

# Specifications for Preparing Written Research Deliverables

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## Acronyms and Terms

ADOT	Arizona Department of Transportation
<i>Chicago</i>	<i>The Chicago Manual of Style</i> ; a manual providing rules on language style and usage
DOT	department of transportation; ADOT's counterpart in another state
dpi	dots per inch
FHWA	Federal Highway Administration; joint sponsor with ADOT on many research studies
NCHRP	National Cooperative Highway Research Program
NTIS	National Technical Information Service; federal depository for US research findings
PI	principal investigator; the researcher leading the consultant team
PM	project manager; the ADOT contact who oversees a research study
SPR	State Planning and Research
TAC	technical advisory committee; advises the project manager on a research study
TOC	table of contents
TRB	Transportation Research Board
TRDP	technical report documentation page; the first page in an ADOT technical report; provides information about the report to NTIS; required by ADOT for technical reports; also called Form DOT F 1700.7
URL	uniform resource locator

# Introduction

## Sources Used

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*Specifications for Preparing Written Research Deliverables* uses two primary published sources for editing standards and decisions. They are:

- *The Chicago Manual of Style* (15th ed. or later)
- *Merriam-Webster's Collegiate® Dictionary* (10th ed. or later)  
(Collegiate® is a registered trademark of Merriam-Webster, Incorporated, Springfield, Massachusetts.)

These specifications may not answer all questions. The Research Center encourages consultants to contact the project manager (PM) or the technical editor for clarification **prior** to submitting a file for review.

## Working with the ADOT Research Center

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The ADOT Research Center is dedicated to inquiry and innovation at the Arizona Department of Transportation. Research Center studies deliver information that can be applied to improve ADOT processes and products, and address the full range of topics of interest to the department. Studies are managed by Research Center staff and conducted by consultants from the private sector, public sector, and universities under contract with ADOT. The consultant team includes a principal investigator (PI), a technical writer, and other key members, each of whom must be experienced and qualified.

Each study's work plan typically requires the consultant team to develop and deliver a *technical memorandum*, or technical memo, following the completion of each major task, and a *final report* and *research brief* at the conclusion of the study.

## The Technical Writer's Role

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The research contract requires the technical writer to write the final report and the research brief. To capably develop these products, the technical writer must comprehend the core of the study's complex content. The PI must communicate enough information so that the writer understands:

- The study objectives
- The work being done to fulfill the contracted tasks in the work plan
- The concepts associated with the study
- The direction and adjustments received from ADOT

## INTRODUCTION

The PI is responsible for ensuring that the writer has enough context, knowledge, and direction to write the final report and the research brief. This process would start with:

- Sharing the scope of work and the approved work plan
- Defining needs and expectations for the writer
- Discussion the concepts, content, and development of technical memos to ensure understanding
- Providing notes and developments from ADOT meetings, emails, and phone calls
- Involving the writer at key ADOT meetings

The technical writer, in turn, is responsible for:

- Asking, at every stage, enough questions to build a thorough understanding of the study, its process, and its findings
- Honestly assessing and giving clear feedback to the PI regarding the information provided
- Writing the report and research brief, not merely editing them

# Technical Memoranda

## Content

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Technical memoranda, or technical memos, fully document major tasks and subtasks from the research study's approved work plan. It is expected that the content often will be highly technical and meant for an audience of subject matter experts. The content must always be accurate, complete, and clear.

Technical memos are not necessarily long, but will thoroughly document the following for each task:

- Brief statement of the purpose or objectives of the task
- Description of the method(s) used
- Presentations of findings
- Figures and tables that may add clarification
- Other elements specified in the work plan, including appendices providing technical data or other essential details
- Text citations with reference list

Always write clearly and professionally. Eliminate jargon or buzzwords. If industry terms are appropriate, make sure that their meaning is clear and define on first use if necessary. Convert colloquialisms to polished plain speaking. Use generic, third-person references like "the team" rather than personal names or first-person references. Do not refer to internal processes, so refrain from mentioning procurement documents, technical advisory committee (TAC) directives, project manager decisions, or other internal workings of a study.

## Formatting

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The technical memo cover uses the ADOT template distributed by the ADOT project manager and must show the study title, SPR number, and technical memo date. The body of the technical memo uses the following required format.

### ***Columns***

Use a single-column, full-page format.

### ***Font***

Use Calibri 11-point type for text, including table captions, figure captions, equations, explanatory text for equations, and text within figures and tables. Print figure and table captions in bold. Text in figures and tables can be smaller than 11-point type but not less than 8 points.

### ***Margins***

One-inch side margins and top margins are required on all pages. Margins for pages with figures and tables may be slightly smaller if necessary.

## TECHNICAL MEMOS

### ***Spacing***

Use Microsoft Word's line spacing of 1.15. Double space only to separate headings and subheadings from text and to separate paragraphs (see below).

### ***Paragraphs***

Separate paragraphs with a blank line. Do not set up paragraphs to have extra spacing before or after the paragraph. Do not indent paragraphs.

### ***Justification***

Left-justify report text. Do not full-justify text.

Columns of numerals entered in tables should be aligned by decimal points.

### ***Headers and Footers***

Headers and footers are not permitted.

### ***Widows and Orphans***

Do not leave a single line of text alone at the top of a page (widow) or bottom of a page (orphan). Most word-processing programs have an automatic feature to prevent these. Do not leave a heading at the bottom of a page without at least two lines of text to accompany it. If feasible, do not split bulleted lists from their introductory sentences or leave a single bullet alone at the top or bottom of a page.

### ***Headings***

Number chapters using numerals without decimals (Chapter 2, not Chapter 2.0). Subsections may be titled, but are never numbered. Keep headings concise and do not extend beyond the page's halfway point. Below are the required formats for headings.

## **CHAPTER 1. TITLE OF FIRST CHAPTER**

(14 pt. bold, all caps, centered)

### **FIRST-LEVEL HEADING**

(11 pt. bold, all caps, flush left, separate line, skip a line before and after)

### **Second-Level Heading**

(11 pt. bold, initial caps, flush left, separate line, skip a line before and after)

### ***Third-Level Heading***

(11 pt. italic, initial caps, flush left, separate line, skip a line before and after)

**Fourth-Level Heading.** (11 pt. bold, initial caps, paragraph indent followed by period, two spaces, and subsequent text; skip a line before only)

**Page Numbering**

Page numbers are centered at the bottom of the page. Use the following format:

Number the body of the text with Arabic numerals (1, 2, 3, etc.) beginning with page 1.

Page numbers run consecutively throughout the entire report, including appendices (i.e., 1, 2, 3, etc.).

**Page Breaks**

When using Microsoft Word, it is sometimes advisable to insert a page break or a Next Page section break to end a page. *Never* insert the following section breaks (options under Page Layout) for any reason:

- Even Page section break
- Odd Page section break

**Appendices**

Certain files that were compiled during a study task may be useful to practitioners and other researchers and will be made available upon request through a public records request. Those will be kept as appendices to the technical memoranda.

When documenting an appendix, if there is only one, name it “Appendix,” not “Appendix A.” If there are two or more appendices, designate each appendix with a letter (e.g., Appendix A, Appendix B). If an appendix also has references cited in the text or as sources of figures and tables, include a reference section with it. Do not use special page numbering, but continue from the main body of the technical memo (see *Page Numbering* above).

There are two ways to format appendices. Pick one and use it for all the appendix files that are submitted for the study:

- **Heading** — The appendix may simply have a heading at the top of the page (e.g., Appendix A: Survey Results) followed by the beginning of the contents on the same page.
- **Cover page** — If using a cover page, center the appendix designation (Appendix B) and the title at the top of the page. Leave the next page blank, and then begin the appendix information on the third page without repeating the heading.

### Developing Recommendations

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Unless it directs otherwise, ADOT expects each research study consultant to develop recommendations from their findings. According to federal requirements, these recommendations are documented in the final report. Development of recommendations, though, starts much earlier, as captured in the applicable technical memorandum.

#### ***Recommendations***

How to develop and present a set of recommendations will vary depending on the research consultant, the research topic, and the stated objectives. Research results are not predetermined, so developing a recommendation and how to document it cannot be prescribed. However, general guidelines should be observed:

- Keep the focus on recommendations. Avoid the reiteration of findings and methods unless needed for clarity.
- Ensure that each recommendation is distinct. Avoid redundancy.
- State the recommendations as a set of feasible options for consideration, rather than as directives.
- Present practice-ready information rather than theoretical or academic concepts.
- If more research is recommended, be specific as to why and what objectives it would achieve.
- When appropriate, organize recommendations in sequence, such as according to length of time required; level of priority or difficulty; or extent of resources expended.
- Limit the description of each recommendation to two or three paragraphs (approximately half of a page).
- Summarize as much as possible without losing essential information.
- Use bullet lists or matrices for organizing thoughts succinctly and coherently. Remember to use parallel construction so that all bullet items are consistent grammatically.
- Describe the recommendation concisely and in practical terms. Always be clear.
- Use objective language, and use passive voice if helpful.
- Since ADOT organizational unit titles might change, refer to work units by distinct function (“environmental planning” or “traffic safety”) rather than formal name (“Multimodal Planning Division”).

# Final Reports

## Overview

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Each study's work plan calls for a final report. The consultant will submit a draft final report written by the research team's technical writer. The draft final report is a clear narrative that focuses on recommendations and finding that will aid in potential implementation. The report will be written for non-academic practitioners who may apply the results in Arizona. The report is not a compendium of the technical memos, but is a summary that captures the key points from the various deliverables throughout the study.

The draft final report will contain the following sections:

- Introduction of the study's background and objectives
- Recommendations and implementation plan
- Findings, including key data relevant to the Recommendations section
- Methods, a brief summary of methods and tools used as relevant to the Findings section
- References listing the sources cited in the report

The draft report will be submitted as a Microsoft Word file of basic text, with any included figures and tables submitted as Word or Excel files (photographs not needing formatting may be submitted as JPEG files with a minimum resolution of 300 dots per inch [dpi]); the final formatting and layout design will be supplied by the Research Center.

## Title Page

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For the final report, complete a simple title page that states the study title in full, the study's SPR number, and the name, firm affiliation, and address of each contributing consultant. List individual names in descending order of contribution, with the primary contributor first. (Note that ORCID's must be obtained for all contributors; the ORCID's are listed on the technical report documentation page; see below.)

## Technical Report Documentation Page (TRDP)

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### *Requirement*

The report author must complete the technical report documentation page (also denoted as Form DOT F 1700.7) for the National Technical Information Service (NTIS). ORCID's must be obtained for each contributing author and listed on the technical report documentation page

The Research Center project manager will provide the consultant with the TRDP template.

## FINAL REPORTS

### **Font Size**

Use 10-point Calibri consistently for all entries in the TRDP.

### **TRDP Content**

See Figure 1 for a sample TRDP. Use the following instructions for filling out the TRDP. There are only seven boxes for the consultant to fill out:

Box 4 (report title and subtitle),  
Box 7 (author name or names),  
Box 9 (performing organization's name and address),  
Box 12 (sponsoring agency name and address),  
Box 15 (supplementary notes),  
Box 16 (report abstract), and  
Box 17 (key words).

**Box 4, Title and Subtitle** — Enter the entire report title, in title case (initial capital letter on significant words); precede subtitles with a colon.

**Box 7, Author(s)** — List first name, middle initial if available, and last name of all authors, primary author first; maintain consistent formality across all author names (e.g., all middle initials or none) unless following author preference in name style. Enter the names of the individuals, not the company. First names must be given. ORCIDs must be obtained and listed.

**Box 9, Performing Organization Name and Address** — Enter name and address of the organization that employs the principal investigator (followed by other subcontractor organizations, if applicable).

**Box 12, Sponsoring Agency Name and Address** — Enter:

Arizona Department of Transportation  
206 S. 17th Ave.  
Phoenix, AZ 85007

**Box 15, Supplementary Notes** — Enter “Project performed in cooperation with the Federal Highway Administration.”

**Box 16, Abstract** — Include a brief (200–250 words) summary of the most significant information contained in the report. The abstract should fit in the box provided in the template.

**Box 17, Key Words** — Enter terms or short phrases that identify the important topics in the report; use initial caps. When possible, choose terms from the Transportation Research Thesaurus. (<http://trt.trb.org/trt.asp>)

**Figure 1. Sample Technical Report Documentation Page (TRDP)**

1. Report No. FHWA-AZ-YR-XXX(X)		2. Government Accession No. LEAVE BLANK		3. Recipient's Catalog No. LEAVE BLANK	
4. Title and Subtitle Title and Subtitle in Initial Capital Letters				5. Report Date MONTH, YEAR	
				6. Performing Organization Code LEAVE BLANK	
7. Author Names In Conventional Order (i.e., John A. Doe)				8. Performing Organization Report No. LEAVE BLANK	
9. Performing Organization Name and Address Name Street Address City, State Zip Code				10. Work Unit No. LEAVE BLANK	
				11. Contract or Grant No. LEAVE BLANK	
12. Sponsoring Agency Name and Address Arizona Department of Transportation 206 S. 17th Avenue Phoenix, Arizona 85007				13. Type of Report & Period Covered FINAL	
				14. Sponsoring Agency Code	
15. Supplementary Notes  Prepared in cooperation with the US Department of Transportation, Federal Highway Administration					
16. Abstract 200-300 words A brief summary of the report stating state the purpose, methods, results and conclusions of the work effort.					
17. Key Words Select specific and precise terms or phrases that identify principal subjects covered in the report			18. Distribution Statement Document is available to the US public through the National Technical Information Service, Springfield, Virginia, 22161		23. Registrant's Seal
19. Security Classification Unclassified	20. Security Classification Unclassified	21. No. of Pages Leave Blank	22. Price		

### Table of Contents (TOC)

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Use autogenerated listings for the TOC. In the table of contents (titled merely “Contents”), list all section headings (Recommendations, References, etc.) with their corresponding page numbers.

Include at least first-level headings within the sections. If second-level headings are used, list the same level of headings for all sections. Do not list subheadings beyond second-level subheadings.

### Acronyms, Abbreviations, and Symbols

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#### *Content*

If the report contains more than five acronyms, list them with their definitions in the front, and define them upon first reference in the TRDP abstract and in the main text.

When the term being defined is not a proper name or is a generic term, such as “technical advisory committee,” use lower case, even though the acronym, TAC in this case, is in all capitals. If the term is a proper name, such as Arizona Department of Transportation, capitalize it appropriately.

Including abbreviations and symbols used in the document is optional for this list. If there are no abbreviations or symbols, title the page as “Acronyms.”

#### *Location*

The list of acronyms, abbreviations, and symbols starts on its own page after the table of contents.

### Report Sections

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The final report format does not have chapter divisions, but instead is divided into sections: Introduction, Recommendations, Findings, Methods, References, and Notes (optional). The report should number approximately 15,000 words total, including figures and tables.

Note that, in addition to the body of the report, the technical writer must also write the abstract for the technical report documentation page (TRDP).

#### *Introduction*

The Introduction presents, in brief, the foundational information and context needed to understand the research. This text may include definitions, key statistics, and historical summary. An effective introduction conveys the reasons for and objectives of the research, while avoiding step-by-step discussion of methodology or developments leading to the initiation of the study. Summarize the study’s scope of work and indicate the type of transportation personnel, by function, who would use the information (for instance, highway designers and traffic safety engineers).

## ***Recommendations***

Most research studies culminate in actionable recommendations for ADOT’s consideration. Final reports place recommendations front and center immediately following the Introduction section so that there is no need for the reader to skip to the end of the report to reach “the good stuff.”

The following points are to help develop this section:

- Use unambiguous language to ensure that recommendations are readily comprehended.
- Do not use terms like “should” and “must” that dictate certain actions to ADOT. Use language that shows the recommendations were developed for ADOT’s consideration.
- Use bullet lists whenever helpful in succinctly presenting information clearly.
- Refer to findings sparingly in support of recommendations; allude to the next section (Findings) as need be.
- Methods are discussed in a later section and should be mentioned here only when necessary to clearly communicate a recommendation.
- If the recommendations are structured based on priorities, resources, or other types of tiers, retain the structure in the report. Here is where a bulleted list may be especially helpful.
- Summarize the anticipated steps that would be necessary for implementing the recommendations.

## ***Findings***

Research findings provide the evidence on which the recommendations were developed. This section summarizes the findings and presents key data relevant to the previous section.

- Be selective. Not every finding or data point necessarily deserves a spot in the final report. What do practitioners want and need to know? What information is essential to establish confidence in the recommendations?
- Use bulleted lists, figures, and tables where appropriate.

## FINAL REPORTS

### ***Methods***

In the final report, this section is the shortest. How the research was performed in the study is of prime importance to the researchers, but less so to the practitioners. Remember that methodology has been documented in the technical memoranda, which are archived and are available upon request through the public records request process.

- Summarize the research process with minimal detail.
- Focus on steps that led to the key findings and recommendations already presented.
- Use bulleted lists as appropriate.
- Combine the Methods section with the Findings section if doing so results in more effective communication of complex information.

### ***References***

Because the Research Center accepts only the author-date citation style, this section is the alphabetical listing of sources for published information cited in the report text. Guidance for citations and reference list formatting is given later in this document. Do not use a numeric list of sources. In the typical final report, this section will be one to two pages long.

### ***Notes (Optional)***

This section showcases key supporting data and information — whether qualitative, quantitative, or narrative — that clarifies the information in the preceding sections. The Notes section is similar to an appendix or appendices but much briefer. This section is not a random collection of raw data but is carefully chosen to support and inform specific points made in Recommendations, Findings, and Methods.

Use headings the same as were applied in the other sections of the final report. The Notes section will be no longer than 10 pages, but preferably fewer.

## **Page and Paragraph Specifications**

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The ADOT Research Center will format the report text in InDesign, so minimal formatting is all that is needed in the submitted Word file.

The word count for final reports is 15,000 words, including figures and tables. Figures and tables count as 250 words each.

***Page Breaks***

When using Word 2010, it is sometimes advisable to insert a page break or a Next Page section break to end a page, but *never* insert the following section breaks (as Word options under Page Layout) for any reason:

- Even Page section break
- Odd Page section break

***Headers, Footers, and Footnotes***

The final report format does not have headers, footers, or footnotes. Rather than using a footnote for a reference, insert the citation in the text. Instead of using a footnote for noting detailed information, incorporate it into the text or place in parentheses.

***Headings***

The final report format does not use chapters, but instead is divided into sections: Introduction, Recommendations, Findings, Methods, References, and Notes (optional).

The headings and subheadings in each section may go to the fourth level. No formatting requirements are set here, but be consistent with whatever format is chosen.



# Figures and Tables

## Requirements

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The following requirements apply to figures and tables that are submitted in technical memoranda and their appendices and final reports. (Research briefs do not have figures and tables.)

Figures—any graphic representation not in text form: photographs, flow charts, graphs, etc.

Tables—any graphic representation of information in a columnar text form, whether alpha or numeric.

Figures and tables must be clear and legible. Labels within figures and text within tables must use a clear, legible font, like Calibri, which is preferred. Hand-drawn or hand-written graphics (or scanned images of hand-drawn graphics) are usually not acceptable.

### **Word Count**

Allow a count of 250 words for each figure and table used. Including text, the maximum word count for a final report is 15,000 words.

### **Quality**

Clear, dark original line art and photographs of sufficient resolution are acceptable. Shaded areas must not obscure text, parts of figures, or table content.

Provide photographs with clear resolution in electronic form (300–600 dpi).

Create tables in Word 2010. Do not convert a table to a Word object that cannot be edited.

Use consistent formatting for similar tables throughout the document. Label table rows and columns descriptively so that the reader can understand the information at a glance.

### **Color**

Use colors in graphs that will be clearly legible on the monitor screen as well as in print. Be aware of how one color “reads” next to another; for instance, is yellow distinct next to light blue? Adjust the color scheme accordingly so that all data is clearly represented.

### **Font Size**

Figures and tables must have no type smaller than Calibri 8 points. (This is in 11-point type. This is in 8-point type.) Use Calibri in a consistent size for similar tables and graphics throughout the report.

## FIGURES AND TABLES

### ***Placement***

Photographs and other graphics are to be presented one image per figure. A pair of photographs is acceptable as a single figure when representing a before–and–after scenario. Do not group three or more photographs/images into a mosaic that requires directional captions, i.e. “clockwise from left.”

All figures and tables must be referred to in the text in numerical order. Figures must appear close to the first reference in the text, but not occurring before that reference. Place figures so that they do not break text that belongs together (e.g., do not break a paragraph) but so they can be seen while reading the text (i.e., on the same page or facing page).

Tables must appear close to the first reference in the text, but not before. Place tables so that they do not break text that belongs together (e.g., do not break a paragraph).

### ***Cite Sources***

Document the proper attribution for any figures or tables taken from another source, whether copied verbatim or just adapted.

See References for information on how to cite sources and on the use of copyrighted materials. Give complete sources if the data shown in a figure or table was not independently collected but was taken from another source.

### ***Copyrighted or Published Material***

See Permission to Use Published Materials for more information.

### ***Numbering Figures and Tables***

Number figures and tables consecutively (e.g., Figure 1, Figure 2, Table 1, Table 2) in the final report all the way through the Notes section. Figures and tables in appendices are numbered consecutively for each appendix: Figure A-1 or Table B-2.

Word 2010 has an automatic feature to help with numbering figures and tables.

### ***Number Alignment in Tables***

Columns of numbers listed in tables must be aligned at the decimal point (or assumed decimal point). Do not center the numbers within the column.

### ***Captions, Titles, and Axis Labels***

Place figure captions BELOW the figure separated by one blank line. Put a period after the figure number.

Place table titles ABOVE the table separated by the 10-point space after the hard return. Put a period after the table number.

Graphs must have clearly labeled axes set in a clear, legible font, like Calibri, in a point size large enough to be easily read (8 points or larger).

### ***Continuation of a Table***

In the final report and the research brief, tables do not extend beyond a page. The final report and the research brief do not focus on reams of data; that type of information, while useful in some circumstances, is to be presented in the technical memoranda and their appendices.

When a table continues for two or more pages in an appendix, note the continuation — with “(Continued)” following the table title on each page. Avoid this construction when possible by breaking into separate tables if at all possible.

### ***Units***

In tables, clearly identify the units used. State the repeated units of measure or degree in the column headings. Do not repeat these units in the columns.

Use the same measurement system that was used in collecting the data. If in metric units (Système Internationale [SI] units), give conversions at the bottom of the table.

### **Not in Research Briefs**

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Do not use figures or tables in the research brief.

## FIGURES AND TABLES

# References in Technical Memos and Final Reports

## Overview

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Whenever quoting, paraphrasing, or referring to information or ideas (that do not fall into the category of “common knowledge”) from a publication or outside source, credit the source in a bibliographic reference. Do not cite secondary sources such as encyclopedias.

Do not use the automated reference listing and citation feature in Word 2010. It may sometimes produce inaccurate results. Follow these guidelines and *The Chicago Manual of Style* instead.

Use of copyrighted material is covered in the section on Permission to Use Copyrighted Materials.

## How to Cite References in Text

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### *Author-Date Citation Style*

When referring to work by another author or discussing that author’s ideas, credit the author with a parenthetical citation at the point of reference in the text. Research Center reports use the author-date system of citation: The reference is given in parentheses in the text and has the surname of the author, the source’s publication date, and, if following a quote, the page that the reference was taken from. There is no comma within the parentheses. See *The Chicago Manual of Style* for more detail on this style.

*Examples:*

- For a single author (Dodd 2002)
- For a pair of authors (Gagnon and Dodd 2007)
- For three or more authors (Peshkin et al. 2010)

## Formatting References Page

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### *Placement*

The references page comes after the main text of the report but before any Notes (an optional section).

### *Content*

The references section must contain every source cited in the text and only those sources. Carefully check that references are not repeated in different formats.

## REFERENCES

### **Source Order**

Alphabetize reference entries by primary author's surname. See *The Chicago Manual of Style* for details on what element is used for alphabetizing when there is no primary author.

### **Sources Cited More than Once**

List a source only once on the references page regardless of how many times it is cited in the document.

### **Format for Entries**

For listings of reference sources, use a modified version of the format given in *The Chicago Manual of Style*. In Word 2010, go to the paragraph menu, and under the indentation section, select a hanging indent for each reference entry. Do not list hyperlinks for references unless noting an exclusive online source; in that case, include the URL, along with the access date.

The first element is the author's name, which is inverted (surname first, given name, middle initial.). If more than one author, list the other authors' names in natural order (given name first, surname last). Give each author's name in full rather than using first and middle initials; using initials is allowed only when the original source does not list the full names.

For sources with three or more authors, list all authors by name in the reference entry and use "et al." in text citations. The exception is when two or more sources have the same author-date citation; see *The Chicago Manual of Style* for treatment of such cases.

A period separates author name from the date, which is a year only. A period separates this from the work's title. If it is a book, it is in italics; if a journal article, it is in quotes. The title is given in title case (initial caps on significant words).

A book's title is followed by the series or report number, if it is part of a series; place of publication followed by a colon; and publisher.

Journal article titles are followed by the journal name in italics and title case, the volume number, then without a space follow with the issue number in parentheses, a colon, and the page range of the entire article. The day or month of the issue may follow the page range, if needed. It is separated by a comma from the page range.

When the publisher's name includes the state name, omit the state abbreviation from the place of publication. When the state abbreviation is needed, use the two-letter postal code.

#### **Examples:**

- Phoenix: Arizona Department of Transportation.
- Thousand Oaks, CA: Sage Publishing.

When citing a source like the Federal Highway Administration (FHWA), use the acronym when citing in the text (FHWA 2008). When listing the source in the References, spell out the name followed by the acronym in parentheses.

*Example:*

Federal Highway Administration (FHWA). 2008. "Travel Demand Management."

### ***Unpublished Works***

Do not include unpublished works in the references. Cite them in the text with the author's name, a description of the author, and the date of authorship in parentheses.

*Example:*

(Joe Jones, ADOT engineer, unpublished data, March 12, 2002).

### ***Interviews***

Do not include unpublished interviews (or other personal communications) in the references. Cite them in the text with the contact's position and agency, and in parentheses give the contact's name with the type and date of communication.

*Example:*

A planner from FHWA confirmed reasons for the choice (Joe Jones, telephone interview, March 12, 2002).

### ***Cross Check***

Make sure that each reference matches its correct in-text referent. Make sure that only works cited in the text are included in the references section.

## REFERENCES

### Reference Listing Examples

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The following source listings show examples of recommended styles. (Some examples come from Transportation Research Board's *Information for Authors* and from *The Chicago Manual of Style*.)

Note punctuation and use of initials and italics. Also note that the formatting for ADOT research reports uses the FHWA report number listed on the report's TRDP.

#### *Book*

Newland, D. E. 1988. *Random Vibrations: Spectral and Wavelet Analysis*. New York: John Wiley and Sons, Inc..

#### *Chapter or section in a book*

McGee, A. M. 2003. "Graduated Driver Licensing." In *Injury Prevention*, J. R. Millman (ed.). Chapel Hill: University of North Carolina Press.

#### *Article in a periodical*

Figueroa, Carlos F. and Amy Nagel. 2017. "Breaking Down Project Complexities." *Public Roads* 81(2): 10-13.

#### *Transportation Research Board (TRB) publication*

Dewan, Shameem A. and Roger E. Smith. 2003. "Creating Asset Management Reports from a Local Agency Pavement Management System." *Transportation Research Record: Journal of the Transportation Research Board* 1853: 13–20.

#### *Government report*

Von Quintus, H. L. and A. L. Simpson. 2002. *Documentation of the Backcalculation of Layer Parameters for LTPP Test Sections*. Publication FHWA-RD-01-113. Washington, D.C.: Federal Highway Administration.

Seekins, Tom, Alan Blatt, and Marie Flanigan. 2013. *Automatic Crash Notification Project: Assessing Montana's Motor Vehicle Crash and Related Injury Data Infrastructure*. FHWA/MT-13-005/6608. Helena: Montana Department of Transportation, Research Programs.

#### *ADOT research report*

Dodd, Norris L., Jeffrey W. Gagnon, Susan Boe, Amanda Manzo, and Raymond E. Schweinsburg. 2007. *Evaluation of Measures to Minimize Wildlife-Vehicle Collisions and Maintain Wildlife Permeability Across Highways: Arizona Route 260*. FHWA-AZ-07-540. Phoenix: Arizona Department of Transportation.

## Permission to Use Published Materials

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### *Using Copyrighted Materials*

Copyrighted figures (including photographs and diagrams) and tables may not be used unless written permission of the copyright owner is obtained and provided to the Research Center. Prior use of copyrighted figures and tables in another publication does not necessarily constitute permission to use it in a specific Research Center publication. Citing the source of figures and tables is not a sufficient substitute for permission.

When conducting the research study, consultants are responsible for securing the appropriate copyright releases and including the release statement in the text; legal liability for failure to do this falls on them. Usage fees are the responsibility of the consultant. Include the original copy of copyright permissions with the draft file submitted to ADOT to maintain in the study file.

For overall copyright explanations and resources, see <http://www.copyright.gov>.

### *Using Materials That Are Not Copyrighted*

Previously published or presented, but not copyrighted, figures and tables may be excerpted on a small scale without permission but must include proper citation. The Research Center reserves the right to determine when it is necessary to obtain permission.

Include the original copy of copyright permissions with the draft file submitted to the Research Center to maintain in the study file.

### *Maps*

Consultants frequently submit maps created using Google Maps. Google Maps encourages use of their maps in publications as long as their embedded attribution is not obscured. Please follow the online guidance that Google gives for crediting their maps and data providers. The following instruction for attribution comes from Google:

“All uses of Google Maps and Google Earth content must provide attribution to both Google and our data providers. We do not approve of any use of content without proper attribution, in any circumstance. We require attribution when the content is shown. . . . Only including “Google” or the Google logo is not proper attribution when there are third-party data providers cited with the imagery. Attribution information will appear automatically on the content if you:

- embed an interactive map using the HTML provided on [Google Maps](#);
- use one our Geo [APIs](#) to create and embed a custom map in your website or application; or
- export a high-res image or .mov file from [Google Earth Pro on desktop](#).

## REFERENCES

“You can find the attribution in the line(s) shown on the bottom of the content in the products along with copyright notices, such as “Map data ©2018 Google”. Note that the exact text of the attribution changes based on geography and content type. The attribution text must be legible to the average viewer or reader.

“In Google Maps, you’ll find our data providers listed in the bottom right corner of the map.”

— taken from *Google Attribution Guidelines*, accessed August 23, 2018;  
<https://www.google.com/permissions/geoguidelines/attr-guide/>

To be safe, regardless of whether the embedded attribution in the image is visible, the Research Center requires repeating the map image’s embedded attribution and placing it below the figure caption. The text of the attribution must say the name “Google” and the relevant data provider(s), such as “Map data: Google, DigitalGlobe”. Place the attribution immediately below the figure caption in Calibri 9-point font.

## Releasing ADOT Study Information

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Consultants who conduct research for ADOT must receive permission from the Research Center before releasing any information associated with the study. “Release” means an action such as publishing, presenting at a conference, discussing with the news media, posting on a website, or even informally sharing with colleagues outside ADOT.

Study information includes any data and technical findings resulting from the research study, in addition to published study reports and interim materials such as technical memoranda, regardless of whether they have or have not been approved by ADOT.

# Research Briefs

## Purpose

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The consultant’s technical writer will write a two-page research brief (not to exceed 500 words), designed to stand as a separate, easy-to-read summary of the study and its recommendations. The potential audience includes practitioners, transportation decision-makers, the media, and the public. After giving context for the purpose of the study, the research brief will focus on findings, recommendations, and implementation by ADOT.

## Content

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### *Length*

The brief is approximately 500 words.

### *Text Only*

The research brief’s content is only text. Do not include the following:

- Footnotes
- Figures
- Tables
- Citations and reference lists (Do not include text that requires a citation.)

### *Style Guidelines*

For concerns with capitalization, grammar, etc., use the style guidance given in later in these specifications.

## How to Write the Brief

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Write the research brief after drafting the final report. Scan the final report and the study’s technical memos for key points (“take aways”). Keep it simple and short.

Organize the content around four headings:

- Why We Did It (the reasons ADOT needed the research)
- What We Learned (the key findings and recommendations)
- How We Did It (brief description of methodology)
- How We’ll Use It (how the research will improve ADOT processes or products)

## RESEARCH BRIEFS

When writing the brief, keep the following points in mind:

- Use terms the public will understand, avoiding jargon and acronyms. The brief uses less technical terminology than the technical memos and the final report. If certain terms are absolutely essential, define them simply and clearly.
- Keep the tone matter of fact and professional but plainspoken. Avoid an academic tone.
- Use short sentences about 15 to 20 words long.
- Keep paragraphs compact. Separate different ideas into shorter sentences so that the main points are obvious and easily understood.
- Simplify language by deleting unnecessary prepositions, clichés, and insider jargon. Replace complex or confusing words with simple, everyday words.
- Make key points directly and concisely. Avoid vague language and padded paragraphs.
- Keep numbers simple and readable by rounding them up.
- Use bullet points or numbered lists to express multiple ideas in a paragraph.

# Grammar and Style for All Deliverables

## Word Use

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### ***Acronyms, First Reference***

Spell out what an acronym stands for at its first use in the TRDP abstract and the main text, then put the acronym in parentheses immediately following. Acronyms defined in the abstract must be defined again on the first use in the body of the report. Do not use an acronym when the term appears only once in the text (except in special cases, such as when the acronym is more widely known than the phrase it represents).

*Example:*

A high-occupancy vehicle (HOV) is may sometimes travel in a reserved lane.

### ***Acronyms, Plural***

To make a plural of an acronym, simply add an “s.” An apostrophe is not used unless the acronym is possessive.

*Examples:*

- Plural: High-occupancy vehicles would be called HOVs.
- Possessive: The HOV’s speed was excessive.

### ***ADOT***

This is the acronym to use when referring to the Arizona Department of Transportation on second reference. Do not use “Arizona DOT.” The relevant pronoun when referring to ADOT is “it,” not “they.”

### ***a.m., p.m.***

When referring to a specific time, use a.m. or p.m., lower case and with periods.

## GRAMMAR AND STYLE

### ***Use of the Word “Data”***

ADOT reports use the word “data” as plural and “datum” as singular.

*Examples:*

- The data show a significant trend.
- Researchers analyzed these data using several methods.
- The datum is an outlier and has been excluded from the graph.

### ***department of transportation (DOT)***

If referring to transportation agencies in general, use this term. Spell out on first reference in lower case and use the acronym on following usage. If making plural, add the “s” to the word “department.” When using a relevant pronoun, refer to a single DOT as “it” rather than “they.”

### ***Prefixes***

Most prefixes do not require a hyphen in current usage. Simply add the prefix unless there is a chance that the new word will be misunderstood. Answers to questions about hyphenation of a particular word can be found in lists of words under each prefix in a collegiate-level dictionary.

Always use hyphens with “quasi-,” “self-,” and “ex-“ (when it means “former”).

*Examples:*

- semiopaque, transoceanic, semipermeable.
- ex-marine, quasi-intellectual, self-discovery.
- recover/re-cover, recreate/re-create, resent/re-sent (depending on the meaning).

### ***Pronoun Use***

Pronouns must agree in number and gender with the nouns they reference. Readers need to be able to identify clearly which noun the pronoun refers to (the antecedent). Usually that means that the antecedent is the last subject used before the pronoun.

Remember that pronouns must agree with the singular or plural nature of their antecedents. Singular groups (ADOT, division, team) require singular pronouns and modifiers (it, this—not they, their, or these).

To emphasize the collective nature of a noun, specify the population meant: ADOT officials (plural) rather than ADOT (singular), the committee members (plural) rather than the committee (singular).

**Gender-Neutral Pronoun Use**

When gender is not specified and usage calls for a singular pronoun, it is acceptable to use “they” or “their.” Modern usage tends to judge “he or she” as too cumbersome.

When referring to ADOT or some other governmental entity, use “it.”

**States**

In report text, spell out names of states. To abbreviate state names in references, tables, and figures, use the two-letter postal code. Do not use conventional abbreviations.

*Examples:*

- In text: Glendale, Arizona, is in the Valley of the Sun.
- In references, tables, and figures: New Orleans, LA.; Tempe, AZ; Baltimore, MD
- Do not use: The car is registered in San Diego, Calif., but it was bought in Minneapolis, Minn.

**Trademarks**

Try to avoid using names of trademarked products when referencing generic concepts (e.g., do not use “Excel” when “spreadsheet” is meant). When using trademarked or registered names, place the registered trademark (®) or trademark (™) symbol after the name on first reference and thereafter do not use the trademark symbol. Trademarked or registered names are always capitalized.

Indicate the trademark owner somewhere in the report, in fine print in a footnote if necessary.

**United States, Abbreviating**

Spell out “United States” when referring to the country as a noun. Abbreviate (without periods) when using as a modifier of some other term.

*Examples:*

- Spell out: The United States faces an overpopulation of deer.
- Abbreviate: The US standard allows that usage.
- Exception: According to FHWA standards, use periods when referring to a roadway, like U.S. Route 60 (U.S. 60 upon second reference).

### **Years**

When describing decades, simply add an s. If the “19” or “20” is not used, place an apostrophe before the year to take its place. As within contractions, the apostrophe indicates that information has been left out.

*Example:*

during the 1980s and '90s

## **Internet and Technology Terminology Guide**

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### ***Handling Technology Terms***

Some tech terms have become commonplace and no longer need to be capitalized (e.g., web, website). Tech terms that are brand names are capitalized and use trademark symbols when applicable (e.g., Excel, Macintosh). Brand names that begin with a lowercase letter (e.g., iPod, iPad) always use the lowercase first letter, even at the beginning of a sentence.

Some terms appear frequently in technical documents. The Research Center recommends the following usage. Please note spelling and hyphenation for these terms:

- Screenshot as one word.
- Drop-down menu uses the hyphen consistently.
- Email without a hyphen.

Note capitalization with these terms:

- Macintosh; PC; personal computer.
- hypertext transfer protocol (HTTP); a transfer protocol; hypertext.
- Internet protocol (IP); the Internet; the net; an intranet.
- Open Source Initiative (the corporation); open-source platforms.
- World Wide Web Consortium; the World Wide Web; the web; a website; a web page.

The basic alphabet keys, as well as all named keys, are capitalized even if they are lowercased on a particular keyboard. Menu items and icon names are usually spelled and capitalized as in a particular application. Acronyms for file formats are rendered in full capitals. Notice that quotation marks are not necessary to designate menu items as long as they are capitalized:

- The function key F2 has no connection with the keys F and 2.
- The Option key on a Mac is similar to the Alt key on a typical PC.
- Choosing Cut from the Edit menu is an alternative to pressing Ctrl+X.
- Save the file as a PNG or a GIF, not as a JPEG.

## URLs

Web addresses must be functional if feasible. If it is known that a particular web address is no longer valid, indicate that in parentheses following the link name.

In a printed work, if a uniform resource locator (URL) has to be broken at the end of a line, the break must be made:

- *After* a colon or a double slash (//).
- *Before* a single slash (/), a tilde (~), a period, a comma, a hyphen, an underline (\_), a question mark, a number sign, or a percent symbol.
- *Before or after* an equals sign or an ampersand.

Never add a hyphen to a URL to denote a line break, and never allow a hyphen that is part of a URL to appear at the end of a line. Keep in mind that a manually broken link (by a space or soft return, for example) will no longer be functional.

*Example:*

`http://www.azdot.gov/TPD/ATRC  
/Research/emphasis_areas.asp`

## Capitalization

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### *Captions and Titles*

In titles, headings, figure and table captions, and the like, capitalize every word except articles (a, an, the), conjunctions (and, but, for, or, nor), and prepositions of four letters or less (to, of, in, with, etc.). When using hyphenated words, capitalize the major elements.

*Examples:*

- Hyphenated words: State-of-the-Art Bridge Design; Planning for Medium-Sized Communities
- Longer preposition: Travel Predictions and Models Beyond the Year 2000; Damage Observed Between Mileposts 60 and 65

### *References to Chapters, Figures, or Tables in Text*

When referring in the text to a chapter, figure, or table, capitalized citations are required.

*Example:*

Chapter 1, Figure 6, Table 9

## GRAMMAR AND STYLE

### ***Names of Roadways***

Titles of roadways must be written consistently throughout the document. Upon first reference, spell out the name: Interstate 10 (not Interstate Highway 10). The following are the ways to write titles of Interstates upon second reference:

- I-35
- I-35W and I-35E (no spaces)

Use “route” when naming roadways other than Interstates. Roadways and highways, such as state routes and U.S. routes, are formatted on second reference as [type of roadway] [space] [number] (notice that there are no hyphens, unlike the Interstates):

- State Route 114 (first reference), SR 114 (second reference).
- U.S. Route 281 (first reference), U.S. 281 (second reference). Notice that U.S. uses periods in this case, according to FHWA standards.
- State Loop 202 (first reference), Loop 202 (second reference).

### ***portland cement***

The word “portland” is lower case when referring to portland cement.

### ***East, West, North, and South***

Capitalize directions with a state, city, or any other geographical region only if it is part of a proper name. Regions familiarly accepted as proper names may be capitalized. Simple directional modifiers are not capitalized when they precede a proper name.

*Examples:*

North Carolina, West Texas or west Texas, Gulf Coast or gulf coast, Gulf of Mexico, Midwest, western United States, southern Louisiana

### ***Position Titles***

Do not capitalize a person’s position title, such as project manager, director, etc. Capitalize position titles only if they come before the name and are official titles, such as President Tyler, Congressman Smith, Director Jones, etc.

*Examples:*

John Smith, research assistant; Tom Smith, director of the center

### ***Programs or Research Items***

Capitalize a program or research item (database, software, etc.) only if it is an official proper name or title. If it is a generic product type, do not capitalize it.

*Examples:*

- intelligent transportation systems (ITS), ground-penetrating radar (GPR), ADOT districts.
- Multimodal Planning Division, the Holbrook District.

### ***“State,” “City,” and “Federal”***

Do not capitalize “state,” “city,” or “federal” unless referring to a specific, official governmental entity.

*Example:*

The State of Arizona [governmental entirety] employs many workers, and the City of Phoenix purchases supplies. The geographic area covered by the state of Arizona [geographic reference] contains several cities, and the city of Phoenix is not far from the city of Mesa, Arizona.

### ***District***

Do not capitalize the word “district” unless it refers to a specific agency name.

*Examples:*

- Three ADOT districts use the technique.
- The Prescott District expects to implement it during fiscal year 2012.

## **Punctuation**

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### ***Bulleted Lists***

When a document lists complex material, it is helpful to pull the list out of the paragraph and separate it with bullets (•) for readability. Use bullets for any listing of three or more items and for listings of two items if they are longer than a line of text.

Use bulleted lists instead of numbered lists unless the items have a specific order or ranking. If using a numbered list, capitalize, indent, and punctuate it the same way as a bulleted list.

## GRAMMAR AND STYLE

When creating bulleted and numbered lists:

- Use a phrase or sentence to introduce the list and end it with a colon (:).
- Ensure that the introductory sentence clearly identifies whether all items apply (use “and”) or whether they stand independent (use “or”). Generally, items in the list will not contain any conjunction linking one item to another.
- For all bulleted lists, whether they are full sentences or phrases, capitalize the first word of each item—even for sub-bullet items.
- For all bulleted lists, if they are full sentences, end the item with a period (or, rarely, a question mark)—even for sub-bullet items. If the items are only phrases, do not end with a period or other form of punctuation.
- Use parallel grammatical construction within bulleted lists. For example, begin each item with a verb or a noun (depending on what is appropriate given the introductory phrase) or make each item a complete sentence. Do not mix complete sentences with phrases.
- Insert a blank line between a completed list and the next paragraph.
- Do not double space between items in a list.

### ***Commas in a Series***

When listing a series (three or more items) within text, use a serial comma (i.e., the comma before the “and”). Especially in technical writing, using the serial comma can make the difference between a clear sentence and an unclear one.

When elements within a series contain internal commas, use a semicolon to separate the elements; otherwise the series can be confusing.

*Examples:*

- The authors were Smith, Johnson, and Walker. (serial comma)
- The authors were Smith, chairman; Johnson, treasurer; and Walker, secretary.

### ***Commas in Compound Sentences***

A true compound sentence contains two full sentences joined by a conjunction. A sentence with compound elements generally contains one subject and two verb phrases. Use a comma to separate the parts of a compound sentence but no comma in a sentence with compound elements.

*Examples:*

- This report identifies some of the key policy questions, but local officials must determine answers at the grassroots level. (compound sentence)
- This report identifies some of the key policy questions regarding the study and sheds light on some of the possible answers. (compound elements)

**Commas with a State or a Year**

Use a comma before and after the name of a state that follows a city. A comma also comes before and after a year that follows a month and day (but there is no comma between a month and year only).

*Examples:*

- Flagstaff, Arizona, is the site of Northern Arizona University.
- January 10, 2009, is the date of the meeting.
- February 2010 will be dedicated to a literature search.

**Hyphens in Modifying Phrases**

Place a hyphen between words that serve as a modifying phrase. The purpose of the hyphen is to help clarify for the reader that both words modify the word that follows. In certain constructions, leaving the hyphen out can prove confusing. Industry usage overrides guideline style (e.g., portland cement concrete). Check for consistency in the use of phrases or words repeated within a report.

*Examples:*

- Figure 1 shows a cross section. The cross-section diameter is 1 inch.
- high-resolution photograph, 12-year period, 5-m span, 5-ft wall or 5-foot wall
- crumb-rubber mixture (but no hyphen in “crumb rubber” used as a noun)

**Hyphens in Modifying Phrases that End in “-ly”**

If the modifying phrase contains -ly, do not use a hyphen.

*Example:*

a thermally induced reaction

**Em Dashes**

Em dashes (also denoted by 1/m) are used to separate thoughts—and insert information—within sentences. Though often represented by two hyphens (--), the proper symbol is the em dash. To create this symbol in Word 2010, type CTRL+ALT+Num-. (To create an en dash, type CTRL+Num.)

**Spacing after Periods**

Use only a single space after a closing period or other closing punctuation.

## GRAMMAR AND STYLE

### ***Parentheses and Periods***

When parentheses or brackets enclose a stand-alone sentence, the period falls inside the parentheses. (This sentence is an example.) If the material in the parentheses is part of a sentence, the period falls outside the parentheses (like this).

When a secondary set of parentheses occur inside parentheses (as here (i.e., the text being read now)), the interior parentheses should be changed to brackets [like this].

### ***Punctuation and Quotation Marks***

Commas and periods always go inside quotation marks. Semicolons and colons normally go outside quotation marks. Question marks and exclamation points depend on use.

*Examples:*

- The article, “How to Grow Red Tomatoes,” was replaced by “How to Grow Yellow Onions”; we finally settled on “How to Encourage Gardening.”
- Did you read “The Tell-Tale Heart”?
- He asked, “Where are you going?”

### ***Titles in Italics Versus Quotation Marks***

Generally, when referring to documents in text, the titles of long works (e.g., books, journals) are in italics, and the titles of short works (e.g., chapters, journal articles) are in quotation marks. The titles of works that are not published (e.g., course titles) are usually set in quotation marks.

*Examples:*

- Place the following types of works in italics: reports, books, manuals, journals, proceedings, newspapers, and dissertations.
- Place the following types of works in quotation marks: articles, book chapters or sections, papers, pamphlets, courses, seminars, classes, and projects.

## Spelling

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### ***American Versus British Spellings***

Use conventional American spelling for Research Center reports.

*Examples of American/British spellings:*

<b>American Spelling</b>	<b>British Spelling</b>
traveled	travelled
acknowledgment	acknowledgement
judgment	judgement
focused	focussed
color	colour
toward	towards
backward	backwards
defense	defence
naturalization	naturalisation
a historical	an historical

### ***Spell Check***

Using a spell check tool is helpful, but cannot ensure correct spelling. Carefully re-read the text for words that are spelled correctly but that are misused.

## Numbers

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### ***When to Spell Out Numbers***

The rules prescribed here differ from those in *Chicago* and better meet the needs of technical reports. Within a sentence, according to these rules, spelling out and using numerals may be combined.

## GRAMMAR AND STYLE

Spell out:

- Numbers between one and nine (e.g., eight cars)
- Rankings, or ordinals, of first through ninth (e.g., the ninth car)
- A number that begins a sentence (e.g. Eighty-seven percent of the people surveyed liked the idea.)

Use a numeral for:

- Numbers 10 and greater (e.g., 10 trucks)
- Rankings, or ordinals, of 10 and greater (e.g., the 10th truck, 21st century)\*
- Percent (e.g., 5 percent)
- Notations with measurements (e.g., 5 m, 2 ft)
- Time when used as data (e.g., 5 seconds)

\*Do not superscript ordinal numerals (e.g., 17<sup>th</sup>).

According to these rules, the following example is correct.

*Example:*

Researchers counted five cars and 10 trucks.

### **Commas with Numerals**

Use commas to separate digits into groups of three when the number is greater than four digits. When a number in text is four digits, it does not have a comma (although commas might be needed in tables and figures for alignment). Dollar amounts of four digits or more may use or omit a comma.

In tabular columns that show both four-digit and five-digit or greater numbers, use commas as needed for clarity, alignment, and appearance.

*Examples:*

- 100,000 and 1000.
- \$1000 or \$1,000.

### **Decimals, Not Fractions**

Where reasonable, use decimals instead of fractions. Place a zero before the decimal point for quantities less than one. Industry usage in some instances (e.g., references to equipment or tools) may require use of fractions. If using fractions, use a consistent form throughout (1/4 or ¼).

*Example:*

0.25 (not 1/4 or ¼ or .25)

## Measurements, Symbols, and Equations

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### ***American Versus Metric Units***

The PI must give measurements in the system that was used to take them. If measurements are taken using Systeme Internationale (SI) units, the measurements must be followed in parentheses by their equivalent customary American units. Round metric values to the same number of digits as were in the American number (11 miles at 1.609 km/mi equals 17.699 km, which rounds to 18 km). Convert mixed American units (feet and inches, pounds and ounces) to the smaller unit before converting to metric rounding (10 feet, 3 inches, = 123 inches; 123 inches x 25.4 mm = 3124.2 mm; round to 3124 mm).

### ***Common Unit Abbreviations***

The following are some units and their abbreviations.

#### *Metric Units*

- liter        L
- meter        m
- millimeter mm
- hectare     ha
- kilogram    kg
- newton      N
- kilopascal  kPa

Do not use the prefixes deci- or deca-.

#### *American Units*

The following are some American units and their abbreviations to use:

- inch        inch or inches (do not abbreviate)
- foot        ft
- yard        yd
- mile        mi
- ounce      oz
- pound      lb
- ton         ton
- quart      qt
- gallon     gal
- barrel     bbl

Do not use plural forms such as lbs.

## GRAMMAR AND STYLE

### ***Numerals with Unit Symbols and Abbreviations***

Use numerals with English and metric abbreviations and symbols in text, tables, and figures.

*Example:*

a width of 12 mm (not 12 millimeters)

*Space:*

Place a space between the numeral and the unit. Leave a space between the degree symbol and the temperature system abbreviation.

*Examples:*

- 5 kg (not 5kg)
- 5 ft
- 5° F

*Period:*

Do not place a period after the measurement abbreviation unless it is at the end of a sentence.

*Example:*

5 kg (not 5 kg.); but a punctuating period may appear following a metric unit at the end of a sentence, "The weight is 5 kg."

*Plurals:*

Do not add an "s" to symbols or abbreviations. If measurement units are spelled out rather than abbreviated, the plural form may be used.

*Examples:*

- 10 kg not 10 kgs
- 5 ft
- 6 yd not 6 yds

**Adjectival phrase:**

Use a hyphen between the numeral and the unit abbreviation when in an adjectival phrase.

**Examples:**

- a 5-m wall
- a 5-ft wall

**When to Spell Out Units**

Spell out metric or English units when not used with a numeral. Use unit abbreviations in figures and tables. In text, be consistent in using numerals with abbreviations.

**Examples:**

- The amount is given in meters.
- The project studied a 5-mile pavement section.

**Percent**

Write out “percent” in text and use a numeral with it, even for numbers less than 10. In a figure or table, use the percent sign with no space between (or include percent designation in the column heading).

**Examples:**

- The increase was 5 percent.
- 10% (in a table or figure)

**Slope**

Express slope in nondimensional ratios with the vertical component shown first and then the horizontal (V:H). Compare the same units (meters to meters, etc.). For example, base tapers previously shown as 8:1 will now be shown as 1:8.

## GRAMMAR AND STYLE

### ***Time***

If units of time (seconds, hours, etc.) are specific measurements, then use a numeral with them and abbreviate. If they are more general, spell out the unit.

If using a numeral, abbreviations (with no periods) may be used for units of time:

- sec (not s)
- min (do not then abbreviate minimum as min.)
- hr
- yr

*Examples:*

- The study ran for two years.
- Researchers examined data at 2 -sec intervals.

### ***Temperature***

When expressing temperature using a degree symbol, use the degree symbol next to the number and leave a space between the symbol and the measurement abbreviation: (10° C)

### ***Symbols***

Use the proper symbols to denote functions in equations, text, and illustrations. This includes the multiplication sign (\*) and the minus sign (-).

Remember to verify the accuracy of any symbols used in the report when the manuscript is reviewed at the various publication stages.

*Example:*

$$5x * 10r = 35yz$$

### ***Equation Numbering***

ADOT guidelines require that equations be numbered consecutively throughout the document (e.g., Eq. 1, Eq. 2).

### ***Equation Placement***

Place the equation on a separate line, using line space to separate it from the paragraph. Indent or center each equation.

Place the equation number in parentheses flush with the right margin on the last line of the equation elements.

*Example:*

Eq. 1 explains my hypothesis:

$$a + b = c$$

(Eq. 1)

### ***Creation of Equations***

If the report uses mathematical symbols, use the equation editor to ensure their accurate reproduction. This creates a unit that appears during PDF conversion as a graphic, but still allows revision to the source file as needed.

If embedding mathematical symbols in text as font characters, the best choice is to use the normal text or symbol character set in Word. Do not use other character sets, because they do not convert reliably to PDF.

### ***Equation Symbol Identification***

Identify symbols after their first use to aid the reader. This identification usually appears in a “where” list. Be consistent throughout the document whether using a list to identify symbols or using paragraph form. Also be consistent in introducing the list (colon or not, etc.). If in paragraph form, use the semicolon (;) to separate each item in the list.

*Example:*

$$y = mx + b$$

(Eq. 1)

Where     y = the y value (ordinate)  
            x = the x value (abscissa)  
            m = slope  
            b = y-intercept

### Writing Tips

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Always write clearly and professionally, whether producing a technical memo or a final report.

- Eliminate jargon or buzzwords. If industry terms are appropriate, make sure that their meaning is clear for the average reader and define on first use if necessary.
- Be plain-spoken but businesslike. Avoid using colloquialisms, field shorthand terms, or conversational language.
- Use generic, third-person references like “the team” rather than personal names or first-person references. Write in passive voice if necessary.
- Delete references to internal processes. Do not mention procurement documents, technical advisory committee (TAC) directives, project manager decisions, or other internal workings of a study. Write a deliverable to capture the work performed and its results.

All written deliverables can benefit from well-organized sentences and concise, direct language that replaces wordy phrases with fewer words. To give some guidance, the Research Center reprints, with permission, this online excerpt from *Daily Writing Tips*, “10 Techniques for More Precise Writing.”

- ***Avoid Vague Nouns***

Phrases that are formed around general nouns such as *aspect*, *degree*, and *situation* clutter sentences.

**Before:** “She is an expert in the area of international relations.”

**After:** “She is an expert in international relations.”

- ***Use Words, Not Their Definitions***

Replace explanatory phrases with a single word that encapsulates that explanation.

**Before:** “The crops also needed to be marketable so that families would be able to sell any yields that exceeded what they personally required.”

**After:** “The crops also needed to be marketable so that families would be able to sell any surplus.”

- ***Avoid Noun Strings***

Reorganize sentences to eliminate series of nouns used as adjectives.

**Before:** “The lack of a secure transfer may hamper computer security incident response efforts.”

**After:** “The lack of a secure transfer may hamper responses to computer-security incidents.”

- **Convert Nouns to Verbs**

When a sentence includes a noun ending in *-tion*, change the noun to a verb to simplify the sentence.

**Before:** “They will collaborate in the creation of new guidelines.”

**After:** “They will collaborate to create new guidelines.”

- **Reduce Verb Phrases to Simple Verbs**

Identify the verb buried in a verb phrase and omit the rest of the phrase.

**Before:** “The results are suggestive of the fact that tampering has occurred.”

**After:** “The results suggest that tampering has occurred.”

- **Replace Complex Words with Simple Ones**

Choose simpler synonyms for multisyllabic words.

**Before:** “The department will disseminate the forms soon.”

**After:** “The department will pass out the forms soon.”

- **Avoid Expletives**

Don’t start sentences with *There is*, *There are*, or *It is*.

**Before:** “There are many factors in the product’s failure.”

**After:** “Many factors contributed to the product’s failure.”

- **Eliminate Prepositional Phrases**

Use possessives to eliminate phrases starting with the preposition *of*.

**Before:** “The decision of the committee is final.”

**After:** “The committee’s decision is final.”

- **Reduce Wordy Phrases to Single Words**

Replace phrases that signal a transition with simple conjunctions, verbs, or other linking words.

**Before:** “Due to the fact that the project is behind schedule, today’s meeting has been postponed.”

**After:** “Because the project is behind schedule, today’s meeting has been postponed.”

—Source: *Daily Writing Tips*, [www.dailywritingtips.com](http://www.dailywritingtips.com)

