United States Department of Agriculture
Soil Conservation Service
P.O. Box 2890
Washington, D.C.
20013

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TECHNICAL RELEASE NO. 24 (2nd Edition), FEBRUARY 1983
210-VI

SUBJECT: ENG - INVESTIGATING ENGINEERING STRUCTURAL PROBLEMS AND DEFICIENCIES

Purpose. To distribute a complete revision of Technical Release No. 24 - Investigating Engineering Structural Problems and Deficiencies.

Effective Date. Effective when received.

Explanation. Technical Release No. 24 has been updated to include references to the National Engineering Manual (210-V), to incorporate minor text revisions, and to include a format for preparing abstracts of engineering reports. After examining numerous abstracts, it has become apparent that a more formal organization of data will better ensure that others may benefit from knowledge gained from investigating problems and deficiencies. Additionally, the abstract format enclosed will make it possible to quickly access information on causes of problems and deficiencies and will standardize the presentation of the main findings of investigating committees.

Directives Canceled. This replaces TR-24 dated December 10, 1964, which should be discarded.

Distribution. This technical release should be available to all SCS personnel who might potentially serve on investigating committees. Distribution is on the reverse. Additional copies may be obtained from Central Supply.

Paul M. Howard

PAUL M. HOWARD
Deputy Chief for Technology
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Enclosure

DIST: See Reverse

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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GA-13	40
HA-15	10
ID-16	20
IL-17	40
IN-18	25
IA-19	40
KS-20	45
KY-21	25
LA-22	30
ME-23	15
MD-24	15
MA-25	15
MI-26	20
MN-27	30
MS-28	40
MO-29	30
MT-30	35
NE-31	30
NV-32	10
NH-33	10
NJ-34	15
NM-35	40
NY-36	25
NC-37	30
ND-38	20
OH-39	40
OK-40	50
OR-41	20
PA-42	35
PR-72	5
RI-44	5
SC-45	25
SD-46	20
TN-47	30
TX-48	100
UT-49	15
VT-50	10
VA-51	25
WA-53	35
WV-54	35
WI-55	20
WY-56	20
Total States	1375

TSC'S	
MTSC-63	25
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Total TSC Staff	105
DC-75	
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OTHER	
ENG @ [redacted] Lanham Md.	25
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REMARKS

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TECHNICAL RELEASE

NUMBER 24

(2nd Edition)

INVESTIGATING ENGINEERING STRUCTURAL PROBLEMS AND DEFICIENCIES

FEBRUARY 1983

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

ENGINEERING

TECHNICAL RELEASE
NUMBER 24

(2nd Edition)

The National Engineering Manual, Part 504, establishes policy for investigating problems and deficiencies. To ensure that all essential information is collected and reported in a usable form, supplementary instructions for conducting investigations are presented in this technical release. These instructions amplify the procedures in NEM §504.04 and §504.05. The main concerns to be addressed in an engineering report dealing with problems and deficiencies are "What permitted the incident?" "What could have prevented it?" Answers to questions similar to those noted in "Abstract Instructions" help to identify reasons for the incident as well as ways to avoid similar occurrences.

INVESTIGATION

Inspect the Site.

Note all visible symptoms of the incident, evidence of watermarks, and other site conditions that may be pertinent in evaluating the problem or deficiency. Borings, test pits, samplings, or onsite tests may be needed to obtain this information.

Study all Pertinent Records and Documents.

This study should include (1) reports of previous inspections by Service personnel or others; (2) statements of eye-witnesses; (3) construction records including plans, diaries, reports, contract modifications, and test records; and (4) the design file, with special regard for field investigation and survey reports, assumptions, criteria, and details.

Interview Key Personnel and Witnesses.

Interview Service personnel and eyewitnesses, preferably at the site of the incident, to clarify or supplement information contained in reports and documents.

Summarize the Facts.

List evidence obtained by observation, documented in investigation reports, noted in the design file, recorded in construction records, or stated by eyewitnesses. The list should include (as appropriate)--

1. A description of the occurrence, its symptoms and results and, if possible, a statement of the sequence and timing of events prior to and during the incident;

2. A summary of site conditions and character of materials, as determined by design and site investigations;

3. A description of key elements of the design, with particular emphasis on critical features, and a list of acknowledged (or clearly inferred) risks taken;

4. A summary of conditions encountered during construction, exposed by the problem or deficiency, or disclosed by subsequent investigations that differed from those adopted as a basis for design;

5. A summary of the background of experience in the use of similar designs under similar conditions;

6. A summary of critical provisions of the construction specifications;

7. A summary of items in the construction records that may: (a) be pertinent to the time sequence of the failure, (b) indicate the scope and quality of inspection, or (c) indicate whether or not construction complied with critical provisions of the specifications;

8. A summary of actions taken subsequent to failure; and

9. A summary of standards and criteria that may be inadequate.

EVALUATION

Summarize the Possible Causes.

List all possible causes consistent with the observed symptoms and known facts.

Evaluate Data to Determine Probable Cause.

Evaluation usually must be made by a deductive process involving: (1) careful study of the facts, (2) consideration of the facts that are consistent with the mechanics of the assumed conditions, and (3) consideration of those assumptions that seem most plausible in light of the sequence and timing of events.

Evaluate the Collection and Interpretation of Basic Data.

Study the design file to determine whether sufficient basic data were collected by surface reconnaissance, surveys, subsurface investigations, materials testing, hydrologic studies, and/or other special studies to furnish an adequate basis for design. The investigating committee must judge whether: (1) the quantity of data collected was sufficient to reveal all pertinent site and hydrologic conditions, (2) the quality of the data collected was sufficient to allow reasonable confidence in the assumptions and approximations made in establishing design criteria, and (3) the quantity and quality of data collected met SCS guidelines.

If the quantity or quality of the basic data is considered inadequate, the committee should determine whether: (1) the designer noted such omissions, discrepancies, or inadequacies and reported them to the authorities responsible for the collection of data; and (2) if such reports were made, adequate and timely measures were taken to collect the necessary supplementary data.

Having evaluated the character of the basic data, the committee should judge whether design assumptions, deductions, and approximations represent a reasonable interpretation of the basic data in light of the facts known at the time the design was accomplished. Further, if the record indicates that conditions during construction were appreciably different from those assumed in design, it should be determined whether: (1) the changed conditions were adequately reported to the designer; and (2) appropriate action was taken to verify the adequacy of the design or to modify it to compensate for the effects of the actual site conditions.

Evaluate the Design.

List and evaluate features of the design that aggravated or alleviated the apparent problem. This evaluation must consider the features normally required by professionally accepted design criteria to protect the structure from the effects of potentially dangerous conditions inherent in the site and materials. The effect of the incorporation or omission of specific design features must be carefully considered. Whenever the design file indicates that critical features were intentionally omitted or substantially modified as the result of the assumption of design risks, this fact must be analyzed in the light of prescribed criteria, Service experience, the conditions unique to the site, and professional acceptance of such risks.

The investigating committee should thoroughly examine the justification for the assumption of design risk. By reviewing the pertinent files and interviewing knowledgeable personnel, the committee should determine the basis for assumption of risk. For example, was assumption of risk based on: (1) engineering interpretation of valid basic data, (2) arbitrary adjustment of criteria to limitations or commitments imposed in the planning phase, or (3) arbitrary adjustment of criteria to limitations imposed by administrative decision. Copies of all data and correspondence bearing on justification for the assumption of design risk should be collected for attachment to the report.

Evaluate the Construction Operation.

List and evaluate elements of the construction operation that might have had a critical bearing on the type of failure considered most probable. The evaluation must consider the facts from three different standpoints: (1) whether the construction operation complied with the critical provisions of the contract specifications; (2) whether the specifications were adequate for the specific installation under consideration; and (3) whether the inspection program was adequate and construction was in accordance with specifications.

CONCLUSIONS

Prepare Conclusions.

From the evaluation of facts, prepare the most reasonable conclusions with regard to whether--

1. The cause of the problem or deficiency can be determined (if so, it must be stated);

2. Responsibility for the problem or deficiency can be assigned to: (a) planning; (b) investigation; (c) design; (d) construction; (e) operation and/or maintenance; or (f) management;

3. Responsibility can be assigned to natural occurrences beyond the reasonable control of the interested parties;

4. The problem or deficiency would have occurred even if construction complied with provisions of the specifications when a combination of problems or deficiencies is suspected but no tangible proof exists;

5. SCS criteria, procedures, and actions were either inadequate or contributed to the problem or deficiency.

RECOMMENDATIONS

Prepare Recommendations.

List, as appropriate, suggestions on how procedures, criteria, designs, staffing, etc., need to be changed to avoid a recurrence of the incident.

If applicable, make conceptual suggestions for alternative treatments. However, the main purpose of an engineering report is to identify the cause of the problem or deficiency, the underlying reason behind the problem or deficiency, and measures that would have prevented the incident. The investigating committee may or may not be involved in recommending remedial treatments. Any recommendations made are considered tentative and need not be extensively described unless they are unique and important to the lesson to be learned from the incident.

PREPARATION

Write the Report.

The report should be carefully prepared to ensure that all essential elements of the inquiry are summarized and explained. The report should conform to the format of the enclosed example. If supplementary documents and exhibits are required, they should be listed as attachments.

Prepare the Abstract

An abstract should be prepared to facilitate review by others. The enclosed format should be followed to provide uniformity. Sketches may be used to supplement a narrative if they facilitate communication and add to brevity.

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
(Location of Incident)
(Date of Report)

ENGINEERING REPORT

Project:
Location:
Site No. (or name of structure):
Appropriation:
General Description of Problem or Deficiency:

Authority. (Refer to the letter appointing the investigating committee.)

Composition of committee. (List names of members.)

Investigation. (Describe the scope of inquiry and list site inspections; records, reports, and documents reviewed; and witnesses interviewed.)

(List all pertinent facts developed by the inquiry with reference to the supporting evidence.)

Evaluation. (Include a complete discussion of possible causes, evaluation of data, deductions, assumptions, evaluation of design and construction operations, and any other discussion that explains how the committee arrived at its conclusions.)

Conclusions. (List conclusions derived from evaluation of pertinent facts.)

Recommendations. (List recommendations or procedures, designs, staffing, etc. If appropriate, list remedial measure recommendations.)

Attachments ( )

_____
(Name), Chairman

_____
(Name)

_____
(Name)

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
(Location of Incident)
(Date of Report)

ABSTRACT OF ENGINEERING REPORT

General Description of Problem or Deficiency:

Location:

Type of Facility (Purpose & Function):

Job Class:

Size:

Date of Installation:

[NATURE OF PROBLEM OR DEFICIENCY:]*

[CAUSE(S) OF PROBLEM OR DEFICIENCY:]*

[ERROR, MISTAKE, OR MISJUDGMENT THAT PERMITTED INCIDENT TO OCCUR:]*

[MEASURES THAT COULD HAVE PREVENTED INCIDENT:]*

Remedial Treatment 1/:

Sketch (if appropriate):

1/ A statement is necessary if the investigating committee has recommendations. For final remedial treatments used or for additional information contact: (Include copy of the abstract with request.)

* NOTE: These phrases simply indicate the desired subject matter within the paragraphs describing the incident. Do not entitle the paragraphs with them; however, these subjects should be clearly discussed.

Problem Category: _____ Site Name: _____

Practice Standard: _____ State: _____

ABSTRACT INSTRUCTIONS
General Description of Problem or Deficiency

Briefly describe the general problem starting with the following (or similar) terminology.

Slope failure...
Excessive erosion...
Differential settlement...
Excessive settlement...
Jugging/dispersive soils...
Unacceptable concrete...
Deterioration of concrete...
Piping/excessive seepage...
Excessive deposition...
Unacceptable corrosion...
Inadequate metal structure...
Malfunction of pipeline...
Blockage of spillway/riser pipe conduit/etc. ...
Vandalism/destruction of...
Displacement of riprap...
Deterioration of wood, CMP, etc. ...
Excessive water pressure...
Improper size...
Improper location...
Unacceptable reservoir leakage/capacity...
Large construction modification...

Examples:

Failure of the downstream slope. Unacceptable concrete in the impact basin. Improper location of pressure relief valves in a pipeline.

NATURE OF PROBLEM OR DEFICIENCY

The discussion answering questions such as the following will help define the problem.

1. What occurred that required reporting?

2. What was the appearance of the engineered structure before the occurrence? What were the changes as a result of the occurrence, or what is the situational condition at the time of this study?

3. What damages (physical, economic, etc.) occurred as a result of the incident?

4. What are the potential dangers that now exist?

5. What emergency action (if any) was taken to alleviate an immediate hazard?

CAUSE(S) OF PROBLEM OR DEFICIENCY

The discussion answering questions such as the following will help identify what contributed to the initiation and progress of events resulting in the current condition.

1. What physically happened to permit the incident to occur, i.e., what was the physical cause(s) of the incident?

2. What was the progression of events leading to the physical cause(s)?

3. What was the principal cause and what were the contributing causes?

ERROR, MISTAKE, OR MISJUDGMENT THAT PERMITTED INCIDENT TO OCCUR

The discussion answering questions such as the following will help define what action(s) or inaction(s) permitted the problem to occur.

1. What went wrong to permit the incident to occur and what could have prevented it? Why were the conditions present that permitted the incident to occur? Was there a lack of basic knowledge, a lack of time to do the job, a failure to get all the facts, etc.? Answers will identify the underlying reason(s) for the incident.

2. Were there arbitrary employee actions? Why?

3. Were reviews adequate?

4. Is there a lack of engineering staff capability of supervison?

5. Is there an excessive workload?

6. Was pressure applied to get the job done without having adequate knowledge of site conditions?

MEASURES THAT COULD HAVE PREVENTED INCIDENT

The discussion answering questions such as the following will help define what measures, if used, could have prevented the incident from happening.

1. What structural feature was lacking (omitted or inadequate)?

2. What operational procedure was improper?

3. What guidance available in the form of policy, criteria, standards or procedures was in error?

4. What shortcomings in personnel resources contributed? These can be in terms of technical skills, staffing limitations, workload scheduling or supporting technical counsel and review.

Redmedial Treatment

The main purpose of an engineering report is to identify the cause of the problem or deficiency, the underlying reason behind the problem or deficiency, and the measures that could have prevented the incident. The investigating committee may or may not recommend remedial treatments. Any recommendations made are considered tentative and need not be extensively described unless they are unique and important to the lesson to be learned from the incident.

Cross Reference Guidelines

To be most useful in informing others of problems experienced, the abstracts are to be cross referenced (bottom left hand corner of abstract) to enable quick access of information important to immediate concerns:

1. A category of problems is included. Use key words in the abstract.

2. References to Practice Standards are to be used.

Problem Categories

I. Earth - External Erosion -

- A. On embankments
- B. On channels/spillways
- C. Near pipe entrance and/or outlet
- D. Dispersion

II. Earth - Internal Erosion -

- A. In embankments
- B. Dispersion
- C. In channels/spillways
- D. Along pipes

III. Earth - Seepage/Drainage -

- A. In embankments
- B. In natural slopes
- C. In channels/spillways
- D. In foundations

IV. Earth - Strength -

- A. Of embankments
- B. Of natural slopes
- C. Of channels/spillways
- D. Of foundations

V. Earth - Consolidation/Settlement -

- A. Differential
- B. Excessive

VI. Earth - Deposition -

- A. In reservoirs
- B. Behind grade control structures
- C. Behind diversion structures

VII. Concrete - Strength/Durability -

- A. Pipes
- B. Slabs/walls
- C. Channels
- D. Joints

VIII. Concrete - Cavitation -

A. Pipes
B. Channels
C. Slabs/walls

IX. Concrete - Vibrations/Earthquakes/Wind/Hydrostatic Uplift/Ice/Deterioration -

A. Pipes
B. Channels
C. Slabs/walls
D. Risers

X. Metal - Corrosion -

A. Pipes (including coupling systems)
B. Fabricated components
C. Gates/appurtenances

XI. Metal - Strength/Durability -

A. Pipes (including coupling systems)
B. Fabricated components
C. Gates/appurtenances

XII. Metal Gates - Malfunction -

XIII. Pumps - Malfunction -

XIV. Structure - Mislocation -

A. Due to faulty survey
B. Other

XV. Excessive Construction Modification - (Inclusive proper descriptive phrase)

XVI. Water - Conveyance -

A. Improper pipe size
B. Improper channel size

XVII. Water - Storage -

A. Improper capacity of reservoir
B. Leakage in reservoir

XVIII. Erosion Protection - Riprap, Gabions, etc. -

A. Channels
B. Stilling basins
C. Pipe drop structures

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