

NASA CONTRACTOR REPORT

NASA CR-1555



NASA CR 1555
e. 1

0060868



TECH LIBRARY KAFB, NM

LOAN COPY: RETURN TO
AFWL (WLOL)
KIRTLAND AFB, N MEX

NASA METRIC SYSTEM STUDY

by Philip F. Eckert and Owen Carlson

Prepared by
INFORMATICS TISCO, INC.
College Park, Md.
for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • FEBRUARY 1970



NASA METRIC SYSTEM STUDY

By Philip F. Eckert and Owen Carlson

Distribution of this report is provided in the interest of information exchange. Responsibility for the contents resides in the author or organization that prepared it.

Prepared under Contract No. NASw-1812 by
INFORMATICS TISCO, INC.
College Park, Md.

for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ABSTRACT

To analyze current metric usage and trends in its usage, a survey was made of 13,143 NASA formal reports. These were the Technical Notes and Technical Memorandums originated by 11 NASA Centers. The method of assembling and identifying the selected document collection, and the procedures used for coding and tabulating the findings are described. Tabular and graphical data are grouped according to the types of measurement systems, the use of each by NASA Centers, and the report publication year. The results show that 22.0% contained metric units only; 31.7% contained English units only; 30.2% contained both units; and 16.1%, neither. Comparisons of two four-year periods, 1962-65 and 1966-69, indicate that the combined usage (metric, predominately metric, and parallel usage) increased from 33.4% to 53.2%.

CONTENTS

	Page
INTRODUCTION	1
METHOD	1
RESULTS - First Phase	3
RESULTS - Second Phase	8
OBSERVATIONS	10
CONCLUSIONS	11
APPENDIX A - Document Definitions and List of NASA Centers	A-1
APPENDIX B - Computer Printout and IBM Card Samples	B-1
APPENDIX C - Eleven NASA Center Printouts by Document Types and Years - First Phase	C-1
APPENDIX D - Breakouts by Year for TM and TN for All Centers	D-1
APPENDIX E - Eleven NASA Center Printouts by Document Types and Years - Second Phase	E-1

NASA METRIC SYSTEM STUDY

By Philip F. Eckert and Owen Carlson
Informatics Tisco, Inc.

INTRODUCTION

Public Law 90-472, enacted August 9, 1968, authorized the Secretary of Commerce to make a study to determine the advantages and disadvantages of the increased use of the metric system* in the United States. The authorization included the appraisal of economic and military advantages of increased usage of the system, the investigation of possible practical difficulties which might be encountered in accomplishing the increased use of the system, comparative studies, and an investigation of current metric usage in the United States. Consultation and cooperation with other government agencies, Federal, State, and local, and, to the extent practicable, with foreign governments and international organizations were directed.

Funds for the first year of the Act were not to exceed \$500,000 of previously appropriated funds to the Department of Commerce and the report to Congress is to be submitted by August 9, 1971, with the Act expiring thirty days after submission of the final report.

To implement this Act, the Secretary of Commerce has assigned responsibility to the National Bureau of Standards (NBS). The Bureau has drafted a government questionnaire and has sought cooperation from NASA and other government agencies. NASA, because of its large automated technical document collection (currently in excess of 600,000), was able to assist in one important aspect of the study - to determine the current metric usage and trends in its usage for a particular sample of its collection - one that would reflect the extent of use of the metric system in the agency.

The NASA Scientific and Technical Information Facility was directed to conduct an analysis of selected documents in the Facility holdings to determine types of measurements used - metric or English systems, both systems or neither. The documents chosen by NASA were the NASA Technical Notes (TND) and the Technical Memorandums (TMX). (See Appendix A for definitions of TND and TMX.)

METHOD

For the first phase, 22 computerized searches of the master NASA document tape file for both types of documents generated or sponsored by 11 NASA Centers (including two organizations considered as Centers for this report) resulted in a total of 13,873 candidate documents for the study. (See Appendix A for a list of the Centers.)

*The Metric System is based upon the meter as a unit of length, the kilogram as a unit of mass, the second as a unit of time, the Celsius degree as a unit of temperature, and units derived therefrom. The modernized Metric System is called the International System (SI) and is described in NBS Handbook 102 of March 10, 1967.

Twenty-two printouts with document citations and an IBM card for each citation were the generated output for the searches. The printouts were first used as checklists for selecting and assembling microfiche or case files from the overall Facility collection. Pencilled coding alongside each citation on the printout consisted of the date of publication for the document, e.g., 65 for 1965 and a "1" for metric usage, "2" for English, "3" for both, and "4" for none.

After each Center printout had been coded, the year and type code were transferred by pencil notation to the lefthand side of the corresponding IBM cards as keypunch input. The year and type were keypunched and verified in columns 70, 71, and 80, respectively. Two sample citations from the Goddard printout and their coded and punched IBM cards are shown in Appendix B. With TN or TM designators and Center acronyms already punched on the cards because of search input coding and with year and type punched after analysis - all in fixed fields it was possible by EAM (Electronic Accounting Machine - the IBM 407) processing techniques to count the types by year, by TN or TM, by Center, and to batch all of the cards for year and type counting. Based on this coding scheme, Appendixes C and D were generated by EAM processing.

The following guidelines and rules were used for determining the type of measurement.

- o Documents with metric units only - Code 1
- o Documents with English units only - Code 2
- o Documents with both types of units - Code 3
- o Documents with none - Code 4
- o A document predominately of one type of measurement and the single mention of the other was classed as both or Code 3.
- o A document with metric units for identification of components or hardware for which no English counterpart unit was available, e.g., 28-volt power supply, 660-megohm resistor, etc., was not deemed sufficient to classify as metric (additional metric usage would have been necessary).
- o Documents which contained indirect metric measurements such as "barn" (10^{-24} sq. cm.) "poise" (absolute viscosity in CGS), "Angstrom" (one ten-thousandth of a micron), "micron" (one millionth of a meter), "torr" or "tor" (one mm of Mercury), etc., were tagged metric or Code 1.

These guidelines caused several documents which were 99.9% English to be classed both because of a solitary mention of microns, Angstroms, 16 mm camera, or millimeters of Mercury, etc. In other words, no attempt was made during the first phase of the study to categorize a both document by 99% metric/1% English, 80% metric/20% English, 50% metric/50% English (parallel usage), etc.

Of the 13,873 candidate documents, 13,143 were analyzed using the above rules. Because a surprisingly large number, 3966, were categorized as both, it was decided to re-examine these documents during a second phase of the study. Of the 3966 documents, 3895 were re-examined under the following rules:

- o Those which were predominately metric were coded 1 in column 79 on the IBM card.
- o Those which were predominately English were coded 2.
- o Those with parallel usage were coded 3.

Based on this secondary coding scheme, Appendix E was generated by EAM processing.

RESULTS - First Phase

Of the 13,143 documents examined, 2888 or 22.0% contained pure metric units; 4166 or 31.7% contained English units only; 3966 or 30.2% contained both units; and 2123 or 16.1%, neither.

The following tables and graphs, derived from the data in the supporting appendixes, depict the metric and non-metric use for a large sample of NASA's holdings as of October 1969.

Table 1

Center Ranking by Pure Metric Usage

<u>Center</u>	<u>Percentage</u>	<u>Documents Reviewed</u>
1. Goddard Institute	63.4	205
2. Goddard Space Flight Center*	36.4	2808*
3. Electronics Research Center	36.4	77
4. Ames Research Center	31.5	1123
5. Lewis Research Center	22.6	2615
6. Marshall Space Flight Center	22.0	1918
7. Langley Research Center	10.1	3014
8. Manned Spacecraft Center	3.4	358
9. Kennedy Space Center	2.4	843
10. Flight Research Center	1.7	177
11. Wallops Station	0.0	5

* Ranked ahead of ERC because of larger sample

Table 2

Center Ranking for Both Types of Measurement

<u>Center</u>	<u>Percentage</u>	<u>Documents Reviewed</u>
1. Lewis Research Center	41.1	2615
2. Marshall Space Flight Center	36.3	1918
3. Kennedy Space Center	34.3	843
4. Langley Research Center	32.0	3014
5. Flight Research Center	30.5	177
6. Manned Spacecraft Center	27.4	358
7. Goddard Space Flight Center	22.1	2808
8. Electronics Research Center	22.0	77
9. Ames Research Center	12.1	1123
10. Goddard Institute	6.8	205
11. Wallops Station*	60.0	5*

* Ranked last because of small sample

Table 3

Center Ranking for Metric and Both Types Combined

<u>Center</u>	<u>Percentage</u>	<u>Documents Reviewed</u>
1. Goddard Institute	70.2	205
2. Lewis Research Center	63.7	2615
3. Goddard Space Flight Center	58.5	2808
4. Electronics Research Center	58.4	77
5. Marshall Space Flight Center	58.3	1918
6. Ames Research Center	43.6	1123
7. Langley Research Center	42.1	3014
8. Kennedy Space Center	36.7	843
9. Flight Research Center	32.2	177
10. Manned Spacecraft Center	30.8	358
11. Wallops Station*	60.0	5*

* Ranked last because of small sample

Table 4

All Documents by Year and Measurement Type

YEAR	MET	ENG	BOTH	NONE	TOTAL
41		1			1
42		1			1
46		1			1
47		1			1
48		2		1	3
49			1		1
50		1			1
51			1		1
52		1			1
53		4		2	6
54		1	3		4
55		4	2	2	8
56	1	2	2		5
57		4	1	4	9
58	4	7	3	3	17
59	5	122	23	10	160
60	34	263	65	22	384
61	101	443	170	86	800
62	140	469	221	124	954
63	303	597	298	235	1433
64	369	551	349	294	1563
65	411	559	546	332	1848
66	371	437	658	311	1777
67	482	371	567	298	1718
68	468	266	718	279	1731
69	199	58	338	120	715
	2888	4166	3966	2123	13143
	22.0%	31.7%	30.2%	16.1%	100%

(For breakouts by year for TN and TM for all Centers, see Appendix D.)

Table 5

All Documents by Center and Measurement Type

CENTER	MET	ENG	BOTH	NONE	TOTAL
Ames	354	425	136	208	1123
Edwards	3	116	54	4	177
ERC	28	5	17	27	77
Godd. Inst.	130	15	14	46	205
Goddard	1023	412	621	751	2808
Houston	12	183	98	65	358
Kennedy	20	425	289	109	843
Langley	304	1500	963	247	3014
Lewis	592	659	1074	290	2615
Marshall	422	423	697	376	1918
Wallops Sta.		2	3		5
	2888	4165	3966	2123	13143
	22.0%	31.7%	30.2%	16.1%	100%

Table 6

Three Two-year Comparisons for Trends - All Centers

YEAR	MET	ENG	BOTH	NONE	TOTAL
62	140	469	221	124	954
63	<u>303</u>	<u>597</u>	<u>298</u>	<u>235</u>	<u>1433</u>
	<u>443</u>	<u>1066</u>	<u>519</u>	<u>359</u>	<u>2387</u>
	18.6%	44.7%	21.7%	15.0%	100%
65	411	559	546	332	1848
66	<u>371</u>	<u>437</u>	<u>658</u>	<u>311</u>	<u>1777</u>
	<u>782</u>	<u>996</u>	<u>1204</u>	<u>643</u>	<u>3625</u>
	21.6%	27.5%	33.2%	17.7%	100%
68	468	266	718	279	1731
69	<u>199</u>	<u>58</u>	<u>338</u>	<u>120</u>	<u>715</u>
	<u>667</u>	<u>324</u>	<u>1056</u>	<u>399</u>	<u>2446</u>
	27.3%	13.2%	43.2%	16.3%	100%

Trends for these three two-year groups are shown graphically in Figure 1.

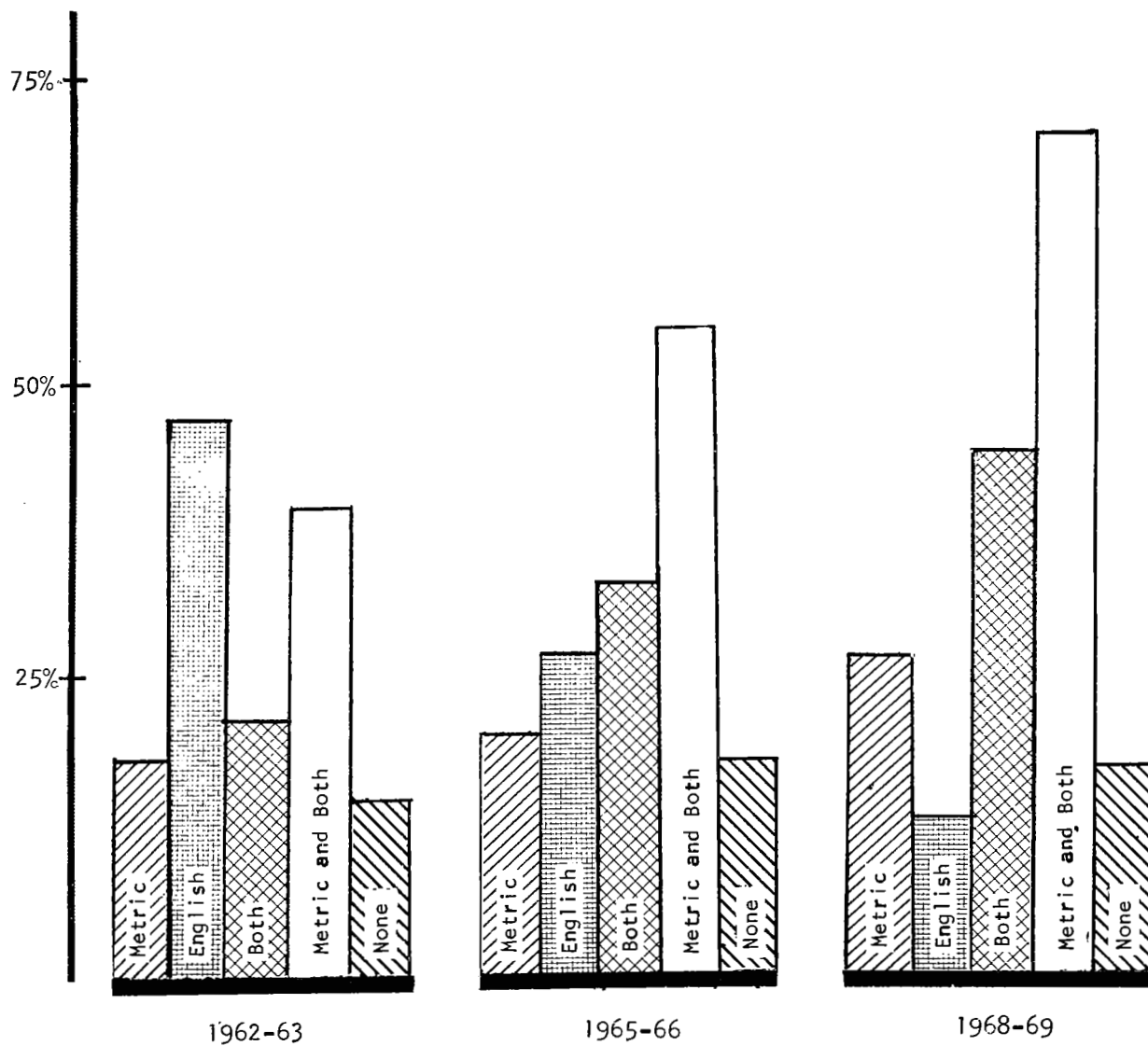


Figure 1. Three Two-year Comparisons for Trends -- All NASA Centers

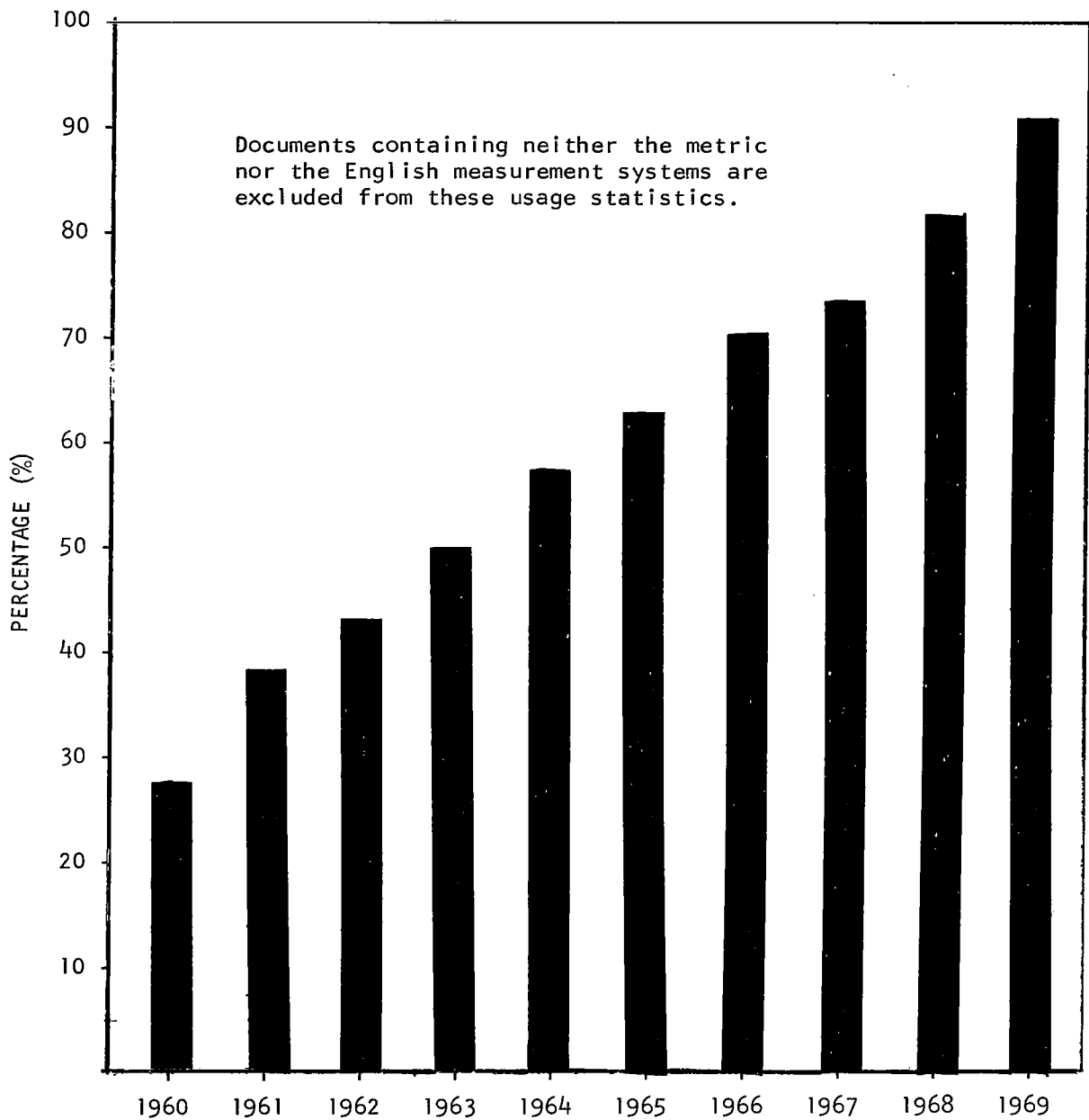


Figure 2. Metric or Both Usage by Percentages for a 10-year Span - All NASA Centers

RESULTS - Second Phase

Re-examination of 3895 documents originally categorized as both yielded the following results:

o Predominately metric	1142	29.3%
o Predominately English	1493	38.3%
o Parallel Usage	1260	32.4%
Total	3895	100.0%

Using these data, Table 7 and Figure 3 were developed.

Table 7

All Documents by Year and Type - All Centers

YEAR	METRIC	ENGLISH	PREDOM METRIC	PREDOM ENGLISH	PARALLEL	NONE	TOTAL
41		1					1
42		1					1
46		1					1
47		1					1
48		2				1	3
49				1			1
50		1					1
51				1			1
52		1					1
53		4				2	6
54		1		2			3
55		4	1	1		2	8
56	1	2		1			4
57		4		1		4	9
58	4	7		3		3	17
59	5	122	2	20		10	159
60	34	263	17	38	4	22	378
61	101	443	55	109		86	794
62	140	469	74	134	7	124	948
63	303	597	124	141	24	235	1424
64	369	551	126	193	27	294	1560
65	411	559	195	225	118	332	1840
66	371	437	165	276	208	311	1768
67	482	371	149	162	247	298	1709
68	468	266	173	138	400	279	1724
69	199	58	61	47	225	120	710
	<u>2888</u>	<u>4166</u>	<u>1142</u>	<u>1493</u>	<u>1260</u>	<u>2123</u>	<u>13072</u>

(For breakouts by year for predominately metric, predominately English, and parallel usage by TN and TM for all Centers, see Appendix E.)

Documents containing neither the Metric nor the English measurement systems are included in these usage statistics.

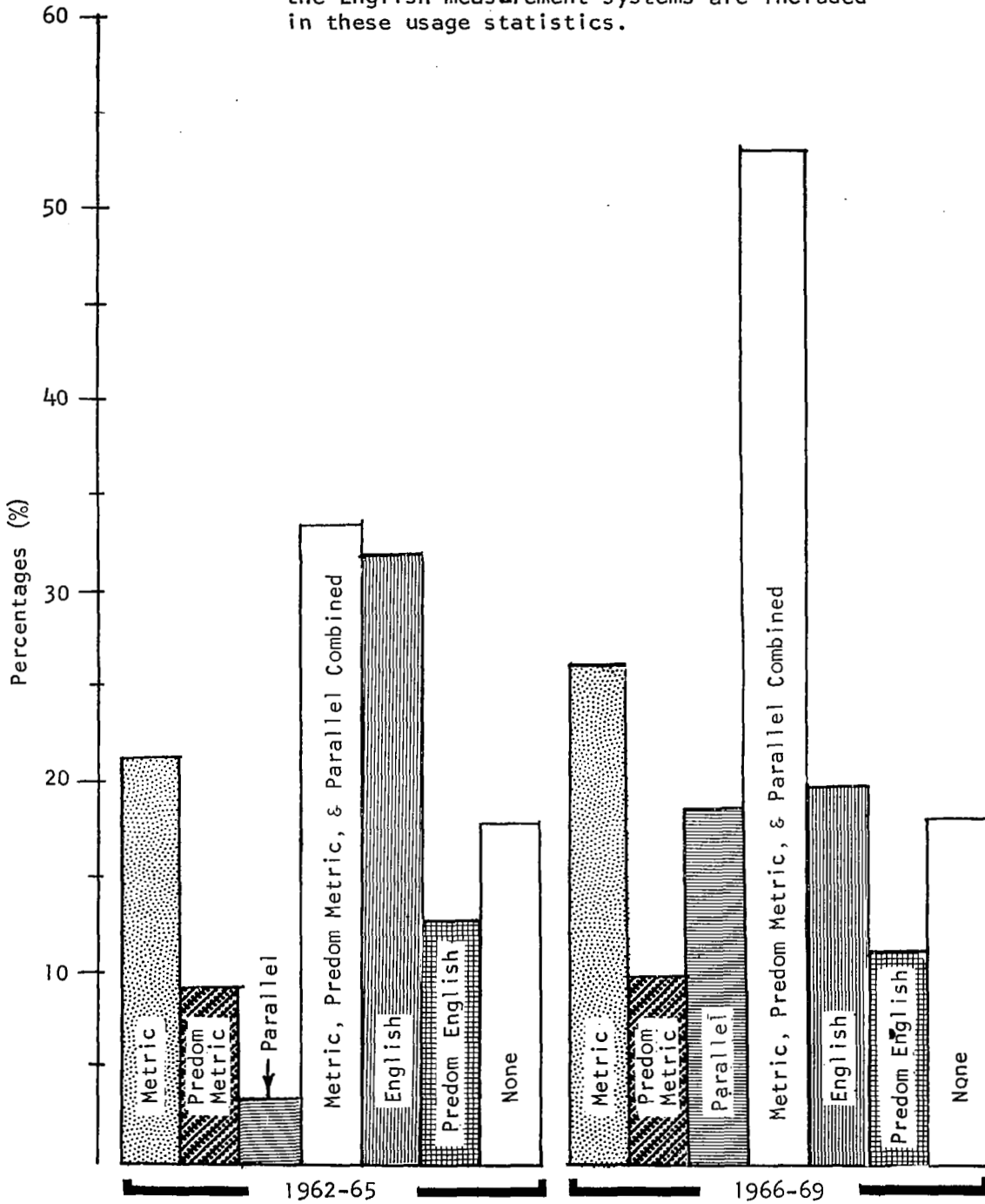


Figure 3. Two Four-year Comparisons for Trends - All NASA Centers

OBSERVATIONS

During the first phase of the study, scanning for measurement usage in a document followed this general pattern: introduction, a table of units and symbols, graphs, charts, and figures. When both types of measurement units were found, the scanning process was halted, often after a search of 25 pages or less. It was usually necessary to scan the entire text of documents heavily laden with units from one type of measurement system before confirming the presence or absence of units from the other measurement system. Re-examination of the documents containing both types of measurements during the second phase for reclassification to predominately metric usage, predominately English usage, or parallel usage required more scanning time per document except for those containing parallel usage. The latter type was usually recognized in less than a minute.

Parallel usage was detected for some of the Centers, particularly for documents written since 1965. Goddard Institute documents contained the heaviest use of the metric or metric and both systems because the authors were principally scientists. On the other hand, most of the Kennedy Space Center documents that dealt with hardware contained English units only. Almost all of the documents pertaining to orbital data, trajectories, spacecraft, and propulsion systems contained English units exclusively. Several aerodynamics documents contained both types of measurements, but the principal measurements are believed to have been made in the English system and the metric counterparts were calculated in order to produce parallel usage documents.

It was evident during the scanning process that metric measurements were used in documents for which the metric system was especially suited. These were usually scientific rather than technical documents, the authors of which are believed to have been scientists. English units were used mainly for documents dealing with hardware - or for documents most likely written by engineers.

Predominately English measurements accompanied by the solitary mention of a convenient metric unit, e.g., liquid leakage expressed in cubic centimeters rather than the awkward fractional- or decimal-parts of a cubic inch were particularly noted in documents on high pressure valves (hardware) sponsored by the Kennedy Space Center. Again, the lack of suitable equivalents in the English system for "torr", "Angstrom", "micron", "barn", "Fermi", etc., caused scores of predominately English documents to be classified as both during the first phase of the study.

The first appearance of "ksi" caused minor consternation until a quick response from a National Bureau of Standards metallurgist assured the researcher that it meant kilopounds per square inch, a purely English unit. The same observation applied to "gal", a metric unit of acceleration (one centimeter per second per second), which was not an abbreviation for gallon in the English system.

CONCLUSIONS

Figures 1, 2, and 3 dramatically portray the increased usage of the metric system by the NASA Centers during the 1960's. An analysis of Figure 3 reveals that the combined usage (metric, predominately metric, and parallel usage) increased from 33.4% to 53.2% over the two four-year periods compared because of a slight increase in pure metric usage and a significant increase in parallel usage. The upward trend in metric usage (metric, predominately metric, and parallel usage) shown in this figure is fully substantiated by the trends shown in Figures 1 and 2.

Increased usage of the metric system for NASA-authored documents during the last four years has undoubtedly resulted from the promulgation in 1964 of two NASA Special Publications - NASA SP-7012, The International System of Units (Physical Constants and Conversion Factors) and NASA SP-7013, NASA Publications Manual. The latter manual suggested the use of the International System (SI) when SI units would impose no difficulty in interpretation of results and parallel usage if difficulty was anticipated by using SI units alone.

APPENDIX A

Document Definitions and List of NASA Centers

Definitions

TECHNICAL REPORTS: Scientific and technical information considered important, complete, and a lasting contribution to existing knowledge.

TECHNICAL NOTES: Information less broad in scope but nevertheless of importance as a contribution to existing knowledge.

TECHNICAL MEMORANDUMS: Information receiving limited distribution because of preliminary data, security classification, or other reasons.

NASA Centers*

	<u>ACRO- NYM</u>	<u>SHORT TITLE</u>	<u>FULL TITLE</u>
1.	AM	Ames	Ames Research Center
2.	ED	Edwards or FRC	Flight Research Center
3.	ER	ERC	Electronics Research Center
4.	GO	Goddard or GSFC	Goddard Space Flight Center
5.	GI	Goddard Institute	Goddard Institute for Space Studies
6.	HO	Houston or MSC	Manned Spacecraft Center
7.	KN	Kennedy or JFK	Kennedy Space Center
8.	LA	LaRC	Langley Research Center
9.	LE	LeRC	Lewis Research Center
10.	HU	Marshall	Marshall Space Flight Center
11.	WA	Wallops Sta.	Wallops Station

* Goddard Institute for Space Studies and Wallops Station are special NASA organizations, but are considered as NASA Centers for this report.

APPENDIX C

Eleven NASA Center Printouts by Document Types and Years - First Phase

AMES RESEARCH CENTER

CENTER	YEAR	MET	ENG	BOTH	NONE	TOTAL
AM TM	53		1			1
AM TM	55		1		1	2
AM TM	57				1	1
AM TM	58		2	1		3
AM TM	59	1	10		1	12
AM TM	60	1	19	3	1	24
AM TM	61	2	15	1	5	23
AM TM	62	11	26	12	3	52
AM TM	63	39	35	23	15	112
AM TM	64	45	25	23	21	114
AM TM	65	46	14	17	15	92
AM TM	66	34	14	10	8	66
AM TM	67	57	17	7	17	98
AM TM	68	15	11	11	4	41
AM TM	69	3			1	4
		254	190	108	93	645
AM TN	60	1	7	3	1	12
AM TN	61	4	54	1	18	77
AM TN	62	2	34	3	8	47
AM TN	63	8	33	1	6	48
AM TN	64	10	25		13	48
AM TN	65	15	26	1	23	65
AM TN	66	17	14	2	15	48
AM TN	67	17	15	3	12	47
AM TN	68	17	18	11	13	59
AM TN	69	9	9	3	6	27
		100	235	28	115	478
		354	425	136	208	1123
		31.5%	37.9%	12.1%	18.5%	100%

FLIGHT RESEARCH CENTER

CENTER	YEAR	MET	ENG	BOTH	NONE	TOTAL
ED TM	59		8			8
ED TM	60		9			9
ED TM	61		6			6
ED TM	62		9			9
ED TM	63	1	2			3
ED TM	64		17		1	18
ED TM	65		3			3
ED TM	66		7	1		8
ED TM	67	1	1	4		6
ED TM	68		3	11		14
ED TM	69		1	5		6
		2	66	21	1	90
ED TN	59		1			1
ED TN	60		3	1		4
ED TN	61		6		1	7
ED TN	62		8		1	9
ED TN	63		7			7
ED TN	64		7	1		8
ED TN	65		5	3		8
ED TN	66		9	5		14
ED TN	67			12		12
ED TN	68		3	8		11
ED TN	69	1	1	3	1	6
		1	50	33	3	87
		3	116	54	4	177
		1.7%	65.5%	30.5%	2.3%	100%

ELECTRONICS RESEARCH CENTER

CENTER	YEAR	MET	ENG	BOTH	NONE	TOTAL
ER TM	63			1		1
ER TM	65	1		1	2	4
ER TM	66	4	2	1	4	11
ER TM	67	1	2	2	5	10
ER TM	68	2		3	1	6
ER TM	69	1		1		2
		9	4	9	12	34
ER TN	66	1	1	1		3
ER TN	67	3		3	3	9
ER TN	68	7		1	6	14
ER TN	69	8		3	6	17
		19	1	8	15	43
		28	5	17	27	77
		36.4%	6.5%	22.0%	35.1%	100%

GODDARD SPACE FLIGHT CENTER

CENTER	YEAR	MET	ENG	BOTH	NONE	TOTAL
GO TM	48				1	1
GO TM	57				1	1
GO TM	59	2	1	1		4
GO TM	60	4	9	1	1	15
GO TM	61	13	23	27	8	71
GO TM	62	37	27	27	17	108
GO TM	63	75	22	44	52	193
GO TM	64	125	41	43	86	295
GO TM	65	154	58	60	112	384
GO TM	66	111	44	72	97	324
GO TM	67	161	58	86	106	411
GO TM	68	141	38	76	82	337
GO TM	69	49	12	35	44	140
		872	333	472	607	2284
GO TN	61	7	2	5	1	15
GO TN	62	21	6	22	16	65
GO TN	63	42	10	26	18	96
GO TN	64	17	16	23	20	76
GO TN	65	21	10	14	16	61
GO TN	66	12	13	23	32	80
GO TN	67	12	12	11	11	46
GO TN	68	15	8	13	23	59
GO TN	69	4	3	12	7	26
		151	80	149	144	524
		1023	412	621	751	2808
		36.4%	14.7%	22.1%	26.8%	100%

GODDARD INSTITUTE FOR SPACE STUDIES

CENTER	YEAR	MET	ENG	BOTH	NONE	TOTAL
GI TM	60	1				1
GI TM	61	1			1	2
GI TM	62	1			1	2
GI TM	63	15	1	2	9	27
GI TM	64	16	1		5	22
GI TM	65	22		1	7	30
GI TM	66	9		2	5	16
GI TM	67	17	2		3	22
GI TM	68	15		1	4	20
		97	4	6	35	142
GI TN	60	8	5	3	3	19
GI TN	61	17	6	5	7	35
GI TN	62	1				1
GI TN	63	3				3
GI TN	64	3				3
GI TN	65				1	1
GI TN	68	1				1
		33	11	8	11	63
		130	15	14	46	205
		63.4%	7.3%	6.8%	22.5%	100%

MANNED SPACECRAFT CENTER

CENTER	YEAR	MET	ENG	BOTH	NONE	TOTAL
HO TM	59		1			1
HO TM	61		1		1	2
HO TM	62		8		8	16
HO TM	63	1	22	7	3	33
HO TM	64		16	8	4	28
HO TM	65		14	12	3	29
HO TM	66	1	22	14	4	41
HO TM	67	3	19	16	10	48
HO TM	68	3	28	9	10	50
HO TM	69	3	4	1	4	12
		11	135	67	47	260
HO TN	62			1		1
HO TN	63		1	1		2
HO TN	64		2	1		3
HO TN	65	1	4	6	6	17
HO TN	66		8	2	6	16
HO TN	67		16	8	3	27
HO TN	68		11	10	3	24
HO TN	69		6	2		8
		1	48	31	18	98
		12	183	98	65	358
		3.4%	51.1%	27.4%	18.1%	100%

KENNEDY SPACE CENTER

CENTER	YEAR	MET	ENG	BOTH	NONE	TOTAL
KN TM	61		1		1	2
KN TM	62		25	23	1	49
KN TM	63	1	69	14	9	93
KN TM	64	3	59	18	19	99
KN TM	65	5	65	52	12	134
KN TM	66	4	87	108	18	217
KN TM	67	1	61	26	23	111
KN TM	68	5	52	33	23	113
KN TM	69		6	15	2	23
		19	425	289	108	841
KN TN	65	1				1
KN TN	66				1	1
		1			1	2
		20	425	289	109	843
		2.4%	50.4%	34.3%	12.9%	100%

LANGLEY RESEARCH CENTER

CENTER	YEAR	MET	ENG	BOTH	NONE	TOTAL
LA TM	41		1			1
LA TM	42		1			1
LA TM	46		1			1
LA TM	47		1			1
LA TM	48		2			2
LA TM	49			1		1
LA TM	50		1			1
LA TM	53		1			1
LA TM	54			1		1
LA TM	55		3			3
LA TM	56		1	1		2
LA TM	57		2		1	3
LA TM	58	3	3	1		7
LA TM	59	1	79	8	1	89
LA TM	60		85	6	2	93
LA TM	61		63	9	5	77
LA TM	62	2	83	10	5	100
LA TM	63	9	127	17	23	176
LA TM	64	8	108	29	18	163
LA TM	65	10	99	58	17	184
LA TM	66	16	32	50	13	111
LA TM	67	32	44	58	15	149
LA TM	68	26	22	56	16	120
LA TM	69	5		26	1	32
		112	759	331	117	1319
LA TN	60	3	76	11	3	93
LA TN	61	4	163	31	8	206
LA TN	62	8	145	22	6	181
LA TN	63	5	145	31	11	192
LA TN	64	10	112	42	11	175
LA TN	65	19	81	67	11	178
LA TN	66	31	10	130	18	189
LA TN	67	27	3	119	16	165
LA TN	68	53	1	123	25	202
LA TN	69	32	5	56	21	114
		192	741	632	130	1695
		304	1500	963	247	3014
		10.1%	49.8%	32.0%	8.1%	100%

LEWIS RESEARCH CENTER

CENTER	YEAR	MET	ENG	BOTH	NONE	TOTAL
LE TM	51			1		1
LE TM	52		1			1
LE TM	53		2		2	4
LE TM	54		1	2		3
LE TM	55			1	1	2
LE TM	56	1	1	1		3
LE TM	57		2	1	1	4
LE TM	58	1	2	1	3	7
LE TM	59	1	22	13	7	43
LE TM	60	1	19	2	1	23
LE TM	61	3	9	5	1	18
LE TM	62	9	14	16	6	45
LE TM	63	23	32	28	24	107
LE TM	64	36	34	31	23	124
LE TM	65	25	41	43	18	127
LE TM	66	19	46	39	10	114
LE TM	67	40	49	65	11	165
LE TM	68	36	39	143	12	230
LE TM	69	22	3	64	5	94
		217	317	456	125	1115
LE TN	60	2	17	11	1	31
LE TN	61	15	39	20	7	81
LE TN	62	11	27	22	2	62
LE TN	63	18	35	37	11	101
LE TN	64	45	39	46	28	158
LE TN	65	34	63	81	32	210
LE TN	66	54	78	73	18	223
LE TN	67	50	38	70	18	176
LE TN	68	91	1	159	31	282
LE TN	69	55	5	99	17	176
		375	342	618	165	1500
		592	659	1074	290	2615
		22.6%	25.2%	41.1%	11.1%	100%

MARSHALL SPACE FLIGHT CENTER

CENTER	YEAR	MET	ENG	BOTH	NONE	TOTAL
HU TM	55			1		1
HU TM	59			1	1	2
HU TM	60	11	14	24	6	55
HU TM	61	26	52	62	19	159
HU TM	62	33	56	54	48	191
HU TM	63	57	51	60	48	216
HU TM	64	48	46	77	43	214
HU TM	65	48	69	120	48	285
HU TM	66	55	45	116	56	272
HU TM	67	58	32	73	37	200
HU TM	68	39	26	46	20	131
HU TM	69	5	2	8	5	20
		380	393	642	331	1746
HU TN	60	2			3	5
HU TN	61	9	3	3	3	18
HU TN	62	4	1	9	2	16
HU TN	63	6	5	6	6	23
HU TN	64	3	2	6	2	13
HU TN	65	9	7	10	9	35
HU TN	66	3	5	9	6	23
HU TN	67	2	2	4	8	16
HU TN	68	2	4	3	6	15
HU TN	69	2	1	5		8
		42	30	55	45	172
		422	423	697	376	1918
		22.0%	22.1%	36.3%	19.6%	100%

WALLOPS STATION

CENTER	YEAR	MET	ENG	BOTH	NONE	TOTAL
WA TM	61			1		1
WA TM	64		1	1		2
WA TM	68		1	1		2
			2	3		5
			2	3		5
		0.0%	40.0%	60.0%	0.0%	100%

APPENDIX D

Breakouts by Year for TM and TN for All Centers

	YEAR	MET	ENG	BOTH	NONE	TOTAL
TM	41		1			1
TM	42		1			1
TM	46		1			1
TM	47		1			1
TM	48		2		1	3
TM	49			1		1
TM	50		1			1
TM	51			1		1
TM	52		1			1
TM	53		4		2	6
TM	54		1	3		4
TM	55		4	2	2	8
TM	56	1	2	2		5
TM	57		4	1	4	9
TM	58	4	7	3	3	17
TM	59	5	121	23	10	159
TM	60	18	155	36	11	220
TM	61	45	170	105	41	361
TM	62	93	248	142	89	572
TM	63	221	361	196	183	961
TM	64	281	348	230	220	1079
TM	65	311	363	364	234	1272
TM	66	253	299	413	215	1180
TM	67	371	285	337	227	1220
TM	68	282	220	390	172	1064
TM	69	88	28	155	62	333
		1973	2628	2404	1476	8481
		23.3%	31.0%	28.3%	17.4%	100%
TN	59		1			1
TN	60	16	108	29	11	164
TN	61	56	273	65	45	439
TN	62	47	221	79	35	382
TN	63	82	236	102	52	472
TN	64	88	203	119	74	484
TN	65	100	196	182	98	576
TN	66	118	138	245	96	597
TN	67	111	86	230	71	498
TN	68	186	46	328	107	667
TN	69	111	30	183	58	382
		915	1538	1562	647	4662
		19.6%	33.0%	33.5%	13.9%	100%
		2888	4165	3966	2123	13143
		22.0%	31.7%	30.2%	16.1%	100%

APPENDIX E

Eleven NASA Center Printouts by Document Types and Years - Second Phase

AMES RESEARCH CENTER

CENTER	YEAR	PREDOM METRIC	PREDOM ENGLISH	PARALLEL MET-ENGL	TOTAL
AMTM	58		1		1
AMTM	60	2	1		3
AMTM	61		1		1
AMTM	62	2	9	1	12
AMTM	63	9	14		23
AMTM	64	13	10		23
AMTM	65	7	10		17
AMTM	66	5	5		10
AMTM	67	3	3	1	7
AMTM	68	5	3	3	11
		46	57	5	108
AMTN	60		2	1	3
AMTN	61		1		1
AMTN	62	1	2		3
AMTN	63	1			1
AMTN	65		1		1
AMTN	66		1	1	2
AMTN	67		3		3
AMTN	68	6	3	2	11
AMTN	69	1	1	1	3
		9	14	5	28

FLIGHT RESEARCH CENTER

CENTER	YEAR	PREDOM METRIC	PREDOM ENGLISH	PARALLEL MET-ENGL	TOTAL
EDTM	66			1	1
EDTM	67			4	4
EDTM	68			11	11
EDTM	69	1		4	5
		1		20	21
EDTN	60		1		1
EDTN	64		1		1
EDTN	65		1	2	3
EDTN	66			5	5
EDTN	67	2		10	12
EDTN	68		1	7	8
EDTN	69		2	1	3
		2	6	25	33

ELECTRONICS RESEARCH CENTER

CENTER	YEAR	PREDOM METRIC	PREDOM ENGLISH	PARALLEL MET-ENGL	TOTAL
ERTM	63	1			1
ERTM	65	1			1
ERTM	66	1			1
ERTM	67	1	1		2
ERTM	68	3			3
ERTM	69	1			1
		8	1		9
ERTN	66		1		1
ERTN	67	3			3
ERTN	68	1			1
ERTN	69	2	1		3
		6	2		8

GODDARD INSTITUTE

CENTER	YEAR	PREDOM METRIC	PREDOM ENGLISH	PARALLEL MET-ENGL	TOTAL
GITM	63	1	1		2
GITM	65	1			1
GITM	66	1			1
GITM	68	1			1
		4	1		5
GITN	60	2	1		3
GITN	61	3	2		5
		5	3		8

GODDARD SPACE FLIGHT CENTER

CENTER	YEAR	PREDOM METRIC	PREDOM ENGLISH	PARALLEL MET-ENGL	TOTAL
GOTM	59		1		1
GOTM	60		1		1
GOTM	61	10	17		27
GOTM	62	10	16	1	27
GOTM	63	24	18	2	44
GOTM	64	21	21		42
GOTM	65	33	24	2	59
GOTM	66	33	38	1	72
GOTM	67	40	43	3	86
GOTM	68	39	35	1	75
GOTM	69	24	10		34
		234	224	10	468
GOTN	61	3	2		5
GOTN	62	13	6	1	20
GOTN	63	12	13	1	26
GOTN	64	14	9		23
GOTN	65	9	5		14
GOTN	66	15	8		23
GOTN	67	3	3	5	11
GOTN	68	7	3	3	13
GOTN	69	3	3	6	12
		79	52	16	147

MANNED SPACECRAFT CENTER

HOTM	63		7		7
HOTM	64	1	7		8
HOTM	65	1	5	6	12
HOTM	66	2	12		14
HOTM	67	6	10		16
HOTM	68	2	4	3	9
HOTM	69		1		1
		12	46	9	67
HOTN	62		1		1
HOTN	63		1		1
HOTN	64	1			1
HOTN	65	3	3		6
HOTN	66		2		2
HOTN	67	1	6		7
HOTN	68	4	6		10
HOTN	69		1	1	2
		9	20	1	30

MARSHALL SPACE FLIGHT CENTER

CENTER	YEAR	PREDOM METRIC	PREDOM ENGLISH	PARALLEL MET-ENGL	TOTAL
HUTM	55	1			1
HUTM	60	12	9	1	22
HUTM	61	24	35		59
HUTM	62	23	26	3	52
HUTM	63	30	14	16	60
HUTM	64	26	38	13	77
HUTM	65	59	36	24	119
HUTM	66	39	45	31	115
HUTM	67	27	26	18	71
HUTM	68	13	15	18	46
HUTM	69	2	2	4	8
		256	246	128	630
HUTN	61	1	2		3
HUTN	62	5	4		9
HUTN	63	4	1	1	6
HUTN	64	3	2	1	6
HUTN	65	5	4	1	10
HUTN	66	5	2	2	9
HUTN	67	2		2	4
HUTN	68	1	2		3
HUTN	69	2	2	1	5
		28	19	8	55

KENNEDY SPACE CENTER

CENTER	YEAR	PREDOM METRIC	PREDOM ENGLISH	PARALLEL MET-ENGL	TOTAL
KNTM	62	1	22		23
KNTM	63	3	9		12
KNTM	64	5	11	2	18
KNTM	65	5	47		52
KNTM	66	9	97		106
KNTM	67	4	20		24
KNTM	68	5	26		31
KNTM	69		14		14
		32	246	2	280

LANGLEY RESEARCH CENTER

CENTER	YEAR	PREDOM METRIC	PREDOM ENGLISH	PARALLEL MET-ENGL	TOTAL
LATM	49		1		1
LATM	54		1		1
LATM	56		1		1
LATM	58		1		1
LATM	59	1	7		8
LATM	60		6		6
LATM	61	1	8		9
LATM	62	3	7		10
LATM	63	8	7	1	16
LATM	64	6	21		27
LATM	65	14	19	25	58
LATM	66	4	8	36	48
LATM	67	10	14	34	58
LATM	68	4	17	33	54
LATM	69	1	1	24	26
		52	119	153	324
LATN	60		6	1	7
LATN	61	6	22		28
LATN	62	2	19	1	22
LATN	63	6	21	2	29
LATN	64	9	22	11	42
LATN	65	7	9	51	67
LATN	66	12	2	115	129
LATN	67	14		104	118
LATN	68	19		104	123
LATN	69	2	1	52	55
		77	102	441	620

LEWIS RESEARCH CENTER

CENTER	YEAR	PREDOM METRIC	PREDOM ENGLISH	PARALLEL MET-ENGL	TOTAL
LETM	51		1		1
LETM	54		1		1
LETM	55		1		1
LETM	57		1		1
LETM	58		1		1
LETM	59	1	12		13
LETM	60		2		2
LFTM	61	2	3		5
LETM	62	5	9		14
LETM	63	15	11		26
LETM	64	11	20		31
LFTM	65	15	25	1	41
LETM	66	8	23	7	38
LFTM	67	15	25	22	62
LFTM	68	32	21	88	141
LFTM	69	7	7	49	63
		111	163	167	441
LETN	60	1	9	1	11
LETN	61	5	15		20
LFTN	62	9	13		22
LETN	63	10	24	1	35
LETN	64	16	30		46
LETN	65	35	36	6	77
LETN	66	31	32	9	72
LETN	67	18	8	44	70
LETN	68	30	2	127	159
LFTN	69	15	1	82	98
		170	170	270	610
		281	332	437	1051

WALLOPS STATION

CENTER	YEAR	PREDOM METRIC	PREDOM ENGLISH	PARALLEL MET-ENGL	TOTAL
WATM	61		1		1
WATM	64		1		1
WATM	68	1			1
		1	2		3
GRAND TOTAL		1142	1492	1260	3895