Technical Reports

Elements of Lab Reports

There is an excellent discussion of technical report elements and their content in the following link: http://ltid.grc.nasa.gov/Publishing/editing/vidcover.htm. You should use this information as a guide to development of the various sections of your lab reports.

The following sections should appear in all reports, with headings either as given or modified to better fit the specific report:

- title page
- summary
- table of contents
- introduction
- experimental methods
- results and discussion
- conclusions and recommendations
- notation
- references
- appendices

Lab reports must be submitted on standard 8.5" x 11" paper, in 12-point Roman (times) font (as a minimum), and with at least 1" margins. In no case should a report contain more than 10 pages, not counting title page, table of contents, notation, references and appendices (all of which should start on new pages). Appendices should be limited to an additional 10 pages. Reports should be prepared using word processing software for ease of revision, which may be required. If progress reports are required, they should be limited to 2 pages of 12-point type, with attached tables, graphs, or calculations.

Title and Summary

The most important parts of a technical report are the title and the summary. They are read by nearly all readers and used to determine 1) whether they are interested in the contents of the report, and 2) their immediate reactions to the work. Whether the readers are your peers or your supervisors, you want their interest and positive reactions to your work.

The title is the first thing that the reader sees. For many, it will be the only thing read. It should be a clear and concise digest of the subject matter of the report. At the same time, it must be as short as possible, without loss of clarity. The last step in report preparation should be revision of the title. If the summary is good, the title can often be constructed by examination of the opening sentence of the summary. The title is an important aid in storing and retrieving information, so it should contain the most important key words related to the subject matter of the report. It is this concept of key words that allows most

authors to construct good titles. List them, and then work out some good titles based on incorporating all of the most important key words into them.

There are a number of common difficulties with technical report titles:

The title is too general (vague, imprecise, or incomplete).
Original: Distillation Tower
Better: Use of the ChE Distillation Tower to Investigate Separation of Ethanol-Water Mixtures

The title does not emphasize the most important aspects of the work.
Original: Evaluation of Gas-to-Liquids Production on the North Slope
Better: Design and Economic Evaluation of a Gas-to-Liquids Plant on the North Slope

The title fails to identify important subject matter in the report.
Original: Investigations Using the ChE Tunnel Dryer
Better: Potential Use of the ChE Tunnel Dryer for Drying Wood Products

The title fails to indicate the nature of the investigation.
Original: Evaluation of Removal of CO_2 by Absorption
Better: Comparative Experiments on CO_2 Removal from Air into Water and Dilute Sodium Hydroxide in the ChE Packed Absorber

The first page in your reports should be the title page. It should contain as a minimum the title, to whom it is submitted and her/his position, the date submitted, and the full names of all authors (all group members).

The summary is the only other part of a report that is of equal importance with the title. It should always appear as the first section of a report or paper, right after the title or title page. Those who are attracted to the title, but do not have time to read the entire report, will read the summary. It turns out that this will be the vast majority of your audience, including management, other than your immediate supervisor and a few others who need the detailed information that the report contains. The summary should clearly answer the question “What is it all about?". There are various names used to identify this part of a report, including “Summary”, “Executive Summary”, and “Abstract”. They all have more or less the same meaning. Some long reports will contain a short Executive Summary (or Abstract) and a more-extended Summary targeting different audiences.

The summary should provide a concise digest of the highlights of the report. It should be as brief as possible. It is like the first or lead paragraph in a newspaper story, the purpose being to let the reader know at the start what has happened and why it is significant. The lead sentence should be, like the title, a mini-summary of the work. A brief statement of the main purpose and importance of the work should follow the lead sentence. In other words, the nature of the problem that has been researched or investigated, and why it is important, should be presented in general terms. If the topic is complex, this may take

more than one sentence. Then, important methods should be indicated. After that, the most significant results and the main conclusions and/or recommendations should be stated. Specific data should not be reported here, unless it is a major element of the report. For example, if money is involved, either as an expenditure or saving, the amount (or rate of return on investment) should be stated in the summary, if this is one of the primary conclusions of the work.

A common mistake is to begin a summary with a simple statement of fact that can be interpreted in two quite different ways: 1) as an important result of the investigation being reported or 2) as a preliminary fact or condition that the author wants the reader to know as background information. For example, a summary might begin with "Methane and air form explosive mixtures." If this is background, it belongs in the introduction. If it is a new fact resulting from the research being reported, a better lead sentence would be "As part of our plant safety evaluation activities, methane + air mixtures containing 2-10 mole % methane have been prepared and found to form explosive mixtures."

It is usually best to report technical work in present perfect or past perfect tense, rather than simple present or past tense. The use of "we" is usually discouraged, i.e., "in this study, mixtures were found to explode", rather than "we found that mixtures exploded".

If the report consists chiefly of recommendations, the writer should briefly state them in the summary. If the report is primarily a discussion of a new method or process, the author should make this clear at the beginning. Positive and negative results should be separated, and, usually, the positive results should be discussed first. It should be clear whether or not the process or method is satisfactory for the intended purpose.

When writing, always keep your audience in mind. Since the audience for the summary will be a broader one than for the body of the report, be particularly careful not to use technical jargon, abbreviations, acronyms, etc., which will be difficult for all the possible readers to understand. When an object is identified by name, a full and accurate name should be used, and then this name should be used consistently throughout the report. Do not strive for literary variety in referring to the object. If an abbreviation or shorter name is needed, it should be put in parenthesis after the full name the first time it is mentioned in the text. This could occur in the summary or in the introduction. It is not good practice to include references in the summary. Save such detail for the introduction or other sections of the report.

Introduction

A common mistake is to mix up material that belongs in a "Summary" with that which belongs in an introduction. The purposes of the introduction section are 1) to present detailed background material needed by the reader to understand the nature of the problem, its importance, and the methods used in the work being reported; and 2) to state the detailed scope of the work being presented. The background on methods can relate to both experiment and theory. The scope of the work is a definition of exactly which part of the general problem area has been studied or considered, and is being reported on. The

summary should relate to the entire report, thus, it should contain some information about background and scope. However, these should be very concise statements, usually accomplished in one or two sentences.

Experimental Methods

The experimental methods section should contain enough information so that the reader understands what equipment was used and how the experiment was carried out. The rule-of-thumb is that a trained engineer, after reading this section, would be able to repeat the experiment using the existing set-up. A schematic of the apparatus is almost always required. The only exception is when the apparatus consists of only a single, standard, well-known instrument. Equipment safety issues should be included in this section.

Results and Discussion

The results and discussion section should contain the data produced, in tabular or graphical form (or both), and a discussion of how these data support your conclusions. Sometimes these are separated into separate "results" and "discussion" sections. The major results and trends in the data must be described in words in addition to tables and figures, so that the readers can understand them fully.

Important results or unusual trends in the data that support or contradict conventional wisdom should be discussed. This will make sense only if there is quantitative assessment of the uncertainties in the data, both from random and systematic errors. All data reported should contain the correct number of significant figures, to match the estimated uncertainties. On finishing reading about the results, the reader should know where all data are located, the estimated uncertainties in the data, and why the data are important.

As discussion, the author gives his/her interpretation of the experimental results. The success or failure of a report usually depends on the accuracy of your interpretation of the results, rather than on the accuracy of the data produced. The only exception would be if the data production is the purpose of the work. When comparing experiment to theoretical predictions, or to other data, the author must be quantitative. Use of "the experimental data agree well with the theory" is not sufficient. A better description would be "the experimental data are all within 10 % of the theoretical predictions".

When your results differ from expected results you must explain the differences. You must justify your reasons for these differences. Guesswork is not satisfactory, unless you can state a valid rationale for your choice of reasons from among the many possible ones.

Conclusions and Recommendations

In this section, the main conclusions from the work should be restated in a concise, simple to understand form. Positive conclusions should probably be highlighted first. If the goals of the work were not fully realized, progress should be discussed and

suggestions given for achieving the unmet goals in future work. Any recommendations should be listed, such as for equipment modification, for future work, or for use of the results. No new data or results should be presented in this section.

Answers to Frequently Asked Questions

- Sections in a report need to be clearly identified – numbering of sections and subsections is helpful in a complex report:

  1.0 Introduction
  1.1 Subject
  1.2 Importance
  1.3 Scope

- All pages (other than the separate title page) must be numbered, including appendices.
- All appendices should have a title and a letter designation (e.g., Appendix D. Computer Program Used to Extract Nusselt Numbers from the Data).
- Page numbers for appendices should be A1, A2, …, B1, B2, …etc.
- All figures and tables must be numbered and have a title (e.g., Figure 3. Calibration Curve for the Inlet Air Rotameter) -- axes titles and column/row headings must clearly identify the data being presented, including units.
- There must be references (by number or letter designation) to all figures, tables, and appendices from the body of the report.
- Figures and tables should be located in the report near the point where they are referenced, unless they are extensive or are not needed for understanding the report, in which case they logically belong in appendices.
- Figures and tables should be kept as simple as possible – use multiple figures or tables to present complex interrelationships.
- All information on figures and tables should be large and easily readable.
- Strive for independent understanding of figures and tables by the reader, through appropriate titles, legends, and keys.
- References to all external work (books, other reports, journal articles, etc.) must appear in a separate references section, by number (in order of appearance in the text of the report) – some examples:

  5. *Chemical Engineers' Handbook*, 5th Edition, Robert H. Perry and Cecil H. Chilton, Editors, McGraw-Hill Book Company, New York (1973).
  6. Anderson, G. S., R. C. Miller, and A. R. H. Goodwin, "Static Dielectric Constants for Liquid Water from 300 K to 350 K at Pressures to 13 MPa Using a New Radio-Frequency Resonator", *J. Chem. Eng. Data 45*, 549-554 (2000).

- All references must be called out from the text of the report – references to books or other large sources should contain page numbers – some examples:

Equation 5 was taken from page 5-52 in Perry's Handbook.[5]
The data in Table 2 came from Anderson et al.[6]
The method of analysis was similar to that used in Reference 7.

Rubric for Grading Lab Reports

A rubric for the grading of all lab reports can be found by following this link: Rubric for Written Technical Reports.

Positive Aspects of a Good Technical Report

The Spring 2000 senior design class came up with the following list of positive aspects of a good design report, which is one type of technical report. They gave priorities to the various aspects identified (high, higher, and highest priority). This analysis may be of use as you prepare and check over your lab reports.

1. **Overall organization and format**

   - All needed sections present (Highest)
   - Logical progression of sections (Higher)
   - Clear headings and subheadings (High)
   - Formatting uniform from section to section (High)

2. **Microscopic organization and internal structure**

   - Good sentence and paragraph structure and transitions (Highest)
   - Spell checked and proofed throughout (Highest)
   - Logical progression of ideas (Higher)
   - Figures effectively illustrate and reinforce content (Higher)
   - Facts/details consistent across sections (Higher)
   - Proper placement of and references to figures and appendices (High)
   - Consistent style throughout (High)
   - Detail not important to understanding report into appendices (High)

3. **Content and style**

   - Unambiguous conclusions, well justified (Highest)
   - Information sufficient to support conclusions (Highest)
   - Proper consideration of safety and environmental factors (Highest)
   - Proper targeting to the intended audience (Highest)
   - Complete design/cost analysis with no important elements missing (Higher)

- All information needed for project included or other sources referenced (Higher)
- Information accurate and methods applied correctly (Higher)
- Attracts interest in topic during reading (Higher)
- Figures self explanatory and have high readability (High)
- No excess verbiage (High)