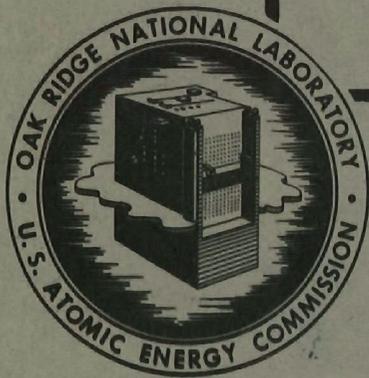


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TECHNICAL REPORT WRITING

By
E. C. Cunningham



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TECHNICAL REPORT WRITING

By

E. C. Cunningham

Methods and Procedures Staff

AUG 1949

OAK RIDGE NATIONAL LABORATORY
Operated By
CARBIDE AND CARBON CHEMICALS DIVISION
Union Carbide and Carbon Corporation
Post Office Box P
Oak Ridge, Tennessee

TECHNICAL REPORT WRITING

ABSTRACT

This report is issued as a guide for the preparation of technical reports that are prepared primarily (1) to support certain conclusions or recommendations on the part of the author, or (2) to provide information to management. The suggested rules and practices set forth are recommended as a means of improving and standardizing such reports originating at the Laboratory.

In the preparation of a report, it is recognized that no single outline can be followed in all cases; however, the one recommended can be used in most instances, and should be used wherever possible in that its use assures easier reading of the report and makes less likely the omission of important features.

In preparing this report, an attempt was made to keep it as brief as possible, yet wide enough in scope that it may serve the purpose for which it was intended.

TECHNICAL REPORT WRITING

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TECHNICAL REPORT WRITING

INTRODUCTION

A formal report is defined as a type of writing used by technical men for presenting the results of research or development investigations. Reports are written for many purposes among which are the following: (1) to present in coherent form data regarding laboratory investigations, (2) to influence decisions by presenting conclusions and recommendations, and (3) to present information of interest to others.

A formal report is the most desirable medium for expressing and presenting technical information concerning the results of research and development investigations. It is possible for such a report to reach a wide audience. A formal report provides a written record of important data, facts, or conclusions which can be used in future work to eliminate duplications of effort and waste of funds. Also, it provides a permanent record for future demands, whether they be historical or academic.

A report should either suggest the course of future work or summarize the past work on the particular problem. If a report gives a clear, concise record of the results of research work, it will provide significant directions for continued progress in the work. Thus, report writing is an essential part of scientific work and may be the most important.

Formal reports on investigations and experimental work require mental alertness on the part of the supervisor and the writer as well as the reader. The supervisor, in the assignment, determines the direction of the work--the assignment should include a clear statement of the problem to be developed by the report writer. The writer should determine to the best of his ability what questions the report should answer and should have an understanding of the persons to whom the report is to be presented, the effect that can be produced on them, and the best way the report can be made to serve them. Obviously, in order to write a good report, the author must also thoroughly understand the subject covered in the report.

At Oak Ridge National Laboratory, the primary purpose in writing a formal report is to present information obtained in research and development work. Periodic reports include monthly progress reports by various sections and quarterly progress reports by all technical divisions. A topical report is written when any fundamental research or engineering development work is completed. Reports of the latter type are sent to the other Atomic Energy Commission installations for their information. The formal report is not written as a paper for publication in a scientific journal.

CHARACTERISTICS OF A GOOD REPORT

The essence of a good report is the picturization of the problem in the mind of the reader. The abstract gives a definite picture of the nature of the work performed. The reader should be able to decide whether or not he wants to read the report by reading the abstract which is usually composed of three sections: (1) brief statements of the problem under consideration, (2) the general methods or procedures employed in achieving the solutions, and (3) the major solutions, facts, conclusions, and recommendations evolved from the work. The abstract should be on a page by itself immediately preceding the table of contents.

The table of contents is equivalent to an outline of the report and gives the number of the page on which each important section of the report begins. Every page of the report is numbered; those pages which contain pictures, diagrams, or other illustration materials are numbered just as though they were consecutive text pages. Illustrations may be listed in a separate contents table under an appropriate heading. The table of contents is inserted immediately preceding the body of the report.

The arrangement of the body of the report is varied to meet the requirements for clearness, completeness, proper organization of the material, and correctness of presentation. The body of the report gives the impression of orderliness.

The Appendix includes the detailed data, compilations, graphs, or other materials related to the discussion which are in too much detail to employ in the report proper but too important to be omitted. The same rules for writing are used in the preparation of the body of the report and the Appendix.

Adequate preparation must be made before a good report can be written. Good composition and correct English must be used and the report rewritten and corrected until it is clear and concise. Also, the report must be sound structurally and adapted practically to the use it must serve.

A good report economizes the mental effort of the reader. The intelligent reader of a technical report should be able to understand it readily and comfortably, and obtain useful information without mental fatigue. The reader is spared doubt as to the intended meaning. Also, the reader should be spared perplexity caused by extravagant style, annoyance at the queerness of terms, and weariness due to verbosity.

In summary, a good report contains the following essential features: (1) the title and abstract whets the reader's curiosity, (2) the introduction and summary gives the reader the primary facts, and (3) the body of the report answers all the reader's questions. A technical report is written for a number of readers, each having different questions. Therefore, it is necessary that the answers be organized and arranged so that they can be located with a maximum of ease.

REPORT WRITING METHODS AND PROCEDURES

It is highly desirable that reports be written as soon as convenient after the work has been accomplished. It is helpful to write technical reports when the subject matter is fresh in mind since less time is required, continuity is easier to realize, and important parts are not forgotten.

Complete notes should be made in bound notebooks from the very beginning of the research. The writer should keep a written statement of the objective of the report before him as he gathers data for the report. Pertinent material bearing on the subject should be assembled and listed under appropriate headings.

The report should have three general headings: (1) abstract, (2) discussion or body of the report, and (3) summary. When a report is written to present the results of an investigation to management, conclusions and recommendations are in order and may become the most important part of the report. The information and ideas to be included in the report should be outlined. The details should be checked to determine their accuracy and relative value. All graphs and illustrations to be used should be drawn up, at least in rough form.

The first rough draft should not be written until the requirements which the report is to satisfy have been determined--what is wanted, why it is wanted, and how it is to be used--and all data have been collected and studied until the relationship between the various parts is known. The rough draft should be double spaced in order to provide space for making corrections.

The rough draft should be read to check the technical accuracy of the report. It should be reread to make sure that correct grammar has been used and that the style and appearance meet standard specifications. Relentless criticism should be applied to the rough draft to reduce faulty and ambiguous statements. It should be revised and rewritten until the manuscript is well organized and easy to follow and no question is left in the reader's mind as to what was done, why it was done, and what is recommended.

The author should be fully satisfied with the rough draft before it is passed on to higher supervision. The following items should be checked and rechecked: technical facts, method of presentation, choice of words, grammar, spelling, uniformity of units and symbols, classification, distribution, and conclusions and recommendations. The rough draft should be as complete as possible with the appendices collected, labelled, and indexed; the title, table of contents, and signatures indicated; all drawings, graphs, or figures submitted in final form ready for reproduction or sample reproductions submitted to save wear and tear on the original copies; and the report assembled ready to be typed for distribution.

TYPES OF REPORTS

The specific purpose a report is intended to meet should be determined before a writer attempts to produce a report. The content and procedure must be regulated and directed toward the most efficient accomplishment of that purpose; every detail that leads toward the purpose should be included and every detail that does not should be omitted. A good report requires a type of presentation that is suitable for the accomplishment of its purpose.

Technical reports constitute written formal presentation of data and information pertaining to or resulting from scientific investigations, or studies. Technical memoranda and letters constitute limited presentation of technical data or information for use by individuals already familiar or concerned with the investigations, tests, or studies involved.

In general, the Oak Ridge National Laboratory issues only two types of reports, namely, periodic or progress reports and topical or completion reports.

Periodic Reports

This type of report is prepared and submitted at regular intervals. Various sections of the Technical Division make monthly progress reports. Quarterly reports present full details of the progress of each research and development division. A periodic report should state the problem, what was done during the report period, the present status, and what will be done during the next report period.

The number and content of the parts of a periodic report may vary with the progress of activities. A report in the form of a letter or a memorandum may have no other parts than the pages of the letter or memorandum. Short reports may vary from filling in of blanks on a form sheet to a formal report of five pages or less. Longer reports may have any or all of the parts enumerated in this report.

Topical Reports

This type of report deals with a specific problem, which should be stated definitely at the outset. In order to achieve its purpose, the report should present a solution to the problem in complete detail. A formal topical report should present all steps, methods, equipment, observations, and conclusions needed to persuade the reader to accept and act upon the recommendations submitted in the report.

FORM AND FORMAT

The content of a report is never so overwhelmingly important that the form in which the material is presented does not matter. Regardless of how important an experiment may be, it ought to be recorded in a report that is easy to read and free from grammatical errors. The individuality of the writer should be preserved, but his individuality should not consist in the repetition of faults that produce an unsightly and inconsistent report. The organization of the report need not necessarily be chronological, but the order must be logical.

The order that is most naturally suited to the material of the report should be chosen and followed consistently throughout. Minute and unimportant divisions should not be listed in the outline. Each topic that is subdivided should have at least two subheads, and topics that are parallel in thought should be parallel in form. Each group of subtopics, taken together, should cover the field stated in its governing topic.

The report should be reproduced by the multilith process on good bond paper, 8½ by 11 inches in size. Plain text material should be typed single-spaced; equations and formulas should be typed double-spaced and be centered on a separate line.

The left margin should be one and one-half inches and all other margins one inch. Each page, beginning with the title page, should be numbered consecutively in Arabic numerals, including pages made up of drawings or tables. Headings for each major division of the report should be capitalized, centered, and underlined. Footnotes should not be used except on tables.

Tables of results, data, or other material should be numbered consecutively in Roman numerals. The number should be centered and underlined. A distinctive title should be centered under the number of the table. If possible, the table should be confined to one page.

All equations in the text should be numbered consecutively in Arabic numerals, placed within parenthesis at the right margin. All symbols should be defined and the units in which they are expressed should be stated either in the body of the text or in a Table of Nomenclature.

A technical report should be adequately documented, identifying references by the use of underlined numbers in parentheses, e.g., (1), (7). Rules of order for citations are given in the Appendix.

Abbreviations used in reports should be consistent throughout and conform to the suggestions and list of standard abbreviations given in the appendix.

LITERARY STYLE

Given the facts, the next step for the report writer is to group them so as to achieve a report that is easy to understand. The report should be written in the natural and sincere style of the author, in accordance with accepted writing practices. It should be the aim of the writer to choose the word that belongs to the thing described, to put the word in its right place, and to arrange the ideas in proper sequence.

The writer should be as economical in the use of words and as painstaking in their selection as purpose and clarity permit. If sentences within a report are grammatically incorrect or show evidence of ambiguity, the entire report is likely to be discredited. Specific suggestions of things to be avoided are listed in the Appendix.

Almost without exception, the technical report should be written in a strictly impersonal style, in the third person.

The same tense should be used throughout unless there is a good reason for change. Needless changes in tense, within a sentence or in successive sentences, usually reflect needless changes in the point of view and reflect confusion on the part of the author. However, the tense of verbs and verbals should express exactly the time meant, and should be in logical sequence.

Unnecessary shifting of nouns and pronouns from singular to plural form or vice versa should be avoided. Each verb should be made to agree in number with its subject and not with a word between it and the subject.

Each sentence should be clear and precise; it should express the writer's exact thought unmistakably. Variations of sentence form makes a report read more smoothly and pleasantly. Long and short sentences, simple and complex sentences, and direct and inverted ones should be interspersed to avoid monotony.

In the choice and placing of punctuation marks, the sole aim should be to bring out more clearly the author's thought; if punctuation does not clarify the text, it should be omitted.

Many words and long phrases can be deleted from reports without loss of information, and often with a gain in clarity. A series of short sentences may be combined into one sentence of reasonable length.

Unsatisfactory: Forty-one tests have been completed on this program for the monthly period. All pertinent data concerning the conditions of testing, descriptive recording of results, and interpretation of results are to be found in the Appendix of this report.

Satisfactory: Forty-one tests were completed this month. Conclusions are summarized below; details will be found in the Appendix.

Unsatisfactory: A kettle was used. It was cylindrical and made of steel. The kettle was three feet in diameter and six feet high. Both the top and the bottom were dished. It was provided with a steam jacket.

Satisfactory: The kettle used was a vertical, steam-jacketed, steel cylinder three feet in diameter and six feet high, with dished heads.

SCIENTIFIC PRACTICES

In the interest of clarity and simplicity, it is desirable that commonly discussed quantities should be represented by the same symbols in all technical reports. Some of the symbols used in reporting radio-chemical methods have been used so generally that they have become almost standard. However, the nomenclature used for technical reports still needs to be clarified and standardized.

Care should be taken to give numbers only to as many figures as are significant. The number of figures gives the reader an immediate rough indication of the probable error of the quantity. In cases, other than fiscal, where one or more non-significant terminal zeros are required as in 32,000 or 32,400, the true number of significant figures can be indicated by writing 32×10^3 instead of 32,000.

The compounding of scientific terms is governed by scientific usage. The hyphen should be used in compound words to safeguard the meaning and to economize the reader's time and attention. Accepted rules of usage are given in College Handbook of Composition by Edwin C. Wooley and Franklin W. Scott.

It is highly advisable to record the current status of experimental work directly in a standard data book. Every page or entry should bear a date and the signature of the person who makes the entries. If an entry is wrong a line should be drawn through it; it should not be erased. All original sketches should be made in the data book, or fastened in like a chart. A very brief description of what is being done should preface each new item. The data book should be indexed as it is used.

The original figures for inclusion in reports should be submitted separately from the report and their places in the report marked with sheets of paper bearing the figure numbers. All figures should have borders, drawn in heavy lines. They should not be folded, since folds often appear as lines in reproduced copies. Drawing specifications in the preparation of figures are given in the Appendix.

In general, photographs should not be used unless they are of particular importance. Line drawings are preferable, especially in showing apparatus. In order to reproduce properly, glossy prints should be provided when photographs are required. Photographs should be sharp and fairly brilliant in contrast, with clear highlights and full details in the background.

A technical report should contain a reasonably complete list of the persons who helped in its preparation. The list should be at the close of the report under a subhead "Acknowledgments".

In general, technical reports written by individuals should be signed.

ACKNOWLEDGMENTS

Many persons have helped directly and indirectly in writing "Technical Report Writing". The author is deeply indebted to a number of department heads, supervisors, engineers, report writers, and secretaries for their helpful suggestions and constructive criticisms. Many studies are quoted or summarized.

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APPENDIX

CLASSIFICATION

13

Report No. _____

This document consists of _____ pages.

Copy _____ of _____. Series _____.

STANDARD TITLE PAGE

FOR A

CLASSIFIED REPORT

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CLASSIFICATION

AUTHORSHIP AND DISTRIBUTION

It is suggested that authorship be assigned in the case of each report. The following outline may be used for major sections of a report as a means of giving credit to individuals for their contributions:

The Title of the Report
Work done by D. B. Jones, E. N. Smith, and S. R. Bell
Report written by K. J. Brown

Except in instances when not more than ten copies are distributed, the names of all those receiving copies of a classified technical report should appear on the second page of the report--the page following the title page. The names of those persons in a division or section for whom the report was done should appear first on the list.

CONTENTS

There should be included in every report a brief table of contents showing the main headings used. For long and involved reports, an extensive alphabetically arranged index may be included. The character and length of the report should indicate whether or not an index should be included.

The type of table of contents used in a United States Atomic Energy MDDC report should be sufficient for simple reports of average length. The table of contents is as follows: (a)

Contents	
	Page
Abstract	1
Introduction	1
Review of literature	2
Material and methods	3
Experimental results	15
Discussion	20
Summary	21
Acknowledgments	22
Bibliography	22

-
- (a) Rekers, P. E. Cultivation of the hematopoietic tissues by tissue culture methods (U. S. Atomic Energy Commission, MDDC series No. 1763) Oak Ridge directed operations, technical information division. Declassified. February 25, 1948. p. 24.

ABBREVIATIONS

For the purpose of promoting uniformity in Oak Ridge National Laboratory reports, the following suggestions, approved by the American Standards Association, are recommended:

1. Abbreviations should be used sparingly in text and with due regard to the content and to the training of the reader.
2. Abbreviations should not be used where the meaning will not be clear. In case of doubt, spell out. Short words such as ton, day, and mile should be spelled out.
3. The abbreviation, "etc.", should be used sparingly.
4. Dimensions, degrees, distances, weights, and other like units should be expressed in figures; for example: 45 in., 20 ft, 21°C, 240 v, 6 tons. Always use figures for decimals and quantities in per cent; for example: 0.987, 10%.
5. Always place a zero before the decimal point in expressing the value of quantities less than unity; thus, 0.21 ft, not .21 ft.
6. The use of conventional symbols for abbreviations in text is not recommended. Such symbols may be used sparingly in tables and similar places for conserving space.
7. The use in text of exponents for the abbreviations of square and cube and of negative exponents for terms involving "per" is not recommended.
8. Terms denoting units of measurement should be abbreviated only when preceded by the amounts indicated by numerals; thus several inches, one inch; but 12 in.
9. Numbers below ten should be written out, numbers above ten should be represented in figures.
10. The period should be omitted in abbreviations except in cases where the omission would result in confusion.

ABBREVIATIONS

absolute	abs	cubic	cu
abstract	abstr	cubic centimeter	cc
addition	addn	cubic feet per minute	cfm
additional	addnl	cubic foot	cu ft
alcohol, alcoholic	alc	cubic inch	cu in
alkaline	alk	cubic meter	cu m
alkalinity	alky	cylinder, (ical)	cyl
alternating current	a-c	cycles per second	cps
amount	amt		
ampere	amp	decimeter	dm
anhydrous	anhyd	decompose	decomp
antilogarithm	antilog	decontamination factor	DF
approximately	appr	demineralize	demin
aqueous	aq	density	dens
associate	assoc	derivative	deriv
association	assn	diameter	diam
atmosphere, (ic)	atm	dilute	dil
atomic	at.	dilution	diln
atomic weight	at. wt	direct current	d-c
auxiliary	aux	distillation	distn
average	av	distilling	distg
avoirdupois	avdp		
		efficiency	eff
barometric	bar.	elevation	elev
barrel	bbl	equilibrium	equil
Battelle Memorial Institute	BMI	equivalent	equiv
Baume	Be.		
Biochemical Oxygen Demand	BOD	feet, foot	ft
biological	biol	figure	fig.
boiling point	bp	fission product	FP
brake horsepower	bhp	foot-pound	ft lb
Brinell harness number	Bhn	free on board	fob
British thermal unit	Btu	freezing point	fp
		frequency	freq
calorie	cal		
centimeter	cm	gallon	gal
centimeter-gram-second	cgs	geological	geol
centipois	cp	gram-calorie	g cal
chemical	chem		
chemically pure	CP	horsepower	hp
circular	cir	horsepower-hour	hp hr
coefficient	coef	hydraulic	hydr
compound	comp		
conductivity	cond	immiscible	immisc
constant	const	inch	in
continental horsepower	cont hp	inorganic	inorg
construction	constr	inside diameter	I D
cosecant	csn	iron-pipe size	ips
cosine	cos		
cotangent	cot	kilogram	kg
critical	crit	kilovolt	kv
crystalline	cryst	kilowatt	kw

ABBREVIATIONS (Cont'd)

laboratory	lab	radius	rad
latitude	lat	revolution	rev
linear foot	lin ft	revolution per minute	rpm
liquid	liq		
logarithm (to base 10, common)	log.	saturated	satd
logarithm (to base e, natural)	ln	saturate	sat.
longitude	long.	saturating	satg
		schematic	schem
manufacture, (er) (ing)	mfg	secant	sec
mathematics (ical)	math	second	sec
maximum	max	separated	sepd
mechanical	mech	soluble	sol
metathesis	metath	solubility	soly
melting point	mp	solution	soln
meter	m	specific	sp
miles per hour	mph	specification	spec
minimum	min	specific gravity	sp gr
miscellaneous	misc	specific heat	sp ht
molar (of solutions)	M	spectrograph	spect
molecule	mol	square	sq
molecular weight	mw	square centimeter	sq cm
		square foot	sq ft
natural	nat	square inch	sq in.
negative	neg	stainless steel	ss
neutron	neut	standard	std
number	no.	symmetrical	sym
nuclear, nucleonics	nuc		
		tangent	tan
organic	org	technical	tech
ounce	oz	temperature	temp
outside diameter	O D	temperature, absolute	abs temp
		tensile strength	ts
page	p	thermal	therm
parts per million	ppm	thermal conductivity	cond therm
pathological	pathol	thermocouple	tc
physical	phys		
physiological	physiol	ultimate	ult
positive	pos	United States Pharmacopeia	USP
potential	pot		
pound	lb	velocity	vel
pound centigrade unit	pcu	velocity, angular	ang vel
pounds per cubic foot	lb/cu ft	versus	vs
pounds per square foot	lb/sq ft	volt	v
pounds per square inch	psi		
powdered	powd	watt	w
power factor	pf	watt hour	w h
precipitate	ppt	weight	wt
		wrought iron	w i
qualitative	qual		
quantitative	quant	yard	yd
		yield point	y p

CHEMICAL ENGINEERING NOTATION

Adopted by American Institute of Chemical Engineers and American Standards Association, ASA Z10, 12—1946.

These symbols are presented to encourage general use. Parentheses indicate occasional alternates. Papers for CHEMICAL ENGINEERING PROGRESS are expected to conform to this list.

Absorptivity (for radiation)— α (alpha)	Evaporation— E latent heat of— h_{fg} , λ (lambda)	Mass— m flow rate— w	Temperature— t absolute— T
Acceleration— a	Expansion linear, coefficient of— α (alpha) volumetric, coefficient of— β (beta)	transfer coefficient gas film— k_g individual— k liquid film— k_L overall— K	Theoretical plate, equivalent, height of, "H.E.T.P."— H_p
Acceleration of gravity— g standard value— g_0	Exponent of compressibility of cake— s	gas film basis— K_G liquid film basis— K_L	Thermal condition of feed, $(L_m - L_n)/$ $F - q$
Activity— a	External work— W_e	velocity— G of liquid— L	conductance— C conductivity— k diffusivity— a (alpha) resistance— R
Activity coefficient, molal basis — γ (gamma), (f)	Fanning friction factor— f	Matter, weight, quantity of— W	Thickness, film, effective— B
Angle— α (alpha), $(\theta$ (theta), ϕ (phi)) solid— ω (omega)	Feed, thermal condition of, $(L_m - L_n)/F - q$ rate— F	Mesh— m, M	Time— t, τ (tau), $(\theta$ (theta))
Angular velocity— ω (omega)	Film mass transfer coefficient liquid— k_L gas— k_g thickness, effective— B	Moisture content, free— W	Tractive force per unit area— τ (tau)
Aperture— a, A	Flow rate, mass— w volumetric, rate of— q weight rate per unit of breadth — Γ (capital gamma)	Mole fraction in liquid— x in vapor— y in vapor, equilibrium value— y^* ratio, in liquid— X ratio, in vapor— Y	Transfer rate of— N unit, "H.T.U.," height of— H_t units, number of— N_t
Area— A, S	Force, total load— F	Molecular weight— M	Vapor mole ratio— Y rate— V
Base of natural logarithms— e	Free energy Gibbs, $(H - TS) - G$ Helmholtz, $(U - TS) - A$ moisture content— W	Moment of inertia— I	Velocity acoustic— V_a, c angular— ω (omega) average— V local— u mass— G mass, of liquid— L
Bottoms, residue, waste— W, B	Fraction volume— x_v weight— x_w	Newton law of motion, conver- sion factor— g_c	Viscosity absolute— μ (mu), $(\eta$ (eta)) kinematic— ν (nu)
Breadth, width— b	Friction coefficient of— f energy balance— F factor, Fanning— f	Number in general— N	Volatility, relative— α (alpha)
Coefficient activity, molal basis— $(f), \gamma$ (gamma) discharge, etc.— C expansion, linear— α (alpha) expansion, volumetric— β (beta) friction— f gas film, mass transfer— k_g heat transfer, individual— h heat transfer, overall— U individual, mass transfer— k liquid film, mass transfer— k_L overall, mass transfer— K gas film basis— K_G liquid film basis— K_L resistance— C	Fugacity— f	Plates, number of— N_p	Volume fraction— x_v humid— v_H specific— v total or per mole— V
Compressibility cake, exponent of— s factor— z	Function— ϕ (phi), ψ (psi), χ (chi)	Power— P	Waste bottoms, residue— B, W
Concentration, volumetric— c	Gas constant, universal— R	Pressure— p	Weight fraction— x_w quantity of matter— W rate of flow per unit of breadth — Γ (capital gamma)
Conductance, thermal— C	Gravity acceleration of— g standard value, acceleration of — g_0	Production rate— R	Width, breadth— b
Conductivity, thermal— k	Heat humid— c_s latent, of evaporation— λ (lambda), h_{fg} mechanical equivalent of— J quantity of— Q specific— c specific, constant pressure— c_p specific, constant volume— c_v specific, ratio of, $c_p/c_v - k, \kappa$ (kappa), γ (gamma) transfer coefficient, overall— U factor— j individual, coefficient of— h rate of— q	Radiation, intensity of— N	Work— W, W_k external— W_e
Constant equilibrium, $y = Kx - K$ gas, universal— R Stefan-Boltzmann— σ (sigma)	Height— Z equivalent to a theoretical plate, "H.E.T.P."— H_p of transfer unit, "H.T.U."— H_t	Radius— r hydraulic— R_H	
Cross section— A, S	Henry's law constant, $c/p - H$	Ratio mole in liquid— X mole in vapor— Y reduction— R_R reflux— R	
Density— ρ (rho)	Humid heat— c_s volume, V_H	Reduction ratio— R_R	
Depth— y	Humidity— H relative— H_R	Reflux ratio— R	
Diameter— D	Hydraulic radius— R_H	Relative humidity, H_R volatility— α (alpha)	
Difference, finite— Δ (capital delta)	Inertia, moment of— I	Residue, waste, bottoms— W, B	
Differential operator— d	Length— L	Resistance cake, specific— α (alpha) cloth, equivalent— r coefficient— C thermal— R	
Diffusivity, thermal— α (alpha)	Liquid rate— L above feed— L_n below feed— L_m	Relative humidity, H_R volatility— α (alpha)	
Diffusivity of vapor— D_v	Logarithms, base of natural— e	Residue, waste, bottoms— W, B	
Distance above datum plane— Z in direction of flow— x		Rotation, rate of— n	
Distillate rate— D		Slope of equilibrium curve— m	
Efficiency— η (eta)		Solid angle— ω (omega)	
Emissivity (for radiation)— ϵ (epsilon)		Solubility— S	
Energy free, Gibbs, $(H - TS) - G$ general— E internal— U internal, per unit weight— u		Solvent present— H_o	
Enthalpy— H per unit weight— $h, (i)$		Specific heat— c at constant volume— c_v at constant pressure— c_p heats, ratio of, $c_p/c_v - k, \kappa$ (kap- pa), γ (gamma) surface— s volume— v	
Entrainment ratio— E		Stefan-Boltzmann constant— σ (sigma)	
Entropy— S per unit weight— s		Surface per unit volume— a specific— s tension— σ (sigma)	
Equilibrium curve, slope of— m constant, $y = Kx - K$ value, mole fraction in vapor— y^*			
Equivalent resistance of cloth— r			

THINGS TO BE AVOIDED

Avoid clumsy circumlocutions such as there is, etc, along the lines of, of the nature of, of the character of, etc.

Wordy: There were two hundred scientists who went to New York.

Improved: Two hundred scientists went to New York.

Do not use trite or flamboyant phraseology in the hope of dressing up the report. Sincerity and naturalness carry force.

The use of we as designating a writer is an affectation and should be avoided.

Make all references to an appendix unequivocally clear by designation. Avoid footnoting where it would be merely a secondary reference.

The appendices of a report are as essential as the third leg of a tripod, and it is well to note that their order is dictated by the sequence of events in the body of the report. Avoid crowding the appendices by putting more than one chart or graph on a page.

Never capitalize without a specific reason.

It is advisable that the ordinate and abscissa of a graph be in units of one, two, or five or 10^n times any one of these three. Avoid clumsy units which fill the page but make interpolation difficult.

Avoid the use of exponents where abbreviations would serve the purpose to better advantage. (lb/cu ft)

Avoid a ridiculous degree of accuracy in numerical expressions.

The percentage symbol (%) should not be used in text material except after numerical symbols.

Incorrect: The % of copper is high.

Correct: The percentage of copper is high.

Avoid unnecessary shifting of subject, voice, mode, tense, number of nouns and pronouns, and of person.

BIBLIOGRAPHIES AND CITATIONS

Generally, footnotes should be reserved for explicit references to the literature of the subject discussed. Footnotes of any other character should be used sparingly, if at all. In the preparation of final copy for a report, footnotes should be numbered consecutively and the assignment of numbers should be postponed, therefore, until the manuscript is either ready for the printer or is set up on duplimats in final form. If copy is prepared for printing, a footnote should be written immediately below the line in which the reference mark is to appear and should be separated from the text above and below by lines extending across the page; if copy is typed on duplimats for final production, the footnote should appear at the bottom of the page on which the reference mark appears and should be separated from the text above by a line extending across the page.

Rule of Order for Citations

The order of the items for a book in a citation to the literature or in an entry for a bibliography is as follows: Name of the author; title of the book; series title (if any); edition (if other than the first); place of publication; publisher; date of copyright; and page cited. The order of the items for a periodical or serial citation to the literature or entry for a bibliography is as follows: Name of the author; title of the article, section, or part; name of the journal or serial; volume; part or number (if necessary); pages; and date of publication. The author's name should be cited surname first followed by initials or given name. If there is only one given name, write it in full; if more than one, write only the initials, each followed by a period.

Titles of books or articles should not be abbreviated. The first word of the title should begin with a capital letter but all other words except proper nouns and proper adjectives should begin with small letters. An exception to this general rule may be made in the case of foreign references where the national practice of a particular country may be followed as a guide.

Complexities of Citation

Page references should be explicit and inclusive, not merely referring to the first page of the work. If full-page plates or figures are an important part of the reference, these may be cited immediately following the reference to pages. Much delay and expense could be obviated in obtaining copies of references which are cited in reports if paging and dates were given in full. Accordingly, if the reference is to a monthly journal, cite month and year; if to a weekly, cite the month, day and year.

Abbreviations should be used sparingly if at all in citing titles, or names of journals, or publishing bodies. In journal references "v." may be used for "volume" or "volumes" and "p." may be used for "page" or "pages". However, in foreign citations such terms as the German "Band", "Heft", "Abt." (abteilung), and "Lief." (Lieferung) or the French "tome" and "livr." (livraison)

should not be translated into the English equivalent. Titles of foreign books and papers should be cited in the language of the original. If it is important that the English equivalent be given, this may be included in the citation, in brackets, immediately following the foreign title.

For unsigned papers or other anonymous works, the first item of the citation will be the title rather than the author. In instances where companies, societies, institutions, conferences, congresses, etc, are the authors of works it is the general rule to cite, as author, the name of the sponsoring body, using the latest form of its corporate name. However, there are many exceptions to this rule and, when in doubt, it is best to consult some standard authority for guidance.]

U. S. Library of Congress. Catalog maintenance division. Cumulative catalog of Library of Congress printed cards. Washington, The Library of Congress [1947--]. Printed in 9 monthly issues with 3 quarterly cumulations and an annual cumulation.

In modern practice there is a tendency to omit quotation marks and underlining in citations unless absolutely necessary for the sake of clarity. This rule, of course, does not apply to direct quotations of text taken from other works. However, in preparing copy for printing, it is common practice to underline titles of books and names of journals. Nonetheless, this should be considered as part of the instructions to the printer because the underlined portions of the citation will appear in italics in the printed text. In preparing diplimats for final reproduction, the omission of quotation marks from titles appears to be preferred, although some authorities recommend retention of underlining for titles of books and for names of journals.

Repetition of Citations

It frequently happens that the same source or authority is cited several times within the text of a technical report. In the interest of economical use of space taken for footnotes, resort is made to numerous abbreviations or devices, some of which are occasionally misused. The latin abbreviation, "ibid." for ibidem, meaning "in the same place", may be used to replace the entire source of reference of the immediately preceding reference. This abbreviation may be used as substitute for both author and title of the immediately preceding reference but it will not replace the page reference. Occasionally, the pronoun or adjective form of this Latin word, idem, is used instead of the adverb form and is abbreviated as id. The Latin expression, loco citato, meaning "in the place cited" may be abbreviated as "loc. cit." and may be used as a substitution for a page reference but should be used only when exactly the same place identified by a former reference is cited. Finally, opero citato, meaning "in the work already cited", may be abbreviated as "op. cit." and may be used to replace the title of the work, but not the name of the author or the page reference. The abbreviation "op. cit." is not used to repeat the title of a journal when the reference is to another author, but may be used in reference to the same author's work in the journal, or to the author's book. This abbreviation should not be used in any instances where more than one book or article by the same author has been cited previously.

Bibliographies

The bibliography or list of sources consulted should be a part of every technical report and may be one of the most important elements of the paper. The bibliography functions in the dual capacity of providing acknowledgment of works consulted which may, or may not, have been expressly referred to by footnotes within the text of the report and of giving the reader of the report a guide to pertinent background material. Bibliographies are usually arranged alphabetically by author but occasionally the purpose of the report is better served with a chronological arrangement according to date of publication, or by a subject classification of entries, using suitable headings to introduce each group. A bibliography is most useful to the reader if each entry is followed by a brief annotation evaluating the reference for its relevancy to the subject matter of the report.

DRAWING SPECIFICATIONS IN THE PREPARATION OF FIGURES

Care should be used to see that figures are legible and that they thoroughly fulfill their purpose. Suggestions for the use of drawings and graphs are given in the following paragraphs.

Drawings. Drawings intended for reproduction should be made with black india ink on tracing cloth, tracing paper, or a medium or heavy white paper having a dull surface that will stand erasure without roughening. For reports in which $8\frac{1}{2}$ x 11 inch paper is used, the space available on a page for figures and legends is approximately 6 x $9\frac{1}{2}$ inches. If a large drawing must be prepared for the sake of clarity, it should be of such proportions that it may be reduced to approximately 6 x $9\frac{1}{2}$ inches. Drawings so large that they must be folded in the published report should be avoided.

Graphs. In general, not more than three or four curves should be shown on the same graph. Coordinate rulings should be limited in number to those needed in making a reading to the desired degree of approximation. In cases where there is a most important curve, a solid line should be used for it, and dashed, dotted, or lighter solid lines for the others. Short scale markings may be inserted between rulings if this is desirable. The rulings should be light enough not to detract attention from the curves being presented. No curves or coordinate rulings of the graph should run through any lettering.

All lettering should be placed so as to be easily read from the bottom or from the right side of the figures; that is, the lettering should face either the bottom or the right side of the drawing.

A figure should be free of all lines and lettering that are not essential for clear understanding. As far as practicable, explanatory comments, supplementary data, or formulas should be placed, not on the face of the figure, but in the figure legend. The legend should be sufficiently complete to make the figure largely self-explanatory without reference to the text.

The scale captions should be placed outside the grid area, normally centered at the bottom for the horizontal scale, and centered on the left side for the vertical scale.

The scale caption should contain in the order named, the standard name of the physical variable plotted, its symbol, if one is used in the text, and the abbreviation, if any, for the unit measure. The standard abbreviation should be in parentheses following the name of the quantity.

Never use captions of the following types: "Velocity in thousands of feet per second", "Velocity X 10^3 ft/sec", and "Velocity (ft/sec X 10^3)". The first of these requires too much space and lettering; the remaining two are ambiguous, since they do not indicate clearly whether the scale numbers have been or are to be multiplied by 10^3 .

The scales used in graphs should conform to drafting standards: One, two, five, or 10^n multiples of these. The numerals representing the scale value should be placed outside of the grid area. The horizontal and vertical scales should be chosen with care to create a correct visual impression of the relationship plotted, for the choice of scales has a controlling influence on the apparent rate of change of the dependent variable.

Except in cases where a visual comparison of plotted magnitudes is important, the bottom (abscissa) and extreme left (ordinate) coordinate lines need not necessarily represent the zero values of the variables plotted. If this suggestion is followed where feasible, space can be saved and the presentation often rendered more effective.

If the scale values are smaller than unity and are expressed in decimal form, a cipher should always precede the decimal point, thus 0.20, not .20.

The use of many ciphers in scale numbers should be avoided, and the best way to do this is to re-express the quantity plotted in terms of a larger unit of measurement. For example, suppose that originally the scale numbers are 15,000, 20,000, 25,000..... and that the scale caption is "pressure lb/sq in."; these scale numbers can be 15,20,25 provided the scale caption is made PRESSURE (10^3 LB/SQ IN). If, in this example, the data are correct to two significant figures and it is desirable to indicate this fact, then the scale of values should be 1.5, 2.0, 2.5..... and the scale caption PRESSURE (10^4 LB/SQ IN).