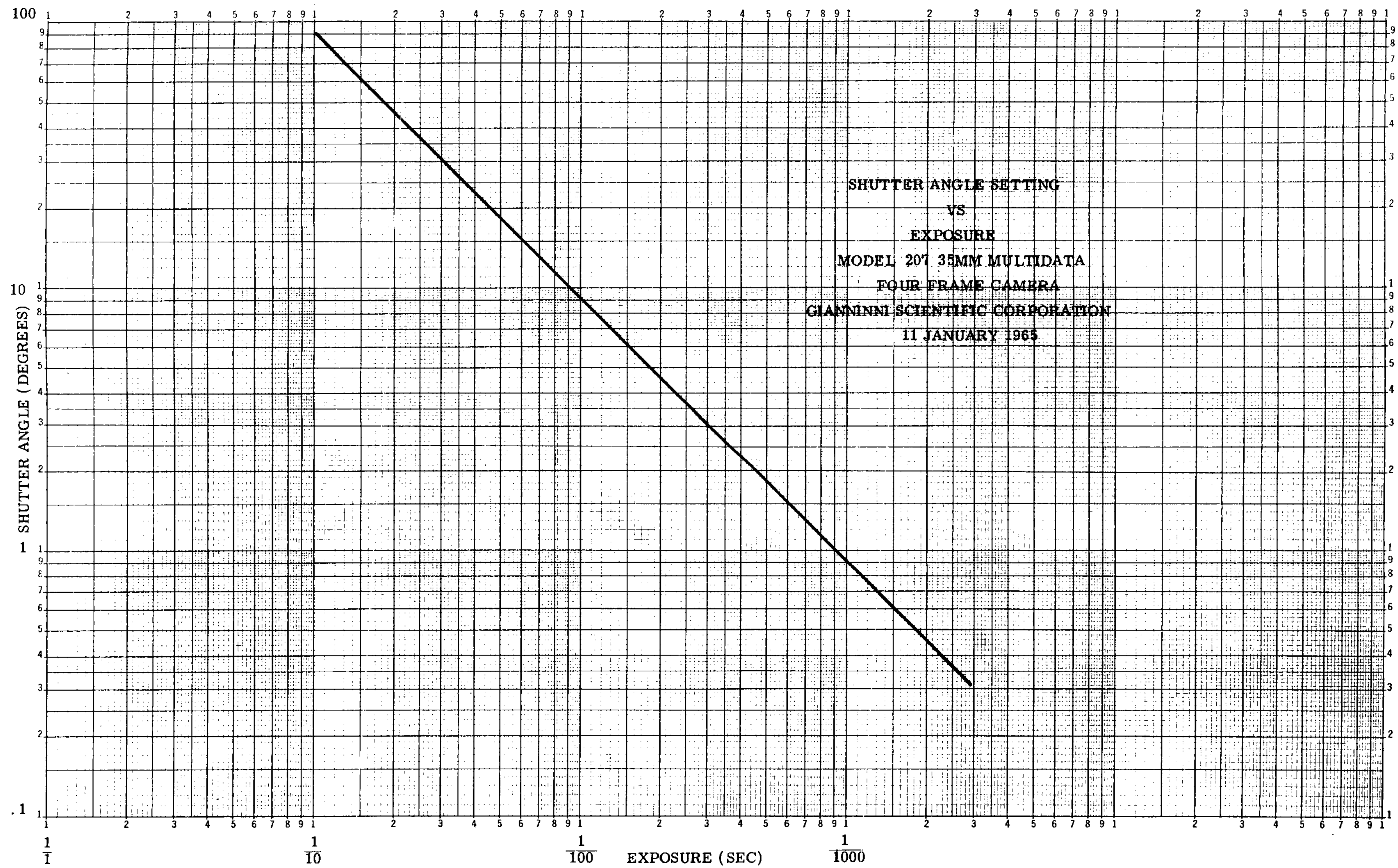

SHUTTER ANGLE SETTING
VS
EXPOSURE
MODEL 207 35MM MULTIDATA
FOUR FRAME CAMERA
GIANNINNI SCIENTIFIC CORPORATION
11 JANUARY 1965
SHUTTER ANGLE (DEGREES)
100
10
1
.1
EXPOSURE (SEC)
1/1
1/10
1/100
1/1000

FIGURE 8-5.

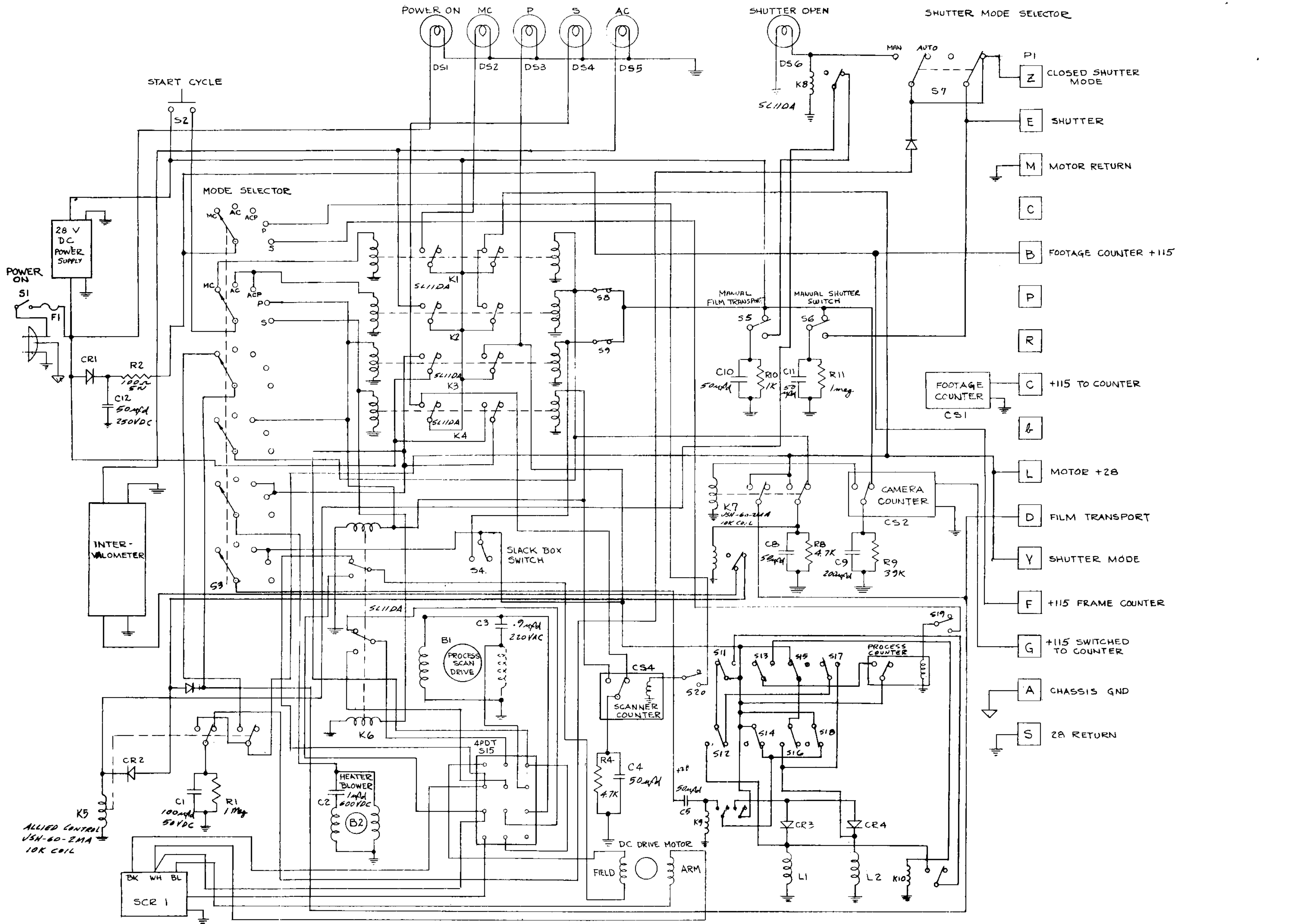


FIGURE 8-6. CAMERA FILM PROCESSOR ELECTRICAL SCHEMATIC