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Rossiter, Walter J. / U.S. Postal Service
QC100 .U56 NO.85-3275 V1985 C.1 NBS-PUB-

NBSIR 85-3275 (R)

U.S. Postal Service Roofing Practices

Reference

NBS

PUBLICATIONS

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November 1985

Prepared for:

U.S. Postal Service
Design Management Division
Real Estate and Buildings Department
Washington, DC 20260-6415

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U.S. DEPARTMENT OF COMMERCE, Malcolm Baldrige, *Secretary*
NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director*

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ABSTRACT

This report reviews the roofing practices of the U.S. Postal Service (USPS). The USPS has direct responsibility for the design, construction, and maintenance of about 100 million ft² of roofing. In addition, it leases buildings having approximately an equal amount of roof area. The approach taken was to obtain information on USPS roofing practices which could be used as a data base for judging strengths, weaknesses, and identifying problems. The primary sources of data were: discussions with USPS personnel; discussions with individuals who provide roofing services to USPS; review of USPS roofing documents; results of the distribution of questionnaires to USPS staff; and the determination of training requirements for those involved with roofing.

The review was divided between two major phases of USPS roofing construction practice. One part involved design, materials, and construction, and the other involved inspection, maintenance, and repair. The primary topics addressed with regard to the review on design and construction were general design considerations, training, responsibility, material selection, and quality control during construction. With regard to maintenance and repair, the review included general considerations, frequency of inspections, responsibility, training, maintenance guidelines and manuals, repairs and when they are conducted, and inspection and maintenance records. The advantages and limitations of the USPS roofing practices were given, and will form the basis of recommendations for improving USPS roofing practices.

Key words: construction; design; low-sloped roofing; maintenance; material selection; repair; review; roofs

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Acronyms Used in Report

This report contains a number of acronyms used by the U.S. Postal Service and the Roofing Industry. The expressions represented by these acronyms are presented here for the convenience of the reader.

<u>Acronym</u>	<u>Expression</u>
A/E	Architect/Engineer
ARMA	Asphalt Roofing Manufacturers Association
BMEO	Building Management and Engineering Office
BUR	Built-Up Roofing
FM	Factory Mutual
FREBO	Field Real Estate and Building Office
MSC	Management Sectional Center
MTSC	Maintenance Technical Support Center
NBS	National Bureau of Standards
NRCA	National Roofing Contractors Association
RIEI	Roofing Industry Educational Institute
UL	Underwriters Laboratories
USPS	U.S. Postal Service

1. INTRODUCTION

1.1 Background

The United States Postal Service (USPS) is among the Nation's largest users of buildings with an inventory of about 34,000. Although USPS leases about 85% of the buildings, the majority are relatively small with the area being less than 10,000 ft². The total roof area of the buildings used by USPS is estimated to be about 200 million ft². However, because USPS owns the majority of its larger buildings, it assumes responsibility for design, construction, and maintenance for about one half of the total roof area of the buildings used. Moreover, in the case of some leased buildings, USPS has indirect responsibility for roof maintenance and repair.

It is difficult to estimate accurately USPS roofing costs for new construction, repair, and replacement, since roofing costs are often combined with those connected with general construction, and repair and maintenance. Roofing industry figures for the United States generally indicate that the annual cost of new roofing construction is about equal to the cost of roof repair and reroofing. Over the last few years, about \$15 million dollars has been spent annually on direct repair and replacement of USPS roofing. If USPS follows the general trend found in the private sector of the roofing industry, another \$15 million dollars may be spent on its new roofing construction each year.

The USPS buildings are located throughout the United States. As may be expected, roof design and maintenance practices differ widely depending on the area, climatic conditions, and local design procedures and materials preference. The complexity of understanding and predicting roofing performance is further

complicated by the many different types of available materials and the variety of application practices.

The USPS requested the National Bureau of Standards (NBS) to provide technical support to obtain quality assurance in its roofing. In providing this support, the following two major tasks were carried out: 1) review of USPS roofing practices, and 2) review of roof management programs currently used by organizations in both the public and private sectors. The information obtained from these two tasks will provide the basis for recommendations for a roof management program applicable to the needs of USPS. This report, one in a series of three reports, addresses USPS roofing practices and provides a discussion and summary of these practices.

1.2 Objective

The objective of this report is to review USPS roofing practices regarding design, construction, maintenance, and repair, and to give the advantages and limitations of the practices.

1.3 Scope

This report is limited to a review of USPS roofing practices. Comparisons with roof management programs conducted by other organizations having many buildings located in various parts of the United States will be the subject to the final report.

2. OVERVIEW OF USPS ORGANIZATION REGARDING ROOFING

The primary objective of the USPS is the collection and distribution of mail for the United States. Facilities are constructed and maintained with this objective in mind. As a consequence, USPS has numerous buildings located in all areas of the United States and its territories ranging in size from a few hundred square feet to over one half million square feet. The organizational structure of the USPS reflects this wide distribution of the buildings and the variability in size. The main units with regard to roof performance within the USPS organization are: Headquarters, Regions, Districts, Management Sectional Centers, and Post Offices. This breakdown in organization is shown in figure 1 along with the practices regarding building design, construction, and maintenance generally carried out within each of the major units. As indicated in figure 1, the design and construction activities are generally separated from the maintenance activities. In addition, major design and construction activities are not carried out at levels below the Regional Offices and Field Real Estate and Building Offices (FREBO). Roofing is only one aspect regarding building design, construction, and maintenance. The units involved with buildings, as would be expected, have responsibility for the total facility.

An overview of the responsibilities of each of the major units is given as follows.

1. HEADQUARTERS -- located in Washington, DC.

- a. Design Management Division -- The Design Management Division is part of the Administrative Group at USPS headquarters. It is responsible for the design of facility projects which cost \$5 million dollars or more. Thus, roofing in such projects is controlled by the Headquarters Project Manager. In addition, Headquarters provides managerial policy to the Regional Offices. Guidelines regarding construction practice including roofing are generally not provided.

MAIN USPS ORGANIZATIONS INVOLVED WITH ROOFING

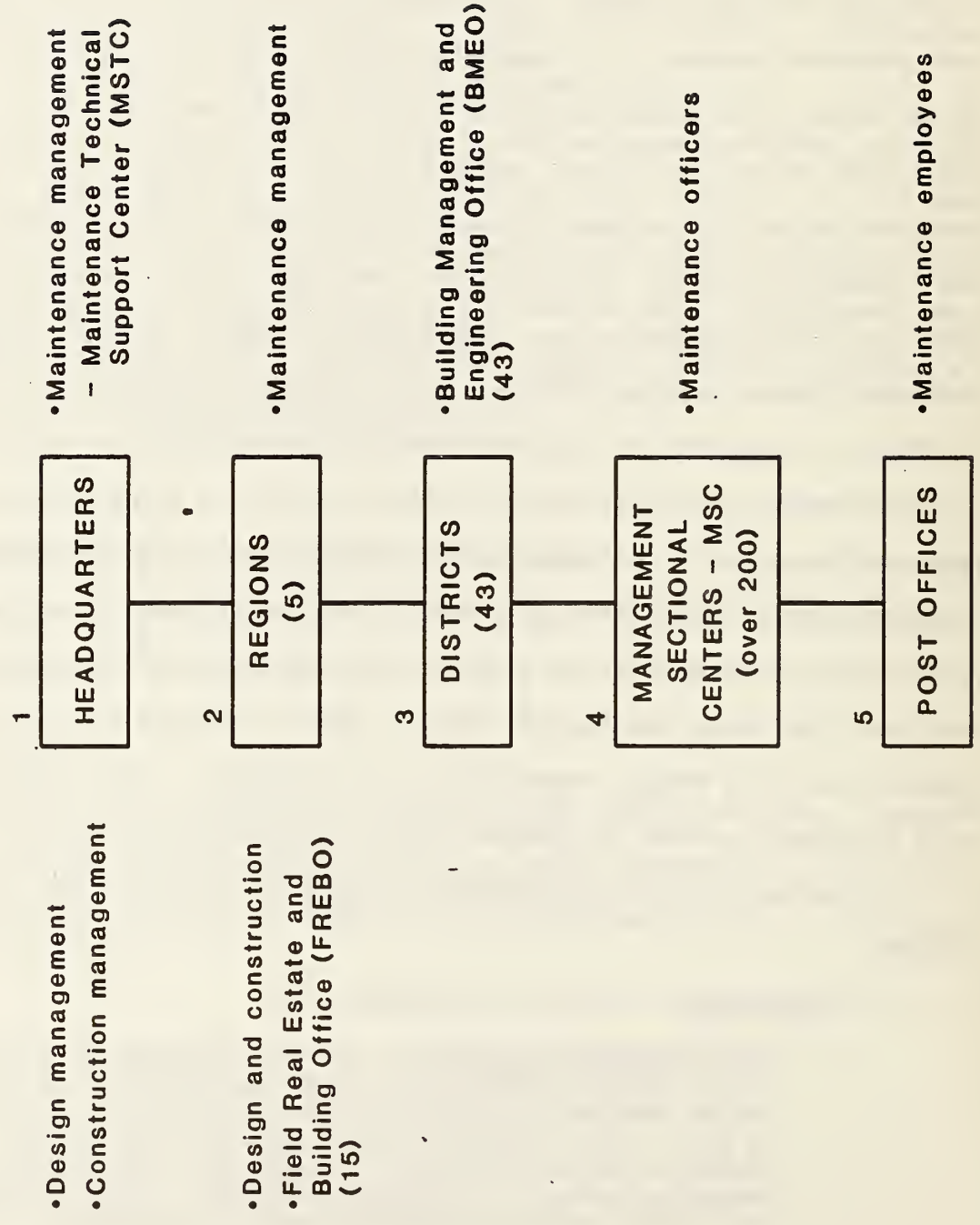


Figure 1. Main USPS Organizations Involved with Roofing

- b. Construction Management Division -- This unit has responsibility for the construction of facilities designed at the Headquarters level. Among the activities included here are bidding, scheduling, monitoring of progress, completion and acceptance of the facility. Also, change orders regarding alterations to the original design and specification which are initiated during construction are handled by the construction management unit.
 - c. Maintenance Management -- This unit is part of an operational group at headquarters and provides policy direction regarding maintenance of facilities. The Maintenance Management Office has connected with it the Maintenance Technical Support Center (MTSC) which provides technical assistance, maintenance handbooks, and technical training.
2. REGIONS -- There are five regions distributed in the northeastern, eastern, central, southern, and western sectors of the United States.
- a. Design and Construction -- This unit generally has responsibility for facility projects costing less than \$5 million. A major responsibility is the setting of administrative policy for the regions. The regions have a certain amount of autonomy from headquarters regarding construction practices. Each region may provide general guidelines for its own use. The operational procedures of the regions may vary from one to another depending upon regional preference. This is particularly true for new roofing design and construction. For example, the Eastern Regional Design and Construction Branch does mostly new design for the Eastern Region. FREBOs (see next paragraph) connected with the Eastern Region do repair and renovation. In contrast, in the Southern Region, all roofing design and construction is the responsibility of the FREBOs connected to the region. None is done by the regional office.
 - b. Field Real Estate and Building Offices (FREBOs) -- There are 15 located across the United States. They are responsible for new design and construction including roofing where the costs do not exceed \$5 million, in cases where the Regions do not handle this responsibility. In addition, they provide for major repair, renovation, and replacement of existing roofing. Such work is normally initiated at the request of the Building Management and Engineering Offices (BMEOs) and submitted through the District Offices.
 - c. Regional Maintenance Management Divisions -- Overall responsibility and policy management for the USPS building maintenance program regarding repair and alteration is provided by the Regional Maintenance Management Offices. In addition, some technical assistance and guidance is provided to the Building Management and Engineering Offices (BMEOs) and Management Sectional Centers (MSCs) through the district offices.

3. DISTRICTS -- USPS has 43 Districts located across the United States. The District Offices have responsibility for the building maintenance program in each of its MSCs (see item 4 below) and for administrative duties including operational, financial, and scheduling decisions regarding maintenance.
 - a. Building Management and Engineering Offices (BMEOs) -- Each district office has connected with it a BMEO. The BMEOs are key units in the maintenance of USPS facilities including roofing. Maintenance related functions under the responsibility of the BMEOs include the coordination and assistance of other USPS organizations, the recommendation of priorities of needed repairs and alterations, identification of responsibility for conducting repair, submittal of plans for approval and funding, the initiation of repair work, and the monitoring of progress for ongoing repair activities. Repair and maintenance of USPS facilities may be done either in-house or by contract. With regard to roofing, the BMEOs conduct in-depth inspections on a regularly scheduled basis, which in many circumstances is every 2-3 years. In general, repair work costing less than \$5000 can be initiated directly by the BMEO. If the cost exceeds that amount, the BMEO requests the FREBO to provide for the completion of the repair. Figure 2 depicts the interactions of the BMEO with the other USPS organizations [1].
4. MANAGEMENT SECTIONAL CENTERS (MSCs) -- There are over 200 MSCs. They are responsible for the maintenance of all buildings including roofs, and the equipment in the building. Regarding roofs, the MSCs have maintenance officers who are responsible for establishing preventive maintenance programs included routine inspections which, for the most part, are on an annual schedule. For minor repairs, the MSC can issue work orders and have repair work completed. When more extensive repair is needed, the MSCs make requests of the BMEOs.
5. POST OFFICES -- For any individual Post Office, the postmaster has responsibility for the maintenance of the facility. Large post offices may have assigned maintenance employees who would, among other duties, provide for routine roof inspection and maintenance. It is at the Post Office level that leaks in roofs are normally first discovered. When such occurrences happen, requests for assistance are made to the upper organizations to have repair work initiated. Postmasters have a small amount of discretionary funding which they may use for minor roof repair. However, since such funding is also used for mail handling needs, it is not likely to be spent on roof repair.

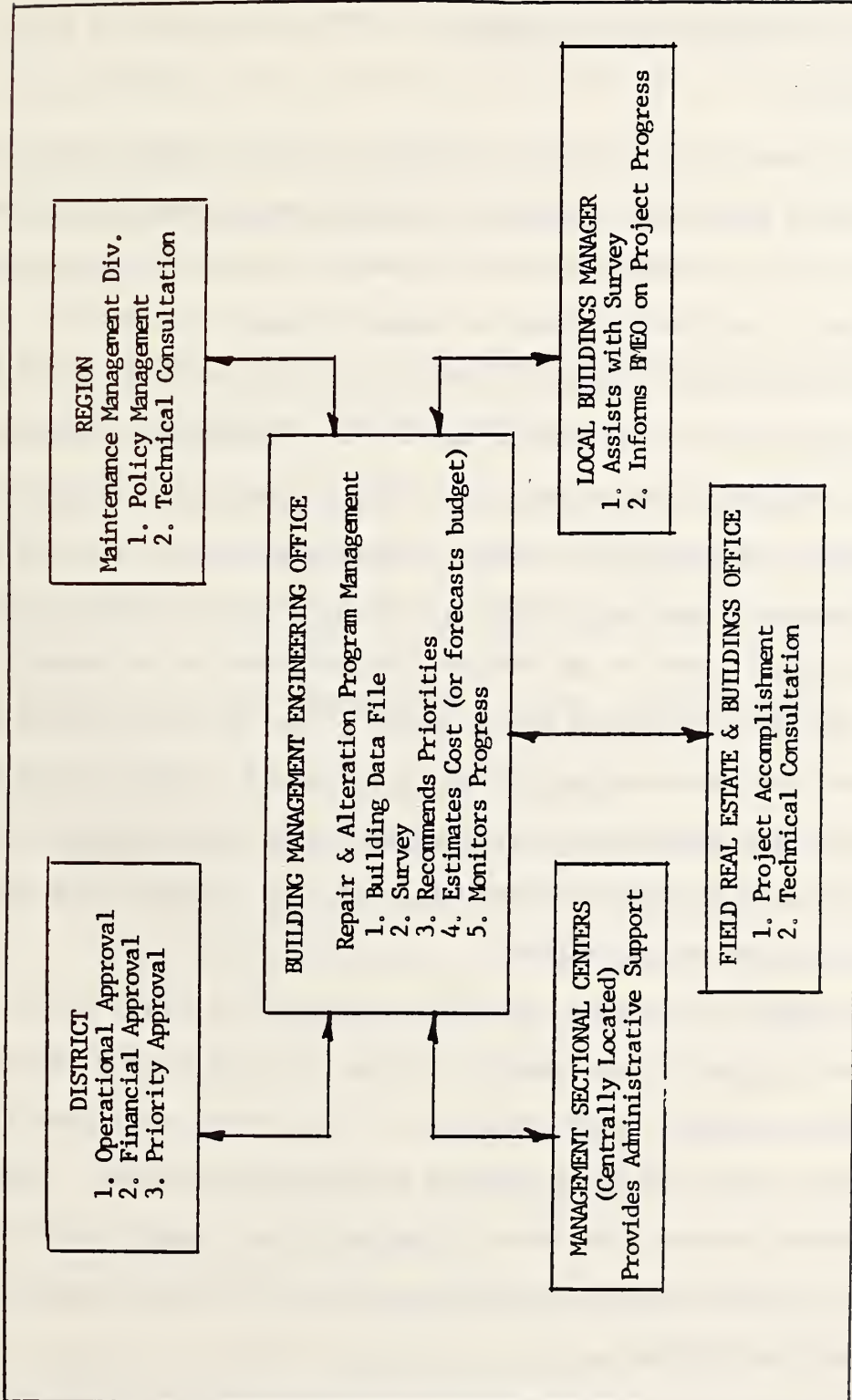


Figure 2. Interactions of the Building Management and Engineering Offices with Other Offices of the USPS.

3. REVIEW OF USPS ROOFING PRACTICES

3.1 Approach

This phase of the study was conducted to review existing USPS roofing practices and activities in order to identify their strengths, weaknesses, and problems so that recommendations may be made to improve existing practices and activities. A two-fold approach was taken to conduct the review. First, NBS research staff briefly looked at USPS roofing practices and activities to become acquainted with its roofing operations. Preliminary discussions were held with USPS personnel, primarily at USPS Headquarters, covering the design, construction, and maintenance areas to obtain an overview of the USPS organizational structure regarding roofing. Next, tasks were proposed for conducting a more in-depth review of the USPS roofing practices and activities.

In planning the conduct of the study, it was recognized that four elements are essential to assuring the quality of successful roofing performance: sound design, suitable materials, good workmanship, and good maintenance. Thus, the review addressed obtaining information about these elements with regard to USPS roofing practices and activities.

Preliminary discussions with USPS headquarters personnel revealed that, with regard to facilities including roofing, the USPS building operations are divided into two major areas (Figure 1). One area centers on design and construction, while the other concerns maintenance and repair. This division was considered during formulation of the work plan. Some project activities primarily considered design and construction, while others were oriented towards maintenance and repair.

The major project tasks undertaken during the study to obtain information and to review USPS roofing activities and practices were to:

- o Hold discussions with USPS personnel having responsibilities for roofing. The discussions were held with both headquarters and field personnel.
- o Hold discussions with individuals who provide the USPS with roofing assistance including architects/engineers (A/Es), and roofing specialists.
- o Review typical contract and maintenance documents used by USPS for roofing construction, and maintenance.
- o Develop two questionnaires concerning USPS roofing practices and activities for distribution to USPS; one questionnaire concerned design, materials, and construction; the other dealt with maintenance and repair.
- o Determine training requirements for USPS roofing personnel.

3.2 Design, Materials, and Construction Practices

This section of the report presents the review of the USPS roofing activities and practices concerning design, materials, and construction. It is based primarily on the review and analysis of information obtained from a questionnaire on that subject. Information obtained in discussions with USPS personnel and others who work under contract to USPS was used to complement the results obtained from the questionnaire. For the most part, information obtained in the discussions with USPS personnel was consistent with that determined from the review of the completed questionnaires.

The questionnaire for design, materials, and construction, along with typical responses, is given in Appendix A. Since most of the questions were multiple choice and respondents could mark more than one answer for some

questions, the average response often totals greater than 100 percent. This questionnaire, which contained 78 questions, was sent to individuals at USPS headquarters, and regional and field offices across the United States. Fifteen organizational units responded. In many cases, those responding were contacted by phone to discuss some of the results and USPS roofing practices in general. In some cases, those responding were visited by NBS staff. The results of the questionnaire, complemented by discussions with USPS personnel, form the basis of the trends regarding USPS roofing design, materials, and construction practices which follow.

3.2.1 Roofing Performance

Those contacted during the study were strongly of the opinion that roofing performance constituted one of the major facilities problems within the USPS system. Most staff also indicated that USPS roofing has improved in recent years because of an increased awareness by USPS of the benefits of having better roofs and the actions which have been taken towards that aim. Nonetheless, although many roofs are providing satisfactory service, discussions pointed out many examples of premature failure and replacement of roofing only a few years after construction. In at least one case, the story was told of a large roof which was partially re-roofed, but before completion of the total job, sections of the new roofing were leaking. In general, because of the concern that USPS roofing was experiencing an unacceptably high incidence of problems with resulting high costs, USPS field personnel encouraged the taking of steps to improve the roofing activities and practices.

Answers to questions concerning roofing performance and problems covered a wide range of topics commonly associated with problem roofing. A wide range

of problems was often mentioned resulting from such causes as poor design and workmanship including construction under adverse weather conditions, improper material selection, and inadequate slope to provide drainage. Specific system problems such as poor flashing details, blisters, splits, alligatoring, and exposed felts with built-up roofing were given as typical examples.

Regarding the performance of roofing systems in general, many responses indicated that the most critical parameter was proper application. The experience of some individuals indicated that most roofing systems specified by USPS will perform satisfactorily if properly installed. These same individuals continued to state that most roofs will experience problems where poor workmanship is involved. This response was not surprising. In fact, it was typical of concerns expressed in 1979 by Federal government agencies having large inventories of roofs [2]. In a report issued by the Federal Construction Council, inadequate workmanship during roofing installation was singled-out as a major cause of poor performance of Federal government roofs.

Both built-up roofing and single-ply roofing was equally noted as having provided satisfactory performance. On the other hand, when discussing unsatisfactory performance, most comments pointed to built-up roofing. Only a few respondents indicated poor performance from single-ply membranes. This response may be partially influenced by the fact that, over the years, USPS has used considerably more built-up membranes than single-ply membranes. It is only in recent years that the use of single-ply membranes has increased for USPS facilities.

3.2.2 General Design and Construction

By and large, the design of roofing systems as well as the preparation of specifications is accomplished by an architectural firm or roofing specialist under contract to the USPS. Less frequently, these task responsibilities are assigned to USPS personnel. With the exception of headquarters, there is no uniformity related to the design and specification phases as the practices varied somewhat among the organizations contacted.

Headquarters, in having responsibility for construction totaling in excess of \$5 million including the roof costs, awards a contract to an A/E firm for total design of the facility in question. This firm has a wide latitude in its selection of the roofing system. The USPS does not have guide specifications for roofing but provides the A/E with general design guidelines. These guidelines address considerations such as: a minimum slope of 1/4 inch per foot; a maximum thermal U-value of 0.05 Btu/h·ft²·°F; materials; roof top equipment; walkways; and warranties. The A/E proposes three roofing-system designs and conducts a life cycle cost (LCC) analysis of the proposals. The LCC analysis provides the justification for which of the three proposed systems is selected. Key factors in the LCC analysis are initial material and installation costs, energy savings, and maintenance costs.

As a matter of recent USPS headquarters practice, the A/E is required to engage the assistance of a roofing specialist. The responsibilities of the specialist are to: review and critique the contract documents; participate in the pre-job conference; review roofing contractors' submittals; provide full-time on-job inspection during installation; and where applicable in cases of major renovation, provide a field evaluation of existing roofing. When a project is still in the design phase, the three parties, A/E, roofing specialist,

and USPS project manager, will discuss and review the comments made by the roofing specialist concerning the A/E's design. Steps to be taken for appropriate revision of the design will be planned. The A/E firm will execute the revisions.

With regard to roofing practices conducted by the regional offices, design and construction practices may vary widely between regions and FREBOs. Some design is conducted in-house, although most is done using the services of an A/E firm or roofing specialist. This may depend upon the office. For example, in the case of one FREBO, essentially all roofing design is conducted in-house. Only major new construction is designed under contract to an A/E firm. In contrast, 5 FREBO offices do no design work in house. For the most part when an A/E firm is under contract, design and material selection is left to the A/E. The USPS project manager reviews and approves the A/E's design. Some general guidelines on preferred systems may be given to the A/E firm by the USPS project manager before design is begun. Such guidance may promote the use of a built-up membrane system over single-ply, or vice versa.

When design work is done for USPS under contract, the A/E may be selected based on merit for the specific job. This is often the case with new construction. A/E firms are also placed under term contract so that they are available as needed, particularly for repairs, renovations, and re-roofing. Limitations on the contracts of the term A/Es are imposed. Generally, the contracts have a 1-year duration with options for repeated 1-year renewals which cannot exceed a total contract term of three years.

Roofing specialists are sometimes used at the regional and field levels for both new and re-roofing. This is not a matter of USPS policy, but a matter of preference of the particular USPS regional office or FREBO. In many cases,

roofing specialists are not used but the A/E firms are instructed by USPS project managers to obtain the assistance of roofing specialists if they consider that such help is needed to design the roof in question.

Recently, some FREBO offices, particularly those in the Southern Region, have initiated a practice of providing contracts to term A/Es who specialize in roofing design and construction. These roofing specialists are selected in lieu of general A/Es to provide evaluation of existing roof, design recommendations on repair, renovation, and reroofing, and inspection and testing (as required) of roofing installation.

The reason why some FREBO offices use roofing specialists for their roof design and construction activities, and other FREBO offices do not, appears to be philosophical. Those engaged in the practice believe that general A/E firms are not adequately knowledgeable in roof design and therefore specialists are needed. Those offices that do not use roofing specialists have the viewpoint that trained designers are professionals capable of generally handling all aspects of building design including roofing. Thus, it is reasoned, specialized assistance in the form of roof specialists is not needed for normal design and construction. Another reason often given is that the A/E under contract may need to design repair work for many areas of the building, and not just the roof. Thus, the A/E cannot necessarily be a roofing specialist in these cases.

This divergent opinion between various FREBOs was reflected in the questionnaire responses. All the responding offices reported satisfaction with the A/E firms used for design and specification of roofing systems. However, the opinion was about evenly divided on whether the A/E firms under contract to

USPS were adequately knowledgeable in roofing technology. Half the respondents answered that the A/E firms were seldom knowledgeable.

In discussing the use of roofing specialists for roof design and construction with FREBO offices which have taken up the practice, much enthusiasm was expressed at its success. Indications were that no major problems have arisen to date with roofs designed and constructed under the practice. Unfortunately, the oldest program of this type has only been in place at one FREBO for about 4 years. Thus, it is difficult to draw conclusions as to its long term success. Nevertheless, the trends based on the limited experience point towards significant reduction in premature failures of new roofs.

One area of concern with the use of roofing specialists for design and construction expressed by some FREBO personnel is that it is imperative that qualified individuals are selected. Uniform criteria have not been established for their selection, although each FREBO engaged in the practice has its own guidelines. For example, one FREBO indicated that the A/E firm must be able to demonstrate specialization in roofing with a minimum number of years of experience.

With regard to the field offices, the majority of the roofing projects undertaken according to the questionnaire respondents involved new and reroofing jobs in a cost in the range of \$5,000 to \$50,000. The new job projects had a slight edge over reroofing which included tear-off of existing membranes. Recovering, repair, and routine maintenance accounted for little effort. Some of the FREBO offices indicated that they are not involved in repair and maintenance applications. Routine repair and maintenance with costs less than \$5000 are handled by the BMEOs.

Almost 50 percent of the FREBO units seldom contact other USPS units regarding roofing problems or information. Forty percent of the units responding indicated that contact is made in cases when design is involved or serious roofing problems and failures are experienced. Questions relating to material selection, application procedures, and maintenance considerations seldom precipitated office to office communications. Periodic meetings are held with selected personnel from the various FREBOs to discuss general engineering and facility problems. Roofing may be a subject at some of these meetings.

3.2.3 Guide Specifications and Other Documents

The majority of the questionnaire respondents reported that the USPS had guide specifications available for both new roofing and reroofing. About 40 percent were of the opinion that such documents were not available. For those who responded affirmatively, there was general agreement among the respondents that the documents available were inadequate for the needs. In discussions with field personnel on this subject, it was generally indicated that USPS did not have guide specifications. The "Facility Design Orientation" package issued to A/Es by headquarters for its construction projects specifically states that USPS has no guide specifications. General requirements for slope and U-value are included in all USPS design. Some field offices have packages for distribution to A/Es. For example, a design checklist including roofing considerations was obtained from the USPS Eastern Regional Office. Regarding roofs, it contained 8 items including the slope and U-value requirements. It is difficult to assume that such a checklist would be considered as a design specification by the questionnaire respondents. Nevertheless, the possibility cannot be ruled out. If it were the case, it may be rationalized as to why

the document would be considered inadequate as a guide specification since it is limited to general design guidelines.

USPS Headquarters has prepared "short form specifications" for use by field real estate and buildings, and maintenance personnel to implement small repair and improvement of construction contracts. The intent is to avoid having field personnel writing new specifications for each small project they encounter. With regard to roofing, the "short form specifications" are for: replacement of a BUR membrane with a new BUR membrane; recovering an existing BUR membrane with a single-ply membrane; recovering a BUR membrane with another BUR membrane; and others for repair or replacement of roof accessories such as metal flashings, drains, gutters, and scuppers.

These "short form specifications" were reviewed during this study. A notable observation was that they require updating due to recent changes which have taken place regarding roofing materials use and availability. Another concern was the manner in which these specifications addressed the allowed recovering of existing membranes which may contain unacceptable amounts of moisture. The finding that the "short form specifications" was out-of-date was not surprising. A general criticism often voiced at the use of form specifications is that they require considerable attention to keep them current. In fact, many USPS personnel raised concerns regarding the need for updating during this study when asked whether they thought the use of master specifications would be beneficial to USPS roofing practice.

The National Roofing Contractors Association's (NRCA) "Roofing and Waterproofing Manual" was the most frequently cited industry document used to assist in roof design, especially with respect to design details for flashings at perimeter walls, penetrations, and the like. Manufacturers' specifications

were also used in a large number of cases. Other documents such as Underwriters Laboratory (UL) and Factory Mutual (FM) bulletins and other releases were used to a lesser extent. The Roofing Industry Educational Institute (RIEI) documents were also cited to a lesser extent. Nevertheless, apparently those who attend RIEI courses use the manuals and information provided. In cases where the FREBO offices are using roofing specialists for design work, no documents were cited. The FREBO offices rely on the advice of the roofing specialists who use the documents of their choice.

3.2.4 Education and Training

A wide difference of opinion is apparent regarding the question whether USPS personnel keep abreast of the current state-of-the-art of roofing technology with respect to design and material selection. Fifty percent of the questionnaire respondents replied affirmatively, while the other 50 percent responded negatively.

This response was not totally surprising considering that the roofing industry has changed drastically in the last few years. Nonetheless, the majority of units indicated that training and educational opportunities in roofing are available for selected staff members. The questionnaire results indicated that less than 25 percent of the staff in any office attend training courses annually and 10 percent take that no training related to roofing. Reluctance to take time away from the work at the office for needed training was a reason often given for lacking of continuing education.

Industry courses such as RIEI and in-house seminars provide the major information sources for keeping the staff current with roofing design, materials, and technology. Very often in-house seminars are conducted by material

vendors at the USPS facility. An attraction of vendors seminars is that they are usually put on without direct expense to the USPS. Questions can, of course, be raised about the objectivity of vendors seminars. One FREBO indicated that it tries to have many broad-based seminars from vendors so that bias may be minimized. In a few cases, roofing specialists are used to provide in-house training.

3.2.5 Responsibility

Eighty percent of the offices responding to the questionnaire indicated that no individual staff member was designated as having office responsibility for design, construction, repair, and maintenance of roofing. In many cases, the reason given was that flexibility in staff responsibility was desired, and thus all project managers were assigned roofing responsibility at one time or another. The project manager has the ultimate responsibility that a given roof is designed and constructed acceptably. Further, there were wide differences of opinion expressed (ranging from none to all) when responding to the question of how many project managers have roof design and construction responsibilities. In some offices, where roofing specialists are used under term contract, one individual in the office is given the responsibility of coordinating the roofing jobs with the specialist.

3.2.6 Roof Slope

The questionnaire respondents indicated almost unanimously that all design documents for new roofs include a provision for a minimum slope of 1/4 inch per foot. This was not surprising since USPS, as a matter of current policy, requires such slope. In cases of roofs on existing buildings, inadequate drainage due to lack of sufficient slope is an often-cited problem with USPS roofing.

3.2.7 Material Selection

In the case of roofs designed by headquarters, material selection is left to the A/E firm working in conjunction with the roof specialist. The A/E must propose 3 systems and make a life-cycle cost analysis on which one of the three systems is selected.

With the field offices, the discussions indicated that material selection is left to the A/E firm or roofing specialist in the majority of both new and re-roofing projects. Alternative systems are proposed for major renovations. Frequently, USPS field staff provide input into the selection process. This was often done by informing the A/Es of materials and systems that are or are not acceptable to the office.

It appears from the discussions that USPS uses all types of roofing materials and systems for its buildings. As more than one USPS individual indicated, "if it is possible to purchase the material, we have it on some of our roofs somewhere." Exact distributions of the types of materials and systems used were not ascertained during the study. Local preferences in some FREBO offices exert a large influence on the materials selected for roofing. Over 80 percent of the questionnaire respondents answered that they preferred one or two roofing systems over others. Some FREBOs are using only single-ply materials; while others are using only BUR. In at least one case of a regional office, there was a strong preference for spray-in-place polyurethane foam.

Many field personnel and most respondents to the questionnaire were of the opinion that membrane materials were selected on a basis of performance or on history in service. As an example, one FREBO project manager indicated in discussions that many phone calls to previous users are made, along with some site visits, to check the performance of new materials for which the FREBO has

little experience. It was reported that the FREBO would not use the new material if the reports on performance were not satisfactory. Discussions with field personnel also indicated that the preference of the A/E or roofing specialist with input from USPS personnel also influence material selection.

The questionnaire respondents indicated that membrane material cost and availability provide little basis for the selection of materials. This response concerning material cost was not unexpected, since the USPS has a requirement that life cycle costs be considered for new roofing, and major repairs and renovations. In general, USPS personnel feel that the mechanism for materials selection is adequate.

Although the respondents feel that the materials selected for specific projects are adequate most of the time, there is a wide range of opinions as to whether or not quantitative or even qualitative comparisons between materials are made. ASTM standards industrial or manufacturers specifications are most often used for material specification. Many of the questionnaire respondents felt that USPS roofing specifications were seldom adequate to define roofing materials.

Those USPS personnel who keep abreast of materials and their performance use information sources such as seminars and formal training courses, technical bulletins, and manufacturers' literature. Although the majority of the questionnaire responses pointed toward expertise in the materials selection area, there was the prevalent opinion that considerable improvement is needed to keep abreast of materials and their performance. Little feedback from in-service performance of materials on the roof occurs. When feedback is received it comes on a one-to-one basis from maintenance people confronted with specific problems. As one FREBO project manager indicated, feedback is seldom obtained

until a "request for services" is received from the BMEO to repair a roof which the office previously designed. Records of material performance are seldom kept and field testing of materials is seldom used to evaluate new materials. Research, either laboratory or field evaluation, is rarely supported by the offices. When it is supported, reports are normally not prepared, and consequently, little use is made of the research by USPS Headquarters or other USPS organizations.

3.2.8 Application

In discussions with many field personnel, poor workmanship during roofing application was considered a major problem with respect to roof performance in the USPS. This was confirmed in the questionnaire responses to questions concerning roofing performance. For example, respondents often indicated that all roofing systems used by USPS will perform satisfactorily if they are applied properly. The majority (70%) of respondents to the question on workmanship indicated that it is satisfactory. Nevertheless, it appears to be significant that about 30% of the respondents indicated that the workmanship is seldom adequate.

Private sector roofing contractors are always used to install USPS roofing. These contractors are selected by an open bid process either for the specific job or on a term contract basis. In discussions, USPS field personnel expressed concern that the open bid process results in some roofs being applied by contractors who are not qualified. This concern was echoed in conversations with roofing specialists who provide roofing service to USPS. A number of individuals stated that local labor obtained in small towns was normally more reliable than that obtained in large cities.

Factors considered in the selection of contractors include past experience, training, and costs. Uniform criteria for contractor selection are not available for the entire USPS system. Certain offices have assembled criteria for their own use, but these may not be used beyond those offices. In these cases, the offices are satisfied that their selection criteria are adequate.

In cases where the work provided by term contractors is not adequate, the contract can be terminated. This has reportedly happened in some instances. In other cases of unsatisfactory performance, the term contractor will not be given additional work, and the contract would not be renewed.

The discussions with USPS personnel found some contrasting opinion concerning contract requirements that the roofing contractor be "approved" by the material manufacturer. Some individuals indicated that such contract requirements could not be used, while others stated they were doing so. In light of this mixed finding, it is interesting to note that the "short form specification" for recovering a BUR system with a single-ply membrane requires, as a contract submittal, that the contractor is approved by the material manufacturer.

3.2.9 Quality Control During Construction

A prejob conference among the various parties involved in the roofing projects is a recommended USPS practice. For the most part, USPS staff members are represented at the prejob conference.

The use of full time inspection during construction to help assure adequate workmanship varies widely depending upon the operational procedure of the local office. Headquarters provides such inspection for its projects through roofing specialists. In this case, the specialists are hired by the A/E using guidelines prepared by USPS headquarters. Likewise, some field offices have similar

requirements for inspection for all new roofing, reroofing, and major renovation regardless of the costs. In other cases, the field offices may provide full-time inspection on projects where costs exceed a certain dollar amount, for example, \$50,000. Full-time, continuous inspection was seldom used by some offices as a normal practice. The field offices usually use a "term" roofing specialist for the inspection. However, at least one FREBO has the roofing contractors hire the inspector for each job as part of the construction contract. The FREBO has to approve the selected inspector who has responsibility to the FREBO.

BMEO staff will occasionally visit a job site where re-roofing is underway, particularly if it is known that inspection is not being provided by the A/E or FREBO. The BMEO inspection is usually not pre-planned for all roofs, and is also a one time occurrence for a given roof. Additionally, the roof is usually conveniently located near the BMEO office.

In cases where field offices do not provide full time inspection as a routine practice, the opinion was often expressed that the assurance of adequate workmanship is the responsibility of the project A/E under contract to the USPS. The A/E should assure that inspection is provided on whatever frequency is adequate to have the construction carried out satisfactorily. The inspection may be done by the A/E or by a consultant. In some cases, USPS personnel will do periodic inspections.

Roof test cuts are not used as a routine procedure to evaluate quality of workmanship during construction of USPS roofs. However, representatives of one FREBO office stated that USPS should define acceptable requirements for membrane properties and allowable application tolerances as determined from test cuts. Their reasoning was that USPS needs to know precisely when the

installation is either "in-spec" or "out-of-spec" for purposes of determining liability should questions of acceptable practice arise.

Communication between the A/E firms and roofing contractors involved in USPS roofing appears to be satisfactory. It is the general consensus that responsible project officers are quite successful in holding the roofing contractor accountable for correcting deficiencies traceable to unacceptable workmanship. However one FREBO office suggested that specific criteria defining unacceptable workmanship need to be better defined so that the contractors responsibility is clearly defined. As an example, the size and percent of voids in the interply layers of asphalt in built-up roofing was given.

Quality audits (final inspections) of the completed roofs are generally conducted by USPS personnel, A/Es and consultants, and representatives of the material manufacturer. Nevertheless, the questionnaire respondents indicated that there are cases where quality audits are seldom conducted. Furthermore, it was generally the consensus that record keeping on the design and construction of roofs requires improvement to assure completeness. The FREBO offices keep warranty records, but the roof file is generally turned over to the BMEQ.

3.3 Inspection, Maintenance, and Repair Practices

The review of the USPS roofing activities and practices regarding inspection, maintenance, and repair is presented in this section of the report. As with the previous section, the information presented is primarily based on a review and analysis of questionnaire results. The results are complemented with

information obtained in discussions with USPS personnel or individuals performing roofing work under contract to USPS.

Appendix B presents the questionnaire for inspection, maintenance, and repair, as well as bar graphs of the responses. Most of the questions were multiple choice, and in some cases, the respondents selected more than one answer. Thus, the average response often exceeds 100 percent. This questionnaire contained 51 questions. It was sent to the Building Maintenance Engineering Offices (BMEOs) and Regional Offices. Thirty-nine units out of 48 responded. The trends in the USPS roofing practices regarding inspection, maintenance, and repair are based on the results of the questionnaires complemented by the information obtained from discussions with USPS personnel and others.

3.3.1 Problems Encountered During Inspections

Those who inspect roofs are obviously in the position to observe common problems experienced by them. In general, based on the experience of the BMEOs, the USPS problems are typical of the U.S. roofing industry in general. The defect most often experienced during USPS inspections involves flashing which has historically been a weak link in low-sloped roofing systems. Most of the membrane problems reported are associated with built-up roofing. This response is interpreted to reflect that, until recently, the USPS was using primarily built-up roofs. With regard to built-up roofs, the inspectors indicated that the major problems were blistering, splitting, and exposed felts. These problems are typical with built-up roofing in general and it is not surprising that the inspectors find such problems with USPS roofing. Another frequently encountered problem, which deals with design, is lack of proper drainage of the roof due to inadequate slope. Problems with single-ply

roofing such as gravel displacement and defective seams were also indicated. Problems with foamed in-place roofing were also reported.

It was reported numerous times that clogged drains and debris on the roofs were encountered during inspections by BMEO staff. Such observations indicate that periodic routine inspections are not being conducted to the extent desirable. These observations are also consistent with the often-expressed BMEO opinion that local preventive maintenance and inspection for roofs is inadequate.

Inadequate workmanship during roofing installation was also considered to be a common problem experienced by those conducting the inspections. Several respondents qualified the level of workmanship as being "poor" or the labor being "unskilled." There was also a strong response implying that inadequate workmanship was allowed due to inadequate inspection during the application of the roofing. Among the defects attributed to inadequate workmanship, flashing was cited as the most common. Others included improper installation of felts, membranes, insulation, bitumen, aggregate, ballast, caulking, and drains. In addition, the improper storage of materials at the job and installation of wet materials were reported in a number of cases.

3.3.2 General Considerations Regarding Maintenance and Inspection

In the vast majority (>95%) of cases, inspections of USPS roofs are carried out by USPS personnel and mainly those having maintenance responsibilities. Consultants or architects are sometimes used for this purpose. In-depth roof inspections by BMEO personnel are held in conjunction with inspections of other areas of the building. Generally, the inspections are planned events as opposed to inspecting after leaks or other problems are reported. Nevertheless,

the BMEOs respond to requests for local assistance when a roof is leaking and corrections are not possible at the local level. About half the questionnaire respondents indicated that roofs are inspected only after leaks or other problems were reported. Routine preventive maintenance inspections are the responsibility of the maintenance officers at the MSC level.

The majority of BMEO staff conducting roofing inspections are likely to seek and use outside assistance with difficult and unusual problems. For the most part, this assistance is provided by USPS FREBOs, contract A/Es, or roofing specialists. The USPS MTSC is seldom used, although MTSC provides assistance in investigating specific roofing problems and making recommendations for their solution.

Within the BMEO offices, each staff member may inspect from 10 roofs to 40 roofs a year. In a few cases, in some offices, staff inspect more than 80 roofs per year. About two thirds of the inspections result in repair work, with the remaining one third involving roof replacement.

3.3.3 Frequency of Inspection

For the most part, indepth roof inspections are conducted once every two to three years by the majority of the BMEO offices. About one quarter of these offices report yearly or twice yearly inspections, while about 10 percent inspect once every three years. The BMEO offices work on an inspection schedule which considers the age and size of the building. The roofs are normally inspected during the inspection of the building. Older buildings (greater than 15 years) having large roof area (greater than about 15,000 square feet) may be inspected once every one or two years. Newer (less than 10 years old) and small buildings may be inspected about once every 4 or 5 years. Buildings

with intermediate ages are generally inspected in a 3 or 4 year interval by a BMEO office. USPS had a requirement that roofs be inspected routinely every 6 months under the direction of the maintenance offices on the local level. However, for normal circumstances, the current USPS directive now requires routine inspection of roofs annually. It is also recommended that more frequent inspections be carried out for buildings located in extreme climates or for those having a history of roofing problems. Directives also provide that roofs be inspected after storms or other climatic events which may damage them.

Based on the results of discussions with USPS personnel and the questionnaire results, there appear to be some problems with having the local inspections conducted as USPS requires. As previously indicated, the BMEO inspectors frequently find clogged drains and debris on roofs. Such routine maintenance defects should be found and corrected during the local inspections. Reasons why the local inspections are not always conducted were not ascertained during the study. Some suggested reasons were the availability of personnel and the reluctance of some local maintenance staff to climb on roofs. In spite of the opinion that local preventive maintenance and inspection is often inadequate, the BMEO personnel generally consider that its own frequency of inspection is quite satisfactory. It is realized that more frequent inspections by the BMEO are difficult to conduct because of limited personnel in the BMEO offices. Thus, local maintenance must be relied upon for the routine inspections.

3.3.4 Responsibility

In general, the BMEO offices responded that they do not have a key staff member with primary responsibility for roof maintenance and repair activities.

On the other hand, they generally felt that those making the inspections were adequately knowledgeable to do so. In many offices, a number of individuals have had training with roof inspection techniques and the use of non-destructive evaluation (NDE) methods of detecting moisture in roofing systems. Nevertheless, in a minority of cases, necessary expertise on the part of the inspectors was considered to be lacking. In addition, about two-thirds of the BMEO respondents to the questionnaire felt that their offices were not adequately knowledgeable about the non-conventional systems, notably single-ply membranes and polyurethane foam.

3.3.5 Training

Training is provided to the inspectors but that less than a quarter of them attend training courses annually. The majority of those having training receive it from the MTSC. Until recently, MTSC provided 4-day courses about 8 or 9 times a year at various postal locations around the country. Two days were devoted to inspection techniques for built-up roofing and two days were spent on the use of nuclear equipment for conducting moisture surveys. The inspection technique course included practical sessions which occur on the roof.

Since most BMEO inspectors receive their training from the MTSC, it is apparent why they should feel that they are not adequately knowledgeable regarding non-conventional systems. MTSC courses in the past have not included non-conventional systems in the curriculum. The course on built-up roofing and moisture surveys is now planned to be replaced with a 40-hour course on inspection, maintenance, and techniques for in-house repairs. The new course will consider all types of roofing problems experienced, and how to fix specific

problems. Course attendees are expected to include not only the BMEO personnel but also local maintenance people who have responsibility for specific buildings, or a group of buildings in an area. Training on the use of nuclear NDE techniques will be discontinued by the MTSC, but the Regions can provide for such training if desired.

Vendor seminars as well as industry-sponsored courses are also sources of training for the BMEO staff. However, use of such sources was considerably less than that for the MTSC course. The RIEI and the NRCA are the most-used industry courses. It is noted that USPS recently sponsored an RIEI course for USPS personnel.

The majority of the questionnaire respondents feel that they do not adequately keep abreast of the current state-of-the-art of roofing technology. In-house courses and vendor seminars are the two most common means of remaining current.

3.3.6 Timing of Repairs

The inspection procedures often reveal deficiencies which require attention ranging from minor maintenance to major repairs and occasionally recovering or replacement. Regardless of the magnitude of the defects, good roofing practice dictates that repairs be made as soon as practicable to avoid worsening of the defect (if minor), or extensive water damage to the roof, other building components, or the building contents. USPS maintenance directives provide that repair work be done in the most expedient and economical method which can be accomplished, whether in-house or by contract. In general, USPS practice does not provide for "on-the-spot" repairs by the inspector. Furthermore, except in a few cases, materials and tools for making "on-the-spot"

repairs were generally not part of the inspectors' equipment. In general, repair work, even that of a minor nature, is done by roof contractors, although USPS building maintenance staff may do some from time to time. In many cases, these are term contractors who are available under contract for one year with the option to be renewed two options twice. The mechanism is available to provide for emergency repairs within one day in the case of roof leaks. However, in discussions with some roofing specialists, they have been critical that such emergency repairs are not carried out soon in many cases. These individuals were also critical that the term contractors were not always fully qualified.

If the repair work is to be done through normal channels, many weeks may pass between the roof inspection and initiation of needed repairs. More than two-thirds of those responding to the questionnaire indicated that repairs were accomplished more than two months after defects were first observed in the roof. Roofing specialists who provide assistance to USPS under contract suggested that steps should be taken to expedite roofing repairs. Often water damage to the roofing and building components occurs before leaks are fixed. One roofing specialist gave an example where base flashings of a large facility were badly deteriorated and leaking. More than 15 months had passed between his inspection of the roof and the time when the bid package to repair the base flashing was let. During that time, the flashings continued to leak. These roofing specialists gave recommendations to NBS staff that USPS should take steps to ensure that repairs are carried out expediently.

3.3.7 Guidelines, Manuals, and Bulletins

Communication was found to be somewhat lacking with regard to the question of availability of guidelines, manuals, and bulletins. USPS has available documents dealing with roof inspection and maintenance. Two examples are Maintenance Handbook #1, "Operation and Maintenance of Real Property," Guide No. P-20 on "Drains, Roof, Gutter, Etc," and Maintenance Handbook MS-6, "Repair and Alteration Surveys," Chapter 2 on "Roofs." Most respondents to the questionnaire indicated that guidelines and manuals were available to assist USPS roof inspections. However, 15 percent of the respondents replied that manuals were not available. In addition, a number of individuals who indicated that USPS has documents available referred to industry publications and not the USPS maintenance handbooks.

For cases where respondents indicated that manuals were available, about three-quarters of them believed that the manuals were inadequate. Guide No. P-20 gives the USPS guidelines for local inspection including walking the roof, checking key items, and removing trash and debris. These guidelines are also given in Maintenance Bulletin MMO-1-85. Chapter 2 of Maintenance Handbook MS-6 gives guidelines for conducting repair and alteration inspections of built-up roofs. In reviewing the MS-6 document, it could be seen why many USPS personnel consider it to be inadequate. First, it only concerns built-up roofing. Attention is not given to single-ply or other types of low-sloped roofing. Second, it needs updating regarding technological advances in roofing technology. Examples of areas of concern include newer systems, bitumens, felts, "resaturation", venting, and the listing of reference publications. Third, reference photos to assist the uninitiated local inspector regarding typical BUR defects are not incorporated. MS-6 was last revised in 1979.

Regarding maintenance bulletins, mixed opinions, divided almost 50-50 in the questionnaire, were expressed as to whether or not the USPS provided timely bulletins about specific aspects of inspection and repair procedures. This response may be another indication of communication problems regarding roofing inspection practices. The question may be asked why some individuals are not aware of bulletins from the MTSC. The MTSC provides bulletins to the local offices regarding generic roofing problems. It also distributes summaries of maintenance and repair information that is taught at industry courses such as RIEI. Conversation with one individual at the local level indicated that MTSC bulletins were received. In this case, the individual found the bulletin to be of assistance, although he admitted having little direct interaction with the MTSC.

Private sector documents such as the NRCA Roofing and Waterproofing Manual, the ARMA/NRCA Maintenance Manual, and the RIEI maintenance publication were commonly used as reference materials. Nevertheless, a few respondents to the questionnaire indicated that they use no industry reference documents regarding inspection and maintenance.

3.3.8 Repairs

When inspections reveal that extensive treatment is required, the inspector provides recommendations as to the course of action to be taken. Under such circumstances, the BMEO will request the services of the FREBO to initiate design of the repair or replacement roof. Thus, the design of the remedial work, as indicated in the questionnaire responses, is normally provided by an A/E firm or roofing specialist under contract to USPS, since the FREBOs generally contract

for their assistance. Some portion of the repair work may also be provided by design personnel at a FREBO.

It should be remembered that, in general, BMEO staff personnel are not designers; thus, they provide recommendations for repair, not design. The BMEOs have dollar limitations and, in general, if a BMEO recommendation for repair costs more than \$5000, the work will be assigned to a FREBO. However, in discussions at one BMEO office, it was indicated that the BMEO can provide repair work up to \$25,000 without assistance of a FREBO. It was stated that, if the BMEO feels it has the capability, it will prepare the scope of work and write the specification, and have a procurement office put the job out to bid. Normally a USPS "short form specification" is used to assist development of the specification. In cases where the BMEO does not have the experience to write the specification, FREBO services will be obtained.

Once design responsibility is placed, the inspector initiating the repair is unlikely to be consulted by the designer. Nevertheless, there are cases where the designer and inspector discuss the repair. Also, the A/E or roofing specialist responsible for design in extensive repairs and renovations almost always makes an on-site roof visit.

3.3.9 Criteria for Repair Versus Replacement

Only 55 percent of the questionnaire respondents felt that USPS has available criteria for condition assessment and for making a decision whether or not a roof should be repaired or replaced. The majority of these felt that the criteria were adequate. The remaining 45 percent responded that such criteria were not available.

The mixed response to this question was not surprising since in many cases, it is difficult to judge when to repair or replace an existing roof. The USPS does not have available a written set of criteria including cost analysis on condition assessment and treatment. It is believed that those who responded affirmatively to this question were relying on their personal experiences as to how they judge roof condition. These experiences were interpreted as criteria, which is not inconsistent with overall industry views. In practice, many roofing technologists have their own procedures for subjectively judging quality. Often the costs of maintaining and repairing the existing roof are compared to the costs of replacement, and are heavily considered in the final decision.

In discussing this question with one individual who indicated that criteria were not available, it was indicated that "rules of thumb" in some cases influence decisions. For example, one rule mentioned was that if a roof is at least 15 years old and considered to be in bad condition, it is re-roofed and not repaired.

3.3.10 Non-Destructive Evaluation

The use of non-destructive evaluation (NDE) methods for assisting the assessment of roofing condition depends upon the individuals involved. In some cases, it is never used, while in others it is always employed. In still others, its use may be considered based on the situation and roof condition. For example, an inspector may have an NDE inspection conducted after a visual inspection has been completed.

The nuclear backscatter technique is by far the most common method. Most often, the NDE inspections are done by USPS personnel. These findings are to be expected since, up to recently, USPS practice provided that each BMEQ office had a nuclear instrument. Moreover, the MTSC, as previously mentioned,

used to conduct a two-day seminar on the use of the nuclear instrument. Presently, the course has been canceled and decisions to use nuclear backscatter or other methods will be left to the Regional Offices. It was found in one series of discussions that a BMEO office was purchasing a capacitance meter. In general, those using NDE techniques feel that they are adequately trained, and that the results of the NDE inspections are reliable. It is noted that the availability of inspectors trained in the use of nuclear backscatter does not preclude the use of consultants providing other NDE services such as thermography or capacitance.

The use of NDE techniques has been beneficial. In discussing this subject with USPS personnel, many examples were given where only selected areas of roofs, found to be unacceptably wet, were replaced, while the dry portions were left in place. The result was, as to be expected, considerable cost savings in the repair of the roofing. It is noted that those who conduct routine roof inspections at the MSC level are directed to request an NDE evaluation of the roof if it is known to be leaking, or suspected of being wet.

3.3.11 Inspection and Maintenance Records

For the most part, inspection and maintenance records are kept by the BMEO offices for the roofs for which they have responsibility. Nevertheless, some respondents to the questionnaire indicated that records are frequently kept but not always. In general, records are usually kept in files in the BMEO office; in some cases, a computerized data base management system is used. Most individuals believe that the record keeping is adequate, but there is a minority opinion which stated that record keeping was not. As an example, it

was reported that a bonded roof was undergoing extensive repair, but the bond on the roof could not be found.

With regard to the use of computerized record keeping, the BMEO offices have recently begun a system to identify the maintenance work needed at individual facilities including roofing, and to track the progress of the work from beginning to end. Estimated costs for all projects are also included in the record. Besides addressing individual roofs, this system will allow a BMEO to follow the number of roof repair or replacement jobs under way and their total costs. It will also allow the BMEOs to know which roofs are continually having problems, including the costs of repair in those cases. Nevertheless, the records are quite limited and do not include information on the roof construction such as age and components, nor is specific information given regarding the nature or cause of the problem.

The lack of information regarding roof construction in the computerized record system means that the records cannot be used to identify materials and systems for which performance has been less than satisfactory. Also, the types of specific problems experienced by USPS roofing resulting in repair and replacement cannot be analyzed. At present, using the conventional file system of record keeping, many BMEO offices seldom use the records to identify poorly performing systems. Moreover, it is felt by the BMEO respondents that maintenance records are hardly ever used in the preparation of guidelines or alert bulletins regarding specific aspects of roof materials and system performance. Maintenance records are, for the most part, not used to recommend research to improve USPS roofing performance.

3.3.12 Inspection Forms

The USPS has available two forms for use during roof inspections (Appendix C). One is for use by maintenance personnel within the Management Sectional Centers (MSCs) who conduct routine inspections on an annual basis. This form provides an overview of steps to be taken in inspecting a roof and a list of deficiencies to be looked for regarding built-up roofing. It also instructs that action be taken to correct the deficiencies. A cover memo accompanying the form states that those using it should be familiar with the inspection of roofs. Discussions with some roofing specialists under contract to USPS have raised some questions as to whether or not those using this form are, in all cases, adequately familiar with roof inspections. A major criticism voiced is that the individual using the form observes a defect in the roofing which is taken to be a major problem, and thus reports that a new roof is needed. However, the defect discovered in the roofing may only require repair to be fixed and not total roof replacement. Review of the form by NBS staff indicated that it does not provide sufficient detail for use by inspectors who are only partially knowledgeable.

The second form available to USPS personnel for roof inspections is a detailed checklist for use by BME0 staff when conducting in-depth inspections. USPS maintenance guidelines indicate that those using the detailed checklist have an good knowledge of roof construction and repair. The checklist contains over 70 items to be observed during the inspection. These items deal with the general condition of the interior and exterior of the building, the roof condition, its surface, the membrane, pitch pans, flashings, copings, parapet walls, penetrations, terminations, and expansion joints. One purpose of the checklist is to assist the BME0 in requesting the services of the FREBO for

major repair and renovation. In the case of both forms, the references to membrane inspection are pertinent primarily to built-up membranes and do not include direct reference to single-ply roofing membranes or other types of low-sloped roofs.

During the course of the study, some of the completed in-depth inspection forms were examined by NBS staff. It was found that the forms were generally being used as checklists, as intended, to note defects found in the roofs. Usually only items found to be deficient were marked. In many cases the information requested at the beginning of the form regarding roof construction was not completed. Additionally, some maintenance individuals are not as yet using the form, which has been available for over a year. In reviewing the form, the thought was discussed that it may be cumbersome to use in having listed over 70 items. The question was raised as to whether a computerized data base system for noting the results of the roofing inspection might be more efficient. Such a system would need to be developed. The system should have the capability of being used on the roof.

4. DISCUSSION

This section presents the advantages and limitations of the USPS roofing practices regarding design, materials, and construction, as well as inspection, maintenance, and repair. It is based on the review of these practices given in sections 3.2 and 3.3. The advantages and limitations are given with respect to USPS current roofing practices and activities which are generally considered to be in line with industry accepted practice.

4.1 Advantages and Limitations of USPS Design, Materials, and Construction Practices

4.1.1 Roofing Performance

A) Advantages

- o Many roofs are providing satisfactory in-service.
- o Both built-up and single-ply membranes have performed satisfactorily.
- o USPS field personnel would welcome steps taken to improve USPS roofing.

B) Limitations

- o Roofing is a major facility problem; problems are typical of those found in the industry for low-sloped roofing.
- o Many premature failures and replacements of roofing occur a few years after construction.
- o Many problems are attributed to improper workmanship during roof application.

4.1.2 General Design and Construction

A) Advantages

- o Headquarters has a uniform policy regarding roof design under its direction.

- o Headquarters requires the use of roofing specialists for design, review, and inspection during application.
- o Some field offices are using roofing specialists for design and inspection during construction; the practice has been successful over the limited time it has been in place; it is being used for both new and re-roofing construction.

B) Limitations

- o Field offices have, in general, no uniform procedures regarding roofing practice; in many cases, the design of the roof is assigned by contract to an A/E firm which is only given general guidance on preferred systems.
- o In many field offices, the A/E is selected on the basis that the firm can handle many facets of building design and repair, and is not a specialist regarding roofing.
- o Criteria are not available to aid in the selection of roofing specialists.
- o Field offices infrequently contact other USPS units regarding roofing.

4.1.3 Guide Specifications and Other Documents

A) Advantages

- o USPS headquarters has prepared "short form specifications" to assist field personnel in small repair and the improvement of construction contracts.
- o Many offices are using the NRCA "Roofing and Waterproofing Manual" to assist in roof design, particularly with the details; other industry documents from organizations such as RIEI, FM, and UL are also used.

B) Limitations

- o The "short form specifications" are in need of updating and revisions.
- o USPS has no guide specifications for roofing, particularly for use in cases where general A/E firms are being used for roof design.
- o Some guidelines are available; however, the documents are generally considered to be inadequate.
- o Not all USPS offices use industry documents such as the NRCA "Roofing and Waterproofing Manual" to assist design.

4.1.4 Education and Training

A) Advantages

- o Training opportunities are made available for USPS staff involved with roofing; training may be in-house or through industry seminars.
- o Many USPS personnel believe that they have sufficient training to keep abreast of current technology changes.

B) Limitations

- o Many USPS staff have difficulty in keeping abreast of changes in roofing technology.
- o A minority of USPS staff take no training related to roofing.
- o Many in-house seminars are conducted by material vendors which can raise questions concerning the objectivity of the information supplied.

4.1.5 Responsibility

A) Advantages

- o In some offices where roofing specialists are used to assist design and construction, a USPS staff member has responsibility for coordinating roofing

B) Limitations

- o In the majority of offices, no individual staff member has responsibility for roofing; all project managers will handle roofing jobs at one time or another.
- o Design, material selection, application, and maintenance responsibilities are not clearly assigned.

4.1.6 Roof Slope

A) Advantages

- o USPS designers are keenly aware of the necessity of proper slope for adequate drainage.
- o USPS has a design requirement for minimum slope of 1/4 inch per foot.

B) Limitations

- o Many existing roofs have poor drainage due to the inadequate slope.

4.1.7 Material Selection

A) Advantages

- o Headquarters requires A/Es to use roofing specialists to assist in material selection.
- o For some field offices, FREBOs are also using roofing specialists to assist in material selection.
- o Life cycle cost (LCC) analyses are used for headquarter projects and field projects involving major renovation.
- o ASTM specifications, as well as other industry documents, are used to specify materials.

B) Limitations

- o Little guidance is given to designers regarding material selection; this has particular importance in cases where roofing specialists are not involved with projects.
- o Although field offices may in some cases give advice to designers on preferred systems, it is usually in regard to the choice of one type (e.g., BUR or single-ply) over another; advice concerning the limitations in use of materials is seldom given.
- o USPS field personnel have difficulty in keeping abreast of new materials their use, and their performance.
- o USPS field personnel receive little feedback on the performance of materials in roofs for which they have had design responsibility.
- o Records of materials performance are seldom kept and field testing of new materials is seldom conducted.

4.1.8 Application

A) Advantages

- o In the majority of roofing applications, workmanship is generally satisfactory.
- o Contractors are selected in many cases with consideration of factors such as past experience, training, and costs; manufacturers approval of the contractor for given materials may be used as one criterion for selection.
- o The contracts of term contractors who provide unsatisfactory workmanship may be terminated.

B) Limitations

- o Although in the majority of cases workmanship is considered satisfactory, poor workmanship is regarded by many USPS offices as a serious problem for many roofing applications.
- o USPS does not have criteria or guidelines for the selection of contractors, although some offices have assembled their own criteria.

4.1.9 Quality Control During Construction

A) Advantages

- o Pre-job conferences with USPS staff present is a general roofing practice.
- o Headquarters provides for full time inspection of major roof constructions using roofing specialists.
- o Some field offices are providing for full time inspection using qualified roofing specialists.
- o USPS project officers generally hold contractors responsible for correcting problems considered due to poor workmanship.
- o Final inspections for acceptance of USPS roofs are generally conducted with USPS personnel present.

B) Limitations

- o Full time inspection during construction is seldom practiced by some field offices.
- o In some cases, inspection is left to the A/E to be provided on whatever frequency considered necessary to assure satisfactory installation.
- o Record keeping regarding roof construction needs considerable improvement.
- o Criteria are not available that define acceptable construction including tolerances.

4.2 Advantages and Limitations of USPS Inspection, Maintenance and Repair Practices

4.2.1 Problems Encountered During Inspections

A) Advantages

- o Problems encountered by USPS inspectors are not specific to USPS roofs.

B) Limitations

- o A common problem encountered is clogged drains and debris on roofs which is indicative that periodic routine inspections are not being conducted to the extent desirable.
- o Poor workmanship during roofing application is often cited by BMEO inspectors as a common USPS roofing problem.

4.2.2 General Considerations Regarding Maintenance and Inspection

A) Advantages

- o Inspection of USPS roofing occurs as a planned event, and not as a reaction to a reported problem.
- o The BMEO offices seek outside assistance in solving difficult roofing problems found during inspection.

B) Limitations

- o Although roof inspections generally occur as planned events, concern has been expressed that some roofs are only inspected when problems such as leaks have been reported by the building occupants.
- o Most field units are not aware of the assistance of MTSC to investigate roofing problems, although the MTSC is available for such help.

4.2.3 Frequency of Inspection

A) Advantages

- o General directive requires that, in general, routine inspection of roofs be conducted annually by local maintenance staff.
- o Directives provide that roofs in severe climatic or having a history of problems be inspected at least more than once a year) and that roofs should also be inspected after storms which may cause damage.

B) Limitations

- o Indepth inspection of roofs by BMEO staff occurs generally only once every two to three years.
- o BMEO in depth inspections frequently find problems with clogged drains and debris on roofs which are indicative that some local routine inspections are not providing needed housekeeping.

4.2.4 Responsibility

A) Advantages

- o BMEO staff who inspect roofs are generally knowledgeable concerning roof inspection techniques.

B) Limitations

- o BMEO offices do not have in general a key staff member who has responsibility for coordination of roof maintenance and repair activities.
- o BMEO staff are often not adequately knowledgeable concerning inspection techniques for the newer roofing systems, notably single-ply membranes and polyurethane foam.

4.2.5 Training

A) Advantages

- o MTSC provides for the development and delivery of training courses for USPS inspectors.
- o MTSC is redesigning and broadening the curriculum of its roof inspection course to address inspection, maintenance, and in-house repair techniques for all types of roofing systems; the course will be designed for local maintenance staff as well as BMEO staff.
- o USPS inspectors attend industry courses given by organizations such as RIEI and NRCA.

B) Limitations

- o Many of BMEO staff take no roofing training annually; consequently they have difficulty in keeping abreast of changes in roofing materials and systems technology.

- Until recently, the MTSC inspection course addressed only built-up roofing.
- The MTSC is dropping its course on the use of nuclear meters for NDE of moisture in roofing; the responsibility for training with NDE techniques is being given to the Regions.

4.2.6 Timing of Repairs

A) Advantages

- USPS directives provide that repairs be made expeditiously.
- Emergency repairs by roofing contractors can be expedited through the BMEO offices in cases of emergency.

B) Limitations

- In many cases, necessary and timely emergency repairs are not carried out.
- Many roof repairs done through normal channels take 2 months or more to be accomplished during which time water damage occurs to the building.

4.2.7 Guidelines, Manuals, and Bulletins

A) Advantages

- USPS provides maintenance manuals.
- MTSC distributes maintenance bulletins regarding generic roofing problems.
- Some BMEO staff use industry maintenance documents such as those prepared by NRCA, ARMA, and RIEI.

B) Limitations

- USPS maintenance manuals for roofing are limited and out of date.
- Many BMEO staff are not aware that MTSC provides maintenance bulletins.
- A few BMEO staff make no use of roofing industry documents or maintenance.

4.2.8 Repairs

A) Advantages

- o Major repairs (in excess of \$5000) are generally placed under the direction of a FREBO which is staffed with trained designers.
- o The A/E, roofing specialist, or FREBO project manager responsible for the major repair generally makes an on-site visit.

B) Limitations

- o The BMEO can provide for major repair work if it considers that it has the capability; this may be a subjective judgement; often in these cases the "short form specifications" are used which are not considered adequate.

4.2.9 Criteria for Repair Versus Replacement

A) Advantages

- o None

B) Limitations

- o Criteria are not available for condition assessment and deciding whether to repair or replace a roof; judgments are often made based on personal experiences.

4.2.10 Non-Destructive Evaluation

A) Advantages

- o USPS has encouraged the use of NDE techniques; each BMEO office has a nuclear backscatter meter; staff at the BMEOs were trained in its use.
- o The use of NDE has resulted in cases where only selected wet areas of roofing have been replaced at considerable cost savings; dry portions of the roofs were left in place.

B) Limitations

- o Some BMEO staff reported that they never use NDE techniques in evaluating roofing.

4.2.11 Inspection and Maintenance Records

A) Advantages

- o The BMEOs have initiated a computerized system for identifying needed repairs and tracking the progress of the repairs.

B) Limitations

- o Although the BMEOs keep records of roof maintenance and repairs, the records are not always kept as they should be.
- o The computerized record keeping for roof repairs does not include information on the type of roof, its age, and the nature of the problem.
- o Existing records are not used to provide alert bulletins regarding roofing performance.

4.2.12 Inspection Forms

A) Advantages

- o USPS has a checklist for those who inspect roofs either on a routine basis or indepth.

B) Limitations

- o It is assumed that those using the forms are familiar with roof inspections; the checklists do not provide sufficient information if the inspector is not fully familiar with roofs.
- o The inspection forms deal primarily with built-up roofing; updating is needed.
- o Not all BMEO staff are using the indepth checklist.

5. SUMMARY

This report reviewed the roofing practices of the U.S. Postal Service (USPS). The USPS has direct responsibility for the design, construction, and maintenance of about 100 million ft² of roofing. In addition, it leases buildings having approximately an equal amount of roof area. USPS buildings range in size from quite small to very large and are located across the United States. The USPS is multi-level organization including Headquarters, Regional Offices, District Offices, Management Sectional Centers, and Post Offices. This organizational structure effects the manner in which USPS conducts its roofing activities and was considered in the review.

The general approach taken during the study was to obtain information on USPS roofing activities and practices which could be used for judging strengths, weaknesses, and identifying problems. The primary sources of data were: discussions with USPS personnel; discussions with those who provide roofing services to USPS; review of typical USPS roofing documents; results of the distribution of questionnaires to USPS staff; and the determination of training requirements for those involved with roofing.

The review focused on two major phases of USPS roofing construction practice. One involved design, materials, and construction, and the other concerned inspection, maintenance, and repair. The division in the review of USPS roofing practices was consistent with the distribution which exist between design and construction groups, and maintenance and repair groups in the USPS organizational structure. The primary topics addressed with regard to the review on design and construction included general design considerations, education and training, responsibility, material selection, and quality control during construction. With regard to maintenance and repair, the review included general considerations,

frequently of inspections, responsibility, training, maintenance guidelines and manuals, repairs and when they are conducted, and inspection and maintenance records.

Based on the results of the review of each of the selected topics, the advantages and limitations of the USPS roofing practices were given. The listed advantages and limitations will form, in part, the basis of recommendations of steps to be taken to improve USPS roofing practices.

6. REFERENCES

1. "Repair and Alteration of Real Property," Maintenance Handbook, MS-7, U.S. Postal Service (June 30, 1979), Exhibit 1-1.
2. "Low-Slope Roofing Problems," Transactions of the Federal Construction Council for 1979-80, Federal Construction Council, Washington, D.C., pp. 21-27.

7. ACKNOWLEDGMENTS

This study was sponsored by the United States Postal Service (USPS), Design Management Division, Real Estate and Buildings Department. The authors acknowledge with thanks the assistance of Mr. Warren L. Walker, Project Manager, who provided technical liaison between NBS and USPS. Thanks are also extended to Mr. William D. Hayen, Maintenance Management Officer, MTSC, and Mr. Leon Schroeder, Facility Systems Branch, Technical Training Center, for their discussions regarding USPS maintenance and training practices. Appreciation is also expressed to Mr. Edwin W. Barnard, Jr., Sverdrup and Parcel, Jacksonville, Florida, for his assistance in describing his experiences with USPS roofing activities and in taking one of the authors to a number of roofs. Finally, the assistance of those USPS staff who took their time to meet with NBS researchers during the study or who completed the questionnaires regarding roofing practices is also gratefully acknowledged.

APPENDIX A. RESULTS OF QUESTIONNAIRE ON DESIGN, MATERIALS, AND CONSTRUCTION

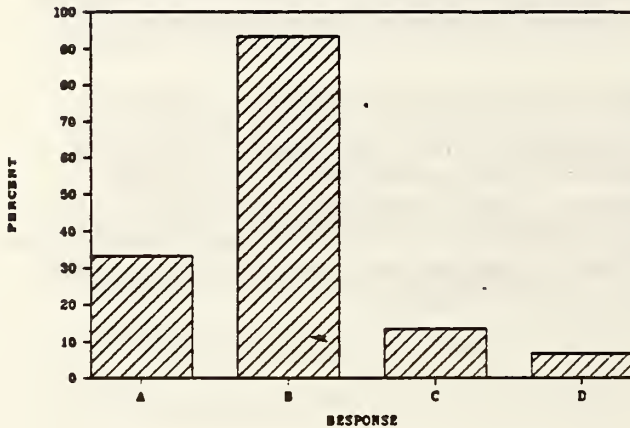
This appendix presents the results of the questionnaire on design, materials, and construction. The questionnaire contained 78 questions for which the majority could be answered as a multiple choice selection. Questions 2, 3, 4, 6, 31, 33, 52, 53, 54, 58, 65, and 66 required written answers.

This questionnaire was sent to each of the USPS Regional (5) and FREBO offices (15), as well as to Headquarters (2). Fifteen completed questionnaires were returned to NBS.

The results are summarized in bar graphs of the percent response versus the multiple choice answer. The question accompanies each bar graph. Since the respondents selected more than one choice for some questions, the average response often totals more than 100 percent. The results are given for only those questions which had multiple choice answers. The information obtained as answer to those questions requiring written responses was used in the summary of USPS activities given in the main body of the report.

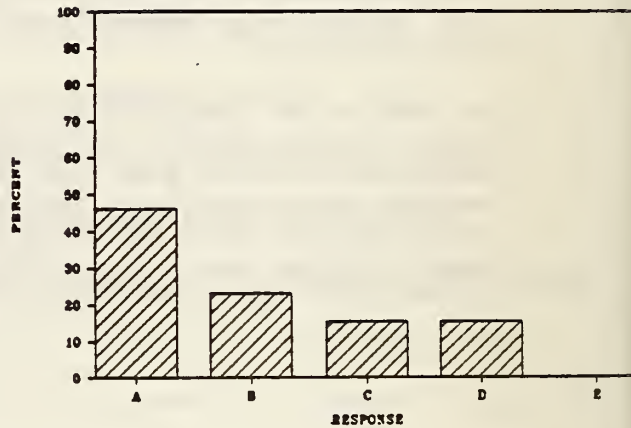
1. For roofing constructions in which your office has involvement, who generally designs the roofing system and develops the specifications:
- a. USPS personnel
 - b. architect or consultant under contract
 - c. USPS personnel with assistance of an architect or consultant
 - d. other _____

PERCENT RESPONSE QUESTION 1



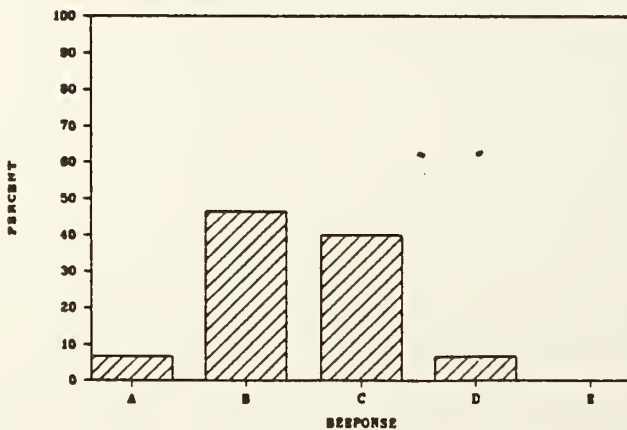
5. Please indicate the approximate number of roofing jobs undertaken by each staff member of your office each year:
- a. less than 10
 - b. between 10 and 20
 - c. between 20 and 40
 - d. between 40 and 80
 - e. greater than 80

PERCENT RESPONSE QUESTION 5



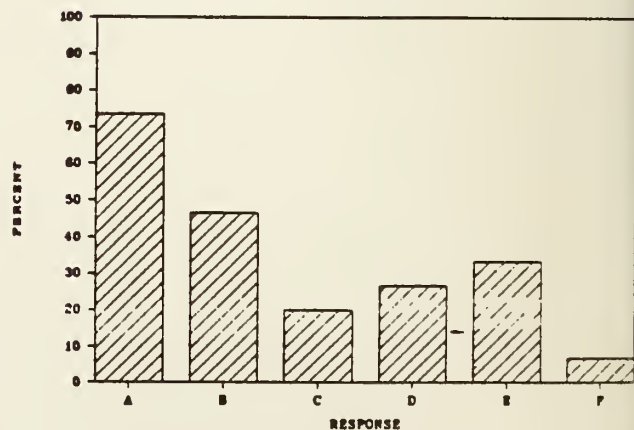
7. To what extent does your office interact with other USPS offices regarding roofing:
- a. never
 - b. seldom
 - c. often
 - d. most of the time
 - e. always

PERCENT RESPONSE QUESTION 7



8. For what reasons does your office interact with other USPS offices regarding roofing:
- a. roofing failures or problems
 - b. design considerations
 - c. information on materials selection
 - d. information on roofing application
 - e. maintenance considerations
 - f. other _____

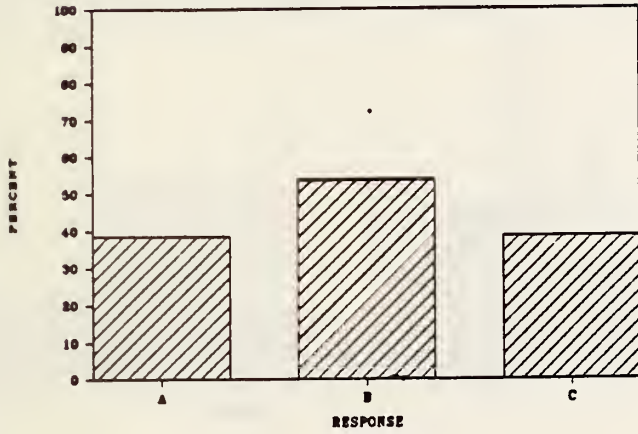
PERCENT RESPONSE QUESTION 8



9. Does USFS have guide specs available for:

- a. new roofing
- b. re-roofing
- c. none

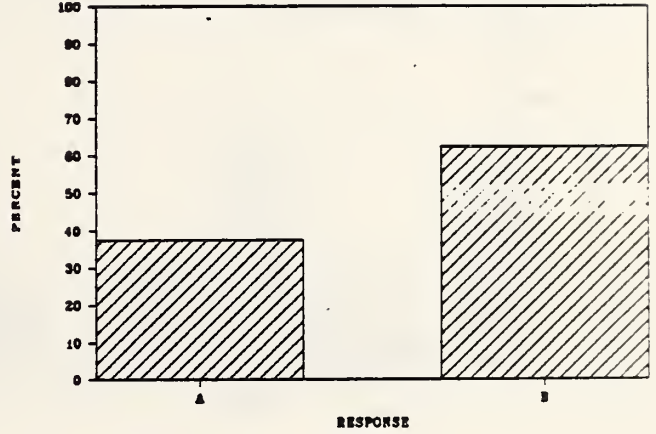
PERCENT RESPONSE QUESTION 9



10. If USFS guide specs are available do you find them adequate:

- a. yes
- b. no

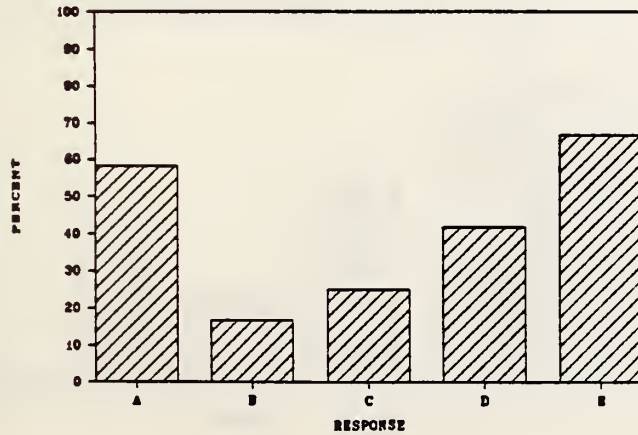
PERCENT RESPONSE QUESTION 10



11. Are any of the documents listed below used to assist in roofing design:

- a. NRCA Roofing Manual
- b. Dept. of Defense guide specs and manuals
- c. ARMA/NRCA Maintenance and repair manual
- d. UL and FM guides
- e. other _____

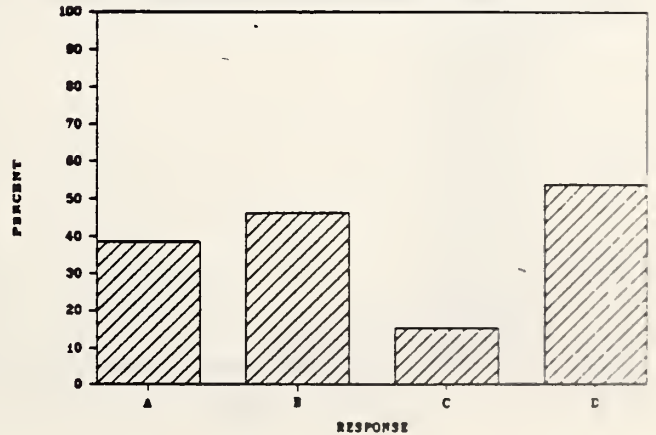
PERCENT RESPONSE QUESTION 11



12. For roofing details such as for penetrations, expansion joints, and gravel stops, which of the following documents are used:

- a. NRCA Roofing
- b. manufacturers literature
- c. USFS Guide Specs
- d. other _____

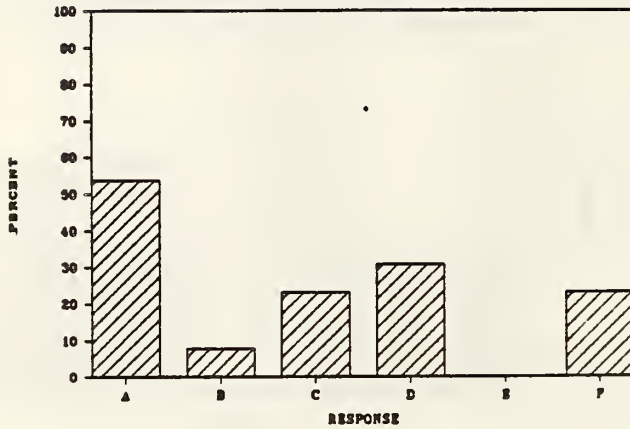
PERCENT RESPONSE QUESTION 12



13. Does your office make use of documents which deal with specific aspects of roof performance and problems such design alerts and bulletins issued by the following organizations:

- a. NRCA or MRCA
- b. ARMA
- c. USPS (MTSC)
- d. RIEL
- e. DoD
- f. other _____

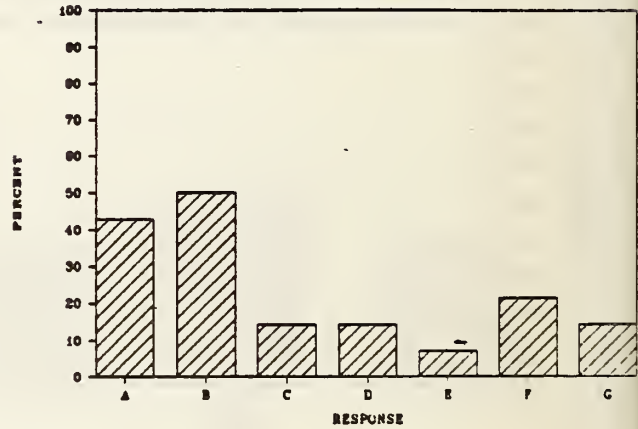
PERCENT RESPONSE QUESTION 13



14. Does your office provide the opportunity for training and educational courses from the following:

- a. RIEL
- b. NRCA
- c. AIA/CSI
- d. USPS (MTSC)
- e. University short courses
- f. other _____
- g. no training provided

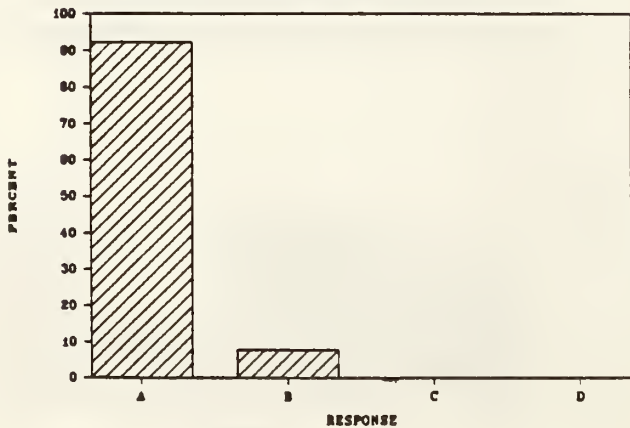
PERCENT RESPONSE QUESTION 14



15. What percent of the staff who have roofing responsibilities attend training courses annually:

- a. less than 25
- b. between 25 and 50
- c. between 50 and 75
- d. more than 75

PERCENT RESPONSE QUESTION 15



16. Do you find that A/E firms under contract to USPS are adequately knowledgeable to roofing technology:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

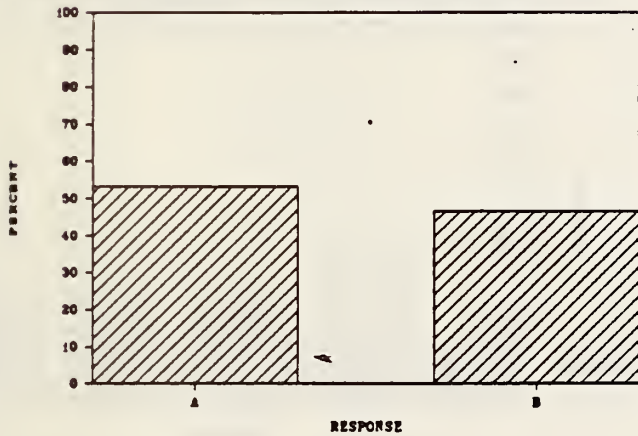
PERCENT RESPONSE QUESTION 16



17. Do you find that your office can adequately keep abreast of changes and advances in roofing technology:

- a. yes
- b. no

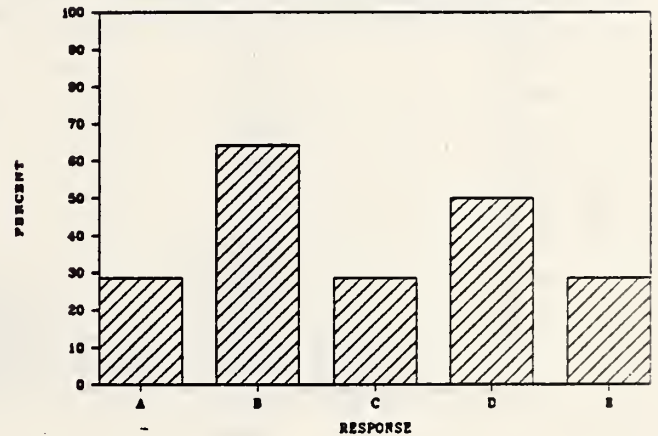
PERCENT RESPONSE QUESTION 17



18. By what mechanism do designers in your office keep abreast of changes and advances in roofing technology:

- a. in-house (USPS) seminars
- b. industry seminars
- c. industry educational courses
- d. vendor seminars
- e. other _____

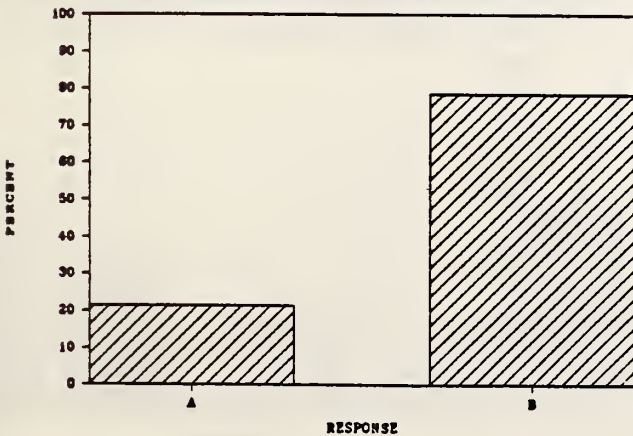
PERCENT RESPONSE QUESTION 18



19. Does your office have a key staff member who has designated responsibility for roofing:

- a. yes
- b. no

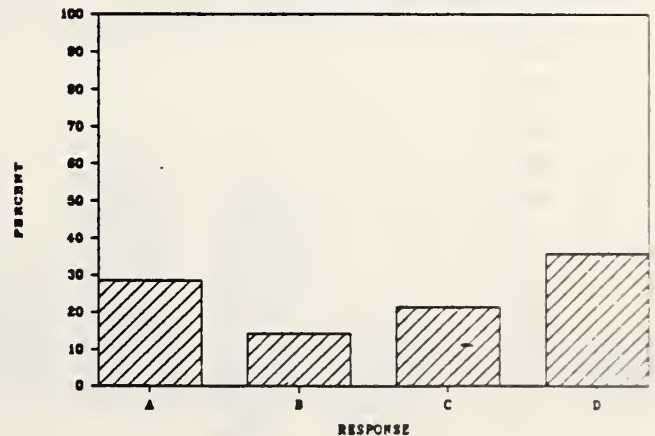
PERCENT RESPONSE QUESTION 19



20. How many of the project managers in your office have responsibility for roof design and construction:

- a. none
- b. few
- c. most
- d. all

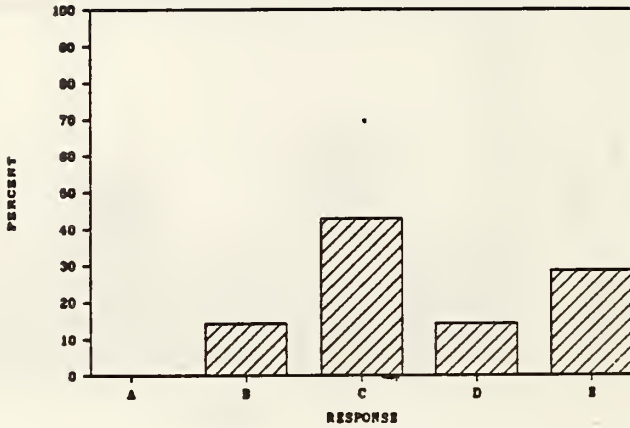
PERCENT RESPONSE QUESTION 20



21. Does your office seek assistance for solutions to roof problems from consultants and other roofing experts:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

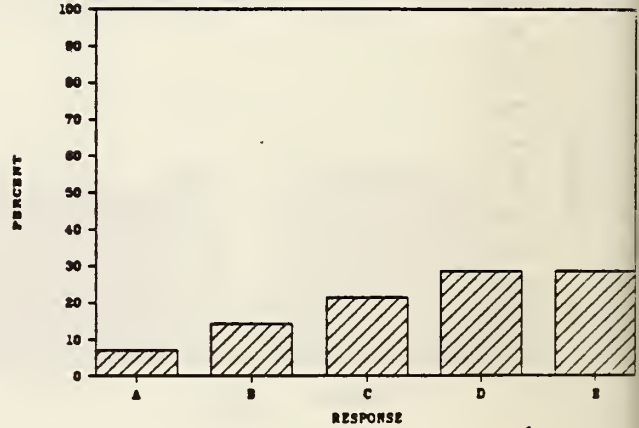
PERCENT RESPONSE QUESTION 21



22. Before initiating roof construction, is your office represented in a "pre-job conference" with those involved in the design and construction:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

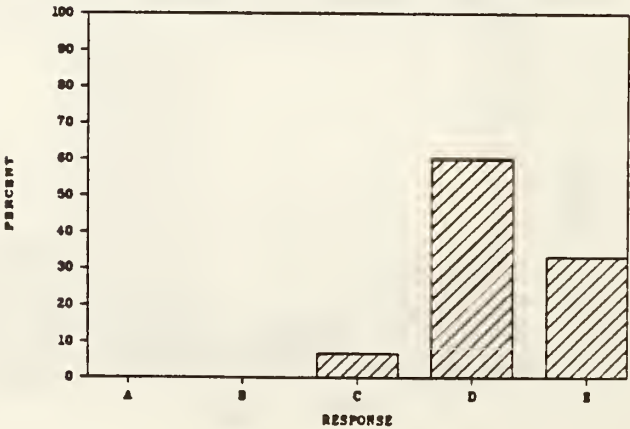
PERCENT RESPONSE QUESTION 22



23. Is adequate slope (normally 1/4 inch per foot) for drainages included in roof design:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

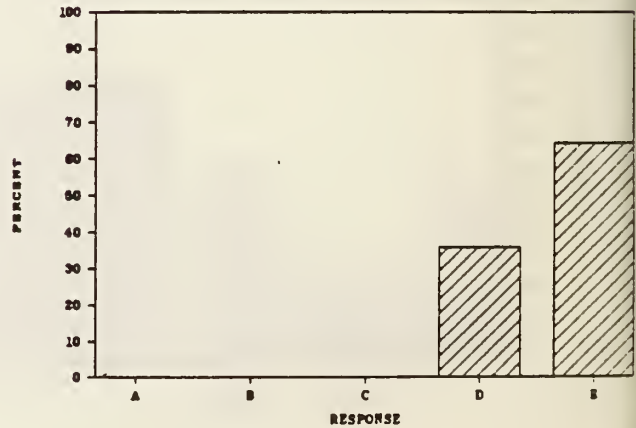
PERCENT RESPONSE QUESTION 23



24. In major repair and re-roofing applications, does the designer (your office or a contract A/E) conduct a roof inspection prior to design:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

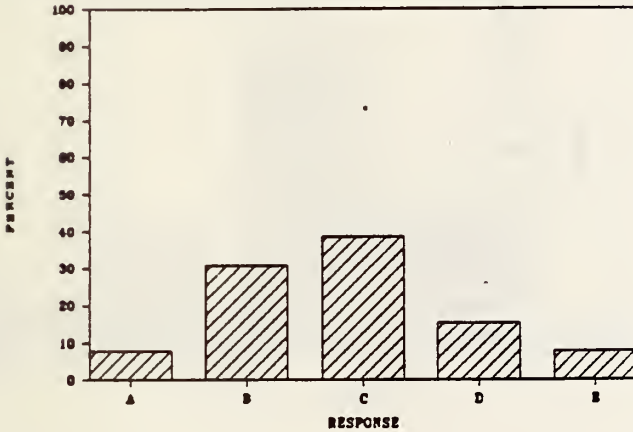
PERCENT RESPONSE QUESTION 24



25. Does your office use non-destructive methods of evaluation (NDE) to assist in the determination of the roof condition and the presence of moisture before deciding whether the roof should be repaired or replaced:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

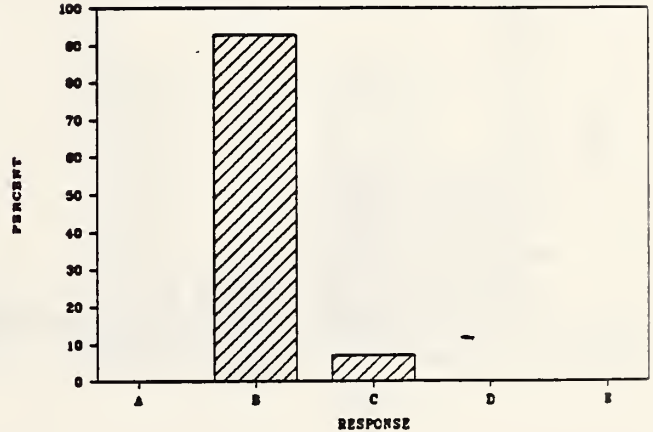
PERCENT RESPONSE QUESTION 25



26. In your experience, do you find that roofs which you have designed and constructed have received adequate maintenance after completion of the construction:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

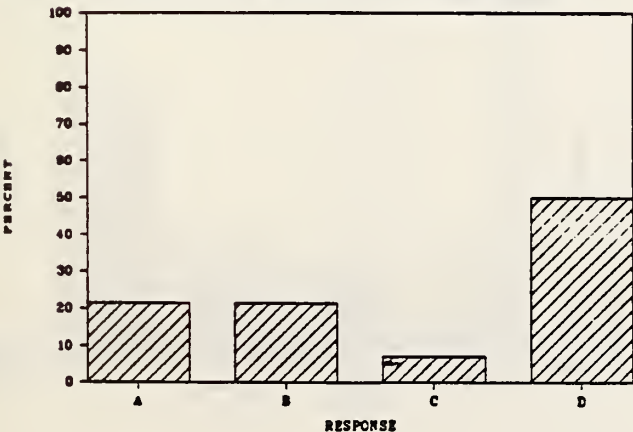
PERCENT RESPONSE QUESTION 26



27. What approximate percentage of the roofing projects undertaken by your office are in response to a request to solve an immediate roof problem (i.e., normally a leak):

- a. less than 25
- b. between 25 and 50
- c. between 50 and 75
- d. more than 75

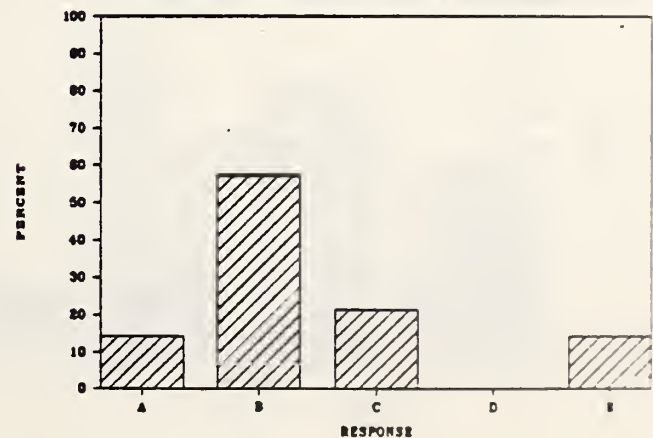
PERCENT RESPONSE QUESTION 27



28. Does your office receive feedback from those responsible for roofing maintenance and repair concerning the in-service performance of roofing designed by your office:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

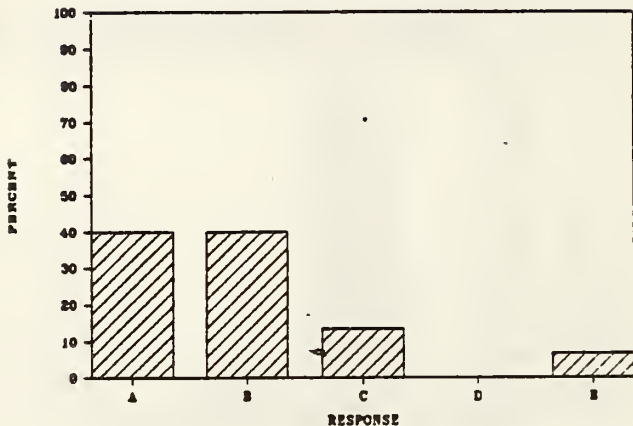
PERCENT RESPONSE QUESTION 28



29. Does your office keep records of the in-service performance of roofs for which it had design responsibility:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

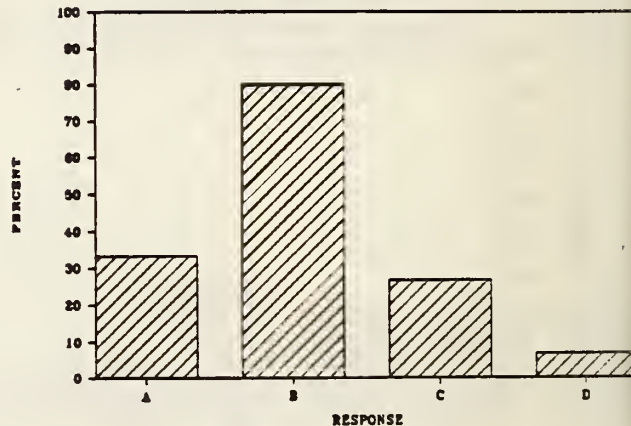
PERCENT RESPONSE QUESTION 29



30. For new roofing constructions in which your office has involvement, who generally selects the membrane material:

- a. USPS personnel
- b. architect or consultant under contract
- c. USPS personnel with assistance of an architect or consultant
- d. other _____

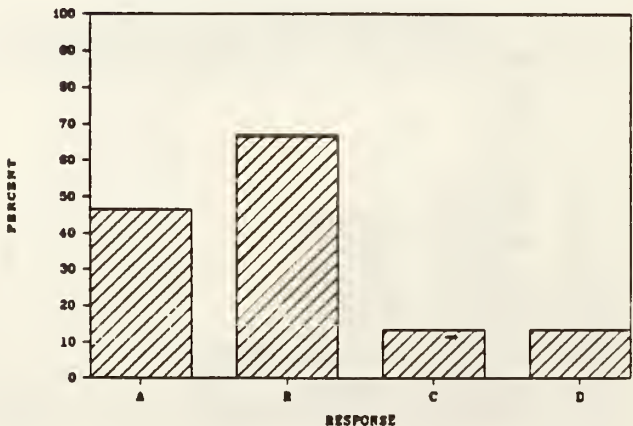
PERCENT RESPONSE QUESTION 30



32. For re-roofing applications in which your office has involvement, who generally selects the membrane material:

- a. USPS personnel
- b. architect or consultant under contract
- c. USPS personnel with assistance of an architect or consultant
- d. other _____

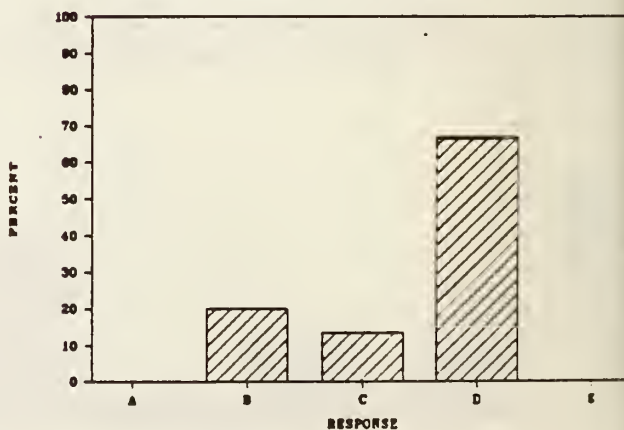
PERCENT RESPONSE QUESTION 32



34. Do you consider that the mechanism by which materials are selected for incorporation in roofing systems is adequate:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

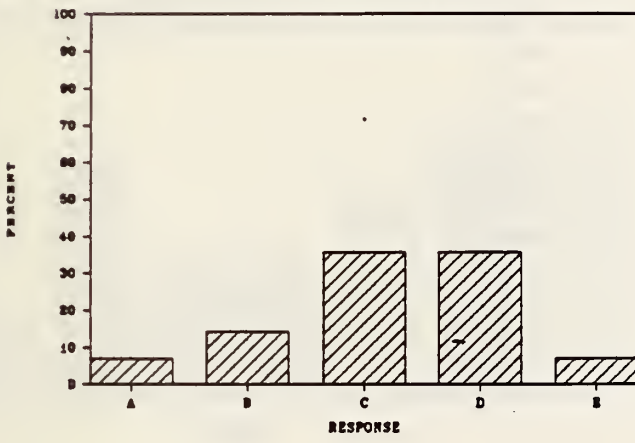
PERCENT RESPONSE QUESTION 34



35. Are qualitative comparisons of different materials carried out as the basis for materials selection:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

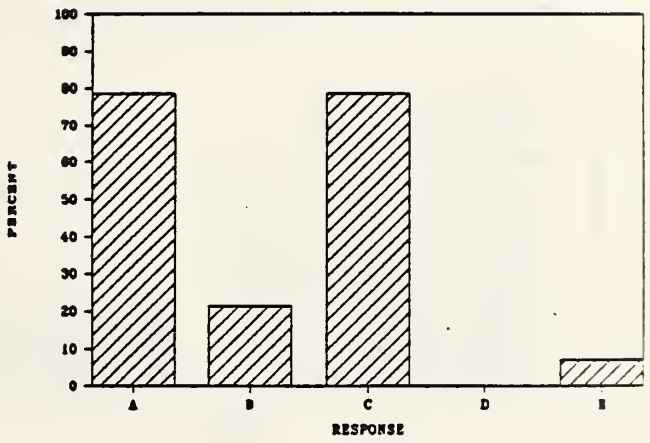
PERCENT RESPONSE QUESTION 35



36. Are any of the documents listed below used in the specification of materials:

- a. ASTM standards
- b. Federal specifications
- c. Industry specifications
- d. Foreign standards
- e. other _____

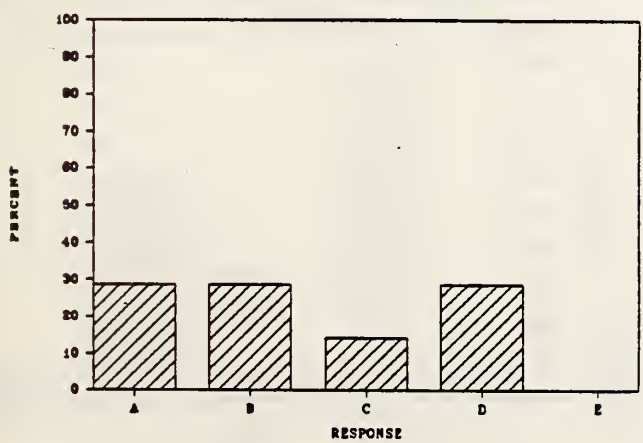
PERCENT RESPONSE QUESTION 36



37. If USPS material specifications are used, are they considered adequate:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

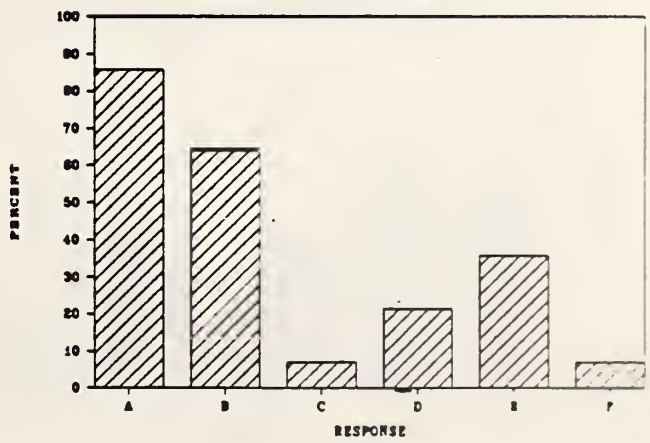
PERCENT RESPONSE QUESTION 37



38. On what basis are membrane materials normally selected:

- a. performance considerations of the roof in question
- b. past history of successful performance on other USPS roofs
- c. materials availability
- d. materials cost
- e. architect's preference
- f. other _____

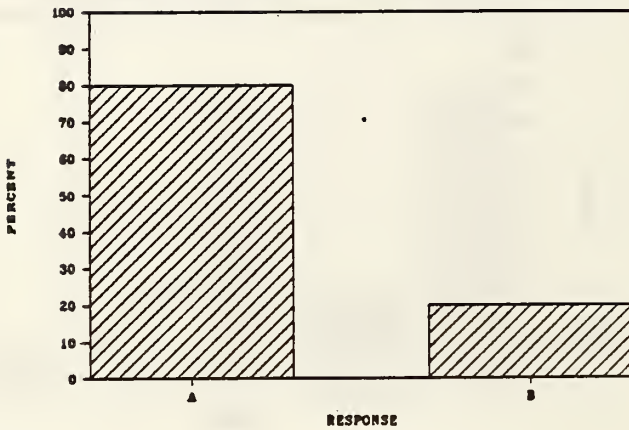
PERCENT RESPONSE QUESTION 38



39. Does your office favor one or two types of roofing systems over others:

- a. yes
b. no
- Please indicate: _____

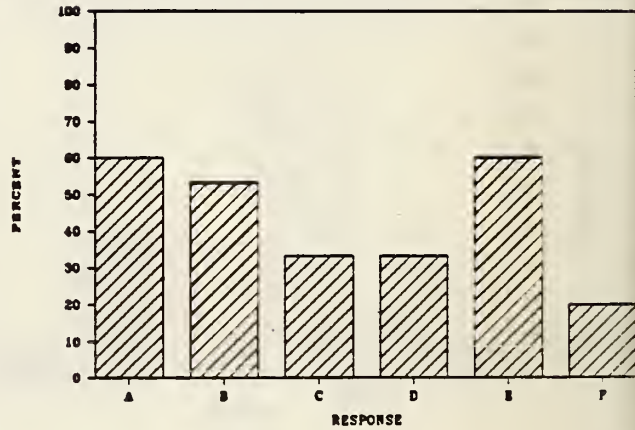
PERCENT RESPONSE QUESTION 39



40. By what mechanism does your office keep abreast of new materials offered for membrane roofing:

- a. industry seminars
b. industry trade publications
c. industry training courses
d. USPS bulletins and circulars
e. vendors' salesmanship and workshops
f. other _____

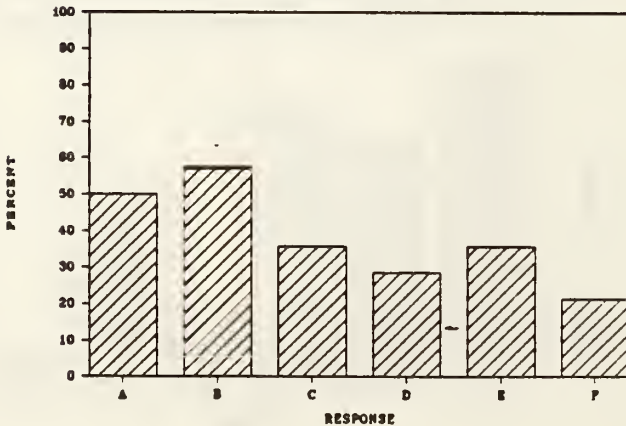
PERCENT RESPONSE QUESTION 40



41. By what means does your office remain aware of the performance of membrane materials and roof systems in service:

- a. industry seminars
b. industry trade publications
c. industry training courses
d. USPS bulletins and circulars
e. vendors' salesmanship and workshops
f. other _____

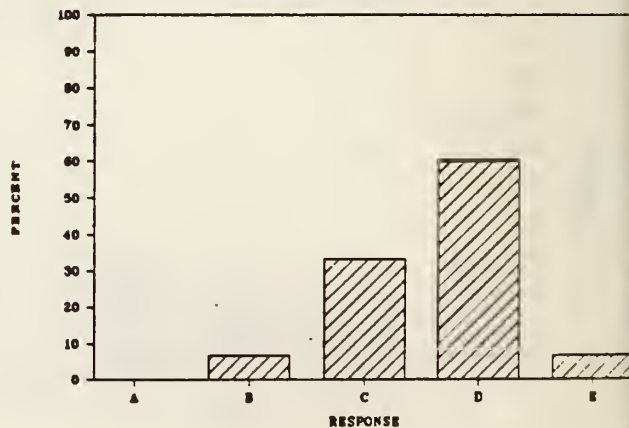
PERCENT RESPONSE QUESTION 41



42. Do you consider that those individuals having responsibility for materials selection are adequately knowledgeable in roofing material and system performance:

- a. never
b. seldom
c. often
d. most of the time
e. always

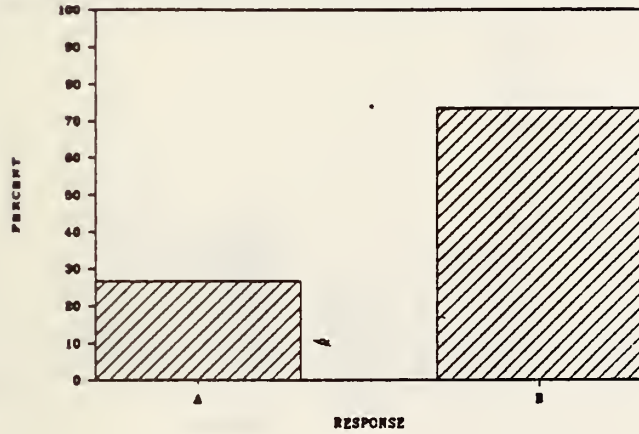
PERCENT RESPONSE QUESTION 42



43. Do you consider that the mechanics for keeping abreast of new roofing materials is adequate:

- a. yes
- b. no

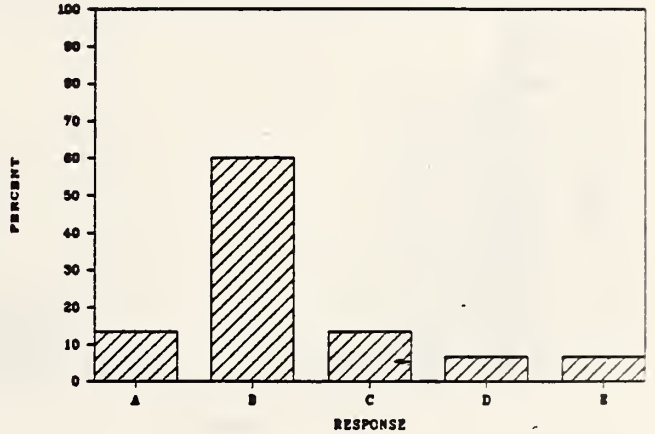
PERCENT RESPONSE QUESTION 43



44. Does your office receive feedback concerning materials performance for roofs for which it had design responsibility:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

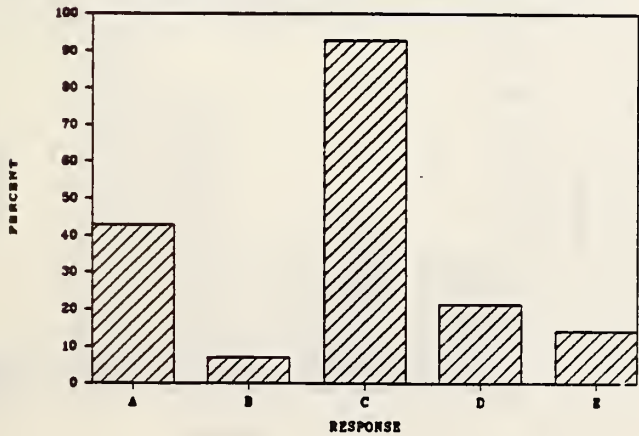
PERCENT RESPONSE QUESTION 44



45. If your office receives feedback on materials performance, by what means is the feedback received:

- a. first hand experience
- b. roof consultant or A/E who participated in the design
- c. USPS maintenance personnel
- d. vendor who supplied material to USPS
- e. other

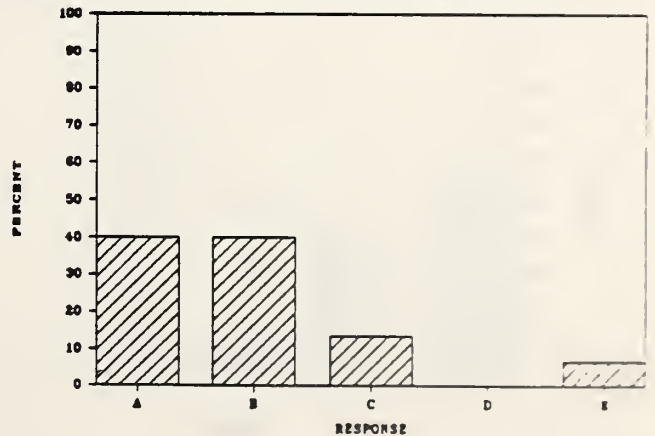
PERCENT RESPONSE QUESTION 45



46. Does your office keep records of the performance of materials which it incorporated in roof designs and constructions:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

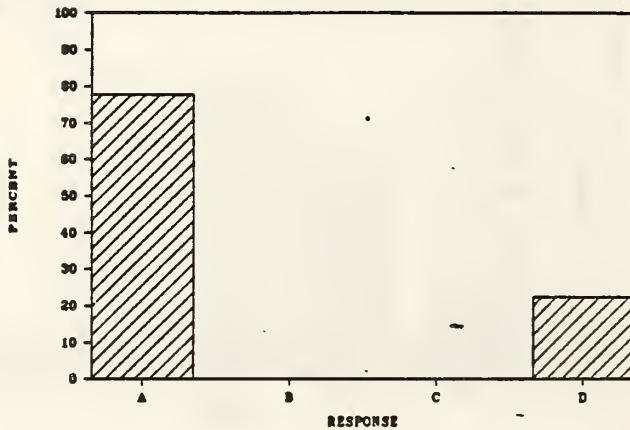
PERCENT RESPONSE QUESTION 46



47. If records are kept concerning in-service materials performance, in what form are they assembled:

- a. project managers notebook or files on individual projects
- b. central file in the office
- c. data processing file using computers
- d. other _____

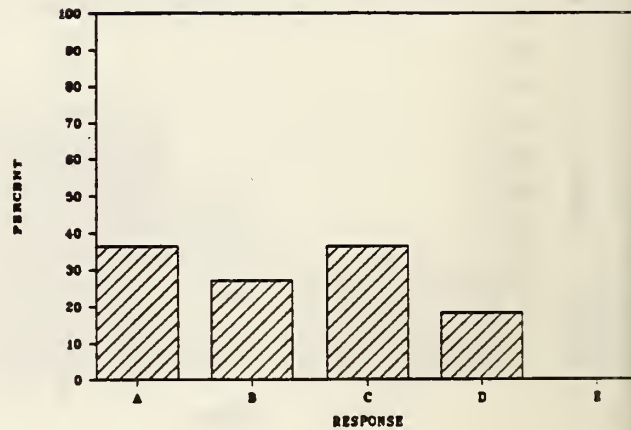
PERCENT RESPONSE QUESTION 47



48. Are data on materials and systems performance in-service analyzed by your office to improve design criteria for future roofing projects:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

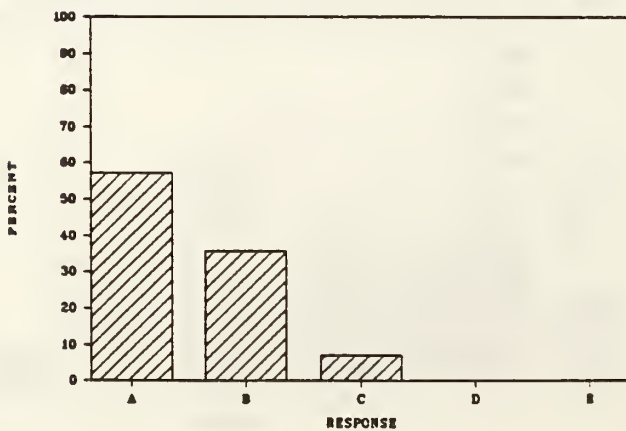
PERCENT RESPONSE QUESTION 48



49. Does your office conduct field tests of new materials and systems before accepting them for general use in all roofing projects:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

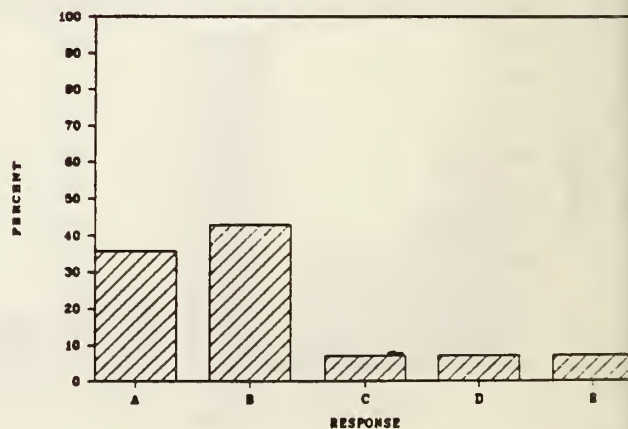
PERCENT RESPONSE QUESTION 49



50. Does your office support research to further the understanding of roofing materials and systems with the aim of improving performance and upgrading design criteria:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

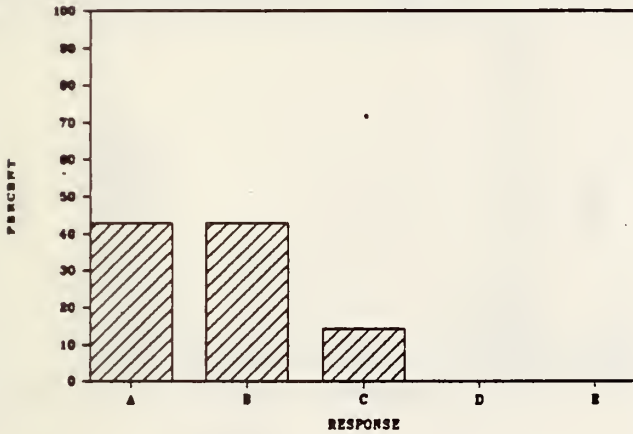
PERCENT RESPONSE QUESTION 50



51. If research and field tests are supported by your office, what becomes of the results:

- a. no report is prepared
- b. a report is prepared but used by the office only
- c. a report is prepared and sent to headquarters for distribution to USPS roofing personnel
- d. a report is published in the technical literature
- e. other _____

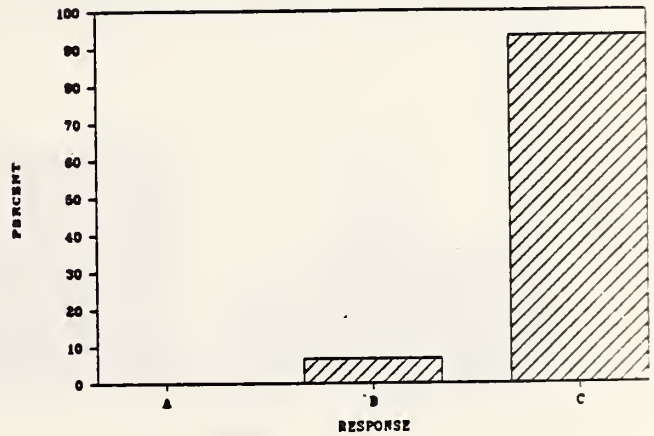
PERCENT RESPONSE QUESTION 51



55. Are private roofing contractors used for the construction of USPS roofing:

- a. often
- b. most of the time
- c. always

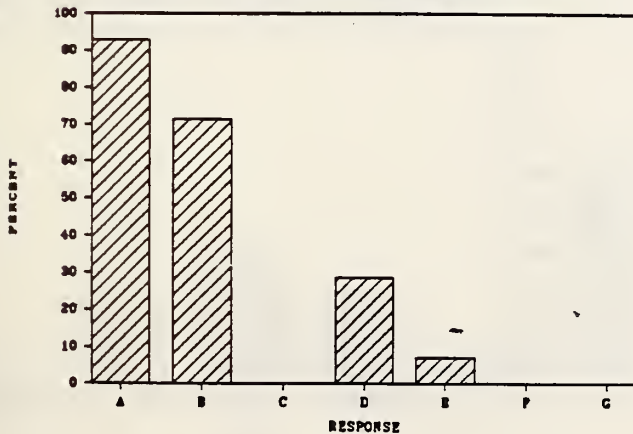
PERCENT RESPONSE QUESTION 55



56. Are USPS personnel used for roofing constructions:

- a. never for new roofing
- b. never for re-roofing
- c. occasionally for new roofing
- d. occasionally for minor repairs/maintenance
- e. occasionally for system application on small jobs
- f. seldom for new roofing
- g. seldom for re-roofing

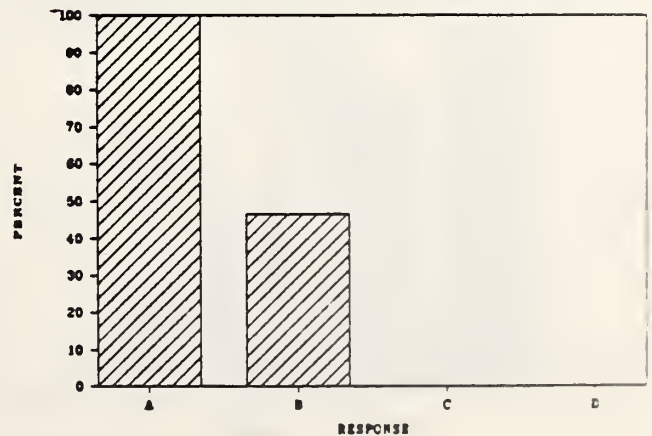
PERCENT RESPONSE QUESTION 56



57. How are roofing contractors selected:

- a. open bid for the job in question
- b. open bid for a term contract
- c. sole-source contractor
- d. other

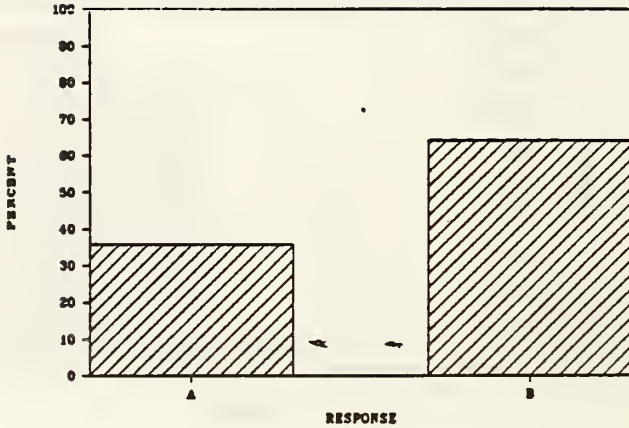
PERCENT RESPONSE QUESTION 57



59. Does USPS have available a set of uniform criteria to assist the selection of roofing contractors:

- a. yes
- b. no

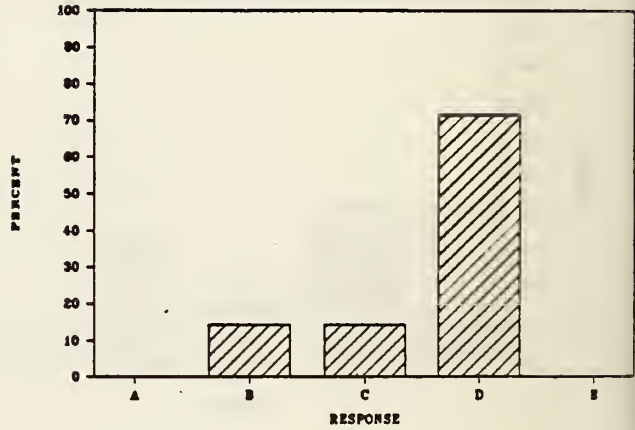
PERCENT RESPONSE QUESTION 59



60. If a set of criteria for contractor selection is available, do you consider that it is adequate:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

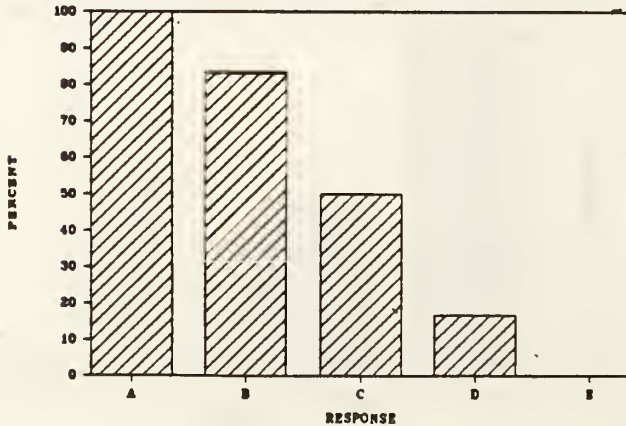
PERCENT RESPONSE QUESTION 60



61. If a set of criteria for contractor selection is available, what factors are considered in the criteria

- a. past experience
- b. training/knowledge
- c. contractor costs
- d. contractor availability
- e. other _____

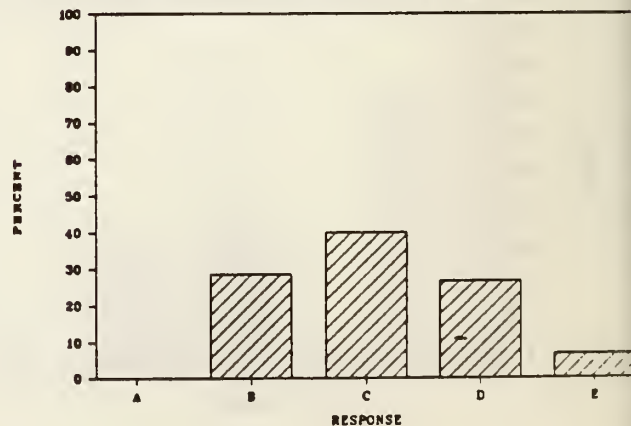
PERCENT RESPONSE QUESTION 61



62. Do you consider that roofing contractors under contract to USPS provide adequate workmanship:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

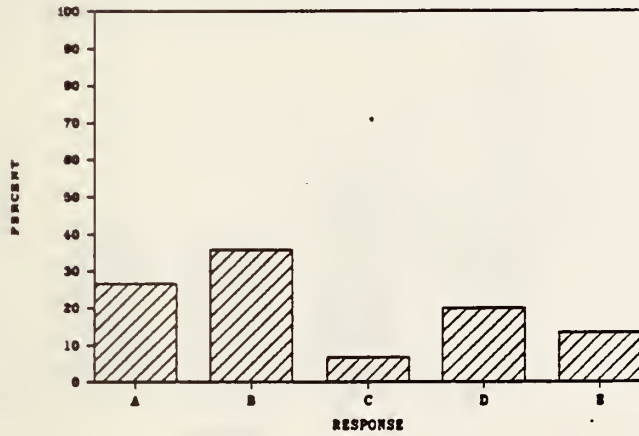
PERCENT RESPONSE QUESTION 62



63. Are roofing contractors selected because they are "approved" by materials manufacturers for application of proprietary membrane systems:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

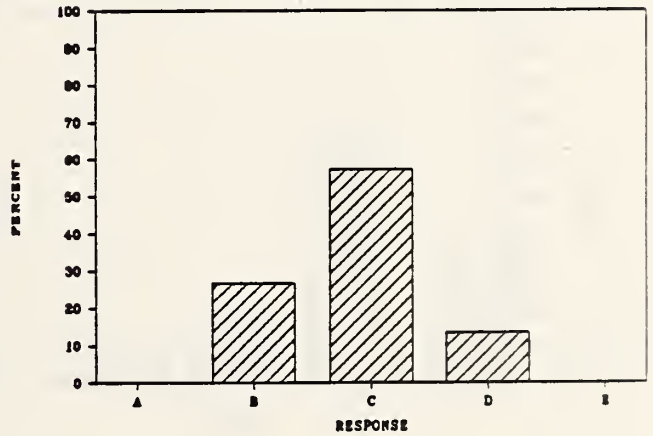
PERCENT RESPONSE QUESTION 63



64. Do you believe that roofing contractors under contract to USPS are adequately knowledgeable regarding industry organizations (e.g., NRCA, ASTM, RIEI) that provide information on roofing performance:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

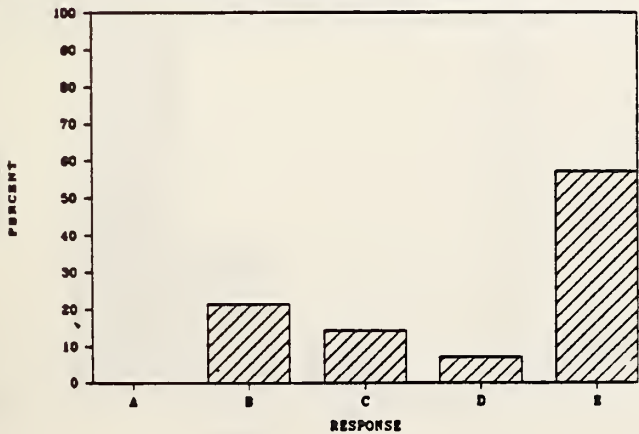
PERCENT RESPONSE QUESTION 64



67. Are quality audits (inspections) of completed roofs conducted to determine whether the construction is satisfactory:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

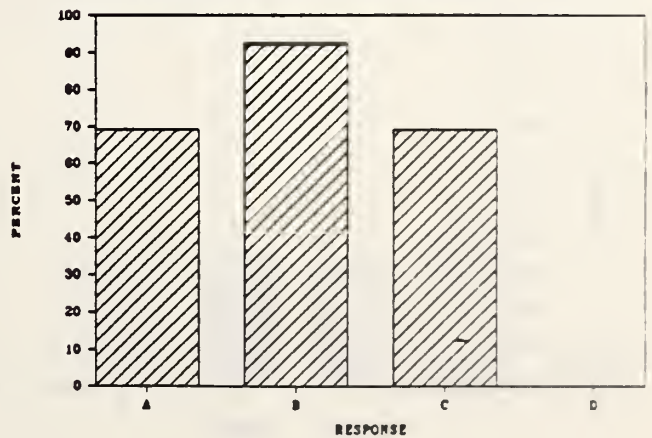
PERCENT RESPONSE QUESTION 67



68. Who conducts the quality audit (inspections) of the completed roofs:

- a. USPS personnel
- b. A/E or roofing consultant
- c. material manufacturer's representative
- d. other _____

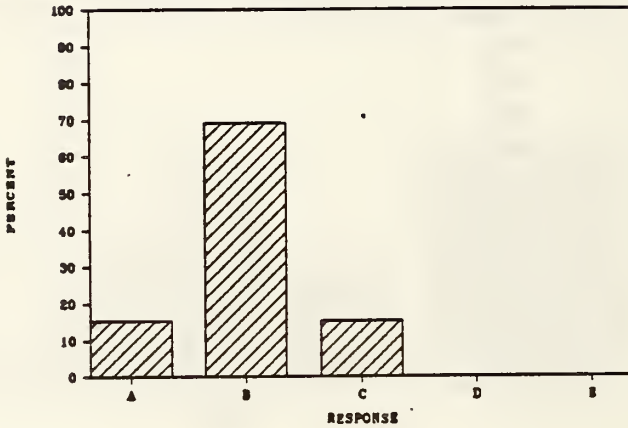
PERCENT RESPONSE QUESTION 68



69. Are roofing "cuts" for examination of the completed roof taken as part of the quality audit procedure:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

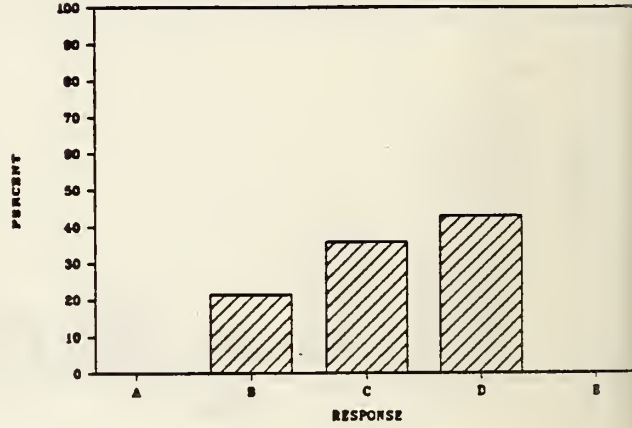
PERCENT RESPONSE QUESTION 69



70. Does your office find that contractors apply the roof system according to specification:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

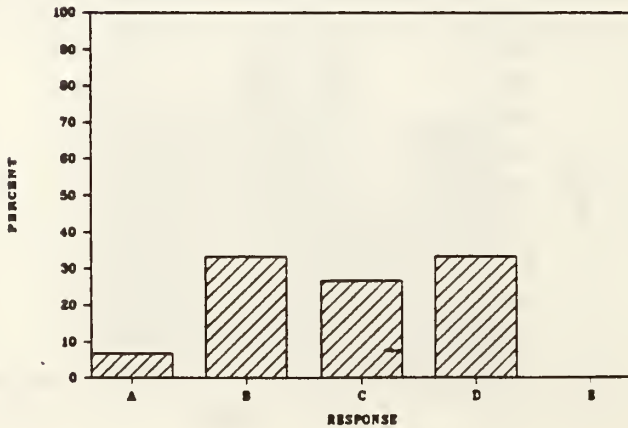
PERCENT RESPONSE QUESTION 70



71. Does your office find that roofing contractors have good communication with the A/E or other individuals responsible for the roof design:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

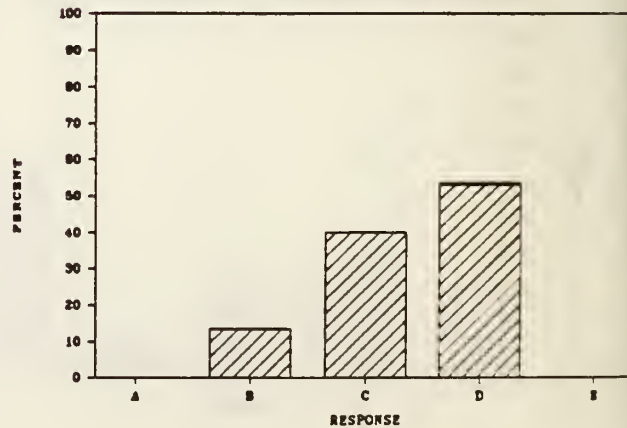
PERCENT RESPONSE QUESTION 71



72. Does your office find that for new construction or extensive renovation, the roofing construction is adequately coordinated with other trades:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

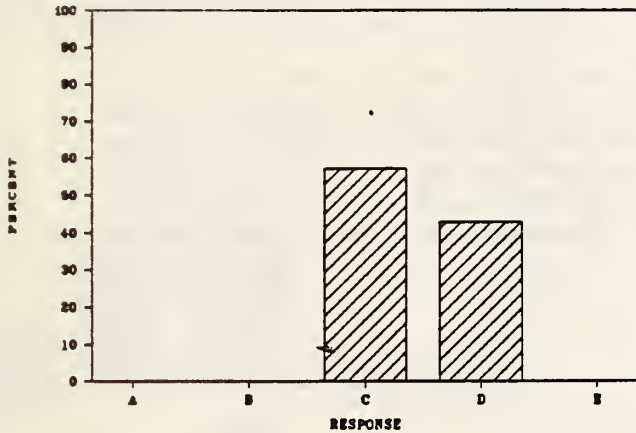
PERCENT RESPONSE QUESTION 72



73. Does your office find that roofing materials are properly stored (e.g., not allowed to become wet) and handled on the job site:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

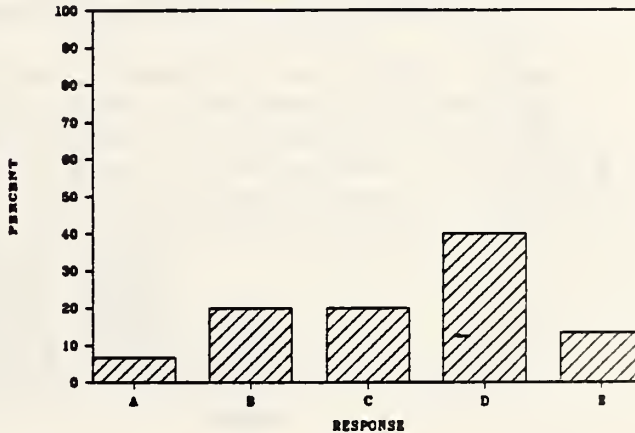
PERCENT RESPONSE QUESTION 73



74. Are construction records (e.g., dates, weather, materials, specs, asphalt temperatures, amount of roofing applied) kept for each job for which your office has responsibility:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

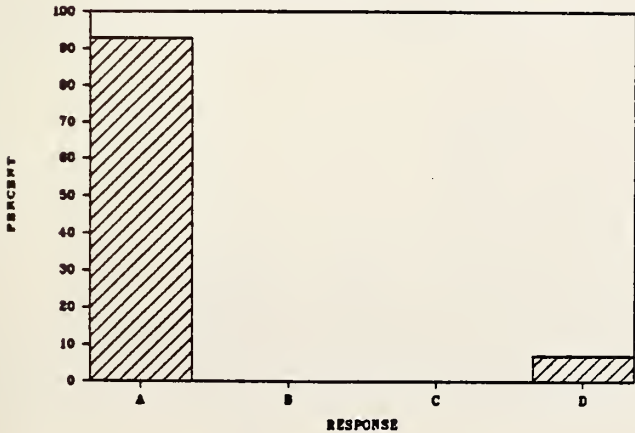
PERCENT RESPONSE QUESTION 74



75. In what form are the construction records kept:

- a. job file
- b. centralized file on roofing; not computerized
- c. computerized data file
- d. other _____

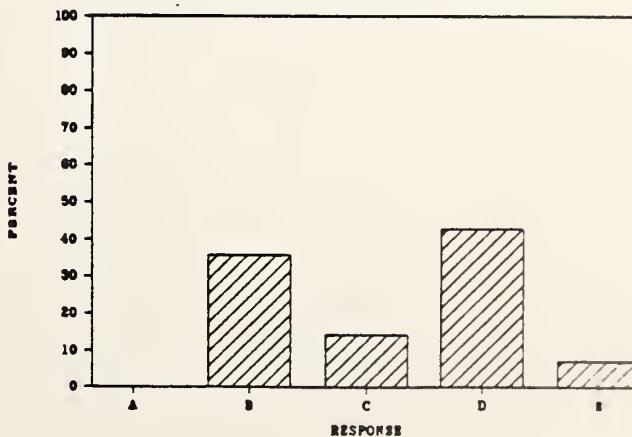
PERCENT RESPONSE QUESTION 75



76. Do you feel that the construction records which are kept are complete:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

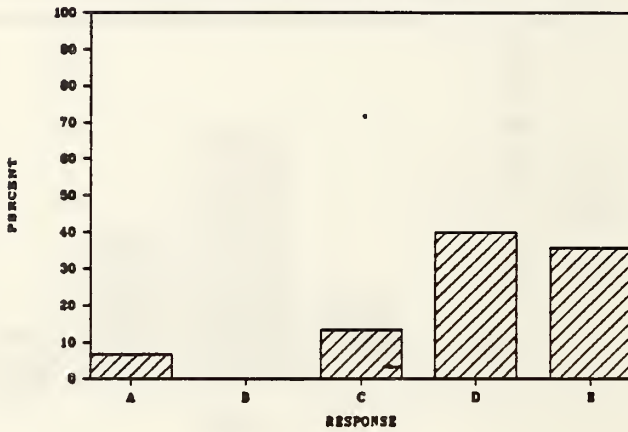
PERCENT RESPONSE QUESTION 76



77. If your office believes that a roofing contractor is responsible for a deficiency in the newly completed roof construction, does your office attempt to hold the roofing contractor accountable for repair of the deficiency:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

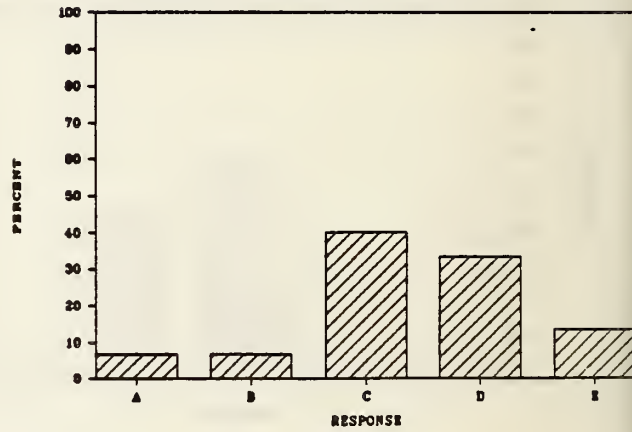
PERCENT RESPONSE QUESTION 77



78. With regard to previous questions, how often is your office successful in holding the roofing contractor accountable for repair of the deficiency:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

PERCENT RESPONSE QUESTION 78



APPENDIX B. RESULTS OF QUESTIONNAIRE ON INSPECTION, MAINTENANCE, AND REPAIR

This appendix presents the results of the questionnaire on inspection, maintenance, and repair. The questionnaire contained 51 questions for which the majority could be answered as a multiple choice selection. Questions 2, 3, 8, 35, 48, 50 and 51 required written answers.

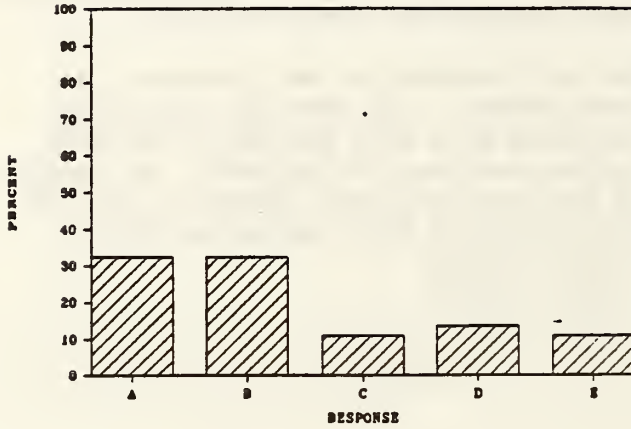
This questionnaire was sent to the USPS (43) Building Management and Engineering Offices (BMEOs), and (5) Regional Offices. Thirty-nine units responded.

As in the case of appendix A, the results are presented as bar graphs of the percent response versus the multiple choice answer. The question accompanies each bar graph. Since the respondents selected more than one choice for some questions, the average response often totals more than 100 percent. The results are given for only those questions which had multiple choice answers. Written answers were considered in presenting the results of USPS roofing activities given in the body of the report.

1. Please indicate the approximate number of roof inspections undertaken by each staff member of your office each year:

- a. less than 10
- b. between 10 and 40
- c. between 20 and 40
- d. between 40 and 80
- e. greater than 80

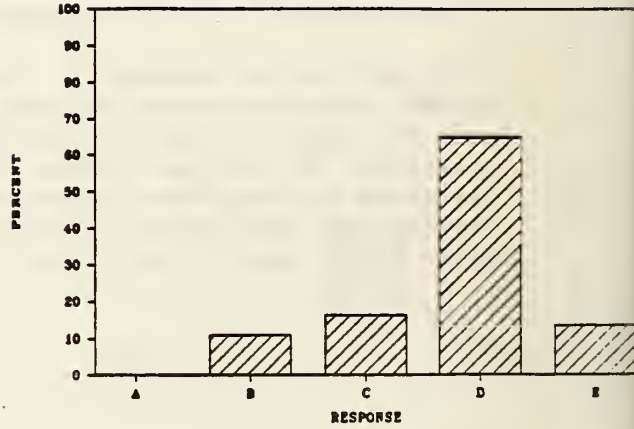
PERCENT RESPONSE QUESTION 1



4. For those buildings which your office has roof inspection responsibility, on the average what is the frequency of inspection:

- a. more than twice a year
- b. twice a year
- c. once a year
- d. once every 2-3 years
- e. less than once every 3 years

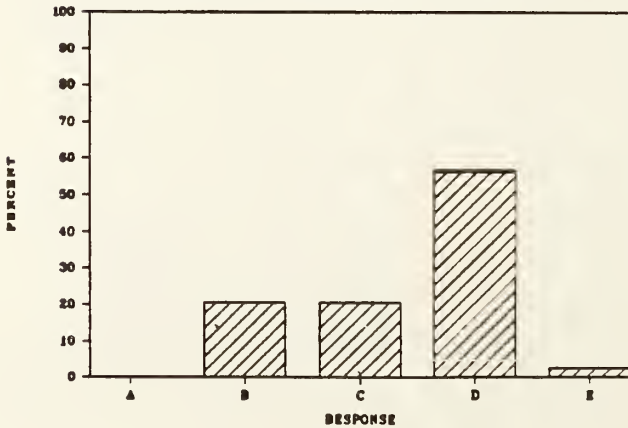
PERCENT RESPONSE QUESTION 4



5. Have you found that for most cases the frequency of roof inspections is adequate:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

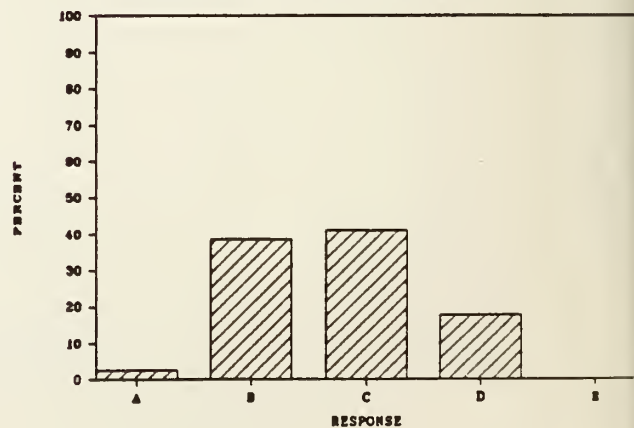
PERCENT RESPONSE QUESTION 5



6. How often in your experience have you found that roofs are only inspected when someone reports a roof leak or other problem:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

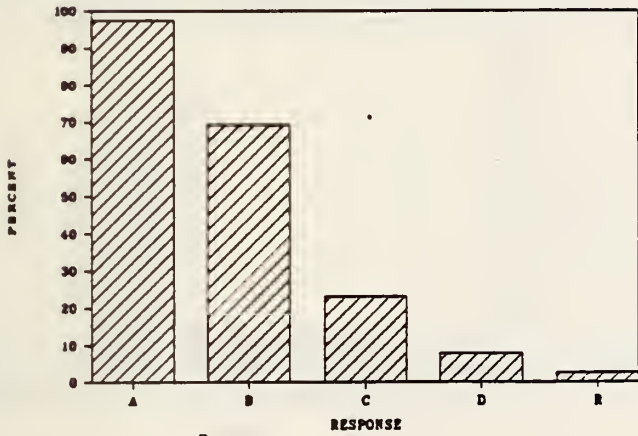
PERCENT RESPONSE QUESTION 6



7. Who generally performs the routine roof inspections:

- a. USPS Maintenance personnel
- b. Other USPS personnel
- c. architect or consultant under contract
- d. USPS maintenance personnel with assistance of an architect or consultant
- e. other _____

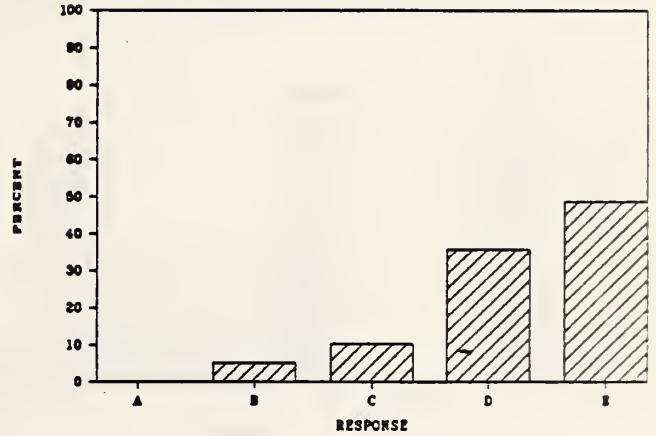
PERCENT RESPONSE QUESTION 7



9. Do those USPS personnel who conduct routine roof inspections also inspect other areas of the building and equipment:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

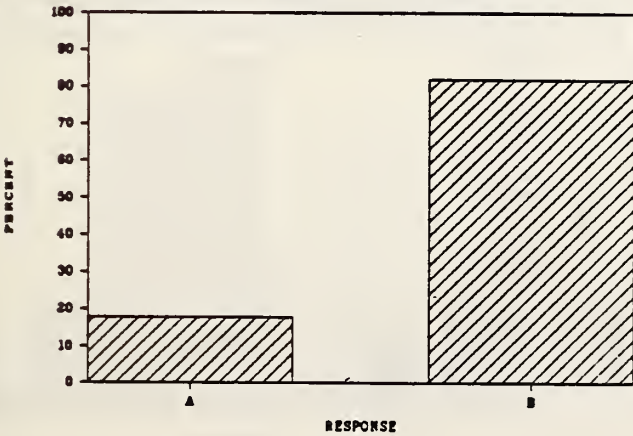
PERCENT RESPONSE QUESTION 9



10. Does your office have a key staff member whose primary responsibility is the inspection, maintenance, and repair of roofs:

- a. yes
- b. no

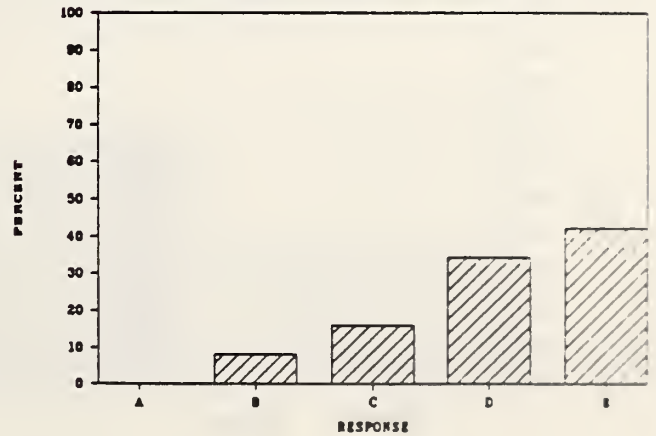
PERCENT RESPONSE QUESTION 10



11. In cases where it is difficult to identify the cause(s) of roof problems, does your office seek outside assistance:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

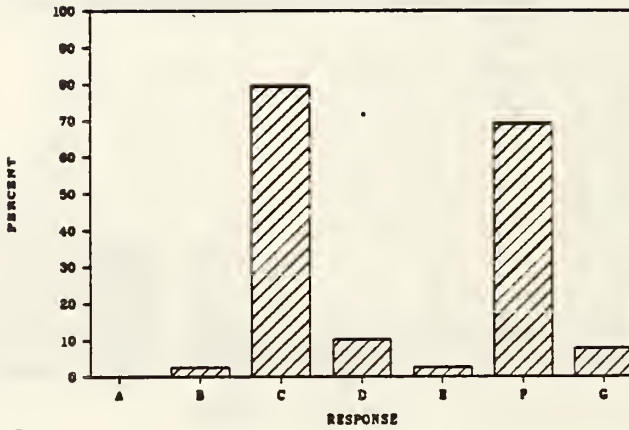
PERCENT RESPONSE QUESTION 11



12. Who provides your office with outside assistance in solving roof problems:

- a. USPS headquarters
- b. USPS regions
- c. USPS FREGOs
- d. USPS AMEOs
- e. USPS MESC
- f. contract A/E or consultant
- g. other _____

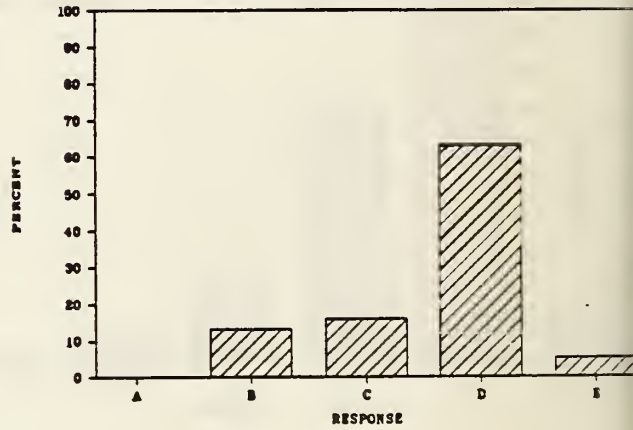
PERCENT RESPONSE QUESTION 12



13. Do you consider that those conducting routine roof inspections are adequately knowledgeable:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

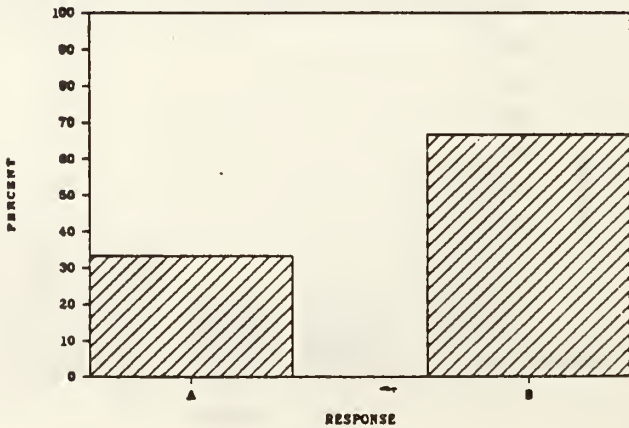
PERCENT RESPONSE QUESTION 13



14. Do you believe that your office is adequately knowledgeable in the inspection, maintenance, repair of non-conventional roof systems such as single-ply and spray-in-place polyurethane foam:

- a. yes
- b. no

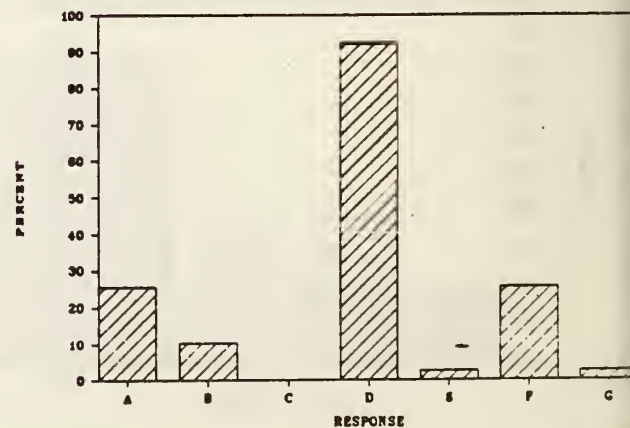
PERCENT RESPONSE QUESTION 14



15. Does your office provide the opportunity for training and educational courses from the following:

- a. RIEI
- b. NRCA
- c. ALA/CSI
- d. USPS (MESC)
- e. University short courses
- f. other _____
- g. no training provided

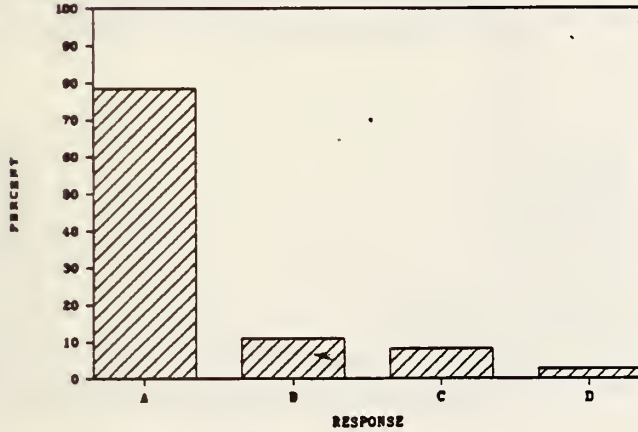
PERCENT RESPONSE QUESTION 15



16. What percent of your staff who conduct routine roof inspections attend training courses annually:

- a. less than 25
- b. between 25 and 50
- c. between 50 and 75
- d. more than 75

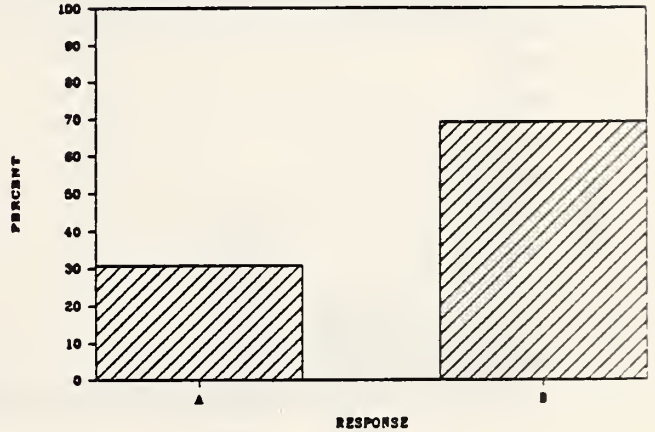
PERCENT RESPONSE QUESTION 16



17. Do you find that members of your office can adequately keep abreast of changes and advances in roofing technology:

- a. yes
- b. no

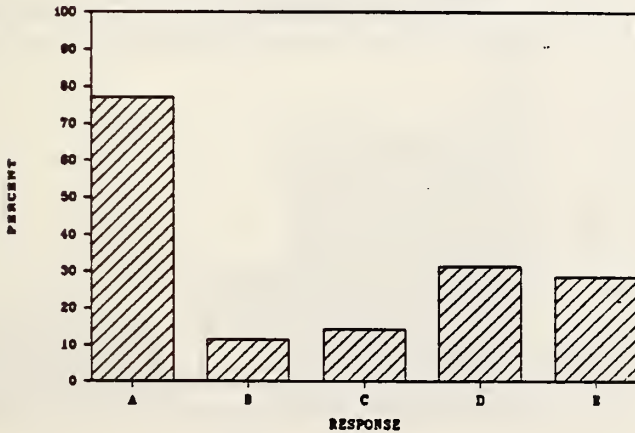
PERCENT RESPONSE QUESTION 17



18. By what mechanism do those staff who conduct routine roof inspections keep abreast of changes and advances in roofing technology:

- a. in-house (USPS) seminars
- b. industry seminars
- c. industry educational courses
- d. vendor seminars
- e. other _____

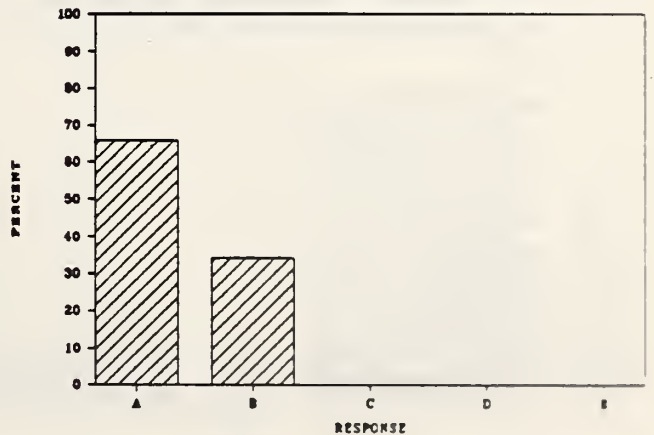
PERCENT RESPONSE QUESTION 18



19. In conducting routine roof inspections, how often does your office make repairs "on the spot":

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

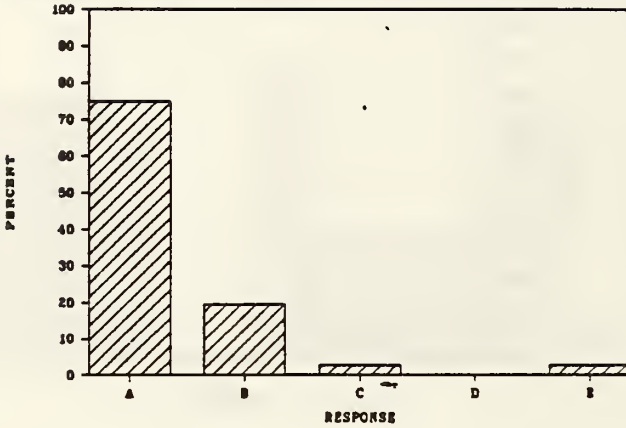
PERCENT RESPONSE QUESTION 19



20. Do those making roof inspections have with them on the roof adequate materials and tools for making "on the spot" repairs:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

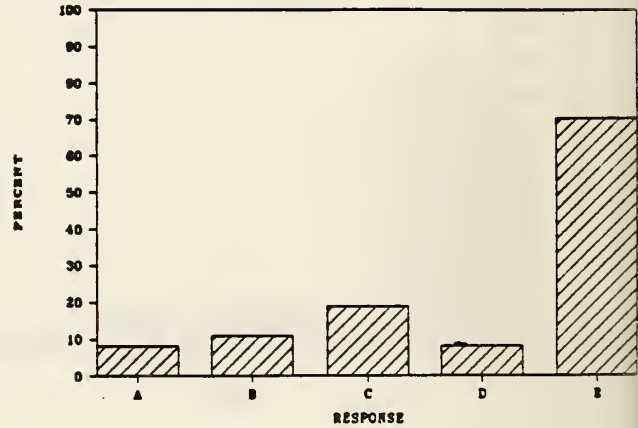
PERCENT RESPONSE QUESTION 20



21. On the average, what amount of time elapses between inspection of the roof and repair of defects which were observed:

- a. less than 1 week
- b. between 1 and 2 weeks
- c. between 2 and 4 weeks
- d. between 1 and 2 months
- e. more than 2 months

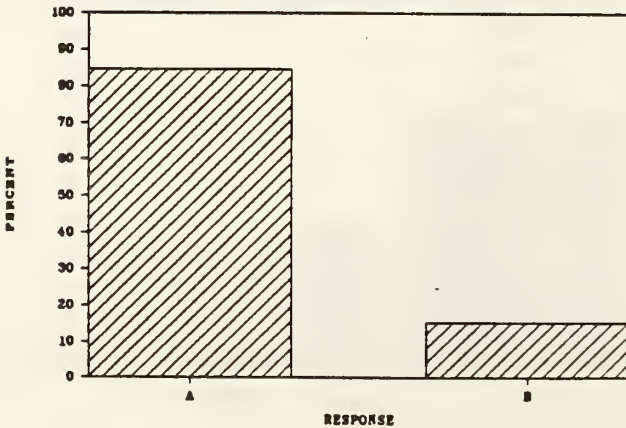
PERCENT RESPONSE QUESTION 21



22. Does USPS have guidelines and manuals available for inspection and maintenance of roofs:

- a. yes
 - b. no
- please indicate title:

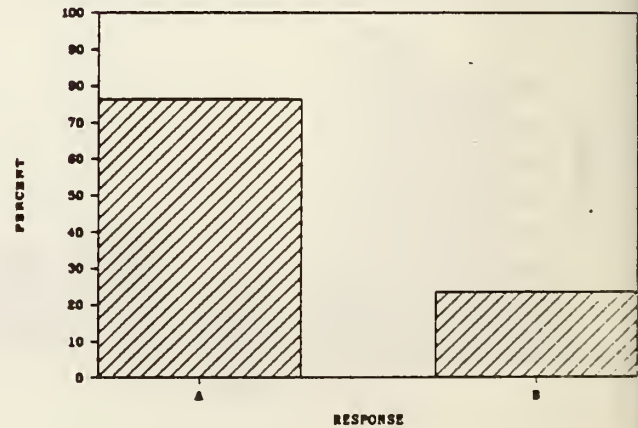
PERCENT RESPONSE QUESTION 22



23. If inspection and maintenance documents are available, do you find them adequate:

- a. yes
- b. no

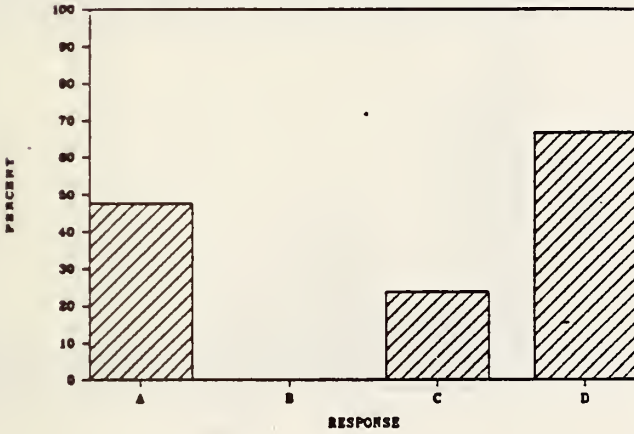
PERCENT RESPONSE QUESTION 23



24. Are any of the documents listed below used to assist in roof inspection and maintenance:

- a. NRCA roofing manual
- b. DoD guide specs and manuals
- c. ARMA/NRCA maintenance and repair manual
- d. other _____

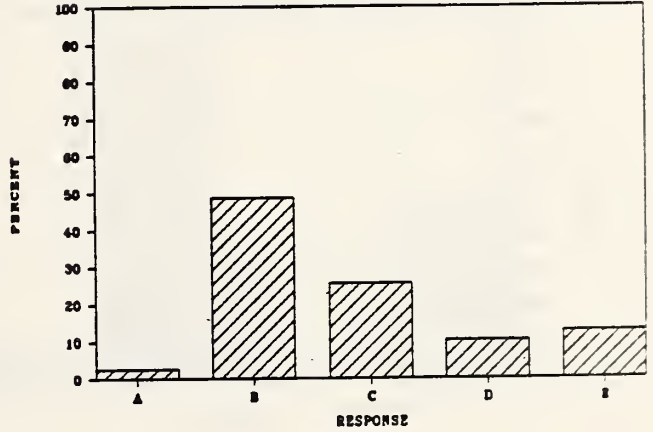
PERCENT RESPONSE QUESTION 24



25. Does USPS headquarters provide maintenance bulletins and guides concerning specific aspects of roof inspections, maintenance and repair:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

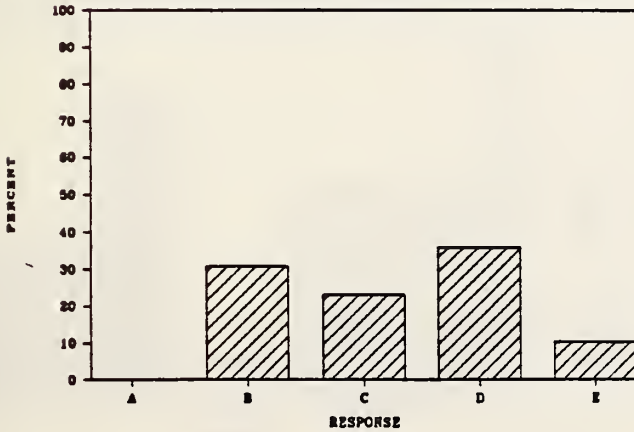
PERCENT RESPONSE QUESTION 25



26. Do you find that the USPS maintenance bulletins and guides concerning roof inspection, maintenance, and repair are of assistance:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

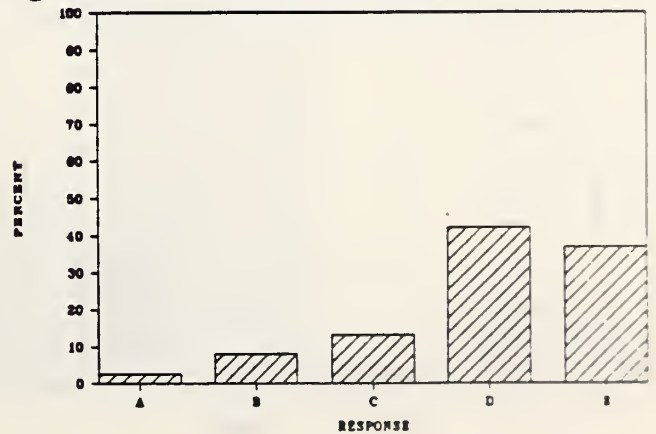
PERCENT RESPONSE QUESTION 26



27. In cases where it was found during the roof inspection that extensive repair or replacement was needed, does the inspector provide recommendations on the repair and replacement:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

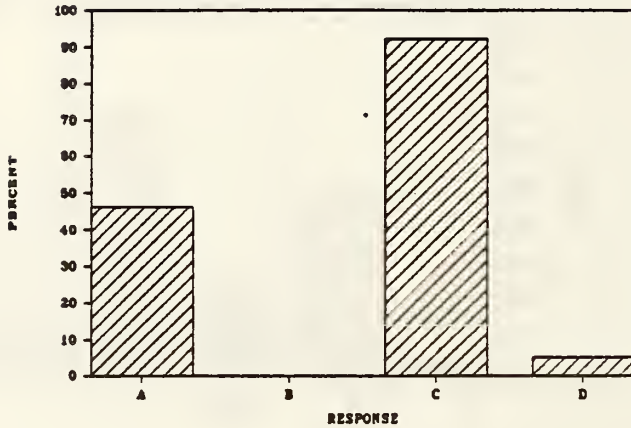
PERCENT RESPONSE QUESTION 27



28. In cases where extensive repair or replacement is needed, who provides the design of the remedial work:

- a. USPS design personnel (FREBOs)
- b. USPS maintenance personnel
- c. architect or consultant under contract to USPS design personnel
- d. other _____

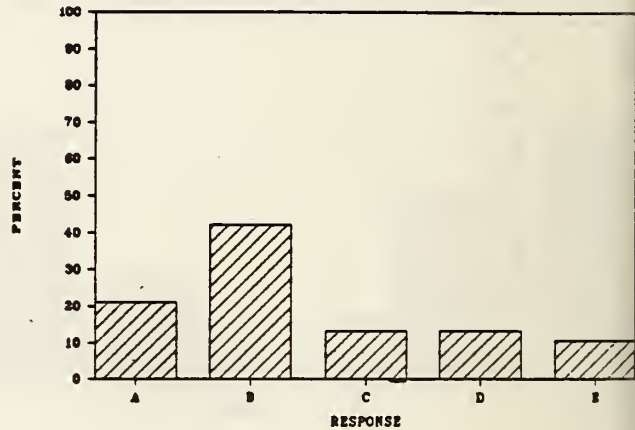
PERCENT RESPONSE QUESTION 28



29. If extensive roof repairs or replacement is needed and the job is designed by someone other than the maintenance inspector, does the designer meet with and discuss the needed work with the inspector:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

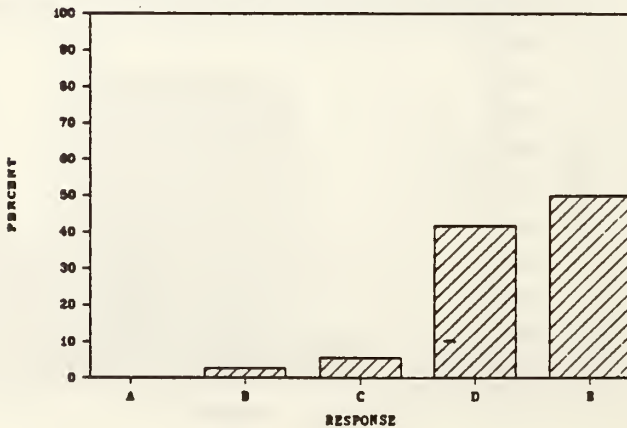
PERCENT RESPONSE QUESTION 29



30. Does the A/E responsible for design of extensive repairs or replacement visit the roof in question:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

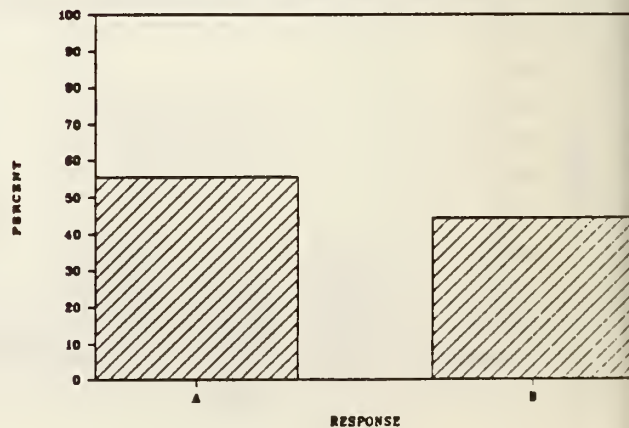
PERCENT RESPONSE QUESTION 30



31. Does USPS have available a set of criteria to assist in the assessment of the roof condition and in making a decision on whether the roof should be repaired or replaced:

- a. yes
- b. no

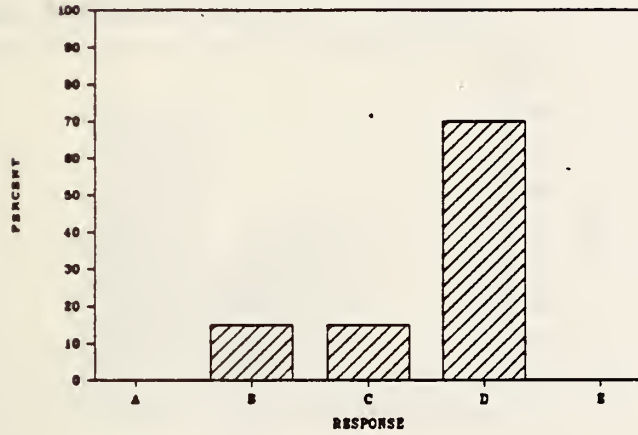
PERCENT RESPONSE QUESTION 31



32. If the answer to the previous question was "yes", do you find that the criteria are adequate in most cases of use:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

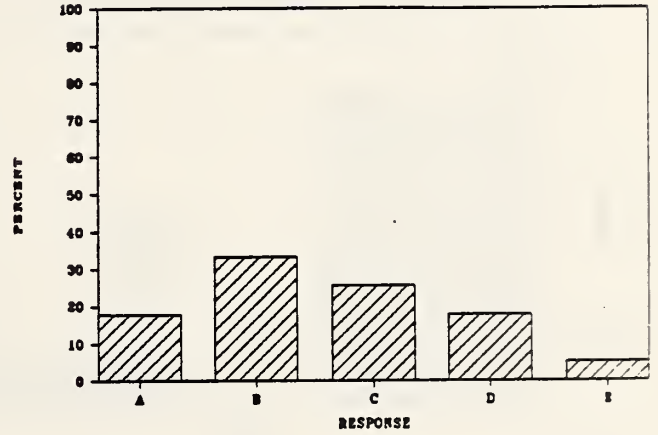
PERCENT RESPONSE QUESTION 32



33. Are non-destructive methods of evaluation (NDE) such as thermography or nuclear used during roof inspections for detection of moisture in the system:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

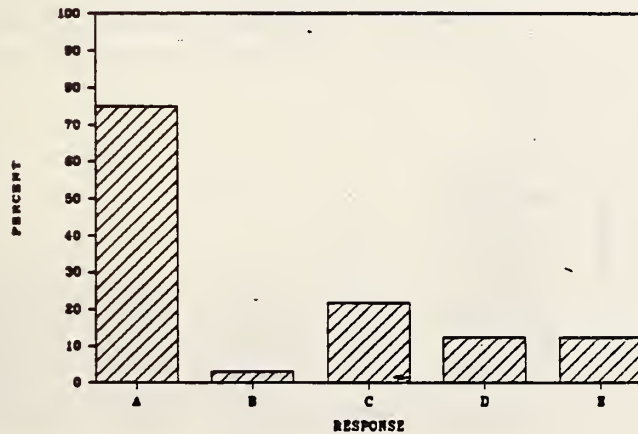
PERCENT RESPONSE QUESTION 33



35. Who conducts the NDE inspections:

- a. USPS maintenance personnel
- b. USPS design personnel
- c. A/E or consultant who specializes in roofing
- d. firm which specializes in use of NDE methods
- e. other _____

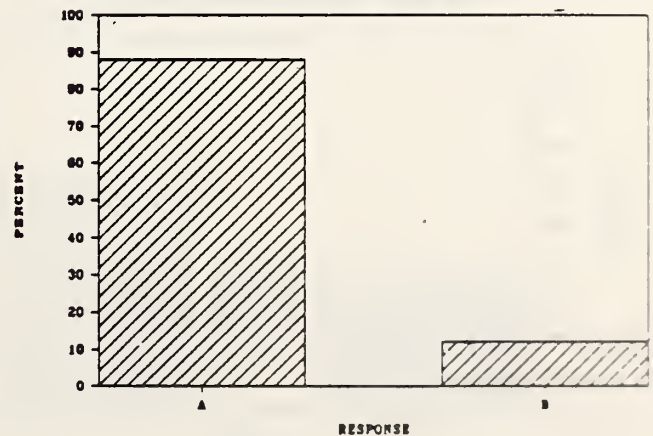
PERCENT RESPONSE QUESTION 35



36. Do you consider that those conducting NDE inspections are adequately trained:

- a. yes
- b. no

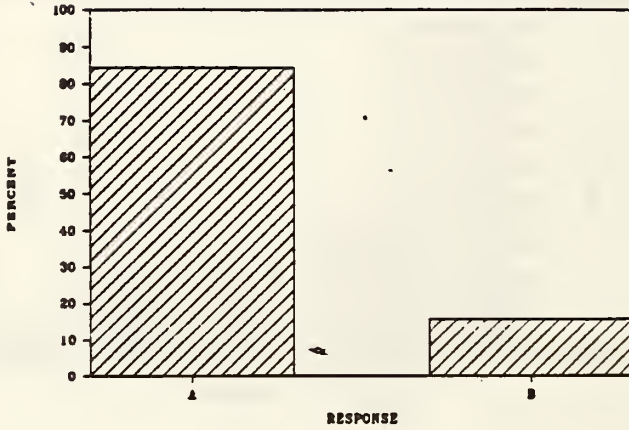
PERCENT RESPONSE QUESTION 36



37. If USPS personnel conduct NDE inspections, are adequate written guidelines available to assist the use of the equipment:

- a. yes
- b. no

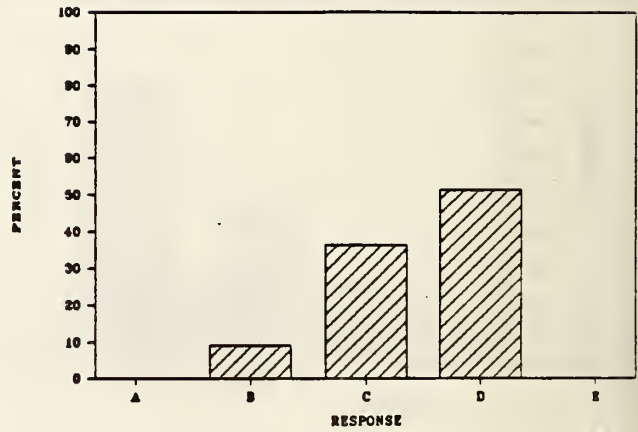
PERCENT RESPONSE QUESTION 37



38. Do you find that the results of NDE inspections are reliable:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

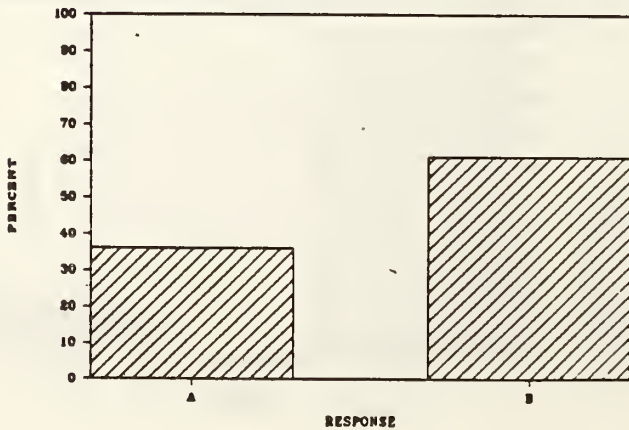
PERCENT RESPONSE QUESTION 38



39. Does USPS have available trained teams whose expertise is the inspection of roofs including NDE methods:

- a. yes
- b. no

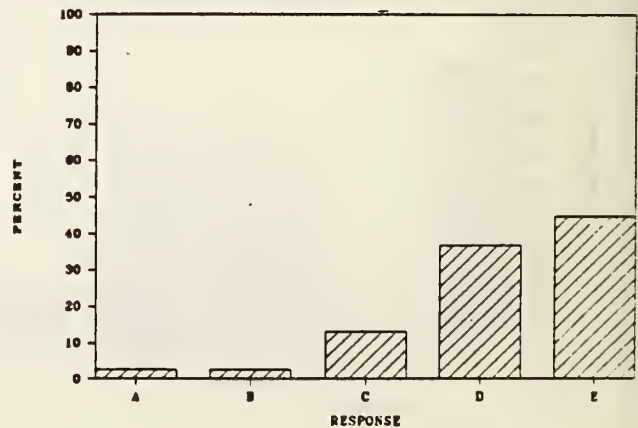
PERCENT RESPONSE QUESTION 39



40. Does your office keep inspection and maintenance records (including dates and work required and accomplished) for the roofs for which it has responsibility:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

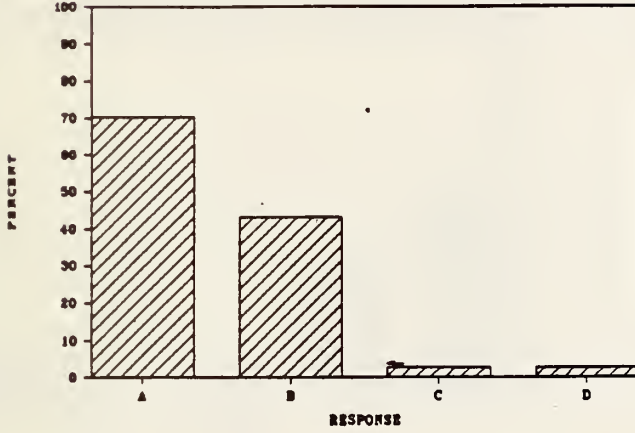
PERCENT RESPONSE QUESTION 40



41. How are the maintenance records kept:

- a. in file of maintenance engineering
- b. in a central file in the office
- c. at USPS regional office or at headquarters
- d. other _____

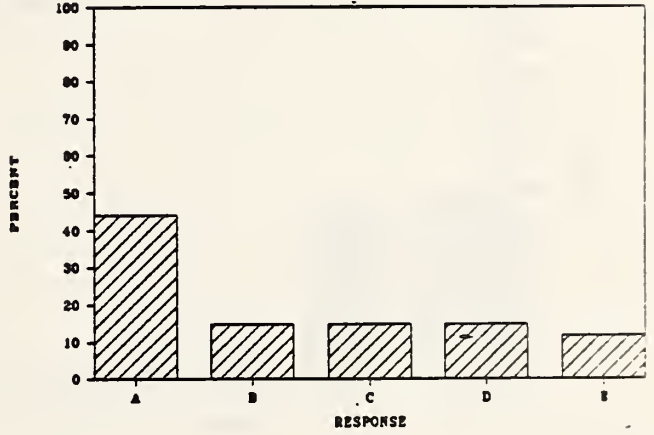
PERCENT RESPONSE QUESTION 41



42. Are maintenance records kept using a computerized data base management system:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

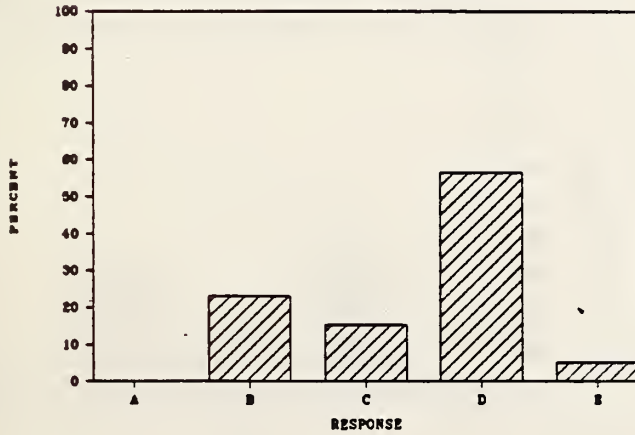
PERCENT RESPONSE QUESTION 42



43. Do you consider that the maintenance records are adequate:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

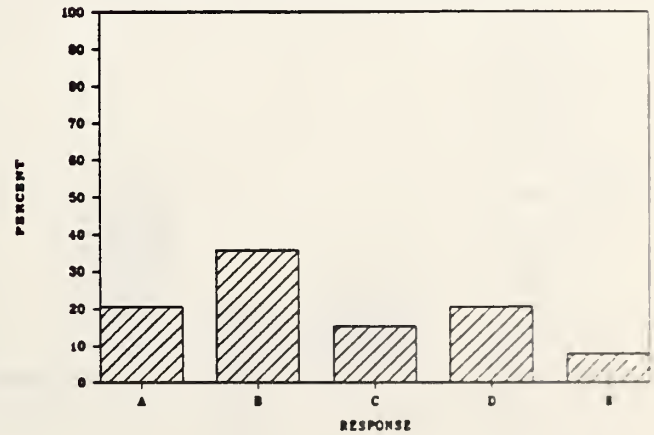
PERCENT RESPONSE QUESTION 43



44. Does your office analyze the maintenance records in order to identify materials and systems for which the performance is less than satisfactory:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

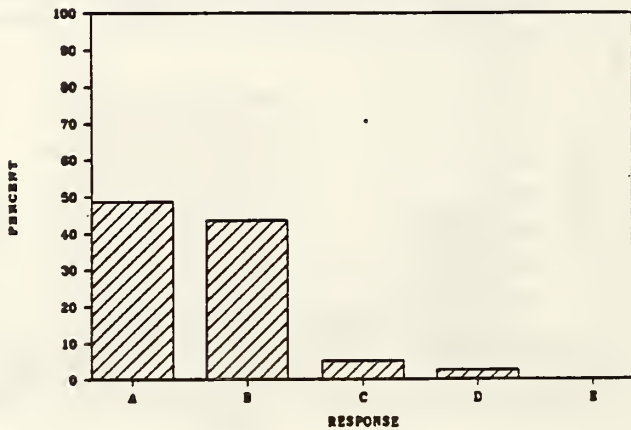
PERCENT RESPONSE QUESTION 44



45. Are maintenance records analyzed to prepare guidelines or alert building for other USPS personnel regarding some specific aspects of roofing materials and systems performance:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

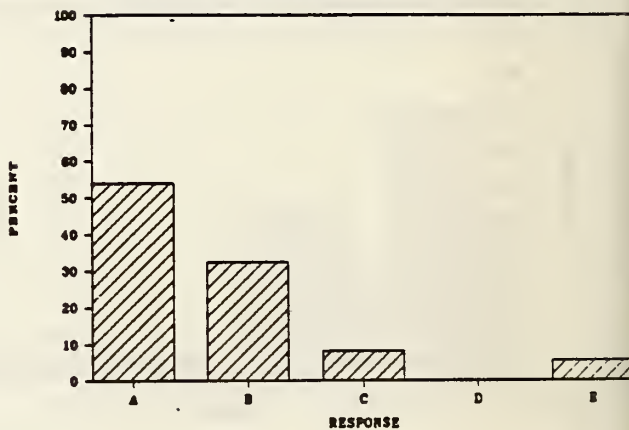
PERCENT RESPONSE QUESTION 45



46. Are maintenance records analyzed to provide the basis for recommended research to improve performance of roofing materials and systems:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

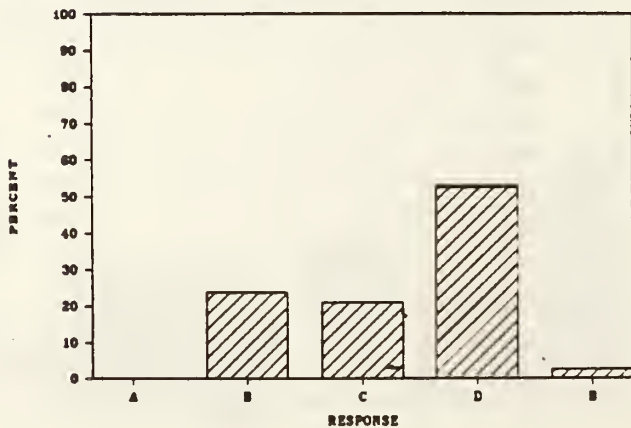
PERCENT RESPONSE QUESTION 46



47. In your experience, have you found that the design of new and replacement USPS roofing constructions has been satisfactory:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

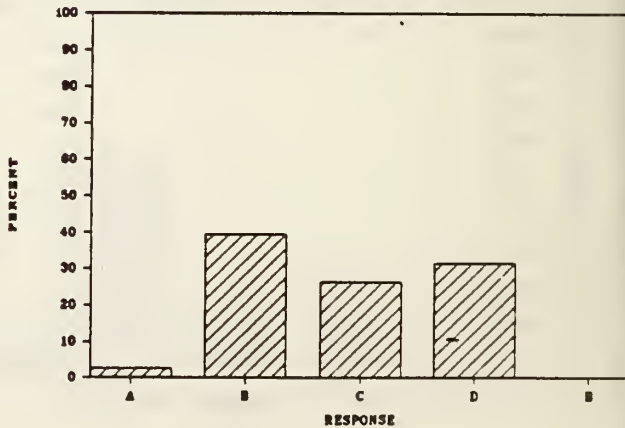
PERCENT RESPONSE QUESTION 47



49. In your experience, have you found that workmanship during new and replacement USPS roof construction has been satisfactory:

- a. never
- b. seldom
- c. often
- d. most of the time
- e. always

PERCENT RESPONSE QUESTION 49



APPENDIX C. USPS ROOF INSPECTION FORMS

Two forms which the USPS has available for use during roof inspections are:

1. Maintenance Check List (MMO-1-85)
2. Roof Inspection Report (MMO-109-83)

This appendix presents copies of these forms.

U.S. POSTAL SERVICE ROOF INSPECTION REPORT						PROJECT NUMBER:
SECTION 1						
A. FINANCE NO.	B. SUB-LOCATION NO.	C. ZIP CODE	D. CITY, STATE			
E. FACILITY NAME			F. ADDRESS			
G. MAINTENANCE RESPONSIBILITY <input type="checkbox"/> USPS <input type="checkbox"/> SEA OTHER AGENCY <input type="checkbox"/> LESSOR			H. YEAR BUILT	I. ROOF AGE	J. LEASE EXPIR. DATE	
K. POSTMASTER/MANAGER			L. ROOF AREA SQ. FT.		M. INSPECTION DATE	
N. RECOMMENDED ACTION <input type="checkbox"/> REPAIR (LOCAL) <input type="checkbox"/> REPAIR CONTRACTOR <input type="checkbox"/> REPLACE <input type="checkbox"/> NUCLEAR SURVEY REQUIRED						
SECTION 2						
A1. DECK TYPE	B1. INSULATION TYPE	C2. MEMBRANE TYPE		D2. MASTIC TYPE		
E2. NUMBER OF PLYS	F2. BALLAST TYPE	E3. STATUS OF ROOF GUARANTEE/BOND		H2. DATE OF LAST MAJOR REPAIR OR REPLACEMENT		
SECTION 3						
INSPECTION AREA	CLASS FY	ACTION BY	WORK ITEM NO.	NECESSARY CORRECTIVE ACTION	DATE OF REPAIR	
EXTERIOR	1. SETTLEMENT WALLS AND FOUNDATION					
	2. PLUMB WALLS AND CORNERS					
	3. MOISTURE/BITUMEN STAINS					
	4. CRACKING					
	5. FASCIA AND SOFFITS					
	6. WALL FINISHES					
	7. OVERHANGS/CORNICES/EDGING					
	8. GUTTERS/DOWN SPOUTS					
	9. EXPANSION/CONTROL JOINTS					
	10.					
	11.					
INTERIOR	12. DAMP					
	13. DISCOLORED CEILING OR CEILING TILE					
	14. PEELING PAINT					
	15. CRACKING/SPALLING					
	16.					
	17.					
	18.					

DEFECT AREA		CLASS FY	ACTION BY	WORK ITEM NO.	NECESSARY CORRECTIVE ACTION	DATE OF REPAIR
ROOF CONDITION	20. OVERALL APPEARANCE					
	21. DEBRIS					
	22. DRAINAGE					
	23. ACCIDENTAL DAMAGE					
	25. GENERAL APPEARANCE					
	24. ALTERATIONS/NEW EQUIPMENT					
	26.					
SURFACE CONDITION	25. BARE SPOTS IN GRAVEL WIND/WATER EROSION					
	27. OXIDATION/ALLEGATORING					
	28. SLUFFAGE					
	29. DIRT ACCUMULATION OR PLANT GROWTH					
	30.					
MEMBRANE CONDITION	31. BLISTERS					
	32. SPPLITING					
	33. PONDING					
	34. PENETRATIONS					
	35. LOOSE/EXPOSED FELTS					
	36. FRACTURES					
	37. DRY FELTS					
	38. FASTENING TO SUBSTRATE					
	39.					
	40.					
FITCH PANS	41. SPREADAGE OF FILL MATERIAL					
	42. ANCHORED PROPERLY					
	43.					
	44.					

INSPECTED AREA		CLASS FY	ACTION BY	WORK ITEM NO.	NECESSARY CORRECTIVE ACTION	DATE OF REPAIR
BASE PLASTER	45. FRACTURE					
	46. BUBBLES					
	47. SAGGING/PULL AWAY					
	48. OPEN LAWS					
	49. DETRIORATION					
	50. CRACKS					
	51.					
	52.					
COUNTER PLASTER	53. FASTENING					
	54. FRACTURE					
	55. METAL FLASHING					
	56. OPEN JOINTS					
	57. CALLINGS					
	58. OPEN LAWS					
	59.					
	60.					
	61.					
CORNER	62. CRACKED OR BROKEN					
	63. OPEN JOINTS/LOOSE MORTAR					
	64. ATTACHMENT TO WALL					
	65. CALLINGS					
	66. FLASHING					
	67. FRACTURE					
	68.					
	69.					
	70.					
	71.					

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INSPECTION AREA		CLASS PV	ACTION BY	WORK ITEM NO.	NECESSARY CORRECTIVE ACTION	DATE OF REPAIR
PARAPET WALLS	71. DETERIORATED MORTAR JOINTS					
	72. CRACKS					
	73. SPALLING					
	74. MOISTURE DAMAGE					
	75.					
ROOF EDGES/GRAVEL STOP	76. SPPLITING					
	77. SECUREMENT					
	78. RUSTING					
	79. DETERIORATED FELTS					
	80. CUTS OR OPENINGS					
	81.					
	82.					
ROOF PENETRATORS	83. BASE FLASHING					
	84. COUNTER FLASHING					
	85. FRACTURES					
	86. CALLINGS					
	87. DRAINAGE					
	88. DISCHARGES PIPED TO DRAINS					
	89. FOOT TRAFFIC DAMAGE					
	90.					
EXPANDED JOINTS	91. OPEN JOINTS					
	92. FRACTURES/SPLITS					
	93. SECUREMENT					
	94. RUSTING					
	95.					
	96.					

INSPECTION AREA		CLASS FY	ACTION BY	WORK ITEM NO.	NECESSARY CORRECTIVE ACTION	DATE OF REPAIR
SAFETY	87. SNOW LOADING SIGNAGE POSTED					
	88. ROOF ACCESS SECURED					
	89. ACCESS LADDER FASTENED					
	100. LIGHTING ROD SAFETY GUARDS					
	101.					
	102.					
REMARKS						
PERSON MAKING REPORT (NAME)			TITLE		SIGNATURE	

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U. S. POSTAL SERVICE
ROOF INSPECTION REPORT

INSTRUCTIONS

1. FILL IN ALL ITEMS IN SECTION 1:
2. COMPLETE ALL ITEMS IN SECTION 2 (BE SPECIFIC)
 - A1. DECK TYPE - WOOD DECK, STEEL DECK, ETC.
 - B1. INSULATION - FIBER BOARD, FOAM, FIBERGLASS, ETC.
 - C1. MEMBRANE TYPE - BITUMENOUS BUILT-UP, SINGLE PLY, SPRAY IN PLACE FOAM, ETC.
 - D2. MASTIC TYPE - COAL TAR PITCH, ASPHALT, ELASTOMERIC, ETC.
 - E2. NUMBER OF PLYS - FOR SINGLE PLY ROOFING STATE THICKNESS OF PLY AND TYPE OF PLY I.E., RAG, ASBESTOS, FIBERGLASS, ETC.
 - F2. BALLAST TYPE - RIVER ROCK, CINDERS, ETC.
 - G2. STATUS OF ROOF GUARANTEE/BOND - IF A GUARANTEE OR BOND IS IN AFFECT PROVIDE EXPIRATION DATE. IN THE REMARKS SECTION PROVIDE PERTINENT INFORMATION.
 - H2. DATE OF LAST MAJOR REPAIR OR REPLACEMENT - PROVIDE DATES. IF THE ROOF HAS HAD MAJOR REPAIRS OR REPLACEMENT WITHIN THE LAST 3 YEARS PROVIDE P/A NUMBER IN REMARKS SECTION.
3. COMPLETE SECTION 3 OF THE INSPECTION, ITEM BY ITEM.
 - A. FOR EACH INSPECTION AREA, IDENTIFY THE FOLLOWING CLASS OF PROJECT MOST CLOSELY DESCRIBING THE WORK NEEDED TO CORRECT CONDITIONS FOUND. ENTER THE APPROPRIATE LETTER FOLLOWED BY A NUMBER, INDICATING THE RECOMMENDED TIME PERIOD FOR ACCOMPLISHMENT (1 - FISCAL YEAR, 2 - NEXT FISCAL YEAR, ETC. UP TO 5 FOR 5 YEARS FROM DATE OF REPORT).

CLASS A - WORK NECESSARY TO CORRECT CONDITIONS WHICH CONSTITUTE IMMINENT HAZARD TO LIFE OR HEALTH, OR AN IMMINENT HAZARD TO PROPERTY OR CONTINUITY OF POSTAL OPERATIONS.

CLASS B - WORK NECESSARY TO PREVENT ACCELERATED DETERIORATION OF THE ROOF OR BUILDING.

CLASS C - WORK THAT WILL RESULT IN IMPROVED BUILDING OPERATING EFFICIENCY AND HAVING ECONOMIC BENEFIT MEETING THE CRITERIA IN PUBLICATIONS 190 AND 191. THIS CLASS CODE SHOULD BE USED FOR REPAIRS NOT URGENT ENOUGH TO BE IN CLASS B.

() - CHECK MARK, CONDITION SATISFACTORY. NO WORK REQUIRED.

B. FOR EACH WORK ITEM INDICATE THE ACTION OFFICE - L - LOCAL AUTHORITY; D - REQUIRES APPROVAL AT THE DISTRICT; R - REQUIRES APPROVAL AT REGION.

C. ASSIGN EACH WORK ITEM A NUMBER. THE FIRST TWO DIGITS SHALL BE THE FISCAL YEAR OF THE INSPECTION, I.E. 83-1, 83-2, 83-3, ETC.

U.S. POSTAL SERVICE MAINTENANCE CHECK LIST

IDENTIFICATION

WORK CODE	EQUIP. ACRONYM				NUMBER			TYPE
2	B	L	D	G	0	0	1	M

SYSTEM/LOCATION Building Inspection	EQUIPMENT TYPE Roof-All Types	MODEL/SERIES	ORIGINAL ISSUANCE DATE
SUB-EQUIPMENT/AREA	DATE LAST REVISED	REVISION NO.	APPROVED BY (INITIALS)

PART OR COMPONENT	ITEM NO.	INSTRUCTIONS (COMPLY WITH ALL CURRENT SAFETY PRECAUTIONS)	FREQUENCY			
Safety Procedure	1.	Comply with all applicable safety rules and regulations.				
Preparation	2.	Review material on Roofs-Inspection and Maintenance. Use copy of reduced size roof plan.				
Building Wall	3.	Observe condition of outside building walls.				
Top Floors	4.	Observe condition of ceilings, walls, etc., on all top floors. Look for indications of leaks, damage, etc.				
Tools-Equipment	5.	Check out required tools and equipment. Examine all items for safety condition (ladders, rope, etc.).				
Roof Perimeter	6.	Walk entire outer edge of roof. Check roof edges, parapet wall, flashings, etc., for bad caulking, open joints, expansion cracks, damage, etc.				
Expansion Joints- Control Joints	7.	Walk entire length of expansion and control joints. Check each side closely for damage and condition.				
Roof Penetrations	8.	Check all roof penetrations for damage or problems (air ducts, fans, support steel, etc.). Not vent pipes.				
Roof Drains	9.	Check each drain for proper drainage, tightness, trash build-up, etc., check roof mat around drain.				
Roof Mat	10.	Walk roof in not more than 20' wide paths. Check roof condition for 10' on either side. Note any damage, exposed roof felts, blisters, loss of flood coat or aggregate, soft spots, boils or alligatoring of bitumen, etc.				
Repairs	11.	All spots requiring repair will be marked by spray paint. Area will be noted on roof print and identified by location and number. Use the number to show the problem and necessary repairs. Issue work order and show when work was completed.				

U.S. POSTAL SERVICE MAINTENANCE CHECK LIST

IDENTIFICATION

WORK CODE	EQUIP. ACRONYM				NUMBER			TYPE
2	B	L	D	G	0	0	1	M

SYSTEM/LOCATION <i>Building Inspection</i>	EQUIPMENT TYPE <i>Roof-All Types</i>	MODEL/SERIES	ORIGINAL ISSUANCE DATE
SUB-EQUIPMENT/AREA	DATE LAST REVISED	REVISION NO.	APPROVED BY (INITIALS)

PART OR COMPONENT	ITEM NO.	INSTRUCTIONS (COMPLY WITH ALL CURRENT SAFETY PRECAUTIONS)	FREQUENCY			
	1.	No time allowance. Safety is included in all items.				
	2.	30 minutes per inspection for review.				
	3.	2 minutes per 100 lineal foot.				
	4.	2 minutes per 1,000 square foot (office). 1 minute per 1,000 square foot (workroom).				
	5.	10 minutes standard.				
	6.	1 minute per 20 lineal foot.				
	7.	1 minute per 20 lineal foot.				
	8.	.5 minute each.				
	9.	.5 minute each.				
	10.	1 minute per 1,000 square foot of roof.				
	11.	30 minutes per standard plus 1 minute per 1,000 square foot roof area.				
		Repairs. <u>Note</u> : Actual repairs are charged to corrective maintenance.				
		T.T. = approximately 100,000 square feet per day.				
		If required roof repairs indicate that water is entering the Built-Up Roof or you have reason to believe the roof insulation is wet, contact your regional Maintenance Management office and request a roof moisture survey.				

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET (See instructions)	1. PUBLICATION OR REPORT NO. NBSIR-85/3275	2. Performing Organ. Report No.	3. Publication Date DECEMBER 1985
4. TITLE AND SUBTITLE <p style="text-align: center;">U.S. Postal Service Roofing Practices</p>			
5. AUTHOR(S) <p style="text-align: center;">Walter J. Rossiter, Jr., William C. Cullen, Robert G. Mathey</p>			
6. PERFORMING ORGANIZATION (If joint or other than NBS, see instructions) NATIONAL BUREAU OF STANDARDS DEPARTMENT OF COMMERCE WASHINGTON, D.C. 20234		7. Contract/Grant No.	8. Type of Report & Period Covered
9. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS (Street, City, State, ZIP) U.S. Postal Service Design Management Division Real Estate and Building Department Washington, D.C. 20260-6415			
10. SUPPLEMENTARY NOTES <p><input type="checkbox"/> Document describes a computer program; SF-185, FIPS Software Summary, is attached.</p>			
11. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here) <p>This report reviews the roofing practices of the U.S. Postal Service (USPS). The USPS has direct responsibility for the design, construction, and maintenance of about 100 million ft² of roofing. In addition, it leases buildings having approximately an equal amount of roof area. The approach taken was to obtain information on USPS roofing practices which could be used as a data base for judging strengths, weaknesses, and identifying problems. The primary sources of data were: discussions with USPS personnel; discussions with individuals who provide roofing services to USPS; review of USPS roofing documents; results of the distribution of questionnaires to USPS staff; and the determination of training requirements for those involved with roofing.</p> <p>The review was divided between two major phases of USPS roofing construction practice. One part involved design, materials, and construction, and the other involved inspection, maintenance, and repair. The primary topics addressed with regard to the review on design and construction were general design considerations, training, responsibility, material selection, and quality control during construction. With regard to maintenance and repair, the review included general considerations, frequency of inspections, responsibility, training, maintenance guidelines and manuals, repairs and when they are conducted, and inspection and maintenance records. The advantages and limitations of the USPS roofing practices were given, and will form the basis of recommendations for improving USPS roofing practices.</p>			
12. KEY WORDS (Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons) construction, design, low-sloped roofing, maintenance, material selection, repair, review, roofs			
13. AVAILABILITY <input type="checkbox"/> Unlimited <input checked="" type="checkbox"/> For Official Distribution. Do Not Release to NTIS <input type="checkbox"/> Order From Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. <input type="checkbox"/> Order From National Technical Information Service (NTIS), Springfield, VA. 22161		14. NO. OF PRINTED PAGES	15. Price

