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LARCMACS

A TEX Macro Set for Typesetting NASA Reports

Linda H. Woessner and Mary K. McCaskill

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National Aeronautics and Space Administration

Langley Research Center
Hampton, Virginia 23665-5225

Contents

Introduction

This LARCMACS user's manual describes the February 1988 version of LARCMACS, the TeX macro set used by the Technical Editing Branch (TEB) at NASA Langley Research Center. These macros were developed by the authors to facilitate the typesetting of NASA formal reports. They are also useful, however, for informal NASA reports and other technical documents such as meeting papers. LARCMACS are distributed by TEB for the convenience of the Langley TeX user community. A copy can be obtained by contacting TEB.

LARCMACS were developed and intended to be used as an extension of Plain TeX. The rare instances where Plain macros have been altered or redefined are documented.

There are some minor differences between LARCMACS and the actual macro set used in production at TEB, mostly relating to a few fonts that are available at TEB but not elsewhere. In all instances, references to these fonts in LARCMACS have been changed to similar standard Plain TeX fonts. Currently, LARCMACS are based on the original "am" series of TeX fonts. Future releases will be upgraded to incorporate the newer "cm" fonts.

This manual is intended to document LARCMACS so that novice TeX users can understand and use them. Some TeX experience, as well as access to a copy of *The TeXbook* (ref. 1), will occasionally be helpful. Familiarity with some of Plain TeX's basic macros is assumed. For the benefit of more advanced users, the actual code for the complete set of LARCMACS macros is included in appendix A.

The format for each macro description is patterned after most UNIX user manuals. The following subheadings are used as follows, where appropriate:

NAME

List the name and short description of the macro.

SYNTAX

Describe command syntax. `Typewriter` type indicates characters to be typed literally. *Italic* type indicates arguments* (characters **not** typed literally). Square brackets (`[ ]`) enclose optional arguments. Ellipses (...) indicate something that can be repeated.

DESCRIPTION

Provide detailed descriptions of the function and usage of a macro. Also describe arguments, syntax variations, and effects of macro options.

EXAMPLE

Provide an example of how a macro is intended to be used and the context.

RESTRICTIONS

Describe known restrictions or limitations on the use of the macro.

* In this manual, the term **argument** refers to a value supplied by the user and used by a macro during a single invocation of the macro.

FILES

List related files that are either part of the macro or are used during execution.

SEE ALSO

List references to related entries and to other documents.

Installation and Use

The best way to install these macros is to copy the whole set of files to the "INPUTS" subdirectory in the TEX hierarchy of files on your computer. Everyone who uses TEX on your system will then have access to LARCMACS, and multiple copies will not be necessary.

Different operating systems may have slightly different names for the TEX directory structure. For example, with the Personal TEX, Inc., version of PCTEX, the LARCMACS files should be loaded into the PCTEX>TEXINPUT directory.

An alternative is to install the files directly into the area where you will be running TEX.

The February 1988 version of LARCMACS should include the following set of files: **bigfonts.tex**, **cosati.tex**, **dblcol.tex**, **larcmacs.tex**, **sans.tex**, **slidefnt.tex**, and **splitcol.tex**. (A file **draft.tex** is also available to produce a very readable rough draft. This file may be used without LARCMACS, but is compatible with them. See the instructions at the beginning of **draft.tex**.)

Once the files are in place, simply include

```
\input larcmacs
```

at the top of your document.

If you already have a macro file that you input at the beginning of all of your documents, you could include the "**\input larcmacs**" in that file.

PCTEX users have a few additional considerations when using LARCMACS:

- Use the "**/f=25000**" option when running TEX. For example to process a file named stuff.tex, enter:

  ```
  tex stuff /f=25000
  ```

- The FILES and BUFFERS parameters in the CONFIG.SYS file should be increased. FILES=32 and BUFFERS=25 seem to work well.

For consistency and maintainability, please make it a practice **not** to edit any of the LARCMACS files. If changes are desired, macros may be redefined and parameter values reset in your own macro files or document files. The most recent definition always holds.

General Format and Parameters

The format recommended by NASA Headquarters for NASA reports is shown in figure 1. The typical typeset page is laid out in two columns, each 20 picas wide, with 2 picas between columns. The resulting page width is 42 picas. Column, or page, length is 55 picas, not counting the page numbers, which appear at the bottom outside edges of the pages. Double-column format is not appropriate for some information, for example, matrix equations, tables, or this manual; thus some reports may be laid out in a single column or in a combination of double and single columns. The three standard heading levels are shown in figure 1, along with sample footnotes, numbered items, and the formal closure. Appendix B includes a sample of a complete NASA report.

Note that the page layout is specified in standard typographic units of measurement. Those not familiar with this measurement system should read Chapter 10 of *The TEXbook* (ref. 1) or an introductory book on typography such as reference 2.

TEX provides a myriad of parameters* that can be used to vary both the style of the output and the manner in which a document is processed. For NASA reports, the Plain TEX default settings were allowed to remain as often as possible. Only the following parameters have been changed:

\baselineskip is affected by the macros in LARCMACS that change the type size. Different size fonts have different amounts of \baselineskip associated with them. With the 10-point default font, \baselineskip is set to 12 points. (This is the same as the Plain TEX default.)

\abovedisplayskip affects the spacing above a displayed equation. It was changed to "12pt plus 2pt minus 2pt" to decrease the amount of stretching and shrinking around equations for more uniform appearance.

\belowdisplayskip was set to the same dimension as \abovedisplayskip. The spacing below an equation is affected.

\tolerance was increased to 1500 from Plain TEX's default of 200, indicating that lines with a "badness" of up to 1500 will be tolerated. Experience and experimentation have shown this to be a more practical value in daily production.

\pretolerance was increased to 500 from Plain TEX's default of 100, meaning that TEX should not attempt to hyphenate a line until "badness" reaches this level. Like \tolerance, this value was chosen through experimentation.

\hoffset was set to −0.25 inch. This value may need to vary depending on what output device is being used.

\voffset was set to 0 inch to conserve paper on continuous roll output devices. This value may also need to vary with different output devices.

\parindent was set to 1.5 ems to conform to NASA specifications.

\hsize was set to 42 picas for NASA specifications.

\vsize was set to 55 picas for NASA specifications.

If you prefer different parameter settings, please do not edit the LARCMACS files. In fact, for consistency, please **do not** edit the LARCMACS files at all. It is good practice to make

* In this manual, the term **parameter** refers to a specific dimension or value that affects some overall aspect of the format of TEX's output, for example, page width.

Indent 1.5 ems

Introduction

The analysis of structures made from boron/aluminum laminates is complicated by the inelasticity and nonlinearity of the stress-strain behavior in the working range of the material. Although the mechanical properties of boron/aluminum laminates have been studied (see, for example, refs. 1, 2, and 3), the stress-strain behavior has not been adequately characterized.

The objective of this invest Footnote ref. acterize the stress-strain behavior of several types of Borsic[1]/aluminum laminates. Two of the laminate types consisted of only 0° or 45° plies; three other laminate types contained both 0° and 45° plies. Both longitudinal and transverse stress-strain curves were obtained for the various laminates. To investigate the inelasticity of the material, some specimens were also subjected to a few loading cycles. The Ramberg-Osgood equation was fitted to the experimental stress-strain data. Elastic constants and the extent of the linear regions in the stress-strain curves were determined for the various laminates. Elastic constants calculated from laminate theory were compared with measured values.

Headings — 12 points

1st level

Results and Discussion

9 points

2nd level

Static Tensile Tests

9 points

3rd level

Stress-strain curves. Stress-strain curves[2] for the static tensile tests are presented in figures 4 to 8 for each laminate orientation. Each figure shows the measured strains in the y- and x-directions and average Ramberg-Osgood curves. The results for longitudinal and transverse specimens are Italic symbols graphs in each figure. Note that for laminates containing 0° fibers, the stress scales for longitudinal and transverse tests in parts (a) and (b) of the figures differ by as much as a factor of 10. In general, the stress-strain curves are very nonlinear, and the Ramberg-Osgood curves model the experimental ones well. The curves are shown to failure. Tables I to V present various parameters measured in the tests or calculated from the data, including the Ramberg-Osgood constants.

Figure 9 shows average Ramberg-Osgood stress-strain curves for all the laminates. The ultimate tensile strains ϵ_{tu} of the four laminates with fibers in the direction of loading are about the same, 0.007 to 0.008. (See fig. 9(a).) In transverse tests of the four laminates, with some fibers normal to the loading direction, the ultimate tensile strains were much smaller and varied greatly, 0.0020 to 0.0065. For $[\pm 45]_{2S}$ laminate orientations, the ultimate tensile strains were much higher than the 0.02 to 0.03 at which the gages failed; the ultimate strain given by the average Ramberg-Osgood equation for the average measured ultimate stress of 220.6 MPa is 0.05.

At least 2 lines

Ultimate tensile strengths. Figure 16 shows a comparison between experimental and predicted tensile strengths for the various boron/aluminum laminates. In the figure, ultimate tensile strengths are plotted against the percentages of 45° plies in the laminates. The symbols are plotted at the average of the experimental results and the tick marks indicate the extremes. The difference between the strengths of $[\pm 45/0_2]_S$ and $[0_2/\pm 45]_S$ specimens indicates a small effect of stacking sequence on strength.

Cyclic Tensile Tests

Three loading cycles did not affect the stress and strain at failure for any of the boron/aluminum laminates. The ultimate tensile stress and strain for each cyclic test are presented in table VII, and these values are within the extremes for the static tests given in tables I to V. However, the laminates exhibited permanent strain on unloading. The permanent strains, which increased with applied stress and with the proportion of 45° plies, were significant—especially for the $[\pm 45]_{2S}$ laminate.

12 points

Summary of Results

6 points

The tensile behavior of five types of boron/aluminum laminates ($[0]_{6T}$, $[\pm 45]_S$, $[0/\pm 45]_S$, $[0_2/\pm 45]_S$, and $[\pm 45/0_2]_S$) was investigated. The following were concluded from the study:

6 points before & after list

1. For the laminates with 0° plies in the loading direction, the ultimate strengths varied linearly with the percentage of 0° plies in the composite. The strengths predicted by assuming that the 0° plies failed first correlated well with the experimental results.
2. The stress-strain curves for all the laminates were nonlinear except at strains below about 0.00025. In the linear region, measured Young's modulus and Poisson's ratio were within 10 to 20 percent, respectively, of those calculated from laminate theory.

The Ramberg-Osgood equation fitted to the stress-strain curves to obtain average curves for the various laminates agreed with the experimental data.

2 picas

Langley Research Center
National Aeronautics and Space Administration
Hampton, VA 23665
February 13, 1981

Formal closure

[1] Borsic: trademark of United Aircraft Products, Inc.

[2] Note that the linear region of the stress-strain curves, for which the elastic constants were calculated, does not characterize the laminates over a significant part of their working range.

Figure 1. Basic format for typeset NASA report. Note that this page is a sample of typesetting style and is not necessarily sensible writing.

desired changes in your own files (either in your own macro file or directly at the top of your document). For example, Plain TeX sets the \hsize parameter to 6.5 inches. LARCMACS resets it to 42 picas. Suppose you usually prefer \hsize to be 6 inches, but have an unusual document where you want the \hsize to be 5.2 inches. The beginning of your document could look like this:

```
                      %initially \hsize=6.5in (Plain TeX)
\input larcmacs       %\hsize changed to 42pc
\input mymacros       %your macro file changes \hsize
                      % to usual preference:  6in
\hsize=5.2in          %change \hsize for this doc only
```

Format Macros

The format macros contained in this section are perhaps the most important and most used macros in LARCMACS. These are the macros that produce the standard NASA format for technical reports:

- Two macros are available to produce two-column format, \doublecol and \splitcol.
- Macros to change the type size are very important. Using TeX's \magnification macro to change type size has the disadvantage that the type size can be changed only once for the entire document. The LARCMACS font size macros allow type size to be changed repeatedly throughout a document.
- LARCMACS contain three macros, \levelone, \leveltwo, and \levelthree, to produce the three standard levels of headings shown in figure 1. Also the macro \contents produces a Contents page if the heading macros are used in a document.
- Macros are included to produce footnotes and reference lists in the standard NASA format.
- Space for figures can be left in the text by using the LARCMACS \figure, \midfigure, and \figurepar macros; or a list of figure captions can be produced with \figleg.
- Running heads can be produced with \runhead, vertical spacing can be more precisely controlled with \solidmedskip, and large titles can be produced with \tlfont.
- Finally the NASA Report Documentation Page appearing as the last page of every NASA report can be produced with the cosati macros.

NAME

doublecol—double-column format

SYNTAX

```
\doublecol
```

DESCRIPTION

The \doublecol macro, if specified at the top of a document, will cause the entire document to be typeset in two columns. NASA formal reports are usually produced in double-column format, with the exception of some reports with an abundance of wide equations and figures that look better in single-column format. Draft versions of a document should never be in double-column format in order to facilitate reviewing and editing.

Specific features of double-column format are as follows:

- The \hsize and \vsize parameters are changed to refer to the dimensions of a single column, and a new parameter, \fullhsize, is introduced to refer to the total width of a page (the total width of both columns plus space between). It is safe to change these parameter values, if desired, without affecting any other features of the double-column format. The values of these parameters, by default, are

  ```
  \hsize=20pc
  \vsize=55pc
  \fullhsize=42pc
  ```

- Plain TeX macros that previously applied to entire pages now apply only to a single column. For example, the macro \eject now ejects a column instead of a whole page, and all the insert macros (\topinsert, \pageinsert, and \midinsert) and the \footnote macro, now apply to single columns instead of entire pages. A new macro, \fullpageinsert, is defined to leave an entire blank page (both columns).

EXAMPLE

A document to be in double-column mode could begin like this:

```
\input larcmacs
\doublecol
     .
     .
     .
```

(See appendix B for sample output.)

RESTRICTIONS

- There is no easy way to use this macro to switch back and forth between double- and single-column format. The entire file is processed in double-column format.
- The columns on the last page are not balanced and there is no easy way to perform that task without cutting and pasting.

FILES

`dblcol.tex`

SEE ALSO

The TeXbook, page 257 (ref. 1)

\splitcol

NAME

splitcol—alternate method for double-column output

SYNTAX

`\splitcol`

DESCRIPTION

This output macro was developed as an alternative to \doublecol for producing double-column format, in response to the restrictions mentioned with that macro. The \splitcol macro has the advantages that provisions are made for balancing columns and for switching back and forth between double- and single-column format.

The \splitcol macro introduces some new parameters that control page format:

\pageheight controls the total height of a page and is set to 55 picas.

\pagewidth controls the total width of a page and is set to 42 picas.

\colwidth controls the width of columns in double-column format and is set to 20 picas.

\bigcolheight is a parameter used by \splitcol for balancing columns and is set to 112 picas. It **must** be slightly more than twice the page height.

These parameters can be adjusted after the \splitcol macro if desired. To improve the readability of 10-point type in single-column format, \splitcol changes \baselineskip to 13 points. In double-column format the \baselineskip remains at 12 points.

After specifying \splitcol, the following formatting commands are available:

- `\begindoublecol` begins double-column format. Single-column pages will be produced (by default) until the appearance of this command.
- `\enddoublecol` causes the columns to be balanced and changes the format back to single column. When a file ends in double-column format, \enddoublecol should precede \vfill\eject (or \bye) at the end of the file.
- `\columnbreak` strongly encourages a break for the left column (see restrictions). This command must be used in vertical mode or inserted with \vadjust.
- `\shortcol` preceding \enddoublecol allows the right column to be slightly shorter when balancing columns.

EXAMPLE

A document that begins in single-column and changes to double-column format would look like this:

`\splitcol`	
.	Document begins in one column
.	
`\begindoublecol`	Change to two columns
.	
.	
`\enddoublecol`	Columns are balanced; change to one column

```
\bye
```

(See appendix B, p. 115, for sample output.)

RESTRICTIONS

- There can be no inserts or footnotes in a file using \splitcol. (It is possible that \pageinsert will work.) It may be possible to work around this restriction by splitting a document into more than one file and using \doublecol and \splitcol as necessary.
- It is tricky to force left column breaks. The \columnbreak command is provided to encourage a break. Attempting to use \eject in the left column will result in a blank right column.

FILES

`splitcol.tex`

SEE ALSO

The TEXbook, page 417 (ref. 1)

TUGboat, vol. 6, p. 29 (ref. 3)

\doublecol

NAME

font size macros—macros to change the type sizes

SYNTAX

```
\sevenpt        \tenpt
\eightpt        \elevenpt
\ninept         \twelvept
```

DESCRIPTION

All these macros change the current family of fonts to a new set of fonts at the specified type size. A font family is a set of typefaces (for example, roman, boldface, italic) that match or complement one another so that they look correct together.

By default, \bf, \it, \sl, etc., all refer to the 10-point size. Requesting a different size, via any of the above macros, will cause all of the related macros (\bf, \it, ...) to change to refer to the new size.

EXAMPLE

```
\sevenpt
The {\it quick} brown fox jumps over the {\bf lazy} dog.\par
\eightpt
The {\it quick} brown fox jumps over the {\bf lazy} dog.\par
\ninept
The {\it quick} brown fox jumps over the {\bf lazy} dog.\par
\tenpt
The {\it quick} brown fox jumps over the {\bf lazy} dog.\par
\elevenpt
The {\it quick} brown fox jumps over the {\bf lazy} dog.\par
\twelvept
The {\it quick} brown fox jumps over the {\bf lazy} dog.\par
```

yields

The *quick* brown fox jumps over the **lazy** dog.

The *quick* brown fox jumps over the **lazy** dog.

The *quick* brown fox jumps over the **lazy** dog.

The *quick* brown fox jumps over the **lazy** dog.

The *quick* brown fox jumps over the **lazy** dog.

The *quick* brown fox jumps over the **lazy** dog.

FILES

`bigfonts.tex` (for \elevenpt and \twelvept)

RESTRICTIONS

Using these macros immediately before or after a displayed equation may affect the space above and below the equation and may change the baselineskip of the surrounding text.

SEE ALSO

math font size macros—\eightptmath, \nineptmath, \tenptmath

NAME

levelone NASA format first level (of three) heading

SYNTAX

\levelone{*heading*}

DESCRIPTION

LARCMACS provides three levels of headings. The \levelone macro produces a heading in the following level-one style:

- Twelve-point, bold, roman font
- Left justified
- Followed by \medskip with page break prevented
- Hyphenation and page breaks are prevented within long headings

A \bigskip should precede \levelone to provide appropriate space above the heading.

EXAMPLE

```
\bigskip
\levelone{Sensitivity Study Results}
```

yields

Sensitivity Study Results

(See other examples in appendix B.)

NAME

leveltwo—NASA format second level (of three) heading

SYNTAX

`\leveltwo{`*heading*`}`

DESCRIPTION

LARCMACS provides three levels of headings. The \leveltwo macro produces a heading in the following level-two style:

- Ten-point, bold, roman font
- Indented on left (all lines of heading indented)
- Followed by \medskip with page break prevented
- Hyphenation and page breaks prevented in long headings

A \bigskip should precede \leveltwo to provide appropriate space above the heading.

EXAMPLE

```
\bigskip
\leveltwo{Effect of Vortex-Lattice Distribution}
```

yields

Effect of Vortex-Lattice Distribution

(See other examples in appendix B.)

NAME

leveltree—NASA format third level (of three) heading

SYNTAX

\levelthree{*heading*}

DESCRIPTION

LARCMACS provides three levels of headings. The \levelthree macro produces a heading in the following level-three style:

- Ten-point slanted font (the standard NASA format calls for bold italic, which is not available with am fonts)
- Preceded by small vertical skip (2 points)
- Indented like a normal paragraph (first line only) and run into paragraph
- Text of heading followed by (bold) period

A \bigskip may precede \levelthree to set off the heading.

EXAMPLE

```
\bigskip
\levelthree{No-flow condition}
One of the fundamental conditions of vortex-lattice theory is the
\lq\lq no-flow'' condition at the control point of each vortex panel. This
\ellipse
```

yields

No-flow condition. One of the fundamental conditions of vortex-lattice theory is the "no-flow" condition at the control point of each vortex panel. This ...

(See other examples in appendix B.)

NAME

contents—automatic table of contents generation

SYNTAX

`\contents`

DESCRIPTION

Including \contents at the beginning of a document will result in the generation of a Contents page in a separate file. You are queried for a file name for the Contents page as TEX processes the original document. Any valid file name is acceptable with the following considerations: A **.tex** extension will be added to the name you select; do not select **contents** for the file name.

After TEX has completed processing the original document, a new file will exist with the name you specified, as described above. This file contains the table of contents in TEX format. To see the file with a preview program or to print a hard copy of it, the file must first be processed with TEX.

The Contents will begin with page number iii and will contain all the headings in the original document that were produced with the \levelone, \leveltwo, and \levelthree macros. It will be in a leader table format including the correct page numbers corresponding to the location of the headings in the original document.

EXAMPLE

See the Contents page of this document. It was produced by including **\contents** at the beginning of the file containing this document.

See appendix B for an additional example.

NAME

leftitem—flush left version of \item

SYNTAX

\leftitem{*refmark*}

DESCRIPTION

This macro was designed to produce the References section that appears in most NASA formal reports. It produces a blocked paragraph, with each line indented, and the *refmark* at the left margin before the first line.

The *refmark* can be any text, usually a number or bullet of some kind. Note that the numbers or bullets are aligned on the left.

EXAMPLE

```
\leftitem{1.}Federal Aviation Adm.:  {\it Integrated FAA Wind Shear
Program Plan.} DOT/FAA/DL-87/1, DOT/FAA/VS-87/1, DOT/FAA/AT-87/1,
U.S.\ Dep.\ of Transportation, Apr.~1987.
\leftitem{2.}National Research Council:  {\it Low-Altitude Wind Shear and
Its Hazard to Aviation}.  National Academy Press, 1983.
\vdots
\leftitem{10.}Payne, Francis~M.; and Nelson, Robert~C.:
Aerodynamic Characteristics of an Airfoil in a Nonuniform Wind Profile.
{\it J.~Aircr.}, vol.~22, no.~1, Jan.\ 1985, pp.~5--10.
\leftitem{11.}Frost, Walter; and Hutto, Enice:  The Influence of
Wind Shear on Aerodynamic Coefficients.  {\it Sixth Conference
on Aerospace and Aeronautical Meteorology}, American Meteorological
Soc., Nov.\ 1974, pp.~317--324.
```

yields

1. Federal Aviation Adm.: *Integrated FAA Wind Shear Program Plan.* DOT/FAA/DL-87/1, DOT/FAA/VS-87/1, DOT/FAA/AT-87/1, U.S. Dep. of Transportation, Apr. 1987.

2. National Research Council: *Low-Altitude Wind Shear and Its Hazard to Aviation.* National Academy Press, 1983.

⋮

10. Payne, Francis M.; and Nelson, Robert C.: Aerodynamic Characteristics of an Airfoil in a Nonuniform Wind Profile. *J. Aircr.*, vol. 22, no. 1, Jan. 1985, pp. 5–10.

11. Frost, Walter; and Hutto, Enice: The Influence of Wind Shear on Aerodynamic Coefficients. *Sixth Conference on Aerospace and Aeronautical Meteorology*, American Meteorological Soc., Nov. 1974, pp. 317–324.

(See also the References section in appendix B, p. 113.)

SEE ALSO

\item, p.102, *The TEXbook* (ref. 1)

NAME

fn—variation of \footnote macro, resulting in a smaller size footnote

SYNTAX

`\fn{`*symbol*`}{`*text*`}`

DESCRIPTION

The \fn macro is similar to (and, in fact, based on) TEX's \footnote macro. The advantage of \fn is that it causes the text of the footnote to be in a smaller type size (8 point).

The *symbol* argument is the reference mark which will appear both at the place where \fn is specified and at the bottom of the page with the footnote. If a superscripted reference symbol is preferred (this is usually the case if numbers (preferred for NASA format) or letters are used for the symbol), the math notation for superscripting may be included in the argument.

The *text* argument includes the entire text of the footnote.

EXAMPLE

The footnote[1] on this page was produced with the following:

```
The footnote\fn{$^1$}{This is  a sample footnote.} on this page ...
```

SEE ALSO

\footnote, pp. 116–117, *The TEXbook* (ref. 1)

[1] This is a sample footnote.

NAME

figure—provides space for figures at the top of text pages and typesets captions

SYNTAX

\figure{*figureheight*}{*caption*}

DESCRIPTION

The \figure macro is convenient to use when you want to insert, into the text, figures that must be produced on a device other than the final output device for the text. It results in the specified amount of space left in the appropriate place and a caption typeset in a slightly smaller (9-point) version of the roman text font.

The *figureheight* argument is used to specify the height of the figure, in any valid dimension, and the *caption* argument specifies the text to be used as a figure caption. The caption should be short enough to appear on one line, centered, under the figure.

The specified amount of space, with the caption centered underneath, will appear at the top of either the current or following page or column. TEX's \topinsert macro is used to determine placement.

EXAMPLE

```
\figure{1.82in}{Figure 2. Side view of vortex panel.}
```

results in the output on p. 111 of appendix B.

RESTRICTIONS

Caption must fit on one line.

SEE ALSO

\topinsert references from *The TEXbook* (ref. 1)

NAME

midfigure—provides space for figures within text and typesets captions

SYNTAX

`\midfigure{`*figureheight*`}{`*caption*`}`

DESCRIPTION

The \midfigure macro is identical to \figure except that it is based on TEX's \midinsert macro instead of \topinsert. The result is that TEX first attempts to put the entire figure, with caption, in the column or page at the place where the reference occurs. If it does not fit, TEX finds a place at the top of the next page or column.

EXAMPLE

```
\midfigure{2.5in}{Figure 1. Body-axis system.}
```

results in the output on p. 111 of appendix B.

RESTRICTIONS

Caption must fit on one line.

SEE ALSO

\figure

\topinsert, \midinsert references in *The TEXbook* (ref. 1)

NAME

figurepar—provides space for figures at the top of text pages and typesets long captions

SYNTAX

\figurepar{*figureheight*}{*caption*}

DESCRIPTION

The \figurepar macro is used identically to \figure except that the figure caption can be longer than one line.

The caption is typeset in a 9-point roman font, in paragraph form, with hanging indentation.

EXAMPLE

```
\figurepar{1.44in}{Figure 3. View along the $X$-axis of the left side of
planform with dihedral.}
```

results in the output on p. 112 of appendix B.

SEE ALSO

\figure

NAME

figleg—figure captions

SYNTAX

`\figleg{`*caption*`}`

DESCRIPTION

The \figleg macro is actually used by the \figurepar macro to produce the figure caption, but may also be useful independently. It generates a single paragraph with hanging indentation.

The *caption* argument specifies the entire caption paragraph.

EXAMPLE

```
\figleg{Figure 9. Vibration mode shapes for the cantilevered
hexahedral grid shown in figure~10.  Numbers in parentheses are exact
frequencies (in hertz); other numbers are continuum plate
frequencies.}
```

yields

Figure 9. Vibration mode shapes for the cantilevered hexahedral grid shown in figure 10. Numbers in parentheses are exact frequencies (in hertz); other numbers are continuum plate frequencies.

NAME

runhead—creates running headlines

SYNTAX

\runhead{*headline*}

DESCRIPTION

The headline created by this macro is centered in 10-point roman type across the top of each page until it is redefined. Often publications will use running headlines to put titles at the top of each page.

EXAMPLE

The following created the running headline on this page:

```
\runhead{Format Macros}
```

NAME

cosati—automatic Report Documentation Page ("cosati") generation

SYNTAX

```
\begincosati
   \one{boxcontents}
   \two{boxcontents}
   \three{boxcontents}
   ⋮
   \twentytwo{boxcontents}
\endcosati
```

DESCRIPTION

The Report Documentation Page (RDP), often called the abstract or cosati page, appears as the last page of every published NASA report. The cosati page macros included in LARCMACS can be used to generate the entire form. The cosati macros can be used in a "fill in the blank" manner. Specify only the numbered boxes on the form that are to be filled in.

Specify for *boxcontents* the text to be entered in each box. The *boxcontents* argument may be an entire paragraph where applicable, for example, in box \sixteen, which contains the abstract.

Some boxes in the cosati form require multiline text. In these, a double backslash (\\) may be used to indicate where the line breaks should occur within the *boxcontents* argument.

EXAMPLE

See the cosati page (and the code used to generate it) on page 116 in appendix B.

FILES

`cosati.tex`

Table Macros

NASA format has traditionally called for both vertical rules and cross rules in tables with more than two columns. Two-column tables are usually produced without rules, but with leaderwork (rows of dots) between the columns. This section documents macros for tables in NASA report format:

- The basic format for tables can be set up with four basic table macros, \table, \boxtable, \ruledtable, and \hardboxtable.
- Symbol lists (a unique type of table appearing in most NASA reports) can be arranged in three formats by using \symboltable, \SYMBOLTABLE, or \indentsymtab.
- Within tables, \tablerule produces cross rules, \tableskip produces vertical space, and \widehead and \boxhead produces column headings.
- Leaderwork tables are easy to set up with \leaderfill, \twodots, \threedots, and the leader line macros, \l, \ql, and \qql.

This section begins with the macros used within tables and then documents the more complicated macros (e.g., \table) which set up overall format for tables.

NAME

tablerule—horizontal rule within a table

SYNTAX

`\tablerule`

DESCRIPTION

The \tablerule macro is to be used within a table to produce a horizontal rule, or line, all the way across the table. It may be inserted following any \cr within a table.

The resulting rule has a thickness of 0.4 point.

EXAMPLE

```
\boxtable{\hsize}{#\hfill & \vrule# & #\hfill \cr
\hfill\Bigstrut Advantages && \hfill Disadvantages \cr
\tablerule
Simple, fast && Does not enhance high frequency\cr
Requires little storage && Inaccurate regional values\cr
Popular && Inaccurate harmonic components \cr
Does not require complete data set &\cr
Accurate global mean &\cr}
```

yields

Advantages	Disadvantages
Simple, fast	Does not enhance high frequency
Requires little storage	Inaccurate regional values
Popular	Inaccurate harmonic components
Does not require complete data set	
Accurate global mean	

NAME

tableskip—medium vertical skip within a table

SYNTAX

```
\tableskip
```

DESCRIPTION

The \tableskip macro is used with alignments to produce a vertical space equivalent to a \medskip. It may be inserted following any \cr within a table.

By default, \medskip is defined to be 6pt plus 2pt minus 2pt.

EXAMPLE

This is the same table as in the \tablerule example, with extra vertical space added using \tableskip.

```
\boxtable{\hsize}{#\hfill & #\hfill \cr
\hfill\Bigstrut Advantages & \hfill Disadvantages \cr
\tablerule
Simple, fast & Does not enhance high frequency\cr
\tableskip
Requires little storage & Inaccurate regional values\cr
\tableskip
Popular & Inaccurate harmonic components \cr
\tableskip
Does not require complete data set &\cr
\tableskip
Accurate global mean &\cr}
```

yields

Advantages	Disadvantages
Simple, fast	Does not enhance high frequency
Requires little storage	Inaccurate regional values
Popular	Inaccurate harmonic components
Does not require complete data set	
Accurate global mean	

RESTRICTIONS

Using \tableskip in a table with vertical rules will result in a break (usually undesirable) in the vertical rules.

NAME

tablerule—horizontal rule within a table

SYNTAX

`\tablerule`

DESCRIPTION

The \tablerule macro is to be used within a table to produce a horizontal rule, or line, all the way across the table. It may be inserted following any \cr within a table.

The resulting rule has a thickness of 0.4 point.

EXAMPLE

```
\boxtable{\hsize}{#\hfill & \vrule# & #\hfill \cr
\hfill\Bigstrut Advantages && \hfill Disadvantages \cr
\tablerule
Simple, fast && Does not enhance high frequency\cr
Requires little storage && Inaccurate regional values\cr
Popular && Inaccurate harmonic components \cr
Does not require complete data set &\cr
Accurate global mean &\cr}
```

yields

Advantages	Disadvantages
Simple, fast	Does not enhance high frequency
Requires little storage	Inaccurate regional values
Popular	Inaccurate harmonic components
Does not require complete data set	
Accurate global mean	

NAME

tableskip—medium vertical skip within a table

SYNTAX

\tableskip

DESCRIPTION

The \tableskip macro is used with alignments to produce a vertical space equivalent to a \medskip. It may be inserted following any \cr within a table.

By default, \medskip is defined to be 6pt plus 2pt minus 2pt.

EXAMPLE

This is the same table as in the \tablerule example, with extra vertical space added using \tableskip.

```
\boxtable{\hsize}{#\hfill & #\hfill \cr
\hfill\Bigstrut Advantages & \hfill Disadvantages \cr
\tablerule
Simple, fast & Does not enhance high frequency\cr
\tableskip
Requires little storage & Inaccurate regional values\cr
\tableskip
Popular & Inaccurate harmonic components \cr
\tableskip
Does not require complete data set &\cr
\tableskip
Accurate global mean &\cr}
```

yields

Advantages	Disadvantages
Simple, fast	Does not enhance high frequency
Requires little storage	Inaccurate regional values
Popular	Inaccurate harmonic components
Does not require complete data set	
Accurate global mean	

RESTRICTIONS

Using \tableskip in a table with vertical rules will result in a break (usually undesirable) in the vertical rules.

SEE ALSO

\tablerule

\medskip, pp. 70–71, *The TEXbook* (ref. 1)

NAME

widehead—allows headings wider than the contents of a column

SYNTAX

`\widehead{`*heading*`}`

DESCRIPTION

Often in tables, a heading of a column is wider than the contents of the column. In these cases, if TEX is allowed to consider the width of the heading in determining the final width of the column, the resulting table will have more white space than is usually desired, and alignment of the column with the heading may be undesirable. The \widehead macro causes TEX to ignore the width of the specified heading or table entry when determining the column width and to center this heading or entry in the column.

EXAMPLE

This example shows a simple two-column table. One column heading uses the \widehead macro, and one does not.

```
\boxtable{4in}{\hfill#\hfill & #\vrule & \hfill#\cr
&& \widehead{Average temperature,} \cr
Year && deg\hfill\cr
\tablerule
1960 && 35 \cr
1961 && 45 \cr
$\vdots$  && $\vdots$\hfill \cr}
```

yields

Year	Average temperature, deg
1960	35
1961	45
⋮	⋮

Without \widehead, the table looks like this:

Year	Average temperature, deg
1960	35
1961	45
⋮	⋮

NAME

boxhead -- generate multiline headings in tables

SYNTAX

\boxhead{\\{*headingline***}** [\\{*headingline*}...] **}**

DESCRIPTION

The result of the \boxhead macro is a box with lines of a multiline heading stacked on top of each other and centered with respect to each other. Each line of the multiline heading is specified by "\\{*headingline*}" in the above syntax. The number of lines of a heading is restricted only by good taste.

Applications for \boxhead are not restricted to table headings, but that has been the most popular usage.

EXAMPLE

```
\boxtable{3in}{\hfill#\hfill & \vrule# & \hfill#\cr
\boxhead{\\{Temperature,}\\{deg}} & \boxhead{\\{Time}\\{of}\\{Day}} \cr}
\tablerule
35 && 7:00 p.m.\cr
49 && 7:00 a.m.\cr
$\vdots$ && $\vdots$\cr}
```

yields:

Temperature, deg	Time of Day
35	7:00 p.m.
49	7:00 a.m.
⋮	⋮

RESTRICTIONS

When the heading at the top of a table contains spanner rules (that is, horizontal rules that span some, but not all, columns), \boxhead does not work well.

NAME

leaderfill fill line with leaders...

SYNTAX

```
\leaderfill
```

DESCRIPTION

The \leaderfill macro replicates a box 1 em wide with a period in its center. A series of such spaced periods are called leaders. This macro fills space in the same manner that \hfill does, except that leaders are produced in the desired space.

It is easy to use (no arguments) and especially useful in tables, and for Contents pages. It is based on TEX's \leaders macro.

EXAMPLE

```
\line{Introduction \leaderfill Page 3}
```

yields

Introduction . . . . **Page 3**

SEE ALSO

\leaders, p. 223, *The TEXbook* (ref. 1)

NAME

twodots—force two leader dots

threedots—force three leader dots

SYNTAX

```
\twodots
\threedots
```

DESCRIPTION

These macros produce exactly two or three leader dots, respectively. They are useful when doing tables with leaders to ensure that at least some leaders appear on the longest line in a column.

EXAMPLE

```
\table{4in}{#\leaderfill & \hfill# & \hfill#\cr
\omit &\multispan2 Target diameter\cr
\omit &\multispan2 \hrulefill\cr
\omit\strut\hfill Parameter \hfill & 1 cm \hfill & \widehead{2.54 cm}\cr
\tablerule
Minimum energy, keV\threedots & 175.83 & 154.91\cr
Maximum energy, keV\threedots & 230.75 & 263.40\cr
Optimum, keV & 200.00 & 200.00\cr}
```

yields

	Target diameter	
Parameter	1 cm	2.54 cm
Minimum energy, keV . . .	175.83	154.91
Maximum energy, keV . . .	230.75	263.40
Optimum, keV	200.00	200.00

RESTRICTIONS

The dots produced with these macros do not line up vertically with dots produced by \leaderfill. Of course, instead of using these macros, the width of the column containing leaders may be specified in the preamble to the table:

```
\table{4in}{\hbox to2in{#\leaderfill} & \hfill# & \hfill#\cr
```

to obtain

	Target diameter	
Parameter	1 cm	2.54 cm
Minimum energy, keV . . .	175.83	154.91
Maximum energy, keV . .	230.75	263.40
Optimum, keV	200.00	200.00

NAME

l, ql, qql—leader table lines

SYNTAX

\l *leftside* & *rightside* \cr

\ql *leftside* & *rightside* \cr

\qql *leftside* & *rightside* \cr

DESCRIPTION

The leader table macro \l produces a line with the *leftside* argument left-justified, the *rightside* argument right-justified, and the space between filled with leaders (dots). The *leftside* and *rightside* arguments can be any text or \hbox.

The leader table macros \ql and \qql are used in the same way as \l, but they produce a line with the leftside argument indented one quad (approximate width of a capital M) and two quads, respectively.

Repeated lines using the \l, \ql, and \qql macros create a two-column leader table. Contents pages, Indexes, and other lists often use this format.

EXAMPLE

```
\leftline{Wing:}
\ql Area, $S$, ft$^2$ & 9.795\cr
\smallskip
\ql Span, $b$, ft & 9.707\cr
\smallskip
\leftline{\quad Incidence, deg, at---}
\smallskip
\qql $\eta$ = 0.1881 & 4.04\cr
\smallskip
\qql $\eta$ = 0.3031 & 3.35\cr
\medskip
\l Landing gear wheel diameter, in. & 3.780\cr
```

yields

Wing:
  Area, S, ft^2 . . . . 9.795
  Span, b, ft 9.707
  Incidence, deg, at—
    $\eta = 0.1881$ 4.04
    $\eta = 0.3031$ 3.35
Landing gear wheel diameter, in. 3.780

NAME

table—basic table macro

SYNTAX

`\table{`*tablewidth*`}{`*tablebody*`}`

DESCRIPTION

The \table macro is essentially TEX's \halign macro with some added features.

The *tablewidth* argument is the overall width of the table. Varying the value of this parameter provides control over the amount of white space that appears in the final table.

The *tablebody* argument contains all of the alignment information just as would be specified to \halign: a preamble plus the contents of the table, with a \cr ending each line and ampersands (&) separating column entries.

The additional features of the \table macro include the following:

- The table will be centered horizontally on the page (or column, if using double-column output.)
- Additional vertical space is added above and below the table to set it apart.
- TEX's \tabskip parameter value is changed to allow "plenty" of room for stretching and shrinking.
- A \strut is automatically included at the beginning of every preamble.
- Spacing between rows (\interlineskip) is turned off.
- A tilde (~) is defined to be a space the width of a digit. It can be used as a placeholder for lining up columns of numbers.
- The macro \. is defined to be a space the width of a decimal point. This can also be useful for lining up columns of numbers.

EXAMPLE

Note the use of ~ and \. in the last column to achieve proper alignment.

```
\table{5in}{\hfill# & \hfill# & \hfill# & \hfill# & \hfill#\cr
\tablerule
& $W$,\hfill & $H$,\hfill & $D$,\hfill & $B$,\hfill\cr
\widehead{Compartment} & in.\hfill & in.\hfill & in.\hfill & in.\hfill\cr
\tablerule
1 & 24.0 & 26.0 & 82.0 & 0\.~\cr
2 & 24.0 & 24.6 & 78.0 & 1.5\cr
3 & 24.0 & 22.6 & 73.0 & 3.~\cr
4 & 24.0 & 20.6 & 68.0 & 4.5\cr
5 & 24.0 & 18.6 & 63.0 & 6.~\cr
6 & 24.0 & 16.6 & 58.0 & 7.5\cr
7 & 24.0 & 14.6 & 53.0 & 9.~\cr
8 & 24.0 & 14.6 & 53.0 & 9.~\cr
8 & 24.0 & 13.6 & 49.8 & 10.5\cr
9 & 24.0 & 12.7 & 46.5 & 12.~\cr
10 & 24.0 & 11.8 & 43.2 & 13.5\cr
11 & 24.0 & 10.9 & 39.9 & 15.~\cr
12 & 24.0 & 10.0 & 36.6 & 16.5\cr
13 & 24.0 & 9.1 & 33.3 & 18.~\cr
14 & 24.0 & 8.2 & 30.0 & 19.5\cr
\tablerule}
```

results in

Compartment	*W*, in.	*H*, in.	*D*, in.	*B*, in.
1	24.0	26.0	82.0	0
2	24.0	24.6	78.0	1.5
3	24.0	22.6	73.0	3.
4	24.0	20.6	68.0	4.5
5	24.0	18.6	63.0	6.
6	24.0	16.6	58.0	7.5
7	24.0	14.6	53.0	9.
8	24.0	14.6	53.0	9.
8	24.0	13.6	49.8	10.5
9	24.0	12.7	46.5	12.
10	24.0	11.8	43.2	13.5
11	24.0	10.9	39.9	15.
12	24.0	10.0	36.6	16.5
13	24.0	9.1	33.3	18.
14	24.0	8.2	30.0	19.5

SEE ALSO

\halign references from *The TEXbook* (ref. 1)

\ruledtable

\boxtable

\hardboxtable

NAME

boxtable—basic table enclosed in a box

SYNTAX

\boxtable{*tablewidth*}{*tablebody*}

DESCRIPTION

This macro is provided to simplify tables that are enclosed with rules. It is the macro most commonly used in TEB to typeset tables in the NASA format, which specifies not only outside rules but also vertical rules between columns.

It is used identically to the \table macro and provides all of the same features, but the resulting table is enclosed in a box. This has the advantage of preventing the user from having to specify additional columns and rows in a table for surrounding rules.

The *tablewidth* argument still refers to the final overall width of the table, including the width of the rules. The *tablebody* argument refers to the entire body of the table, including the preamble.

EXAMPLE

Contrast the following example with the previous example of the \table macro. Again notice the use of ~ and \. in the last column.

```
\boxtable{5.25in}{\hfill# & \vrule# & \hfill# & \vrule#
     & \hfill# & \vrule# & \hfill# & \vrule# & \hfill#\cr
&& $W$,\hfill && $H$,\hfill && $D$,\hfill && $B$,\hfill\cr
\widehead{Compartment} && in.\hfill && in.\hfill && in.\hfill && in.\hfill\cr
\tablerule
1 && 24.0 && 26.0 && 82.0 && 0\.~\cr
2 && 24.0 && 24.6 && 78.0 && 1.5\cr
3 && 24.0 && 22.6 && 73.0 && 3.~\cr
4 && 24.0 && 20.6 && 68.0 && 4.5\cr
5 && 24.0 && 18.6 && 63.0 && 6.~\cr
6 && 24.0 && 16.6 && 58.0 && 7.5\cr
7 && 24.0 && 14.6 && 53.0 && 9.~\cr
8 && 24.0 && 14.6 && 53.0 && 9.~\cr
8 && 24.0 && 13.6 && 49.8 && 10.5\cr
9 && 24.0 && 12.7 && 46.5 && 12.~\cr
10 && 24.0 && 11.8 && 43.2 && 13.5\cr
11 && 24.0 && 10.9 && 39.9 && 15.~\cr
12 && 24.0 && 10.0 && 36.6 && 16.5\cr
13 && 24.0 && 9.1 && 33.3 && 18.~\cr
14 && 24.0 && 8.2 && 30.0 && 19.5\cr}
```

results in

Compartment	W, in.	H, in.	D, in.	B, in.
1	24.0	26.0	82.0	0
2	24.0	24.6	78.0	1.5
3	24.0	22.6	73.0	3.
4	24.0	20.6	68.0	4.5
5	24.0	18.6	63.0	6.
6	24.0	16.6	58.0	7.5
7	24.0	14.6	53.0	9.
8	24.0	14.6	53.0	9.
8	24.0	13.6	49.8	10.5
9	24.0	12.7	46.5	12.
10	24.0	11.8	43.2	13.5
11	24.0	10.9	39.9	15.
12	24.0	10.0	36.6	16.5
13	24.0	9.1	33.3	18.
14	24.0	8.2	30.0	19.5

SEE ALSO

\table

NAME

ruledtable—table macro for more complex tables

SYNTAX

\ruledtable{*tablewidth*}{*tablebody*}

DESCRIPTION

This macro is provided to allow you more fine-tuning control over spacing around columns in the table. This control is necessary when the first column of the table is a vertical rule (and \boxtable is not appropriate). The macro \ruledtable is used in the same way as the \table macro and provides all of the same features, with one important difference.

Some amount of \tabskip glue must be specified within the preamble for the table (using TeX's \tabskip parameter) because \tabskip is set to 0 point (no stretch or shrink) before the alignment begins. The \tabskip parameter specifies the amount of glue (space) that TeX inserts between every column of a table, including before the first column and after the last column. Setting \tabskip to 0 point in this manner effectively "turns off" spacing before the first column of your table. This is especially useful if the first column of your table contains only a vertical rule.

EXAMPLE

```
\ruledtable{5in}{\tabskip.25in plus 6in minus.25in \vrule# & #\hfill &
    \vrule# & \hfill# & \vrule# & \hfill# & \vrule# & \hfill# &
    \vrule#\tabskipOpt\cr
\omit && \multispan7\hrulefill\cr
\omit \strut\tabskip.25in plus 6in minus.25in & && B.F.O.\hfill &&
     Skin\hfill && Lens\hfill&\cr
\tablerule
&Dose, rad && 12.545 && 54.649 && 34.319&\cr
&Fraction of exposure limit && 0.421 && 0.692 && 0.860&\cr
\tablerule}
```

results in

	B.F.O.	Skin	Lens
Dose, rad	12.545	54.649	34.319
Fraction of exposure limit	0.421	0.692	0.860

The following example is admittedly complex, but \ruledtable is used in complex circumstances. The \tabskip parameter must be controlled in this case because of the spanner rules touching the outer edges of the table.

```
\ruledtable{5.5 in}{\vrule#\tabskip4em plus 6in minus 4em &
     \hfill#\hfill & \vrule# & \hfill# & \vrule# &
     \hfill#\hfill & \vrule# & \hfill# & \vrule#\tabskip0pt\cr
\tablerule
&\multispan3\hfill 1915--1948\hfill\Bigstrut &&
     \multispan3\hfill 1941--1959\hfill &\cr
\tablerule
&\widehead{Fiscal year} && \widehead{Thousands \$} &&
     \widehead{Fiscal year} && \widehead{Millions \$} &\cr
\tablerule
& 1915 && 5.0 && 1941 && 11.2 &\cr
& 1916 && 5.0 && 1942 && 19.9 &\cr
& 1917 && 87.5 && 1943 && 25.4 &\cr
& 1918 && 112.0 && 1944 && 38.4 &\cr
 .
 .
 .
& 1933 && 920.0 && 1959 && 101.1 &\cr
\omit && && \multispan5\hrulefill\cr
& 1934 && 953.6 && Subtotal && 1095.0 &\cr
& 1935 && 1255.7 && && &\cr
 .
 .
 .
& 1940 && 4180.0 && && &\cr
\multispan5\hrulefill &&\cr
&Subtotal\Bigstrut && 24\thinspace 926.1 && && &\cr
\tablerule
&\multispan7 Total \Bigstrut\leaderfill 1.12 billion &\cr
\tablerule}
```

results in

1915–1948		1941–1959	
Fiscal year	Thousands $	Fiscal year	Millions $
1915	5.0	1941	11.2
1916	5.0	1942	19.9
1917	87.5	1943	25.4
1918	112.0	1944	38.4
1919	205.0	1945	40.9
1920	175.0	1946	24.0
1921	200.0	1947	30.7
1922	200.0	1948	43.4
1923	225.6	1949	48.6
1924	307.0	1959	128.0
1925	470.0	1951	63.1
1926	534.9	1952	69.0
1927	513.0	1953	66.3
1928	550.0	1954	62.4
1929	836.7	1955	55.9
1930	1300.0	1956	72.7
1931	1321.0	1957	76.7
1932	1051.0	1958	117.3
1933	920.0	1959	101.1
1934	953.6	Subtotal	1095.0
1935	1255.7		
1936	2543.8		
1937	1630.5		
1938	1280.8		
1939	4063.9		
1940	4180.0		
Subtotal	24 926.1		
Total . . . . 1.12 billion			

RESTRICTIONS

It is advisable to use the \table and \boxtable macros also provided in LARCMACS until a need for this additional control arises. Problems with rules not meeting could be one indication. It would also be good to review references to \tabskip in *The TEXbook* before experimenting with this macro.

SEE ALSO

\table

\boxtable

\hardboxtable

\tabskip references from *The TEXbook* (ref. 1)

NAME

hardboxtable more complex table enclosed in a box

SYNTAX

\hardboxtable *{tablewidth}{tablebody}*

DESCRIPTION

This macro combines the features of \ruledtable and \boxtable. Perhaps it would have been more aptly named "ruledboxtable"? It is used like \ruledtable (\tabskip must be specified), but the resulting table is enclosed in a box. See \ruledtable for more information.

EXAMPLE

The following is the same as the previous example under \ruledtable, but the \vrules and \tablerules previously used to specify the box around the table are no longer necessary:

```
\hardboxtable{5.5 in}{\tabskip4em plus 6in minus 4em# &
     \hfill#\hfill & \vrule# & \hfill# & \vrule# &
     \hfill#\hfill & \vrule# & \hfill# & \tabskip0pt#\cr
&\multispan3\hfill 1915--1948\hfill\Bigstrut &&
     \multispan3\hfill 1941--1959\hfill &\cr
\tablerule
&\widehead{Fiscal year} && \widehead{Thousands \$} &&
     \widehead{Fiscal year} && \widehead{Millions \$} &\cr
\tablerule
& 1915 && 5.0 && 1941 && 11.2 &\cr
& 1916 && 5.0 && 1942 && 19.9 &\cr
& 1917 && 87.5 && 1943 && 25.4 &\cr
& 1918 && 112.0 && 1944 && 38.4 &\cr
 .
 .
 .
& 1933 && 920.0 && 1959 && 101.1 &\cr
\omit && && \multispan5\hrulefill\cr
& 1934 && 953.6 && Subtotal && 1095.0 &\cr
 .
 .
 .
& 1940 && 4180.0 && && &\cr
\multispan5\hrulefill &&\cr
&Subtotal\Bigstrut && 24\thinspace 926.1 && && &\cr
\tablerule
&\multispan7 Total \Bigstrut\leaderfill 1.12 billion &\cr}
```

results in

1915–1948		1941–1959	
Fiscal year	Thousands $	Fiscal year	Millions $
1915	5.0	1941	11.2
1916	5.0	1942	19.9
1917	87.5	1943	25.4
1918	112.0	1944	38.4
1919	205.0	1945	40.9
1920	175.0	1946	24.0
1921	200.0	1947	30.7
1922	200.0	1948	43.4
1923	225.6	1949	48.6
1924	307.0	1959	128.0
1925	470.0	1951	63.1
1926	534.9	1952	69.0
1927	513.0	1953	66.3
1928	550.0	1954	62.4
1929	836.7	1955	55.9
1930	1300.0	1956	72.7
1931	1321.0	1957	76.7
1932	1051.0	1958	117.3
1933	920.0	1959	101.1
1934	953.6	Subtotal	1095.0
1935	1255.7		
1936	2543.8		
1937	1630.5		
1938	1280.8		
1939	4063.9		
1940	4180.0		
Subtotal	24 926.1		
Total			1.12 billion

For another example, look at the file `cosati.tex` in appendix A. The macro \hardboxtable is used to produce the RDP (abstract) page in NASA reports.

RESTRICTIONS

Like \ruledtable, \hardboxtable should be reserved for difficult alignments where problems have surfaced in using \table or \boxtable.

SEE ALSO

\table

\boxtable

\ruledtable

NAME

symboltable—standard format for symbol lists in NASA reports

SYNTAX

\symboltable{*colwidth*}{*tablecontents*}

DESCRIPTION

Almost every NASA technical report contains a "Symbols" section including a table defining the symbols used in the report. In addition, short lists defining symbols after a particular equation are common throughout a report. The format for these tables is almost always two left-aligned columns. The first column is a narrow one containing the symbol and the second column is much wider for the definition. In addition, the definition for any single symbol may extend beyond one line of the table.

The *colwidth* argument is used to specify the desired width of the second column. The overall width of the table is defined to be \hsize.

The *tablecontents* argument is actually the body of the symbol table. It may contain as many lines as desired of the following form:

symbol & *definition* \cr

where *symbol* is the symbol for the left column, enclosed in dollar signs ($...$) where appropriate, and *definition* is the text that defines the symbol. The text definition will be broken into as many lines as necessary.

EXAMPLE

In the following example, \hsize has been temporarily set to 20 picas.

```
\symboltable{14pc}{
$b$ & wing span, m (ft)\cr
\tableskip
$C_m$ & pitching-moment coefficient, $M_Y/qS_b$\cr
\tableskip
$M_Y$ & pitching moment, N-m (ft-lb)\cr
\tableskip
SPL & sound pressure level\cr
\tableskip
Subscripts:&\cr
\tableskip
$L$ & left wing\cr
\tableskip
max & maximum\cr}
```

results in

b	wing span, m (ft)
C_m	pitching-moment coefficient, M_Y/qS_b
M_Y	pitching moment, N-m (ft-lb)
SPL	sound pressure level
Subscripts:	
L	left wing
max	maximum

(See also appendix B, p. 110.)

SEE ALSO

\indentsymtab

\SYMBOLTABLE

NAME

indentsymtab—indented version of symboltable

SYNTAX

\indentsymtab{*colwidth***}{***tablecontents***}**

DESCRIPTION

This macro is identical to \symboltable except that the entire resulting table is indented 1.5 ems on the left. For narrower tables and tables appearing in the text of a report, this may produce a better appearance.

As in \symboltable, *colwidth* is the width of the second column, and *tablecontents* is actually the body of the table. See \symboltable for more information.

EXAMPLE

In the following example, \hsize has been temporarily set to 20 picas.

```
\indentsymtab{14pc}{
$b$ & wing span, m (ft)\cr
\tableskip
$C_m$ & pitching-moment coefficient, $M_Y/qS_b$\cr
\tableskip
$M_Y$ & pitching moment, N-m (ft-lb)\cr
\tableskip
SPL & sound pressure level\cr
\tableskip
Subscripts:&\cr
\tableskip
$L$ & left wing\cr
\tableskip
max & maximum\cr}
```

results in

b	wing span, m (ft)
C_m	pitching-moment coefficient, M_Y/qS_b
M_Y	pitching moment, N-m (ft-lb)
SPL	sound pressure level
Subscripts:	
L	left wing
max	maximum

(See also appendix B, p. 111.)

SEE ALSO

\symboltable

\SYMBOLTABLE

NAME

SYMBOLTABLE—three-column version of symboltable

SYNTAX

\SYMBOLTABLE{*colwidth*}{*tablecontents*}

DESCRIPTION

This macro is identical to \symboltable, except that it provides an extra column for symbols. It is useful in instances where two different sets of symbols must be used. For example, a variable may be represented by one symbol in the report and a different symbol in a computer listing.

As in \symboltable, *colwidth* is the width of the column containing definitions, and *tablecontents* is the body of the table. The *tablecontents* argument consists of lines of the form

symbol & *symbol* & *definition* \cr

See \symboltable for more information.

EXAMPLE

In the following example, \hsize has been temporarily set to 20 picas.

```
\SYMBOLTABLE{10pc}{
$b$ & B & wing span, m (ft)\cr
\tableskip
$C_m$ & CM & pitching-moment coefficient, $M_Y/qS_b$\cr
\tableskip
$M_Y$ & MY & pitching moment, N-m (ft-lb)\cr
\tableskip
SPL && sound pressure level\cr
\tableskip
Subscripts:&\cr
\tableskip
$L$ && left wing\cr
\tableskip
max && maximum\cr}
```

results in

b	B	wing span, m (ft)
C_m	CM	pitching-moment coefficient, M_Y/qS_b
M_Y	MY	pitching moment, N-m (ft-lb)
SPL		sound pressure level
Subscripts:		
L		left wing
max		maximum

SEE ALSO

\symboltable

\indentsymtab

Math Macros

The ease with which mathematics can be typeset with TEX is its greatest advantage. The macros in this section slightly fine-tune TEX's math capability:

- Font size macros for use within displayed equations can be used without affecting the surrounding text.
- The displayed math macros \Eqalign, \Eqaligncondno, and \Eqno customize TEX's displayed math macros for NASA format.
- The macro \bmatrix complements TEX's other matrix macros to produce matrices with square brackets. Partitioned matrices can be typeset with the macros \vdashes, \dashfill, \twodashes, and \threedashes.
- The macro \bmit complements Plain TEX's \bf macro, in order to obtain lowercase Greek characters in boldface type.
- Struts for use not only in math but also in text and tables are based on TEX's big, Big, bigg, and Bigg delimiter sizes.
- Macros to produce hyphens in math and small slanted fractions in text are also available.

NAME

math font size macros—macros to change type size of displayed equation

SYNTAX

```
\eightptmath

\nineptmath

\tenptmath
```

DESCRIPTION

Sometimes it is desirable to change the type size of a particular displayed equation. For example, if an equation is particularly large or wide, it may fit better within the column, or simply look better, in a smaller type size.

These math font size macros change the size of the fonts for the duration of the equation with no effects on surrounding text. The \baselineskip also remains unchanged.

To use these macros, simply insert one of them after the $$ at the beginning of the equation.

EXAMPLE

```
$$
\eightptmath
\eqalign{D_2(T)
&=\left\{
{e^{[(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda _1\lambda_2]^{1/2}T/2}
\over-(\lambda_1+\lambda_2+\lambda_3)
   [(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2]^{1/2}
   +(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2}\right.\cr
&\quad -\left.
{e^{-[(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda _1\lambda_2]^{1/2}T/2}
\over-(\lambda_1+\lambda_2+\lambda_3)
   [(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2]^{1/2}
   +(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2}\right\}
2\lambda_1\lambda_2e^{-(\lambda_1+\lambda_2+\lambda_3)T/2}\cr}
$$
```

results in

$$\begin{aligned} D_2(T) &= \left\{ \frac{e^{[(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2]^{1/2}T/2}}{-(\lambda_1+\lambda_2+\lambda_3)[(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2]^{1/2}+(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2} \right. \\ &\quad - \left. \frac{e^{-[(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2]^{1/2}T/2}}{-(\lambda_1+\lambda_2+\lambda_3)[(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2]^{1/2}+(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2} \right\} 2\lambda_1\lambda_2 e^{-(\lambda_1+\lambda_2+\lambda_3)T/2} \end{aligned}$$

which is still too wide!

RESTRICTIONS

These math font size macros must be used in math mode.

SEE ALSO

font size macros—\eightpt, \ninept, \tenpt

NAME

Eqno—variation of eqno, to produce 10-point roman (non-math) equation number

SYNTAX

\Eqno(*equationnumber*)

DESCRIPTION

\Eqno is a variation of \eqno from Plain TEX that processes the *equationnumber* in horizontal mode (like text) rather than in math mode. The *equationnumber* will be treated like text, and will be output in 10-point roman font.

Note the parentheses ( ) in the syntax as opposed to the usual curly braces that surround arguments. The parentheses are used to emphasize the fact that parentheses will appear around the equation number in the output.

To prevent the type size of the equation number from being affected, This macro should be used whenever the type size of the displayed equation is adjusted. Also, using \Eqno will ensure that any letter designations in equation numbers will be in roman (text) type.

EXAMPLE

```
$$
Ax  + By + C =  0 \Eqno(2a)
$$
```

yields

$$Ax + By + C = 0 \qquad (2a)$$

Also

```
$$
\eightptmath
\eqalign{D_2(T)
&=\left\{
{e^{[(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda _1\lambda_2]^{1/2}T/2}
\over-(\lambda_1+\lambda_2+\lambda_3)
   [(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2]^{1/2}
   +(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2}\right.\cr
&\quad -\left.
{e^{-[(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda _1\lambda_2]^{1/2}T/2}
\over-(\lambda_1+\lambda_2+\lambda_3)
   [(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2]^{1/2}
   +(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2}\right\}\cr
&\quad \times2\lambda_1\lambda_2e^{-(\lambda_1+\lambda_2+\lambda_3)T/2}\cr}
\Eqno(A2)
$$
```

yields

$$D_2(T) = \left\{ \frac{e^{[(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2]^{1/2}T/2}}{-(\lambda_1+\lambda_2+\lambda_3)[(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2]^{1/2}+(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2} - \frac{e^{-[(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2]^{1/2}T/2}}{-(\lambda_1+\lambda_2+\lambda_3)[(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2]^{1/2}+(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2} \right\} \times 2\lambda_1\lambda_2 e^{-(\lambda_1+\lambda_2+\lambda_3)T/2} \qquad \text{(A2)}$$

SEE ALSO

\eqno, pp. 186–187, *The TEXbook* (ref. 1)

NAME

Eqalignno—version of eqalignno with 10-point roman equation number

SYNTAX

\Eqalignno{*alignedmath*}

DESCRIPTION

\Eqalignno is a variation of TeX's \eqalignno. It is used identically to \eqalignno. Please refer to *The TeXbook* (ref. 1) for details about \eqalignno.

The only difference is that the equation number is ensured to be in the 10-point roman font. To prevent the type size of the equation number from being affected, this macro should be used whenever the type size of the displayed equation is adjusted. The equation number is assumed to be horizontal mode material (roman type), not math mode (italic type).

EXAMPLE

```
$$
\eightptmath
\Eqalignno{D_2(T)
&=\left\{
{e^{[(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda _1\lambda_2]^{1/2}T/2}
\over-(\lambda_1+\lambda_2+\lambda_3)
   [(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2]^{1/2}
   +(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2}\right.\cr
&\quad -\left.
{e^{-[(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda _1\lambda_2]^{1/2}T/2}
\over-(\lambda_1+\lambda_2+\lambda_3)
   [(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2]^{1/2}
   +(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2}\right\}\cr
&\quad\times2\lambda_1\lambda_2e^{-(\lambda_1+\lambda_2+\lambda_3)T/2}
&(A2)\cr}
$$
```

yields

$$\begin{aligned}D_2(T) &= \left\{ \frac{e^{[(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2]^{1/2}T/2}}{-(\lambda_1+\lambda_2+\lambda_3)[(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2]^{1/2}+(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2}\right. \\ &\quad - \left. \frac{e^{-[(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2]^{1/2}T/2}}{-(\lambda_1+\lambda_2+\lambda_3)[(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2]^{1/2}+(\lambda_1+\lambda_2+\lambda_3)^2-4\lambda_1\lambda_2}\right\} \\ &\quad \times 2\lambda_1\lambda_2 e^{-(\lambda_1+\lambda_2+\lambda_3)T/2} \qquad \text{(A2)}\end{aligned}$$

SEE ALSO

\eqalignno, pp. 192–193, *The TeXbook* (ref. 1)

NAME

Eqaligncondno—variation of \Eqalignno, right-justified "condition" before equation number

SYNTAX

\Eqaligncondno{*alignedmath*}

DESCRIPTION

This macro is similar to \Eqalignno in that the equation number appears in 10-point roman type. The important distinction of \Eqaligncondno is that a third part of each expression can be aligned on the right before the equation number. This makes Eqaligncondno ideal for constructions with "conditions" (hence the name!)

EXAMPLE

```
$$
\Eqaligncondno{f(x) &= 0 & \hbox{if } (x = 0) & (2a)\cr
               f(x) &= {1\over x} & \hbox{(if } x > 0) & (2b)\cr
               f(x) &= \infty & \hbox{(Otherwise)} & (2c)\cr}
$$
```

yields

$$f(x) = 0 \qquad \text{if } x = 0 \qquad (2a)$$

$$f(x) = \frac{1}{x} \qquad \text{if } x > 0 \qquad (2b)$$

$$f(x) = \infty \qquad \text{Otherwise} \qquad (2c)$$

SEE ALSO

\Eqalignno

\eqalignno. pp. 192–193, *The TEXbook* (ref. 1)

NAME

bmatrix—matrix with square brackets

SYNTAX

\bmatrix{*matrixcontents*}

DESCRIPTION

The \bmatrix command uses TeX's \matrix macro to produce a matrix from *matrixcontents* and encloses the matrix in square brackets ([ ]). It is analogous to Plain TeX's \pmatrix macro.

The *matrixcontents* argument contains all the entries for the matrix. Column entries should be separated with ampersands (&), and \cr should be used to designate the end of each row.

EXAMPLE

```
$$
  \bmatrix{ 1 & 2 & 3 \cr
            4 & 5 & 6 \cr
            7 & 8 & 9 \cr}
$$
```

yields:

$$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$

SEE ALSO

\matrix, \pmatrix references in *The TeXbook* (ref. 1)

NAME

vdashes—vertical dashes for partitioned matrices

SYNTAX

```
\vdashes
```

DESCRIPTION

The \vdashes macro works similarly to TEX's \vdots macro for matrices. It is useful for generating vertical dashed lines in partitioned matrices.

EXAMPLE

```
$$
\bmatrix{K_{11} & \vdashes & K_{13} & \vdashes & K_{15}\cr
         K_{21} & \vdashes & K_{33} & \vdashes & K_{35}\cr
         K_{51} & \vdashes & K_{53} & \vdashes & K_{55}\cr}
$$
```

yields

$$\begin{bmatrix} K_{11} & \vdots & K_{13} & \vdots & K_{15} \\ K_{21} & \vdots & K_{33} & \vdots & K_{35} \\ K_{51} & \vdots & K_{53} & \vdots & K_{55} \end{bmatrix}$$

SEE ALSO

\vdots, p. 177, *The TEXbook* (ref. 1)

\twodashes, \threedashes, \dashfill

NAME

dashfill—fill space with horizontal dashes

SYNTAX

```
\dashfill
```

DESCRIPTION

The \dashfill macro fills space in the same manner that \hfill does, except that dashes are produced in the desired space. This macro was developed for partitioned matrices.

EXAMPLE

```
$$
\bmatrix{K_{11} & \vdashes & K_{13} & \vdashes & K_{15}\cr
        \multispan5\dashfill\cr
              & \vdashes & K_{33} & \vdashes & K_{35}\cr
              &\multispan4\dashfill\cr
        \multispan3Symmetric\hfill & \vdashes & K_{55}\cr}
$$
```

results in

$$\begin{bmatrix} K_{11} & \vdots & K_{13} & \vdots & K_{15} \\ \hdashline & \vdots & K_{33} & \vdots & K_{35} \\ \cdashline{2-5} \multicolumn{3}{l}{\text{Symmetric}} & \vdots & K_{55} \end{bmatrix}$$

SEE ALSO

\vdashes, \twodashes, \threedashes

NAME

twodashes, threedashes—horizontal dashes for partitioned matrices

SYNTAX

```
\twodashes

\threedashes
```

DESCRIPTION

These macros produce either two or three short consecutive horizontal dashes for use in partitioned matrices. They can be used similarly to \cdots or \ldots in Plain TEX. They are especially useful in partitioned matrices when \dashfill produces only one dash. Use the two- or three-dash version depending on your preference in your application.

EXAMPLE

```
$$
\bmatrix{w_1\cr \twodashes\cr w_2\cr \twodashes\cr w_3\cr}
=
\bmatrix{w_1\cr \threedashes\cr w_2\cr \threedashes\cr w_3\cr}
=
\bmatrix{w_1\cr \dashfill\cr w_2\cr \dashfill\cr w_3\cr}
$$
```

results in

$$\begin{bmatrix} w_1 \\ -- \\ w_2 \\ -- \\ w_3 \end{bmatrix} = \begin{bmatrix} w_1 \\ --- \\ w_2 \\ --- \\ w_3 \end{bmatrix} = \begin{bmatrix} w_1 \\ - \\ w_2 \\ - \\ w_3 \end{bmatrix}$$

SEE ALSO

\cdots, \ldots, p. 172, *The TEXbook* (ref. 1)

\dashfill, \vdashes

NAME

bmit—lowercase Greek in boldface font

SYNTAX

```
\bmit
```

DESCRIPTION

Vectors, matrices, and tensors are usually represented by boldface characters. Roman letters and **capital** Greek letters can be obtained in math mode with Plain TeX's \bf macro. However, lowercase Greek letters are a different matter. In LARCMACS the lowercase Greek letters have been defined as in Exercise 17.20 of the *The TeXbook* (ref. 1) and \bmit causes lowercase Greek to be boldface.

The macro \bmit should be used like \rm, \it, and \bf and enclosed in braces to avoid unwanted font changes elsewhere in the equation.

Please **note** that \bf is used to obtain **capital** Greek and \bmit is used to obtain **lowercase** Greek.

EXAMPLE

```
$$
\tilde{\bmit\xi}
=\left\{\matrix{\tilde{\bmit\xi}'\cr
                {\bf\Gamma}'\cr}\right\}
=\left\{\matrix{\tilde{\bmit\xi}'\cr
                {\bf T}_A{\bmit\delta}'_c\cr}\right\}
$$
```

results in

$$\tilde{\boldsymbol{\xi}} = \left\{\begin{matrix}\tilde{\boldsymbol{\xi}}' \\ \mathbf{\Gamma}'\end{matrix}\right\} = \left\{\begin{matrix}\tilde{\boldsymbol{\xi}}' \\ \mathbf{T}_A\boldsymbol{\delta}'_c\end{matrix}\right\}$$

RESTRICTIONS

Not all installations of am fonts have a bold math italic font.

If you were to type a lowercase Greek letter under the effect of \rm or \bf, you would get a spurious character; for example, `${\rm\alpha}$` would result in ff.

SEE ALSO

Exercise 17.20 in *The TeXbook* (ref. 1)

NAME

bigstrut, Bigstrut, biggstrut, Biggstrut—struts to adjust vertical spacing

SYNTAX

```
\bigstrut, \Bigstrut, \biggstrut, \Biggstrut
```

DESCRIPTION

Struts are useful for adjusting vertical spacing in math constructions and in tables. These struts have height and depth, but no width, and thus do not result in any visible output. A \bigstrut has the height plus depth of a \big(. A \Bigstrut has the height plus depth of a \Big(. A \biggstrut has the height plus depth of a \bigg(. And, a \Biggstrut has the height plus depth of a \Bigg(.

EXAMPLE

```
$$
\left\{\Biggstrut\left\{\biggstrut\left\{\Bigstrut\left\{\bigstrut
\right\}\right\}\right\}\right\}
$$
```

yields

$$\left\{\Bigg.\left\{\bigg.\left\{\Big.\left\{\big.\right\}\right\}\right\}\right\}$$

Another more practical example, but not as much fun, is

```
$$
p=\cases{\displaystyle
        -{p_o\beta\over\pi}-\sum^{10}_{n=1}p_n\cos n\theta
           &\hfill$(-0.2<\xi<0.2)$\cr
        \Biggstrut 6.895\times10^5
           &\hfill$(\vert\xi\vert>0.2)$\cr}\eqno{(27)}
$$
```

which results in

$$p=\begin{cases}\displaystyle -\frac{p_o\beta}{\pi}-\sum_{n=1}^{10}p_n\cos n\theta & (-0.2<\xi<0.2)\\[3ex] 6.895\times10^5 & (|\xi|>0.2)\end{cases}\qquad(27)$$

Without the \Biggstrut, the spacing in this equation is unbalanced:

$$p=\begin{cases}\displaystyle -\frac{p_o\beta}{\pi}-\sum_{n=1}^{10}p_n\cos n\theta & (-0.2<\xi<0.2)\\ 6.895\times10^5 & (|\xi|>0.2)\end{cases}\qquad(27)$$

For other examples of using these struts, see the examples in the "Table Macros" section.

SEE ALSO

\strut and \mathstrut references in *The TEXbook* (ref. 1)

NAME

hyphen—produce hyphen in math mode

SYNTAX

\hyphen

DESCRIPTION

In math mode, the hyphen character (-) produces a minus sign. The macro \hyphen produces a normal 10-point hyphen, even in math mode. It is useful in instances in math mode when a hyphen is desired rather than a minus sign.

EXAMPLE

```
Compare ${\rm Lift-curve\ slope}=\partial C_L/\partial\alpha$ with
${\rm Lift\hyphen curve\ slope}=\partial C_L/\partial\alpha$
```

yields

Compare $\mathrm{Lift-curve\ slope}=\partial C_L/\partial\alpha$ with Lift-curve slope $=\partial C_L/\partial\alpha$

NAME

smallhyphen—produce small-sized hyphen in math mode

SYNTAX

```
\smallhyphen
```

DESCRIPTION

This macro produces a small (7-point) hyphen. It is useful for hyphens that appear in superscripts or subscripts.

EXAMPLE

```
Compare ${\rm SPL_{structure-borne}}$ with
${\rm SPL_{structure\smallhyphen borne}}$
```

yields

Compare $\mathrm{SPL}_{\mathrm{structure-borne}}$ with $\mathrm{SPL}_{\mathrm{structure\text{-}borne}}$

NAME

slant—small, slashed, in-line fraction

SYNTAX

\slant{*numerator*}{*denominator*}

DESCRIPTION

Fractions within the text can be produced with the slash character (1 2/3) or with Plain TeX's \over macro ($1{2\over3}$). Typographers have traditionally used small fractions (1²⁄₃). The \slant macro produces a small, slashed fraction within text.

Do not enclose \slant in dollar signs ($...$).

EXAMPLE

The first two sentences under DESCRIPTION were produced by the following:

```
Fractions within the text can be produced with the slash character
(1 2/3) or with Plain \TeX's \\over macro (1${2\over3}$).  Typographers
have traditionally used small fractions (1\slant{2}{3}).
```

SEE ALSO

fractions, pp. 139–141, *The TeXbook* (ref. 1)

Miscellaneous Macros

This section contains macros for a variety of purposes:

- Macros to draw boxes around things.
- Macros to produce special characters such as degree signs, ellipses, and trademark symbols.
- A macro to produce a large font.
- A macro to control vertical spacing more precisely.

NAME

boxit—draw a box around something, including some surrounding spacing

SYNTAX

`\boxit{`*text*`}`

DESCRIPTION

The \boxit macro is similar to one from Exercise 21.3 in *The TeXbook*. The given text is surrounded an all four sides by 3 points of space and ruled lines.

The *text* argument can be almost any text or box. It will be processed in restricted horizontal mode.

EXAMPLE

```
\boxit{\TeX}
```

yields

TeX

RESTRICTIONS

The resulting box does not have the same baseline as the original text.

SEE ALSO

Exercise 21.3, pp. 223 and 331, *The TeXbook* (ref. 1)

\boxittable

NAME

boxittable—draw a box that exactly fits around something

SYNTAX

`\boxittable{`*text*`}`

DESCRIPTION

The \boxittable macro is similar to the \boxit macro. The given text is surrounded by ruled lines on all four sides.

This macro is useful for ruled tables where no extra space around the perimeter is desired. In fact, it is used in the definition of \boxtable and \hardboxtable.

The *text* argument can be either text or a box (containing an entire table, for example). It will be enclosed in an \hbox.

EXAMPLE

```
\boxittable{\hbox{\TeX}}
```

yields

TEX

RESTRICTIONS

The resulting box does not have the same baseline as the original text.

SEE ALSO

\boxit

NAME

deg—degree symbol for text (horizontal mode)

SYNTAX

\deg

DESCRIPTION

For use in text, outside of math mode, \deg is a simple way to produce a small superscripted circle, or degree symbol.

EXAMPLE

```
The temperature rose 10\deg\ when heat was applied.
```

yields

The temperature rose 10° when heat was applied.

RESTRICTIONS

This macro overrides the \deg macro from Plain TeX.

Attempts to use this macro within math mode will yield unusual characters.

SEE ALSO

\deg, p. 162, *The TeXbook* (ref. 1)

NAME

ellipse—produce an ellipse (...)

SYNTAX

```
\ellipse
```

DESCRIPTION

In Plain TEX, it is necessary to go into math mode to produce an ellipse properly. This macro is provided to easily produce an ellipse within text, or horizontal mode.

EXAMPLE

```
Hmmm \ellipse\ I wonder why?
```

yields

Hmmm ... I wonder why?

SEE ALSO

\ldots, p. 73, *The TEXbook* (ref. 1)

NAME

solidmedskip variation of \medskip with stretching prevented

SYNTAX

```
\solidmedskip
```

DESCRIPTION

Plain TEX's \medskip macro is defined to be a vertical skip of 6 points that is allowed to stretch or shrink by 2 points.

Occasionally, it is preferable to have more control over the amount of vertical space used in certain places. The \solidmedskip macro provides an (almost) fixed amount of vertical space the same size as a \medskip. A \solidmedskip is not allowed to stretch and is only allowed to shrink an unnoticeable amount (1 point).

EXAMPLE

```
\line{\vbox to 32pt{\hbox{There is a medskip}
      \medskip
      \hbox{between these lines}}
\hskip.5in
      \vbox to 32pt{\hbox{There is a solidmedskip}
      \solidmedskip
      \hbox{between these lines}}
\hfill}
```

yields

There is a medskip	There is a solidmedskip
	between these lines
between these lines	

While TEX is running, we receive the following messages concerning the left and right "vboxes," respectively:

```
Underfull \vbox (badness 2318) detected at line 6
Underfull \vbox (badness 10000) detected at line 9
```

The badness is much worse (the worst it could be) for the right vbox because the \solidmedskip does not stretch vertically.

NAME

tlfont—large font for miscellaneous titles

SYNTAX

```
\tlfont
```

DESCRIPTION

This macro changes the current font to a large roman font (\magstep 2, approximately 14 points). The macro \tlfont is not intended for use within NASA formal reports, but may have other applications.

EXAMPLE

```
\tlfont  This is a title!
```

yields

This is a title!

RESTRICTIONS

This macro is not set up to work with the \contents macro.

NAME

trademark—trademark symbol

SYNTAX

```
\trademark
```

DESCRIPTION

This macro produces a small superscripted R enclosed in a circle, known as a "trademark" symbol.

EXAMPLE

```
\TeX\trademark\ is a trademark of the American Mathematical Society.
```

yields

TEX® is a trademark of the American Mathematical Society.

Appendix A
LARCMACS Definitions

The following is the actual code for the complete set of LARCMACS macros. For consistency please do not edit any of the LARCMACS files. If changes are desired, macros may be redefined and parameter values reset in your own macro files or document files.

We do encourage you to study these definitions and use the ideas applied in these macros in your own macro definitions.

```
%
% This is LARCMACS.TEX as of February 1988
% This is the generic version of MACROS.TEX used by TEB at LaRC.
% (Written by Linda Woessner and Mary McCaskill)
%
% For questions/problems, contact:
% Cheryl Williams(x2561) or  Mary McCaskill(x3325)
%
%
%  MISC. MACROS
%
%  Boxit macro as per ex 21.3 in TeXbook
\def\boxit#1{\vbox{\hrule\hbox{\vrule\kern3pt
\vbox{\kern3pt\hbox{#1}\kern3pt}\kern3pt\vrule}\hrule}}
%
%  Boxit macro without 3pt spacing
\def\boxittable#1{\vbox{\hrule\hbox{\vrule\vbox{#1}\vrule}\hrule}}
%
%  Leader macros
\def\leaderfill{\leaders\hbox to 1em{\hss.\hss}\hfill} %fill line
\def\twodots{\hbox to 2em{\leaderfill}}                %force two leaders
\def\threedots{\hbox to 3em{\leaderfill}}              %force three leaders
%
%  Non-Math Degree symbol
\def\deg{\char'027}
%
%  Flush left version of \item (for reference lists)
\def\leftitem#1{\par\noindent\rlap{#1}%
\hskip\the\parindent\hang}
%
%  Alternate definition for backslash character (\\)
%\def\\{$\backslash$}
%
%
```

```
% TABLE MACROS
%
% For use within tables...
\def\tablerule{\noalign{\hrule}}                      %hrule within a table
\def\widehead#1{\omit\strut\hidewidth#1\hidewidth}   %for wide headings
\def\tableskip{\noalign{\medskip}}                    %blank vert space
\def\\{\centerline}                                   %alt. def for centering
\def\boxhead#1{\omit\hfill\vbox{\vskip2pt\normalbaselines\hsize1pt%
#1\vskip2pt}\hfill}% #1 is lines of boxhead preceded by \\ and enclosed {}
%
% Leadertable macros
\def\l#1&#2\cr{\line{\strut#1\leaderfill#2}}                 %#1 . . . #2
\def\ql#1&#2\cr{\line{\strut\hbox{\quad}#1\leaderfill#2}}    %one left indent
\def\qql#1&#2\cr{\line{\strut\hbox{\qquad}#1\leaderfill#2}}  %double indent
%
% Symboltables for NASA Technical Reports
\def\symboltable#1#2{\tabskip=0pt\halign to \hsize{##\hfill%
\tabskip 2em plus 2in minus 2em&\vtop{\hsize#1\noindent\raggedright%
\strut##\strut}\hfill\cr#2}}
%
% Indented version of Symboltable
\def\indentsymtab#1#2{\tabskip=0pt\halign to \hsize{\hskip1.5em##%
\hfill%
\tabskip 2em plus 2in minus 2em&\vtop{\hsize#1\noindent\raggedright%
\strut##\strut}\hfill\cr#2}}
%
% Three column version of Symboltable
\def\SYMBOLTABLE#1#2{\tabskip=0pt\halign to \hsize{##\hfill%
\tabskip 2em plus 2in minus 2em&%
##\hfill&\vtop{\hsize#1\noindent\raggedright%
\strut##\strut}\hfill\cr#2}}
%
% Basic table macro
% Use: \table{<desired width>}{<table body including preamble>}
\newdimen\digitwidth\newdimen\decimalwidth
\def\table#1#2{\tabskip=3em plus 6in minus 3em%
\setbox0=\hbox{\rm0}\digitwidth=\wd0%
\setbox0=\hbox{\rm.}\decimalwidth=\wd0%
$$\vbox{\def~{\kern\digitwidth}%
\def\.{\kern\decimalwidth}%
\baselineskip10pt\offinterlineskip%
\halign to #1{\strut#2}}$$}
%
% Ruledtable is just like table, except that tabskip is set to 0,
% initially. Tabskip glue with stretch and shrink must be specified
% within the table's preamble! Use this macro instead of \table
% if you're having problems with rules not meeting.
\def\ruledtable#1#2{\tabskip=0pt$$\vbox{\setbox0=\hbox{\rm0}%
\digitwidth=\wd0\def~{\kern\digitwidth}%
```

```
\setbox0=\hbox{\rm.}\decimalwidth=\wd0\def\.{\kern\decimalwidth}%
\baselineskip10pt\offinterlineskip%
\halign to #1{\strut#2}}$$}
%
%  Boxtable is like table, but puts a box (rules) around entire table.
\newdimen\tablewidth
\def\boxtable#1#2{\tabskip=4em plus 6in minus 4em$$\boxittable{\vbox{%
\setbox0=\hbox{\rm0}\digitwidth=\wd0\def~{\kern\digitwidth}%
\setbox0=\hbox{\rm.}\decimalwidth=\wd0\def\.{\kern\decimalwidth}%
\baselineskip10pt\offinterlineskip%
\tablewidth=#1\advance\tablewidth by -0.8pt%
\halign to\tablewidth{\strut#2}}}$$} %\table<width><table body>
%
%  Hardboxtable combines the features of Ruledtable and Boxtable
\def\hardboxtable#1#2{\tabskip=0pt$$\boxittable{%
\setbox0=\hbox{\rm0}\digitwidth=\wd0%
\setbox0=\hbox{\rm.}\decimalwidth=\wd0%
\vbox{\def\.{\kern\decimalwidth}%
\def~{\kern\digitwidth}\baselineskip10pt\offinterlineskip%
\tablewidth=#1\advance\tablewidth by -0.8pt%
\halign to\tablewidth{\strut#2}}}$$} %\table<width><table body>
%
%  Figure and Legend macros
\def\figure#1#2{\topinsert\vskip#1\bigskip\centerline{\ninept#2}\endinsert}
\def\midfigure#1#2{\midinsert\vskip#1\bigskip\centerline{\ninept#2}\endinsert}
\def\figurepar#1#2{\topinsert\vskip#1\bigskip\ninept\figleg{#2}\endinsert}
\def\figleg#1{\par\noindent\hang#1\par}
%
%
%  MATH MACROS
%
%  Misc.
\def\ellipse{$\ldots$}                     % alternate def for . . .
\def\bmatrix#1{\left[\matrix{#1}\right]}  %\pmatrix with square brackets
\def\Biggstrut{\vphantom{\Bigg(}}
\def\biggstrut{\vphantom{\bigg(}}
\def\bigstrut{\vphantom{\big(}}
\def\Bigstrut{\vphantom{\Big(}}
%
%  Superscripted hyphen
\newbox\hyp
\setbox\hyp=\hbox{\sevenrm-}
\def\smallhyphen{\copy\hyp}
%
%  Hyphen in math mode
\newbox\hyphn
\setbox\hyphn=\hbox{\rm-}
\def\hyphen{\copy\hyphn}
%
```

```
% Slashed-form fractions
\def\slant#1#2{$\sevenrm\raise.3em\hbox{#1}\kern-.166em\raise2pt\hbox{/}
\kern-1.2pt\hbox{\sevenrm#2}$} % small (in-line) slashed-form fraction
%
% Partition matrix macros
\catcode`@=11 %allow at signs to be letters, temporarily!
\def\vdashrule{\vrule width 0.4pt height 6pt}
\def\hdashrule{\hrule width 6pt height 0.4pt}
\def\vdashes{\lower6pt\vbox{\baselineskip4\p@ \lineskiplimit\z@
\kern6\p@\hbox{\vdashrule}\hbox{\vdashrule}\hbox{\vdashrule}}}
\def\dashfill{\xleaders\hbox to 7.5pt{\hss\leaders\hdashrule\hskip6pt\hss}
\hfill}
\def\twodashes{\hbox to 15pt{\dashfill}}        %force two dashes
\def\threedashes{\hbox to 22.5pt{\dashfill}}     %force three dashes
\catcode`@=12 % at signs are no longer letters
%
% Change character definitions to allow bold lower case greek
\mathchardef\alpha="710B
\mathchardef\beta="710C
\mathchardef\gamma="710D
\mathchardef\delta="710E
\mathchardef\epsilon="710F
\mathchardef\zeta="7110
\mathchardef\eta="7111
\mathchardef\theta="7112
\mathchardef\iota="7113
\mathchardef\kappa="7114
\mathchardef\lambda="7115
\mathchardef\mu="7116
\mathchardef\nu="7117
\mathchardef\xi="7118
\mathchardef\pi="7119
\mathchardef\rho="711A
\mathchardef\sigma="711B
\mathchardef\tau="711C
\mathchardef\upsilon="711D
\mathchardef\phi="711E
\mathchardef\chi="711F
\mathchardef\psi="7120
\mathchardef\omega="7121
\mathchardef\varepsilon="7122
\mathchardef\vartheta="7123
\mathchardef\varpi="7124
\mathchardef\varrho="7125
\mathchardef\varsigma="7126
\mathchardef\varphi="7127
%
% Redefine eqalignno to force the eqno to be in 10pt roman (MKM)
\catcode`@=11
```

```
\def\Eqalignno#1{\displ@y\tabskip=\centering\halign to%
\displaywidth{\hfil$\displaystyle{##}$\tabskip=0pt&%
$\displaystyle{{}##}$\hfil%
\tabskip=\centering&\llap{\tenrm ##}\tabskip=0pt\crcr#1\crcr}}
%
% Align conditions to equations on right, and produce 10.5pt eqno (MKM)
\def\Eqaligncondno#1{\displ@y\tabskip=\centering%
\halign to\displaywidth{\hfil$\displaystyle{##}$\tabskip=0pt%
&$\displaystyle{{}##}$\hfil\tabskip=1em%
&\hfil$\displaystyle{##}$\tabskip=\centering%
&\llap{\tenrm##}\tabskip=0pt\crcr#1\crcr}}%
\catcode`@=12
%
% Allow type size of equations to change without affecting
% surrounding text (MKM)
\def\eightptmath{\eightpt\baselineskip=12pt\fam=-1}
\def\nineptmath{\ninept\baselineskip=12pt\fam=-1}
\def\tenptmath{\tenpt\fam=-1}
%
% Produce 10pt, roman equation number without extra braces (MKM)
\def\Eqno(#1){\eqno\hbox{\tenrm (#1)}}
%
% Trademark symbol (MKM)
\def\trademark{$^{\hbox{\sevensy\char'015\kern-.80em\fiverm R}}$}
%
%
% FORMAT MACROS
%
% Double column format
\newif\ifdbl\dblfalse % doublecolumn format? (initially false)
\def\doublecol{\ifdbl\relax\else\input dblcol\global\dbltrue\fi}
%
% Splitcol output format (See file for documentation)
\def\splitcol{\input splitcol\relax}
%
% Footnote with superscripted ref mark, and smaller font text
\def\fn#1#2{{\baselineskip10pt\eightpt\footnote{#1}{#2}}}
%
% Level two heading font
\font\romanboldbigten=ambx10 scaled \magstephalf
\def\levtwofont{\baselineskip 12pt\romanboldbigten}
%
% Level one heading. (Hyphenation and page breaks prevented--MKM)
\def\levelone#1{\vbox{\rightskip=0pt plus 1fil \spaceskip=.3333em
\xspaceskip=.5em \pretolerance=9999 \tolerance=9999
\hyphenpenalty=9999 \exhyphenpenalty=9999
\twelvept\noindent\bf#1}\par\nobreak\medskip}
\def\leveltwo#1{\vbox{\leftskip=\parindent\rightskip=0pt plus1fil%
\spaceskip=.3333em\xspaceskip=.5em\pretolerance=9999\tolerance=9999%
```

```
\hyphenpenalty=9999\exhyphenpenalty=9999\levtwofont\noindent#1}\par%
\nobreak\medskip}
%
%  Level three heading
\def\levelthree#1{\relax\par\vskip2pt\indent{\IT#1}{\bf.}}
%
%  Medium skip with no stretch (and very little shrink)
\def\solidmedskip{\vskip 6pt plus 0pt minus 1pt}
%
%  Head and foot lines
\def\runhead#1{\headline={\hfill\tenrm#1\hfill}}
\def\lftfootline{\tenbf\folio\hss}
\def\rtfootline{\tenbf\hss\folio}
\footline={\ifodd\pageno\rtfootline\else\lftfootline\fi}
\headline={\hfill}
%
%  Title font
\font\romanboldfourteen=ambx10 scaled \magstep2
\def\tlfont{\baselineskip 16pt\romanboldfourteen}
%
% "Cosati" or "Abstract" page
\def\begincosati{\input cosati\relax}
%
%  Table of Contents generation
\newwrite\ct
\def\contents{%
\message{Please type the filename for contents:}
\read16 to\filename
\immediate\openout\ct=\filename
\immediate\write\ct{\string\input}
\immediate\write\ct{larcmacs}
\immediate\write\ct{\string\footline={\string\hss\string\tenbf%
   \string\folio\string\hss}}
\immediate\write\ct{\string\pageno=-3 \string\hsize=35pc\string\parindent=0pt}
\immediate\write\ct{\string\levelone{Contents}}
%new definitions for heading macros
\def\levelone##1{\vbox{\rightskip=0pt plus 1fil \spaceskip=.333em
\xspaceskip=.5em \pretolerance=9999 \tolerance=9999
\hyphenpenalty=9999 \exhyphenpenalty=9999
\twelvept\noindent
\write\ct{\string\medskip\string\line{##1\string\leaderfill{\folio}}}
\bf##1}\par\nobreak\medskip}
\def\leveltwo##1{\vbox{\leftskip=\parindent\rightskip=0pt plus 1fil
\spaceskip=.3333em \xspaceskip=.5em \pretolerance=9999 \tolerance=9999
\hyphenpenalty=9999 \exhyphenpenalty=9999 \levtwofont\noindent
\write\ct{\string\smallskip\string\line{\string\quad{##1}\string
\leaderfill{\folio}}}
##1}\par\nobreak\medskip}
\def\levelthree##1{\relax\par\vskip2pt\indent
```

```
\write\ct{\string\line{\string\qquad{##1}\string\leaderfill{\folio}}}
{\IT ##1}{\bf.}}
}% end contents macros
%
%  Hyphenation exceptions
%  Create your own hyphenations.tex file with exceptions to TeX's
%  hyphenation rules. You will need to remove the % preceeding the
%  following line:
%\input hyphenations.tex
%
%
%  FONT MACROS
%
%  Different size fonts
\newif\ifbfl\bflfalse   % big fonts loaded?  (initially false)
%
%  Seven point roman font family
\def\sevenpt{\normalbaselineskip=9pt\normalbaselines%
\textfont0=\sevenrm\scriptfont0=\fiverm\scriptscriptfont0=\fiverm%
\def\rm{\fam0\sevenrm}\rm%
\textfont1=\seveni\scriptfont1=\fivei\scriptscriptfont1=\fivei%
\def\mit{\fam1}\def\oldstyle{\fam1\seveni}%
\textfont2=\sevensy\scriptfont2=\sevensy\scriptscriptfont2=\fivesy%
\def\cal{\fam2}%
\textfont3=\tenex\scriptfont3=\tenex\scriptscriptfont3=\tenex%
\def\it{\fam\itfam\sevenit}% \it is family 4
\textfont\itfam=\sevenit%
\def\bf{\fam\bffam\sevenbf}% \bf is family 6
\textfont\bffam=\sevenbf\scriptfont\bffam=\sevenbf%
\scriptscriptfont\bffam=\fivebf}
%
% Eight point roman font family
\def\eightpt{\normalbaselineskip=10pt\normalbaselines%
\font\eighttt=amtt8%
\textfont0=\eightrm\scriptfont0=\sevenrm\scriptscriptfont0=\sixrm%
\def\rm{\fam0\eightrm}\rm%
\textfont1=\eighti\scriptfont1=\seveni\scriptscriptfont1=\sixi%
\def\mit{\fam1}\def\oldstyle{\fam1\eighti}%
\textfont2=\eightsy\scriptfont2=\sevensy\scriptscriptfont2=\sixsy%
\def\cal{\fam2}%
\textfont3=\tenex\scriptfont3=\tenex\scriptscriptfont3=\tenex%
\def\it{\fam\itfam\eightit}% \it is family 4
\textfont\itfam=\eightit%
\def\bf{\fam\bffam\eightbf}% \bf is family 6
\textfont\bffam=\eightbf\scriptfont\bffam=\sevenbf%
\scriptscriptfont\bffam=\sixbf%
\def\tt{\fam\ttfam\eighttt}% \tt is family 7
\textfont\ttfam=\eighttt}
%
```

```
% Bigeight and Bigten point font families used at TEB: here = 8 and 10 pt
\def\bigeightpt{\eightpt\relax}
\def\bigtenpt{\tenpt\relax}
%
% Nine point roman font family
\def\ninept{\normalbaselineskip=11pt\normalbaselines%
\textfont0=\ninerm\scriptfont0=\sevenrm\scriptscriptfont0=\sixrm%
\def\rm{\fam0\ninerm}\rm%
\textfont1=\ninei\scriptfont1=\seveni\scriptscriptfont1=\sixi%
\def\mit{\fam1}\def\oldstyle{\fam1\ninei}%
\textfont2=\ninesy\scriptfont2=\sevensy\scriptscriptfont2=\sixsy%
\def\cal{\fam2}%
\textfont3=\tenex\scriptfont3=\tenex\scriptscriptfont3=\tenex%
\def\it{\fam\itfam\nineit}% \it is family 4
\textfont\itfam=\nineit%
\def\bf{\fam\bffam\ninebf}% \bf is family 6
\textfont\bffam=\ninebf\scriptfont\bffam=\sevenbf%
\scriptscriptfont\bffam=\sixbf}
%
% Ten point roman font family (default)
\def\tenpt{\normalbaselineskip=12pt\normalbaselines%
\textfont0=\tenrm\scriptfont0=\eightrm\scriptscriptfont0=\sixrm%
\def\rm{\fam0\tenrm}\rm%
\textfont1=\teni\scriptfont1=\eighti\scriptscriptfont1=\sixi%
\def\mit{\fam1}\def\oldstyle{\fam1\teni}%
\textfont2=\tensy\scriptfont2=\eightsy\scriptscriptfont2=\sixsy%
\def\cal{\fam2}%
\textfont3=\tenex\scriptfont3=\tenex\scriptscriptfont3=\tenex%
\def\it{\fam\itfam\tenit}% \it is family 4
\textfont\itfam=\tenit%
\def\sl{\fam\slfam\tensl}% \sl is family 5
\textfont\slfam=\tensl%
\def\bf{\fam\bffam\tenbf}% \bf is family 6
\textfont\bffam=\tenbf\scriptfont\bffam=\eightbf%
\scriptscriptfont\bffam=\sixbf
\textfont\ttfam=\tentt
\def\tt{\fam\ttfam\tentt}    % \tt is family 7
\textfont9=\tenbi\scriptfont9=\eighti\scriptscriptfont9=\sixi%
\def\bmit{\fam9}}
%
% Eleven point font family
\def\elevenpt{%
\ifbfl\relax\else\input bigfonts\global\bfltrue\fi
\textfont0=\elevenrm \scriptfont0=\tenrm \scriptscriptfont0=\eightrm
\def\rm{\fam0\elevenrm}\rm
\textfont1=\eleveni \scriptfont1=\teni \scriptscriptfont1=\eighti
\def\mit{\fam1} \def\oldstyle{\fam1\eleveni}
\textfont2=\elevensy \scriptfont2=\tensy \scriptscriptfont2=\eightsy
\def\cal{\fam2}
```

```
\textfont3=\elevenex \scriptfont3=\elevenex \scriptscriptfont3=\elevenex
\def\it{\fam\itfam\elevenit} % \it is family 4
\textfont\itfam=\elevenit
\def\bf{\fam\bffam\elevenbf} % \bf is family 6
\textfont\bffam=\elevenbf \scriptfont\bffam=\tenbf
\scriptscriptfont\bffam=\eightbf
\normalbaselineskip13pt\normalbaselines}
%
% Twelve point font family
\def\twelvept{%
\ifbfl\relax\else\input bigfonts\global\bfltrue\fi
\textfont0=\twelverm \scriptfont0=\tenrm \scriptscriptfont0=\eightrm
\def\rm{\fam0\twelverm}\rm%
\textfont1=\twelvei \scriptfont1=\teni \scriptscriptfont1=\eighti
\def\mit{\fam1} \def\oldstyle{\fam1\twelvei}
\textfont2=\twelvesy \scriptfont2=\tensy \scriptscriptfont2=\eightsy
\def\cal{\fam2}
\textfont3=\twelveex \scriptfont3=\twelveex \scriptscriptfont3=\twelveex
\def\it{\fam\itfam\twelveit} % \it is family 4
\textfont\itfam=\twelveit
\def\bf{\fam\bffam\twelvebf} % \bf is family 6
\textfont\bffam=\twelvebf\scriptfont\bffam=\tenbf
\scriptscriptfont\bffam=\eightbf
\normalbaselineskip14pt\normalbaselines}
%
% Larger roman fonts for report headings
%\def\slidefont{\input slidefnt\relax}
%
% Sanserif fonts
\def\tensans{\font\ss=amss10\font\ssi=amssi10\font\ssb=amssbx10%
\input sans\null}
\def\eightsans{\font\ss=amssq8\font\ssi=amssqi8\font\ssb=amssbx8%
\input sans\null}
%
% Define preloaded and magnified fonts
\font\boldit=ambi10   %math bold italic
\font\IT=amsl10       %text bold italic at TEB (Here, slanted)
%
\font\ninerm=amr9     % smaller roman text fonts
\font\eightrm=amr8
\font\sixrm=amr6
%
\font\ninei=ammi9     % math italic
\font\eighti=ammi8
\font\sixi=ammi6
%
\font\tenbi=ambi10      % bold math italic
\font\eightbi=ammi8     %(here, 8pt is just math italic, not bold)
\font\sixbi=ammi6       %   "   6      "          "
```

```
%
\font\ninesy=amsy9     % math symbols
\font\eightsy=amsy8
\font\sixsy=amsy6
%
\font\ninebf=ambx9     % boldface extended
\font\eightbf=ambx8
\font\sixbf=ambx6
%
\font\nineit=amti9     % text italic
\font\eightit=amti8
\font\sevenit=amti7
%
%\font\capsfont=amcsc10  % caps and small caps font
%
% TEB parameters
\def\enddbl{\vfill\eject\end}
\baselineskip 12pt
\abovedisplayskip=12pt plus 2pt minus 2pt
\belowdisplayskip=12pt plus 2pt minus 2pt
\tolerance 1500
\pretolerance 500
\hoffset -0.25in
\voffset 0in
\parindent 1.5em
\hsize 42pc
\vsize 55pc
\tenpt
\endinput
```

```
% This is BIGFONTS.TEX as of April, 1987.
%
% Eleven and Twelve point fonts
%
\global\font\twelverm=amr10 scaled \magstep1
\global\font\twelvebf=ambx10 scaled \magstep1
\global\font\twelvei=ammi10 scaled \magstep1
\global\font\twelvesy=amsy10 scaled \magstep1
\global\font\twelveex=amex10 scaled \magstep1
\global\font\twelveit=amti10 scaled \magstep1
\global\font\elevenrm=amr10 scaled \magstephalf
\global\font\eleveni=ammi10 scaled \magstephalf
\global\font\elevensy=amsy10 scaled \magstephalf
\global\font\elevenex=amex10 scaled \magstephalf
\global\font\elevenbf=ambx10 scaled \magstephalf
\global\font\elevenit=amti10 scaled \magstephalf
\global\bfltrue
\endinput
```

```
% This is COSATI.TEX as of April, 1987.
%
% BEGINCOSATI
\hoffset-1.0in\voffset0.0in
\newbox\agency
\setbox\agency=\hbox{\eightrm Sponsoring Agency Code}
\def\army{\setbox\agency=\hbox{\eightrm Army Project No.}}
\hsize8.5in\nopagenumbers\vsize11in\parindent0pt
\newdimen\extra\extra=46pc   %height of table minus 1st and last rows
\newdimen\dmin\dmin=3pc
\newdimen\gmin\gmin=2pc
\newdimen\imin\imin=3.5pc
\newdimen\lmin\lmin=3pc
\newdimen\qmin\qmin=1in
\newdimen\qsize\qsize=1in
\def\\{\hfil\break}
\newbox\boxa\newbox\boxb\newbox\boxc\newbox\boxd\newbox\boxe\newbox\boxf
\newbox\boxg\newbox\boxh\newbox\boxi\newbox\boxj\newbox\boxk\newbox\boxl
\newbox\boxm\newbox\boxn\newbox\boxo\newbox\boxp\newbox\boxq\newbox\boxr
\newbox\boxs\newbox\boxt\newbox\boxu\newbox\boxv\newbox\boxw\newbox\boxx
\newbox\boxy\newbox\boxz\newbox\trash
\def\one#1{\setbox\boxa=\hbox{\strut\quad#1\quad}}
\def\two#1{\setbox\boxb=\hbox{\strut\quad#1}}
\def\three#1{\setbox\boxc=\hbox{\strut\quad#1}}
\def\four#1{\setbox\boxd=\vbox{\hsize=25pc\strut#1\strut\hfil}}
\def\five#1{\setbox\boxe=\hbox{\strut\quad#1}}
\def\six#1{\setbox\boxf=\hbox{\strut\quad#1}}
\def\seven#1{\setbox\boxg=\vbox{\hsize=25pc\strut#1\strut\hfil}}
\def\eight#1{\setbox\boxh=\hbox{\strut\quad#1}}
\def\nine#1{\setbox\boxi=\vbox{\hsize=25pc\strut#1\strut\hfil}}
\def\ten#1{\setbox\boxj=\hbox{\strut\quad#1}}
\def\eleven#1{\setbox\boxk=\hbox{\strut\quad#1}}
\def\twelve#1{\setbox\boxl=\vbox{\hsize=25pc\strut#1\strut\hfil}}
\def\thirteen#1{\setbox\boxm=\hbox{\strut\quad#1}}
\def\fourteen#1{\setbox\boxn=\hbox{\strut\quad#1}}
\def\fifteen#1{\setbox\boxo=\vbox{\hsize38pc\strut#1\strut\hfil}}
\def\sixteen#1{\setbox\boxp=\vbox{\hsize38pc\strut#1\strut\hfil}}
\def\seventeen#1{\setbox\boxq=\vbox{\hsize20pc#1\hfil}}
\def\eighteen#1{\qsize=\ht\boxq\ifdim\qsize<1in\qsize=1in\fi
\setbox\boxr=\vbox to\qsize{\hsize20pc\strut#1\hfil\vfil}}
\def\nineteen#1{\setbox\boxs=\hbox{\strut\quad#1}}
\def\twenty#1{\setbox\boxt=\hbox{\strut\quad#1}}
\def\twentyone#1{\setbox\boxu=\hbox{\strut\quad#1}}
\def\twentytwo#1{\setbox\boxv=\hbox{\strut\quad#1}}
\setbox\boxa=\null\setbox\boxb=\null\setbox\boxc=\null
\setbox\boxd=\vbox to 3pc{\hsize=26pc\hfil\vfil}\setbox\boxe=\null
\setbox\boxf=\null
\setbox\boxg=\vbox to 2pc{\hsize=26pc\hfil\vfil}\setbox\boxh=\null
```

```
\setbox\boxi=\vbox to 3.5pc{\hsize=26pc\hfil\vfil}\setbox\boxj=\null
\setbox\boxk=\null
\setbox\boxl=\vbox to 3pc{\hsize=26pc\hfil\vfil}\setbox\boxm=\null
\setbox\boxn=\null
\setbox\boxo=\vbox to 4.5pc{\hsize37pc\hfil\vfil}
\setbox\boxp=\vbox to 23pc{\hsize37pc\hfil\vfil}
\setbox\boxq=\vbox to 1in{\hsize=20pc\hfil\vfil}
\setbox\boxr=\vbox to 1in{\hsize=20pc\hfil\vfil}
\setbox\boxs=\null\setbox\boxt=\null\setbox\boxu=\null
\setbox\boxv=\null
\newbox\leftbox\newbox\rightbox
% ENDCOSATI
\def\endcosati{\eightpt
\advance\dmin by -\ht\boxd\advance\gmin by -\ht\boxg
\advance\dmin by -\dp\boxd\advance\gmin by -\dp\boxg
\advance\imin by -\ht\boxi\advance\lmin by -\ht\boxl
\advance\imin by -\dp\boxi\advance\lmin by -\dp\boxl
\setbox\leftbox=\vbox{\hsize323.6pt%
% Width of leftbox is 27pc - width of rule in middle (0.4pt)
\vbox{\leftline{\strut\ 4. Title and Subtitle}
\hbox to \hsize{\quad\copy\boxd\hfill}
\ifdim\dmin>0pt \vbox to \dmin{}\fi}
\hrule
\vbox{\leftline{\strut\ 7. Author(s)}
\hbox to \hsize{\quad\copy\boxg\hfill}
\ifdim\gmin>0pt \vbox to \gmin{}\fi}
\hrule
\vbox{\leftline{\strut\ 9. Performing Organization Name and
Address}
\hbox to \hsize{\quad\copy\boxi\hfill}
\ifdim\imin>0pt \vbox to \imin{}\fi}
\hrule
\vbox{\leftline{\strut\ 12. Sponsoring Agency Name and Address}
\hbox to \hsize{\quad\copy\boxl\hfill}
\ifdim\lmin>0pt \vbox to \lmin{}\fi}
}
\setbox\rightbox=\vbox to\ht\leftbox{\hsize=13pc
\leftline{\strut\ 5. Report Date}\vfill
\hbox to \hsize{\strut\copy\boxe\hfill}\vfill
\hrule
\leftline{\strut\ 6. Performing Organization Code}\vfill
\hbox to \hsize{\strut\copy\boxf\hfill}\vfill
\hrule
\leftline{\strut\ 8. Performing Organization Report No.}\vfill
\hbox to \hsize{\strut\copy\boxh\hfill}\vfill
\hrule
\leftline{\strut\ 10. Work Unit No.}\vfill
\hbox to \hsize{\strut\copy\boxj\hfill}\vfill
\hrule
```

```
\leftline{\strut\ 11. Contract or Grant No.}\vfill
\hbox to \hsize{\strut\copy\boxk\hfill}\vfill
\hrule
\leftline{\strut\ 13. Type of Report and Period Covered}\vfill
\hbox to \hsize{\strut\copy\boxm\hfill}\vfill
\hrule
\leftline{\strut\ 14. \box\agency}\vfill
\hbox to \hsize{\strut\copy\boxn\hfill}\vfill
}
\advance\extra by -\ht\leftbox\advance\extra by -\dp\leftbox
\advance\extra by -\ht\boxo\advance\extra by -\dp\boxo
\advance\extra by -\ht\boxp\advance\extra by -\dp\boxp
\ifdim\qsize<1in\advance\extra by -1in\else\advance\extra by -\qsize\fi
\advance\qmin by -\ht\boxq\advance\qmin by -\dp\boxq
\hardboxtable{40pc}{##&\hbox to 13.455pc{##\hfil}&%
\vrule##&##\hfil\hbox to 3pc{}\tabskip0pt plus40pt minus10pt&\vrule##%
\tabskip0pt&##\hfil&\vrule##&##\hfil\cr
\tablerule
\noalign{\vbox to 32pt{\vfill\hbox to 40pc{\hfill\twelvept Report
    Documentation Page\hfill}%
\vfill}}
\tablerule
\strut&\ 1. Report No.&&\ 2. Government Accession No.&&
    \multispan3{\ 3. Recipient's Catalog No.\hfil}\cr
&\copy\boxa\hfil&&\copy\boxb\hfil&&\multispan3{\copy\boxc\hfil}\cr
\tablerule
%\multispan4{\copy\leftbox}&&\multispan3{\copy\rightbox}\cr
\noalign{\hbox{\copy\leftbox\vrule\copy\rightbox}}
\tablerule
\multispan8{\strut\ 15. Supplementary Notes\hfil}\cr
\multispan8{\hfil\copy\boxo\hfil}\cr
\tablerule
\multispan8{\strut\ 16. Abstract\hfil}\cr
\multispan8{\hfil\copy\boxp\hfil}\cr
\noalign{\vskip\extra}
\tablerule
\multispan8{\hbox to 3.5in{\strut\ 17. Key Words (Suggested by Authors(s))
    \hfil}\vrule\ 18. Distribution Statement\hfil}\cr
\multispan8{\hbox to 3.5in{\quad\ifdim\qmin>0pt\vbox to 1in{\copy\boxq\vfil}
\else\copy\boxq\fi\hfil}\vrule\quad\copy\boxr\hfil}\cr
\tablerule
&\strut\ 19. Security Classif.(of this report)\quad&&\ 20. Security
    Classif.(of this page)\quad&&\ 21. No. of Pages\ &&\ 22. Price\cr
&\strut\copy\boxs\hfil&&\copy\boxt\hfil&&\copy\boxu\hfil&&\copy\boxv\hfil\cr
\tablerule}
\vskip-0.7pc
\leftline{\hskip 0.92in{\eightbf NASA FORM 1626} \sixrm OCT 86 \hfill
NASA-Langley, 1987\hskip0.92in}
\centerline{For sale by the National Technical Information Service,
```

```
Springfield, Virginia 22161-2171}
\vfill\eject}
\endinput
```

```
%
% This is DBLCOL.TEX as of April, 1987.
%
% To produce double column output, simply put "\doublecol"
% at the top of your file after "\input larcmacs".
% (Or you may use this file directly without larcmacs by
% putting "\input dblcol" instead.)
%
% Double column output using this macro has the advantage that
% inserts and footnotes still work (on a column by column basis).
% The disadvantage is that it does not provide an easy way to
% switch back and forth between double and single column format.
%
% The dimensions of a page output with this format are as follows:
% \fullhsize - width of both columns plus space between (42pc)
% \hsize - width of a single column (20pc)
% \vsize - height of a column (55pc)
%
% All of the insert macros (\topinsert, \midinsert, \pageinsert, and
% \footnote) work on columns instead of full pages. For example,
% \pageinsert will leave a blank column.  A new macro, \fullpageinsert
% is defined to leave an entire blank page.
%
\newdimen\fullhsize
\fullhsize=42pc \hsize=20pc
\vsize 55pc
\def\toplevel#1{\vfill\supereject\fullline{\hfill{\tlfont#1}\hfill}%
\vbox to 9pt{\hsize=\fullhsize\vfill}}
\def\fullline{\hbox to \fullhsize}
\newcount\fullpagecount
\def\fullpageinsert{\advance\fullpagecount by1\message{fpi++++++++++++++}}
\let\lr=L \newbox\leftcolumn
\output={\if L\lr%
        \global\setbox\leftcolumn=\columnbox \global\let\lr=R%
   \else \doubleformat \global\let\lr=L\fi%
   \ifnum\outputpenalty>-20000 \else\dosupereject\fi}
\def\doubleformat{\shipout\vbox{\makeheadline%
   \fullline{\box\leftcolumn\hfil\columnbox}%
   \makefootline}%
   \advancepageno%
  \ifnum\fullpagecount>0\shipout\vbox{\makeheadline\vfill\makefootline}
   \message{(BLANK PAGE \the\pageno!)}%
   \global\advance\fullpagecount by-1\message{----------fpi}
    \advancepageno\fi}%
\def\columnbox{\leftline{\pagebody}}
%
\def\finishinserts{\ifnum\fullpagecount>0%
        \loop\hbox{}\vfill\eject\global\advance\fullpagecount by-1%
```

```
            \message{(BLANK PAGE \the\pageno!)}%
        \ifnum\fullpagecount>0\repeat}
%
\def\makeheadline{\vbox to 0pt{\vskip-22.5pt%
  \fullline{\vbox to8.5pt{}\the\headline}\vss}\nointerlineskip}
\def\makefootline{\baselineskip24pt\fullline{\the\footline}}
%
\def\doubleeject{\supereject\if R\r \null\vfill\eject\fi}
\def\enddbl{\supereject\if R\lr \null\vfill\eject\fi\end}
%
\message{[Typesetting double column format....]}
\endinput
```

```
% This is SPLITCOL.TEX as of April, 1987.
%
% The \splitcol macro (output routine) was developed by Mary McCaskill
% to allow balancing of columns and switching from double columns to
% single column output.
%
% The \splitcol macro is used as follows: Include "\input splitcol"
% at the beginning of your file. (Or, if you already have "\input larcmacs",
% then you only need to put "\splitcol"). Your text will come out in
% single column format by default. To switch to double column format,
% use \begindoublecol and \enddoublecol.
%
% The format commands used within splitcol are as follows:
%
% \begindoublecol \splitcol produces single column pages until
% this command appears, then begins double column
%
% \enddoublecol This command causes the columns to be balanced
% and changes the format back to single column.
% \enddoublecol precedes \vfill\eject when a file
% ends with double columns.
%
% \columnbreak Strongly encourages a break for the left column.
% (See note (1) below). This command must be used
% in vertical mode or in a \vadjust{}.
%
% \shortcol Allows the right column to be short when balancing
% columns. Precedes \enddoublecol.
%
% The \splitcol command has some drawbacks:
%
% (1) It is tricky to force left column breaks. You may use the \columnbreak
%     command above to encourage a break. If you try to force a break with
%     \eject, instead you will get a blank right column!
%
% (2) There can be no \topinserts, \midinserts, or footnotes in a file
%     using \splitcol. \pageinsert may work. You can sometimes get around
%     this by splitting up your document into one or more files.
%
% (3) \splitcol does not affect the current font, but it does change the
%     \baselineskip to 13pt in single column format. You may re-specify
%     \baselineskip after \splitcol if you desire.
%
% Questions/Problems concerning the use of splitcol should be directed to
% Mary McCaskill x3325.
%
\hsize=42pc \vsize=55pc \baselineskip=13pt \maxdepth=2.2pt
\newdimen\pageheight \pageheight=\vsize
```

```
\newdimen\pagewidth \pagewidth=\hsize
\newdimen\colwidth \newdimen\bigcolheight
\colwidth=20pc \bigcolheight=112pc %bigcolheight is a little more than 2\vsize
%
\output{\onepageout{\unvbox255}}
%
\newbox\partialpage \newdimen\savesize
\def\begindoublecol{\begingroup\savesize=\vsize
     \output={\global\setbox\partialpage=\vbox{\unvbox255\bigskip}}
     \eject %put single col on current page into \partialpage
     \output={\doublecolumnout}
     \hsize=\colwidth \vsize=\bigcolheight \baselineskip=12pt
     \advance\vsize by -2\ht\partialpage %subtract partialpage height from
     \message{[Typesetting double columns ...]}} %                    \vsize
%
\def\enddoublecol{\message{[Balancing columns ...]}
     \output{\balancecolumns} \eject
     \global\output={\onepageout{\unvbox255}}
     \global\vsize=\savesize\endgroup\pagegoal=\vsize
     \baselineskip=13pt \message{[Typesetting single column ...]}}
%
\def\doublecolumnout{\dimen0=\pageheight
     \advance\dimen0 by -\ht\partialpage %subtract partialpage height from
                                         %    vsize
     \splittopskip=\topskip \splitmaxdepth=\maxdepth
     \setbox0=\vsplit255 to \dimen0 \setbox2=\vsplit255 to \dimen0% split
                                                              %bigcolumn
     \onepageout\pagesofar
     \global\vsize=\bigcolheight
     \unvbox255\penalty\outputpenalty} %put rest of box255 back in vert list
%
\def\pagesofar{\unvbox\partialpage %output partialpage (single col)
     \wd0=\hsize \wd2=\hsize
     \hbox to \pagewidth{\box0\hfil\box2}} %put cols together
%
\def\balancecolumns{\setbox0=\vbox{\unvbox255} \dimen0=\ht0
     \advance\dimen0 by \topskip \advance\dimen0 by -\baselineskip
     \divide\dimen0 by 2
     \splittopskip=\topskip \splitmaxdepth=\maxdepth
     {\vbadness=10000 \loop \global\setbox3=\copy0
          \global\setbox1=\vsplit3 to \dimen0 \ifdim\ht3>\dimen0
          \global\advance\dimen0 by 1pt \repeat} %loop to balance cols
     \setbox0=\vbox to \dimen0{\unvbox1}
     \ifnum\shrt=0 \setbox2=\vbox to \dimen0{\unvbox3}
     \else \setbox2=\vbox to \dimen0{\dimen2=\dp3 \unvbox3 \kern-\dimen2\vfil}
     \fi \shrt=0
     \global\output={\balancingerror}
     \pagesofar}
%
```

```
\newhelp\balerrhelp{Please change the page into one that works.}
%
\def\balancingerror{\errhelp=\balerrhelp \errmessage{Page can't be balanced.}
    \onepageout{\unvbox255}}
%
\def\onepageout#1{\shipout\vbox{\makeheadline \vbox to \pageheight{#1}
      \makefootline} \advancepageno \ifnum\outputpenalty>-20000
      \else\dosupereject\fi}
%
\def\makefootline{\baselineskip24pt \hbox to \pagewidth{\the\footline}}
%
\def\makeheadline{\vbox to 0pt{\vskip-22.5pt
     \hbox to \pagewidth{\vbox to 8.5pt{}\the\headline}\vss} \nointerlineskip}
%
\def\columnbreak{\penalty-5000} %for breaking at bottom of left column
%
\newcount\shrt \shrt=0
\def\shortcol{\shrt=1} %to allow right column to be short when balanced
\endinput
```


C-2

The following file is not a part of LARCMACS, but is available on request. It may be used with or without LARCMACS.

```
%This is file draft.tex to setup format for rough drafts for
%     Technical Editing
%IMPORTANT!!!!!
%If used with larcmacs, remove the % from the line below
\input larcmacs \twelvept
%If used without larcmacs, remove the % from the line below
%  \magnification=\magstep1
%Page size for 8 1/2 by 11 paper
   \hsize=6.5 true in
   \vsize=9 true in
%Text will be double spaced
%Definition to be used in heading macros
%Causes lines to be centered across page
\newdimen\skipdimen \newdimen\plusdimen
\def\raggedcenter{\skipdimen=\hsize\divide\skipdimen by2
                  \plusdimen=\skipdimen\divide\plusdimen by3
                  \multiply\plusdimen by 2
                  \advance\skipdimen by -\plusdimen
     \leftskip=\skipdimen plus\plusdimen \rightskip=\leftskip
     \parfillskip=0pt \spaceskip=.3333em \xspaceskip=.5em
     \pretolerance=9999 \tolerance=9999 \hyphenpenalty=9999
     \exhyphenpenalty=9999}
%Definitions of three heading levels
%First heading level is centered in boldface type
   \def\levelone#1{\goodbreak\vskip18pt
        \vbox{\raggedcenter\noindent\bf #1}
        \par\bigskip\nobreak}
%Second heading level is on left margin in boldface type
   \def\leveltwo#1{\goodbreak\vskip18pt
        \vbox{\rightskip=0pt plus 1fil \spaceskip=.3333em
        \xspaceskip=.5em \pretolerance=9999 \tolerance=9999
        \hyphenpenalty=9999 \exhyphenpenalty=9999
        \noindent\bf #1}
        \par\nobreak\medskip}
%Third heading level is run-in at beginning of paragraph in italic type
%NOTE: the period is included in the macro
   \def\levelthree#1{\goodbreak\medskip
        {\it #1.}\ }
%These heading macros are followed by the heading in {}; for example,
%      \levelone{Introduction}
%      \leveltwo{Experimental Facility}
%      \levelthree{Data for first configuration}
%         NOTE: no period after heading
```

Appendix B

Sample Report

This appendix presents the TEX document file and the typeset results for a "typical" NASA report. Please realize that this is a make-believe report that has been composed to illustrate the use of LARCMACS; it is not intended to represent a necessarily well-written report. (In fact, a real report was torn apart and pieced together at random.)

TEX Document File

The first file is for the body of the report:

```
%%This file is the body of a report
\input larcmacs
\contents %%Create a file for Contents page
\doublecol %%Double-column format
\levelone{Summary}
Wind shear is considered by many in the aviation community to be one of the
major safety issues facing their industry. The Federal Aviation
Administration has addressed this problem through an integrated wind shear
program plan, which incorporates the expertise of industry, universities, and
various government agencies such as the National Aeronautics and Space
Administration, the National Oceanic and Atmospheric Administration, and the
Department of Defense. The plan is aimed at reducing the hazard of
low-attitude wind shear through improved training and operating procedures,
 wind shear detection systems, and flight guidance systems.
\bigskip
\levelone{Introduction}
Wind shear is considered by many in the aviation industry to be one of their
major safety issues.  Listed in table~1 are 32~U.S.\ aircraft accidents or
incidents that have occurred from 1964 to 1985 and were attributed
to low-altitude wind shear (refs.~1 and 2).  The crash of Delta
flight~191 on August~2,~1985, in which 135~people died while on an
approach to landing at Dallas-Fort Worth International Airport, is the latest
reminder of the danger of this weather phenomenon.
In January 1985 the Federal Aviation Administration (FAA) began developing
the Integrated FAA Wind Shear Program Plan (ref.~1) aimed at reducing
the hazard of low-attitude wind shear. The program plan incorporates
the expertise of industry, universities, and various government agencies,
such as the National Aeronautics and Space Administration (NASA),
the National Oceanic and Atmospheric Administration (NOAA), and the
Department of Defense (DOD), into a 5- to 10-year research and
development effort. The plan is divided into the following
five~program elements:
\medskip
\item{1.}Education, training, and operating procedures
\item{2.}Ground sensors for the detection of low-level wind shear
```

```
\item{3.}Airborne sensors and flight guidance systems
\item{4.}Terminal information systems
\item{5.}Low-level meteorological hazard characterization
\medskip
\noindent Integral to each of these program elements is the fundamental
need to better understand the physics of low-level encounters.
NASA's contribution to the wind shear program is focused primarily on the
third and fifth program elements. The objective of the NASA research
effort is to provide the technology base that will permit reduction
of low-altitude wind shear risk through airborne detection, warning,
and avoidance.
This paper is divided into five sections. The first describes the
modifications required to the vortex-lattice program in order to
incorporate the wind velocity gradients and to compute their aerodynamic
effects. The second  describes the program checkout and validation. This
is followed by the formulation of the wind shear aerodynamic
coefficients and a series of sensitivity studies. The final section
summarizes the results of this study and lists recommendations for
further research.
\bigskip
\levelone{Symbols}
\symboltable{15pc}
{{\bf A} & matrix of shear coefficient slope
     $(\partial/\partial\alpha)$, per rad\cr
\tableskip
AR & aspect ratio\cr
\tableskip
$a_1,\ldots,a_8$ & geometry-dependent constants in force equations\cr
\tableskip
{\bf B} & matrix of shear coefficient intercept $(\alpha=0)$\cr
\tableskip
$b$ & wing span, ft\cr
\tableskip
$b_1,\ldots,b_3$ & geometry-dependent constants in boundary
     condition equation\cr
\tableskip
$C_{D}$ & drag coefficient, ${{\rm Drag}\over q_\infty S_{{\rm ref}}}$\cr
\tableskip
$C_{L}$ & lift coefficient, ${{\rm Lift}\over q_\infty S_{{\rm ref}}}$\cr
\tableskip
$\ell$ & lift, lb\cr
\tableskip
$\tilde{\ell}$ & lift per unit span of line vortex element, lb/ft\cr
\tableskip
$N$ & total number of vortex panels\cr
\tableskip
$p$ & roll rate, rad/sec\cr
\tableskip
$x, y, z$ & distance along $X$-, $Y\!$-, and $Z$-axis, respectively, ft\cr
```

```
\tableskip
$\alpha$ &  angle of attack, rad\cr
\tableskip
$\phi$ & planform dihedral angle, rad\cr
\tableskip
$\psi$ & sweep angle of spanwise horseshoe vortex element in
     $X$-$Y$ plane, rad\cr
\tableskip
\noalign{\leftline{Subscripts:}}
\tableskip
$c$ & chordwise vortex element\cr
\tableskip
$j$ & index for control point\cr
\tableskip
$l$ & left half of planform\cr
\tableskip
$n$ & index for elemental panel\cr} %%End of symboltable
\bigskip
\levelone{Modification of Vortex-Lattice Algorithm}
The algorithm used in this study was a modified version of the vortex-lattice
computer program presented in reference~14. The computer program
presented in the reference was developed to compute the aerodynamic load
distribution for single or dual planforms in a uniform flow field. This
program had to be modified to compute the load distributions resulting
from nonuniform sheared flow fields. The modifications of the boundary
condition and the force and moment equations are discussed in the
following sections.
%%Definition on new macro
\def\bsmatrix#1{\left\{\matrix{#1}\right\}}
\bigskip
\leveltwo{Definition of a Spatially Varying Wind Field}
The local wind velocities for a uniform flow field at a point defined in the
body-axis system, as shown in figure~1, can be written as
%%
$$\pmatrix{u_w\cr
\noalign{\medskip}
          v_w\cr
\noalign{\medskip}
          w_w\cr} = -U_\infty
\pmatrix{\cos\alpha\cos\beta\cr
\noalign{\medskip}
        \sin\beta\cr
\noalign{\medskip}
        \sin\alpha\cos\beta\cr}\eqno(1)$$
%%
where
\bigskip
\indentsymtab{14pc}
{$u_{w},v_{w},w_{w}$ &  relative wind velocity in $X$-, $Y\!$-, and
```

```
     $Z$-direction, respectively\cr
\tableskip
$U_{\infty}$ & free-stream velocity\cr
\tableskip
$\alpha$ & angle of attack\cr
\tableskip
$\beta$ & sideslip angle\cr}
\bigskip
%%Figure 1 inserted at end of paragraph
\midfigure{2.5in}{\c{Figure 1. Body-axis system.}}
The nonuniform flow field is defined by adding the local wind velocities
due to the wind shear to the uniform-flow-field equation:
%%
$$\pmatrix{u_w\cr
\noalign{\medskip}
          v_w\cr
\noalign{\medskip}
          w_w\cr}
= \pmatrix{u_S\cr
\noalign{\medskip}
          v_S\cr
\noalign{\medskip}
          w_S\cr} - U_\infty
\pmatrix{\cos\alpha\cos\beta\cr
\noalign{\medskip}
        \sin\beta\cr
\noalign{\medskip}
        \sin\alpha\cos\beta\cr}\eqno(2)$$
%%
The effect of sideslip is not addressed within the limits of this study. For
zero sideslip, the wind field equation becomes
%%
$$\pmatrix{u_w\cr
\noalign{\medskip}
          u_w\cr
\noalign{\medskip}
          w_w\cr}
=\pmatrix{u_S\cr
\noalign{\medskip}
         v_S\cr
\noalign{\medskip}
         w_S\cr} -U_\infty
\pmatrix{\cos\alpha\cr
\noalign{\medskip}
        0\cr
\noalign{\medskip}
        \sin\alpha\cr}\eqno(3)$$
%%
The local wind shear velocity components $u_{S},$ $v_{S},$ and
```

```
$w_{S}$ are defined in terms of the spatial wind velocity gradients as
%%
$$\pmatrix{u_S\cr
\noalign{\medskip}
           v_S\cr
\noalign{\medskip}
           w_S\cr}\equiv
\pmatrix{{\partial u_S\over \partial x} & {\partial u_S\over \partial y}
              & {\partial u_S\over \partial z}\cr
\noalign{\medskip}
         {\partial v_S\over \partial x} & {\partial v_S\over \partial y}
              & {\partial v_S\over \partial z}\cr
\noalign{\medskip}
         {\partial w_S\over \partial x} & {\partial w_S\over \partial y}
              & {\partial w_S\over \partial z}\cr}
\pmatrix {x\cr
\noalign{\medskip}
          y\cr
\noalign{\medskip}
          z\cr}\eqno(4)$$
\bigskip
\leveltwo{Boundary Condition}
\levelthree{No-flow condition}
One of the fundamental conditions of vortex-lattice theory is the
\lq\lq no-flow'' condition at the control point of each vortex panel. This
boundary condition simply states that no flow can pass through the vortex
panel at the control point, so that the flow is required to be tangent to the
mean camber line of the surface. The control points are located at the
three-quarter-chord midspan point of each vortex panel. This boundary
condition provides the equation used to compute the vortex strength of
each panel.
A side view of a vortex panel for a planform with no sideslip or dihedral
is shown in figure~2. The no-flow condition for a planform of this
type can be written as
%%
$$\eqalignno{& U_\infty\sin(\alpha+\alpha_i)-u_S\sin\alpha_i\cr
\noalign{\medskip}
&\qquad=\omega_S \cos\alpha_i+\omega\cos(\alpha+\alpha_i)&(5)\cr}$$
%%
where
\medskip
\indentsymtab{16pc}
{$\alpha_i$ & local angle of incidence\cr
\tableskip
$w$ & local downwash velocity\cr}
%%Insert figure 2 at top of column
\figure{1.82in}{Figure 2. Side view of vortex panel.}
\bigskip
\levelthree{Planform with dihedral}
```

```
The boundary condition for a planform with dihedral yields a slightly
different equation for each side of the planform. Figure~3 provides a
view along the $X$-axis of the left side of a planform with dihedral.
Figure~4 provides the same view for the right side. The equation for the left
side is
%%
$$\eqalignno{&\left[U_\infty\sin(\alpha+\alpha_i)-u_S\sin\alpha_i\right]
                  \cos \phi_l+(v+v_S)\sin \phi_l\cr
\noalign{\medskip}
             &\qquad=\left[w_S\cos\alpha_i+w\cos(\alpha + \alpha_i)\right]
                  \cos\phi_l & (6)\cr}$$
%%
where
\bigskip
\indentsymtab{16pc}
{$v$ & local sidewash velocity\cr
\tableskip
$\phi_l$ & dihedral angle for the left side\cr}
%%Insert figures 3 & 4 at top of column
\figurepar{1.44in}{Figure 3. View along the $X$-axis of the left side of
planform with dihedral.}
\figurepar{1.32in}{Figure 4. View along the $X$-axis of the right side of
planform with dihedral.}
\bigskip
The equation for the right side is
%%
$$\eqalignno{&\left[U_\infty\sin(\alpha+\alpha_i)-u_S\sin\alpha_i\right]
                  \cos\phi_r-(v+v_S)\sin\phi_r\cr
             &\quad=\left[w_S\cos \alpha_i + w\cos(\alpha+\alpha_i)\right]
                  \cos\phi_r & (7)\cr}$$
If $\alpha$ and $\alpha_{i}$ are assumed to be small such that the sine
of the angle can be approximated by the angle in radians and $\phi$ is
defined as
%%
$$\phi = \phi_{l} = -\phi_{r}$$
%%
then the boundary condition can be expressed in the form of a single
equation as
%%
$$\nineptmath
\Eqalignno{&{w\over U_\infty}-{v\over U_\infty}\tan\phi\cr
           &\qquad=\alpha+\left(1-{u_S\over U_\infty}\right)
                \alpha_i+{v_S\over U_\infty}\tan\phi-{w_S\over U_\infty}
                &(8)\cr}$$
%%
The downwash and sidewash velocities for a particular horseshoe vortex can be
expressed as
%%
$$\eqalignno{w & = {\Gamma\over 4\pi}F_w & (9)\cr
```

```
\noalign{\vskip1pc}
            v & = {\Gamma\over 4\pi}F_v & (10)\cr}$$
%%
where
\bigskip
\indentsymtab{15pc}
{$F_w,F_v$ & downwash and sidewash influence functions, respectively\cr
\tableskip
$\Gamma$ & vortex strength\cr}
\bigskip
\noindent The influence functions are only dependent upon the planform
geometry and free-stream Mach number, and therefore require no
modification for a\break nonuniform wind field. The development
of the influence functions is provided in reference 14. Incorporating
the downwash and sidewash equations into the boundary condition
equation yields
$$\eqalignno{(F_w-F_v\tan\phi){\Gamma\over U_\infty}
                 & =4\pi\left[\alpha+ \left(1 - {u_S\over U_\infty}\right)
                 \alpha_i\right.\cr
\noalign{\medskip}
            &\quad +\left.{v_S\over U_\infty}\tan\phi -
                 {w_S\over U_\infty}\right]& (11)\cr}$$
%%
Note that the wind shear velocities effectively act as
an incremental change in the local angle of attack of the vortex
panel. This is more clearly seen by rewriting the boundary condition as
%%
$$(F_w-F_v\tan\phi){\Gamma\over U_\infty}
     =4\pi (\alpha+\alpha_i+\alpha_S)\eqno(12)$$
%%
where $\alpha_{S}$ is an additional local angle of attack
due to the wind shear velocities:
%%
$$\alpha_S= - {u_S\over U_\infty}\alpha_i+{v_S\over U_\infty}
     \tan\phi-{w_S\over U_\infty}\eqno(13)$$
%%
The effect of the wind shear distribution across the planform is therefore
analogous to distortion of the planform shape through twist or camber, as was
noted in reference~9.
\bigskip
\levelone{Sensitivity Study Results}
The aerodynamic effects of wind shear were investigated through a series of
sensitivity studies using the modified vortex-lattice program and
were characterized in the form of shear coefficients. The first of
these studies focused on determining the effect of the vortex-lattice
distribution on the computation of the shear coefficients. The
second study examined the variation of the wind shear effect with
planform geometry. The final study used a wing and stabilizer
configuration to determine the magnitude of the wind shear effect
```

in a simulated microburst.
\bigskip
\leveltwo{Effect of Vortex-Lattice Distribution}
The objective of the first of the series of sensitivity studies was to determine the effect of the vortex-lattice distribution on the computation of the shear coefficients. This was done by varying the spanwise and chordwise distributions of the vortices for a particular wing geometry. The wing planform used in this part of the study was configuration~2 of table~2. The vortex distribution was varied for each of the nine individual shear conditions, with the origin of the shear coincident with the aerodynamic center of the planform.
Those shear coefficients which had a magnitude of zero or nearly zero were omitted. The variation in the value of the shear coefficients with vortex-lattice arrangement demonstrated similar trends as those reported for the aerodynamic coefficients in reference~13. Increasing the spanwise N_s and chordwise N_c distributions of vortices resulted in an asymptotic convergence of the shear coefficient value. Spanwise distributions less than 30 and chordwise distributions less than 4 resulted in significant variations in the computed coefficient values.
\bigskip
\leveltwo{Planform Geometry Effects}
The objective of this sensitivity study was to determine how the wind shear effect varied with\break planform geometry. This was done by varying the sweep, taper, aspect ratio, and dihedral of a simple wing configuration and comparing the resultant effect on the shear coefficient values. Planform configurations~3 to 11 of table~2 were the wing geometries used. The baseline planform was configuration~5. The aspect ratio effect was obtained through comparison of the baseline with configurations~3 and 4; the dihedral effect was obtained through comparison with configurations~6 and 7; the sweep effect was obtained with configurations~8 and 9; and the taper ratio effect was obtained with configurations~10 and 11. All the planform configurations had identical wing areas, with no camber or twist. A vortex distribution of 4~chordwise and 40~spanwise was used in computing the shear coefficients, with the origin of the shear coincident with the aerodynamic center of the planforms.
\bigskip
\levelone{Concluding Remarks}
The objective of this study was to investigate and characterize the aerodynamic effects of shear flow through a series of sensitivity studies of the wind shear components and wing planform geometry parameters. In addition to the data base developed through these sensitivity studies, several pertinent results were \hbox{established.}
\bigskip
\item{1.} A method of characterizing the aerodynamic effect of wind shear in the form of wind shear aerodynamic coefficients was formulated.
\item{2.} A method of modifying the boundary condition, the wind field, and the force and moment equations of a vortex-lattice algorithm, for computing the aerodynamic effects of wind shear was demonstrated. This approach should be directly applicable to more complex potential flow

algorithms.
\item{3.} The magnitudes of the aerodynamic effects were demonstrated by computation of the changes in the aerodynamic coefficients of a conventional wing and stabilizer configuration on a fixed flight path through a simulated microburst.
\bigskip
This study was, however, limited in several respects. The effect of sideslip angle was not accounted for in the formulation of the wind shear aerodynamic coefficients. To account for this effect, an additional matrix of sideslip-dependent wind shear aerodynamic coefficients should be added to the formulation. The limits of potential flow theory restrict the results to the linear angle-of-attack range. The thin-wing approximation of vortex-lattice approach is an additional limitation. Perhaps the greatest limitation of the study was the exclusion of the effects of the fuselage and vertical surfaces. The vertical surfaces (fin and rudder) should affect the lateral wind shear aerodynamic coefficients in a similar manner as the horizontal stabilizer affected the longitudinal coefficients. The fuselage effect in sheared flow may also be significant. Just as a cylinder in a flow with circulation produces lift, a fuselage in a sheared flow field may produce significant forces.
\bigskip
\ninept\levelone{References}

\leftitem{1.}Federal Aviation Adm.: {\it Integrated FAA Wind Shear Program Plan.} DOT/FAA/DL-87/1, DOT/FAA/VS-87/1, DOT/FAA/AT-87/1, U.S.\ Dep.\ of Transportation, Apr.~1987.
\leftitem{2.}National Research Council: {\it Low-Altitude Wind Shear and Its Hazard to Aviation}. National Academy Press, 1983.
\leftitem{3.}Fujita, T.~Theodore: {\it The Downburst---Microburst and Macroburst.} SMRP-RP-210, Univ.\ of Chicago, 1985. (Available from NTIS as PB85 148 880.)
\leftitem{4.}Gera, Joseph: {\it The Influence of Vertical Wind Gradients on the Longitudinal Motion of Airplanes}. NASA TN\break D-6430, 1971.
\leftitem{5.}Sherman, Windsor~L.: {\it Theoretical Study of the Effect of Wind Velocity Gradients on Longitudinal Stability and Control in Climbing and Level Flight}. NASA TP-1332, 1978.
\leftitem{6.}Sherman, Windsor~L.: {\it An Analytical Study of the Longitudinal Response of Airplanes to Positive Wind Shear}. NASA TP-1765, 1981.
\leftitem{7.}Bochis, Vladimir: Dynamics of an Aircraft in Wind Shear of Arbitrary Direction. {\it J.~Guid., Control, \& Dyn.}, vol.~7, no.~5, Sept.--Oct.\ 1984, pp.~615--619.
\leftitem{8.}James, D.~G.: Two-Dimensional Airfoils in Shear Flow. I. {\it Q.~J.\ Mech.\ \& Appl.\ Math.}, vol.~4, pt.~4, 1951, \break pp.~407--418.
\leftitem{9.}Vidal, Robert~J.: The Influence of Two-Dimensional Stream Shear on Airfoil Maximum Lift. {\it J.~Aerosp.\ Sci.}, vol.~29, no.~8, Aug.\ 1962, pp.~889--904.
\leftitem{10.}Payne, Francis~M.; and Nelson, Robert~C.:

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Aerodynamic Characteristics of an Airfoil in a Nonuniform Wind Profile.
{\it J.~Aircr.}, vol.~22, no.~1, Jan.\ 1985, pp.~5--10.
\leftitem{11.}Frost, Walter; and Hutto, Enice:  The Influence of
Wind Shear on Aerodynamic Coefficients.  {\it Sixth Conference
on Aerospace and Aeronautical Meteorology}, American Meteorological
Soc., Nov.\ 1974, pp.~317--324.
\bye
```

The following is the file for the appendix of our sample report. Note that this file uses \splitcol, and therefore the page will be balanced. Had there been no figures inserted in the text of the report (previous file), it too could have been processed with \splitcol and then the last page would have been balanced.

```
%%File for appendix
\input larcmacs
\pageno6 %%begin on p. 6
\splitcol %%Use format that allows format to be changed from 1 to 2 columns
\begindoublecol %%begin double-column format
\levelone{Appendix}
\levelone{Program Checkout and Validation}
Once the computer program had been modified to incorporate the effects of
wind shear on the planform load distribution, some means of checking the
program had to be devised. Since measurements of this type have not been
conducted, a direct comparison of measured and computed results was not
possible. However, if the appropriate spatial wind velocity
derivatives are coupled, a curved flow field synonymous to rotary motion
can be modeled. Through imposition of this type of flow field and computation
of the resultant change in the planform load distribution, the rotary
stability derivatives can be computed. The modified program could then
be checked by a comparison of the computed rotary stability derivatives
with values measured in the wind tunnel or with values computed with other
\hbox{algorithms.}
A rolling motion can be simulated if the $\partial w_{S}/\partial y$
and $\partial v_{S}/\partial z$ terms are coupled. The coupled
terms must be of equal magnitude to simulate the rotary motion:
%%
$$p = {1\over 2}\left({\partial v_{S}\over \partial z}
    - {\partial w_{s}\over \partial y}\right)\Eqno(A1)$$
%%
In a similar fashion, pitching and yawing motion can be simulated with the
following equations:
%%
$$\Eqalignno{q & = {1\over 2}\left({\partial w_{S}\over\partial x}
                - {\partial u_{S}\over\partial z}\right) & (A2)\cr
```

```
\noalign{\vskip1pc}
            r & = {1\over 2}\left({\partial u_{S}\over \partial y}
               - {\partial v_{S}\over\partial x}\right) & (A3)\cr}$$
%%
A direct comparison of the stability derivatives computed with the
algorithm presented in reference~16 was possible for planforms without
dihedral. Such a comparison was made with planform configuration~1 of
table~2. The calculated results were derived for 4~chordwise and 30~spanwise
horseshoe vortices. This provided a fairly even distribution of
vortices about the planform and a reasonable computation time. No effort
was made, at this point in the study, to determine the sensitivity of the
vortex distribution on the coefficients being computed or to optimize the
distribution accordingly. The stability derivatives computed by the
two methods were identical to the fifth significant digit.
The computed results were also compared with wind-tunnel measured values
for planform configurations~1 and~2. The wind-tunnel data were extracted
from a series of studies conducted by the National Advisory Committee for
Aeronautics (NACA) during the late forties. The studies investigated the
effect of various wing planform geometry parameters, such as sweep, taper,
and aspect ratio, on the rotary stability derivatives (refs.~17 to 22).
The majority of the wind-tunnel data were measured in a special low-speed
stability tunnel which generated curved flow fields using special screens
and curved test section walls. A photograph of the test section, set up
to measure the effects of yawing motion, is shown in figure~5.
Planform configurations~1 and 2 were common to most of these studies
and provided a considerable data base to compare with the
analytical results of the modified program. The airfoil for both
configurations was an NACA~0012 section perpendicular to the planform
leading edge. Figures~6 and 7 show the calculated and
experimental values of $C_{L}$, $C_{m}$, $C_{L_{q}}$, $C_{m_{q}}$,
$C_{l_{p}}$, $C_{l_{r}}$, $C_{n_{p}}$, $C_{n_{r}}$, $C_{Y_{p}}$, and
$C_{Y_{r}}$ for configurations~1 and 2, respectively.
The calculated results compared favorably with the wind-tunnel data up to
$C_{L}$ values of about 0.5, or roughly a $10^\circ$ angle of attack. The
breakdown in the vortex-lattice theory at the higher $C_{L}$ values was not
unexpected, as this is a basic limit of linear potential flow theory. The
rolling and yawing derivatives provided much better agreement with the
wind-tunnel data than did the pitching derivatives. This agreement
was attributed to the relatively few chordwise vortices used in the
computation. Reference~14 recommends use of 10 or more chordwise
vortices to compute such longitudinal variations. The favorable
comparison of the stability derivatives at the lower $C_{L}$
values was taken as a validation of the modifications made to the
vortex-lattice program.
\enddoublecol %%End double columns; page will be balanced
\bye
```

The following is the file for the Contents. This file was produced when TEX ran on the text because of the \contents macro near the beginning of the text file. Because the appendix was produced with a separate file, the appendix entry in the Contents was added. Only the lines marked by the * were added.

```
  \input
  larcmacs
  \footline={\hss\tenbf\folio\hss}
  \pageno=-3 \hsize=35pc\parindent=0pt
  \levelone{Contents}
  \medskip\line{Summary\leaderfill{1}}
  \medskip\line{Introduction\leaderfill{1}}
  \medskip\line{Symbols\leaderfill{1}}
  \medskip\line{Modification of Vortex-Lattice Algorithm\leaderfill{1}}
  \smallskip\line{\quad{Definition of a Spatially Varying
     Wind Field}\leaderfill{2}}
  \smallskip\line{\quad{Boundary Condition}\leaderfill{2}}
  \line{\qquad{No-flow condition}\leaderfill{2}}
  \line{\qquad{Planform with dihedral}\leaderfill{3}}
  \medskip\line{Sensitivity Study Results\leaderfill{3}}
  \smallskip\line{\quad{Effect of Vortex-Lattice Distribution}\leaderfill{4}}
  \smallskip\line{\quad{Planform Geometry Effects}\leaderfill{4}}
  \medskip\line{Concluding Remarks\leaderfill{4}}
  \medskip\line{References\leaderfill{4}}
* \medskip\line{Appendix---Program Checkout and Validation\leaderfill6}
* \bye
```

The following file is for a Report Documentation Page (RDP):

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%% File to produce Report Documentation Page (RDP)

\input larcmacs
\begincosati
\one{NASA TP-2856}
\two{}
\four{Thrust-Reverser Flow Investigation on a Twin-Engine Transport}
\five{November 1988}
\six{}
\seven{Gregory M. Gatlin and P. Frank Quinto}
\eight{L-16426}
\nine{NASA Langley Research Center\\
Hampton, VA 23665-5225}
```

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\twelve{National Aeronautics and Space Administration\\
Washington, DC 20546-0001}
\ten{505-68-71-04}
\thirteen{Technical Paper}
\fifteen{}
\sixteen{An investigation was conducted in the Langley 14- by 22-Foot
Subsonic Tunnel to study the effects of engine thrust reversing on an
aft-mounted twin-engine transport and to develop effective testing
techniques. Testing was done over a fixed and a moving-belt ground plane
and over a pressure-instrumented ground board. Free-stream dynamic
pressure was set at values up to 12.2 psf, which corresponded to a maximum
Reynolds number based on mean aerodynamic chord of
7.65 $\times$ 10$^5$. The thrust reversers examined included cascade, target,
and four-door configurations. The investigation focused on the range of
free-stream velocities and engine thrust-reverser flow rates that would be
typical for landing ground-roll conditions. Flow visualization techniques
were investigated, and the use of water or smoke injection into the
reverser flow proved effective to determine the forward progression of the
reversed flow and reingestion limits. When testing over a moving-belt ground
plane, as opposed to a fixed ground plane, forward penetration of the reversed
flow was reduced. The use of a pressure-instrumented ground board enabled
reversed flow ground velocities to be obtained, and it provided a means
by which to identify the reversed flow impingement point on the ground.}
\seventeen{Thrust reverser\\
Reingestion\\
Flow visualization\\
Ground effects\\
Engine simulation}
\eighteen{Unclassified---Unlimited\hfil
\vskip4pc
\hfil Subject Category 02\hfil}
\nineteen{\quad Unclassified}
\twenty{\quad Unclassified}
\twentyone{154}
\twentytwo{A08}
\endcosati

\bye
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Typeset Output

The pages of this sample report have been reduced to 80 percent. The page numbers in the TEX document file corresponding to the typeset text on a particular page are listed at the bottom of the page.

Contents

Page 107

Summary

Wind shear is considered by many in the aviation community to be one of the major safety issues facing their industry. The Federal Aviation Administration has addressed this problem through an integrated wind shear program plan, which incorporates the expertise of industry, universities, and various government agencies such as the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, and the Department of Defense. The plan is aimed at reducing the hazard of low-attitude wind shear through improved training and operating procedures, wind shear detection systems, and flight guidance systems.

Introduction

Wind shear is considered by many in the aviation industry to be one of their major safety issues. Listed in table 1 are 32 U.S. aircraft accidents or incidents that have occurred from 1964 to 1985 and were attributed to low-altitude wind shear (refs. 1 and 2). The crash of Delta flight 191 on August 2, 1985, in which 135 people died while on an approach to landing at Dallas-Fort Worth International Airport, is the latest reminder of the danger of this weather phenomenon.

In January 1985 the Federal Aviation Administration (FAA) began developing the Integrated FAA Wind Shear Program Plan (ref. 1) aimed at reducing the hazard of low-attitude wind shear. The program plan incorporates the expertise of industry, universities, and various government agencies, such as the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and the Department of Defense (DOD), into a 5- to 10-year research and development effort. The plan is divided into the following five program elements:

1. Education, training, and operating procedures
2. Ground sensors for the detection of low-level wind shear
3. Airborne sensors and flight guidance systems
4. Terminal information systems
5. Low-level meteorological hazard characterization

Integral to each of these program elements is the fundamental need to better understand the physics of low-level encounters.

NASA's contribution to the wind shear program is focused primarily on the third and fifth program elements. The objective of the NASA research effort is to provide the technology base that will permit reduction of low-altitude wind shear risk through airborne detection, warning, and avoidance.

This paper is divided into five sections. The first describes the modifications required to the vortex-lattice program in order to incorporate the wind velocity gradients and to compute their aerodynamic effects. The second describes the program checkout and validation. This is followed by the formulation of the wind shear aerodynamic coefficients and a series of sensitivity studies. The final section summarizes the results of this study and lists recommendations for further research.

Symbols

A	matrix of shear coefficient slope ($\partial/\partial\alpha$), per rad
AR	aspect ratio
$a_1,\ldots,a_8$	geometry-dependent constants in force equations
B	matrix of shear coefficient intercept ($\alpha = 0$)
b	wing span, ft
$b_1,\ldots,b_3$	geometry-dependent constants in boundary condition equation
C_D	drag coefficient, $\frac{\text{Drag}}{q_\infty S_{ref}}$
C_L	lift coefficient, $\frac{\text{Lift}}{q_\infty S_{ref}}$
ℓ	lift, lb
$\tilde{\ell}$	lift per unit span of line vortex element, lb/ft
N	total number of vortex panels
p	roll rate, rad/sec
x, y, z	distance along X-, Y-, and Z-axis, respectively, ft
α	angle of attack, rad
ϕ	planform dihedral angle, rad
ψ	sweep angle of spanwise horseshoe vortex element in X-Y plane, rad

Subscripts:

c	chordwise vortex element
j	index for control point
l	left half of planform
n	index for elemental panel

Modification of Vortex-Lattice Algorithm

The algorithm used in this study was a modified version of the vortex-lattice computer program presented in reference 14. The computer program presented in the reference was developed to compute the aerodynamic load distribution for single or dual planforms in a uniform flow field. This program had to be modified to compute the load distributions resulting from nonuniform sheared flow fields. The modifications of the boundary condition and the force and moment equations are discussed in the following sections.

Definition of a Spatially Varying Wind Field

The local wind velocities for a uniform flow field at a point defined in the body-axis system, as shown in figure 1, can be written as

$$\begin{pmatrix} u_w \\ v_w \\ w_w \end{pmatrix} = -U_\infty \begin{pmatrix} \cos\alpha\cos\beta \\ \sin\beta \\ \sin\alpha\cos\beta \end{pmatrix} \tag{1}$$

where

u_w, v_w, w_w	relative wind velocity in X-, Y-, and Z-direction, respectively
U_∞	free-stream velocity
α	angle of attack
β	sideslip angle

Figure 1. Body-axis system.

The nonuniform flow field is defined by adding the local wind velocities due to the wind shear to the uniform-flow-field equation:

$$\begin{pmatrix} u_w \\ v_w \\ w_w \end{pmatrix} = \begin{pmatrix} u_S \\ v_S \\ w_S \end{pmatrix} - U_\infty \begin{pmatrix} \cos\alpha\cos\beta \\ \sin\beta \\ \sin\alpha\cos\beta \end{pmatrix} \tag{2}$$

Figure 2. Side view of vortex panel.

The effect of sideslip is not addressed within the limits of this study. For zero sideslip, the wind field equation becomes

$$\begin{pmatrix} u_w \\ u_w \\ w_w \end{pmatrix} = \begin{pmatrix} u_S \\ v_S \\ w_S \end{pmatrix} - U_\infty \begin{pmatrix} \cos\alpha \\ 0 \\ \sin\alpha \end{pmatrix} \tag{3}$$

The local wind shear velocity components u_S, v_S, and w_S are defined in terms of the spatial wind velocity gradients as

$$\begin{pmatrix} u_S \\ v_S \\ w_S \end{pmatrix} \equiv \begin{pmatrix} \frac{\partial u_S}{\partial x} & \frac{\partial u_S}{\partial y} & \frac{\partial u_S}{\partial z} \\ \frac{\partial v_S}{\partial x} & \frac{\partial v_S}{\partial y} & \frac{\partial v_S}{\partial z} \\ \frac{\partial w_S}{\partial x} & \frac{\partial w_S}{\partial y} & \frac{\partial w_S}{\partial z} \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix} \tag{4}$$

Boundary Condition

No-flow condition. One of the fundamental conditions of vortex-lattice theory is the "no-flow" condition at the control point of each vortex panel. This boundary condition simply states that no flow can pass through the vortex panel at the control point, so that the flow is required to be tangent to the mean camber line of the surface. The control points are located at the three-quarter-chord midspan point of each vortex panel. This boundary condition provides the equation used to compute the vortex strength of each panel.

A side view of a vortex panel for a planform with no sideslip or dihedral is shown in figure 2. The no-flow condition for a planform of this type can be written as

$$U_\infty \sin(\alpha + \alpha_i) - u_S \sin\alpha_i = w_S \cos\alpha_i + w \cos(\alpha + \alpha_i) \tag{5}$$

where

α_i	local angle of incidence
w	local downwash velocity

Figure 3. View along the X-axis of the left side of planform with dihedral.

Figure 4. View along the X-axis of the right side of planform with dihedral.

Planform with dihedral. The boundary condition for a planform with dihedral yields a slightly different equation for each side of the planform. Figure 3 provides a view along the X-axis of the left side of a planform with dihedral. Figure 4 provides the same view for the right side. The equation for the left side is

$$[U_\infty \sin(\alpha + \alpha_i) - u_S \sin\alpha_i]\cos\phi_l + (v + v_S)\sin\phi_l = [w_S \cos\alpha_i + w\cos(\alpha + \alpha_i)]\cos\phi_l \tag{6}$$

where

v local sidewash velocity

ϕ_l dihedral angle for the left side

The equation for the right side is

$$[U_\infty \sin(\alpha - \alpha_i) - u_S \sin\alpha_i]\cos\phi_r - (v + v_S)\sin\phi_r = [w_S \cos\alpha_i + w\cos(\alpha + \alpha_i)]\cos\phi_r \tag{7}$$

If α and α_i are assumed to be small such that the sine of the angle can be approximated by the angle in radians and ϕ is defined as

$$\phi = \phi_l = -\phi_r$$

then the boundary condition can be expressed in the form of a single equation as

$$\frac{w}{U_\infty} - \frac{v}{U_\infty}\tan\phi = \alpha + \left(1 - \frac{u_S}{U_\infty}\right)\alpha_i + \frac{v_S}{U_\infty}\tan\phi - \frac{w_S}{U_\infty} \tag{8}$$

The downwash and sidewash velocities for a particular horseshoe vortex can be expressed as

$$w = \frac{\Gamma}{4\pi}F_w \tag{9}$$

$$v = \frac{\Gamma}{4\pi}F_v \tag{10}$$

where

F_w, F_v downwash and sidewash influence functions, respectively

Γ vortex strength

The influence functions are only dependent upon the planform geometry and free-stream Mach number, and therefore require no modification for a nonuniform wind field. The development of the influence functions is provided in reference 14. Incorporating the downwash and sidewash equations into the boundary condition equation yields

$$(F_w - F_v\tan\phi)\frac{\Gamma}{U_\infty} = 4\pi\left[\alpha + \left(1 - \frac{u_S}{U_\infty}\right)\alpha_i + \frac{v_S}{U_\infty}\tan\phi - \frac{w_S}{U_\infty}\right] \tag{11}$$

Note that the wind shear velocities effectively act as an incremental change in the local angle of attack of the vortex panel. This is more clearly seen by rewriting the boundary condition as

$$(F_w - F_v\tan\phi)\frac{\Gamma}{U_\infty} = 4\pi(\alpha + \alpha_i + \alpha_S) \tag{12}$$

where α_S is an additional local angle of attack due to the wind shear velocities:

$$\alpha_S = -\frac{u_S}{U_\infty}\alpha_i + \frac{v_S}{U_\infty}\tan\phi - \frac{w_S}{U_\infty} \tag{13}$$

The effect of the wind shear distribution across the planform is therefore analogous to distortion of the planform shape through twist or camber, as was noted in reference 9.

Sensitivity Study Results

The aerodynamic effects of wind shear were investigated through a series of sensitivity studies using the modified vortex-lattice program and were characterized in the form of shear coefficients. The first of these studies focused on determining the effect of the vortex-lattice distribution on the computation of the shear coefficients. The second study examined the variation of

Pages 100 to 102

the wind shear effect with planform geometry. The final study used a wing and stabilizer configuration to determine the magnitude of the wind shear effect in a simulated microburst.

Effect of Vortex-Lattice Distribution

The objective of the first of the series of sensitivity studies was to determine the effect of the vortex-lattice distribution on the computation of the shear coefficients. This was done by varying the spanwise and chordwise distributions of the vortices for a particular wing geometry. The wing planform used in this part of the study was configuration 2 of table 2. The vortex distribution was varied for each of the nine individual shear conditions, with the origin of the shear coincident with the aerodynamic center of the planform.

Those shear coefficients which had a magnitude of zero or nearly zero were omitted. The variation in the value of the shear coefficients with vortex-lattice arrangement demonstrated similar trends as those reported for the aerodynamic coefficients in reference 13. Increasing the spanwise N_s and chordwise N_c distributions of vortices resulted in an asymptotic convergence of the shear coefficient value. Spanwise distributions less than 30 and chordwise distributions less than 4 resulted in significant variations in the computed coefficient values.

Planform Geometry Effects

The objective of this sensitivity study was to determine how the wind shear effect varied with planform geometry. This was done by varying the sweep, taper, aspect ratio, and dihedral of a simple wing configuration and comparing the resultant effect on the shear coefficient values. Planform configurations 3 to 11 of table 2 were the wing geometries used. The baseline planform was configuration 5. The aspect ratio effect was obtained through comparison of the baseline with configurations 3 and 4; the dihedral effect was obtained through comparison with configurations 6 and 7; the sweep effect was obtained with configurations 8 and 9; and the taper ratio effect was obtained with configurations 10 and 11. All the planform configurations had identical wing areas, with no camber or twist. A vortex distribution of 4 chordwise and 40 spanwise was used in computing the shear coefficients, with the origin of the shear coincident with the aerodynamic center of the planforms.

Concluding Remarks

The objective of this study was to investigate and characterize the aerodynamic effects of shear flow through a series of sensitivity studies of the wind shear components and wing planform geometry parameters. In addition to the data base developed through these sensitivity studies, several pertinent results were established.

1. A method of characterizing the aerodynamic effect of wind shear in the form of wind shear aerodynamic coefficients was formulated.
2. A method of modifying the boundary condition, the wind field, and the force and moment equations of a vortex-lattice algorithm, for computing the aerodynamic effects of wind shear was demonstrated. This approach should be directly applicable to more complex potential flow algorithms.
3. The magnitudes of the aerodynamic effects were demonstrated by computation of the changes in the aerodynamic coefficients of a conventional wing and stabilizer configuration on a fixed flight path through a simulated microburst.

This study was, however, limited in several respects. The effect of sideslip angle was not accounted for in the formulation of the wind shear aerodynamic coefficients. To account for this effect, an additional matrix of sideslip-dependent wind shear aerodynamic coefficients should be added to the formulation. The limits of potential flow theory restrict the results to the linear angle-of-attack range. The thin-wing approximation of vortex-lattice approach is an additional limitation. Perhaps the greatest limitation of the study was the exclusion of the effects of the fuselage and vertical surfaces. The vertical surfaces (fin and rudder) should affect the lateral wind shear aerodynamic coefficients in a similar manner as the horizontal stabilizer affected the longitudinal coefficients. The fuselage effect in sheared flow may also be significant. Just as a cylinder in a flow with circulation produces lift, a fuselage in a sheared flow field may produce significant forces.

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Pages 102 to 104

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Appendix

Program Checkout and Validation

Once the computer program had been modified to incorporate the effects of wind shear on the planform load distribution, some means of checking the program had to be devised. Since measurements of this type have not been conducted, a direct comparison of measured and computed results was not possible. However, if the appropriate spatial wind velocity derivatives are coupled, a curved flow field synonymous to rotary motion can be modeled. Through imposition of this type of flow field and computation of the resultant change in the planform load distribution, the rotary stability derivatives can be computed. The modified program could then be checked by a comparison of the computed rotary stability derivatives with values measured in the wind tunnel or with values computed with other algorithms.

A rolling motion can be simulated if the $\partial w_S/\partial y$ and $\partial v_S/\partial z$ terms are coupled. The coupled terms must be of equal magnitude to simulate the rotary motion:

$$p = \frac{1}{2}\left(\frac{\partial v_S}{\partial z} - \frac{\partial w_s}{\partial y}\right) \quad \text{(A1)}$$

In a similar fashion, pitching and yawing motion can be simulated with the following equations:

$$q = \frac{1}{2}\left(\frac{\partial w_S}{\partial x} - \frac{\partial u_S}{\partial z}\right) \quad \text{(A2)}$$

$$r = \frac{1}{2}\left(\frac{\partial u_S}{\partial y} - \frac{\partial v_S}{\partial x}\right) \quad \text{(A3)}$$

A direct comparison of the stability derivatives computed with the algorithm presented in reference 16 was possible for planforms without dihedral. Such a comparison was made with planform configuration 1 of table 2. The calculated results were derived for 4 chordwise and 30 spanwise horseshoe vortices. This provided a fairly even distribution of vortices about the planform and a reasonable computation time. No effort was made, at this point in the study, to determine the sensitivity of the vortex distribution on the coefficients being computed or to optimize the distribution accordingly. The stability derivatives computed by the two methods were identical to the fifth significant digit.

The computed results were also compared with wind-tunnel measured values for planform configurations 1 and 2. The wind-tunnel data were extracted from a series of studies conducted by the National Advisory Committee for Aeronautics (NACA) during the late forties. The studies investigated the effect of various wing planform geometry parameters, such as sweep, taper, and aspect ratio, on the rotary stability derivatives (refs. 17 to 22). The majority of the wind-tunnel data were measured in a special low-speed stability tunnel which generated curved flow fields using special screens and curved test section walls. A photograph of the test section, set up to measure the effects of yawing motion, is shown in figure 5. Planform configurations 1 and 2 were common to most of these studies and provided a considerable data base to compare with the analytical results of the modified program. The airfoil for both configurations was an NACA 0012 section perpendicular to the planform leading edge. Figures 6 and 7 show the calculated and experimental values of C_L, C_m, C_{L_q}, C_{m_q}, C_{l_p}, C_{l_r}, C_{n_p}, C_{n_r}, C_{Y_p}, and C_{Y_r} for configurations 1 and 2, respectively.

The calculated results compared favorably with the wind-tunnel data up to C_L values of about 0.5, or roughly a 10° angle of attack. The breakdown in the vortex-lattice theory at the higher C_L values was not unexpected, as this is a basic limit of linear potential flow theory. The rolling and yawing derivatives provided much better agreement with the wind-tunnel data than did the pitching derivatives. This agreement was attributed to the relatively few chordwise vortices used in the computation. Reference 14 recommends use of 10 or more chordwise vortices to compute such longitudinal variations. The favorable comparison of the stability derivatives at the lower C_L values was taken as a validation of the modifications made to the vortex-lattice program.

Pages 105 to 106

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16. Abstract

An investigation was conducted in the Langley 14- by 22-Foot Subsonic Tunnel to study the effects of engine thrust reversing on an aft-mounted twin-engine transport and to develop effective testing techniques. Testing was done over a fixed and a moving-belt ground plane and over a pressure-instrumented ground board. Free-stream dynamic pressure was set at values up to 12.2 psf, which corresponded to a maximum Reynolds number based on mean aerodynamic chord of 7.65×10^5. The thrust reversers examined included cascade, target, and four-door configurations. The investigation focused on the range of free-stream velocities and engine thrust-reverser flow rates that would be typical for landing ground-roll conditions. Flow visualization techniques were investigated, and the use of water or smoke injection into the reverser flow proved effective to determine the forward progression of the reversed flow and reingestion limits. When testing over a moving-belt ground plane, as opposed to a fixed ground plane, forward penetration of the reversed flow was reduced. The use of a pressure-instrumented ground board enabled reversed flow ground velocities to be obtained, and it provided a means by which to identify the reversed flow impingement point on the ground.

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Pages 107 to 108

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Index

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Linda H. Woessner: Newport News, Virginia.

Mary K. McCaskill: NASA Langley Research Center, Hampton, Virginia

16. Abstract

This LARCMACS user's manual describes the February 1988 version of LARCMACS, the TEX macro set used by the Technical Editing Branch (TEB) at NASA Langley Research Center. These macros were developed by the authors to facilitate the typesetting of NASA formal reports. They are also useful, however for informal NASA reports and other technical documents such as meeting papers. LARCMACS are distributed by TEB for the convenience of the Langley TEX user community. LARCMACS contain macros for obtaining the standard double-column format for NASA reports, for typesetting tables in the ruled format traditional in NASA reports, and for typesetting difficult mathematical expressions. Each macro is described and numerous examples are included. Definitions of the LARCMACS macros are also included.

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