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SUPERVISION AND INSPECTION OF FEDERAL CONSTRUCTION

Technical Report No. 54

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National Research Council

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The Federal Construction Council serves as a planning, coordinating, and operating body to encourage continuing cooperation among Federal agencies in advancing the science and technology of building as related to Federal construction activities.

In this pursuit, its specific objectives include: Assembly and correlation of available knowledge and experience from each of the agencies; elimination of undesirable duplication in investigative effort on common problems; free discussion among scientific and technical personnel, both within and outside the Government, on selected building problems; objective resolution of technical problems of particular concern to the Federal construction agencies; and appropriate distribution of resulting information.

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FEDERAL CONSTRUCTION COUNCIL
TASK GROUP T-50
on
SUPERVISION AND INSPECTION OF FEDERAL CONSTRUCTION

While the Federal Construction Council itself has over-all responsibility for its technical programs, specific projects such as this one are carried out under the direction of appointed task groups of engineers, architects, and scientists, each possessing qualifications in some phase of the subject under consideration.

Each task group member serves as a specialist in his field or as a generalist in the problem area, not as a spokesman for or representative of his own agency or any other organization with which he may be associated.

At the request of the Council, the following persons were designated by the various agencies to organize and direct the study.

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FOREWORD

The ensuring of satisfactory construction of buildings and other projects--the broad function of supervision and inspection--has long been one of the areas of most serious concern to Federal construction agencies. From time to time, various individual agencies have undertaken in-depth studies which resulted in significant improvements in the effectiveness of supervision and inspection for the agencies involved; but major problems have persisted. The BRAB Federal Construction Council concluded that further improvement might well be obtained through an interagency study, aimed primarily at determining which of the various practices and procedures employed by the different agencies have proved worthwhile and which have not. For this purpose, a task group of Federal Government specialists in supervision and inspection (T-50) was formed. This report is the result of its efforts.

The effort expended by the members of Task Group T-50 in carrying out the study is gratefully acknowledged.

This report of the Task Group has been reviewed and approved by the Federal Construction Council, and approved for publication in the public interest by the Building Research Advisory Board.

Robinson Newcomb, Chairman
Building Research Advisory Board

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I
INTRODUCTION

A. Objectives

Objectives were to study current Government agency practices and procedures relating to supervision and inspection of Federal construction; to identify areas most in need of improvement; and to recommend practices and procedures to achieve more effective supervision and inspection.

B. Scope/Limitations

The broad range of Government procedures and practices relating to construction supervision and inspection came under consideration. Ultimately, detailed examination was limited to a group of general subjects within each of which it was ascertained that problem areas exist.

C. Conduct of Study

The study was conducted by a group of technical specialists from seven Federal agencies, each of whom is particularly knowledgeable concerning supervision and inspection of construction. At the outset, this Task Group examined broad aspects of agency policy and procedures relating to construction supervision; evaluated those in light of actual practice; then, on the basis of findings plus collective experience and judgment, identified as a point of departure a number of areas, including the ones listed above under Scope/Limitations, as involving the greatest need for improvement. To supplement Task Group experience, a detailed questionnaire, designed to elicit specific information on current agency practices and procedures, was thereafter developed and directed to the agencies responsible for the largest portion of design and/or construction of Federal projects.

Responses to the questionnaire were subsequently studied and evaluated by the Task Group. Resulting conclusions and recommendations, as well as related discussion, are presented in this report.

D. Organization of the Report

This report comprises: Section I, this Introduction; Section II, Conclusions and Recommendations, containing (without elaboration) Task Group conclusions as to the nature of problems of supervision and in-

spection, and recommendations for the solution of such problems; and Section III, Discussion, in which reasons for or explanation concerning the conclusions and recommendations are presented. A glossary of terms used in connection with Federal construction work is appended.

II
CONCLUSIONS AND RECOMMENDATIONS

Many of the problems encountered in Federal construction projects directly or indirectly stem from or are aggravated by agency practices and procedures regarding supervision and inspection of construction. During its study, the Task Group attached major importance to those areas that contribute to: Increased cost of construction; inferior quality of materials and workmanship; delay in construction; inaccuracies in work; and confusion regarding responsibility and authority.

Presented below without elaboration are conclusions regarding current practices and/or procedures in each of those areas of supervision and inspection where the Task Group has found a need for improvement, along with recommendations for solving the indicated problems.

A. General Considerations

1. Who Should Supervise and Inspect Government Projects

Conclusions

Given the circumstances peculiar to Federal construction, the needs and interests of the Government are best served when regular Government employees of the construction agency supervise and inspect Government construction projects. Utilization of an A-E firm in a supervision and inspection capacity--particularly in the absence of active and continuous monitoring by a representative of the responsible agency--frequently opens the way to difficulties which would be avoidable were agency personnel used instead. However, occasional retention of the design firm, or employment of an A-E firm, to provide supervision and inspection services on Government construction projects is justifiable and proper when the regular field staff of an agency is insufficient to meet the requirements of current projects.

Recommendation

Insofar as possible, field supervision and inspection of all Federal construction projects should be performed by the construction authority, utilizing its own personnel, or, on temporary basis, those of another construction agency (in accordance with recommendation on p. 19). However, when this approach is precluded by unavailability of the necessary personnel at either the construction authority or other agency, and a private professional

organization such as an A-E firm must thus be employed, a representative of the construction authority should be assigned as resident engineer.

2. Relationships among Organizations Involved in a Construction Project

Conclusions

Misunderstandings and disputes between personnel of the construction agency and of the user agency and/or design organization (Government or private) have frequently arisen from the lack of firm agreement, established prior to the start of the project, on the limits of authority and extent of responsibility of each organization involved.

Similarly, some of the dissatisfaction expressed by agencies with regard to the quality of supervision and inspection received from architectural-engineering firms (and some of the irritation at demands for service which the A-E firm considers beyond the obligations accepted under the construction agreement) are also frequently due to incompleteness or lack of precision in contract documents.

Recommendations

Reliance on oral or vaguely written agreements between the construction authority and other concerned Government and private organizations regarding such matters as areas of responsibility and authority, procedures to be followed, and proper lines and methods of communication, should be avoided. Such matters should, instead, at all times be carefully delineated in written agreements between the construction authority and other Government organizations and/or be spelled out in contracts for service with architectural-engineering firms. As a minimum, the following general provisions should be included in all such agreements and contracts:

a. That the construction authority has exclusive responsibility for ensuring that all project work accords with the requirements of contract documents; that no personnel from other organizations are permitted to communicate officially with the contractor, except as specifically provided for in the written agreement or contract

b. That any changes to construction contract documents requested by user agency or design authority can be effected only through formal change order executed by the contracting officer, and that the followthrough on such changes is to be coordinated by the contracting officer with all organizations having an interest in the project

c. That it is within the purview of the construction authority to effect any changes which will not in any way alter the basic scope of the contract documents or the functional requirements of the facility, and which are within funding limits; that, however, all other changes require prior approval of user agency and/or design authority.

In particular, the contract with an A-E firm retained for field supervision and inspection should provide that a specific number of supervision and inspection personnel will be supplied to the project for specifically defined periods; that such personnel will meet certain agreed-to-minimum qualifications; and that assignment of such personnel will be subject to review and approval by the construction authority.

Similarly, the contract or agreement under which an A-E firm or a Government organization designs a project should require that the design organization, whether Government or private, will be available--either by appearance of appropriate personnel at the project site or by prompt reply to all communications from the field--to answer questions and assist field supervision in solution of design-related problems as such may arise.

B. Organization, Responsibility and Authority, and Qualifications of Field Supervisory Staff

1. Organization of Staff

Conclusion

Performance of the field supervisory staff, and consequently the quality of construction, are adversely affected on many Government projects when assignment of field supervisory personnel reflects: Establishment of staff size primarily from considerations of project size and budget; determination of staff composition on the basis of rigid organization charts; omission from the staff of personnel needed to perform particular and/or specialized functions; delay in selection of basic staff until construction is imminent.

Recommendations

All factors influencing requirements for field supervision and inspection should be considered in determining staff size and composition, including but not limited to: Type and technical complexity of work involved; project scheduling; proficiency and dependability of contractor; quality of work produced by trades and crafts; geographical location; and qualifications of available staff personnel, as well as size and budget of the project.

A basic staff of key personnel, comprising the resident engineer and principal assistants, should be assigned to a project well in advance of contract award, to ensure ample time for familiarization with the contract documents and with the project site before construction begins. (The number of assistants and the types assigned to the resident engineer should be determined, to the extent possible or practicable, on the basis of information available at the start of a project concerning the factors mentioned above, and with due consideration for the recommendations of the designated resident engineer.)

Size of the overall staff should remain flexible throughout the term of the project, with personnel numbers and types assigned to the various branches of work adjusted to suit particular requirements at any given period of construction.

In determination of the types of personnel required for adequate staffing of a project, safety should be considered as a specialized function requiring the services of an individual qualified through training and experience to prescribe safety practices and procedures and to assume overall responsibility for enforcement of safety regulations. On large and/or hazardous projects, a safety specialist should be assigned to the staff on full-time basis. For any project on which, by virtue of size or nature, a full-time safety inspector is not warranted, a specialist should be assigned on a part-time basis; however, care should be exercised that no one individual is called upon to fill more such part-time assignments concurrently than can be efficiently and effectively handled.

In addition, administrative and/or clerical assistants should be assigned to field supervision staffs, in order to free the resident engineer and technical assistants for complete concentration on primary duties and responsibilities.[1]

Authority to select, recruit, hire, and assign field supervisory personnel should, under all circumstances, be retained and exercised by the central or regional office of the construction agency; however, the designated resident engineer should be afforded opportunity to make recommendations regarding assignment of field personnel and such recommendations should be given due consideration.

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[1] If the alternative Task Group solution regarding enforcement of labor laws (footnote 2, p. 8) is accepted, staff assistants to handle labor matters will also be needed.

2. Responsibility and Authority

Conclusion

Considerable delay and confusion on some Government construction projects, and many of the morale problems of field supervisory forces, are attributable to failure to grant the resident engineer authority commensurate with the broad responsibilities generally assigned either explicitly or implicitly.

Recommendations

The formally stated responsibilities of the resident engineer should include the following items:

a. Enforcing compliance with plans, specifications, and general provisions of contracts for the project.

b. Ensuring project progress according to schedule.

c. Arranging with other organizations for reviews, approvals, and tests required in connection with the project.

d. Managing the field office in accordance with agency regulations.

e. Effecting correction of errors, omissions, or oversights found in the plans and specifications--by direct action if within delegated authority, or, if not, by requesting action of others.

For effective discharge of such responsibility, the resident engineer should be recognized as the field representative of the contracting officer and should be delegated authority commensurate with his qualifications and capabilities to accomplish the following:

a. Interpret contract drawings and specifications

b. Reject work which is of inferior quality or which otherwise fails to meet contract requirements

c. Stop work in progress when continuation seems likely to result in an undesirable element of construction which would be difficult to correct, or when safety considerations warrant such stoppage

d. Direct contractor attention to those areas where effective coordination is necessary to achieve desired results--without, however, responsibility or authority to direct operation or coordination of contractor work

e. Recommend disbursal of payments to the contractor on the basis of work completed and accepted, or withholding of such payments where work is uncompleted or is, for any reason, deemed unacceptable

f. Give final approval of shop drawings, materials, samples, and similar items submitted by the contractor[1]

g. Assign responsibility and delegate authority to assistants in accordance with individual capabilities and particular talents

h. Initiate and negotiate potential changes to the contract and, within limits prescribed by each agency, approve and implement such changes and authorize associated payments and extensions of time.

In all cases, the authority delegated to the resident engineer should be commensurate with assigned responsibilities; whenever a construction agency, for any reason, sees fit to limit the authority of the resident engineer on a project, the area of assigned responsibility should also be comparably limited.

The resident engineer should be left free of any responsibilities not directly related to supervision and inspection of construction, particularly responsibility for contractor labor and employment practices. In this area, the sole function of the resident engineer should be the reporting through appropriate channels, to the Government department having primary responsibility for enforcement of applicable laws or directives,[2] of any violations detected in the normal course of work.

3. Qualifications of Field Supervisory Personnel

Conclusion

Utilization by agencies of nonprofessional or subprofessional personnel as resident engineers and field staff engineers is no longer justifiable, in view of the complex nature of modern

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[1] Whenever an ample complement of qualified personnel is available on the staff of the resident engineer, performance of preapproval checking of shop drawings for selected materials and equipment may (but does not have to) be left to that staff. Lacking such staff qualification, preapproved checking should be performed by the design agency (see p. 15).

[2] An alternative solution would be for the cognizant Government agency to provide funding to construction agencies for expenses incurred in retaining and assigning qualified personnel with specific responsibility for policing of contractor labor practices.

building technology and the responsibility and authority which such personnel are expected to accept and exercise.

Recommendations

The various members of field supervisory staffs should be required to possess the following minimum qualifications:

a. Resident engineers should be professional engineers (as defined by the U. S. Civil Service Commission),[1] with substantial administrative ability plus extensive experience in supervision of construction projects, including familiarity with Government work. Technical competence should have been satisfactorily demonstrated prior to assignment as a resident engineer, together with the ability to represent the agency diplomatically in the field and to secure contractor compliance with the requirements of contract documents.

   The extent and nature of individual experience and the possession of the attributes listed should be considered in relation to project size and complexity; in no case should an individual possessing less than the minimum professional qualifications be assigned to a construction project as resident engineer.

b. Each field staff engineer should possess the education and experience necessary for effective supervision of the branch of work to which assignment is made.

   Field staff engineers should be technically competent to furnish engineering details, recognize improper construction, prescribe procedures and methods required in solution of field problems, provide professional advice to the resident engineer, supervise and train subordinates, and, in addition, should be capable of dealing diplomatically and effectively with the contractor.

c. Inspectors should possess training and experience sufficient to ensure recognition of improper construction; should be capable of reading plans and comprehending specifications; and should be particularly experienced in the trade (within a branch of work) to which assignment is made.

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[1] Under Civil Service Commission regulations, an architect or other construction-oriented individual, meeting specified requirements of education and/or experience--as well as a graduate engineer--may qualify as a professional engineer and thus be eligible for the position of resident engineer.

C. Conduct of Supervision and Inspection

1. Channels of Communication

Conclusions

Failure to establish proper or clearly defined channels of communication between field supervisory forces and other organizations or individuals having responsibilities in a project has, in many instances, contributed to delay, error, and misunderstanding. Similarly, unauthorized or erroneous statements, made by field supervisory personnel to personnel of other Government or private organizations, have resulted in misunderstandings and in repercussions that were both unanticipated and undesirable.

Recommendations

Definite procedures should be established governing communications between field supervisory staff personnel and organizations other than the construction agency (or individuals) having or expressing interest in the project. Insofar as practicable, such procedures should include the following provisions:

a. The resident engineer should report to and receive instructions from only one source of higher authority.

b. All communications from user agency personnel, the public, public officials, or others, which may either embarrass or inadvertently commit a higher echelon of the construction agency, should be referred to higher authority for answering.

c. A channel of communication should be established providing direct contact between resident engineer and designer, permitting expeditious exchange of information concerning field problems affecting design.

d. Channels of communication between Government and contractor field personnel should be established and agreed upon by all concerned and should be utilized without unauthorized exception throughout the construction period. In particular, construction agency personnel should confine communications to the appropriate level of contractor supervision; should never issue instruction to workmen; and should limit to brief exchanges any conversations intended to promote friendly relations with personnel not on a level appropriate for communication.

2. Part-Time Supervision and Inspection

Conclusion

Although assignment of personnel on a part-time basis to supervise and inspect a construction project, or a segment of a project, is frequently justifiable and proper when a job is limited in size and/or free of complexities, difficulties have resulted when part-time supervision and inspection personnel are employed in situations where full-time duty is needed to ensure satisfactory work. Also, in many cases where part-time supervision and inspection would otherwise suffice, effectiveness is diminished almost to the vanishing point by visits to the job site made too infrequently to meet the need or on such regular schedule that the timing of visits can be readily anticipated.

Recommendation

Part-time supervision and inspection should be employed only when a project is neither large enough nor complex enough to justify assignment of personnel on a full-time basis. Size and complexity should not, however, be the only criteria; such factors as the record of contractor performance should also be considered before a decision to use part-time supervision and inspection is reached. Moreover, if there are indications after a project has started that satisfactory results are not being obtained by use of the part-time approach, full-time supervisors/inspectors should be immediately assigned.

When part-time supervision and inspection are employed, special effort should be made to ensure that the quality of work done is not adversely affected by the fact that a Government representative is not on hand at all times. In particular, visits to the job site should be made without prior announcement, and on a varying schedule, but with sufficient frequency to ensure compliance with contract requirements.

3. Personnel Assignment: Area vs. Branch of Work

Conclusions

Better supervision and inspection are generally obtained when individual assignments are made in accordance with familiarity with a particular branch of work (e.g., mechanical, electrical), instead of entailing the overseeing of all work being done in an area of a project. Area assignments are justifiable and proper only when a project is relatively spread out and the work being done does not require specialized knowledge in different branches. The practice--followed on occasion in some agencies--of assigning on the basis of area in the absence of these conditions is not justifiable.

Recommendation

Supervision and inspection personnel should, as a rule, be assigned responsibility only for branches of work with with training and experience provide assurance of familiarity. Responsibility should be assigned for all work being carried out in an area of a project only if the work is connected with or related to the speciality of assignee; is relatively simple in nature; and, even then, only if this basis of assignment seems justified by circumstances (e.g., in a spread-out project).

4. On-the-Job Meetings

Conclusion

Although there is unanimity of agency endorsement of the principle of holding progress meetings for resolving problems and eliminating misunderstandings, much or all of the potential value becomes lost when such meetings are held only after urgent difficulties have arisen.

Recommendation

Formally planned on-the-job meetings, convened periodically in accordance with a predetermined schedule, should be held on all projects of any appreciable size and attended by all parties whose interests are involved. The frequency of such meetings should be determined by the size and complexity of the job, the demonstrated ability of the field supervisory staff, the record of performance of the contractor, and any relevant consideration peculiar to the agency. The records or minutes of these meetings should contain details of any resulting agreements or decisions and the procedure to be followed for implementation.

5. Field Records, Reports, and Administrative Manuals

Conclusions

Although all agencies require that field supervisory forces maintain records and regularly report to central or district offices on project activities, the prescribed scope of records and reports, and the procedures for transmittal and dissemination to all parties concerned with the project, are inadequate in many cases to serve the needs of those having responsibilities in the project--e.g., due to the manner in which reports are prepared, reviewed and filed, vital information with regard to a project is sometimes overlooked and necessary corrective action not taken.

Field supervisory personnel cannot be expected consistently to maintain correct records, pursue appropriate procedures, and submit required reports without benefit of administrative and procedural manuals which promulgate agency-wide approved methods.

Recommendation

Instructions should be issued for maintenance of complete and accurate records and preparation of reports for each construction project. Such instructions should be included in administrative manuals issued to guide field personnel in conforming to an agency wide filing system, correspondence format, and uniform system of reporting and accounting.[1]

Reports should contain all facts pertinent to the project and should be transmitted to higher-echelon supervision in a manner that will ensure timely and effective communication. Every report, documented with pertinent supporting information or evidence, should be sent, in accordance with a predetermined schedule, to the office having the next higher level of responsibility. Copies of documented reports relevant to existing or potential problem areas should be forwarded immediately and directly to the appropriate authority for action, and copies of correspondence initiating action on a project should be available to the field supervisory staff to ensure availability of adequate information.

Complete and accurate historical records should be maintained to preclude later misconceptions concerning methods and progress of construction. To this end, entries into the daily log should include, but not be restricted to, the following:

Contractor Activities

- Operations, by trade
- Number of workmen employed, by trade
- Equipment on job, with hours of utilization

Supervision and Inspection

- Actual or potential delays
- Contractor violations and/or work rejected
- Significant instructions to contractor personnel
- Any authorized and/or potential change orders
- Assignments of inspection personnel
- Material received--accepted or rejected
- Test reports or results
- Samples and other submissions--status

[1] While administrative manuals are considered definitely worthwhile and needed, the value of technical manuals which describe proper inspection practices has been questioned, primarily on the ground that such manuals might in some cases recommend procedures which conflict with project specifications. The Task Group does not believe that use of such manuals should necessarily be discontinued; however, special care should be taken in preparation of manuals to ensure against creation of possible conflict with specifications.

General Information

Brief description of weather
Visitors, including names and purpose of visit
Any unusual happenings.

6. Provision of Inspection Aids

Conclusions

Effectiveness of field supervisory forces has, in some instances, been limited by failure to provide such forces with all of the equipment and other inspection aids necessary for accurate evaluation of the work--with the result that construction errors and deviations from contract requirements can much more readily escape detection. Conversely, when field supervisors and inspectors are allowed or encouraged to rely on check lists to direct and govern the scope and detail of inspection procedures, the resulting tendency is to discourage the application of good judgment gained through training and experience.

Recommendations

Field supervisory personnel should be provided the inspection aids necessary to thorough evaluation of the work. A basic list of inspection aids should be prepared and should be expanded as necessary to meet the requirements of large and/or complex projects; as a minimum, the following should be included:

Standard Federal Specifications and other referenced specifications related to the job

Building, sanitary, and electrical codes, when applicable

Agency policy and administrative manuals

Basic reference tables

Basic drafting instruments and equipment

Basic measuring devices--tapes, rules, calipers

Transit and level

Ten-foot metal straight edge

Concrete slump cone and rod

Any special clothing required to facilitate thorough inspection

Engineer's hammer, nails, cord, and keel.

The field supervisory staff should be furnished sufficient copies of contract drawings, specifications, and shop drawings, as well as changes thereto, for each staff member to have a set pertaining to his branch of work, in order to obviate the need for frequent trips to the project office to check details. Use of check lists should be limited in application to items of repetitive nature (e.g., concrete slump tests, periodic preparation of concrete test cylinders, inspection of reinforcing materials prior to installation), or as a reminder of items of work requiring correction or completion toward the end of the construction period.

7. Contractor Submittals, Mill Inspection and Laboratory Testing

Conclusions

Current practices and procedures regarding checking and approval of shop drawings, materials, samples, and submittals, conduct of mill and plant inspections, and testing of materials, prefabricated items, and manufactured equipment are in many cases inadequate to ensure against violation of specification requirements and/or design intent. Specifically, current practices and procedures have resulted in disputes between construction and design agency personnel concerning acceptability of items submitted by contractors, and authority and responsibility in this area; insufficient mill and plant inspections; too heavy reliance on contractors to provide quality control tests; acceptance of unverified performance information supplied by manufacturers.

Recommendations

Agencies should jointly undertake a broad study of the whole question of ways to ensure quality of materials, prefabricated items, and manufactured equipment used on construction projects, with the objective of developing consistent, rational, and easily applied practices and procedures for all agencies to follow. In the meantime, agencies should take the following steps to overcome the most serious shortcomings which exist:

a. The resident engineer, under authority delegated by the contracting officer, should have the right and responsibility of final approval of all information and materials submitted as evidence of the suitability of products proposed for use by the contractor--e.g., all shop drawings, product-descriptive literature, samples, and similar items. Although checking of such submissions may be permitted to devolve on the resident engineer when staff is adequate, responsibility for review of shop drawings and other submissions should otherwise always rest with the design agency. Where critical technical considerations are involved, review and recommendation by the design agency should be a requisite prior to final approval by the resident engineer. Wherever possible,

those items of construction requiring review by the design agency prior to final approval should be so designated in advance of construction. In addition, the resident engineer should have the option of obtaining design agency review and recommendations on any other item prior to final approval.

b. Construction contracts should include provisions that ensure access by Government personnel, at the option of the construction agency, to mill or plant for the purpose of inspecting contract materials and fabrications. Agencies should exercise this right of inspection whenever the critical nature of the material or product or other circumstance warrants such action. To facilitate Government inspection of materials and manufactured items for construction projects, a combined directory of agency mill and plant inspection organizations should be established, similar in scope to the Defense Contract Administration Services Organization Directory. This directory should provide information concerning inspection and testing facilities of each organization, along with details concerning service charges, channels of communication, and required procedure for securing services. Whenever an agency has need for plant inspection services, the directory should be used for guidance, and the organization which can perform the services at least cost to the Government should be requested to make the inspection; the services of such facilities should be made available whenever mutually agreeable to both the construction agencies and the testing facilities.

c. Any contractual requirements that contractors provide for material testing and quality control should be discontinued. Agencies should assume complete control over testing by either conducting tests in their own facilities, or by directly retaining outside professional testing services. Provisions in the Armed Services Procurement Regulations, or the regulations of other agencies, which conflict with this desideratum should be modified accordingly.

D. Obtaining and Retaining Field Personnel

Conclusion

The recurring shortage, experienced by most agencies, of personnel well qualified in engineering specialties, construction procedures, and administration, presents a problem of considerable magnitude. Several interrelated factors contribute to the personnel problems of construction agencies--ineffective recruitment methods, compounded by pay scales noncompetitive with those of industry; inability to retain competent personnel due to management practices, working conditions, and fluctuation in volume of construction; inadequate and misdirected training programs; and lack of interagency cooperation directed toward balancing of personnel requirements.

Recommendation

All agency practices connected with personnel matters relating to supervision and inspection should be reexamined, with a view toward securing an adequate supply of qualified staff personnel. In particular, every effort should be made to ensure that practices encompassed in each of the following four areas of personnel management are implemented:

1. Recruitment[1]

   Instead of relying only on the Civil Service Commission roster of applicants to obtain field personnel, agencies should institute a dynamic recruiting program, making use, for example, of the following methods:

   a. Dissemination throughout the Government structure of information relevant to employment opportunities

   b. Direct advertising in appropriate news media and national magazines

   c. Recruiting drives among undergraduates at colleges and other schools.

2. Retention of Qualified Personnel

   To reduce the loss of personnel from resignations, agencies should work to eliminate the causes of low morale and dissatisfaction, in particular by

   a. Ensuring payment to field personnel of salary and wage scales commensurate with assigned responsibilities and competitive with those established for comparable work in other sectors of the construction industry. Toward this end, agencies should jointly request that the Civil Service Commission declare the employment situation in construction supervision and inspection to be acute, and take appropriate steps to raise salaries and wages of both professional and nonprofessional personnel sufficient to attract and retain well qualified individuals.

   b. Jointly seeking partial exemption of field personnel from provisions of Federal annual leave regulations which limit the amount of accumulated annual leave that can be carried over from one year to the next, to enable field personnel to

[1] Recruiting would of course be made easier if the modifications in wages, pay scales, and leave practices recommended below under Retention of Qualified Personnel were also put into effect.

work continuously for extended periods on long-term construction projects without loss of annual leave time. (Such exemption should cease upon completion of the work, or at such time as leave can be taken without danger to quality or progress of construction; at that time, or within a reasonable period, supervisors and inspectors should be required to use all leave in excess of what is normally retainable under regulations.)

c. Ensuring that field personnel are always provided with a field office and facilities providing adequate space, light, reasonable physical comfort, and other appropriate basic amenities.

d. Provision to field personnel of opportunity for technical and professional growth and subsequent promotion, through judicious selection of job assignments and by making improved training and educational programs available (see 3 below).

e. Jointly seeking appropriate liberalization of regulations to effect full reimbursement for expenses incurred in Government-initiated transfer, including moving, storage, temporary living accommodations, and incidentals.[1]

f. Adoption of those recommendations made elsewhere in this report which affect morale.

3. Training and Educational Programs

Agencies should develop meaningful educational and training programs relating to supervision and inspection, and those personnel demonstrating a capacity for growth should be given opportunity, and be strongly encouraged, to take advantage of such programs. Educational program should permit personnel to obtain, at Government expense or on cost-sharing basis, formal education aimed at professional development. Training programs should be directed toward improving the technical knowledge and administrative skills required to cope with specific supervision and inspection problems of contemporary construction. An additional program should be developed by which engineering trainees (usually recent college graduates) can be given on-the-job training, on a planned basis, under the guidance of experienced and competent professional personnel, in all aspects of supervision and inspection work--both in the field and at the central office.

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[1] Such regulations have recently been liberalized to a degree, but further broadening of reimbursement arrangements is necessary.

The organization of educational and training programs, and, where appropriate, actual instruction, should be the responsibility of the senior engineers of the agency involved, with the agency personnel department handling only administrative details.

4. Clearing House for Exchange of Agency Supervision and Inspection Personnel

A cooperative interagency central clearing house should be established to facilitate both permanent transfers and temporary exchanges of qualified field personnel between agencies, as a means of partially overcoming the difficulties caused by the fluctuations inherent in construction activity.

This clearing house should maintain, and periodically disseminate throughout the agencies, a current list of permanent construction positions for which applications are being invited by each agency, as well as one of qualified Federal construction employees--with eligibility status of each--who are available for employment by reason of actual or impending reductions in force, or desire for transfer or promotion; together with information concerning short-term personnel needs, broken down by agency, plus a list of field personnel available for loan, with qualifications.

Each agency should take whatever steps are appropriate for its organization to ensure that all pertinent information is promptly sent to the clearing house, and that optimum use is made of the information it provides, with a view toward assisting displaced personnel to find new assignments within the Government; and/or securing personnel suited by qualification and (where pertinent) location to fill immediate agency needs without transfer of personnel.

E. Preventing Repetitive Deficiencies

1. Monitoring and Evaluation of Performance of Field Supervisory Forces

Conclusion

Higher echelons of agencies have in some instances been ineffective in monitoring and evaluating the performance and field supervisory personnel, because of inadequate methods and procedures for maintaining awareness of on-the-job conditions, generally the result of infrequent and perfunctory visits to the project.

Recommendation

The responsible agency administrator or his representative should visit the project site periodically and frequently enough to observe all major segments of construction. Actual field conditions should be carefully noted for comparison with those re-

ported by field supervision. All findings should be recorded in written reports to serve as documentary background for corrective action (or commendation) as may be appropriate.

In addition, user agency feedback information regarding quality of construction should be utilized as a means of evaluating performance of field supervision. All information concerning deficiencies which may relate to field supervision and inspection practices and procedures should be evaluated by those responsible for directing field activities; appropriate action should be taken as indicated to correct or to discourage continuance of such deficiencies.

2. Evaluation and Utilization of Performance Information

Conclusion

Deficiencies associated with construction materials and practices recur intermittently because of either lack of effective agency mechanisms for obtaining, processing, and evaluating feedback information, or failure fully to utilize existing procedures.

Recommendation

Each Federal construction agency should establish and assiduously utilize a mechanism for processing feedback information concerning performance of materials and equipment incorporated into construction. Qualified technical central-office personnel should be assigned responsibility for review and evaluation of deficiencies in materials, equipment, and/or construction practices, as reported either by field supervisory and inspection forces during the construction period or by user agency personnel after acceptance and occupancy of the facility. Corrective action should be taken by appropriate authority to ensure that such deficiencies do not recur in design, specifications, or construction. Each agency should obtain the cooperation of all subordinate branches or organizations in order to facilitate exchange of information on both problems and solutions.

3. Dissemination of Performance Information

Conclusion

Opportunity for improvement in design and construction is frequently lost because of failure of agencies to interchange information relevant to materials, as well as to procedure practices developed in the course of construction activities.

Recommendation

All construction agencies should cooperatively establish a mechanism for disseminating facts and findings concerning materials, procedures, and practices associated with design and/or construction of Federal projects. Information concerning improvements or deficiencies in any area affecting design or construction should be exchanged through a clearing house arrangement and/or an interagency group assigned responsibility for periodically reviewing and disseminating to all agencies the findings and data developed by each. Agencies should exchange ideas and knowledge concerning construction problems and techniques of mutual interest with private organizations, such as associations. This exchange should be effected through a joint agency-industry task force set up for the purpose and meeting periodically, as in the present arrangement of the Federal Fire Council.

F. Procedure for Adopting Certain Recommendations Contained in This Report

Recommendation

The Federal construction agencies should establish an interagency committee to give consideration to those recommendations contained in this report that require joint action, particularly interchange of supervision and inspection personnel; cooperation in recruitment of personnel; appeals to the Civil Service Commission for improvement in pay scales and relaxation of regulations governing accumulated annual leave; changes in responsibility for and methods of enforcement of labor laws; and interchanging of information concerning construction materials, procedures, and practices. Efforts of this committee should be directed toward furthering awareness and understanding of the problems involved, devising methods and procedures for implementation, and fostering adoption of accepted recommendations.

III
DISCUSSION

Although this report is concerned solely with supervision and inspection of Federal construction projects, the steps that precede actual construction are enumerated below for clarification of the functions performed by each organization sharing in interest or responsibility. Regardless of the agency involved, most Government construction projects will involve the following steps, although not necessarily always in the same sequence:

1. User agency recognizes need for construction.

2. User agency, with or without assistance of design agency or authority, establishes design criteria and prepares preliminary estimate of cost.

3. User agency, with assistance of design authority, determines feasibility of project.

4. User agency requests Congressional authorization and funds for design of project.

5. Design authority or private architectural-engineering firm prepares preliminary drawings.

6. User agency accepts preliminary design.

7. Design authority and user agency prepare cost estimate and preliminary construction time schedule.

8. User agency requests Congressional appropriation of construction funds.

9. Design authority or private A-E firm prepares final working drawings and specifications.

10. User agency accepts design.

11. Responsibility is assigned to construction agency for administration and supervision of project.

12. Construction agency issues invitations and takes bids.

13. Construction agency awards contract.

14. Construction agency assigns own supervisory and inspection personnel to project, or employs an A-E firm to supervise and inspect construction (in the latter case, usually the same firm employed for design).

15. Contractor starts construction.

16. During construction period, field supervisory force checks and approves shop drawings, materials, etc.; interprets drawings and specifications; exercises quality control; enforces contractor compliance with contract provisions; expedites progress; effects necessary changes to contract; handles construction problems; and generally ensures that all requirements of contract documents are fulfilled.

17. Upon completion of work, contracting officer or authorized representative, with or without assistance and advice of user agency, design authority, or A-E conducts final inspection, and, if work is found to be satisfactory, accepts project for the Government.

For clarification regarding the sometimes perplexing distinction between supervision and inspection of construction, it bears saying that supervision, in addition to involving responsibility for protecting user agency interests in all matters affecting construction, entails exercise of sound and experienced professional judgment in securing compliance with provisions of the contract documents. Among functions falling into this area are: Interpretation of contract documents; effecting of necessary changes to the contract; and approval of payment to the contractor. On the other hand, inspection has as its principal function the detection, under the direction of supervision, or deficiencies in construction.

Although certain basic differences exist between Federal construction and private segments of the industry--particularly in the manner in which the construction contract is drawn, bid, and administered--methods and procedures employed are, in most respects, common throughout the construction industry. Divergence exists in the manner in which supervision of the construction contract is carried out: On Government construction projects, Federal employees cannot deviate from specific requirements of the contract documents without formal change to the contract; private industry, on the other hand, can employ procedures suited to its particular needs, limited only by restrictions imposed by building codes and similar regulations.

A. General Considerations

1. Who Should Supervise and Inspect Government Projects

Although the majority of agencies responding to the questionnaire indicated that field supervision and inspection are executed principally by construction agency personnel, with only occasional assistance from private architectural-engineering firms, some employ A-E's extensively for these purposes. It is the opinion of the Task Group that all Federal construction agencies could expect to obtain improved quality, with better control, greater economy, and more expeditious progress in construction, if agency personnel were used for field supervision and inspection.

Among factors considered are the following:

a. The authority to make changes, officially interpret the contract documents, authorize payments to the contractor, or deviate in any manner from contract provisions, cannot legally be delegated to other than a Federal employee. Accordingly, only limited responsibility for field supervision and inspection can be assigned to an A-E; ultimate responsibility must be retained by the agency.

   With limited authority and responsibility, an A-E cannot legally make many of the decisions which are necessary to keep a project moving; the result is that, on an A-E-supervised job, many of the problems which should be settled in the field are necessarily referred to the central or regional office of the Government agency involved, creating extra work and delay for everyone concerned. (The problem can be mitigated by having A-E personnel work under direction of a Government resident engineer--as explained subsequently in this discussion.)

b. A-E personnel are generally not as well qualified to supervise and inspect Government projects as Government personnel, due to lack of familiarity and/or continuous experience with the special requirements of Government construction work. If A-E supervision and inspection are used, the construction agency must either closely monitor the work of A-E forces until the necessary experience has been gained on the job, or accept the risk that mistakes (sometimes serious) will be made because some seemingly minor detail has been missed. A further consideration in this regard is the fact that, while experience gained by agency personnel on construction projects can be expected to result in increased proficiency and thus enhancement of personnel value to the agency on subsequent assignments, any comparable qualitative growth by A-E personnel is lost to the agency with the conclusion of the particular project assignment.

c. For a given amount of money, an A-E firm generally cannot afford to do as thorough a job of supervising and inspecting a Government construction project as a Government agency. The basic reason is that, because of wide fluctuations in demand for A-E field supervision services, an A-E field staff is usually composed mainly of temporary personnel hired for a particular job; in order to obtain qualified personnel on this basis, relatively higher salaries must be offered, certainly well above Government rates. For a given amount of money, therefore, an A-E cannot put as many qualified men on a project as can a Government agency. And, of course, the fact that the A-E needs to realize a profit further limits the number of men who can be provided. Normally, the only way for an A-E to match the number of field personnel a Government agency could provide for a given amount of money would be through use of lower-salaried, less-qualified men; in view of the obvious risk to the professional reputation of an A-E which such practice would entail, few A-E firms would even suggest that this could or should be done.

It is recognized that the need for some A-E supervision and inspection will continue as long as suitable agency personnel remain in short supply. Task Group experience indicates that, in such circumstances, the agency is well advised to assign a qualified Federal employee to the project as resident engineer, with authority to act as the field representative of the contracting officer.

The subject of who should supervise and inspect Government construction projects cannot be dropped without mention of the fact that one Federal agency has recently adopted the policy of placing greater emphasis on responsibility for quality control by the contractor. Essentially this new policy obligates the contractor to prepare, and obtain agency approval of, a program for quality control that will ensure results consistent with contract requirements.

Although this approach has been generally satisfactory in the manufacturing field, the results obtainable in this situation have yet to be determined. With no record of performance on which to judge value, the Task Group has refrained at this time from any expression of opinion or pertinent recommendation.

2. Relationships Among Organizations Involved in a Construction Project

As illustrated by the list of steps involved in a Government construction project (beginning of this Discussion section, p. 22), there can be, and in most cases are, several different Government and private organizations having interest in or responsibility for a Government project, including the user agency,

design agency, construction agency, A-E design firm, A-E supervision and inspection firm, construction firm. Smooth execution of the actual construction phase of the project requires that each of the various organizations understand clearly the nature and extent of its responsibilities and duties, the limitations of its authority, and the proper procedures for carrying out its duties and for dealing with other organizations involved in the project, and, further, that each perform its assigned tasks scrupulously within the framework of such understandings. The means employed to achieve understanding and compliance between Government agencies is a written agreement of some type; between a Government agency and private firm, a contract.

In fact, such agreements and contracts are routinely executed in connection with Government construction projects; the problem is that terms frequently are not precise or detailed enough to preclude disputes, misunderstandings, or circumvention of established rules.

Following are some typical occurrences--and the undesirable consequences which can result therefrom--taking place on Government construction projects when agreements and/or contracts are vaguely written:

a. During a visit to the project site, a representative of the user agency sees some detail which he would like changed or corrected; not appreciating the fact that changes of any type usually involve cost changes, require coordination with other work, and necessitate modification of various other parts of the overall design, and lacking clear instruction on how to go about having changes made, he requests the contractor to affect the desired changes. The contractor thereupon complies--on the assumption that the user agency representative has the requisite authority. The likely results include an almost certain followup request from the contractor for additional money and/or delay in the work and/or an adverse effect on the design, plus, of course, a lengthy legal dispute and a substantial amount of paper work.

b. In the course of construction, the contractor encounters a problem of some type which can be solved by an apparently slight, but actually consequential, adjustment in, for example, a partition or plumbing line location, and requests resident-engineer authorization to effect changes. The resident engineer, viewing the requested changes as minor in nature, and lacking clear instructions regarding what types of change cannot be made without violating the design or detrimentally affecting future user-agency operations, complies. The likely result is a subsequent complaint from the user agency along with a demand that corrective action be taken, and/or a spoiled overall design, plus, of course,

as in the previous example, a legal dispute and much paper work.

c. The field staff detects work being performed by the contractor which is of a questionable nature and, in the absence of clear-cut rules on the proper channels of communications to use in such circumstances, requests advice from the wrong source (e.g., from the A-E firm rather than from the design agency) on the course of action to take.

   The recipient of the request, equally unsure about the proper channels or communications and/or uncertain of responsibility in the matter, ignores the request completely, or delays in answering until authorization is received, or directs an answer to the wrong organization. Regardless of the way the situation develops, the result is that the field staff receives the advice (if at all), too late to be of help; and must either act without the benefit of advice, or order work halted until advice is received.

These and similar problems would, it is believed, be minimized if agreements and contracts were written precisely and contained, as a minimum, the provisions recommended by the Task Group (see p. 4).

It should be emphasized that the intention of the Task Group is not that agreement and contracts be written so as to prohibit continued employment of informal practices that have proven satisfactory; rather, contractual recognition and control of such practices, including methods and limitations relevant to continued use, will tend to enhance the value to the Government while limiting the opportunity for abuse.

The practice, for example, of effecting trades or exchanges with the contractor--generally in order to correct design errors or omissions, or latent deficiencies, without recourse to change orders--could be of benefit to the Government if covered by contract provisions so as to guard against the chance of misapplication for the purpose of obscuring construction deficiency, oversight, or possible questionable conduct in the execution of duties and responsibilities.

With regard specifically to contracts with A-E firms for supervision and inspection services, there are special problems not touched on in the preceding discussion--in particular, the matter of how much in the way of services and what types of personnel the A-E firm is expected to supply under the contract, as well as the maintenance, disposition, and ownership of the project files. Currently, contracts between A-E firms and agencies are for the most part somewhat vague on these points; many such contracts, in fact, cover only purpose, time, and money. Such vagueness is believed contrary to the best interest of both the A-E firm and

the agency, creating as it does a basis for disputes as to whether the A-E firm has in fact satisfied the contract, or whether it has been required to exceed the contract.

The proper approach, is to delineate clearly and precisely in the contract the work to be performed, the manner of A-E operation, and the numbers and qualifications of personnel to be assigned to the project, with provision for agency review and approval of individuals to be assigned--all this, of course, in addition to matters relating to responsibility, authority, channels of communication and disposition of records, as discussed previously.

Another matter deserving of special mention is the duties and responsibilities of the design organization (Government or private) during the construction phase. Problems invariably arise during construction which can best or, in some cases, can only be solved by the design organization. When an inordinate number of such problems arise and the time involved in developing solutions becomes considerable, design organizations have been known to object to being asked for advice, on the ground that the design budget did not provide for such services. Objection on this basis in understandable, yet the advice is nevertheless needed. The proper course, the Task Group believes, is to include in design contracts or agreements provision for a prescribed amount of design organization consultation during construction, with provision for extending of such service as required by developing conditions. The resident engineer could then require the designer to answer questions and assist in solution of field problems either by appearing in person at the project site or by prompt reply to telephone or written communications from the field.

The need to include in the design agreement a provision requiring the A-E to be available for consultation is recognized by AIA in report No. 20, dated 7 February 1966, from which the following is quoted:

> Services of the Architect-Engineer During Construction.
>
> A. The Architect-Engineer should be available for consultation, and, when practicable, will be called upon by the Government on a request basis as noted in the scope of work portion of the contractual document.
>
> 1. Significant changes to plans and specifications required in the field generally should be worked out by the Architect-Engineer and the Government prior to construction. If this is not feasible, a record of such changes should be transmitted by the Architect-Engineer.

2. Changed conditions encountered during construction, different from those shown on the plans and specifications should be resolved by the Architect-Engineer.[1]

B. Organization, Responsibility and Authority, and Qualifications of Field Supervisory Staff

1. Organization of Staff

A field supervision and inspection staff for a Government construction project of any appreciable size comprises a resident engineer, at least one supervisory engineer for each of the major branches of work (mechanical, electrical, structural) involved in the project, inspectors to assist supervisory engineers, plus various clerical, administrative, and technical assistants, and specialists.[2]

Ordinarily, a part of this staff will be assigned full time to the project for all or most of the period during which work is in progress. This part of the staff is considered by the Task Group to comprise the basic staff (or staff nucleus). The full staff includes the basic staff plus individuals added from time to time, for relatively short periods, during the course of the project to augment the basic staff or to oversee some special phase of the work.

From analysis of current practice at Government agencies, the Task Group found three matters relating to staff organization that require attention: Timing of assignments to the staff; criteria for determining staff size and composition; need for administrative and technical specialists.

With regard to timing of assignments, two problems have been found to exist rather widely. The first, and by far more serious, is late assignment of the basic staff. The Task Group believes very strongly that the basic staff needs to be named and assigned

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[1]Although the above excerpt from AIA report No. 20 defines the role of the architect-engineer in effecting changes attributable to field conditions that differ from design assumptions, no mention is made regarding A-E participation in review of proposed changes in basic design or of A-E opportunity to advise the Government concerning such changes. This is an area that may well bear future investigation.

[2]While it is usually essential that all basic fields of engineering related to construction be represented on the staff, effective supervision can be furnished by one technically competent supervisor on small and repetitive projects, provided that the supervisor has adequate time to observe all elements of the work and has access to specialists as such are needed--for safety as well as for the various aspects of construction.

to a project well in advance of contract award, to afford staff members ample opportunity for familiarization with contract drawings, specifications, and site conditions. Experience indicates that, through early familiarization with the project, potential problem areas can frequently be perceived and corrective measures planned in advance, to ensure smoother progress. The second problem is too early or too late assignment of supplementary personnel to the staff. Inefficient utilization of personnel results from the former (too early assignment), and inadequate supervision and inspection from the latter--sometimes with serious consequences. The answer is, obviously, to provide better scheduling.

With regard to criteria for determining size and composition of the staff, the Task Group believes that many agencies are not sufficiently flexible in this area, in spite of the significant improvement made within the past few years. Most agencies consider size, type, budget, and (in some instances) complexity of a project in determining size and composition of field staffs. Such criteria, while adequate for establishing the basic staff and for making a preliminary estimate of size and composition for the full staff, are not satisfactory for making a final decision regarding the full staff. Rather, consideration must also be given to such factors as:

a. Contractor attitude--significantly closer supervision and inspection are called for where a contractor is trying, for example, to cut cost to compensate for perhaps too low a bid.

b. Quality of contractor supervision--Government field forces will ususally have many extra problems to solve when a contractor is unable to provide competent supervisory personnel.

c. Quality of workmanship produced by trades and crafts--more thorough inspection is needed to ensure adequate quality when (as is commonly true in some parts of the country) mechanics available for a job are of substandard capability.

d. Competence of the field staff itself--wherever it is not possible, for any reason, to assemble a field staff of satisfactory competence and substantial experience, it is generally necessary to compensate by use of extra personnel.

e. Completeness and accuracy of project plans and specifications--plans containing many errors invariably create problems requiring extra supervision and inspection work.

f. Special and/or latent field conditions--when field problems are unusually numerous or complex, the required level of competence on the part of field forces is necessarily higher.

Obviously, factors such as these cannot, because of their nature, be evaluated until after a project has started, and the impact may

change as work progresses. The Task Group believes that provision needs to be made for varying size and composition of the field staff not only from job to job but also, as necessary, from time to time during the conduct of a particular project, and that agency criteria for staffing must ensure the requisite degree of flexibility. This means discontinuance of use of rigid manning tables and elimination of too stringent funding limitations for supervision and inspection of projects.

With regard to need for administrative and technical specialists on field staffs, the Task Group believes that some agency practices provide for insufficient support in two areas--safety and office administration.

The enforcement of safety regulations on construction projects is normally undertaken by the agency responsible for supervision and inspection. In most instances, the agency delegates this responsibility to the resident engineer and staff. The mistake, and the problem source, is that, in many cases, no one assigned to the staff is properly trained in safety practices.

Enforcement of safety regulations involves hazard awareness and sensitivity to dangerous conditions. While some hazardous or nonsafe conditions may be readily recognized by regular field supervisory and inspection personnel, many less obvious but no less dangerous conditions may exist unnoticed by those untrained in safety practices. And, while handbooks regarding safety are usually available to agency personnel, use without prior training in fundamental principles of safety is no more productive than use of an engineering handbook without training in engineering practices and procedures. In fact, safety is a specialty requiring appropriate education and experience on the part of the individual charged with prescribing safety practices and ensuring enforcement.

When enforcement is assigned to a field staff having no safety specialist, various undesirable results may eventuate: First, the staff may spend so much time on safety that other matters are not properly attented to; second, the staff may, because of the press of other duties, inadvertently permit job safety to suffer; third, a wrong decision regarding safety may be rendered which results in an accident. In addition to other considerations, the legal consequences can be serious, in light of a continuing trend in the direction of holding legally liable, in event of accident, all parties involved in a construction project--specifically including agencies.

To minimize the likelihood of any of the unfortunate and undesirable consequences of accident, the solution is to assign a safety specialist to each field staff--full-time if possible, part-time if the size or nature of the job does not warrant a

full-time man--as is done in most industrial plants, where safety is left to specialists in the prescribing and enforcing of safety practices.

There is also a need to provide the field staff with administrative specialists and/or clerical help. According to a majority of construction agencies, demands imposed by administrative and office duties often prevent the resident engineer from making the frequent or regular inspection tours requisite to his responsibility--which provide the only direct means for the observation of construction operations and the close monitoring of staff activities necessary to decisions affecting construction quality and work progress. Only if relieved of items of administrative and related detail, by the availability of suitable personnel, can the resident engineer be expected to have the time needed to deal properly with technical and managerial matters.

The Task Group has also found serious problems with regard to enforcement of labor laws (see p. 35). If the alternative solution to the problem suggested by the Task Group is accepted (footnote 2, p. 8), a specialist for labor matters will probably be needed on most field staffs.

2. Responsibility and Authority

It is a basic principle of sound management that an individual given a job to perform ought to be assigned a set of definite and clear-cut responsibilities, and simultaneously be delegated the authority necessary to carrying out of those responsibilities. The Task Group believes that, to varying degrees, this cardinal principle is violated by a high proportion of agencies with regard to supervision and inspection work, and in particular with regard to the work of the resident engineer. The manner of violation varies with the agency involved--some agencies, for example, assign to the resident engineer numerous responsibilities of both broad and specific nature, but delegate only limited authority or leave the amount of authority variable, subject to the inclination of regional or central office; others formally assign only limited responsibilities and delegate correspondingly limited authority, but in fact hold the resident engineer accountable for numerous matters besides those formally assigned; still others are vague about both responsibility and authority. The result is likely to be low morale and poorer-than-professional performance on the part of the resident engineer, along with less-than-fully-effective supervision and inspection of projects; the seriousness of the consequences depends on the agency and the individual resident engineer involved.

This basic management principle appears to have been inadvertently violated with regard to supervision and inspection for two interrelated reasons. First, it is difficult to decide what exactly

the responsibilities of resident engineers should be or to determine precisely what authority is needed to carry out the responsibilities once these are established--in fact, it is often difficult even to describe such responsibilities and authority in writing--because supervision and inspection involved essentially the overseeing of the work of others and the solving of problems to keep the project moving forward properly and on schedule. The responsibilities and authority required to carry out such activities are necessarily not self-evident since, in theory anyway, required action could, in many cases, be taken equally well either by the resident engineer or by higher authority. Second, to the degree to which responsibility and authority cannot be precisely predicted or calculated in advance, the understandable tendency on the part of management is to set limits in such manner as to minimize the number of instances in which the resident engineer can take action without prior approval, or to leave the whole question basically unresolved so that matters of responsibility and authority can be decided on a day-to-day or job-to-job basis as the situation dictates. The reason usually given for taking one of these approaches is that the caliber of resident engineers on agency staffs is not uniform and that some means is needed of safeguarding the Government against improper action by the occasional inexperienced or inadequately qualified individual.

Without disputing that the determination of responsibility and authority for resident engineer work is a real problem, or that the reluctance of agency management to give broad or specific responsibility and authority is understandable, the reasons do not justify violation of an accepted management principle. The Task Group believes the underlying problems amenable to solution, and is convinced that the resident engineer can and ought to be assigned definite clear-cut responsibilities accurately reflecting the area of accountability, together with sufficient specific authority to permit effective carrying out of the responsibilities.

The list of responsibilities presented on p. 7 shows the matters for which the Task Group believes the resident engineer ought to be held accountable.

It should be emphasized that, even though the responsibilities enumerated have greater breadth or more specificity than those formally assigned to resident engineers by a number of agencies, the list does not include any items for which resident engineers have not in effect been held accountable all along by most agencies. This being the case, the Task Group believes it better for all concerned that the fact be recognized formally. It is emphatically the Task Group conviction that the resident engineer, as the individual having closest continuous familiarity with the project, is the one individual most properly and logically to be held accountable for proper completion of the project; exercise

of the cited responsibilities is intended to provide the range and leeway for achieving this goal.

With regard to authority, it is believed that, as a minimum, the resident engineer needs to be able to act in the ways enumerated on p. 7.

Delegation of the listed items of authority to the resident engineer would result in the shifting of authority at a number of agencies from the central or regional office (and in some cases from the design agency) to the resident engineer. The fact that such a shift would take place is, however, only incidental; the primary objective is to ensure resident engineer authority sufficient to meet responsibilities.

In particular, it is the intention to make certain that the resident engineer has sufficient authority to act quickly and decisively in dealings with contractors and to maintain effective control over all aspects of the project which relate to quality assurance.

Ability of the resident engineer to act quickly is essential to prompt solution of the problems and answering of the questions that must be dealt with immediately if project progress is to be maintained; but promptness of response is possible only if and when the resident engineer has authority to act without constantly obtaining approval from higher authority at central or regional office level.

Similarly, the ability to act decisively is essential to effective enforcement of contract provisions, which requires from the contractor the cooperation and respect that are likely to be obtained only when the resident engineer has authority to speak officially as a representative of the Government on important matters relating to the project. If, instead, most important questions and problems have to be referred to higher authority, the contractor may well be tempted to look upon the resident engineer as merely a middle-man, a go-between to be bypassed whenever possible in favor of direct dealing with higher authority; at best, the contractor may be expected to treat resident engineer views with some condescension or skepticism, as certainly not the final word. (It should be emphasized that resident engineer authority to speak officially would not prevent the contractor from appealing a decision to higher authority, but the burden of appeal would rest on the contractor to obtain reversal or modification rather than the ones resting, as is now frequently the case, on the resident engineer to obtain backing for a decision.)

Maintenance of effective resident engineer control over all aspects of the project relating to quality assurance is necessary to ensure that the resident engineer is not held responsible unfairly for the shortcomings or defaults of someone else, and at

the same time to avoid giving the resident engineer a basis for disclaiming responsibility for a wrong decision or for failure to take a needed action. To guard against such possibilities, it is essential that there be no division of the authority to act on matters relating to basic resident engineer responsibility.

The authority which the Task Group has proposed be delegated to the resident engineer is believed sufficient to permit actions quick and decisive enough and retention of project control effective enough for meeting of all resident engineer responsibilities.

The Task Group finds solid reason for rejecting the argument, advanced in some quarters, that many resident engineers on agency staffs are not competent to exercise greater authority than is now generally granted. The majority of resident engineers are, in Task Group experience, mature, competent, dedicated men capable of making sound decisions, and it is unfair to ascribe to resident engineers in general the limitations of perhaps a small group. In any event, such limitation would constitute no valid reason for widely circumscribing authority and responsibility, for it is poor practice to tailor the job to the limited man; the proper approach is to obtain men of the caliber necessary to do the job (a subject discussed elsewhere in this report).

Also, there is presumably a fear in some quarters that a resident engineer, once granted broad authority, may be led into making offhand decisions about matters with which he is not familiar. This the Task Group seriously doubts; the more logical presumption would be that of exercising ordinary good judgment and seeking advice when necessary.

A special matter related to responsibility and authority which is of particular concern to the Task Group is the continual assignment to the resident engineer of responsibility for enforcement of labor laws. With such responsibility the resident engineer must, in effect, act as law enforcement officer for the agency having primary jurisdiction over the laws involved. Continuation of the practice of assigning the resident engineer such duties is considered undesirable for three reasons: First, such laws have, in recent years, so increased in number and broadened in scope that the time and effort required for enforcement has become heavily burdensome. Second, should the resident engineer and assistants take in earnest the full instructions given relevant to policing of contractor labor practices, the relationship with the contractor may well become strained; supervision of the project will inevitably be made more difficult; and all possibility of the cooperation essential to quality construction will be virtually precluded. Third, the resident engineer, ordinarily an individual with only technical training, cannot be expected to offer the background required of an investigator of labor practices; his primary interest, is, properly, in the securing

of construction that complies with requirements of the contract documents, and he is poorly equipped to deal effectively with complex labor laws. For these reasons, the Task Group believes that the responsibility of the resident engineer in labor matters is best limited to reporting of obvious violations to the Government department having primary interest in this area, with responsibility for detailed investigation and enforcement left to that department.[1]

3. Qualifications of Field Supervisory Personnel

A majority of agencies responding to the questionnaire employ both professional engineers and nonprofessional personnel as field supervisors. The Task Group feels there is a place for non-professionals in field supervisory capacity where the type of construction is repetitive and of little complexity; however, technological advances in materials and methods of construction, current demands for accelerated rates of progress in the work, increasing sophistication and complexity of methods and tools of construction inspection, and the expanded use of professional engineers by contractors and others with whom the supervisor must deal, all indicate that agency employment practices need review and adjustment to ensure compatibility with current project requirements.

Greater and more effective agency efforts must be expected in upgrading the quality of supervisory personnel and in seeking to retain experienced field engineers, if satisfactory supervision is to be attained. Minimum qualifications must be established that envision employment in major field supervisory positions of professional engineers who are: Proficient in supervision of construction projects; capable of ensuring fulfillment of contract documents requirements; and competent to represent the agency effectively and diplomatically in the field.

Field supervisors constitute essential supporting staff of the resident engineer and have need of an engineering background with specific knowledge and experience in a particular technical branch

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[1] If, for any reason, it is not possible to relieve the resident engineer of primary responsibility for enforcement of labor laws, then, alternatively, a labor law enforcement specialist ought to be assigned to the field staff in the same way that safety or technical specialists are. With a professional labor law enforcement assistant on the staff, the resident engineer could reasonably be expected to accept responsibility in this area; however, the problem of possible strained relations between contractor and resident engineer as a result of enforcement activities would not be solved by this approach. Moreover, additional funds would be required for supervision and inspection work to pay the salary of the added assistant.

of construction. Effectiveness is dependent upon the ability to supervise inspection personnel, instruct trainees, and provide technical advice. Individuals lacking these qualifications and capabilities cannot properly execute field supervisor duties.

Inspectors can appropriately be subprofessional or nonprofessional personnel who have attained the level of training and experience necessary to distinguish, under guidance of a supervisor, between proper and improper construction, and who are capable of comprehending plans and specifications.

The breadth and nature of responsibility and authority necessary for effective supervision of a construction project in the field precludes the inspectors or other nonprofessional personnel as supervisors in charge of important Federal construction projects. Most inspectors lack the education, experience, and training necessary to qualify for a supervisory position, and it is doubtful that provision of the training necessary to qualify an inspector for a supervisory position would be economically feasible or practicable.

C. Conduct of Supervision and Inspection

1. Channels of Communication

As indicated by agency responses, no consistent policy exists regarding communications between field supervision and higher-echelon supervision, the designer, the contractor, workmen, the public, or public officials. The Task Group believes that the absence of a firm agency policy regulating communications contributes to misunderstanding that in many instances is detrimental to the best interests of the Government.

When the resident engineer receives instructions from, and is required to report to, more than one higher authority, the result may be the representation of diverse interests and receipt of contradictory communications--leading in turn to the necessity for engaging in clarifying correspondence, at the expense of time available for supervisory duties. Performance of the resident engineer would be enhanced and the incidence of misunderstanding reduced with direct communication and reporting limited to only one higher authority. Whenever the project-governing office is a regional or district office, central office communications relevant to a particular project ought to be addressed to the regional or district office rather than directly to the field supervisory staff.

It is essential to successful achievement of design intent in construction that the designer be required to answer field questions relevant to drawings and specifications. The most expedient channel of communication is direct contact between the resident engineer and the designer. It is important that field supervi-

sion record all such communications, particularly any relating to field problems involving possible design error or omission.

It is the opinion of the Task Group that, when field supervisory forces bypass appropriate levels of contractor supervision in handling any matters of significance relating to the construction project, a potential source of serious discord is created, which can generate bad relationships between Government supervision and the general contractor.

Some agencies have no set rules regarding what channel of communications should be followed between Government and contractor personnel; channels of communication for each job are decided upon separately, depending on the circumstances: If the Government-contractor relationship is exceptionally good, the agency field staff is authorized to discuss aspects of the job directly with lower level foremen or mechanics involved; if relationship appears strained, the staff deals only with the general superintendent concerning project affairs. The Task Group considers this approach to be wrong and believes that all contacts between Government field personnel and lower-level contractor personnel are best kept to absolute minimum; personal contact between agency field personnel and workmen--whether to issue instructions or to promote cordial relations--is likely to provoke resentment on the part of the contractor if carried to any serious extent.

Similarly, when field supervisors bypass the general contractor to deal directly with subcontractors and suppliers (unless so requested by the contractor in particular instances), relations with contractor personnel are likely to deteriorate appreciably, adversely affecting the quality and progress of construction. Conduct of the work requires frequent, if not daily, communications between field supervisors and contractor personnel; only when proper channels and levels of communication are established and agreed upon by both parties before construction begins, and are utilized without unauthorized exception throughout the construction period, can cooperative and productive relations between the parties be anticipated.

Although some agencies consider communications between field supervision and the public and public officials to be conducive to good public relations, communications of this nature can have undesirable repercussions when statements attributed to field supervisors are either inaccurate or misunderstood. To avoid this possibility, it is preferable that all information concerning a project, or the organizations or individuals associated with the project, be disseminated by higher echelon personnel from the central or district office.

2. Part-Time Supervision and Inspection

To varying degrees, all agencies endeavor to furnish full-time inspection on all elements of construction that will be concealed by subsequent operations, particularly on projects of appreciable size; however, part-time supervision is employed extensively on smaller projects or those of repetitive nature. The Task Group is particularly concerned regarding the indiscriminate use of part-time supervision, as dictated by funds available for supervision and inspection without regard for the complexity or scheduling of the project.

The need for field inspection is not always or necessarily in direct proportion to the budget, and the lack of close supervision frequently results in latent deficiencies which appear at a later time, to the distress of both construction authority and user agency. When it is necessary that part-time supervision be employed, it is important that inspection be made on nonroutine basis; otherwise familiarity with the visit routine may provide a temptation to anticipatory actions having the effect of covering over aspects of construction that could be deemed questionable.

3. Personnel Assignment: Area vs. Branch of Work

A number of agencies make assignments for supervision and inspection of construction work in some instances by construction site area, in others by branch of work; the method generally depends upon the type of project, workload, and availability of manpower. Proper inspection procedures require that supervisors and inspectors constantly observe construction methods, and recognize and require correction of improper construction at its inception. A supervisor determining that a particular procedure or method of building employed by the contractor is at variance with proper practice must be capable of evaluating deficiencies and approving corrective action. In most instances, an area of a construction project encompasses diverse branches of work. Of utmost importance in supervision and inspection is the capability of supervisors to recognize problems that occur in a particular branch of the work, attributable to: Error or omission in drawings or specifications; lack of coordination; ambiguities in contract documents; and field conditions differing from design assumptions. It is delusory to assume that an individual trained only in structural work can readily recognize or effectively resolve such problems occurring in the mechanical or electrical branches, or in architectural trades or crafts. In view of these considerations, the most effective method is to divide and classify the work by branches and to assign qualified personnel to each branch.

4. On-the-Job Meetings

Although the value of progress meetings is generally recognized by all agencies, some hold such meetings only on an "as-needed" basis. It is the opinion of the Task Group that, unless such meetings are held periodically in accordance with a predetermined schedule, a strong likelihood always exists that problems or disputes will have assumed serious proportions before the need for a meeting is apparent.

In addition to providing the contractor with an orderly means for presenting problems, on-the-job meetings provide all principal parties an opportunity to present questions, resolve problems, and generally improve relationships. Typical of areas encompassed are: Coordination of all project planning and work; scheduling of occupancy; payments; interpretation of drawings and specifications; field problems, and job progress.

The effectiveness of such meetings is dependent in large part upon frequency and upon the attendance of representatives of all parties having an interest in the project, including construction agency, contractor, and principal subcontractors, and, when appropriate, design authority and user agency. Optimum frequency ought to be determined on the basis of size and complexity of the project, proficiency of agency field supervisory force, and reliability and capability of the contractor. When minutes of each meeting are prepared by the field staff office and are distributed to all parties concerned, the opportunity for misunderstanding is considerably lessened. It is essential that any agreements or decisions resulting from such meetings be reviewed and approved by appropriate authority.

5. Field Records, Reports, and Administrative Manuals

While all construction agencies require that field supervision record and report particular items of information concerning construction projects, the extent and type of information required varies with the agency. It is the opinion of the Task Group that effective central or regional office control of a construction project is dependent, in substantial degree, upon the maintenance of complete and accurate records, and reporting of all required information in a systematic manner. Items considered minimum and essential to proper field records and reports are listed on p. 13; the list is not intended to be all-inclusive, nor to preclude other items which, because of the unusual nature of a particular project or the conditions peculiar to an agency, may also be deemed essential information.

Special reports that promptly transmit information concerning actual or potential problem areas are also needed to ensure that higher-echelon supervision is afforded opportunity to take prompt

and effective action whenever necessary. Inclusion of such information only in routine reports tends to conceal its importance to central or regional office personnel responsible for receiving, distributing, and filing of field reports, and thus delays any needed effective action by appropriate authority.

Most agencies employ administrative manuals as a guide to agency-wide filing and correspondence format. The Task Group believes it desirable for all agencies to have a standardized administrative operation in the field, particularly to ensure that files and records are understandable to visiting administrative personnel.

6. Provision of Inspection Aids

It is apparent from an analysis of responses that agencies have no well developed policy regarding issuance of inspection aids to field supervisory personnel. The Task Group feels that certain inspection aids are essential to proper evaluation of construction work. Effective supervision and inspection requires frequent checking of elevations, dimensions, tolerances, quality and condition of material, and similar items. In addition, there is constant need for reference to standard and Federal Specifications, tables, codes, and similar information sources. Unless there are available at the project site the equipment and other inspection aids required for accurate determination of compliance with contract requirements, it is likely that field supervisors will frequently omit important functions associated with inspection. Task Group opinion is that all construction agencies would benefit from establishment of a list of the basic inspection aids to be issued without exception to field supervisory forces on each project (see p. 14). These basic aids would be supplemented with any additional equipment considered useful or necessary in light of considerations peculiar to the project.

Some agencies employ check lists in the conduct of inspection. These generally tend to stifle initiative and encourage field inspection personnel to ignore items of work not specifically listed. As a reminder concerning listed conditions, or as a guide to routine and uncomplicated items of construction, a check list serves a purpose. However, check list use will not provide for the quality of supervision and inspection which can be anticipated only when properly qualified personnel are employed and when informed judgment and initiative are recognized as being of irreplaceable value.

Procedural manuals that tend to be specific in treatment of technical areas are of questionable value, because of the danger of conflict with individual project specifications; however, procedural manuals intended as a guide to effective inspection techniques, if carefully written to avoid the danger cited, can be beneficially employed.

7. Contractor Submittals, Mill Inspections, and Laboratory Testing

Assemblies and items of equipment and most materials used on construction projects are manufactured or processed in one way or another before reaching the construction site. The quality of these items affects the overall quality of the completed project as much as, if not more than, the quality of the work done in the field; the quality of such items, however, for obvious reasons, cannot be controlled by the field staff. A variety of practices and procedures have, therefore, been developed to control the quality of such items, using means aside from or in addition to inspection by the field staff; in toto, such practices and procedures are somewhat elaborate, due to a combination of factors--limitations imposed by Government procurement regulations, practical problems of coordinating materials and dimensions on construction projects, the difficulty of testing materials and equipment in the field. The main features of the overall approach used by most Government agencies can be summarized as follows:[1]

a. Contract documents indicate general performance and/or material requirements for items to be used on the project; brands and model numbers are not listed, and, as a rule, details are not provided for items to be specially fabricated.

b. Contractors are required (sometimes explicitly, sometimes implicitly) to indicate to the construction agency by means of submittals--shop drawings, brochures, acceptance certificates, technical literature, samples, test reports--exactly what is to be provided to meet the contract requirements.

c. Personnel familiar with the contract documents (e.g., construction agency personnel and/or design agency personnel and/or personnel from the A-E design or supervision and inspection firm) check submittals against the contract requirement to determine whether the items proposed for use meet such requirements; based on this check, a recommendation of approval or disapproval of a proposed item is made to the Government officer authorized to act officially.

d. The authorized Government officer (usually either the contracting officer, or the resident engineer or chief design engineer under authority delegated by the contracting officer) reviews the recommendation and notifies the contractor that the item is either approved or disapproved;[2] submittals for

[1] Many of the practices and procedures are also found on private and state and local Government projects.

[2] If an item is disapproved, the contractor can either appeal or propose an alternative item.

approved items become, for all practical purposes, part of the contract documents.

e. Appropriate measures are taken to ensure that materials, assemblies, and equipment used on the project conform to the submittals (if provided) and/or to the requirements of the contract documents. The appropriate measures to be taken (which can be, for example, Government inspection during manufacture at the supplier mill or plant; shop, laboratory, or field tests; and/or checking of labels and stamps on received goods) are sometimes but not always delineated in contract documents.

The basic concept of the general approach is unquestionably sound and has, in the main, proved workable. The problem is that the procedures and rules associated with the execution of the various features have evolved over the years on an essentially piecemeal basis, with presumably too little consideration given to the overall objective or to practical problems involved in day-to-day operations. The result is that there are a number of serious questions associated with various practices and procedures which have never been adequately answered in general terms or even thoroughly studied in light of the overall objective--such questions, for example as:

a. For which types of material, assembly, and equipment should the contractor be required to provide submittals?

b. What information should be included in submittals for different items?

c. By whom should submittals be checked and by whom approved?

d. What is the best method to use in various circumstances to ensure that items actually received and used on the job are the same as the ones described in approved submittals (or conform to contract requirements if no submittal has been required), and by whom should the determination of appropriate method be made?

The Task Group believes that what is needed is a broad, in-depth study of the whole matter of ensuring the quality of equipment and materials used on construction projects, aimed at developing, among other things, some basic guidelines on how the quality of different categories of equipment and materials should be checked and how such checking should be accomplished. A study of this type would of course have to involve designers, specification writers, and managers, as well as construction personnel.

Such a study would necessarily be a long-term affair; some current problems, however, need not and should not be allowed to continue until a definitive solution is developed. Specifically, the Task

Group believes that, with regard to the matter of submittals, mill inspection, and laboratory testing agencies ought immediately to:

a. Develop clear and precise rules on who should approve and who should check submittals.

   At present, there is considerable disagreement among the various agencies and, in some cases, confusion within individual agencies on these points. Approval authority (i.e., formal authority actually to sign submittals, indicating approval) rests at the present time variously with the contracting officer, an official of the design agency, or the resident engineer.[1] The job of checking submittals (i.e., making comparison with contract requirements and recommending approval or disapproval) is variously assigned to the design agency and/or the A-E design firm and/or the resident engineer and his staff.

   With regard to approval authority, the Task Group believes that the resident engineer is, in almost all cases, the one in the best position to exercise such authority (delegated, of course, by the contracting officer). The primary reason is that the resident engineer is ordinarily the highest-ranking Government official intimately familiar with the job, and, therefore, better able than anyone else to exercise the authority from a position of knowledge; conversely, other candidates for this authority, being less knowledgeable about the job, are more likely to have to give pro-forma approval. Because of familiarity with the job and the work of the contractor, the resident engineer would, with approval authority, also be better equipped than anyone else to expedite approval or to call for double checking when necessary.

   There is, on the other hand, no one best group to which to assign checking duties. The field staff usually does a better job than design personnel on items for which dimensional compatibility with other items already in place is a primary consideration, or which can be checked properly only in light of contractor attitude and performance; the design organization usually does a better job than the field staff on items having important relationship to overall design requirements; in some cases, checking by both groups is required, and in other cases there is no clear-cut choice.

[1] In most agencies, basic approval authority rests only with the contracting officer, but the contracting officer usually can and, in many cases does, delegate this authority to someone else.

The Task Group believes that a degree of flexibility needs to be maintained in assigning checking duties, so that in all cases the proper amount of checking is assured. However, where no clear-cut choice is apparent, field staff checking is considered preferable on the basis of greater familiarity with job conditions and greater objectivity concerning contract requirements (design personnel have, understandably, been known to evaluate submittals in light of what is desired rather than what the contract calls for, resulting in legal disputes which the contractor is likely to win). Because of manpower limitations, the field staff is, of course, not always able to assume general checking duties; then such duties must be assumed by the design organization. Where design compatibility is a major consideration, the design organization should certainly do the checking instead of or in addition to the field staff; in fact, where items for which such considerations are of critical importance, the need for design organization checking ought to be noted in the agreement between the design organization and the construction organization; the agreement ought also to provide for design personnel consultation when necessary on items checked by the field staff.

b. Make greater use of mill and plant inspections.

While most processors and manufacturers maintain inspection facilities, thoroughness in testing and checking of materials and manufactured items is sometimes less than satisfactory, particularly when the product is of special design.

Considerable improvement in quality of materials and manufactured products which cannot be properly checked at the construction site frequently results when such items are inspected at the mill or plant by Government personnel. Government contracts usually contain a provision that allows Government personnel access to a mill or plant to inspect items being made for a Government project. Unfortunately, agencies tend to make infrequent use of this provision, in all likelihood because of the expense or inconvenience entailed.

The problems could be ameliorated and greater use made of mill and plant inspection if all construction agencies were to cooperate in this area. In the absence of a field inspection organization, fee-based utilization of the existing facilities of another agency could be effected; an illustrative example is the sharing of mill and plant inspection by all agencies within the Department of Defense through the Defense Contract Administration Services Organization. Establishment of a similar all-agency directory, with assignment to each mill and plant inspection organization of responsibility based on capability and convenience of location, could insure more

effective and economical inspection, with attendant improvement in quality. On occasion, certain technically complex and unusual fabrications or equipment may require inspection by specialists unavailable to the designated regional office responsible for plant inspection, and it is anticipated that, in such circumstances, the agency responsible for construction would provide a qualified individual and assume full responsibility.

c. Modify, in some cases, arrangements for having testing done.

To control the quality of such materials as concrete, reinforcing steel, earth fill, and similar items, most construction agencies require the construction contractor to retain and pay for the services of commercial testing laboratories and to report results to the agency. It is the opinion of the Task Group that this practice is undesirable for two reasons: First, it makes the contractor a customer of the testing organization, putting the contractor in a position to exert influence--even inadvertently--on the tester; second, it places the contractor in a position to influence such factors as selection and preparation of samples which can have considerable effect on test results.

If agencies themselves were to undertake testing of all such materials, by utilizing Government facilities or directly retaining commercial testing laboratories, it is believed uncertainty regarding meaning of results would be minimized.

D. Obtaining and Retaining Field Personnel

A serious shortage of well qualified agency field personnel (both professional and nonprofessional) now exists. This situation poses a more serious and basic problem than any other taken up in this report; for, even with the best possible organization, policies, and procedures for supervision and inspection activities, satisfactory supervision and inspection cannot be obtained without an adequate number of qualified men to staff field offices.

Three main reasons exist for the indicated shortage: Failure to make consistent and effective use of all appropriate channels for recruiting of new personnel; excessively high rate of loss of qualified personnel, through resignations due to dissatisfaction with various conditions of work, including (but by no means limited to) pay scales and opportunities, or through reductions-in-force due to fluctuation in work load; inadequate educational and training programs to upgrade personnel. The Task Group believes that these areas of shortcoming must all be dealt with to ensure effectiveness of the supervision and inspection function.

1. Recruitment

Some agencies at present rely primarily on the Civil Service Commission roster of individuals seeking Government employment to obtain personnel for field work. Although the procedure for obtaining personnel through use of the roster is well established and generally effective, the situation with regard to field supervision and inspection seems sufficiently critical to demand use of more dynamic methods to attract qualified individuals--e.g., widespread dissemination within the Government of information concerning openings for employment; advertising in news media and appropriate national magazines; professional recruitment drives at engineering colleges and other schools.

Such methods are used at present by a number of Government agencies doing research work as well as by private organizations, and these (or similar methods) will have to be employed if construction agencies are to compete successfully for the limited supply of qualified individuals available.

Recruiting of field personnel has been difficult in the past because of various undesirable features of the work; steps to eliminate or offset these are discussed directly below. Adoption of the recommendations on these matters should contribute to making recruitment efforts more successful.

2. Retention of Qualified Personnel

Certain agency practices are apparently the direct cause of dissatisfaction and resignation--or of low morale and consequent less-than-optimum performance--on the part of many competent personnel. These practices involve, in addition to matters taken up in other connections in this report, such considerations as salaries and wages, annual leave regulations, field offices and facilities, professional growth and promotion opportunities, transfer expense reimbursement. Specifically:

a. Salaries and wages.

Salaries of professional field employees and wages of inspectors in various categories and in diverse geographical areas need to be raised significantly if agencies are to attract and retain competent personnel with which to staff field offices.

Salaries higher than those paid professional personnel doing design work need to be offered to professional field personnel as a means of compensating for certain features of field work which are unattractive in comparison and contrast with those of design. Among these features are relatively poorer and more hazardous working conditions, recurrent relocation

requirements, lower professional prestige, more hurried work pace, less job security. In the face of such comparative disadvantages, it is not surprising that agency field organizations find it difficult to compete successfully for qualified professional personnel with design organizations or architecture-engineering firms.

The situation with regard to inspectors is similar. Inspection personnel are, for the most part, drawn from the ranks of construction trade mechanics; although working conditions of inspectors are, if anything, somewhat better than those of mechanics, there seems no reason for offering less incentive or compensation to obtain inspectors. The problem lies in Government wage scales for inspectors, which are lower than for either Government or non-Government mechanics, so that often the only ones available for inspection work are those debarred by age or informity from working at the trade, or those unable to perform satisfactorily in mechanic capacity. Consequently, a substantial percentage of Government inspectors are either less qualified than the mechanics whose work is to be inspected, or are physically unsuited to the rigors of the job. Yet inspection is important work demanding considerable technical knowledge, and being hired as an inspector should be considered a step up from mechanic status--not a step down, as is now the case. Although some mechanics might be willing to accept a small cut in pay to obtain the better working conditions which go with the position of inspector, the pay gap is now too large for such switchovers. Given this situation, wage scales for inspectors need to be increased to approximate or exceed those of mechanics in the same fields, if enough well qualified men are to be successfully recruited for the vital inspection function.

The solution to the problem of inadequate pay for professional personnel is relatively straightforward, by virtue of the fact that the Civil Service Commission has authority to declare the employment situation in a given field acute and, within limits, to raise the GS grade salaries for positions in that field in order to attract the needed personnel. To obtain such action with regard to professional construction personnel, the agencies involved need to convince the Commission that an acute shortage exists and that a raise is justified as a means of inducement for obtaining new and retaining present employees; a joint statement from all construction agencies that such is the case might well suffice for the purpose.

The solution to the problem of inadequate pay for inspection personnel is not as simple as for professionals. Inspectors are classified and paid according to the Group IVb pay scale, whereas mechanics are on the Group III scale. Group IVb pay

scales, at any given grade, are uniform throughout the United States, whereas Group III pay scales vary to conform to wages prevailing in each local area throughout the country. In order, therefore, to raise the wages of inspectors to match or exceed those of mechanics, inspectors would either have to be transferred to the Group III scale, with various attendant problems, or the grades of inspectors would have to be raised on the Group IVb scale, and made sufficiently flexible to meet local wage levels. Neither of these changes could be readily made, yet the problem is serious enough to warrant an effort at solution. Because of the high pay rates for mechanics of some types, transference of inspectors directly to the Group III scale might in some cases result in another inequity; i.e., inspector wages exceeding those of supervisors; however, through judicious classification, it should be possible to minimize the number of instances of such occurrence.

b. Annual leave regulations.

Another problem that can detrimentally affect both employee morale and the quality and progress of work is posed by regulations concerning annual leave. The period of construction on many Federal projects covers a year or more. If responsibility for achieving results consistent with contract requirements is to be fulfilled, presence of the resident engineer and staff is required at the job site, without appreciable interruption, throughout the construction period. Temporary replacement by individuals--even fully competent ones--who are unfamiliar with the project, or with details concerning the work, including the status of drawings, materials, contractor operations, and progress in construction, may well add to the project cost through delays or contributions to future problems. However, field staff personnel who refrain from taking earned leave during the construction period face loss of such leave under current regulations restricting the number of days of annual leave that may be accumulated and carried beyond the end of the leave year. While in many instances the best interests of the Government may suffer if annual leave is granted during the construction period, a costly loss in morale may result from forced sacrifice of annual leave. Some adjustment in regulations governing accumulation of annual leave as it affects agency field supervisors and inspectors is the apparent solution. Permitting supervisors and inspectors to accumulate annual leave during the construction period--but with a proviso that all accumulated leave above the amount normally permitted be used within a prescribed period of time after completion of assignment--would resolve the problem with maximum fairness to both agency and employee.

c. Field offices.

Fulfillment of many of the responsibilities and duties of field supervisory staff requires extensive use of the field office. While field offices are frequently temporary, this alone does not justify inadequate work space; lack of proper heating, ventilation, or air conditioning; poor or improper lighting; lack of adequate sanitary facilities; and other unwelcome conditions that are frequently the lot of field employees. Unless construction agencies provide field office facilities that compare reasonably well with those provided at permanent locations, employee discontent, and the normal consequence thereof, can be anticipated.

d. Professional growth and promotion opportunities.

Morale, dedication, and loyalty, on the part of employees in general and professional employees in particular, are likely to be proportionate to the conviction that a job contributes to individual growth and/or offers the chance for advancement. This conviction is at present lacking in many Government field supervisors and inspectors for a number of reasons (not necessarily applicable to all agencies): The practice of hiring a large percentage of field personnel on a job-to-job basis; failure to offer educational and training programs; failure to make job assignments with a view toward developing the potential of personnel; failure to promote deserving field personnel within the field organization or into central or regional office jobs.

Measures to deal with the first two matters are discussed in sections 3 and 4 below. With regard to job assignments, agencies ought to assign personnel, whenever practicable, to jobs offering some challenge, which will broaden technical knowledge or increase the ability to deal with construction problems, to the advantage of both individual and agency.

Agencies ought similarly to promote deserving field personnel to better positions within the field organization (or when circumstances justify, to central or regional office jobs).

e. Transfer expenses.

Most transfers are effected for the convenience of the agency; thus it seems grossly unfair to expect the employee, directly or indirectly, to bear the costs incurred in relocation. Moving costs for personal belongings and household goods, and transportation charges for employee and family, do not necessarily constitute the total of expenses incurred in relocation. For example, it is frequently necessary for the employee to rent his current home, requiring the storage of furnishings;

at the destination, temporary accommodations may be required until a suitable residence can be secured--often a particularly difficult problem for a family in an area remote from any large community; extra food and incidental costs may well be incurred during the period of transiency. Private industry appears to be well ahead of the Government in recognition of and dealing with the problem; although some liberalization on the part of the Government has occurred, agencies need to learn from and perhaps even emulate industry practice regarding relocation costs if this source of employee discontent is to be eliminated or minimized.

3. Training and Educational Program.

A partial solution to agency personnel problems exists in developing the potentialities of both professional and nonprofessional employees through effective agency-sponsored training and educational programs. However, since supervisory and inspection personnel fall into diverse categories--professionals with broad construction experience; subprofessionals or nonprofessionals with experience ranging from minimal to extensive--training needs vary widely; e.g., a professional with extensive experience may have use for instruction in the latest advanced construction and inspection techniques, while other personnel with little or no experience may require training in all or most basic phases of construction. For this reason, the Task Group believes a three-pronged attack on the training problem is needed: An educational program to permit personnel to obtain at Government expense or on cost-sharing basis, formal education aimed at professional development; training program directed toward improving technical knowledge and administrative skills; on-the-job training in all aspects of supervision and inspection work.

In organizing and implementing these programs, particular care needs to be exercised to ensure that maximum benefit is derived by the participants and, indirectly, by the agency. In this regard, the Task Group believes that:

a. On-the-job training should be conducted under the direction of competent supervisors and should expose participants to all aspects and elements of construction, with strongest emphasis on the branch of construction most closely related to the specialized educational background or experience of the individual.

   On-the-job training for professionals should not be confined to technical matters; such personnel need to be knowledgeable concerning agency policies, practices, and procedures, and the functions of the various divisions of the agency. This goal can best be achieved by rotation of professional personnel, to afford each an opportunity for gaining, under the guidance of an experienced resident engineer, firsthand know-

ledge relevant to the functions and operations of each level of authority.

b. Along the same lines, professionals ought to be given formal education in administration; for the ability to achieve success in relationships with contractors, architects, engineers, and others, and to assign duties to and secure cooperation from subordinates, is dependent largely upon administrative competence.

c. With regard to formal educational and training programs, only those individuals should be offered opportunity to participate who demonstrate the willingness to participate fully and the capacity to grasp and utilize the information provided; otherwise, considerable money and effort could well be wasted.

4. Clearing House for Exchange of Agency Supervision and Inspection Personnel

A particularly troublesome problem common to all construction agencies is the fluctuation in construction activity that occur seasonally and year-to-year. The variation in volume of construction affects the employment security of supervisors and inspectors and, conversely, aggravates employee recruitment and retention problems of the agencies. A prospect for amelioration rests in the fact that frequently, while one agency is experiencing difficulties in recruiting construction personnel essential to meeting demands of an expanding program, another is facing an actual or potential reduction in force due to a diminishing workload.

The Task Group believes that employee uncertainties could be reduced and agency recruiting problems simultaneously alleviated by cooperative action of all construction agencies in establishing a central clearing house or other means for publicizing existing employment opportunities in supervision and inspection Government-wide, and for maintaining a current list of qualified Federal employees (with eligibilities) who are available for employment because of actual or anticipated reduction in force, or because of desire to transfer.

This same mechanism could be expanded to permit agencies to balance personnel requirements by loan or exchange on a temporary basis, especially to satisfy critical needs for supervisors and specialists. By publicizing personnel rquirements, with particulars concerning qualifications, location, and the period of time for which services are required, an agency could often obtain help from another agency whose work program permits loan of such an individual. As a minimum, this could alleviate the immediate need while providing time, if necessary, to recruit a qualified

permanent employee. Exchange or loan could, in addition, lessen the necessity for transfer or temporary relocation when qualified and available personnel happen to be situated in the geographic area of need; in such circumstances, supervision and inspection costs would be reduced by the amount of relocation expense, while those employee morale problems associated with transfer would be avoided.

E. Preventing Repetitive Deficiencies

1. Monitoring and Evaluation of Performance of Field Supervisory Forces

Task Group experience indicates that periodic visits to the project site by higher-echelon supervision, during which detailed examinations are made, is probably the most effective means available to central and regional offices for monitoring and evaluating the quality and extent of field supervision being provided by the staff; such visits, it has been found, also serve to stimulate field supervision in the performance of duties. Although in most agencies higher-echelon supervisors do visit projects from time to time, the visits are, it is believed, often too perfunctory or too infrequent to permit adequate monitoring and evaluation.

This situation, the Task Group believes, needs to be corrected. Visits ought to be made regularly, with sufficient time allocated to each visit to permit effective monitoring of the staff. Sound evaluation of field supervision calls for: Observation of all elements of construction, completed or in progress; comparison of actual field conditions with those reported by field supervision; discussion of job progress and problems with staff members; general appraisal of morale; clear and accurate reporting of findings in writing; plus prompt and appropriate action as indicated.

2. Evaluation and Utilization of Performance Information

Although most construction agencies receive feedback information concerning the quality and performance of materials and equipment used on construction projects, the Task Group finds that, in many instances, this information is not effectively directed toward improvement in construction.

Feedback information generally concerns deficiencies in materials, equipment, and workmanship that occur on a construction project. Such deficiencies may be operational or qualitative, resulting in less than the desired level of performance. Causes vary, but deficiencies are usually attributable to design, construction, quality control, or inspection. Directing of information concerning deficiencies to the attention of the construc-

tion agency--either by field supervisory and inspection forces during the construction period, or by the user agency after acceptance and occupancy--is of value only in proportion to the action taken by the construction agency not merely to correct the immediate problem but also to prevent recurrence.

Before remedial action can be undertaken, feedback information concerning problem areas required careful analysis to determine cause, and evaluation to prescribe appropriate corrective action. This responsibility has to be assigned to suitably qualified personnel if the effects of deficiencies in construction are to be minimized or eliminated. By making analysis and evaluation a primary duty of appropriate personnel unencumbered with other administrative or supervisory responsibilities, agencies will improve the likelihood of effective action to reduce repetitive deficiencies in both design and construction, and of corresponding improvement in quality of construction.

Collection and processing of feedback information, if the objectives indicated by the Task Group are to be reached, is a complex undertaking. Essential elements of an effective feedback program include: Recognition of deficiencies, particularly those which tend to be repeated, as well as unusual achievement related to design and/or construction; reporting procedures specifically designed for transmitting information necessary to evaluation of construction; analysis of feedback information; interpretation of the results of analysis; formulation of appropriate action, either remedial or developmental and promotional; development of followup instructions; and communication of these instructions, as appropriate, to designers, contract administrators, field supervisors, and contractors. Such a program would provide for early awareness by all interested parties concerning successful design and construction practices as well as deficiencies. Development of such a program will require careful consideration of the full range of objectives as well as the alternative procedures whereby those objectives may be achieved--a matter beyond the scope of the present study but appearing to merit consideration by the agencies as a matter for separate investigation. Provided that such an effort did result in an effective feedback program for Federal construction, its benefits would be far-reaching in better construction quality and reduction of costs, and more effective research in building technology.

3. Dissemination of Performance Information

The Task Group believes that means for considerable improvement in both the quality and cost of construction exist within the construction agencies through free exchange of information concerning problems. Deficiencies in design, construction procedures, and inspection practices could often be avoided or the effects minimized, provided that information concerning the

existence and nature of such deficiencies were disseminated and utilized; otherwise each agency must independently find solutions to problems that may have been previously encountered and resolved elsewhere.

Dissemination of information concerning particularly difficult problems may further contribute to the development of solutions by directing attention to areas worthy of concentrated cooperative study by the several Government agencies and industry. As a minimum, all agencies would be forewarned of a problem encountered for which no solution has been found.

F. Procedure for Adopting Certain Recommendations Contained in This Report

The Task Group recognized that certain recommendations contained in this report cannot be made effective unless all or most construction agencies cooperate in establishing a procedure for implementation. These recommendations involve procedures and practices for conducting plant and mill inspections; recruiting and interchanging of supervisory personnel; dissemination of information relevant to deficiencies in construction materials, products, and practices; plus responsibilities regarding enforcement of labor laws, and Civil Service Commission action to improve compensation within grades. To achieve the improvement in construction quality and costs envisioned by the Task Group in these areas requires that all agencies cooperate in establishing an inter-agency organization similar in character to the Federal Fire Council.

GLOSSARY

Definition of Terms Used in Report

Architect-Engineer or A-E (Firm)--- A private organization retained to design and prepare drawings and specifications for a project and/or to supervise and inspect construction in the field.

Basic Staff---------- Resident engineer and those principal assistants assigned to a project throughout the construction period.

Branch of Work---------- Any one of the technologically differentiated segments of construction (e.g., structural, electrical, mechanical, architectural).

Construction Agency or Authority--- A Government organization responsible for administration, supervision, and inspection of the construction project--even if actual field supervision is on occasion performed by an architect-engineer firm retained for this purpose.

Contract Documents---------- The general, special, and supplementary divisions of the contract specifications; contract drawings and any additions or deletions; specifications, including references, standards, legal documents, referenced specifications, and any changes thereto.

Contracting Officer---------- An administrator with authority to act for a Government agency in all matters concerning construction--whether authority covers a single region or district or extends to entire agency.

Design Agency or Authority--------- A Government organization responsible for design of a Federal construction project--even if actual design and

	preparation of drawings and specifications should be performed by an architect-engineer firm retained for this purpose.
Designer----------	The Government and/or private organization which actually develops the design and prepares drawings and specifications for a project.
Field Staff Engineer----------	An engineer assigned responsibility for field supervision and inspection of one or more specialized branches of the work (e.g., structural, mechanical, electrical) under direction of the resident engineer.
Field Supervision----------	The aggregate of functions necessary to monitor construction work in order to ensure compliance with contract requirements.
Inspector----------	An individual (experienced in one or more branches of construction) assigned to the field staff with responsibility for inspecting the work under direction of a field supervisor.
Professional Engineer----------	An individual who through formal education, training, and/or extensive experience, meets Civil Service Commission requirements for rating as a professional engineer--whether or not registered as a PE.
Resident Engineer----------	The individual in charge of supervision and inspection of construction at the project site. (Some agencies use different title; e.g., Resident Officer in Charge of Construction.)
User Agency----------	The Government organization which has initiated a project and will take possession of the facility upon completion--which may, in certain circumstances, retain authority over design and construction, utilizing its own personnel, or engaging the services of an A-E firm.