FINAL REPORTS GUIDELINES

Requirements

• *Your written Final Report must be submitted electronically as a doc (not docx) file to the designated TA by 5PM on your normal meeting day during Oral Week. This means Tuesday of weeks 4, 7 and 10 for sections AA and AB, Wednesday of weeks 4, 7 and 10 for section AC, and Thursday of weeks 4, 7 and 10 for section AD.*

Audience

• Plan on writing for a technical manager who already understands the experimental objectives and fundamentals.

Length

• What you believe is appropriate without being excessive. Use common sense.

What to omit

• Do not include a letter of transmittal or a table of contents

Organization

• Title Page. This must be a separate page. Include a descriptive title (limit 10 words), author, lab section, team members, date, experiment number (1-3).
• Introduction**.** Describe the relevance of your work, the project objectives and all the background material (theory) that will help the reader understand your system and objectives.
• Materials and Methods. Describe the equipment, materials, and procedures you used. Provide one or more schematics (professional diagrams for the systems). Make your own diagrams, unless you are citing data from a reference. The description must be sufficiently detailed to allow a knowledgeable person to reproduce your results. However, do not be excessive by including obvious details.
• Results and Discussion. Present your major results (in the form of graphs and/or tables), including estimated uncertainties. Do not put lengthy data or results tables here, they belong in the appendices. Use the appropriate number of significant figures. Interpret and analyze your results. Also send the spreadsheet file (xls not xlsx) that you used for sample calculation. The following example notes trends but lacks sufficient "interpretation":

- "The data in Tables 1.1 and 1.2 show that for gases at low density, the viscosity increases with increasing temperature. For liquids, on the other hand, the viscosity usually decreases with increasing temperature. "
- Here is an "interpretation" of the above trends: "This difference in temperature dependence is understandable from a molecular viewpoint. In gases, the molecules are free and travel long distances between collisions to transfer momentum (hence the low viscosity). As temperature increases, the mean molecular speed of the gas increases. This in turn increases the frequency of gas collisions and therefore increases the momentum transfer or viscosity. In liquids, the molecules are not free but closely packed into a 'cage' which prevents them from easy motion. Hence liquids are more viscous than gases. As temperature increases, there is more energy for each molecule to escape this cage and move more freely. Thus, the viscosity of

liquids decreases with increasing temperature."
- Since the above is well-established, you could also say: "These trends agree with the standard molecular models of viscosity in gases and liquids [ref.]." and provide an appropriate literature citation.

• Conclusions. Summarize your findings. Relate them to the objectives (as stated in your Introduction). Each conclusion must follow logically from information in the results and discussion sections.

• Recommendations. Recommend further action, experiments or improvements as needed. If desired, you may combine with this section with the "Conclusions" section.

• References. This section lists all the literature cited in the report (including figures, equations, and theory). For example, the following sentence might appear in the Introduction. "In a tube of circular cross-section, the velocity profile of a Newtonian liquid in fully-developed, laminar flow is parabolic [1]." Number citations (in square brackets) and list them in the order you use them in the text. For each citation, use the following convention, which is standard for the *AIChE Journal*:

- For Books
  1. Bird, R.B., W. E. Stewart, and E. N. Lightfoot, Transport Phenomena, p. 42-47, 126-130, John Wiley and Sons, Inc., New York (1960).
- For Journal Articles
  2. Grafton, R. W., "Loss of brain mass due to excessive reading of student laboratory reports", Chem. Eng. Edu., 18, 457 (1963).
- For web content
  3. "Violating the conservation of mass in Unit Operations Experiments", http://www.unitoperations.html

Always include page number(s) when citing books to point the reader to the appropriate section.

• Appendices. These include:
- Data and Results. Tabulate all data collected by the team that is not presented in the report.
- Sample Calculations. Show how you performed each calculation (including error propagation and statistical analysis). Organize in sections by calculation type, with a descriptive title or a brief paragraph in between mathematical steps. Work through the calculation step-by-step for a typical case, first symbolically, then with numerical values (making it clear which raw data and/or literature values you are using). Include dimensions of all numerical values and results.
- Supplementary Information (optional). Items that support your results but are too detailed or lengthy to include in the main body, such as a computer code.Organize by sections with descriptive titles. Each section must contain enough explanation to stand on its own.

Hints

• Sample calculations: We encourage you to use a spreadsheet for repetitive calculations, but **you must provide a separate step-by-step procedure in detail for each type of calculation**.
- As a test, ask yourself, "Could someone else easily use my procedures or my data to reproduce my results?" If not, make your sample calculations clearer.
- Include units with all values and make sure the unit conversions work out.
- Give full source citations for all literature data, including page number and year of publication.

- Materials and Methods:
    - Highlight the key aspects of your procedure. What steps are critical in order to get good results?
    - Be specific about quantities used, key dimensions, etc.
- Equations and background material:
    - Give a reference unless the equation is common knowledge (such as the Ideal Gas Law) or you derive it.
    - Include the essential background
- Nomenclature:
    - You need to define the variables in form of a paragraph after presenting them.
- Interpretation:
    - Generalize your results and point out important trends. Do your best to explain anomalies in your results.
    - Do not just speculate: back up your ideas with order-of-magnitude calculations, error propagation analysis, and/or literature values. Address the assignment you were given.
    - Do not just state the results. Interpret them and put them in perspective for the intended audience.

Spreadsheets

- Organization:
    - Keep raw data (actual readings you obtained) separate from things you calculated based on them.
    - Include self-explanatory headings with units.
    - Put the most important worksheets first so they stand out. Use a descriptive label on the worksheet tabs.
    - It is possible to overdo this. Too many sheets can be confusing. The basis for all calculations (including error analysis) must be documented in separate sample calculations.
- Formatting:
    - Use formatting (shading, borders) to set off raw data from calculated quantities, to distinguish one "run" from another, etc.
    - Insert comments to provide additional explanation of unusual features. Insert extra text in cells to help the reader understand what you are doing.
    - Control the number of significant figures displayed!!! This is especially important for measured values, but also for calculated results.

Style and Grammar

- Tense:
    - Use past tense to describe things that you did or that happened. For instance: "The measured pressure drop was 2 kPa. Consequently, we decreased the flow rate."
    - Use present tense to describe things that remain true. For instance: "The viscosity of air decreases with increasing temperature." Avoid changing tense within a paragraph.
- Person
    - Most books on technical writing suggest that you should avoid use of the first person. If in doubt, this is good advice, but the first person, particularly the use of “we”, does have a place in technical writing if done in moderation. "We" can make a report seem less stuffy than repeated use of the passive voice. For example, you might say, "We only studied fully turbulent, incompressible flow..." instead of

"This work is restricted to consideration of fully turbulent ..." Avoid passive voice sentences that are confusing.

- Equations:
  - Write equations on a line separate from the text. Number them consecutively, with the number in parentheses flush with the right hand margin.
  - Define new symbols immediately following each equation. When referring to a particular equation, abbreviate "equation" as "Eq." "The use of Eq. 5 is ..." Don't abbreviate "Equation" when it is the first word of a sentence, however.
- Abbreviations:
  - Avoid abbreviations where possible.
  - Abbreviate units of measure only when preceded by a number.
  - The abbreviations of an SI unit should not be followed by a period unless it is the end of a sentence.
  - Abbreviations are usually in lower case letters, but there are exceptions. If in doubt, consult a dictionary. Exceptions include Chap., Eq., Fig., Hz, pH, A (ampere), K, J (joule), V (volt).
  - Do not use contractions in your report.
  - The "standard" AIChE symbol for a dimensionless group is an upper case N followed by a subscript (NRe, for example). We prefer the practice of most other organizations: an appropriate capital letter and one lower case letter, such as:

    Reynolds number: Re
    Prandtl number: Pr
    Peclet number: Pe
    Schmidt number: Sc
    Nusselt number: Nu

- Tables:
  - Tables should have a title and be numbered in sequence.
  - Place short tables within the text. Long tables should appear on a separate page and should follow the page on which they are mentioned.
  - Give units for all column headings. Footnotes may be included at the bottom of tables.
- Figures and Graphs:
  - Figures should be computer-generated.
  - Number graphs serially with all other figures.
  - All figures and graphs should have a title. Titles should be descriptive, not merely a statement of the variables appearing on the ordinate and abscissa. Thus "Friction Factor vs. Reynolds Number" is not a good title. A better one might be "Friction Factor for Turbulent Flow in Smooth Tubes."
  - A figure may be embedded in the text or follow the page on which it is first mentioned.
  - Center graphs on a page with adequate margins.
  - Label the axes clearly, show the scale and its units and adjust the scale to facilitate the reading of the data.
  - Experimental points may be small circles, triangles, or other shapes.
  - Use horizontal or vertical error bars to indicate the magnitude of the uncertainty in plotted points.
  - If the objective is to compare sets of data, either superimpose them on a single graph or use multiple graphs with the same scales for the abscissas and ordinates.
- Numbers:
  - Write small integers (zero to nine) as words (e.g., "three repetitions," not "3 repetitions"). Write all others as numbers, unless they begin a sentence.

- Exception: write the small integers as numbers when they are followed by a unit of measurement, or when many numbers appear in one paragraph.

Grading

• Planning reports are graded on 100 points; 80% of the grade goes to the Task Leader and 30% of the grade to each other team member to incentivize teamwork. It is acceptable to "recycle" appropriate parts of the Planning Report in the Final Report. A sample grade sheet is available in the Course Overview packet and on the course website.