

SESSION ON  
HYDRAULIC STRUCTURES

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<i>Compilation of Reports on Hydraulic Model Studies</i>	.	GEORGE E. BARNES
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# COMPILATION OF REPORTS ON HYDRAULIC MODEL STUDIES

by

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## IMPORTANCE OF SUBJECT

No important hydraulic structures are built today whose design is not developed in part by the aid of hydraulic model studies. In fact, such studies are usually a major factor in design. Their accurate recording and reporting is of great importance, not only for immediate purposes, but because the data may be of wide interest and may be valuable reference material. The future use of reports made for current work is of course insured, where the action of the prototype is to be recorded and correlated with the action of the model, by means of measuring devices built into the actual structure.

## ENGINEERING AND ENGLISH IN REPORT WRITING

The subject of report writing is generally taught in our colleges by the departments of English. However, the writer believes that the subject should be taught only with the active participation of engineering teachers, for the following reasons:

- (1) the engineering teacher, not the English teacher, has the accurate knowledge born of experience, of the uses to which engineering reports are put,
- (2) this knowledge is the key to writing a report which will successfully serve its purpose,
- (3) teachers of English do not possess and cannot acquire this key; their rightful authority in the subject being restricted to matters of form and composition, and,
- (4) the student will develop a proper insight into the subject only when he is taught by an engineering teacher,

on the place and function of engineering documents and reports, in civil engineering work.

#### PLACE OF ENGINEERING DOCUMENTS IN CIVIL ENGINEERING WORK

The preparing and handling of engineering documents is an extraordinarily important part of civil engineering. In organizations entrusted with the execution of large projects, careful planning of routines is required for the handling of technical data and information. Such material must, where possible, be conventionalized to permit quick and accurate interpretation. Also, its preparation and release must be timed with respect to the general program of operations of which it is part.

#### GENERAL FORMS OF ENGINEERING DOCUMENTS

With regard to scope, form, and content, the familiar forms of engineering documents such as specifications, contract and construction drawings, contract and bid forms, field notes, design calculations, and technical memoranda have, in every engineering office, somehow evolved to a certain degree of uniformity. With some documents, legal considerations have been a controlling factor. The principal influence of course has been a matured conception of what is required and what is not, which arises from long experience. Engineers have this experience in common. In handling material prepared by other engineers, they expect to find it not only complete but easy to scan and assimilate. In fact, if it does not meet certain minimum requirements as to form, arrangement, and expression, it may fail utterly to serve the purpose intended, however accurate and complete it might prove to be, on further search.

#### ENGINEERING REPORTS

Engineering reports are among the most important of engineering documents, though less conventionalized than most. Standardization is neither desirable nor possible, because reports serve a wide variety of purposes. Nevertheless certain basic essentials should be insisted upon and should characterize every report regardless of its purpose or destiny. In the type of report here considered, the general problem under study is to be stated so as to be fully understood, the method of solving the problem and the results secured are to be presented in complete form, and the conclusions and recommenda-

tions are to be fairly drawn by reasonable interpretation of the facts disclosed. The report should be organized specifically for the needs of the person who is to use it; more precisely, it should be organized so that several readers with different objectives may use it for their individual purposes with the greatest of facility and expedition, so that the necessary information can be culled without going over unrelated items to find that which is wanted. The writer appreciates that some of these observations may seem trite; yet they are made for emphasis because the matters enumerated are so frequently overlooked, resulting in poor or inadequate reports.

#### ESSENTIALS OF A GOOD REPORT

First, a good report should follow some generally acceptable outline or form, so that the material will be well organized. Second, it should read well, which is a matter of expression or language, and also skillful structure and logical sequence. This is a matter less readily formulated. Good English and proper grammar are expected as a matter of course, and something beyond. This is the contribution which the writer makes from his own experience, facility and individuality, which enables him to meet the mind of the reader. Finally, a report must be technical exposition of the highest order, because the material is of a nature only to be adequately presented in the form of studied and well considered analysis and opinion. It must bear the most critical review. The third essential, therefore, properly can be called only "good engineering."

#### REPORT FORM

In a course in report writing which the writer took as an undergraduate, the instructor centered attention on project reports by several engineering firms. These were broken down for analysis, and several principles were established. Two outlines taken from student notes have been useful to this day, though not always followed literally. The first outline shows the essential parts of an engineering report, and the second indicates procedure to guide in organizing and rendering the material to go into the report. The outlines have been adopted with some modifications by the Department of English at Case School of Applied Science and by two federal engineering organizations; they are given below for the benefit of anyone who might wish to use them:

## A. Outline for Engineering Report

1. Front Cover  
Brief Title, name of author
2. Title Page
  - a. full title of report, may be 20 or 30 words
  - b. name of person or firm who writes report, with titles
  - c. name of person or client for whom report is written
  - d. city and state in which you have your office
  - e. date

Note: three forms of title page

<b>A REPORT-</b> <hr style="width: 80%; margin: 5px auto;"/> <hr style="width: 80%; margin: 5px auto;"/>  <hr style="width: 80%; margin: 5px auto;"/> <hr style="width: 80%; margin: 5px auto;"/>
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Block

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Bull's Eye

<b>A REPORT</b>  <hr style="width: 80%; margin: 5px auto;"/> <hr style="width: 80%; margin: 5px auto;"/> <hr style="width: 80%; margin: 5px auto;"/> <hr style="width: 80%; margin: 5px auto;"/>
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Diamond

3. Two letters
  - a. from client (a copy)
  - b. from writer, conveying report
4. Table of Contents
5. Sheet with word report
6. The report proper
  - a. introduction
    1. reason, purpose, and scope
    2. method of investigation
    3. work accomplished
  - b. summary
  - c. body of report  
steps leading to result
  - d. conclusions
  - e. recommendations
7. Sheet with word Appendices
8. Appendices—Plans, Maps, Photographs, Drawings, Tables, Statistics

9. Bibliography—Name of Author, of Book, Place, Publisher, Date, Contents
10. Index
11. Back cover.

#### B. Eleven Steps in Writing a Report

1. Think over what you already know.
2. Outline it.
3. Fill in facts you want to know.
4. Plan, with detail, methods and amount of time to get these facts. Plan interviews, appointments, field work, etc.
5. Execute plan and get the material.
6. Outline the material.
7. Write first draft.
8. Go over draft and correct.
9. Typewrite text, make title page, table of contents, etc.
10. Arrange and bind.
11. Review thoroughly.

#### C. Requisites for a Good Report

1. a definite answer
2. promptness
3. neatness
4. accuracy
5. no errors in logic  
no sweeping generalizations; no false statements;  
indicate the limits of error; honesty

#### D. Essentials for Good Report

1. clearness; consistent and logical plan for the report.
2. completeness; units complete; summary, introduction, recommendations.
3. conciseness; compact
4. accurate English; no ambiguous words; not too technical words, always simplest if there is choice; simple sentence structure; short sentences; one idea per sentence; one idea per paragraph.

5. emphasis obtained
  - a. mechanical—capitalizing; underlining; color; headings, side or marginal readings.
  - b. grammatical—most important part of sentence at beginning or end.

#### CONDUCT OF MODEL STUDIES

The preceding remarks apply to reports on hydraulic model studies, as well as other types. In writing a good report it is essential to be guided by a clear conception, in each case, of the part that the model studies are to play in the design or in the project, and the specific responsibilities of the parties to the work. Model studies are neither a mechanical process for grinding out the right answer nor are the findings mere approximations of the truth because dynamic similarity is imperfectly attained. Significant results from model studies are to be expected only where experience and judgment, derived both in the laboratory and in practical design and construction, are brought to bear on the work. In the statements which follow, model studies are assumed to be of the type whose primary purpose is to assist design, and the writer's attitude is that of a designer who has special tools with which to work.

#### ORGANIZATION FOR WORK ON HYDRAULIC MODEL STUDIES

A common, but not necessarily typical, arrangement between laboratory and project is to have the laboratory under contract for building the models and securing the measurements, and to have the laboratory director under personal service contract as consultant, with duties including both supervision of the work and advising on design. In advising on design, his opinions are drawn from general experience, but more specifically on the data he has been able to secure in the laboratory. The engineering office engaging such services ordinarily has a resident engineer at the laboratory as an inspector and liaison man between the office and the laboratory. The resident engineer facilitates and expedites the work, but does not direct it, having authority not over technical matters but over contractual provisions. In order to simplify the discussion in this paper, such an arrangement is assumed in the following paragraphs.

## ORIGINAL RECORDS

The original records from which the report material is compiled, include (1) the laboratory diary, (2) the office or personal diary, and (3) the laboratory data sheets (later converted into tables and charts, after which the data sheets are filed for record purposes), and (4) the log of tests, which is a daily tabulation of the principal features of successive tests, kept up daily as a check list. The laboratory diary contains one page for each day, with notations on personnel, their duties, tests run, stage of model construction, changes in operating conditions, and in fact everything not contained in tabulated form on the data sheets. The diary is extremely valuable when writing the report, after the situation at the time tests were run cannot be fully recaptured and the order of work is difficult to remember. The personal diary keeps a record of conferences, official visitors, phone calls, policies discussed, new data on limiting conditions for design as they arise during the development of the plans, and such matters. The laboratory data sheets are of the nature described in a previous paper by the writer.<sup>1</sup> The log of tests is a tabular list, with a single horizontal line of notations for each test, under appropriate column heads giving the major features and results of each test.

## TYPES OF REPORTS REQUIRED

In general, three types of reports are required, namely: (1) Preliminary reports, which precede the actual model construction, and are drawn for the purpose of (a) giving earliest possible definition to the structure, so that drawings may be prepared with least likelihood of changes, and (b) evaluating the hydraulic problems involved, so that model studies may be planned with the most productive schedule; (2) progress reports, which recite usually from week to week the nature of the work undertaken and projected for the period following, with tentative findings for the use of designers, and (3) the final report, which is either a compilation of the preceding reports, or better, a self contained comprehensive report, completely written from scratch but containing, naturally, much of the material previously prepared. This is perhaps the most satisfactory form of final report, both for supporting material on any recommendations made and for permanent reference.

### PREPARATION OF EXHIBITS

Since it is advisable to draw all plates, tables and other exhibits for the report, while the data are fresh in the minds of the operators, it is necessary to decide early on the several types of exhibits and what they are to contain. The writer has used the following scheme: Tables are designated Table A (Title), Table B (Title), etc., and include all the data from which curves were drawn, and also the results of computations. Plates, which include photographs, curves, hydraulic gradients or water surface profiles, scour contours, etc., are numbered 1, 2, 3, 4, etc., with suitable titles. Sheets, or drawings which give accurate definition to the models and prototype, are numbered as Sheet 1 of 10, Sheet 2 of 10, etc. Tables are included in the running text, but plates and sheets are at the back of the report, with the plates first and the sheets last.

### SUGGESTED FORM FOR THE FINAL REPORT

The following form is suggested for the final report:

1. Cover, with abbreviated title.
2. Blank page (cover sheet).
3. Title page, with full title.
4. Table of Contents, containing in order, by item and page location,
  - a. List of Tables
  - b. List of Plates
  - c. List of Drawings
  - d. Letter of Transmittal
  - e. Synopsis of the Report
  - f. Report contents, part by part, section by section, paragraph by paragraph; wherever possible, each paragraph should have a caption.
5. Sheet, with the single word "Report."
6. The report itself.
7. Plates.
8. Sheets or Drawings.

### CONTENTS OF THE REPORT

The report should be absolutely complete, however long. A report can be concise, whether 10 or 200 pages in length. Conciseness is a matter of organization and writing, not of mere length. How-

ever, if the amount of experimental work is great and includes building and testing many models on the same project, extreme care is required in organizing a long report so as to permit information in it to be readily abstracted and digested by the reader. It will be necessary not only to pay particular attention to report structure and sequence of topics, but to include paragraphs which explain briefly the organization of the report, the character and location of the types of material and exhibits included, and the key to nomenclature. The writer would classify the information to be included in the report under the following heads:

1. Summary of the Report.
2. Conclusions and Recommendations; clear language and direct reference to drawings giving definition to the structure.
3. Authority for the work and nature of work ordered.
4. Service required for the structure, the basic data for design, and any design limitations imposed by conditions at the site whether hydraulic (such as unusual tailwater conditions) or structural (such as unusual foundation or site features).
5. General paragraphs giving organization of the report; character and location of material and exhibits in the report; key to nomenclature; terms in which results are expressed (preferably using elevations, velocities, rates of discharge, etc., as for the prototype).
6. Analysis of design, independent of model studies, but characterizing the nature of the tests to be made.
7. Staff organization, laboratory facilities, instrumentation and precision of work, in sufficient detail for a clear conception of the circumstances affecting tests.
8. Governing theory which applies to the particular model studies under test; brief statement, not a dissertation.
9. Description of the models, as to fabrication, erection, etc., again insofar as required for proper evaluation of strength of test results.
10. Recitation of Test Procedure.
11. Detailed discussion of individual tests or groups of tests.
12. Analysis of Test Data; critical survey of material gained in tests, and interpretation, for general reference, in the case of coefficients secured, friction factors, scale effects, and other matters.
13. Exhibits; plates, drawings, etc.

With report material of the character shown above, it should be

possible for the reader to review all of the original data and the circumstances of test, for the purpose of independent analysis and deduction or for interpretation beyond the immediate objectives of the study at hand, if this should prove desirable. Only in this way will the fullest benefit of the work result.

## EXHIBITS

It has been found desirable to make plates or drawings in the report in conformity with the following brief description:

- a. Drawings: Drawings are used to record the model layout and details, dimensioned as in the prototype, but showing construction and fabrication details as in the model, particularly where the materials and details are related to the character of the measurements secured. In certain cases, model dimensions (sheet thicknesses, etc., may be mixed in with prototype dimensions, without confusion, especially where the material shown is obviously model detail). As in construction drawings, the sheets should be arranged from the general (plans, sections) to the specific (details). Piezometers and instrumentation should be shown. If drawings are to be reduced, the lettering and weight of lines should take this into account. For an  $8\frac{1}{2} \times 11$  report, a convenient sheet size is  $22 \times 36$  overall, which upon reduction yields a page  $11 \times 18$ . This can be folded so that the title in the lower right hand corner is left exposed. Drawings can be reproduced as black line prints from a vandyke negative, or as photostats or lithoprints.
- b. Plates: Plates are used to show charts and graphs, small diagrams, or photographs. It is convenient to print the laboratory or office card in the lower left corner, and all fixed parts of the title in the lower right corner, on either standard graph paper or white thin bond paper. Other lettering can be added with mechanical aids. In the case of photographs, the following procedure is serviceable: A border for the photograph or photographs is drawn in ink, and the photo title and identification number are lettered in. A negative is then made of the sheet. The negative is cut, and the individual negatives of the views to be shown, are mounted in place. The assembly forms the master negative, from which direct contact prints of the finished page can be made, complete with titles. It should be noted that for any form of photographic reproduction other than the direct contact print, some detail will be sacrificed. For that reason the

writer prefers the direct contact prints, though they are more expensive.

## REPRODUCTION

For completely satisfactory reproduction of the reports, commercial lithoprinting and binding is preferred, provided sufficient copies will be used (say a hundred or more) to bring down the cost. Lithoprinting is extremely satisfactory for the text, and for drawings; the photographic work may be either lithoprinted, or handled as described above.

## CONCLUDING REMARKS

Many organizations are issuing reports on hydraulic model studies, that are admirable in every respect. The writer has learned much from experience in handling such work, and the suggestions contained herein, which derive from that experience, may be found useful, though perhaps applicable only in part in many cases. In the interest of hydraulic engineering and the advances which are being made through the agency of hydraulic model studies, this discussion is offered in the hope that it may assist in the important matter of getting valuable work in suitable record form.

## BIBLIOGRAPHY

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- (4) Barnes, George E. "A Report on Hydraulic Model Studies for the Outlet Works and Spillway of the Keystone Dam, on the North Platte River, Near Ogallala, Nebraska," issued by Case School of Applied Science, Cleveland, Ohio, 1936.
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