ME 107B COURSE INSTRUCTIONS

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INTRODUCTION

It is the objective of ME 107B to develop an understanding of basic methods for the experimental examination of the behavior and performance of engineering systems, and for the interpretation of results through critical examination and modeling. It is also an objective to continue the development of the student's skills in technical communication through the requirement of individual report writing and group oral reporting. Further, it is an objective of the course to foster the growth of the student's perception of professional standards for investigation and reporting. These objectives are pursued within the context of laboratory experimentation.

Students, working in groups of five or six, perform three experiments over the course of the semester. The performance of each experiment proceeds through an orientation period, a planning phase, a period of experimentation, a period during which data are analyzed, and, finally, a time when final reports are prepared. For each experimental investigation, three reports are required: Planning Report; Interim Report; Final Report. There is also an Oral Presentation at the end. In the following sections of these instructions, report formats and grading schedules are described. Writing skills and an understanding of professional reporting standards are developed and improved by practice. Successive laboratory reports should build on the strengths and weaknesses of the previous reports. Formal feedback on the previous report is provided during the four week of each cycle. Students are encouraged also to visit the instructors during office hours to discuss the experiments at all stages through the cycle. Refer to the semester-specific schedule for particular dates of the cycles and any other milestones.

REPORTS, GENERAL

Handling of Reports Reports are due at the beginning of the class period on scheduled dates. Planning reports should be turned in at the start of each class period, or, at the instructor's office. Check with the individual instructor for their policy on this. Oral report locations will be specified by instructors.

Planning and Interim reports are normally graded immediately and returned to the students. Final reports are graded before the next lab starts. Final reports are retained by the instructor until course final grades have been assigned but students are welcome to review their reports in the meanwhile by arrangement with the instructor.

Grading of Reports. The breakdown of point allowances is given in the sample grading sheets, but particular instructors may have their own policies. *Check with them at the start of each cycle as to their specific grading policy.*

Point penalties may be assessed to groups or individuals for late reports, for inadequate participation, or for the unlikely event of a violation of laboratory regulations. The penalty for a late final report is 20% per calendar day (or fraction of a day) late, of the score which would have been given if the report had been turned in on time. Thus, you can't afford to miss your deadlines — as in the "real" world. Any report or portion of a report returned to the student as unacceptable and ungraded must be completed in a satisfactory manner and resubmitted within one week of its return to the student. The point penalty on unacceptable work will be 50% of the normal grade assigned the acceptable work that has been resubmitted.

To receive a grade in this course, a student must complete all scheduled experimental work and reporting in an acceptable manner, regardless of the penalty that may be assessed.

Special Circumstances Circumstances involving illness and personal difficulties will be given individual consideration upon written request to the instructor in charge of the experiment.

Report Format It should be noted that each major reporting activity, public or private, adheres closely to its own internally established report format. While formats differ in superficial respects, most contain the same essential elements in recognizable form. Differences in emphasis or embellishment reflect anticipated differences in audience.

The format for the ME 107B Planning Report was designed to provide experience in the project oriented group approach applied to problems in engineering experimentation. Beyond preparing the Planning Report, the group must act as a team in conducting the experiment and then reducing the data.

The format for the generic ME 107B Final report resembles that of most institutional and industrial technical reports. However, since formats do typically vary across different institutions, you will find that the instructors also have their own preferences and this variation in required formats is an intentional feature of the course intended to provide you with a more realistic exposure to typical industrial practice. *So, check with the instructor as to their particular required formats for the report.*

The generic format is designed to develop a comprehensive report of new experimental work for a general technical audience having an interest in the same or related fields. Since the ME 107B Final Reports are typically prepared individually — but certain parts of it are done by the group — it is required that each student understand the experiment in its entirety, construct an effective organization of the background materials, develop the results and then analyze them, providing graphical materials and tables, as appropriate. The report is concluded by a summary within which certain conclusions may then appear, and following that, a set of recommendations. The Appendix contains *documentary materials only.* Such material may be, for example, the original data sheets, sample calculations from the Planning Report, or internal details of estimates of error bounds.

In the ME 107B Final Report format, the Appendix is never needed by the general audience to understand the report, but may provide information useful to a specialized group (as an immediate example, your instructors), who will need to know in the fullest detail how certain results were obtained.

GENERIC FORMAT OF THE REPORTS

—CHECK WITH INSTRUCTORS FOR THEIR PARTICULAR FORMATS—

PLANNING REPORTS

The purpose of the planning report is to document the group's planning and preparation for the experimental investigation. This is due at the start of the second week. Preparation of the planning report should be a group effort so that all students will be equally acquainted with the proposed conduct of the experiment and the precise method of data reduction.

The planning report should enable persons who are unfamiliar with the experimental system to operate the system safely and properly, to establish the proposed running conditions, to collect and record all necessary information on the prepared data sheets, to check for data reliability, consistency or reproducibility, and to determine all final results from the data which is to be entered on the data sheets.

A well-prepared planning report significantly reduces the amount of work required for a good final reports. Portions of the planning report may be included in the final report appendix.

PLANNING REPORT FORMAT

A one-page letter of transmittal and the following sections:

1. Experimental Objective
2. Experimental System
3. Experiment Instrumentation
4. Schedule of Experimental Conditions
5. Schedule of Personnel Assignments (what, who, when)
6. Data Reduction

7. Data Sheets
8. Graphs or Tables for Data and Data Consistency

Letter The letter identifies the particular experimental investigation, the group number and names of group members performing the investigation, and the location, date and time of performance. Business letter format is used. Only one person signs the letter. The letter accompanies the report, it is not part of the report.

Experimental Objective The opening statement of the planning report is a concise statement of the experimental objective. For most ME 107 experiments, a single paragraph suffices.

Experimental System The experimental system section contains a complete description of the laboratory setup. A detailed schematic diagram of the system is included. Identification of equipment on the diagram is consistent with procedure instructions and measurement labels on the prepared data sheets. All material and energy transfer locations are identified on the diagram. (An exact copy of a schematic diagram posted at some experiment stations may not meet all of these requirements.)

Experiment Instrumentation This section describes all instruments that will be used. The location and purpose of each instrument in the experiment should be identified and correlated to the system schematic diagram. The capabilities and limitations of these instruments should be considered. Ranges and least significant bits, or smallest increments should be noted.

Schedule of Experimental Conditions The proposed schedule of experimental conditions indicates how the operating conditions are to be identified, the proposed runs, and the frequency or number of observations for each run.

Schedule of Personnel Assignments The schedule of personnel assignments identifies the duties of each group member during each set of running conditions. Personnel assignments are made to stations for which the duties are well defined. The explanation of the duties of each station includes all procedures and safety precautions. Terms are consistent with the schematic diagram and the data sheet headings. Duties may include responsibilities for system control, recording of data and/or data evaluation. When planning station duties, logistics must be considered. Timing, location and communication are important. A block diagram indicating the role of each station in the overall sequence or procedure may be appropriate.

Data Reduction The data reduction section consists of a detailed plan for obtaining all intermediate and final results. The data reduction scheme shows exactly how each measurement is to be used to arrive at a final result. All units, property values, constants and conversion factors are included. Prepared tables which provide for listing all intermediate and final results, and which specify (by equation number) which relations are necessary to determine each intermediate and final result, are recommended. Data reduction tables are often organized so that the sequence of columns (left to right) corresponds as nearly as possible to the sequence of calculation of intermediate and final results. For complicated data reduction schemes, a block diagram indicating the sequence of calculations may be included. All equations and relations are numbered and the meaning of all symbols is explained. Terms are consistent throughout the report. *Sample calculations using a typical data set are to be included and a preliminary estimation of uncertainties is to be made*. Word processed sample calculations are often time consuming to generate and difficult to follow, given the complexities associated with greek symbols, super- and sub-scripts. The group might consider the merits of a neat and thorough handwritten section in the style of traditional homework.

Data Sheets The data sheets section contains a complete set of data sheets for recording all observations. It is important to include equipment and instrument identification. Column headings are consistent with the schematic diagram labels and the instructions for each station assignment. The data sheets are prepared so that the meaning of each heading can be understood without reference to other information. Space for comments, instrument calibration, or corrections should be included.

Graphs or Tables for Data Evaluation This section contains graphs or tables for data evaluation as well as proposed means for checking data reliability, consistency, or reproducibility of data during the course of the experiment. Calibration, control, or consistency curves or tables may be appropriate. Figures (or tables) with labeled axes (or headings) indicating the expected range of data or results should be included in this section.

An explanation of the intended use of all figures and tables is included. All figures and tables are numbered and titled.

REPORT OF INTERIM RESULTS

The purpose of the interim report is to present progress to date, and intended direction of the experimental investigations. The group members will have most likely gained experience and insight from the first laboratory and may wish to expand, alter, or update the direction of the second investigation. Preparation of the interim report will be a group effort. The format for this report will be either all written, or a mix of oral and written presentations, which *will be declared by each experiment instructor*. In the oral option, the main body of the report will be presented by all group members. The mandatory written appendices will also be submitted at this time for detailed review by the experiment instructor.

INTERIM REPORT FORMAT

A letter of transmittal and the following sections:

1. Theoretical Considerations
2. Presentation of Results
3. Discussion of Results
4. Discussion of Uncertainties
5. Additional or Revised Planning

INTERIM REPORT APPENDICES

6. Compiled Raw, Intermediate, and Final Data
7. Tabular and Graphic Material
8. Data Analyses and Uncertainty Methods
9. Experiment Description
10. Updated Planning Report

Theoretical Considerations The intent of this section is to provide a concise yet complete summary of the theoretical background that is relevant to this investigation. The planning report should have presented the more lengthy discussion of theory and its application in the Data Reduction. Several issues should be considered when comparing theory to experiment:

- Relevant background and required assumptions for this evaluation.
- Suitability or relevance of theory to this laboratory environment.
- Completeness or limitations in the theoretical model.

Special attention should be given to corrections and omissions in the planning report.

Presentation of Results The experimental results should be first presented in an organized and complete manner, to provide an informed basis for the more detailed examination of these results. Results and their interrelations are generally best visualized and understood when presented in a well organized graphic or tabular format. Graphs and tables are considered to be “stand alone material”. They should include descriptions contained in the Caption, Title, Scales or Column headings, Legends, and Notes that avoid the need for additional explanation. Both the intermediate and final results should be presented as deemed appropriate.

Discussion of Results The purpose of this discussion is to make engineering value judgments on the results. Does the presented theory agree with the experimental results ? Was the setup and instrumentation adequate to confirm or refute your theoretical model ? The focus of your discussion should be factual, rather than opinionated.

Discussion of Uncertainties The quality of experimental results is closely related to the adequacy of the instrumentation. The quantitative statement of this concern is the uncertainties or tolerances which are assigned to results. The uncertainties assigned to your results should be logically traced to the uncertainties of each measurement. Related factors which might be of concern are linearity, bandwidth, and repeatability. Where possible, a primary or cross calibration of instruments provides increased confidence in the results. The possibility of systematic errors in the experiment setup or instruments should be considered.

Additional or Revised Planning The section should describe the revised system and procedures that will be used in the second laboratory session. Your descriptions will be related to the previous session, but should be complete to the extent that the reader should not have to refer to the Planning Report.

INTERIM REPORT APPENDICES

Compiled Raw, Intermediate, and Final Data This section should provide a *well organized* compilation of the groups progress in the first laboratory session. Much of the information in this section will be in the form of numerical tables or equations. Complete sentences describing the meaning or flow of these tables and equations should also be included. The original raw data sheets recorded during that session should be provided. Any intermediate data needed to generate the final results should also provided. A tabulation of final results should also be included.

Tabular and Graphic Material Copies of all of the final presentation materials should be included for review. Supplemental notes and comments may be needed to explain the more obscure or confusing items.

Data Analyses and Uncertainty Methods The data reduction section of the Planning Report should provide the basis or starting point for this section. The data reduction techniques should be extended, revised, or updated as needed to complete the second laboratory session. The format of this section should be the same as that of the Planning Report.

Experiment Description A rather detailed and lengthy description of the experimental system and procedure was needed for the planning report, in order to properly conduct the experiment. For the interim and final reports, this description should be brief and concise. Your reader only needs a good understanding of the context or setting of your experiment in order to properly interpret your results. They most likely have little interest in repeating your experiment.

Updated Planning Report The original graded report should be resubmitted for reference or review by the instructor. Changes and corrections should be accomplished in a manner that does not obliterate the original. Brief changes may be red lined. More lengthy corrections should be accomplished using labeled revision pages or supplemental pages.

FINAL REPORTS

The Final Report is a full report of the experimental investigation which focuses on the results and conclusions of the experiment. The Final Report is prepared and submitted by each individual group member. However, large parts of the report are a group effort.

FINAL REPORT FORMAT

The Final report must be accompanied by a letter of transmittal. The report itself contains the following elements:

1. Title Page
2. Abstract
3. Table of Contents
4. Introduction
5. Theory (Group effort: one copy in each report)
5. Brief Experimental System (Group effort: one copy in each report)

6. Development of Results and Discussion
7. Summary, Conclusions and Recommendations
8. References if necessary, or footnotes in text
9. Appendix (Group effort. Submit one copy only as a separate document.)

The Final Report must set down the basic theoretical background for the experiment in sufficient detail so that the experimental methods and procedures, the data reduction and the results and conclusions, *all can be understood without reference to the Appendix*.

Letter The letter which accompanies the Final Report is similar in form and content to the letter which accompanies the Planning Report. It identifies the particular experiment and laboratory group, and specifies the location, date and time of performance. The objective of the experiment is not necessarily stated, since the final report contains this information.

Title Page The title page completely identifies the topic, names of all participants, and the location, date and time of the experiment. The words "title page" do not appear on the title page.

Abstract An abstract is a brief and concise statement that indicates what useful information is contained in the report. The abstract does not represent an attempt to present this useful information in detail, although one or more major conclusions should be included. For this report format, an abstract does not contain more than 150 words. A list of (two to five) key words may also be included on the same page as the abstract.

Table of Contents A table of contents is included in reports which exceed approximately ten pages in total length. The proper title for this table is "Contents". The table of contents lists the pages on which the major section begin. A list of figures (or tables) is generally included if there are ten or more items to be listed. The figures (or tables) are listed in numerical order, with the title and the page number of each item. The table of contents and the list of figures (or tables) are not given table numbers. *Report pages must be numbered.*

Introduction The introduction includes a precise statement of experimental objective and should also include:

1. The motivation for the study or applications of the results.

The organization and composition of the Introduction is crucially important to the development of the report and to its success in conveying the results and significance of your work. Since an objective of ME107B is to assist in the improvement of your skills in technical communication it is emphasized that the Introduction must be *individually* written.

Theory (Group effort, but present in each final report.) All background material necessary for an understanding of the experimental method and for the reduction of observations. This includes all principal formulae and may include references. The very basic background information found in commonly used texts may simply be referenced. The specific theoretical background necessary for the understanding of the experiment, the data reduction, and the presentation and discussion of theoretical results must be presented in these sections.

Experimental System (Group effort, but present in each final report.) The section on the experimental system is a concise description of the system, its operation, and the important measurement techniques. Sketches and diagrammatic material are normally an essential part of this section.

Development of Results and Discussion The results and discussion section contains:

1. A formal concise development of final results, in as general a form as possible. (A further discussion of this element follows.)
2. A discussion of:
   a. The accuracy of the results;
   b. The ability to predict the results on the basis of theories or correlations.
   c. The meaning of the results in light of the stated experimental objectives.

Development of Results The word "development" implies a logically structured exposition in which, typically, the major features of the results are introduced first. Once a suitable background has been established secondary features are then introduced at appropriate times. In the course of this exposition quantitative values and uncertainties are cited and suitable comparisons are made. These should be made both in the body of the narrative and also through the use of graphs. Reference should be given to tables so that all relevant numerical values are accessible.

It should be emphasized that the first essential of a comprehensive technical report is clarity. The report must be understandable to a general technical audience. Members of that audience, some of whom may be your clients, require a well organized, accurate, complete and credible account of the outcome of an experimental investigation. In this activity compactness is a virtue, but never at the expense of clarity. It should be remarked that journal research papers are written for a specialized audience and understandably may be written to a different standard of brevity.

When making comparisons between your work and that found in the literature, be sure to cite the source. Comparisons between your experimental measurements and the general theory should be fully supported by prior discussion of the theoretical background in the Introduction. Tables of intermediate calculated values may be referred to in the Appendix where such documentation seems appropriate. Complete results, including those previously presented in the interim report, should always appear in this section.

Significant deviations between results and predictions should be discussed and probable reasons for the deviation, if known, should be stated. If some of the data are suspected of being erroneous, this should be stated. If a procedure or running condition led to possible error or uncertainty, an alternate method may be proposed.

Within the discussion of results some examination should be made of the perceived success or failure in achieving the experimental objective. The tone of the discussion should be positive. Note and explain the apparent shortcomings, but do not dwell on them.

Summary and Conclusions The summary briefly reviews the purpose and scope of the investigation, the methods used, and the results. The length of the summary is about 5% of the length of the report. Following the summary, the major conclusions of the reported investigation are listed *and numbered*. Each conclusion is a single sentence. The number of conclusions should not be excessive, the inclusion of minor or obvious points reduces the impact of the major conclusions. (It is unlikely that there will be more than three or four major conclusions for most ME 107B experiments.) If there is a positive recommendation which would significantly improve either safety or accuracy, or further the scope of the experiment, it may be stated after the conclusions.

Often report summaries (with conclusions) are widely circulated and many people read no more than the summary. In this case, the summary section is placed in front of the table of contents, and a separate conclusions section follows the results and discussion section. Such "executive" summaries are not a part of the 107B format.

References If there are fewer than five references, the citations may be given in footnotes and a reference list may be omitted. Examples of acceptable form for citation are:

1. H. Schlicting, Boundary-Layer Theory, McGraw Hill Book Co., Sixth Edition, translated by J. Kestin, p.63 (1968).
2. C.L. Tien and L.S. Yao, "Analysis of Conduction Controlled Rewetting of a Vertical Surface," Journal of Heat Transfer, 97, pp.161-165 (1975).

A reference list (of which the proper title is "References") is a listing of authors (last name last) and citations of articles or books in the order in which references were made in the text of the report. In this case, each reference is identified by a number in the text, and the citation is given only in the reference list. A footnote is often given with the first reference in the text which explains that the numbers indicate numbered references in the reference list. A bibliography consists of an alphabetical list of authors (last name first) together with the citation of the articles or books on the same topic as the report. The works listed in the bibliography need not have been referenced anywhere else in the report.

Appendix (Group effort) The Appendix may contain the following sections:

1. Details of the experimental systems and all procedures and safety precautions (this may be taken directly from the planning report).
2. Calibration, control or consistency curves used during the course of the experiment to check or interpret data (these may be taken from the planning report and completed, if necessary).
3. Original data sheets. The data sheets should contain all data with no erasures. If an incorrect value is recorded, it should be lined out. If a data point is considered unreliable, a note should be made on the data sheet. Data sheets should never be typed or re-written.
4. Sample calculations for all intermediate and final results, and for any predictions of results based on available theories or correlations. These may be given in tabular form listing all intermediate and final results and referring to numbered equations or relations included in this section. *If a computer or calculator program was used, a program listing, as well as sample input/output, are included. A step-by-step calculation with all intermediate values must accompany the calculator program. The proper units are given for all quantities.*
5. Derivations justifying or explaining the relations used for data reduction or prediction of results, if appropriate. As an example; certain intermediate steps in the evaluation of an integral.
6. Analysis of measurement uncertainty and error, and the effect on final results (statistical analysis may be included, if appropriate).
7. A nomenclature list which gives the meaning of all symbols, subscripts and superscripts used in the report. All symbols should have been defined at least once in the body of the report.
8. The complete planning report, noting any corrections that may be needed.
9. Other information which may be necessary to complete the Final Report.

Since important information is contained in the Appendix, the Final Report should refer to the Appendix. It is important to state, in the final report, what additional information is available in the Appendix. However, to emphasize an earlier statement, the principal theoretical considerations, experimental methods, results and conclusion all must be contained within the main body of the report so that these may be understood without reference to the Appendix.

REMINDERS

Here are a number of remarks which will help you avoid frequently encountered errors in the Final Report.

1. CHECK WITH YOUR INSTRUCTOR FOR ALL FORMAT REQUIREMENTS. THIS GENERIC DESCRIPTION MAY NOT APPLY TO YOUR PARTICULAR EXPERIMENT. It's your responsibility to ensure you know the requirements.
2. List your associates in the letter of transmittal.
3. Include at least one quantitative result in the Abstract.
4. Number pages and number equations.
5. Refer to the Appendix only for documentary items. Never refer to the Appendix for working equations.
6. Do not include introductory material in the Results and Discussion section unless it has already appeared in the Introduction, and you note that you are repeating.
7. Define all symbols, performance parameters, etc. in the body of the text.
8. Provide captions, titles, and legends for all tables and figures.
9. Never begin the Development of Results with a table.
10. Provide at least one graphical representation of major results.
11. If you have used a word processor, delete your files from the hard disk.
12. RUN YOUR SPELL CHECKER AND PROOF READ CAREFULLY. No excuses for typos etc.
13. DON'T BE LATE. In the "real" world, this could cost you your job. Here, it'll probably cost you a letter grade — what a waste…

ORAL PRESENTATIONS

The (final) oral presentation is delivered in conjunction with the final written report. Each group member participates in an overall group presentation, lasting about 20–30 minutes. It is an opportunity for the investigators and the supervisor(s) to interact at the conclusion of the investigation. Preliminary or detailed questions may be pursued, and the direction of future work may be outlined.

SUGGESTED ORAL PRESENTATION FORMAT

The oral presentation consists of an organized presentation of the experimental investigation which may cover the same topics as the final written report. Each student presents some aspect of the work. Questions may be asked during and/or after the presentation. Each student makes a presentation of at about five minutes (without questions). With questioning, the total time for the Oral Report should not exceed about one hour.

Questions posed by the instructor may pertain directly to the presentation, or may pertain to aspects of the experiment (phenomena, systems, applications) which were not fully discussed in the presentation.

PREPARATION FOR ORAL PRESENTATION

Several suggestions are listed which may aid in preparation:

1. Before the presentation, the group decides what each member will present. The presentations are scheduled in logical order.
2. At the start of each presentation, it is customary to introduce yourself, or to be introduced by the previous speaker.
3. Each speaker should make an introductory statement explaining what topic(s) will be discussed in the presentation.
4. The use of visual aids improves the quality of a presentation and increases the amount of information which can be presented in a given time period. Equations and figures take time to write or sketch. You can save time by providing the audience with copies, or by using a prepared display (blackboard, posters, slides, transparencies) for the whole audience to see.
5. Communication is best when the speaker speaks clearly and not too quickly. If you have trouble formulating sentences, try slowing your pace. When speaking, stand and face the audience. Control your body movements (e.g. no waving arms) and your body language too (if you are nervous, try to hide it by breathing slowly and knowing in advance what you're going to say).
6. It is unusual for a technical presentation to be entirely memorized. But you can put yourself at ease by planning your first sentence or two as well as your last sentence or two. In effect, you are planning your first and last impressions on the audience. NEVER, EVER try to do a presentation "on the fly". It won't work and you'll only embarrass yourself with your obvious lack of preparation.

LABORATORY ACTIVITIES

Instructions regarding laboratory activities have been formulated in the interest of promoting safety in the laboratory and professional behavior for participants in the course.

Laboratory Regulations Cooperation is requested in the observation of the following laboratory regulations:

1. No piece of equipment may be started without permission of either the instructor or the mechanician associated with the laboratory experiments.
2. If additional equipment or instrumentation is needed for an experiment, it is to be obtained from the instructor or the mechanician.
3. In the event of any failure, breakage or unexpected change in running conditions promptly notify the instructor or mechanician so that the problem may be corrected and (further) damage prevented.
4. Laboratory equipment is to be shut off at 4:45 p.m. and students are to be out of the building by 5:00 p.m., unless an instructor remains with the equipment and students, and the mechanician has been notified.
5. Laboratory equipment may be used by students during the assigned class hours only, unless special written permission has been given by the instructor and the mechanician has been notified.
6. Pages and diagrams posted in frames near experiment stations are not to be removed at any time.

In addition, several laboratory standards promote good safety records:

1. If unusual sounds develop in an experimental system, attempt to find the cause and notify the instructor or mechanician if necessary.
2. If there is any doubt as to proper system operation and procedure, ask the instructor or the mechanician. Inexperience or carelessness in handling equipment under normal or emergency conditions may result in serious injury to an individual or to the equipment.
3. Changes in valve settings or switch positions should not be made unless the effect of the change on the system is known. Changes should be made slowly (if possible) and the system instrumentation should be watched for evidence of expected changes. Allow sufficient time for both system and instrumentation response.

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