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Engineering Field Notes

Administrative Distribution

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THE ENGINEERING FIELD NOTES SERIES is published periodically as a means of exchanging engineering-related ideas and information on activities, problems encountered and solutions developed, or other data that may be of value to Engineers Service-wide.

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Roads Program Costs: Continuing Efforts Addressing the Issue

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ROads Analysis & Display System

The ROads Analysis and Display System (ROADS) is the most recent initiative implemented to help the Forest Service better manage the Roads program. It provides information and tools to analyze and monitor economic efficiency and to control the costs associated with the program. The system will help greatly in presentations to people outside the Forest Service (including Congress) and assist them to better understand the Roads program. ROADS also provides a systematic approach for tracking the progress toward achieving a cost-efficient road system.

The First Year

In 1987, ROADS was implemented on all National Forests and used to report the year's program accomplishments. The display portion of ROADS immediately provided information on road development activities during 1987. Tables 1 through 3, generated by ROADS, display unit costs that appear in the annual *Report of the Forest Service*. They show our accomplishments with respect to meeting congressional direction to reduce the average unit cost of timber road construction.

Future Benefit

Last year was for implementing and testing ROADS. The system is not perfect, but the intent is to implement, review, and refine as needed. As we refine and better understand this analysis and display system, and as Forest Service managers are able to review and compare indicators, we will identify areas of the Roads program where we can obtain greater efficiency.

Keep up the Good Work

The implementation of ROADS is affecting all National Forests and Regional Offices and is requiring a team effort of people from Timber, Fiscal, PD&B, and Engineering Staffs, along with line officers. Everyone should stay involved in monitoring, evaluating, and using ROADS; your efforts are appreciated.

NOTE TO: Engineering Field Notes (EFN) readers
RE: Corrections to EFN, Vol. 20, March-April 1988, article "Roads Program Costs: Continuing Efforts Addressing the Issue"
FROM: D. Carroll, Editor--EFN
DATE: March 7, 1988

Please mark your copy of Engineering Field Notes, Volume 20, March-April 1988, to show the following corrections to the subject article:

On page 4, Table 1 -- change the parenthetical statement in the table's title to read

"(thousand $/mile)"

On page 4, Table 2 -- change the parenthetical statement in the table's title to read

"(thousand $/mile)"

I regret any problem or inconvenience that this correction may cause. Thank you -- D.CARROLL:W01B

Table 1.—Actual unit costs: fiscal year 1985 (million $/mile).

Region	Cost of engineering and building roads (A)	Cost of administering and supporting program (B)	Gross unit cost (A+B)
1	32.7	8.1	40.8
2	31.0	5.0	36.0
3	28.1	12.0	40.1
4	29.3	10.8	40.1
5	45.2	6.3	51.5
6	42.9	6.9	49.8
8	28.5	3.5	32.0
9	26.6	7.4	34.2
10	184.7	106.8	291.5
National	36.6	8.9	45.5

Table 2.—Actual unit costs: fiscal year 1987 (million $/mile).

Region	Cost of engineering and building roads (A)	Cost of administering and supporting program (B)	Gross unit cost (A+B)
1	29.1	5.5	34.6
2	22.9	3.7	26.6
3	20.1	5.5	25.6
4	27.3	8.0	35.3
5	43.1	7.7	50.8
6	40.6	5.6	46.2
8	25.1	3.1	28.2
9	24.4	7.1	31.5
10	163.9	66.5	230.4
National	33.8	7.6	41.4

Table 3.—Percentage of change.

Region	Cost of engineering and building roads (A)	Cost of administering and supporting program (B)	Gross unit cost (A+B)
1	-11.0	-32.1	-15.2
2	-26.1	-26.0	-26.1
3	-28.5	-54.2	-33.7
4	-6.8	-25.9	-12.0
5	-4.6	+22.0	-1.4
6	-5.4	-18.8	-7.2
8	-11.9	-11.4	-11.9
9	-9.0	-4.1	-7.9
10	-11.3	-37.7	-21.0
National	-7.7	-14.6	-9.0

Timber Bridge Technology

Clyde G. Weller
Chief Structural Engineer
Washington Office

Stressed timber is catching the eye of innovative bridge engineers across the United States. The progress of stressed timber and the potential for increased use and more innovation are greater than ever. Stressed timber is not new; Canadian stressed timber bridges are more than 10 years old and showing outstanding performance.

Wheeler Consolidated, Inc., constructed two stressed timber slab decks as part of the national timber bridge workshops at Penn State and Colorado State Universities. We are continuing to collect data and evaluate the performance of these bridges.

To date, the 16-inch deep, 46-foot span Penn State bridge has lost its camber but has stabilized. As predicted, the relaxation in the stressing rods has stabilized. The bridge has a 2- to 3-inch asphalt wearing surface. The Penn State bridge is pictured in figure 1. The Colorado State bridge is a 40-foot span with 4-inch-by-14-inch laminae.

Figure 1.—Dr. Ralph Mozingo of Penn State University has designed and created a model of a system that he feels can and will increase the longitudinal stiffness of the stressed timber slab deck while decreasing the slab thickness.

For both bridges, Wheeler used 8-, 12-, 16-, and 20-foot-long planks. The design requires three of four laminae to be continuous at any point. Some bridge engineers are questioning whether the bridge is stiff enough. The deflection on these two bridges is about an inch and a half with one highway load truck (or 1 in 500 stiffness). These bridges are two-laned so deflection would be more like 1 in 250 if both lanes were loaded.

We are exploring the use of a parallel chord truss to increase longitudinal stiffness. At the University of Wisconsin, Madison, Professor Mike Oliva, in cooperation with the Forest Products Laboratory, has been testing many configurations of the stressing rods. The individual trusses are made of 4-inch by 6- to 12-inch chord members of the 12-, 16-, and 20-foot lengths, and the webs are 4-inch by 12-inch by 4-foot blocks on 8-foot centers. The chords are connected to the web with 3/8-inch by 18-inch-long dowel spikes.

Recent Projects

The Forest Service constructed a 40-foot span demonstration bridge (pictured under construction in figure 2) in September 1987 on the Hiawatha National Forest in Region 9. The chords are 4 inches by 6 inches, and the web members are 4 inches by 12 inches by 4 feet on 8-foot centers. This bridge has longitudinal stiffness in excess of 1 in 500. Wheeler constructed the bridge superstructure in two panels and delivered them to the site for a simple field installation of 3 hours by novice Forest Service employees.

Region 9 is also installing on the Chequamegon National Forest a two-span, 36-foot-long, continuous 8-inch deep stressed slab deck on existing abutments and pier. Wheeler should be able to evaluate potential composite action. This continuous slab will help reduce longitudinal deflection.

Region 1 constructed a 30-foot span stressed microlam slab deck on the Idaho Panhandle National Forest. Trus-Joist has designed a stressed microlam superstructure similar to a tri-T precast concrete. These sections can be panelized for shop construction and simple field installation. Figure 3

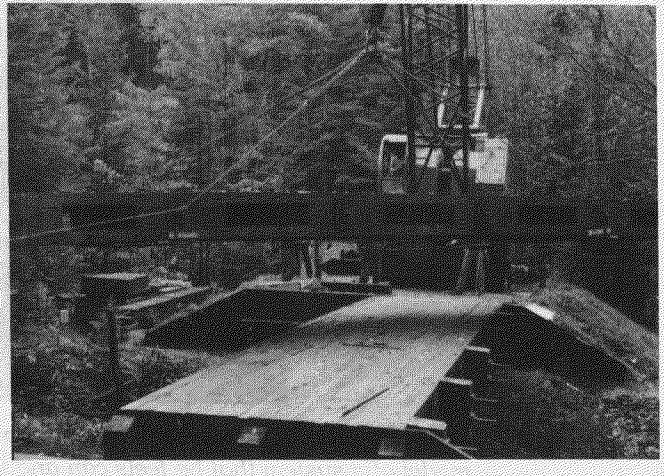

Figure 2.—40-foot span demonstration bridge.

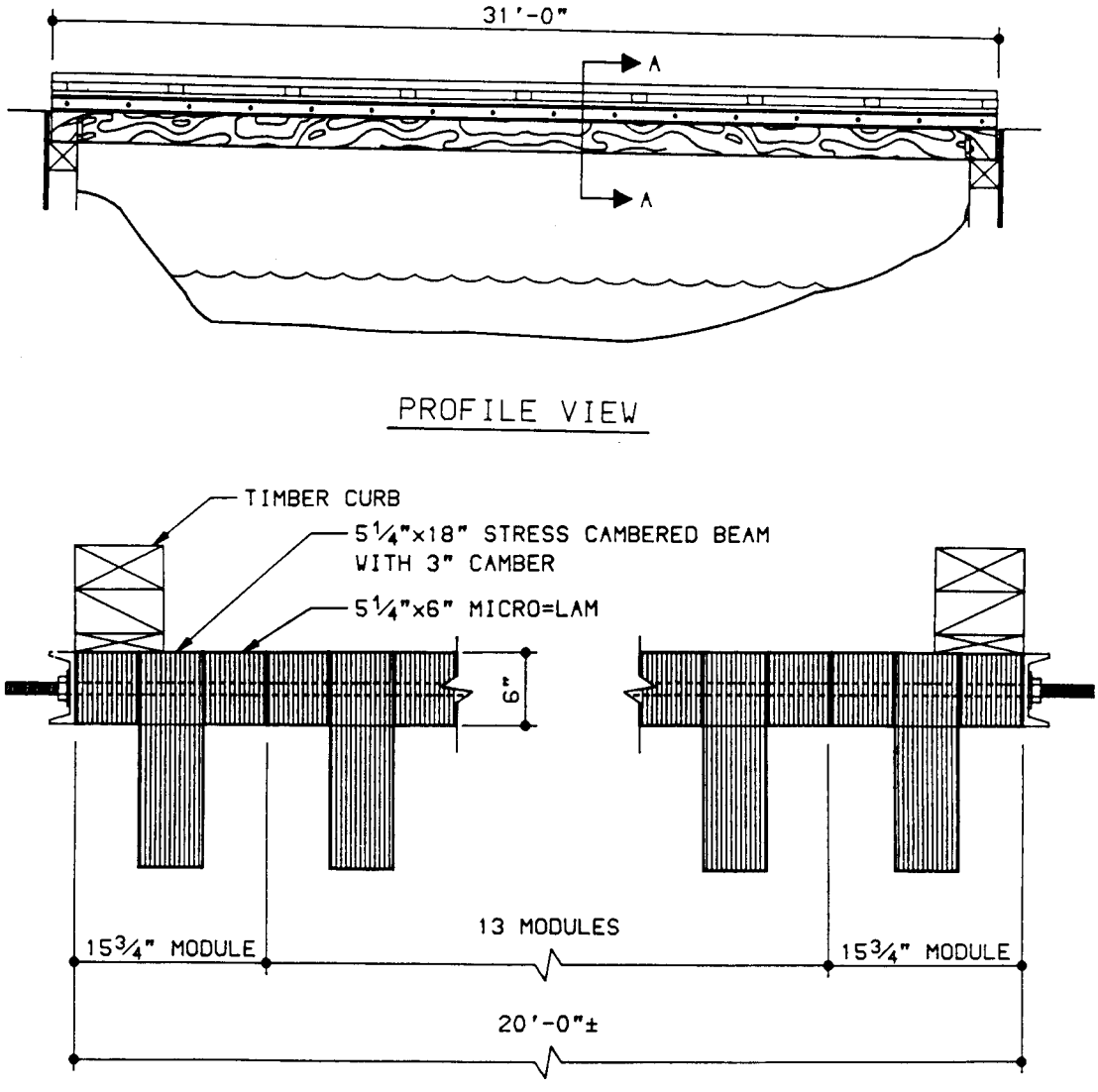

Figure 3.—Profile and cross-section of the stressed microlaminated design.

shows the profile and cross-section views of the stressed microlaminated design.

The United States now has more than 20 stressed timber bridges.

ASCE, TRB, & AASHTO Technical Committee Progress

The timber bridge technical committees are seeking greater involvement from ASCE, TRB, and AASHTO. ASCE has selected V.S. (Hota) Gangaroa of West Virginia University as chairman of the timber bridge subcommittee. Don Flemming of the Minnesota Department of Transportation has been doing an excellent job for the AASHTO timber bridge technical committee, but he needs more support. The TRB timber bridge subcommittee will meet for the first time at the January TRB meeting in Washington, DC.

The AASHTO standards need updating and rewriting by a good structural engineer. The committee submitted a project to the FHWA Coordinated Federal Lands Highway Technology Implementation Program Council to finish research on ultimate strength (load resistance factor design) of stressed timber and to write AASHTO specifications for design.

Mike Ritter, Structural Engineer, Washington Office, is working hard to complete the "Timber Bridge Design and Construction Manual." It is scheduled for rough draft completion in March 1988, with a publication date of September 1988.

Timber Bridge Conferences

There have been three timber bridge conferences held to date: one in 1986 in Portland, Oregon, and two in 1987 in University Park, Pennsylvania, and Fort Collins, Colorado. There will be two more timber bridge workshops in 1988: one in Charleston, West Virginia, in May and the other in Madison, Wisconsin, in September. Both workshops have steering committees already established. Bill Grabner, Region 6, and representatives of industry are working in Oregon to hold an additional conference in 1988. A number of other States have requested conferences.

EFN

Forest Service Implementation of Federal Guidelines for Dam Safety—1987 Progress Report

Skip Coghlan
Civil Engineer
Washington Office

Washington Office Note

The following report summarizes Forest Service progress in implementing the Federal Guidelines for Dam Safety. The October 4, 1979, Presidential Memorandum asked all Federal agencies responsible for dams to adopt the Guidelines and to report progress toward implementing the Guidelines to the Director of the Federal Emergency Management Agency (FEMA). The Regions recently reported their progress in implementing dam safety, and that information appears in this Forest Service progress report, which will be combined with other U.S. Department of Agriculture reports for submittal to FEMA.

Although we have made significant progress in accomplishing dam safety inspections and identifying needs, we still must accomplish many repairs and not fall behind in routine maintenance and scheduled inspections. Also, we must complete appropriate Emergency Action Plans and warning systems. We want to anticipate and prevent disasters—not react to them.

Introduction

There has been little change in Forest Service dam safety responsibility and jurisdiction since the 1986 progress report. The Forest Service has responsibility and jurisdiction for 1,316 dams and administers permits for 2,366 additional dams owned by others but located on the National Forests. The total 3,682 dams are classified as: 560 high hazard, 1,041 moderate hazard, and 2,081 low hazard.

Permitted dam owners include private parties, cooperative and nonprofit groups, local governments, and other Federal agencies. The owners design, construct, operate, and maintain the structures subject to Forest Service review and approval. Most newer dam permits include a clause requiring complete compliance with the Guidelines by the permittee.

Significant Action Since the 1986 Progress Report

In addition to informal inspections, we have scheduled intermediate and formal inspections for all Forest Service structures according to risks and hazards, and these are being accomplished. We perform special inspections as indicated, accomplish or schedule identified safety correction needs, prepare high-priority Emergency Action Plans, and consider recommendations contained in the 1986 progress report. For example, Regions have

developed Memorandums of Understanding with State dam safety agencies, strengthened permit requirements, and worked directly with permittees to improve compliance of permitted structures with the Guidelines.

Funding priority for hazard analysis, inundation mapping, instrumentation, warning systems, and repairs for Forest Service dams continues to be a problem. Particularly for older dams, both Forest Service and permittee, the values for which a dam was originally constructed often will no longer support needed investments. Funding dam work by benefiting function requires the simplest dam work to compete with all other priorities in that function. With the work distributed among several functions, there is no focus on dam facility needs as a whole. Major safety hazards regularly reach funding priority, but other significant safety items and routine work, although scheduled, often get postponed.

The Forest Service had seven dam failures during the reporting period, none with loss of life or catastrophic damage. One of these dams has been reconstructed to a higher standard and returned to service.

Implementation Progress

1. The Chief of the Forest Service is responsible for ensuring that every reasonable effort is made to ensure the safety of dams located on National Forest lands. The Forest Service Dam Safety Officer, through the Director of Engineering, advises the Chief on matters related to dam safety. The Regional Foresters of the nine Regions are responsible for the implementation of the Guidelines and the requirements described in FSM 7500. The Regional Engineer in each Region has the primary staff responsibility for overseeing the Dam Safety Program. Qualified Engineers regularly inspect all Government-owned Forest Service dams and report noted deficiencies in writing to the Forest Supervisor of the Forest on which the dam is located. Qualified engineers, mainly from State agencies, or engineers retained by the owner regularly inspect permitted dams.

2. Legislation does not impede the Forest Service Dam Safety Program. The Government adequately funds major safety repairs and routine inspections of Forest Service dams. The Forest Service program budget policy, however, of funding dam work by benefiting function (for example, recreation, wildlife, and so forth) impedes full application of the Guidelines to the Dam Safety Program in several ways. First, the simplest dam work must compete with all other priorities and targets in that particular function. With work distributed among several functions, there is no focus on dam facility needs as a whole, especially routine safety repairs and such management activities as hazard analysis, inundation mapping, instrumentation, warning systems, and emergency action plans. Furthermore, for many older Forest Service and permittee dams, the original purpose of the dam is no longer applicable, and the value for current benefiting uses does not support needed management and repair. In cases where there is lost contact with the permittee or the permit did not clearly make the permittee responsible, there is no benefiting function. Although needs are identified and scheduled, the low funding priorities frequently lead to continued postponement of the work.

3. The Dam Safety Staff is adequate. The States, other agencies, consultants, and a sharing among Regions provide further staffing for workloads or special skill needs.

4. A national Forest Service dam workshop was held in 1987 involving Engineers from all Regions. Several Regions held workshops or formal training sessions, or participated in State or other agency training sessions. Regional Engineers provide on-the-job training while on functional assistance trips to the Forests. Two Regions identified that a significant benefit accrued from involving line officers and other staff members as well as Engineers in dam safety training. This practice will continue.

5. We update the Forest Service dams inventory at least annually, and it is available on request. The number of dams by hazard class are as follows:

Region	*High*	*Moderate*	*Low*	*Total*
1	33	52	103	188
2	130	276	500	906
3	19	29	85	133
4	144	183	430	757
5	152	375	532	1,059
6	41	37	53	131
8	21	37	196	254
9	11	44	170	225
10	9	8	12	29
Total	560	1,041	2,081	3,682

This total is approximately double that given in the 1986 progress report. This is primarily because of improvement in the inventory and inclusion of many structures under 25 feet in the low- and even moderate-hazard classifications.

6. The Forest Service provides independent review of design, construction, and major repairs. Consultants, States, and other Federal agencies typically furnish external reviews.

7. We have scheduled all Forest Service dams for intermediate and formal inspections according to their size, hazard classification, condition, downstream risk, and consistency with the Guidelines. There are special inspections when the need arises.

8. Each of the nine Regions has an active rehabilitation program for Forest Service dams. We schedule deficiencies for correction as they are identified. Budget priorities sometimes delay or extend these schedules. Permitted dams experience similar or somewhat worse funding difficulties.

9. Emergency Action Plans are completed on essentially all Forest Service high-hazard dams and on selected moderate-hazard dams. Emergency Action Plans are complete on an estimated 75 percent of the permitted high-hazard dams, and we are working with permittees to achieve 100 percent.

Inundation maps, instrumentation, and warning systems are not complete for all plans.

10. Although not formally stated in Forest Service policy, the Regions have adopted and applied the Interagency Committee on Dam Safety Guidelines as appropriate.

11. There have been no agency-conducted or GAO Service-wide reviews of dam safety during this period. We have made significant progress working with permittees to bring permitted structures into conformance with the Guidelines since this issue was raised in an earlier GAO review and particularly since the last progress report. Memorandums of Understanding with the States and the States' growth in capability have been major factors in the improvement.

12. As mentioned throughout this report, the Regions have worked closely with the States, building a strong relationship. Regions have Memorandums of Understanding with most States, and the States have significantly increased their capability. The result has been significant progress in bringing permitted structures into conformance with the Guidelines.

13. The Forests work closely with local governments on land-use zoning to restrict development in inundation areas below dams. States also assist in enforcement, but in some cases they cannot prevent private development. In one case, a proposed development would have increased the hazard rating of a permittee dam. The permittee proceeded with legal action against the developer for the cost of dam improvements necessitated by the higher hazard classification. The developer modified the proposal rather than face this issue in court.

14. We use risk analysis subjectively to assess hazard classification, prioritize inspections, and design and rehabilitate dams. If a formal risk assessment is needed, we involve a consultant with appropriate risk analysis capability.

15. The Forest Service had seven failures and two incidents in six Regions during the reporting period. None involved loss of life or catastrophic damage. One failed dam and one incident dam have been reconstructed to a higher standard. The remainder are fully breached or locked open so the reservoirs will not store.

16. With the Federal Highway Administration, the Forest Service cosponsored a study titled "Development of a Methodology for Estimating Embankment Damage Due to Flood Overtopping" (FHWA/RD-86/126). Also, Rocky Mountain Region Dam Safety Engineer, Keith Bakeman, presented the paper, "Dam Breach Incremental Damage Analysis," at the Colorado State University International Symposium on Design of Hydraulic Structures, 1987.

EFN

A Ski Area Monitoring Expert System Prototype

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Washington Office Note

This article describes the Ski Area Monitoring Advisory System software shared with the Regions in a Washington Office Engineering 7100 letter dated September 30, 1987. On November 3–5 in Denver, as a followup technology transfer response, 11 individuals from four Regions attended a tutorial on how to develop their own applications using Insight 2+ (now Level 5). In 1988, the following activities using the experience gained should be under way: Regions 1, 2, and 5 will be trying the Ski Area Monitoring Advisor, and Region 2 also will be trying the Bridge Replacement Advisor, which operates similarly to the ski area system, while developing and trying the Sign Plan Advisory.
—Dale R. Petersen, P.E.

Introduction

Expert systems are computer programs that provide users with specific problem-solving assistance. The assistance provided is based on heuristics and experiential knowledge of one or more subject-domain-knowledgeable people, often referred to as subject-domain experts.

Decisionmaking is one problem-solving activity that some expert system developers are interested in supporting. For example, Syntelligence, Inc., has developed an expert system, known as the Lending Advisor, that has the ability to consider most, if not all, of the factors involved in approving or not approving a potential loan client. The Lending Advisor assists users like BankAmerica with making important loan decisions.

The OXKO Corporation won a competitive contract with the Forest Service to develop an expert decisionmaking system prototype that will demonstrate the expert system's ability to support important Forest Service tasks. The demonstration system is called the Ski Area Monitoring Advisor.

Courtesy OXKO Corporation, Annapolis, Maryland.

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The Advisor was developed to demonstrate the utility of personal-computer-based expert systems in support of decisionmaking in the subject domain of ski area monitoring. The Forest Service sought a cost-effective method that would emphasize quality decisionmaking on this subject and would directly support the Forest Service personnel in the field who need help the most.

Ski area operations are a private-sector venture on National Forest land under special-use permits. Permittees are responsible for inspections and operations according to national, State, and local laws. The Forest Service monitors permittees to ensure that they fulfill their responsibilities. Because the Forest Service is in transition from doing inspections and detailed reviews to performing overall surveillance, oversight, or monitoring, no monitoring methodology has been prescribed.

Ski area monitoring is a large-problem domain. Forest Service personnel monitor 14 facets of a ski area operation, including avalanche control, business management, employee training, and engineered facilities. These 14 facets consist of many important subjects of interest. For example, the engineered facilities facet encompasses seven important subjects: aerial tramways (ski lifts), bridges, buildings, dams, roads, snowmaking systems, and water and sewage systems.

Ski Lift Monitoring

The demonstration system developed thus far supports decisionmaking for the specific subject of ski lift monitoring. With a decrease in the number of personnel available to monitor the Nation's ski lifts on public lands, and a decrease in time available to choose which ski lifts should be monitored by Forest Service representatives, the Forest Service hopes that a computer system based on this demonstration system will help Forest Service personnel quickly and effectively pick those ski lifts that most need attention. In addition, it is hoped that the expert decisionmaking system tool will be extended to support the other facets and subjects related to ski area monitoring tasks and that other expert systems might be developed to assist Forest Service personnel in the performance of other Forest Service tasks and business.

The importance of this monitoring activity should not be underestimated. It is part of an overall safety program for ski area operations.

When Forest Service representatives monitor a ski lift, they address many technical, procedural, and management issues. Technical issues include wire rope and splice condition, such adequate safety devices as backstop brakes, and sufficient evacuation equipment, including ladders and passenger-lowering equipment. Procedural issues include operations personnel training and evacuation. Management issues include important logbook maintenance, such as wire rope maintenance logbook, and maintenance management systems. Representatives take notes on what they observe. These notes form the basis of an informal rating for the ski lift.

Individual Forest Service offices maintain file cabinet data bases of ski lift monitoring actions. To select a ski lift for monitoring, Forest Service personnel search their personal, manual data bases and their own experiential

knowledge data bases. Using manual data search techniques and nonstandard, informal rating techniques, Forest Service representatives select ski lift monitoring candidates.

Poorly rated ski lifts or lifts that have not been monitored for a long time are of more interest to Forest Service monitoring personnel than ski lifts that have been recently monitored and rated well.

The present method for choosing ski lifts for monitoring is manual, labor-intensive (thereby costly), inconsistent, and in some cases random. The Forest Service hopes to develop an expert-system-based decisionmaking aid to automate this task to reduce the labor intensiveness (and thereby the cost) of this work, standardize the decisionmaking techniques used to select ski lift monitoring candidates, and produce effective, nonrandom decisions.

The Forest Service has been very fortunate from the standpoint of personnel. At the time of the expert system demonstration development project, the Forest Service employed a truly world-class domain expert on the subject of ski lifts (including the specific subject of ski lift monitoring). Besides this world-class expert, the Forest Service also has a few extremely knowledgeable and capable professionals who have high levels of knowledge in the ski lift monitoring subject domain.

The OXKO Knowledge Engineer developed the demonstration system primarily from material received from the domain expert. The Knowledge Engineer interviewed the expert for a day and obtained a great deal of information. Additional material was obtained from a few hours of interviewing two other Forest Service professionals and from material mailed to OXKO by a fourth Forest Service professional. All of the material was carefully studied. The demonstration system's architecture was based primarily on material derived from magazine articles written by the domain expert and the interviews with the expert and the other Forest Service personnel.

The present manual monitoring technique does not include any specific monitoring activity forms, because Forest Service personnel individually maintain their own monitoring history information. The demonstration system was built with the supposition that a form based on material in some of the expert's articles, such as "New Look for Lift Inspection," *Ski Area Management Magazine*, by Charles F. Dwyer, P.E., would be developed and that all future monitoring actions would use the form.

One of the valid values for every point on the form would be "NA" for "not available" or "not applicable." This is needed because many, if not all, monitoring actions involve only a subset of all ski lift issues. Therefore, the form would standardize the data recording action but not affect or modify the actual monitoring tasks. When returned to a Forest Service office, the form could be used as a data entry form to facilitate the storage of the data as well as provide the Forest Service with the ability to retrieve automated data.

Data retrieval, however, is still a long way from decisionmaking. Trying to consider approximately 40 monitoring items for the hundreds of ski lifts the Forest Service personnel must monitor is a large decisionmaking task. The monitoring items are reported not by numeric scores, but rather as linguistic fuzzy variables (that is, good, fair, poor), making the task more complex. Therefore, Forest Service personnel cannot add up the individual monitoring scores and arrive at composite ratings for each lift. Instead, the linguistic fuzzy variables must be converted to numeric member values. These member values can then be added to arrive at a composite rating for each lift.

This could be done manually, but it would be very labor intensive and error-prone. Also, more conventional automated techniques could be used; however, the programming would poorly model the way the problem is to be solved. An expert system with linguistic fuzzy-variable support provides a cost-effective, automated solution that approximates the manner in which the problem will be solved, assuming that the monitoring issues addressed by the domain expert are to be followed.

An additional issue is the career status of the domain expert who is planning to retire shortly. The expert's knowledge will be lost unless it is somehow captured and made accessible to those in the Forest Service who need it to continue the important task of ski lift monitoring. This factor provides additional support for the expert-system solution.

Demonstration System

Examples of what has been accomplished with a new technology are often helpful to those who are attempting to use the technology for the first time or are attempting to do for the first time what the example illustrates. Describing what was done is helpful; describing some of the technical aspects is even more helpful for developers. For this reason, we will look at some of the technical aspects of the demonstration system.

The software tools used in the development of this system included the Insight 2+ expert system shell product of Level Five Research, Inc., of Florida (now owned by Information Builders, Inc., of New York) and PC Paintbrush Plus from ZSoft. The computer hardware included an IBM PC/XT and a Princeton image scanner.

All the knowledge base logic and the data bases were developed using the Insight 2+ tool. The demonstration system also provides some graphic presentations of particular ski lift components of interest. The graphic presentations were created by scanning hard copy graphic material obtained from a ski lift manufacturer and creating compressed digital files that can be readily displayed by Insight 2+. Figure 1 depicts a typical ski lift structure.

The demonstration system includes two knowledge bases, four DBPAS (data base/PASCAL) programs, two data bases, four graphics files, and one PASCAL routine, and can be run from the development environment of Insight 2+ or directly from a run-time version of Insight.

Figure 1.—A typical ski lift structure.

The system has three categories of rules. There are metarules that help manage the system, rules to work the user system interface, and rules to translate the linguistic fuzzy variables into numeric values and calculate the ski lifts' ratings. The third category is the most important and interesting. Figure 2 provides some rule examples from this category.

The four rules in figure 2 deal with the linguistic rating that a Forest Service monitor gives a particular ski lift in relation to its wire rope and cable logbook. If this logbook is present, is checked, and presents all that it should, then the rating of the particular ski lift is increased by 0.9. If the logbook is present, is checked, and presents most of what it should present, then the rating is increased by 0.5. If the wire rope and cable logbook of a particular ski lift are not checked by the monitor, then the rating is increased by 0.5.

```
RULE Wire rope and cable logbook check good
IF Wirelog = GOOD
THEN Wire rope and cable logbook has been checked
AND Rating := Rating + .90

RULE Wire rope and cable logbook check fair
IF Wirelog = FAIR
THEN Wire rope and cable logbook has been checked
AND Rating := Rating + .50

RULE Wire rope and cable logbook check NA
IF Wirelog = NA
THEN Wire rope and cable logbook has been checked
AND Rating := Rating + .50

RULE Wire rope and cable logbook check poor
IF Wirelog = POOR
THEN Wire rope and cable logbook has been checked
AND Rating := Rating + .10
```

Figure 2.—Rule examples.

In this case, the 0.5 value is an attempt to provide a neutral value that does not artificially inflate or unfairly penalize the particular ski lift's rating for a factor that the Forest Service monitor did not check on a particular monitoring action. If the logbook is present, is checked, and presents significantly less information than is reasonable, then the rating is increased by only 0.1.

The descriptions or translations of the linguistic variables discussed above might be different from those that a particular Forest Service monitor uses, because monitors may use their own descriptions. The translations might be different, but the heuristic scale represented by the good, fair, and poor linguistic variables is standard for all ratings. Also, the numeric equivalence will be standard across all Forest Service offices. The domain expert, however, might change the actual values to be used across the Forest Service prior to moving the demonstration system to an operational use status. The actual values will be changed only if the expert feels that other numbers will better model his thinking.

The demonstration system was developed using reasonable values for the linguistic fuzzy variables. The expert, however, may choose to change these numbers prior to operational use. For example, the expert may choose to change the NA numeric value from 0.5 to 0.4 or the FAIR numeric value from 0.5 to 0.6.

The demonstration system considers 27 important ski lift monitoring factors out of approximately 50 that the Forest Service may consider. The 27 factors are listed in figure 3. If the Forest Service chooses to continue this project, one area of work will be to extend the knowledge base to consider other monitoring factors.

(1) Lift Manufacturer
(2) Lift Owner
(3) Authority for Lift
(4) Forest Service Monitor
(5) Number of Fatalities
(6) Number of Major Injuries
(7) Number of Minor Injuries
(8) Overall Inspection Rating
(9) Overall Monitoring Rating
(10) Operations and Maintenance System
(11) Area Operations Manual
(12) Daily Preoperations Inspection and Checklist
(13) Maintenance Logbook Condition
(14) Operations Logbook Condition
(15) Wire Rope and Cable Logbook
(16) Daily Operational Logbook
(17) Written Maintenance Schedule Condition
(18) Designer's Maintenance Manual Presence
(19) Lift Schedule of Maintenance Presence
(20) Manufacturer's Service Bulletins Records
(21) Required Signs
(22) Operating Instructions
(23) Emergency Procedures
(24) Personnel Training
(25) Lighting Procedures
(26) Closing Procedures
(27) Evacuation Plan

Figure 3.—Ski lift monitoring factors considered by the demonstration system.

The system includes two data bases. The data bases are in the dBase III format; however, the Insight 2+ data base editor was used instead of dBase III for the development project. One data base includes the raw monitoring data. This data base will be updated after each monitoring action. The second data base includes some basic information about each ski lift in the raw-data data base (such as lift location and type) as well as the composite rating assigned by the expert system. This second data base is used to provide decision support information to the Forest Service personnel via the expert system. Currently, the two data bases can be updated either with the Insight 2+ data base editor or dBase III. A candidate for a system improvement would be another expert system that would be a data base front end. This task could also be accomplished using the Insight 2+ (or the new Level 5) tool.

We should consider a possible operational scenario that the Forest Service might employ that would include the effective use of a production version of this system. First, the Forest Service would have to develop a form (or alternatively give the people in the field personal computers for direct data entry). The form could be simple in design and easy to use. Figure 4 shows what the form could look like, given the 27 monitoring factors currently being considered in the demonstration system.

USDA FOREST SERVICE
SKI AREA MONITORING
SKI LIFT MONITORING FORM

Forest:_____ District:_____
Ski Area:_____ Lift ID:_____

Lift Type:_____ Date Monitored:_____

Lift Manufacturer:_____
Lift Owner:_____
Authority Over Lift:_____
FS Monitor:_____
Number of Fatalities:_____
Number of Major Injuries:_____
Number of Minor Injuries:_____

(Check one)	*Good*	*Fair*	*Poor*	*NA*
Overall Inspection Rating				
Overall Monitoring Rating	_____	_____	_____	_____
Ops & Maintenance System	_____	_____	_____	_____
Area Ops Manual Rating	_____	_____	_____	_____
Daily Preop Inspect & Checklist	_____	_____	_____	_____
Maintenance Logbook Condition	_____	_____	_____	_____
Ops Logbook Condition	_____	_____	_____	_____
Wire Rope and Cable Logbook	_____	_____	_____	_____
Daily Operational Logbook	_____	_____	_____	_____
Written Maintenance Schedule	_____	_____	_____	_____

(Check one)	*Yes*	*No*	*NA*
Designer's Maintenance Manual present	_____	_____	_____
Lift Schedule of Maintenance present	_____	_____	_____
Manuf. Service Bulletins Records present	_____	_____	_____
Required Signs installed	_____	_____	_____
Operating Instructions present	_____	_____	_____
Emergency Procedures present	_____	_____	_____
Personnel Training Documentation present	_____	_____	_____
Lighting Procedures present	_____	_____	_____
Closing Procedures present	_____	_____	_____
Evacuation Plan present	_____	_____	_____

Figure 4.—Possible monitoring form.

Next, the Forest Service monitoring personnel could use the forms (or the personal computers) to record all monitoring actions. Returning to their offices, the monitoring personnel would enter the form data into the personal computer data base (not necessary if the personal computer is taken into the field).

The next time a Forest Service member was planning to monitor a ski lift in his or her territory (usually a specific Forest Service District within a specific National Forest), the Forest Service member could run the expert system. The system would consider all the factors of all of the lifts in the data bases

(hopefully including all lifts in the territory), rate the lifts, and provide a rating report of the lower rated lifts. The system would also pinpoint the lowest rated lift and possibly would supply some graphic information on an area of concern specific to this low-rated lift. The monitor could go into the field, rate the low-rated ski lift, and fill in another form. The cycle would then repeat.

The bottom line for this project is that prototypes for a standard ski lift monitoring data recording scheme and a standard, cost-effective, time-saving ski lift rating system have been developed and are available for demonstration. Furthermore, the recording scheme and rating system can be easily modified to accommodate changes in thinking or for local applications, and they also serve well as models for other applications of a similar nature.

EFN

Space Shuttle Handheld Photography: A Unique Archive of Imagery

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Introduction

If Columbus had a camera to carry on board his ship in 1492, we would not be wondering about the precise point of his landing. In our time, however, carrying a camera of some type has become a routine part of the activities of people, whether they are visiting family in Tennessee, seeing the sights in Washington, DC, traveling on safari in Africa, or cruising through space in a U.S. space shuttle.

That a photograph is worth a thousand words is an accepted premise now. Photographs can quickly document the activities of people and the condition of resources. They can record data for use by researchers who are interested in change, trends, and present conditions. The Space Shuttle Program gives astronauts a unique perspective on Earth. They can see broad areas of the sea, land, and clouds. They carry cameras, and most missions include the photography of Earth features.

The Earth Observations Project Office of the National Aeronautics and Space Administration (NASA) coordinates the photographs of Earth and onboard astronaut activities. This group manages the handheld photography program and provides archive and indexing services. The project objective is to provide the NASA Public Affairs Office with fast access to photographs taken during the mission. All other objectives are subordinate to this. Even with this emphasis, the majority of images collected during a flight are of features on the Earth's surface.

From the beginning, space travelers have carried cameras into space on their voyages. Astronauts have photographed each other, their spacecraft, the moon, lunar activities, construction in space, and Earth. There is a growing archive of images of varying quality of many parts of Earth.

To an observer on Earth, the space shuttle flies upside down. The photograph in figure 1 shows the shuttle stabilizer and part of the cargo bay poised over the limb of Earth. This photograph was taken through an aft cabin window and shows the Himalayan Range with the high plateau of Tibet on the right. The haze-covered area to the left is India and Nepal.

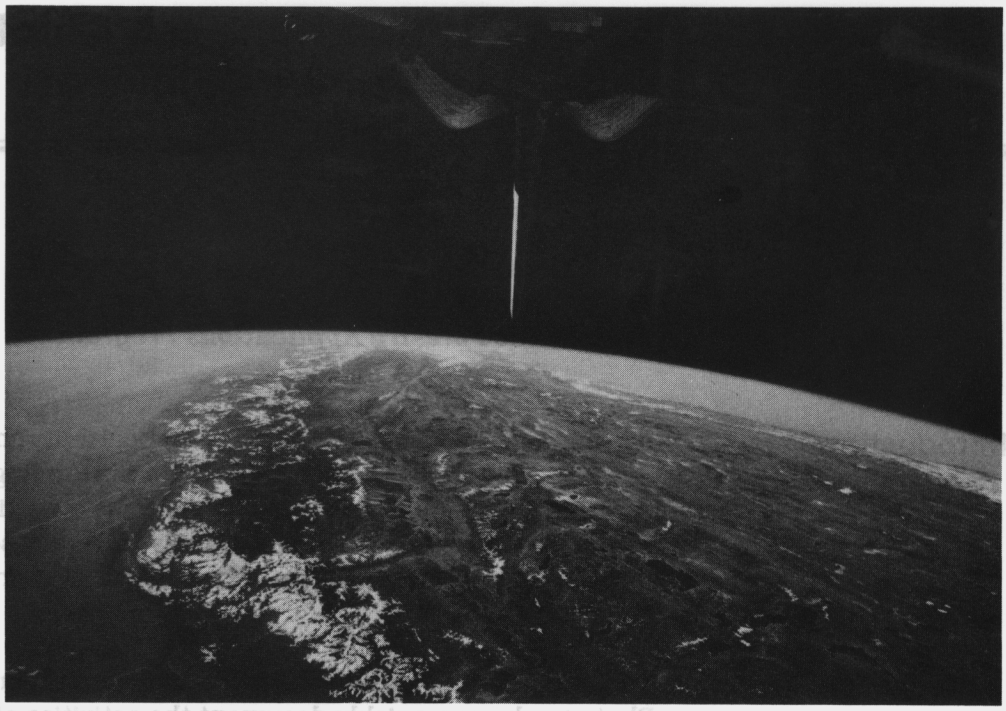

Figure 1.—Earth from the space shuttle.

Cameras & Film Used

Linhof Aero Technika 45 and Hasselblad EL/M are the cameras used to obtain handheld Earth Observations Experiment photographs during missions. The Linhof uses a 5-inch-wide Kodak Ektachrome 64 professional film type 5017, with interchangeable 90- and 250-millimeter lenses. The Hasselblad uses 70-millimeter Kodak Ektachrome 64 professional film type 6017 and 70-millimeter Kodak Aerochrome infrared film type 2443, with interchangeable 50-, 100-, and 250-millimeter lenses. The catalog for each mission lists the camera, lens, and other pertinent information for each frame of photography. Hasselblad cameras are responsible for most photographs in the archive.

The cameras routinely have film that meets the specific needs of the NASA Public Affairs Office. One of the paramount needs is for the rapid processing of exposed film so that photographs will be available for press releases or as illustrative material. As soon as a shuttle lands, the exposed magazines of film go to processing. This usually occurs within a couple of hours.

Note that black and white reproductions printed in *Engineering Field Notes* show great degradation in image quality from the printing process. On color transparencies, however, detail is much more clear and differences between geologic features and vegetative types are sharp and easy to identify.

Photographs are taken through various windows in the space shuttle. Figure 2 illustrates the windows in the shuttle that can be used. This causes some slight degradation of image quality. The resolution of features on the ground, however, is comparable to or slightly better than that of a digital Thematic

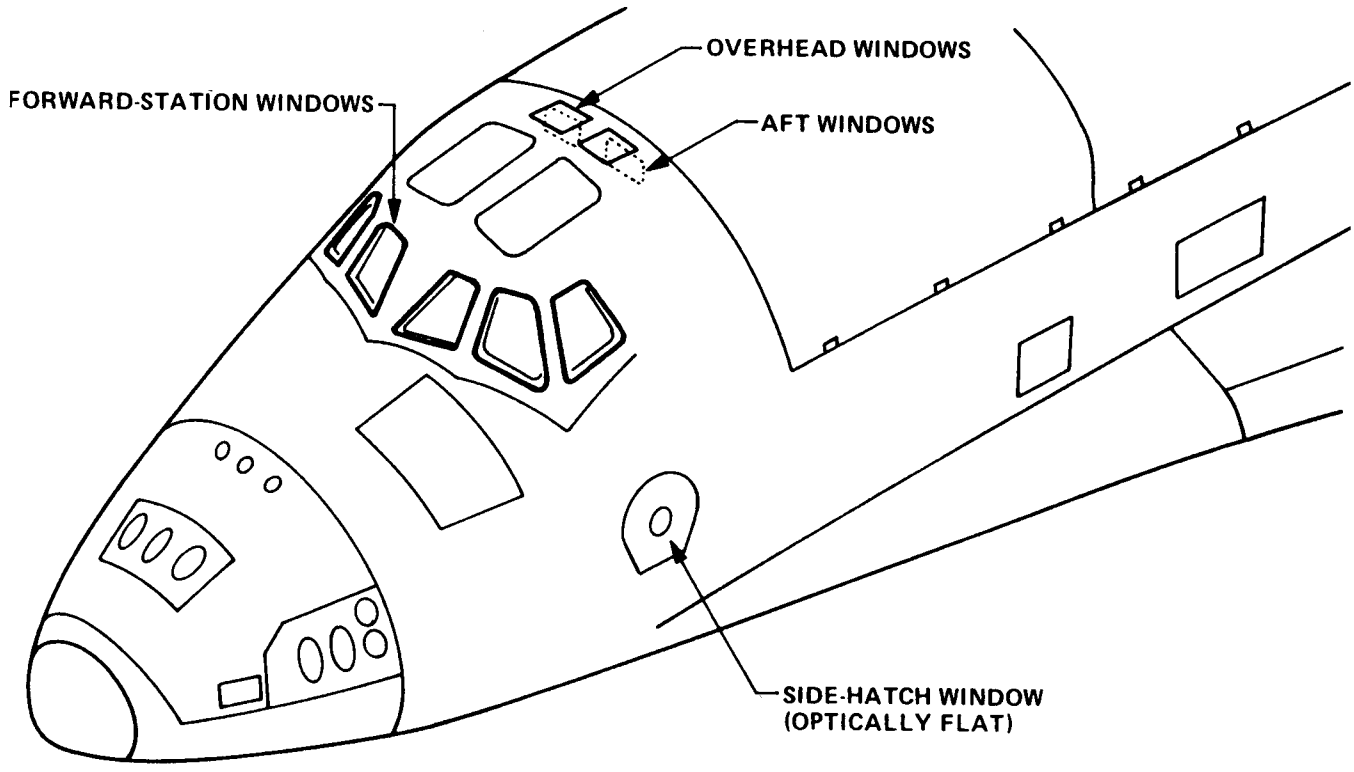

Figure 2.—Drawing illustrating the placement of windows in the space shuttle. (Illustration by NASA-Lockheed is taken from a NASA catalog of imagery.)

Mapper image; that is, ground features (depending on contrast and shape) of 5 to 10 meters can be identified.

A Growing Collection of Images

Prior to a shuttle mission, the astronaut crew learns how to use the cameras that they will carry on the shuttle. They also are briefed on specific photograph needs. The mission flight plan incorporates handheld image needs and provides a specific schedule for acquiring the photographs. The plan describes desired photographs in detail so that proper ground areas are located.

There are a variety of photographs in this growing archive of images. Photographs of the space shuttle, crew members, and astronauts at work on satellites are intermingled with photographs of the Earth's limb at sunset, cloud patterns, and the Earth's surface. Photographs through the shuttle windows are of lakes, forests, coastlines, oceans, and cities. While the surface of Earth is far from being completely photographed, individual photos or groups of images are scattered over that part of Earth from a latitude of almost 57° north to 57° south. Coverage is worldwide, with concentrations between 27° north and south. Fewer shuttles go to 52° north or south, so there are fewer photographs between 27° and 57°.

REPRESENTATIVE LIST OF STS 41-G HASSELBLAD PHOTOGRAPHY

ROLL	FRAME	GEO-NAME	FEATURE	CENTER POINT LAT	CENTER POINT LON	NADIR LAT	NADIR LON	CC%	DR	TL	FL	E	S	DATE	GMT	NADIR ALT	NADIR AZI	NADIR ELE	NADIR ORB
39	108	USA-UTAH	LAKE POWELL/CANYONLANDS	37.0N	111.0W	37.1N	110.6W	2		NV	100	N	N	84 281	20:55:8	123	137	40	38
40	5	ARGENTINA	CLOUDS	50.8S	64.2W	50.8S	64.2W	100		NV	100	N	Y	84 285	21:43:7	126	120	8	104
40	6	FALKLAND ISLANDS	EAST FALKLAND	51.5S	58.5W	51.8S	61.5W	80		NV	100	N	N	84 285	21:43:37	127	118	7	104
40	7	USSR	STANOVOY MTS/GONAM RIVER	56.0N	125.0E	56.1N	125.1E	5		NV	100	N	Y	84 285	22:30:59	125	76	2	105
40	8	USSR	STANOVOY MTS/GONAM RIVER	56.0N	125.5E	56.2N	126.1E	5		NV	100	N	Y	84 285	22:31:8	125	77	3	105

REPRESENTATIVE LIST OF STS 41-G LINHOF PHOTOGRAPHY

ROLL	FRAME	GEO-NAME	FEATURE	CENTER POINT LAT	CENTER POINT LON	NADIR LAT	NADIR LON	CC%	DR	TL	FL	E	S	DATE	GMT	NADIR ALT	NADIR AZI	NADIR ELE	NADIR ORB
120	3	USA-MASSACHUSETTS	CAPE COD/BOSTON	41.5N	70.0W			70	E	HO	90	N	N						6
120	4	IRELAND	ENGLAND	53.0N	8.0W			80	SW	HO	90	N	N						15
120	5	USSR	ARAL SEA	45.5N	60.0E			80	SE	HO	90	N	N						15
120	6	USSR	ARAL SEA	44.5N	58.0E			70	S	HO	90	N	N						15
120	7	CHINA	TAKLIMAKAN DESERT	38.0N	76.5E			30		NV	90	N	N						15

Figure 3.—A representative listing of images from a mission catalog.

Literally thousands of images are in NASA files. Fortunately, a report of the photography acquired during the mission follows each mission. The representative samples of listings in figure 3 come from a catalog of images that is prepared after each flight, including information about location and quality for each frame and technical data and notes about the features to be found in the images.

Catalog maps such as the one in figure 4 give the user basic information about location. In the final analysis, however, the selection of photographs to be used for a project must be made from either microfilm records or from the original material. Catalog maps show (frame by frame) the areas where handheld imagery has been acquired. Earth Observations Photography Summary Maps contain the center-point positions and frame numbers, printed in red, for Earth Observations Experiment photographs. Frame numbers of photographs that cannot be located are in blue and reflect the position of the shuttle at the time the photograph was taken. Where a large concentration of photographs is contained in a small area, the points are inside a box, with the frame numbers bracketed outside. The index must be used to obtain the center-point latitude and longitude for each individual frame number.

The Data Base & Searches

NASA has placed all data about the handheld images in a data base retrieval system at the Johnson Space Center in Houston, Texas. Any qualified user of the imagery can arrange for personal access to the data base. It is set up for 80-column screen display, and researchers with Apple or IBM machines can perform fast searches.

Once in the data base, a user has several options. Some options guide the user through specified searches, or the user can make lists of images by

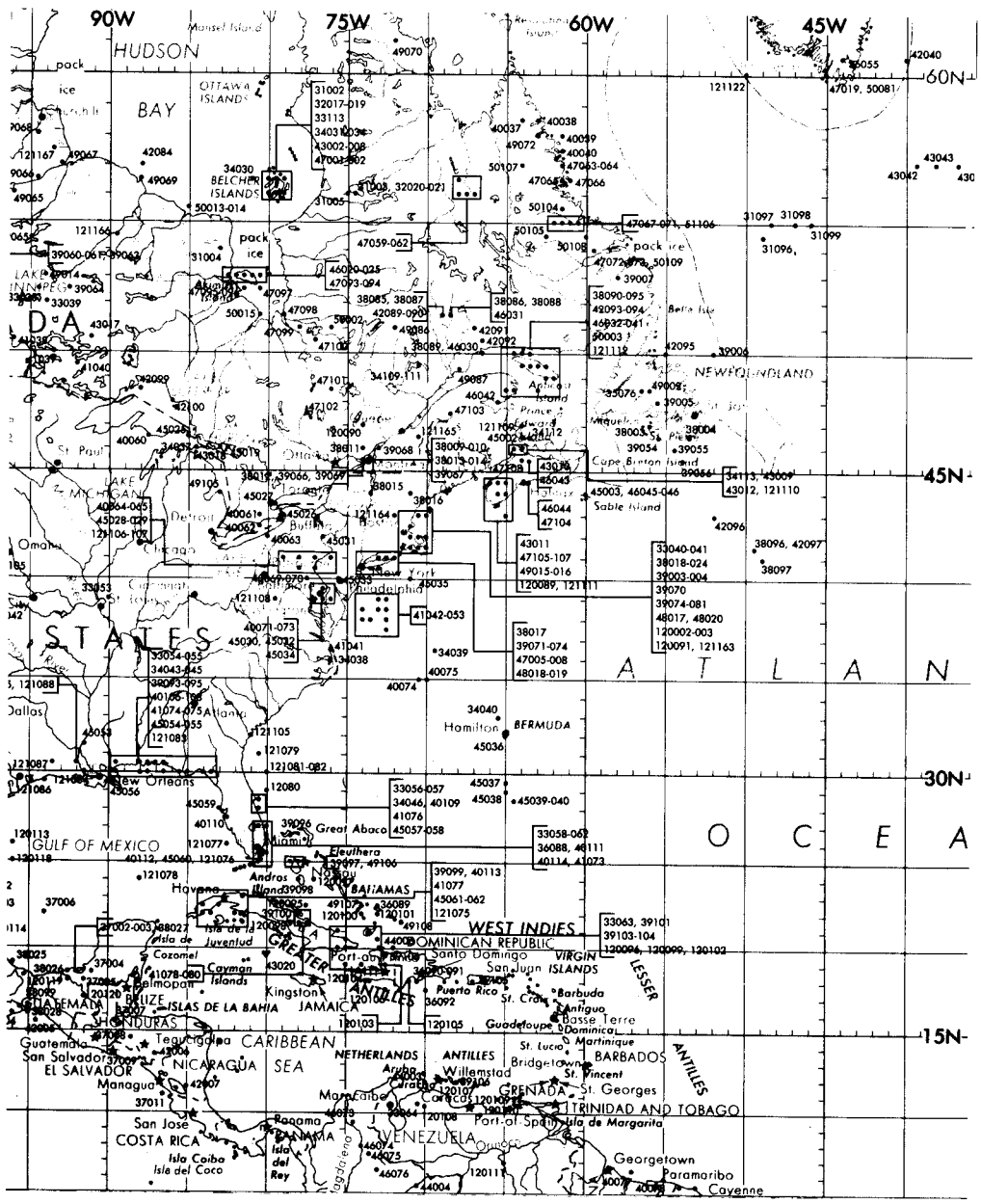

Figure 4.—Part of a catalog index map.

country or by latitude and longitude or a combination of both. The location of images for the United States is grouped by State, while images of other countries or areas are indexed by country name.

Figure 5 shows part of a search list of images of Sudan, Africa, that was retrieved from the data base. The user enters the header information at the top of the page at the proper prompt in the search routine. When the search is completed, the data is arrayed as specified. This information is taken from the full data base. The user can obtain more data about each frame by calling up each individual frame. When that is done, all available data for the frame of interest are presented. Most column headings are self-explanatory;

```
Enter COUNTRY WANTED: SUDAN
Enter BEGINNING LATITUDE  RANGE: 12
Enter ENDING    LATITUDE  RANGE: 14
Enter LATITUDE  DIRECTION (N OR S): N
Enter BEGINNING LONGITUDE RANGE: 24
Enter ENDING    LONGITUDE RANGE: 31
Enter LONGITUDE DIRECTION (E OR W): E
Enter SORTED BY LAT/LON OR MISSION (L OR M): M

   MS     ROLL MOD  FRAME      COUNTRY                CLOUDS   FEATURE    LENS

41B        40        2230   SUDAN          13.5N,  24.5E    0    JABAL MARR 100
41B        40        2231   SUDAN          13.0N,  24.5E    1    JABAL MARR 100
41B        41        2402   SUDAN          13.0N,  24.5E    0    JABAL MARR 250
41B        46        3014   SUDAN          13.0N,  24.5E    0    JABAL MARR 250
41B        46        3015   SUDAN          12.0N,  26.0E    0               250
51G(25)    45   45     1   SUDAN          13.0N,  24.2E    5    JABAL MARR 250
```

Figure 5.—Part of a data base search list.

"MOD" refers to a data module number. This is a number on the film that usually represents the roll number. It may be different on occasion from the listed roll number.

Characteristics of the Imagery

It is important that potential users keep the basic characteristics of the imagery in mind. For example, most of this imagery is not vertical photography. A vertical photograph may occur more as an accident than by plan. Many are either low- or high-oblique photographs. The images are primarily natural color, and the original images are positive transparencies. The image size is either 4 by 5 inches (from the Linhof camera) or 70 by 70 millimeters (from the Hasselblad camera). Stereo pairs are frequently acquired.

Uses of the Imagery

The imagery has been collected for years for the primary purpose of meeting NASA's needs, such as for public affairs activities. Some images, however, help in research projects. For example, an image of Lake Chad (in Africa), acquired in 1976, was used in a research project that assessed changes in the lake's surface area. This low-oblique photograph of Lake Chad was digitized and rectified for that particular project. Other applications can use this procedure.

Figure 6 shows the Great Salt Lake in Utah (taken on a space shuttle mission on October 31, 1985) in a view similar to the original Lake Chad photograph. (The Lake Chad photograph was more vertical than the image in figure 6.) The collection of imagery certainly constitutes a historical archive that in the future will have value as our descendants look back on the development of space travel and use. It also contains many images that will prove to be of value in change detection of Earth conditions over long time periods. The Great Salt Lake Desert is more prominent on this black and white reproduction than the Great Salt Lake, which is just below the center of the photograph. On this print, one can see Interstate 80 as it crosses the

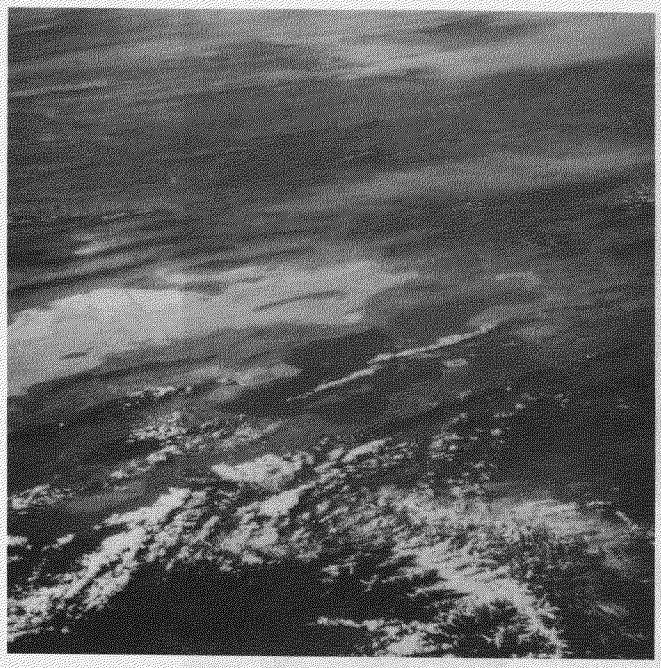

Figure 6.—Central Utah.

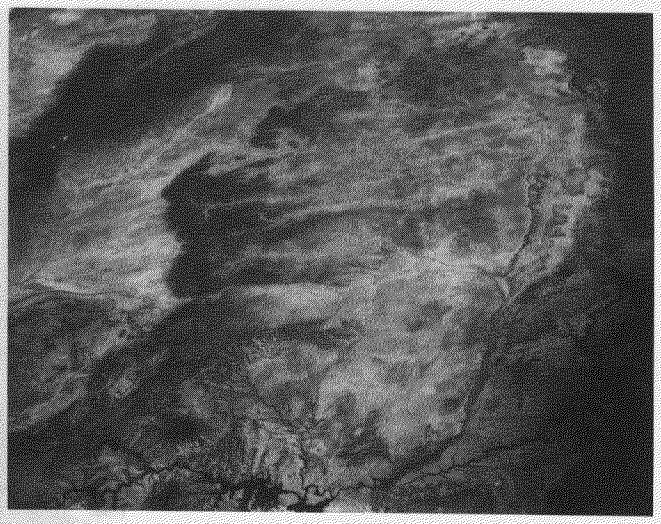

Figure 7.—Northern Arizona from space.

Desert. Antelope Island is visible. The white areas at the bottom of the image are the Wasatch and Uinta Mountains under snow and cloud.

Some images, such as the one of northern Arizona in figure 7, provide unique regional views and perspectives of land areas. Northern Arizona occupies most of this photograph. Lake Powell (in the foreground) feeds water into the Grand Canyon (in the lower right corner). Monument Valley is at left center, and the Navajo and Hopi Indian Reservations cover most of the center of the photograph. The original natural color image, soil types, and subtle geologic features are clearly differentiated.

In the United States, there is detailed, large-scale photographic coverage of almost every acre of land. This coverage tends to lessen the value of small-scale shuttle photography in resource management. That is certainly not the case for most of the rest of the world, where such a collection of imagery constitutes a potentially valuable and useful resource.

As a result, Forest Service users may find few uses for the imagery acquired with handheld cameras. There may be only infrequent needs for Regional views for reports or slide presentations. When needed though, such views are available. Forest Service personnel (and others) who go on foreign assignments may find valuable photographs of their area of interest in this archive.

There are unique photographs of many transient events. Figure 8 shows a series of smoke plumes from fires along California coast forests. This may contribute to a knowledge of air flow and smoke dispersal. Depending on the scheduling of shuttle flights, such transient events as major fires, volcanic eruptions, floods, and any large-scale (episodic) event may be captured on

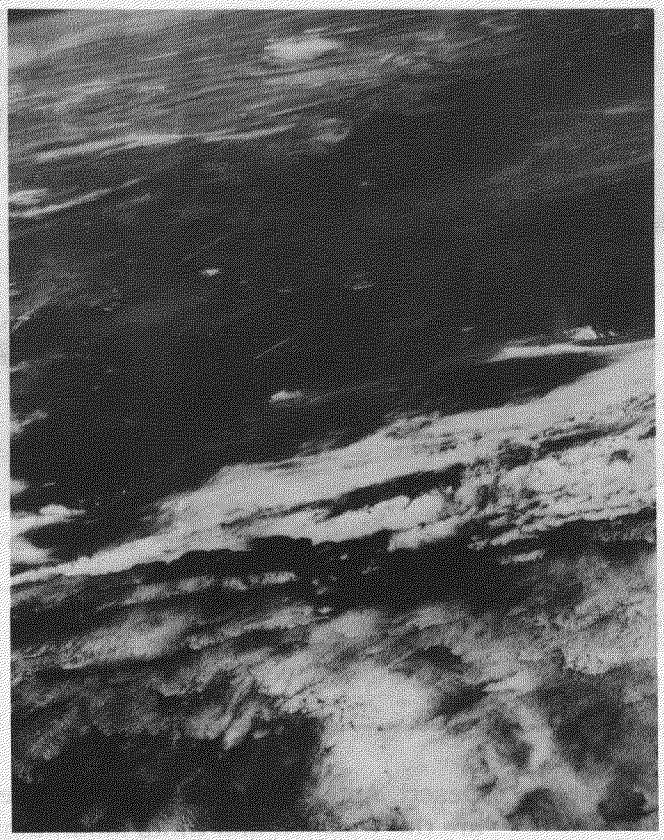

Figure 8.—Forest fires in California.

film. Smoke from fires along the coast of California drift south toward the Sacramento Valley. A major fire southeast of Crescent City sends two or three convection columns into the atmosphere. The smoke plumes stand out in stark contrast on the original color transparency. This photograph clearly depicts Mount Shasta, Honey Lake, Pyramid Lake, Crescent City, and farm lands west of Clear Lake Reservoir.

If managers have a critical need for special and specific images, the NASA Earth Observations Project Office will consider that need in mission planning. In the Forest Service, the Nationwide Forestry Applications Program coordinates the requests for special handheld camera imagery. It is important to remember that the acquisition of the images may or may not occur. Shuttle commanders control actual schedules, which are often affected by mission events.

A spectacular image is figure 9, which is a view of the Alps in Switzerland and the Po River Valley. Snow cover in the higher elevations and strong backlighting highlight the geomorphological characteristics of the mountains.

Plans for Future Shuttle Cameras

There is interest among NASA project managers and resource investigators that may lead to the placement of permanent cameras in the cargo bays of space shuttles. At this time, the concept centers on placing cameras

Figure 9.—The Swiss Alps.

inside a Get Away Special (GAS) can. A GAS can is a relatively small, space-conserving, inexpensive, sealed container for experimental packages to be carried on the shuttle. GAS cans are not serviced by the astronauts but are connected to shuttle systems for power and other support. This container takes up little room in the cargo area.

The best arrangement would have the cameras controllable from mission control to aim the camera. In this way, specific areas of interest could be located and photographed. If the concept is approved, managers in mission control will be able to expose the film as areas of interest are crossed by the fixed-aim cameras. This will require the addition of a video camera so that the scene visible to the camera will be visible to the managers in mission control.

Ordering Imagery

Once a desirable image has been identified, a print or duplicate transparency can be ordered from the EROS Data Center in Sioux Falls, South Dakota. This requires a full identification of the photograph by mission, roll, and frame number. If a MOD number is assigned to a frame, it also should be included, especially when it is different than the given roll number.

At this time, duplicate transparencies are available for $25. This fee applies to contact duplicates or to 9-inch-by-9-inch enlarged transparencies. The

cost for prints is the same as it is for other forms of photography. A 9-inch-by-9-inch print costs $19, and a 36-inch square print costs $65. There are intermediate prices for sizes in between these two.

Summary

Space operations have provided the inhabitants of Earth with a unique perspective on their fragile world. Astronauts, similar to travelers on a foreign journey, carry cameras to document their travels. The photographs they return to Earth are a unique resource of data about worldwide conditions. Many images may prove of value where current photography does not exist. Some photographs can provide broad regional views of land areas that are not available from any other source.

Appreciation

Help provided by Chuck Wood, Barbara Nowakowski, Ken Hancock (all of NASA), and Pat Jones, of Lockheed, is happily acknowledged. These people provided information, documents, guidelines, illustrations for this article, access to the image archive, and technical support.

EFN

Facilities Training System—Sharing Our Facilities Training Resources

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Introduction

There is a new Forest Service-wide opportunity with which individuals can improve their skills in the many diverse areas involved in facilities engineering and management. The Facilities Training System is the result of the efforts of several individuals, committee meetings, and discussions over the past 4 years. The Facilities Training Advisory Group, which is composed of representatives from Forests, Regions, Stations, and the Washington Office, manages the system.

We expanded the original concept—providing a means to improve facility maintenance and operations inspection skills—to include construction inspection and a host of facilities management considerations. In addition, the Facilities Training System meets the broad range of current knowledge levels of individuals, whether new to the facilities and job or experienced and seeking to expand their skills.

The basic tenet of this system is *sharing*—in materials, in experiences, and in opportunity. We hope that the system will be of value to field personnel and that those who use the system will provide their continued support and input to expand its usefulness to others.

The Facilities Training System data base described in this article became operational in February 1988.

Facilities Training System

The Facilities Training System consists of a data base to provide users with three types of information.

Training Library

The training library has materials that the Forest Service owns, including a description of the material, where it is located, and whom to contact to borrow the materials. Some items are designed for self-instruction, using videotapes and reference materials that may be retained by the individual. These include specifically purchased training materials developed by the Corps of Engineers and others. In some instances, materials developed by

the Forest Service will be included. Hopefully, these offerings will increase as time, need, and opportunity arise.

Training Opportunities

Training opportunities are being offered within the agency, by other agencies, and the private sector that seem appropriate to the needs of our personnel. Everyone's assistance in identifying appropriate courses being offered is important to the success of sharing these opportunities. Along with the description of the materials, location, and contact person, a candid critique of the material is important. The latter information can provide others with guidance as to the relative worth of investigating the opportunity further.

Inspection Aids

Inspection aids developed by various individuals, units, and other sources improve both the quality and efficiency in field activities. Included initially are several "customized" inspection forms. Later, information will be added to discuss use of equipment, methods, and ideas that may be of interest to inspection personnel.

Data Through the Data General

A Data General-based computer system will provide these three types of data and will afford all personnel the opportunity to access, view, and use the materials as desired. For example, local personnel may retrieve the full text of inspection forms for adoption or adaption (by local edit) as desired.

Obviously, some information will require more updating than others. Training opportunities come and go but are often reoffered. Because of this, some courses may have "past" dates listed. This is intended to illustrate the reoffering potential. Initially, the Washington Office Engineering Staff will "maintain" the data in the system on at least a quarterly basis. Data may be submitted at any time for sharing by sending it via the Data General to: G.LIPPERT:WO1B. This information should be in the format provided later in this article.

Ultimately, the Facilities Training System will reside in the Data General Information Center environment. However, the management of and priorities for Service-wide Information Centers are being developed. As an interim step, we have established the Training System in the information systems (IS) environment with the probable Information Center data base structure. Because of this situation, users may:

(1) Access and use the information directly if they have IS training and Write Append Read Execute (WARE) as part of their personal Data General profile.

(2) Contact their IS Manager or other person familiar with IS capabilities for assistance.

Accessing the Facilities Training System

Until the national Information Center software is established, we are storing the facilities information in the IS environment. We have established three drawers for facility inspection aids, information about training opportunities in facilities engineering, and a facilities engineering training library.

The following retrieval information is generic to all drawers in the system. The examples used in this article illustrate the information in the system in early December 1987. Additional information will be added periodically. Thus the user should consult the directory about contents and date of entry.

The overall IS Facilities Training System structure is designed as shown in figure 1. Several facility inspection aids are currently available for retrieval (see figures 2 and 3).

Retrieval Example

Retrieval Instructions—Facility Inspection Forms

The steps for retrieving the custom inspection forms from WO1B are: create a place to receive information on your computer, retrieve the drawer directory, select the information you want, retrieve the information from the host, use as you desire, and conserve computer storage space by deleting files you no longer need.

> In all the following instructions, words that are in **boldface** type refer to things that you must type and enter. Those that are in brackets (for example, **<EXECUTE>**) refer to a single key, generally a function key at the top of the keyboard.
>
> If you accidentally press the wrong key, **<CANCEL/EXIT>** will generally erase the error.

Five Steps

There are five steps for retrieving one of the custom inspection forms. Note that you must have Write Append Read Execute access to a STAFF drawer in the IS environment to perform these steps. The five steps are as follows:

(1) Establish a drawer to receive the retrieved data. This drawer will be called **YOURDRAWER** in these instructions. This is an IS drawer. A single form may be retrieved in any convenient STAFF drawer to which

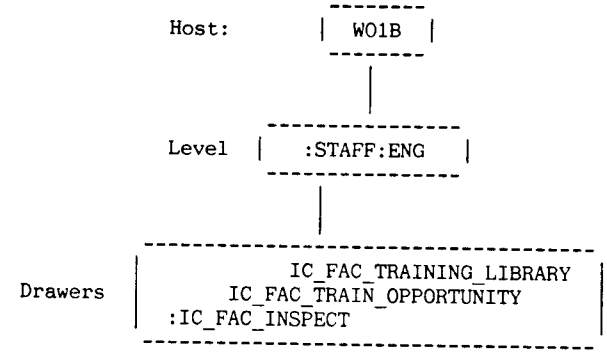


Figure 1.—Overall Facilities Training System structure.

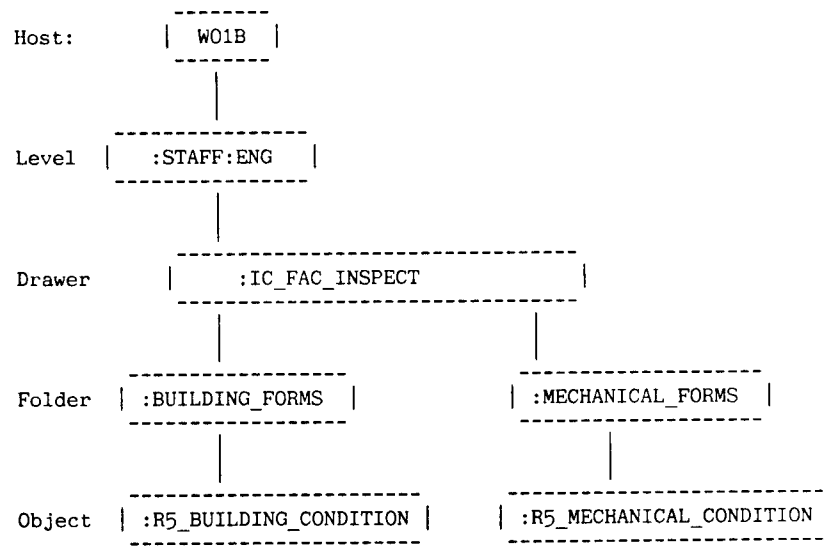


Figure 2.—An example of facility inspection aid.

you have WARE access. The 14 original inspection forms will occupy less than 500 blocks.

(2) Retrieve the directory of a drawer, as this example will demonstrate. Pressing your **INDEX** key cannot tell you the names of objects on a remote host. But you can find out what objects are available by retrieving the object directory from each drawer. Each directory contains the folder name and object name of each object in that drawer and the date it was inserted or revised.

Location of file to be retrieved:
Host Name: **WO1B**
Level (1. Public, 2. Staff): **2** Staff Name: **ENG**
Drawer Name: **IC_FAC_INSPECT**
or
Drawer Name: **IC_FAC_TRAINING_LIBRARY**
or
Drawer Name: **IC_FAC_TRAIN_OPPORTUNITY**
for all three drawers:
Folder Name: **SUMMARY_GENERAL_INFORMATION**
File Name: **DIRECTORY**

(3) Retrieve the directory or object using RIS. From the IS Main Menu, select Utilities (**3**). From the UTILITY FUNCTIONS Menu, select Retrieval and DCC Access (**6**). From the RETRIEVAL, NFC AND FCCC ACCESS Menu, select Retrieval (**1**). Enter the following information for proper unit folder and document:

Location of file to be retrieved:
Host Name: **WO1B**
Level (1. Public, 2. Staff): **2** Staff Name: **ENG**

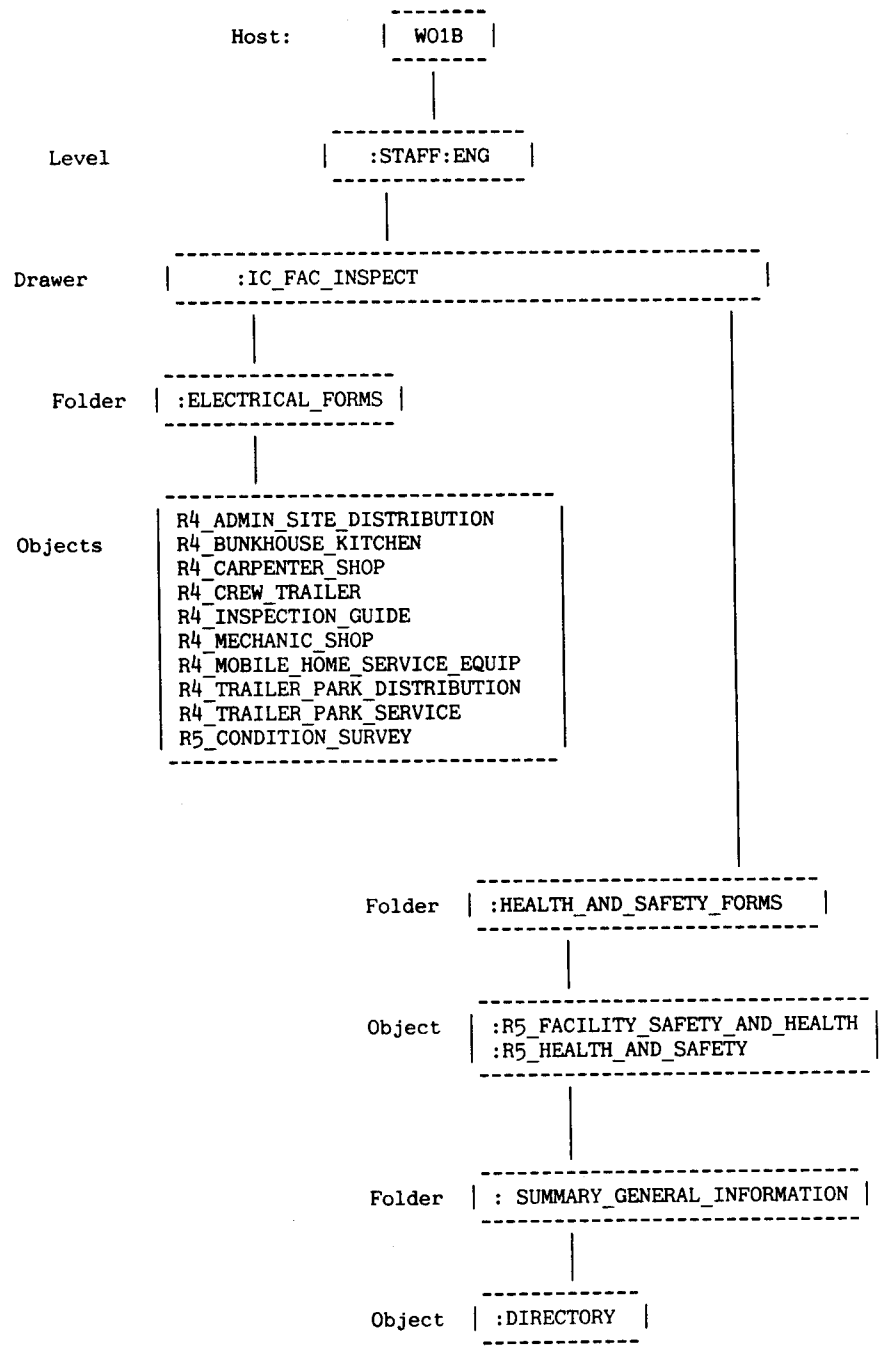


Figure 3.—Another example of facility inspection aid.

Drawer Name: **IC_FAC_INSPECT** for example
Folder Name: **SUMMARY_GENERAL_INFORMATION**
File Name: **DIRECTORY**

Location into which to put the file:
Level (1. Public, 2. Staff): **2** Staff Name: **YOUR STAFF NAME**
Drawer Name: **YOURDRAWER**
Folder Name: **YOURFOLDER**
File Name: **DIRECTORY**

Shall I retrieve the file now? **Y**

Execute (Y/N)? **Y**

Review the directory in the IS environment by entering **VIEW DIRECTORY.** Retrieve desired objects by repeating step 3, using the Folder Name and File Name of each object selected from the directory. An object may be printed in the IS environment by entering the command **QPRINT/QUE=NA R5_BUILDING_CONDITION** for example, where **NA** stands for your printer number. Return to the CEO Main Menu either by pressing **CTRL-SHIFT-F1** or by pressing **CANCEL/EXIT** until you return to the CEO Main Menu.

(4) Import forms or files from IS to CEO as you wish. (This step is optional and is only necessary if you do not plan to use the data in the IS environment.) From the CEO Main Menu, select Filing (**5**). From the FILING FUNCTIONS Menu, select Import (**7**).

Enter the path name of the form:
STAFF:ENG:YOURDRAWER:YOURFOLDER:R5_BUILDING_CONDITION

From Line into Paragraph: **Y**

Enter the following in the FILING MENU:
Drawer Name: **YOUR CEO DRAWER**

Folder Name: **YOUR CEO FOLDER**
Document Name: **R5_BUILDING_CONDITION**

Complete the DEFINE DOCUMENT SUMMARY.

(5) Delete objects that are no longer needed to conserve space on the Data General. From the IS Main Menu, select Access Information (**1**).

Level: Staff (**2**)
Drawer Name: **YOURDRAWER**
Folder Name: **YOURFOLDER**
Command: **DELETE/V R5_BUILDING_CONDITION** for example

Submitting New Data to the System

Data desired to be added to the system should be sent to G.LIPPERT:WO1B. We need DRAWER, FOLDER, and DOCUMENT data. FOLDER names are the same for all DRAWERS, as follows:

(1) Electrical.

(2) Mechanical.

(3) Life safety.

(4) Hazardous materials.

(5) Site work/landscaping/drainage.

(6) Concrete/masonry/steel.

(7) Interior & exterior carpentry.

(8) Doors/windows.

(9) Interior & exterior finishes.

(10) Moisture/insulation/roofing.

(11) Summary and general info.

For the TRAINING LIBRARY drawer, the document data required are as follows:

(1) Subject (folder).

(2) Type of media (videotape, slide-tape, film, self-study/correspondence, reading material, or inspection form).

(3) Name of course, publication, or form.

(4) Description of course, publication, or form.

(5) Intended audience (professional, technician, nontech.).

(6) Prerequisites.

(7) Location of material.

(8) Whom to contact for further information.

(9) General remarks regarding the material.

For the TRAINING OPPORTUNITIES drawer, the document data required are as follows:

(1) Subject area (folder).

(2) Date(s) of course.

(3) Title of course.

(4) Type of course (workshop, seminar, classroom, etc.).

(5) Location.

(6) Sponsor.

(7) Course description.

(8) Intended audience.

(9) Prerequisites.

(10) Tuition.

(11) Nomination deadline.

(12) Coordinator/tel. no.

(13) General remarks regarding course.

For the INSPECT drawer, the document data required are the full text, date, and origin of the document.

EFN

Techline Notes

Fumigants Control Decay in Timbers

Large, exterior structural timbers are usually pressure treated, but deep seasoning checks can develop that penetrate the treated shell. Water for the growth of decay fungi is trapped in the checks, and the result is interior decay.

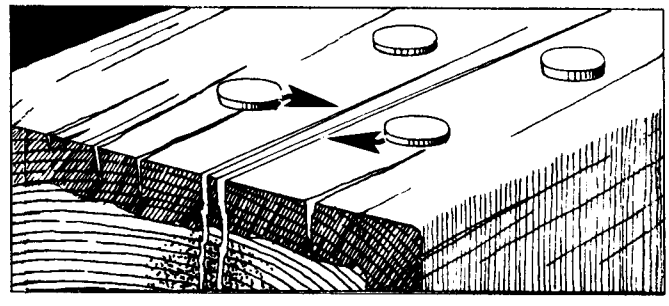
Preservatives applied by ordinary flooding from a brush or spray penetrate the wood only slightly and so cannot stop this decay. Recent research at the Forest Products Laboratory, in cooperation with the U.S. Naval Facilities Engineering Command, has shown that such fumigants as Vapam (sodium N-methyl dithiocarbamate) and chloropicrin (trichloronitromethane) applied to holes drilled in the timbers (for example, curbing) and plugged can stop internal decay.

Before applying the fumigant, inspect the timbers thoroughly to determine drilling patterns that avoid metal fasteners, seasoning checks, and severely rotted wood. Drill holes straight down to within about 1 inch of the bottom. Holes can be drilled in a cluster in the top or in pairs.

Treatment holes should be no more than 4 feet apart. The amount of chemical needed and the size and number of treating holes required depend on timber size. For example, a 7- by 8-inch timber can be protected by applying 0.13 pint (60 ml) into four equally spaced holes above a decayed area.

The fumigant can be squirted into the holes with a 1-pint polyethylene squeeze bottle. During application, wear protective clothing and position yourself upwind. Immediately after adding the fumigant, plug the holes with preservative-treated dowels or rubber stoppers. Be sure to leave enough room in the treating holes so that the plugs can be driven in without squirting the chemical.

Decay originates in deep-seasoning checks.



Treating holes should be situated on both sides of checks.

Eventually these fumigants lose effectiveness and retreatment is necessary. When this happens varies. Chloropicrin will remain effective for 10 or more years, whereas Vapam-treated timbers need retreatment in about 5 years.

Because these chemicals are toxic, the user needs to be familiar with proper handling and application procedures. The use of trade and company names is for the benefit of the reader; such use does not constitute an official endorsement or approval of any service or product by the U.S. Department of Agriculture to the exclusion of others that may be suitable.

For technical information, contact Terry Highley, Project Leader, Forest Products Laboratory, One Gifford Pinchot Drive, Madison, WI 53705-2398. (608) 264-5613.

Inspection of Timber Trusses & Glulam Arches

Wood is one of our oldest building materials, and its long-term performance can be observed in buildings that are several centuries old. It does not deteriorate because of age alone, but there are service conditions that have major effects on its durability. Deterioration can result from a number of factors, such as errors in original design or construction, changes in loading, or inadequate maintenance practices that allow rain entry. Deterioration often advances slowly and is not immediately obvious. By the time it is apparent, trouble may be widespread. Inspection on a routine schedule can identify problems or potential problems before they become severe. Corrective measures at early stages may involve only minor expenses; however, if deterioration is allowed to continue, the result may be costly major repairs or even complete demolition of the building.

Researchers at the Forest Products Laboratory, working with the U.S. Naval Facilities Engineering Command, have developed an inspection manual for facility condition evaluation standards that prescribes the procedures for identifying the deficiencies in timber trusses and laminated wood arches. This manual first defines the types of deterioration and lists the underlying causes of the defects. A rating system is developed, based on the urgency of action required at the level of the public works engineering staff. Inspection equipment and procedures are then explained.

The basic knowledge contained in the manual can be applied to inspection procedures for establishing a condition-rating system that will inform managers of the requirements for maintenance or repairs. These standards are limited to instruction for inspecting to identify possible problem areas that may require indepth study, and do not include analysis or repair methods. Additional inspection may be required by a professional to determine the exact extent of deterioration and to evaluate its effect on the structure. While many of the principles discussed apply to all wood structures, the emphasis is on heavy-timber trusses and glulam arches.

Copies of the Navy manual, NAVFAC MO-111.1, "Inspection of Wood Beams and Trusses," can be obtained by contacting Information Services, Forest Products Laboratory, One Gifford Pinchot Drive, Madison, WI, 53705-2398. (608) 264-5637.

Control of Decay in Above-Water Marine Pilings

Wood is one of the most widely used materials for piers and wharfs. Each year, however, millions of dollars of above-water marine structures are lost to decay because the wood is inadequately treated. Particularly prone to decay are the heartwood portions of pressure-treated Douglas-fir fender piles and other large structural wooden members with deep checks in the wood that penetrate beyond the treated zone. Premature failure of marine pilings is also serious in fender piles, which are required to protect both the docking vessel and the pier or wharf from possible impact damage.

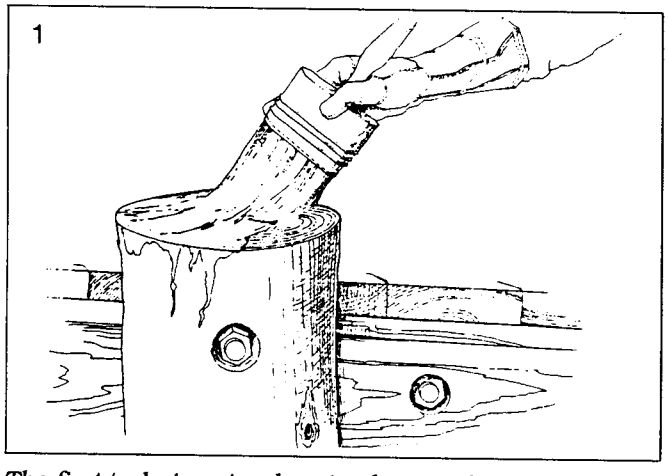
Recent research conducted by the Forest Products Laboratory, in cooperation with the U.S. Naval Facilities Engineering Command, has shown that two simple in-place treatments can be used to prevent above-water decay and extend service life of marine pilings at least 10 years:

(1) The first technique involves in-place application of either Osmoplastic (Osmose Co.) or ammonium biflouride to the top surface of cutoff piles.

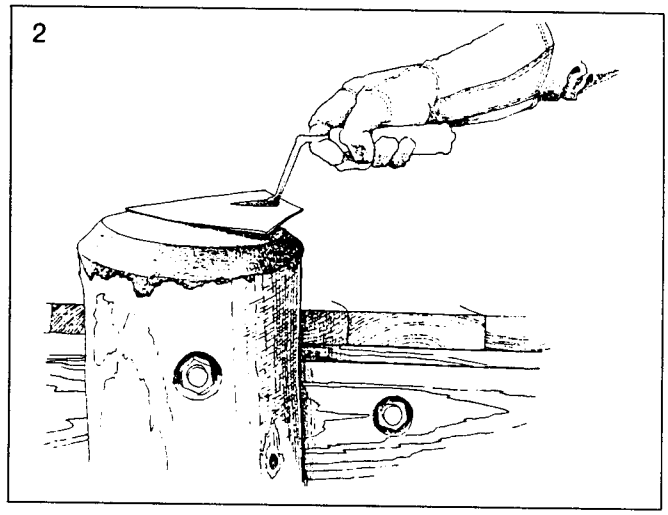
(2) The second technique, used in conjunction with the first, involves the application of a coal-tar coating "cap" on top of the treated cutoff pile.

The importance of this research is emphasized by the fact that replacement costs for piles, decks, curbs, fender pilings, and other waterfront structures have increased substantially in recent years. Equally important is the fact that wood is the only material to combine four specific advantages: high strength-to-weight ratios, resiliency, ease of construction, and relatively low cost.

Some of these materials are toxic; the user needs to be familiar with the proper handling and application procedures. The use of trade and company names is for the benefit of the reader; such use does not constitute an



The first technique involves in-place application of either Osmoplastic (Osmose Co.) or ammonium biflouride to the top surface of cutoff piles.



The second technique, used in conjunction with the first, involves the application of a coal-tar coating "cap" on top of the treated cutoff pile.

official endorsement or approval of any service or product by the U.S. Department of Agriculture to the exclusion of others that may be suitable.

For technical information, contact Terry Highley, Forest Products Laboratory, One Gifford Pinchot Drive, Madison, WI 53705-2398. (608) 264-5613.

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