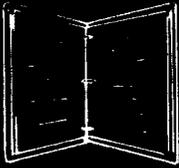


Rec'd 11/6/79

**ENGINEERING  
TECHNICAL  
INFORMATION  
SYSTEM**

**FIELD NOTES • TECHNICAL REPORTS  
DATA RETRIEVAL • MANAGEMENT  
PROFESSIONAL DEVELOPMENT**

**VOLUME 11 NUMBER 9**

**Field  Notes**

**COLOR MICROFILMING OF LARGE  
DOCUMENTS -- A NEW DIMENSION  
TO INFORMATION**

**REGION ONE ACTIVITIES**

**WASHINGTON OFFICE NEWS**



**FOREST SERVICE**

**SEPTEMBER 1979**

**U.S. DEPARTMENT OF AGRICULTURE**





## **ENGINEERING FIELD NOTES**

**Volume 11 Number 9**

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**FOREST SERVICE  
U.S. DEPARTMENT OF AGRICULTURE  
Washington, D.C. 20013**



COLOR MICROFILMING OF LARGE DOCUMENTS

A NEW DIMENSION TO INFORMATION

*Ernest P. Taubes*  
*Consultant*

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The reproduction of large documents, such as engineering drawings, charts, maps, etc., has been considered solved with the acceptance of the aperture card and the development of standard reductions, according to rules promulgated by the Department of Defense (DOD) roughly 18 years ago and spelled out in Mil Spec 9868D.

Color microfilming of such documents, particularly if the color is part of the information content, has been attempted for at least as long as I have been in the microfilm business--38 years.

None of the films available until about seven or eight years ago was good enough; i.e., had a high enough resolving capability to record large documents at the reductions required to microfilm one document per film frame on 35-mm film and make all the legends clearly readable.

About seven years ago, the Environmental Protection Agency (EPA) retained my services as a consultant. They offered an engineering service to local governments (City, County or State) to solve specific irrigation, water supply or other ecological problems. For this purpose they used standard geodetic maps, which the engineers marked up with colored inks and pencils.

To emulate the DOD, which requires aperture cards for all engineering information, they microfilmed the marked-up maps and furnished the microfilm on aperture cards to their "customers."

The colored maps and mark-ups photographed in black-and-white as a series of grays; thus the "customer" could not tell a red from a green line.

Therefore my task was to investigate the feasibility of using color film to record the marked-up maps. I accepted the assignment and

requested from Eastman Kodak, (the only supplier in this country of professional color films) sample quantities of all available color films that could conceivably be used to record standard geodetic maps with reference information as small as 5-point type at a DOD Standard 24X reduction. I planned to run a series of tests with these films.

Kodak furnished Kodachrome, Ektachrome, Kodacolor and Ektacolor materials; but none was good enough for my purposes.

While discussing my results with some of the Kodak research people, one of them mentioned a new special film, developed for aerial reconnaissance, which had a high enough resolution capability to record such maps at 24X satisfactorily and produce fully legible duplicates. This film, an Ektachrome, was only available on special order on 35-mm double perforate with an identifying number of S0356. It was so new that they would not furnish me samples but agreed to record the EPA sample maps and produce duplicates at Kodak Research Laboratories in Rochester, New York.

This film resolved a 5.6 at 24X, which is more than enough to record 5-point type. Subsequently, on special order, Kodak furnished the EPA with 35-mm unperforated film (S0456) both for the camera and for duplicating on a roll contact printer.

In 1971 the National Archives decided to re-investigate the feasibility of recording large maps and charts on microfilm. The National Archives is the depository of all information on the history of the United States. Maps and charts relating to the development of the United States are stored in the Cartographic Department and are available to the public for study and reference.

A number of these maps and charts are "document" maps or charts; i.e., hand-drawn, hand-lettered and painted. An example is the collection prepared on the Lewis and Clark expedition, both unique and priceless.

The material used to make these maps and charts runs the gamut from heavy linen to cheapest wood pulp (there were no standards for material and size) and in a total collection of well over 1,500,000 items, more than 20% are literally disintegrating.

The problem of trying to save these maps and charts was recognized 50 years ago and the idea of reducing them to microfilm was investigated over 30 years ago and quickly abandoned. At that time only 35-mm film was available and neither the film nor the cameras and lenses were good enough to accomplish this in black-and-white.

The idea behind the microfilming of these maps and charts was to accept the film as a second original, provided it contained all the information of the original, and furnish film copies with a suitable

reader to the public for study or reference. The original would be kept in strict archival storage.

Since the microfilm image on 35-mm film in 1947 was not able to record all the information clearly in these maps and charts (some of the legend on the document maps is as small as 1/2 mm) it was decided to laminate some of them at an exorbitant cost. Beyond the high price it was also found that due to the heat and pressure required for laminating, some of the color value, which in a good percentage of these maps and charts is part of the information content, was altered in the process.

Therefore only a very small percentage of these maps and charts was ever laminated.

Since the quality of the microimage has improved tremendously in the past 15 years (a whole "ultra-high reduction" microfilm industry has developed, which reduces document pages as much as 250X) the National Archives decided in 1971 to reinvestigate the feasibility of using a microfilm image instead of the original.

Therefore they first selected a cross-section of all the maps and charts in the file, from good to terrible and from small to extra-large. Fourteen such representative maps and charts were to be recorded on all film sizes that conceivably could record clear images, i.e., 35 mm, 70 mm and 105 mm.

To eliminate all problems due to faulty camera equipment, it was decided to use two sources for each film size.

The microimages were carefully evaluated to determine which film size could produce fully legible copies of all maps and charts, regardless of condition and size of the original.

One-hundred-five-millimeter images at a maximum of 10X reduction, covering 40- x 60-inches in one frame were found to be the only ones with a 100% image quality.

Once this was determined on the 14 test maps and charts, it was decided to run a production test of about 1400 maps and charts, that is a representative collection in the files.

This second test was to be run on a specially designed camera. It was to have an alphanumeric title of about 100 characters in a single line in each frame, legible with the unaided eye. It was to have three "standard" reductions, push button controlled (5.5X, 8X and 10X), with automatic focus and it was to produce two exposures in sequence automatically from each map or map section.

While the camera was being designed and built to meet these specifications, the question of using color film was raised and, since I

was being retained by the National Archives as a consultant on this project, I suggested that the same color film, S0456 Ektachrome, be used as it was for the EPA.

Thus this production test was recorded both in black-and-white and color to determine the feasibility of recording all the deteriorating maps and charts in color, or only that portion that has the color as part of the information content.

The test proved conclusively that some specific color films, cameras and lenses are good enough today to record large documents without loss of information content.

Today Eastman Kodak produces a series of other relatively high resolving color films.

Specifically S0456 is now a standard item; it is:

1. Kodak Photomicrographic Color Film #2483 for recording microscopic slides in color. It has a resolving power of 200 lines/mm. It has a daylight speed of 16 and a tungsten speed of 5. It uses an E4 processing cycle, which requires 13 solutions and about one hour. With 200 lines/mm, it is good enough even at 30X to record the average engineering drawing.

2. The Kodak Pamphlet D5 "Kodak Photo Materials for Micrographics" lists three color films;

- a. KA Color Film 5288/7288. This film is a Kodachrome. The resolving power is 100 lines/mm. It has a daylight speed of 40, the tungsten speed has to be determined on test with the proper filters. It uses a K14 process but cannot be processed "inhouse." Kodak will process the film in Rochester. With 100 lines/mm it is only good enough for a maximum of 16X reduction, i.e., at a full DOD "D" aperture on 35-mm film a maximum of 20 x 28 inches; Mil Spec 9868D limits 16X to a maximum of 17- x 22-inches.
- b. Recordak Color Master 5284. This film is listed as a Kodacolor Camera Master. In fact the emulsion is identical with "Eastman Color Intermediate Negative Film 5271/7271." This film was developed to copy Kodachrome or Ektachrome films at 1:1 by contact or projection. It is very slow emulsion; it can be exposed in a camera provided the area to be recorded is no larger than 8 1/2- x 11-inches and is illuminated with about 1,500 foot-candles. It has a resolution of 250 lines/mm. It is available only in "spec 707," i.e., 35-mm double perforate. The processing cycle is an Eastman Color Print process (modified).

- c. Recordak Color Print Film 6289. This film emulsion is identical with Eastman Color Print Film 5381/7381 and is a Kodacolor Positive. It has a resolution of 500 lines/mm. It is only available on 8 mil base in "spec 914" which is 105 mm.

*COLOR FILMS FOR MICROGRAPHICS*

FILM	FILM NO.	DESCRIPTION	BASE	NOMINAL THICKNESS (IN MILS)	SPEED	PROCESSING	RESOLUTION lines/mm	MAXIMUM REDUCTION
<b>Recordak KA Color</b>	5288/7288	Color Reversal for Camera & Duplication	Acetate	5.7	daylight 40	K14	100	16X*
<b>Recordak Color Master</b>	5284 = 5271/7271	Color Negative Master	"	5.9	very slow	Process ECP	250	24X**
<b>Recordak Color Print</b>	6289 = 5381/7381	Color Duplicate for Distribution	"	8.0	Contact	Process ECP	500	Contact Duplicate***
<b>Ektachrome Professional Film</b>	Ektachrome 200	Color Reversal for Camera	"	5.0	daylight 200	E6	125	20X
"	Ektachrome 160	Color Reversal for Camera	"	5.0	Tungsten 160	E6	125	20X
"	Ektachrome 64	Color Reversal for Camera	"	5.0	daylight 64	E6	125	20X
"	Ektachrome 50	Color Reversal for Camera	"	5.0	Tungsten 50	E6	125	20X
<b>Ekachrome Photomicrographic</b>	2483	Color Reversal for Camera	Estar	4.0	daylight 16 Tungs. 5	E4	200	30X****
<b>Ektachrome Professional Film</b>	5071	Color Reversal Duplicating Film	Acetate	5.0	Tungsten 4	E6	125	1:1*****
"	6121	Color Reversal Duplicating Film	"	5.0	Tungsten 4	E6	125	1:1*****

\*Kodachrome type, not suitable for "in house" processing.

\*\*Very slow speed requires high level of illumination, therefore limited to small documents and relatively low reduction ratio.

\*\*\*Can only be used with negative color master.

\*\*\*\*High resolution makes this film suitable for really large documents (Drawings, Maps and Charts) and relatively high reduction ratios.

\*\*\*\*\*Low fading characteristics make this film suitable for "archival" uses.

\*\*\*\*\*Relatively low contrast.

You might ask why the Micrographics Material Pamphlet offers as standard a 35-mm double perforate "Camera Negative Master" and a

105-mm 8 mil duplicate print film to record only small documents? The answer is: This is what Eastman Kodak uses to produce colored microfiche. They do not use step-and-repeat microfiche cameras for black-and-white or color. They use a "strip-up" system with specially adapted cameras. These have an accurate pulldown or a Geneva motion and produce automatically one blank frame after every 12 (COSATI) or 14 (NMA) exposures. After exposure the film is developed, stripped down to the proper width, locating holes punched into the blank frames and cut into individual strips. These strips are positioned by means of the locating holes on special mounting boards. These are the microfiche masters which stay with Kodak and are used for distribution copies in special contact printers.

Thus for color microfiche double perforate, 35-mm film is used and stripped down to either COSATI or NMA spec width. The stripped up master is contact printed to the 105-mm print film.

The Professional and Finishing Markets Division has a series of relatively high resolving films which however are not known in the Business Systems Markets Division which includes micrographics. S0456, the present 2483 Photomicrographic Color Film, is one that you can only get from the Professional and Finishing Markets Division. In addition they list four Ektachrome Professional Films (two for daylight and two for Tungsten).

3. They all have a uniform resolution of 125 lines/mm; this will permit good results even at 20X or at a full "D" aperture on 35-mm 25- x 35-inches. All these films use an E6 processing cycle, which has less than half the processing solutions and takes half the time.

4. There are two Ektachrome duplicating films available, 5071 and 6121. Both resolve 125 lines/mm. Both can be processed in E6. Specifically 5071 is advertised as a highly stable film and thus suitable for archival storage with practically no fading in 50 years.

As it is obvious from the above, it takes considerable research to find suitable color films for microfilming of large and small documents. The Kodacolor Negative Master and duplicating print films have the highest resolution capabilities by far, but the slowness of the emulsion restricts them to small documents only, with specially adapted equipment. The 2483 film is still the best for really large and difficult originals, even though the E4 processing cycle is tedious and requires considerable care in time and temperature.

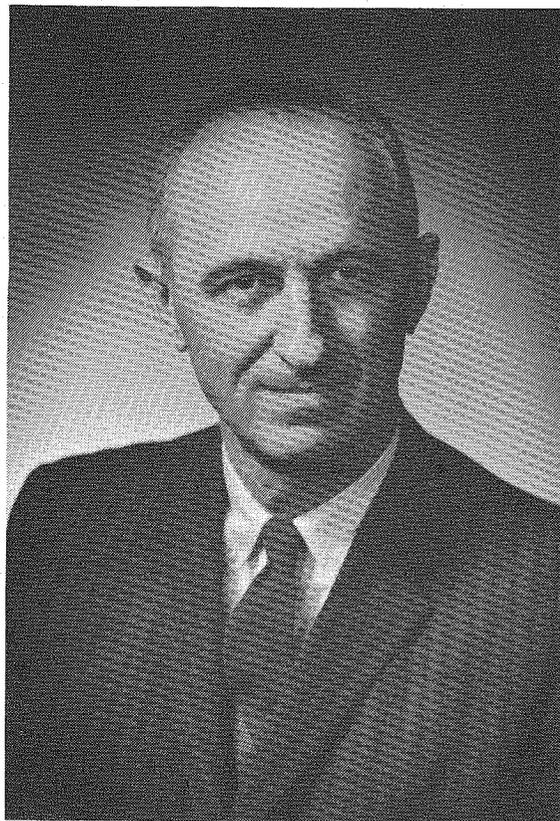
The other Ektachrome films are quite versatile and the E6 cycle is much simpler and less demanding than the E2. Thus for originals that do not require extreme resolution capabilities these films are

preferable. They can be had in 105-mm width on special order and are well suited for step and repeat microfiche cameras.

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ABOUT THE AUTHOR

*Ernest P. Taubes is an engineering consultant specializing in reprography. He was formerly president of Photo Devices, Inc., Rochester, New York; vice president, Photostat Company (presently ITEK); president of Microtronics Corporation, New York City; and chief engineer, Graphic Microfilm Corporation, Waltham, Massachusetts. In his 38-year career in micrographics, he has been responsible for the design, development and/or engineering and manufacture of more than 380 different simple and/or highly complex photographic apparatus and machines. He is one of the original 14 founders of the NMA; has served as an NMA director; is an NMA Fellow and received the NMA Pioneer Award.*





## REGION ONE ACTIVITIES

*Mel Dittmer*  
*R-1 Management Systems Engineer*

Regional Engineer Bob Larse has disappeared from the Engineering Offices. He was appointed to fill the job of Acting Deputy Regional Forester for Resources until a replacement for Tom Coston is on board; Coston was selected to move up to the Regional Forester's position.

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Architectural/Technical Services Group is developing contracts for the construction of slightly different facilities:

1. The new Wise River Ranger Station Office on the Beaverhead NF will include passive solar heating. The extra construction costs were projected to be paid off by energy savings in 12 years; but, with recent spiraling oil prices, the cost efficiency of this unit will probably be greater than first estimated.

2. On the Spotted Bear Ranger District, Flathead NF, a hydro-electric project is underway; the Forest is constructing the diversion dam and water transmission line. A contract for the generator and associated equipment is planned that will produce 50 to 100 kilowatts of power for this remote Ranger Station. Feasibility studies for hydro-electric projects at other locations are in the planning stage.

3. A log barracks to accomodate 48 people is in the contracting stage for the Avery Ranger District, Idaho Panhandle NF. It is somewhat unique for Forest Service facilities, as it consists of 12 apartments that are designed to serve four single persons or a small family. Each apartment is self-contained, and has two bedrooms, kitchen, bath, and living/dining room.

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We have filled the recently established Engineering Computer Applications Specialist position. This job consists of managing Regional Engineering computer applications, methods, and processes that are used by the R-1 Forests. This is an important task; as engineering computer applications have flourished over the years, each Forest has gone its separate way. Our incumbent Engineer, Gerry Shimada, seems to be making progress.

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Since early last winter, we have been exploring the concepts of Value Engineering as a tool for reducing costs while maintaining or enhancing quality. The term Value Engineering (VE) is nearly synonymous with the terms Value Analysis (VA) and Value Management. Some training has been completed, and more is planned. While Engineering has taken the initiative in the assessment and use of this technique, the application of VA/VE can be used in all work activities. The extent to which Region 1 will use Value Analysis/Value Engineering is being studied by our management team.

WASHINGTON OFFICE NEWS

CONSULTATION AND STANDARDS

Walter E. Furen  
Assistant Director

STANDARD SPECIFICATIONS  
FOR  
CONSTRUCTION OF ROADS AND BRIDGES

M. E. Unruh  
Construction and  
Maintenance Engineer

← a credit line!

Revision of the Standard Specifications is proceeding according to plan. Copies of the new version should be shipped to Regional and Forest Offices by September 15, 1979; staggered shipments will be used for offices that are to receive a large number of copies. The actual implementation date is expected to be about January 1, 1980.

In addition to changes in Standard Specifications, six documents, in particular, will be modified as part of the implementation package:

1. Forest Service General Provisions, Public Works Contract-Form 6300-42;
2. Timber Sale Contract, "C" Provisions;
3. FSM 7721.7;
4. Schedule of Items;
5. Formats and design of Engineers' Estimate Form;
6. Federal Procurement Regulations-Part 4G-18.

The purpose of the revision effort was to..."refine the wording and requirements of the General Provisions and Standard Specifications to realistically and effectively meet Forest Service needs to provide a single specification book for road and bridge construction."

Within that overall plan, specific objectives were identified:

1. Correct errors
2. Standardize wording
3. Update technical materials and references
4. Eliminate duplication and ambiguities
5. Simplify procedures
6. Reduce contract preparation and administrative problems
7. Reduce need for Regional Specifications
8. Standardize and include Specifications for certain items, such as Construction Staking
9. Reduce differences between procedures and requirements for timber sale and public works contracts.

There were some significant changes in the make-up of the book.

- a. The General Provisions for Construction of Public Works and for specified Roads-Timber Sale Contracts have been removed from the text. In lieu of the former, there are General Specifications containing portions of the 1977 General Provisions for Timber Sale and Public Work Contracts that are included in Sections 100-149 of the Standard Specifications, thereby reducing duplication. The parts of the 1977 General Provisions pertaining only to Public Works are carried in Form 6300-42; those pertaining only to Timber Sales are included in "C" Provisions.
- b. In Section 106, a price adjustment provision for bituminous materials that don't meet specifications allows for price reductions and acceptance in lieu of complete rejection.
- c. A new Construction Staking Specification (Section 170) covers a wide range of accuracy options to fit most (if not all) Forest Service conditions.
- d. Under Excavation and Embankment (Section 203), Construction tolerance table has been added.
- e. Section 305 has been added to cover aggregate removal from stockpiles and placement on roads.

- f. Under Aggregates (Section 703), gradations are included for all aggregate specifications.

Timber Sale Contract "C" Provisions related to cost adjustments, i.e., Altered Quantities-C5.251, Design Change-C5.252, and Cost Adjustment for Physical Change-C5.253, will be modified to facilitate use of the measurement and payment options provided by the Standard Specifications. Generally, this method will bring procedures for cost adjustments closer together in contracts for Timber Sales and Public Works.

GIARDIASIS

Bill Opfer  
Engineer, Environmental Health

The following is a summary of a presentation given at the recent Regional Sanitary Engineers Meeting in Orlando, Florida. The talk was given by Mr. Edward Lippy with the Health Effects Research Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. Mr. Lippy was closely involved with the investigation of the giardiasis outbreak that occurred in Berlin, New Hampshire, in the spring of 1977.

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Giardiasis ranks third on the list of reported waterborne disease outbreaks during the period of 1971-1977. It accounted for 10 percent of the outbreaks and 18 percent of the illnesses. The first reported outbreak of giardiasis was in 1965 at Aspen, Colorado, with 123 cases. In 1976, 639 cases occurred during an outbreak in Camas, Washington. In 1977, there was an outbreak in Berlin, New Hampshire, with an estimated 750 cases.

Outbreaks of giardiasis have occurred mostly in the northern tier of the United States; Colorado leads with the greatest number of cases. This is attributable to three possible reasons:

1. The giardia cyst that causes infections in humans survives very well in cold water; it has been reported to survive in laboratory tests for up to 3 months.
2. Many communities in these areas use surface water supplies with a minimum of treatment, usually simple chlorination.
3. There is a relatively large amount of forested area and wildlife in these northern areas.

Although beaver have been implicated in the outbreak of giardiasis, researchers suspect that the beaver infection was initially caused by human contamination of water. The estimated infection rate for humans in this country is about 4 to 6 percent and, for dogs, 20 percent.

The following is a summary of information concerning the organism itself. Giardia is a member of the animal kingdom. It is a single-cell, flagellated protozoan organism with two distinct stages in its life cycle. The reproductive stage is a trophozoite, with reproduction by binary fission. Trophozoites contain a nucleus and a medium body. The nucleus is the brain power that tells the cell when to divide. The giardia trophozoite is 6 to 12 microns wide, 9 to 12 microns long, and 2 to 4 microns thick. The trophozoite is not the stage that is likely to be found in water supplies.

The giardia cyst has the same internal structure as the trophozoite, except that the cysts might have from 2 to 4 nuclei each. The cyst is 6 to 9 microns wide and 9 to 12 microns long. Cysts are the stage most likely to be found in the water supply.

The organism is ingested as a cyst. The cyst can be transmitted by person-to-person contact through the fecal/oral route or by ingestion of contaminated food or water. Infections can range from asymptomatic carrier states to acute disease characterized by diarrhea, bloating, malabsorption, fatigue, and weight loss. Infection and disease can be long-term, with cases lasting as long as 5 years. The mean duration of illness is 2 to 3 months. Reported cure rates approach 90 percent.

Giardiasis is a serious problem facing the Forest Service due to the number and location of water systems with surface supplies. Some research has been done, and much more is currently underway.

Boiling water for a minimum of 1 minute will apparently destroy the giardia cyst; however, boiling the water for 3 to 5 minutes is recommended. Tests have shown that filtration with diatomaceous earth is very effective in removing the cyst. Currently, we do not have good dosage criteria for disinfecting giardia cysts.

As the use of National Forest lands increases, the probability of additional disease outbreaks will increase. Regions should keep in close contact with local EPA regional offices for answers on the latest results from current research.

## OPERATIONS

*Harold L. Strickland*  
*Assistant Director*

### *STUDY OF SERVICE-WIDE EQUIPMENT MANAGEMENT*

*Robert Hartman*  
*Engineer, Equipment Management*

A Forest Service Task Force was recently directed to review Service-wide fleet management activities. The Task Force was selected from Washington Office, Regional Office, and Forest levels; it was charged with "assessing the existing strengths and weaknesses of fleet management in the Forest Service," as well as developing "an action plan for implementation of recommendations" from the recent Office of Audit Report on Forest Service Fleet Management.

The scope of the study was defined to include the management of all equipment identified in FSM-7130 and to review all types of ownership. The Task Force Report would provide an action plan for improvement of Forest Service equipment management.

The Task Force Report was recently completed and distributed throughout the Forest Service. In the Report, the Task Force identified five basic issues where equipment management needs improvement. They developed 22 recommendations, proposed 7 action teams, identified the team members, and provided timeframes for completion of the action plan.

The reason for this renewed emphasis on equipment management is management's realization that the cost of owning, leasing, renting, and operating equipment is a significant portion of the total Forest Service budget. The Working Capital Fund (WCF)-supported fleet of equipment contains over 15,000 motor vehicles and 2,800 construction and miscellaneous equipment units and is valued at \$95 million. Current WCF annual expenditures in support of Forest Service equipment exceed \$60 million. In addition to WCF equipment, the Forest Service uses a large amount of other equipment--vehicles, construction units, and specialized units that are obtained and supported by direct project expenditures. This includes commercially leased equipment, employee-owned equipment, and Government-owned equipment purchased with project funds. The exact value of this equipment is not known because accurate records are not available.



CHANGES TO FIELD NOTES

The changes noted below are corrections to two articles that appeared in earlier editions of Field Notes; each change should be attached securely on the respective page.

Field Notes, Volume 11, Number 4, page 24, third entry from bottom:

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Fire Retardant Measurement System	Pickett, Ted L.	A	SD	7957/ 1201/ 8062	1-79
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(cut on this line)

Field Notes, Volume 11, Number 7, page 12, second full paragraph:

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Certain assumptions are made to simplify the program (most can be changed if conditions warrant): entrance and trash rack losses are combined and are represented as 1.8 times the velocity head for full pipe flow; the specific roughness coefficient\* is the same for the full length of the outlet conduit and for the vent pipe; air weighs 0.06 pound per cubic foot (0.9611 kilograms per cubic meter) and can be changed for lower altitudes; temperature and vapor pressure effects are neglected, because the limit imposed on the air velocity makes the pressure loss in the vent pipe extremely small in most cases; and the conduit flows at normal depth if it flows partially full.

(cut on this line)





## INVITATION TO READERS OF *FIELD NOTES*

Every reader is a potential author of an article for *Field Notes*. If you have a news item or short article you would like to share with Service engineers, we invite you to send it for publication in *Field Notes*.

Material submitted to the Washington Office for publication should be reviewed by the respective Regional Office to see that the information is current, timely, technically accurate, informative, and of interest to Forest Service Engineers (FSM 7113). The length of material submitted may vary from several short sentences to several typewritten pages; however, short articles or news items are preferred. All material submitted to the Washington Office should be typed double-spaced, and, ideally, all illustrations should be original drawings, glossy prints, or negatives.

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		R-8	Bob Bowers		

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