ASD TECHNICAL NOTE 61-117
PART II

MECHANICAL PROPERTIES INFORMATION PROCESSING SYSTEM

Fatigue of Metals

CORROSION AND HEAT RESISTANT METALS

SECTION I

Contract AF 33(616)-7238
S.A. 1(61-1094)
S.A. 2(62-479)

November 1961

BELFOUR ENGINEERING CO.

SUTTONS BAY, MICHIGAN

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FOREWORD

The graphic displays of metals fatigue data presented in this report have been prepared by the BELFOUR ENGINEERING COMPANY under U.S.A.F. Contract No. AF33(616)-7238, S.A.1 (61-1094), and S.A.2 (62-479). This contract was initiated under Project No. 7381, "Development of a Materials Property Data Processing System", Task No. 73812. Administration of the project is under the direction of the Applications Laboratory, Directorate of Materials and Processes, Aeronautical Systems Division, Wright-Patterson Air Force Base, with Don M. Ingels, Lt/USAF acting as project engineer.

This report is one of a series being prepared for periodic dissemination.

ABSTRACT

The graphs presented herein display metals fatigue information from various sources of published and unpublished test reports which have been processed and regenerated through a semi-automatic data processing system. Each series or set of graphs contain descriptive information (legends) which identifies the material, test procedure, test conditions and the most significant test and/or material variables associated with the plotted data. The data displayed in each set of graphs is intended to answer very general "questions" and to serve as a guide to further investigation of specific areas within the subject presented.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

D. A. Shinn
Chief, Materials Information Branch
Application Laboratory
Materials Central

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INTRODUCTION

This is one of a series of reports presenting compilations of test results pertaining to fatigue of metals.

The information contained in each set of graphs is the result of a relatively general "question" asked of a semi-automatic data processing system which stores, processes and regenerates the information in the requested form. More specific and detailed presentations and analyses are usually possible. These are available upon request. The graphic form in which this information is presented is only one of various types of output of which this mechanized system is capable. Tabulations and listings may also be generated by the system.

These data are intended to assist in the determination of reliable and efficient materials properties. The information contained herein should be used with due consideration to applicable specifications and established organizational procedures.

All graphs are labeled with a "search number". These serve to identify a broad block of information associated with a particular (internal) data processing pattern. Graph numbers are assigned in sequence within any search for the purpose of separating and identifying sub-groups of useful information. There is no requirement for graphs in any number sequence to have any relationship other than being the product of the same search. Alphabetic characters following a common graph number are used to identify a series or set of graphs which are related. Subsequent graphs within a series (bearing a common graph number) are used to indicate effects and interactions associated with some obvious variables. The unlimited number of combinations available for display and analysis dictates that these presentations be limited to relatively general subject matter. Detailed studies can be performed on request.

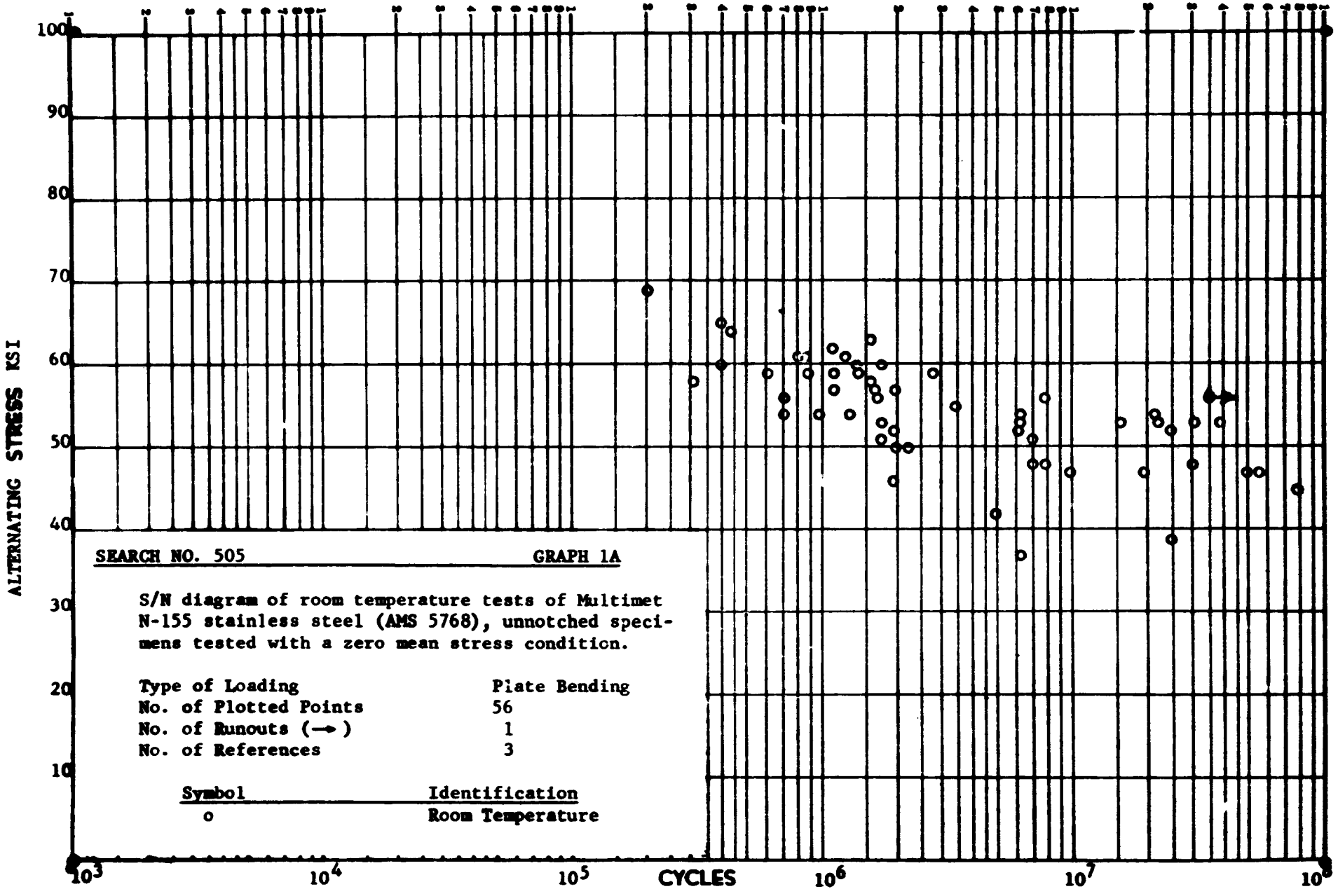
A legend on each graph describes the material, test type and other variables necessary to identify the plotted data. The reference list for each graph set follows the last graph of the set.

S/N Diagrams of Corrosion and Heat Resistant Materials tested at room and elevated temperatures. All specimens unnotched.

Graph Number	Material Identification	Ult. Tensile Strength, KSI	Test Temperature	Type of Loading
1A	Multimet N-155, AMS 5768	119-126	Room Temp.	Bending
1B	Multimet N-155, AMS 5768	119-126	1000 - 1500°F	Bending
1C	Multimet N-155, AMS 5768	119	Room Temp. & 1200 - 1500°F	Rotary Beam
2	Timken 16-25-6, AMS 5727	120	Room Temp. & 1200°F	Axial
3A	Lapelloy 311	136	900 - 1100°F	Axial
3B	Lapelloy 311	129	Room Temp. & 900°F	Rotary Beam
4A	Stainless Steel 403	141	Room Temp. & 500 - 900°F	Axial
4B	Stainless Steel 403	129	Room Temp. & 700 - 900°F	Rotary Beam
5	S-816, AMS 5534	147	Room Temp. & 1350 - 1650°F	Rotary Beam
6A	Inco SHS - 260	260	500 - 800°F	Axial
6B	Inco SHS - 260	129-132	Room Temp.	Rotary Beam
7A	S-816, AMS 5765	147	Room Temp. & 1350 - 1650°F	Axial
7B	S-816, AMS 5765	Hardness; Rockwell C 26	Room Temp. & 1200 - 1500°F	Bending
7C	S-816, AMS 5765	Hardness; Rockwell C 26	1200°F	Bending
7D	S-816, AMS 5765	N.A.*	1200 - 1500°F	Rotary Beam
8	GMR - 235	N.A.	Room Temp. & 1200°F	Axial
9A	UDIMET 500	N.A.	Room Temp. & 1200°F	Bending
9B	UDIMET 500	N.A.	1800°F	Bending
10A	RC-A55 Ti Alloy	76, 86 125 & N.A.	Room Temp.	Rotary Beam
10B	RC-A55 Ti Alloy	76, 86 125 & N.A.	Room Temp.	Rotary Beam
11	AMS 4923, Ti 140 A	130 - 150	Room Temp. & 600°F	Rotary Beam
12A	6% AL - 4% V-Ti Alloy	136 & 170	Room Temp. & 750°F	Axial
12B	6% AL - 4% V-Ti Alloy	140	Room Temp.	Rotary Beam

*N.A. Indicates information not available from original source document.

AUTOMATIC DATA ANALYSIS



SEARCH NO. 505 GRAPH 1A

S/N diagram of room temperature tests of Multimet N-155 stainless steel (AMS 5768), unnotched specimens tested with a zero mean stress condition.

Type of Loading	Plate Bending
No. of Plotted Points	56
No. of Runouts (→)	1
No. of References	3

Symbol	Identification
o	Room Temperature

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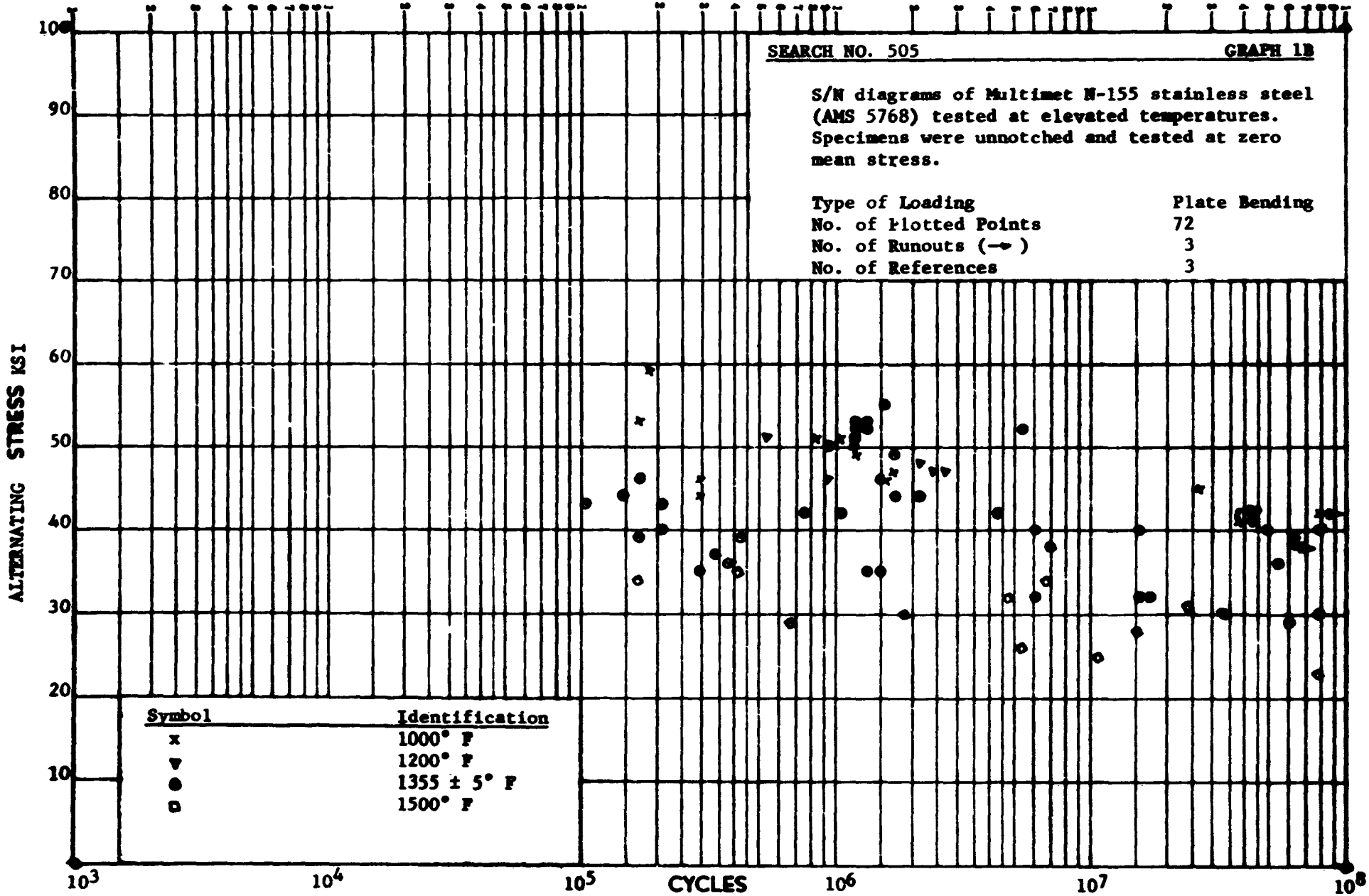

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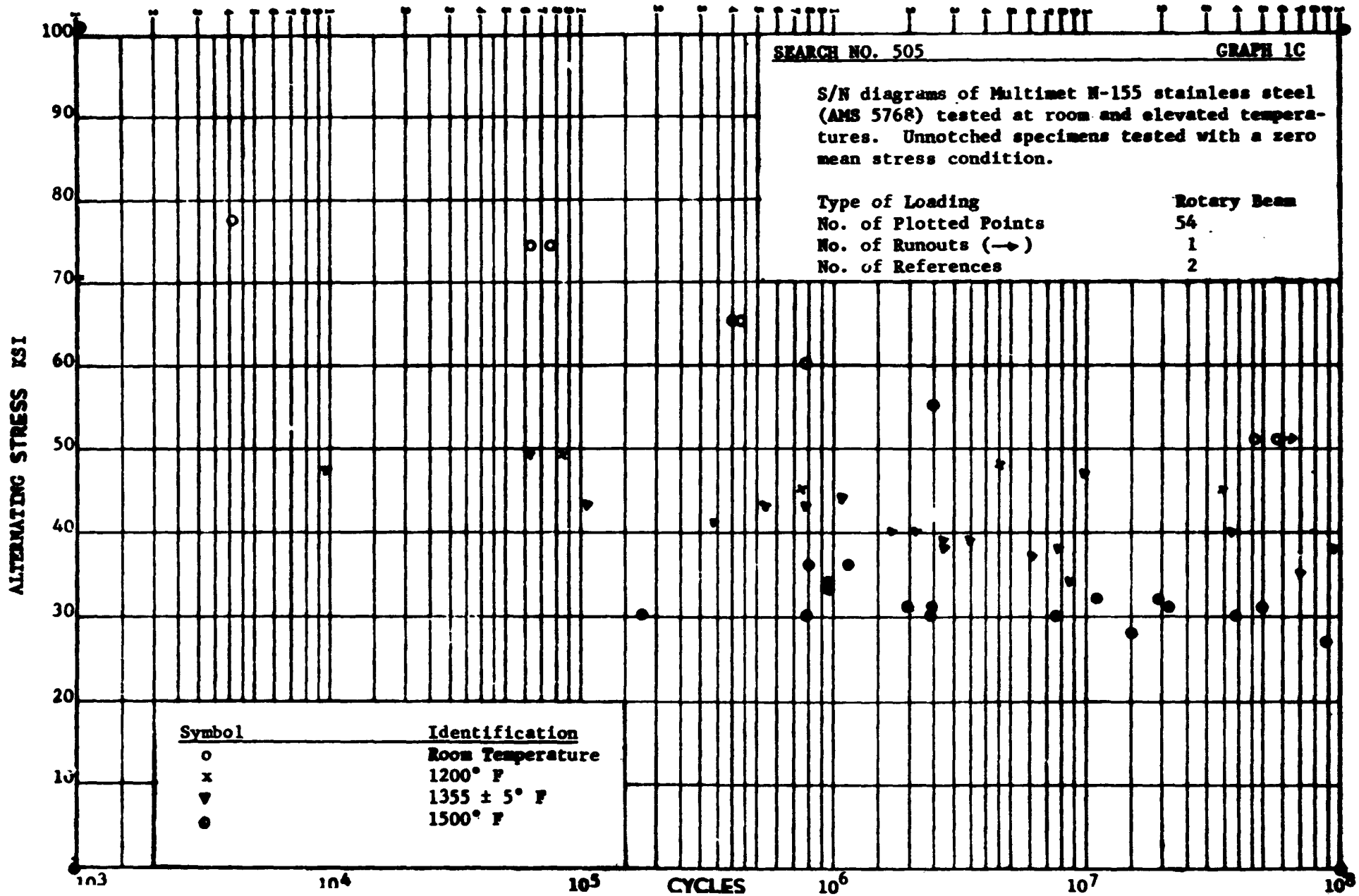
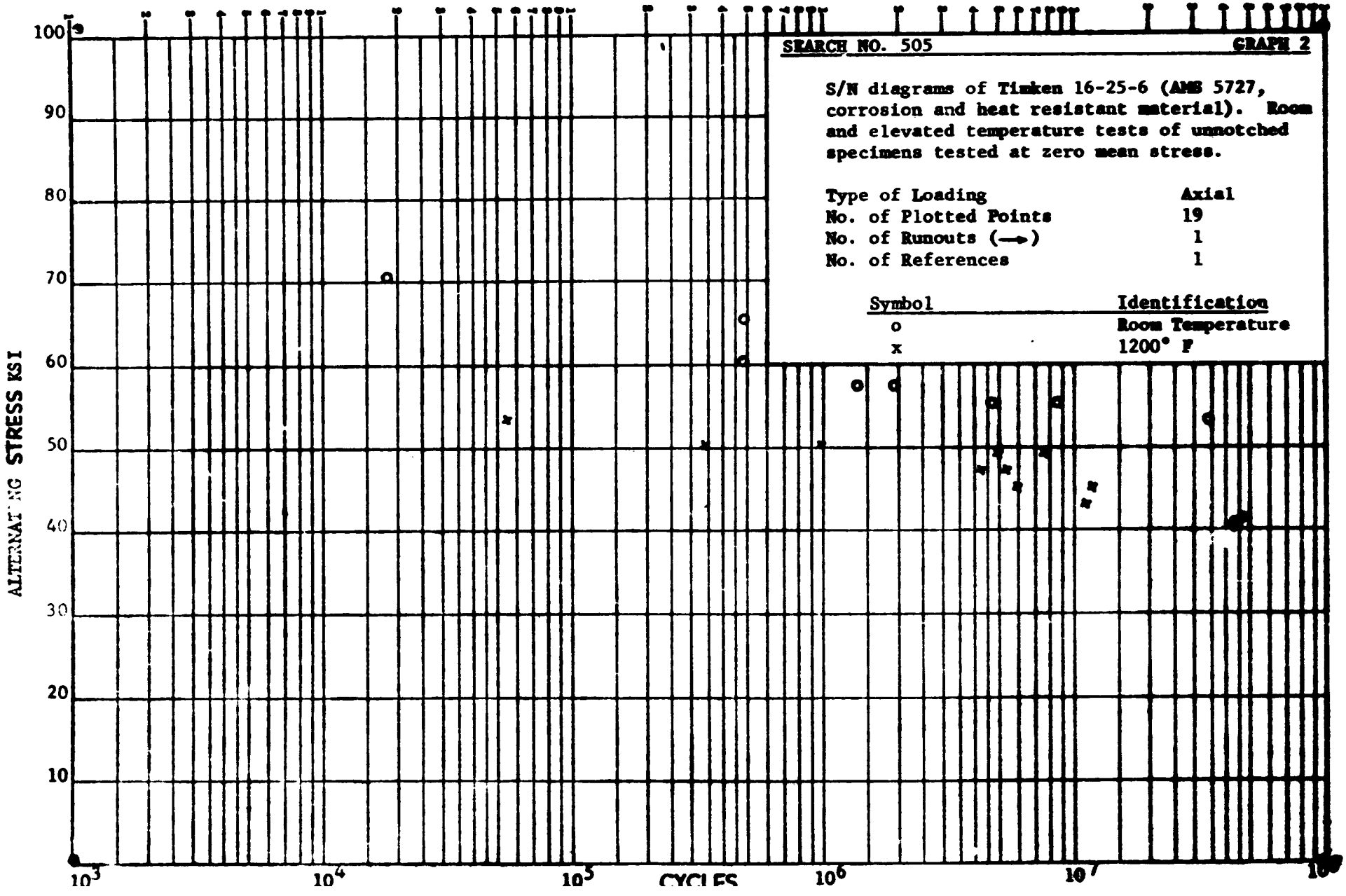


REFERENCES ---- GRAPH SERIES NO. 1(A-C), SEARCH 505

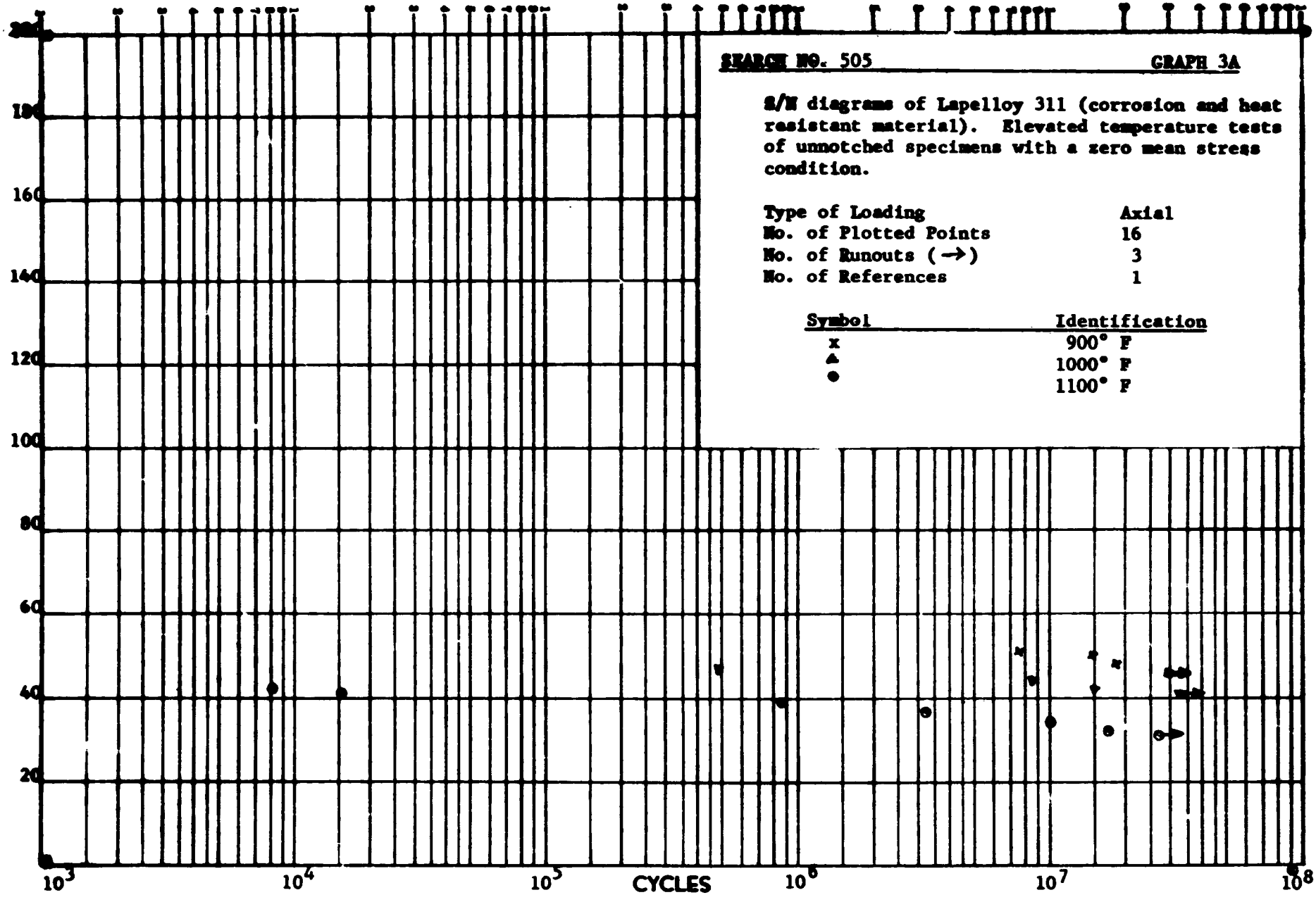
Reference Number	Reference
058	Ferguson, R.R.; "Effect of Surface Finish on Fatigue Properties at Elevated Temperatures in Low Carbon N-155 with Grain Size ASTM-1" NACA RM E51D17 (June 1951)
059	Ferguson, R.L.; "A Further Investigation of the Effect of Surface Finish on Fatigue Properties at Elevated Temperatures". NACA 3142 (March 1954)
061	NACA Subcommittee on Heat Resisting Materials, "Cooperative Investigation of Relationship Between Static and Fatigue Properties of Wrought N-155 Alloy at Elevated Temperatures". NACA TN 3216 (April 1955) NACA RM 51A04 (March 1951)
069	Anon, "Room and Elevated Temperature Fatigue Characteristics of Ti-641-4V". Technical Service Department, Titanium Metals Corporation of America (December 1957).

AUTOMATIC DATA ANALYSIS



REFERENCES ---- GRAPH NUMBER 2, SEARCH 505

Reference Number	Reference
092	Vitovec, F.H.; Lazan, B.J.; "Fatigue, Creep, and Rupture Properties of Heat Resistant Materials", WADC TR 56-181, ASTIA AD 97240 (August 1956)


SEARCH NO. 505
GRAPH 3A
S/N diagrams of Lapelloy 311 (corrosion and heat resistant material). Elevated temperature tests of unnotched specimens with a zero mean stress condition.
Type of Loading Axial
No. of Plotted Points 16
No. of Runouts (→) 3
No. of References 1
Symbol Identification
x 900° F
▲ 1000° F
● 1100° F
ALTERNATING STRESS KSI
200
180
160
140
120
100
80
60
40
20
10^3
10^4
10^5
CYCLES
10^6
10^7
10^8

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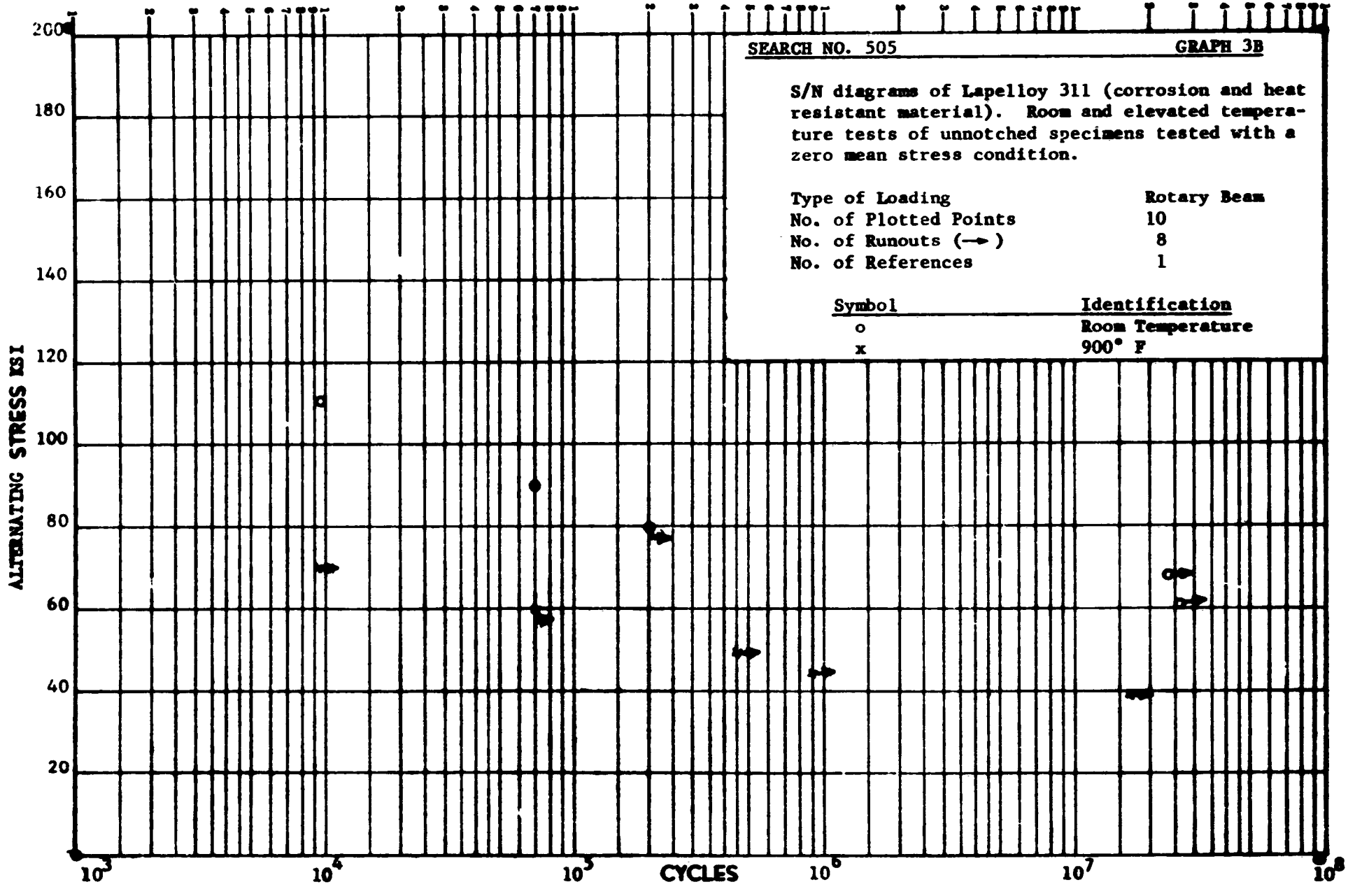

REFERENCES ---- GRAPH SERIES NO. 3 (A & B), SEARCH 505

Reference Number	Reference
070	Podnieks, E.R.; Lazan, B.J.; "Damping Elasticity and Fatigue Properties of Titanium Alloys, High Temperature Alloys, Stainless Steels, and Glass Laminate at Room and Elevated Temperatures". WADC TR 56-37 (March 1956)
092	Vitovec, F.H.; Lazan, B.J.; "Fatigue, Creep, and Rupture Properties of Heat Resistant Materials", WADC TR 56-181, ASTIA AD 97240 (August 1956)

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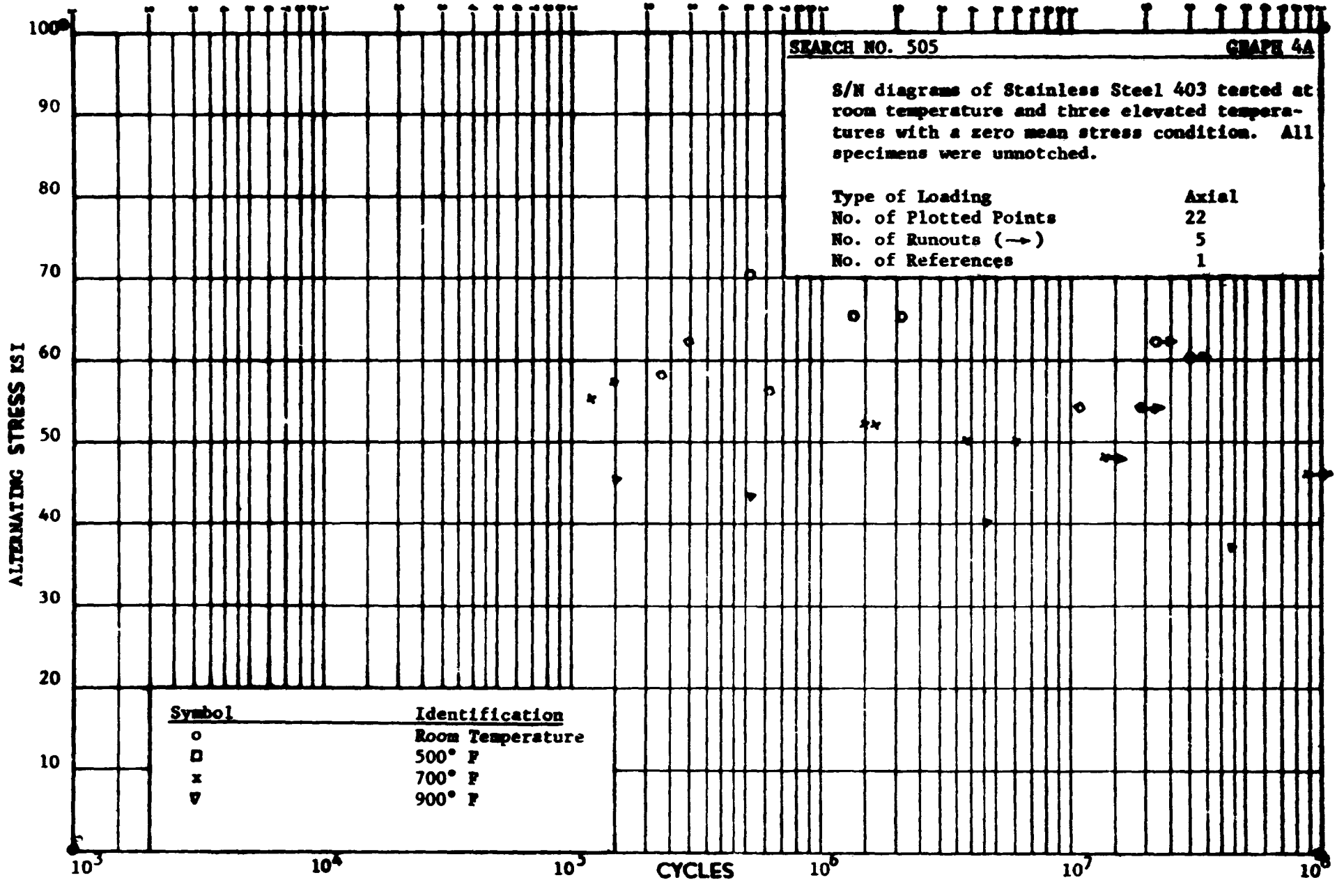

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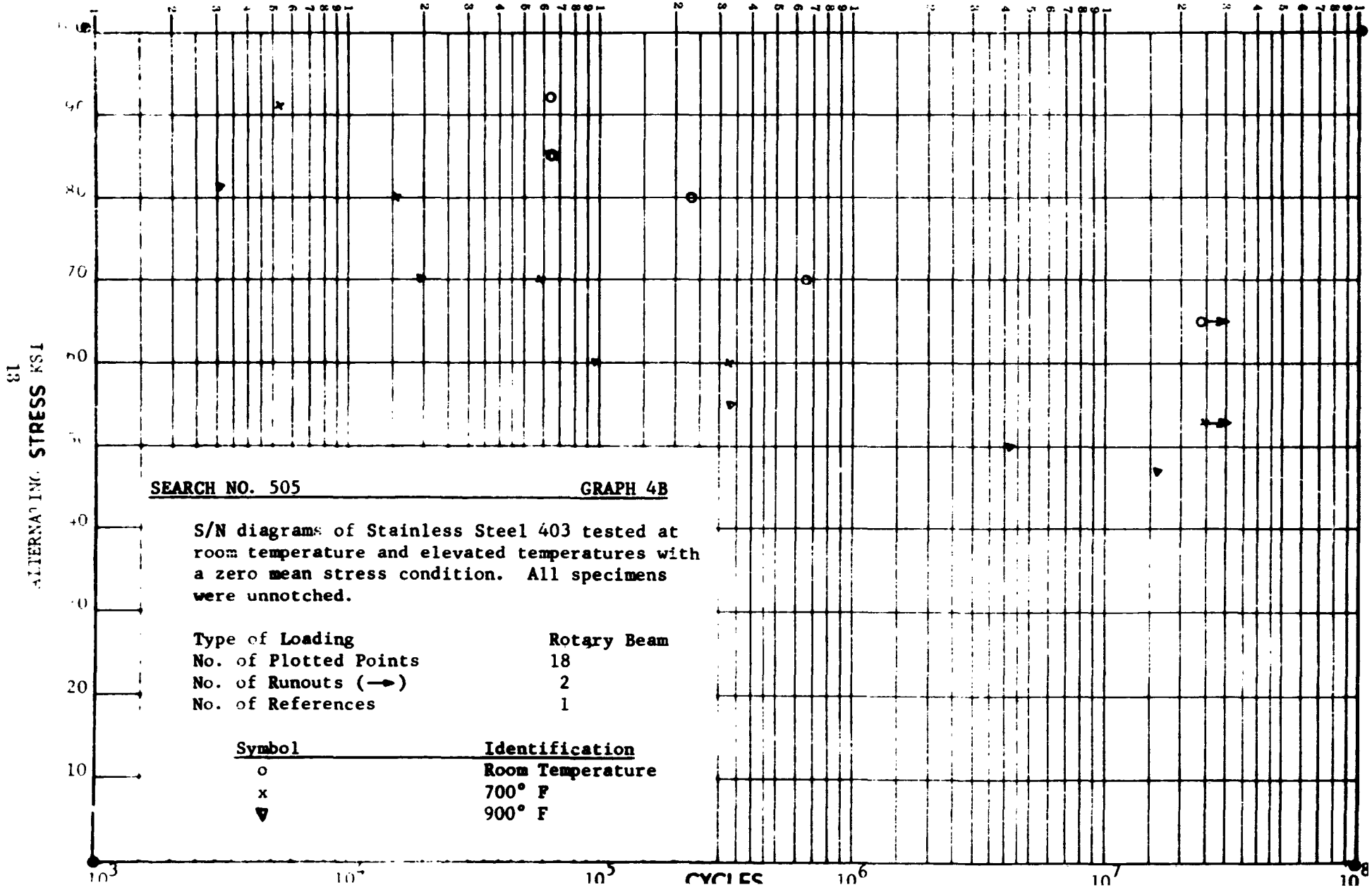

SEARCH NO. 505 **GRAPH 4B**

S/N diagrams of Stainless Steel 403 tested at room temperature and elevated temperatures with a zero mean stress condition. All specimens were unnotched.

Type of Loading	Rotary Beam
No. of Plotted Points	18
No. of Runouts (→)	2
No. of References	1

Symbol	Identification
o	Room Temperature
x	700° F
▼	900° F

REFERENCES ---- GRAPH SERIES NO. 4 (A & B), SEARCH 505

Reference Number	Reference
070	Podnieks, E.R.; Lazan, B.J.; "Damping Elasticity and Fatigue Properties of Titanium Alloys, High Temperature Alloys, Stainless Steels, and Glass Laminate at Room and Elevated Temperatures". WADC TR 56-37 (March 1956)
092	Vitovec, F.H.; Lazan, B.J.; "Fatigue, Creep, and Rupture Properties of Heat Resistant Materials", WADC TR 56-181, ASTIA AD 97240 (August 1956)

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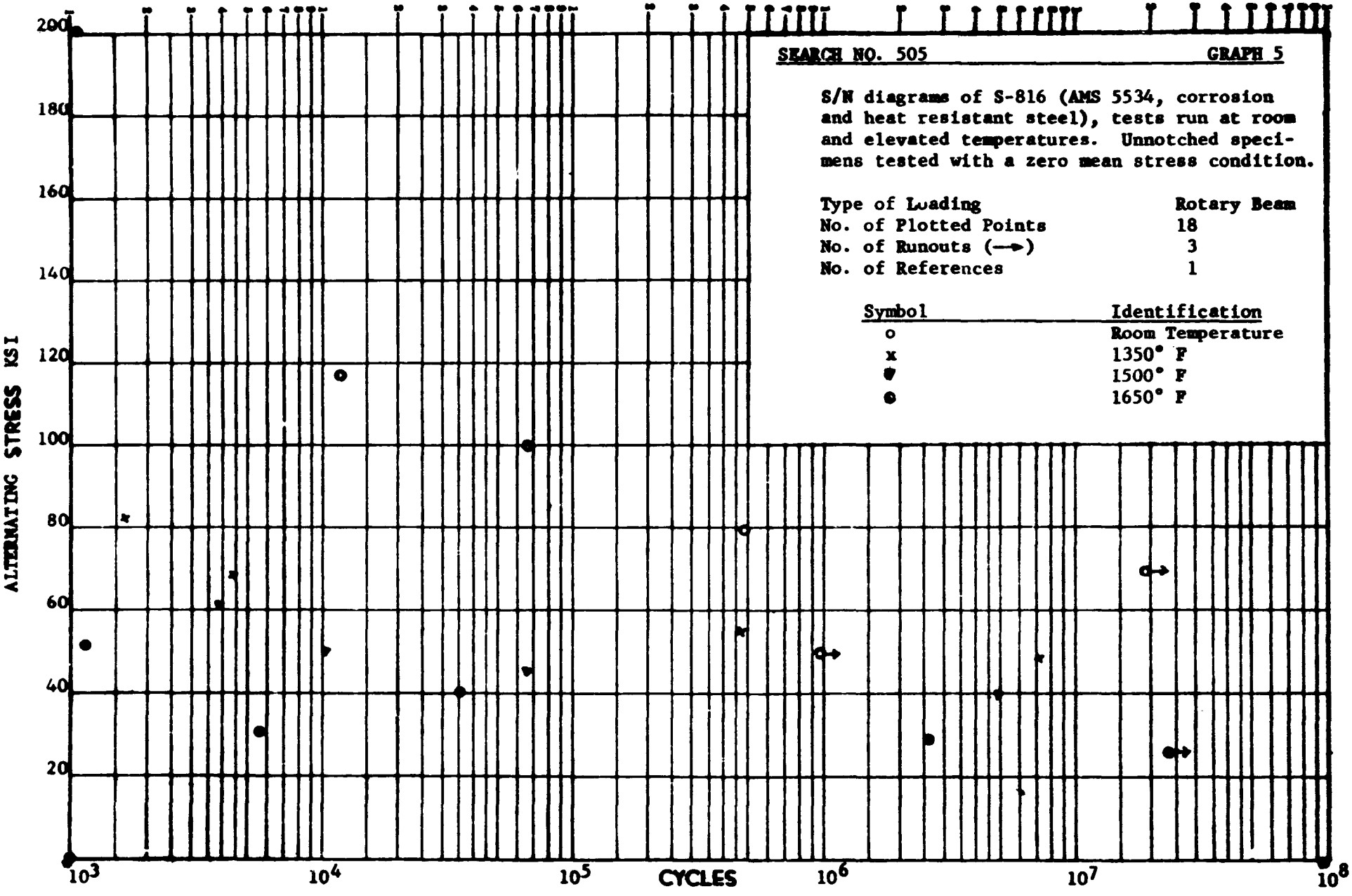

REFERENCES ---- GRAPH NUMBER 5, SEARCH 505

Reference Number	Reference
070	Podnieks, E.R.; Lazan, B.J.; "Damping Elasticity and Fatigue Properties of Titanium Alloys, High Temperature Alloys, Stainless Steels, and Glass Laminate at Room and Elevated Temperatures". WADC TR 56-37 (March 1956)

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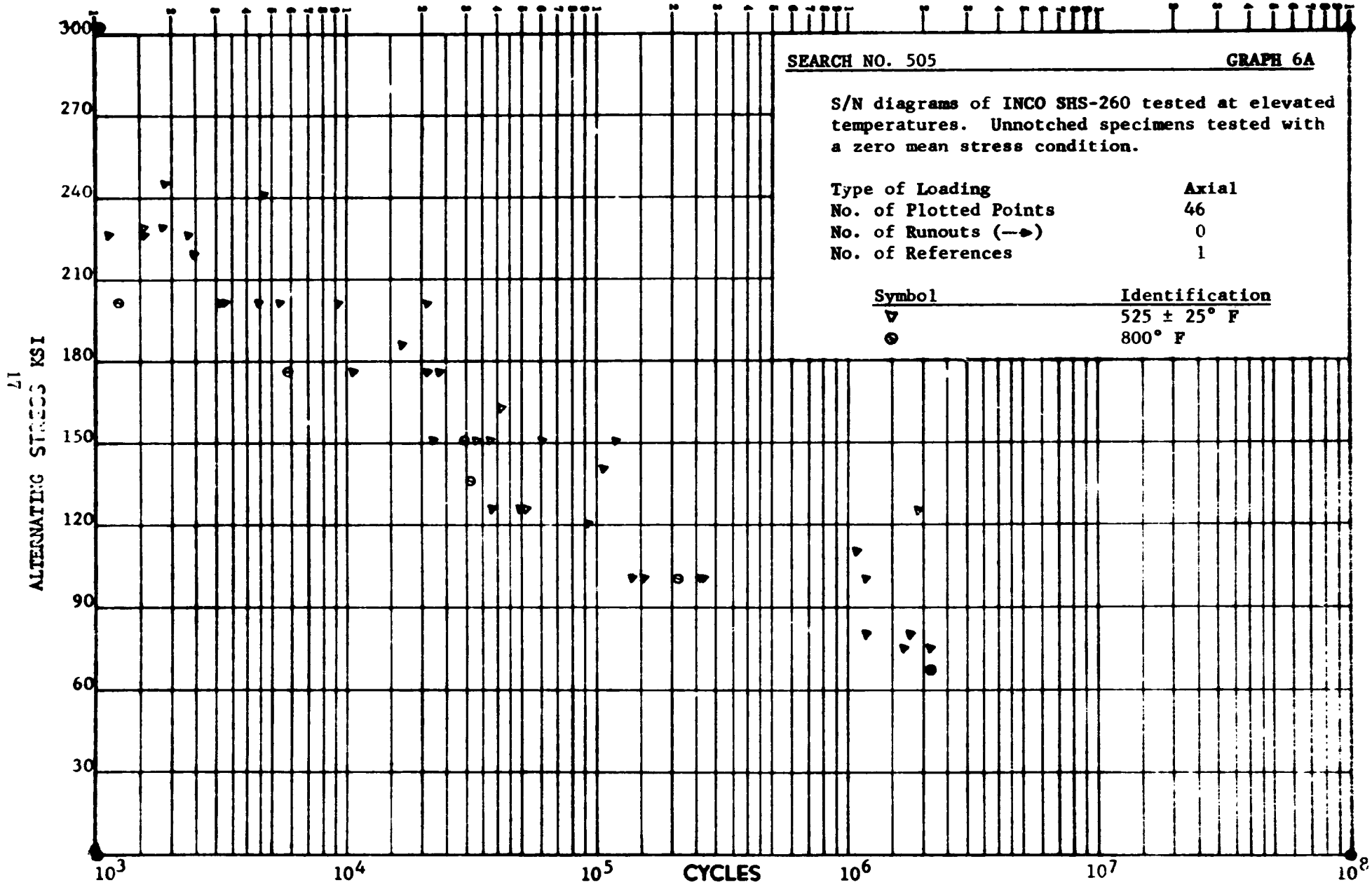

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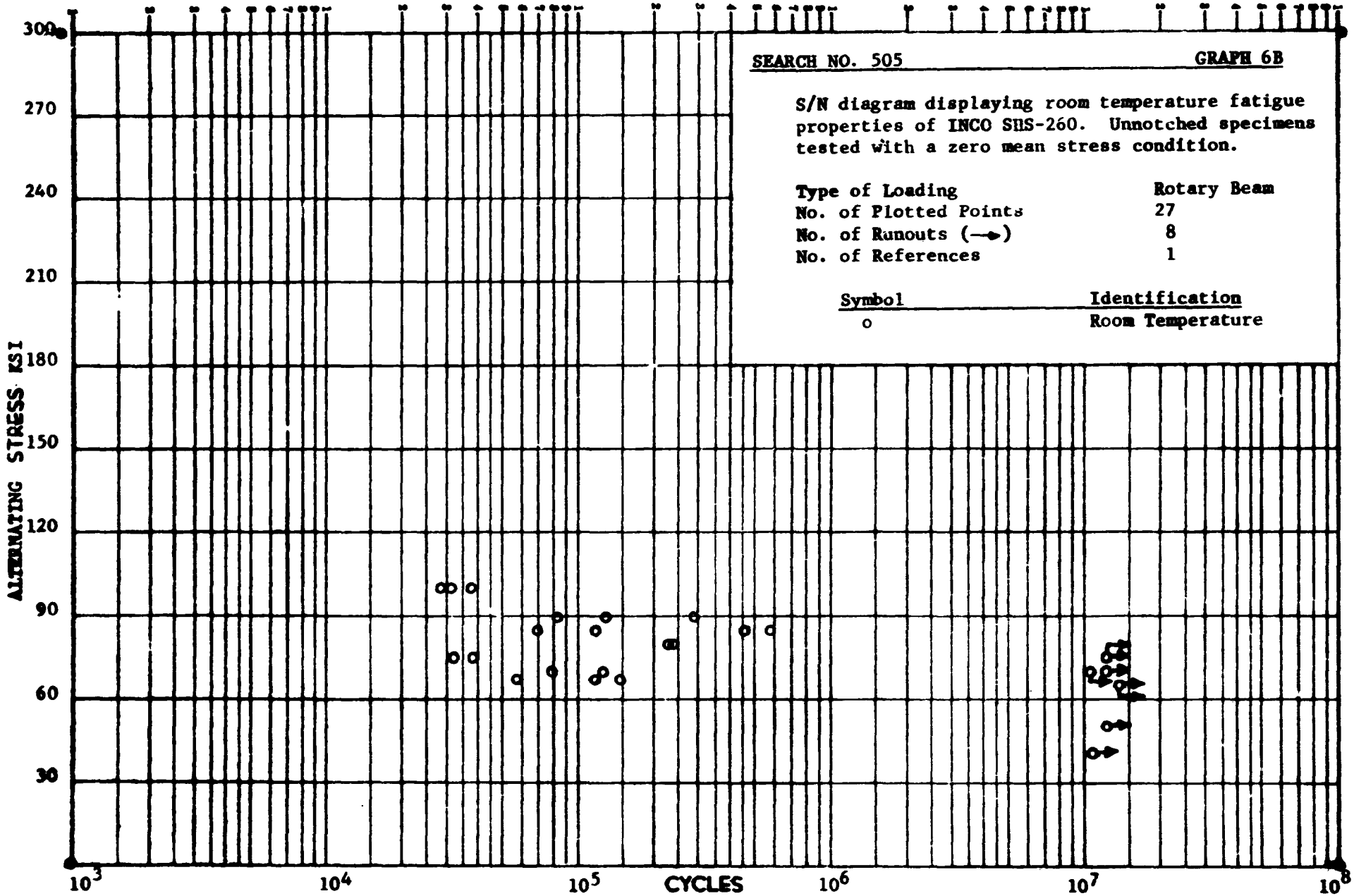

REFERENCES ---- GRAPH SERIES NO. 6 (A & B), SEARCH 505

Reference Number	Reference
031	Thomassen, L., Sinnott, M.J., Demmler, A.W., Jr., "The Influence of Surface Treatment on the Fatigue Properties of Titanium and Titanium Alloys", WADC TR 53-437, Part 2 (October, 1954).
036	Muvdi, B.B., Sachs, G., Klier, E.P., "Design Properties of High-Strength Steels in the Presence of Stress Concentrations, Part II, Axial Load Fatigue Properties of High-Strength Steels", WADC TN 56-395, ASTIA No. AD 110619 (December, 1956).

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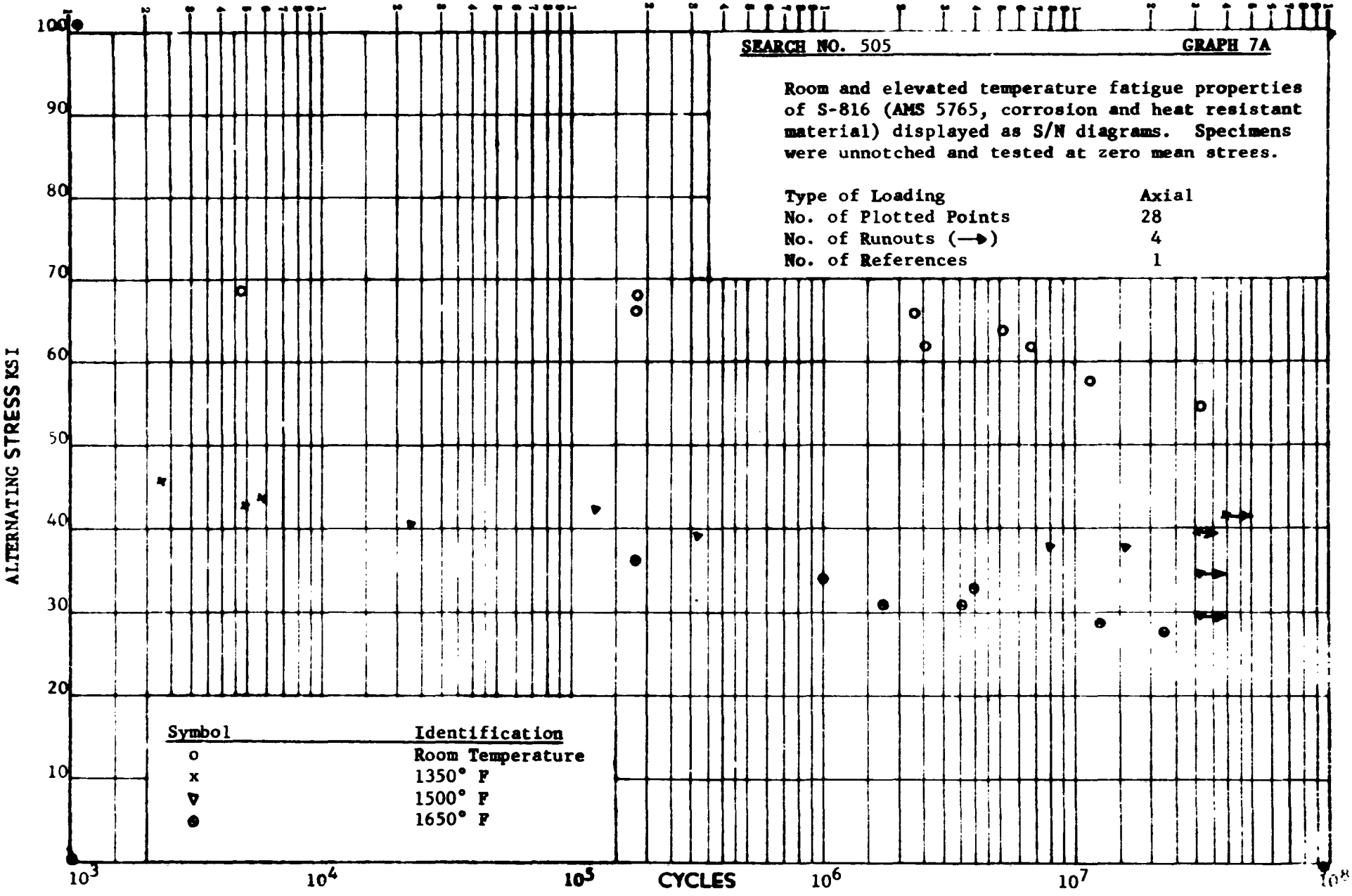

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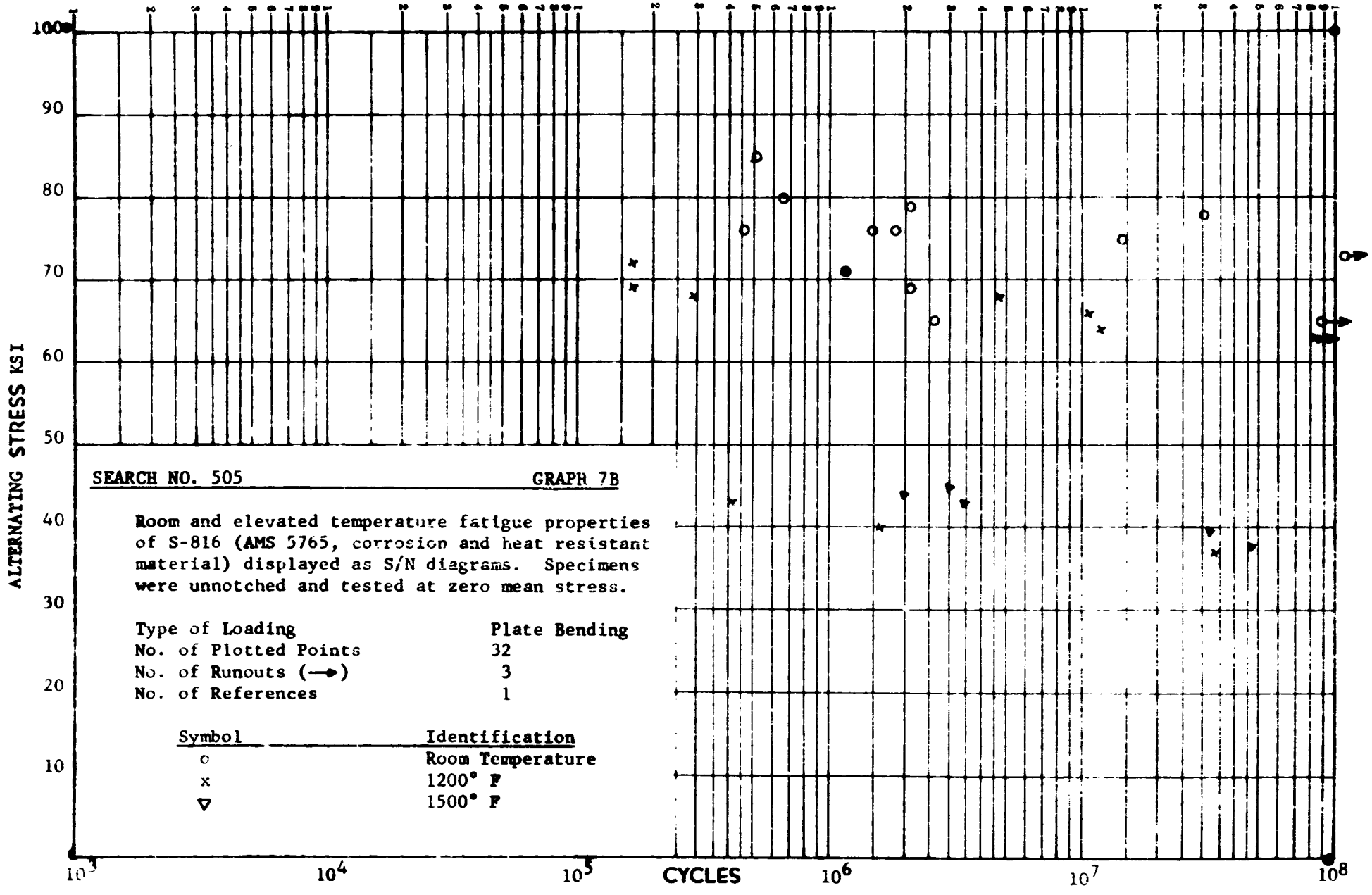


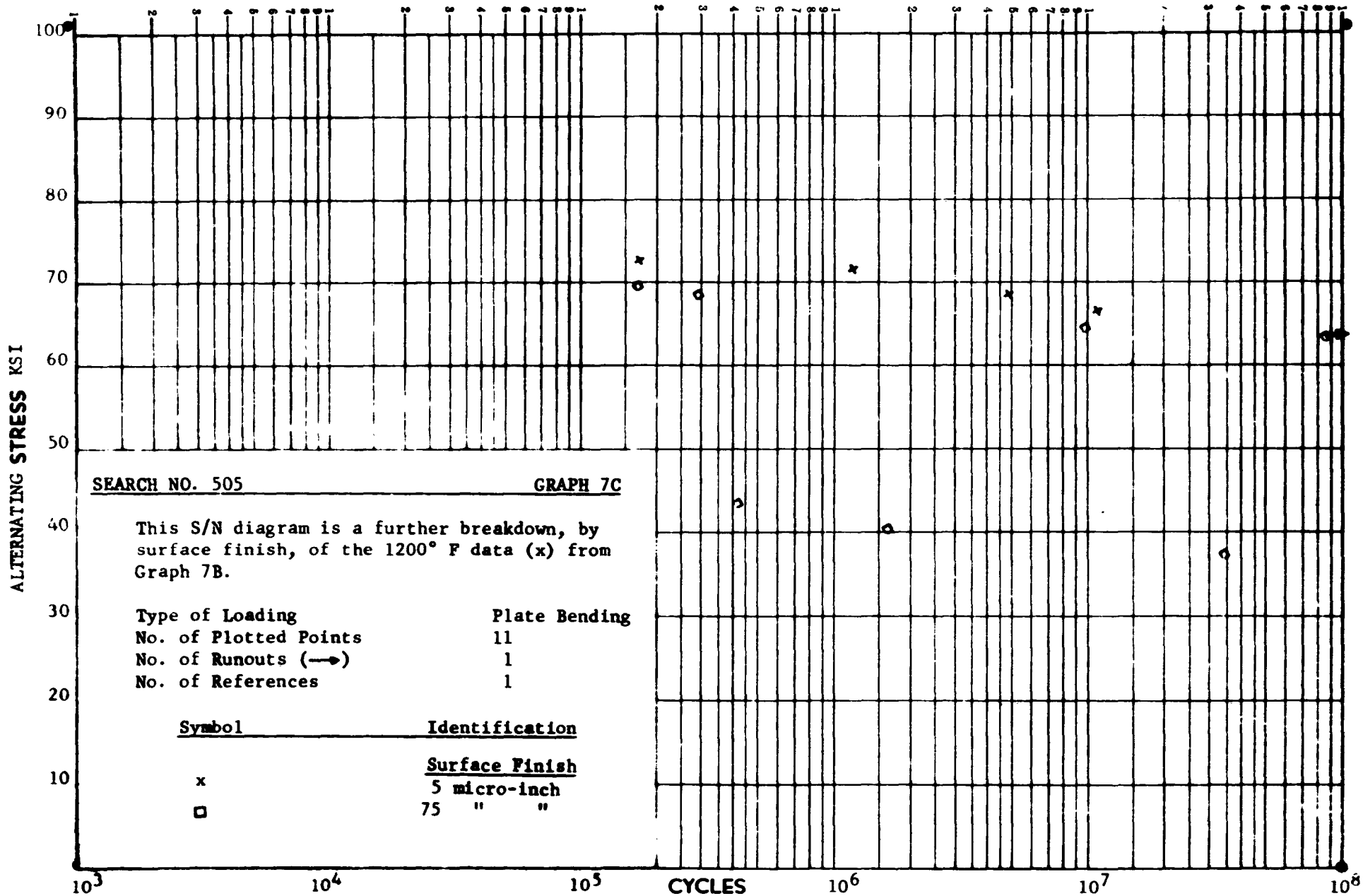
SEARCH NO. 505 GRAPH 7B

Room and elevated temperature fatigue properties of S-816 (AMS 5765, corrosion and heat resistant material) displayed as S/N diagrams. Specimens were unnotched and tested at zero mean stress.

Type of Loading	Plate Bending
No. of Plotted Points	32
No. of Runouts (→)	3
No. of References	1

Symbol	Identification
o	Room Temperature
x	1200° F
▽	1500° F

AUTOMATIC DATA ANALYSIS



SEARCH NO. 505 GRAPH 7C

This S/N diagram is a further breakdown, by surface finish, of the 1200° F data (x) from Graph 7B.

Type of Loading	Plate Bending
No. of Plotted Points	11
No. of Runouts (→)	1
No. of References	1

Symbol	Identification Surface Finish
x	5 micro-inch
□	75 " "

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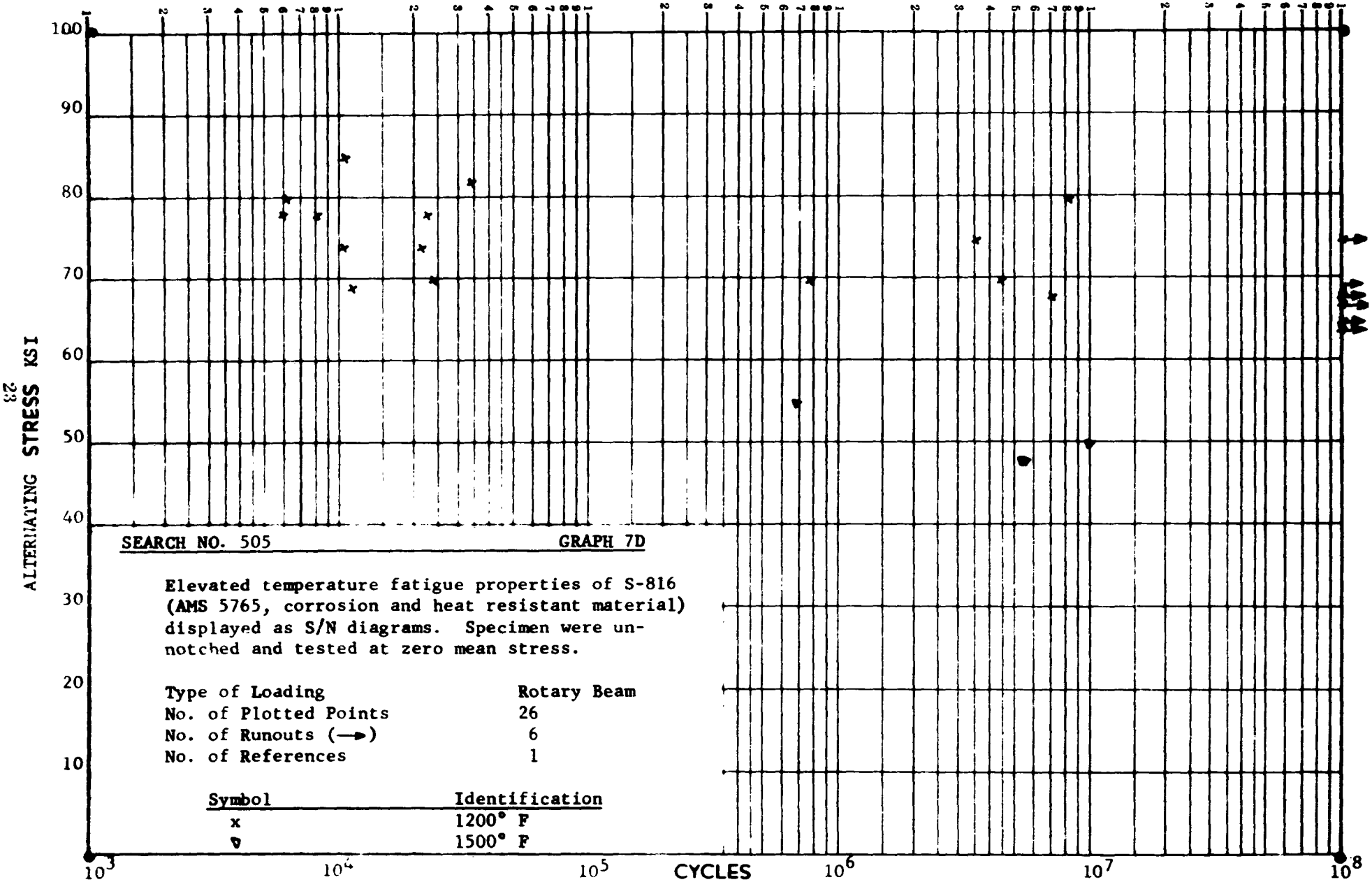

SEARCH NO. 505 GRAPH 7D

Elevated temperature fatigue properties of S-816 (AMS 5765, corrosion and heat resistant material) displayed as S/N diagrams. Specimen were un-notched and tested at zero mean stress.

Type of Loading	Rotary Beam
No. of Plotted Points	26
No. of Runouts (→)	6
No. of References	1

Symbol	Identification
x	1200° F
▽	1500° F

REFERENCES ---- GRAPH SERIES NO. 7 (A-D), SEARCH 505

Reference Number	Reference
019	Smith, Frank C., Brueggeman, William C., and Harwell, Richard H., "Comparison of Fatigue Strengths of Bare and Alclad 24S-T3 Aluminum Alloy Sheet Specimens Tested at 12 to 1000 Cycles per Minute", NACA TN 2231 (December, 1950).
059	Ferguson, R.L.; "A Further Investigation of the Effect of Surface Finish on Fatigue Properties at Elevated Temperatures". NACA 3142 (March 1954).
119	General Electric, "High Temperature Fatigue Testing". Report R-452015A (December 1946).

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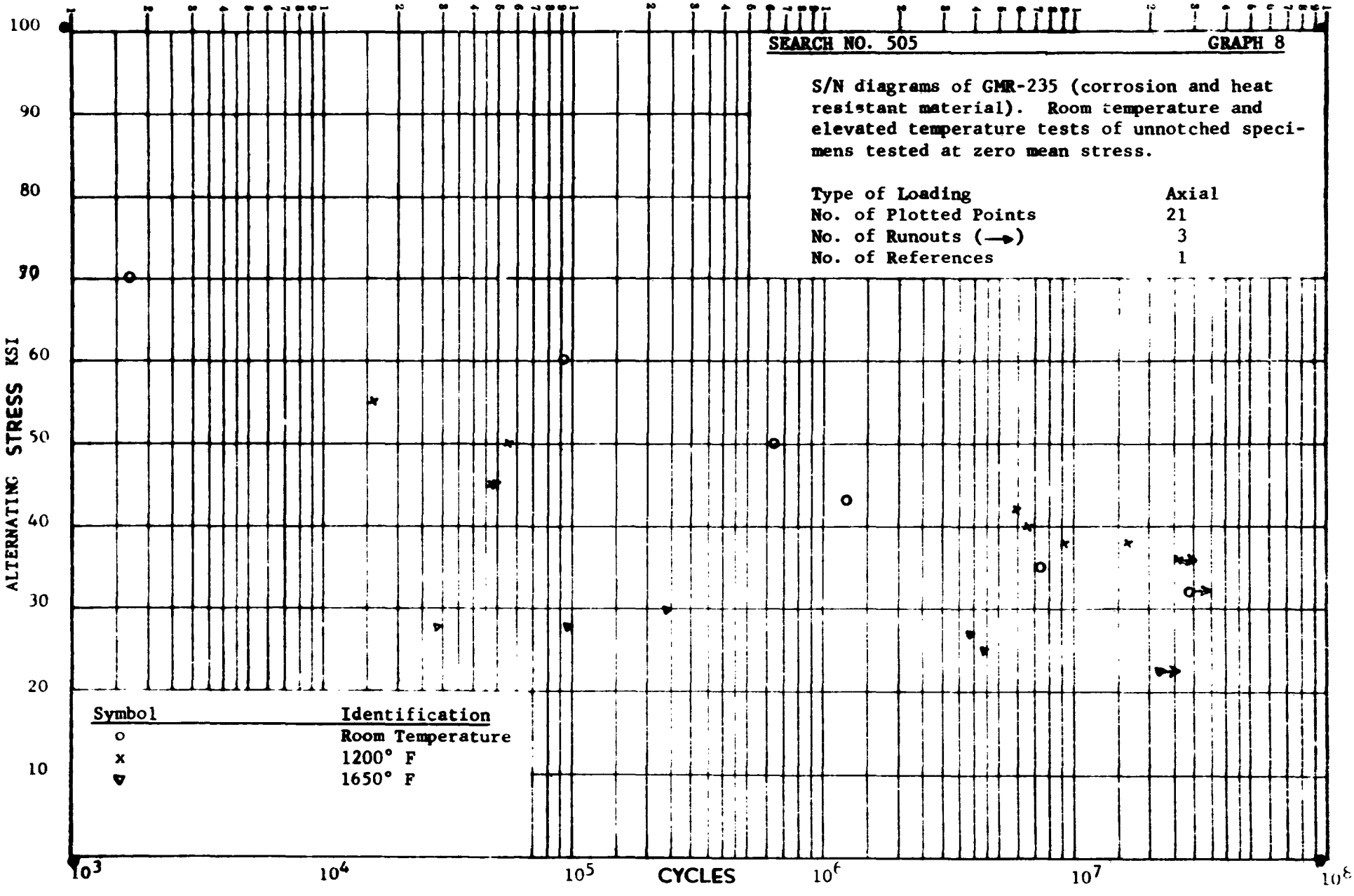

REFERENCES ---- GRAPH NUMBER 8, SEARCH 505

Reference Number	Reference
121	Vitovec, F.H.; "Fatigue, Creep, and Rupture Properties of the Alloys UDIMET 500 HASTELLOY R-235 and GMR-235". WADC TR 58-340 (Oct. 58)

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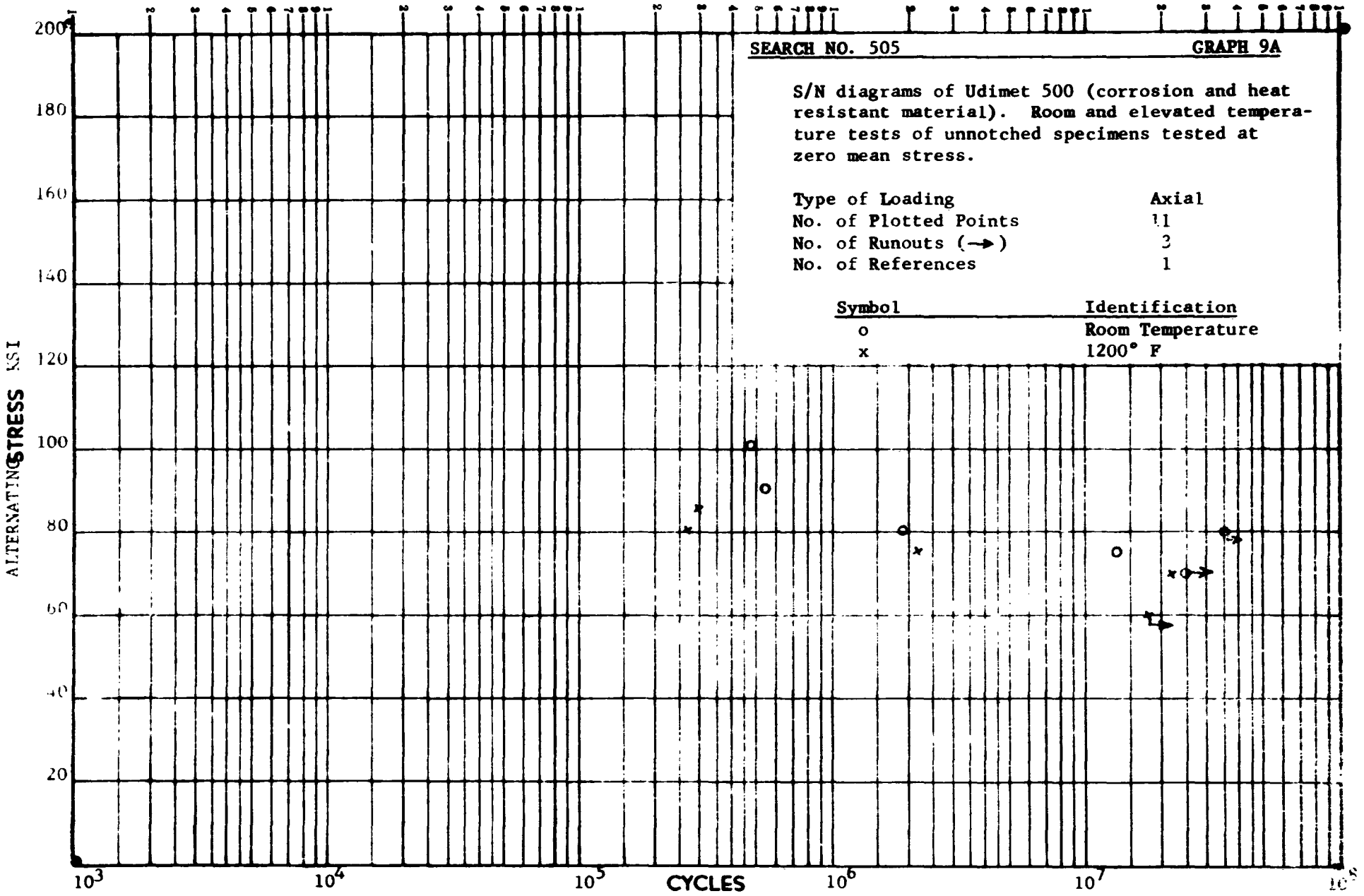

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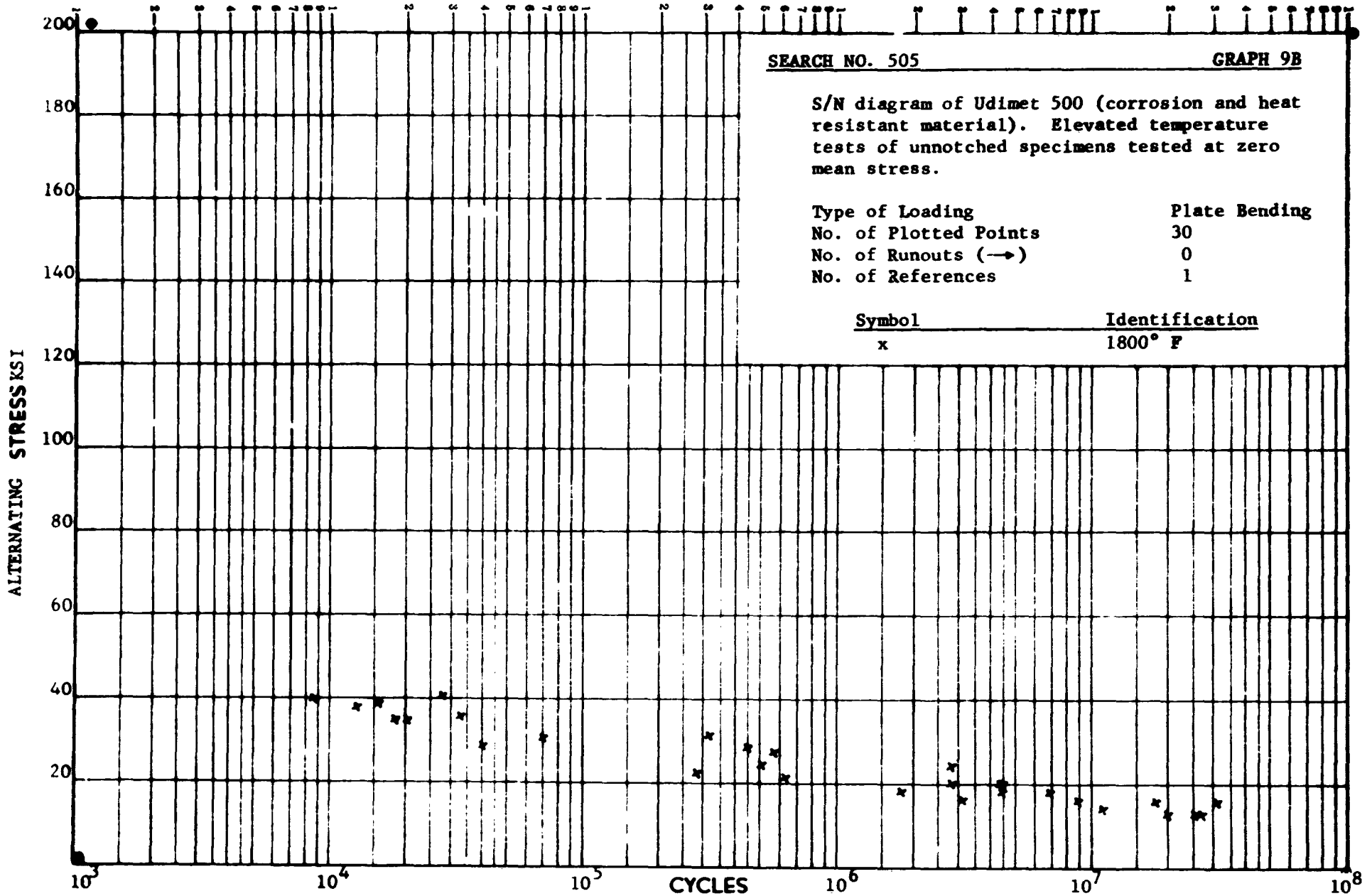

REFERENCES ---- GRAPH SERIES NO. 9 (A & B), SEARCH 505

Reference Number	Reference
110	General Electric Co. "The Effect of Protective Coatings on the Cantilever Bending Fatigue Properties of Udimet 500 Alloy @ 1800°F". MLER-WCLT L-59-11 (April 1959)
121	Vitovec, F.H.; "Fatigue Life of 2024-T4 Aluminum Alloy at Low Stresses" WADC TN 56-433 & ASTIA AD 113355 (October 1956)

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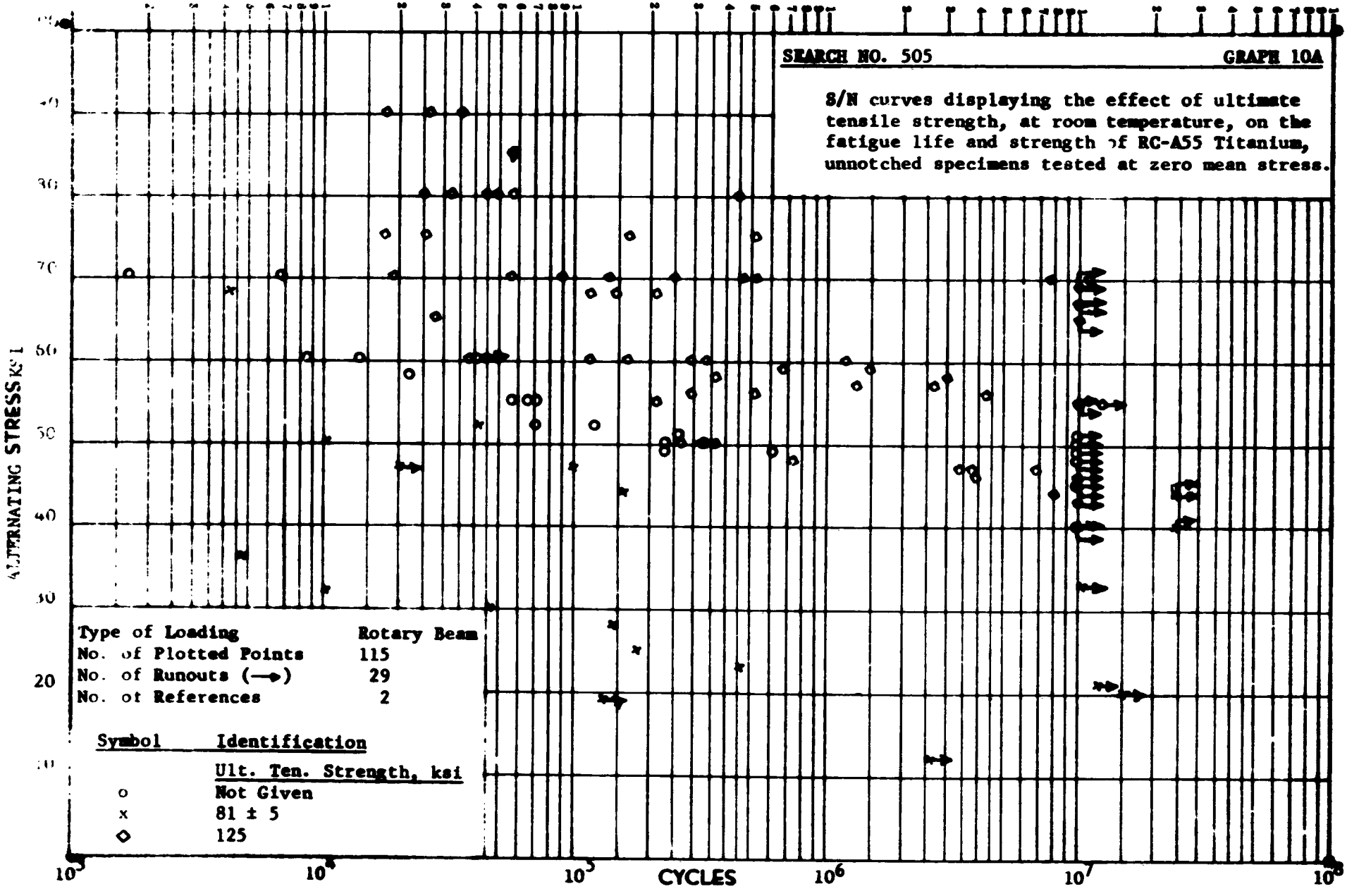

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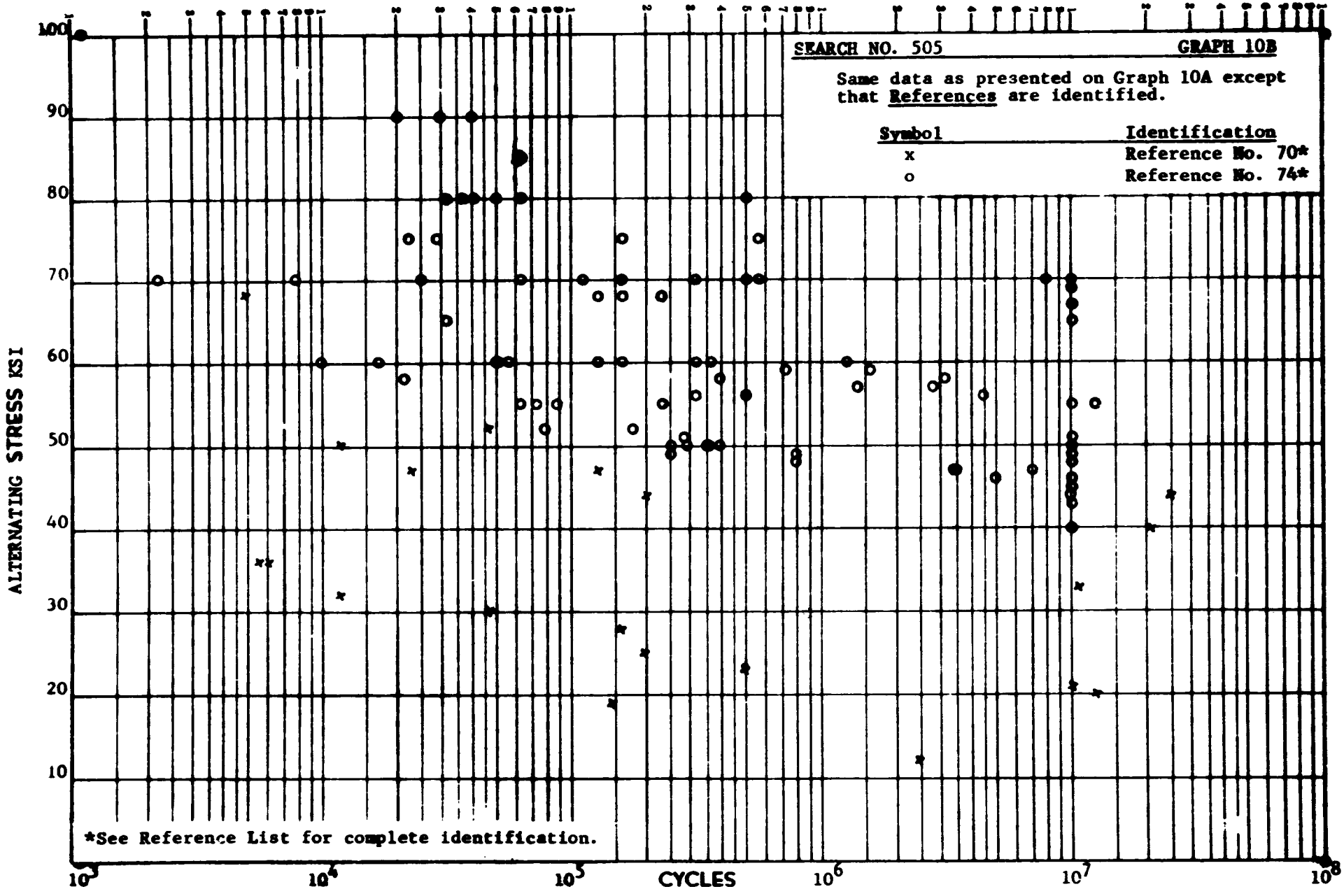

REFERENCES ---- GRAPH SERIES NO. 10 (A & B), SEARCH 505

Reference Number	Reference
070	Podnieks, E.R.; Lazan, B.J.; "Damping Elasticity and Fatigue Properties of Titanium Alloys, High Temperature Alloys, Stainless Steels, and Glass Laminate at Room and Elevated Temperatures". WADC TR 56-37 (March 1956)
074	Romualdi, J.P.; D'Appolonia, E.; "Research & Development of Effect of Range of Stress and Prestrain on Notched Specimens of Titanium and its Alloys". Carnegie Institute of Technology (October 1953).

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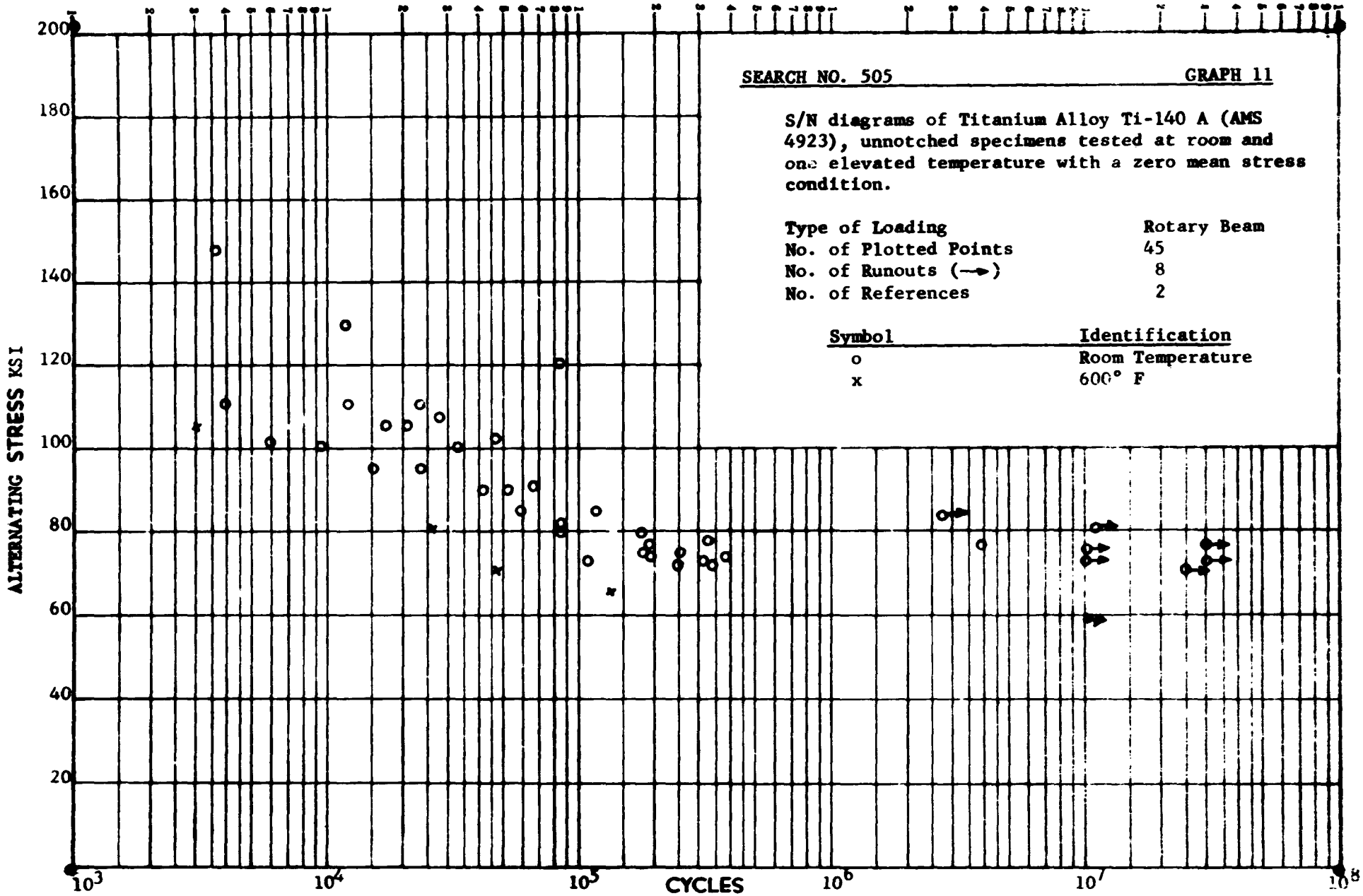

REFERENCES ---- GRAPH NUMBER 11, SEARCH 505

Reference Number	References
070	Blatherwick, A.A.; and Lazan, B.J.; "Fatigue Properties of Extruded Magnesium Alloy ZK60 Under Various Combinations of Alternating & Mean Axial Stresses". WADC TR 53-181 (Aug. 1953)
084	Kaufan, J.G.; Crum T.G.; D'Appolonia, E.; "Correlations of the Mechanical Properties of Ti-150A, RC-130A, RC-130B Ti-Alloy & Ti-75A Titanium Alloys". Carnegie Institute of Technology (April 1954)

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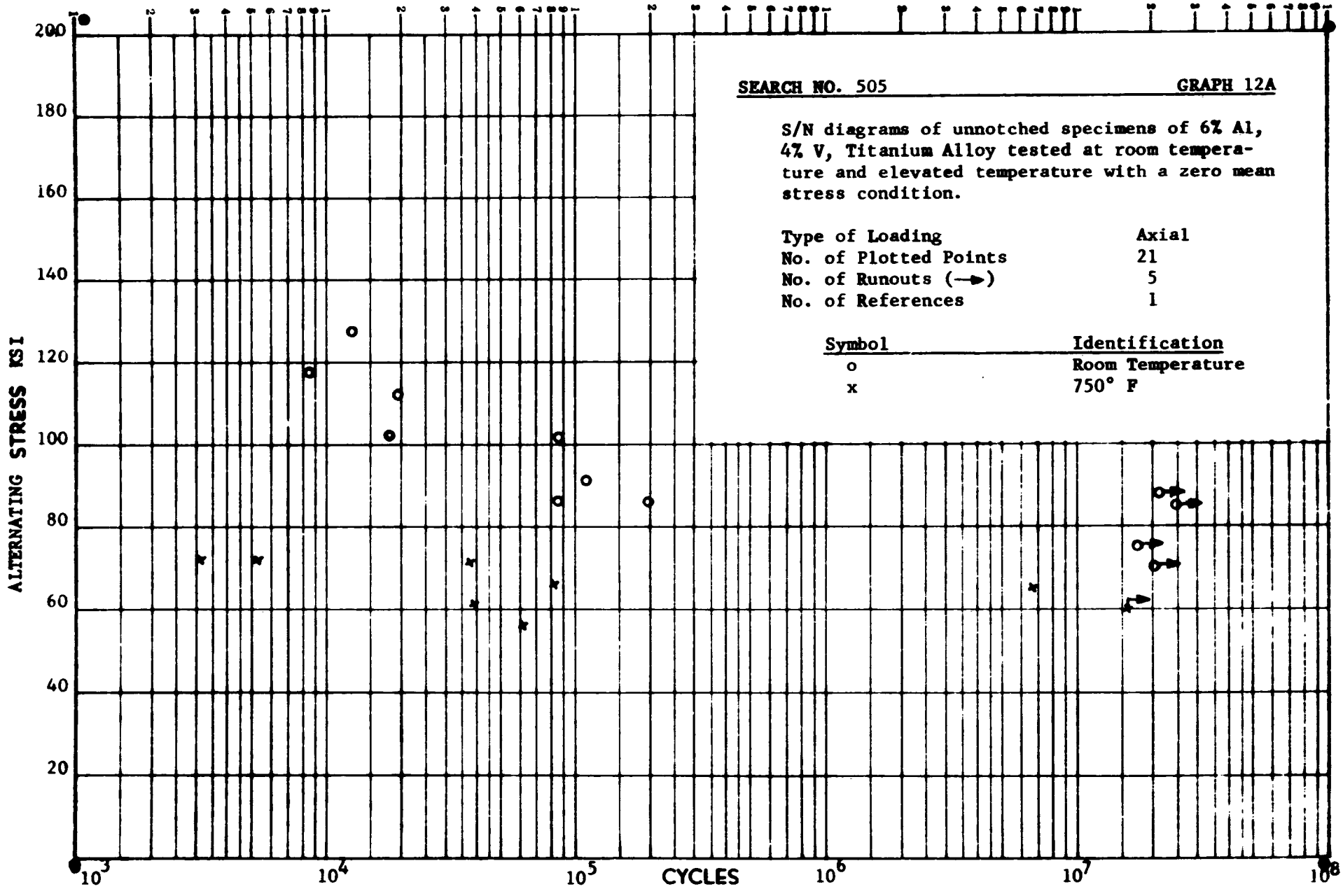

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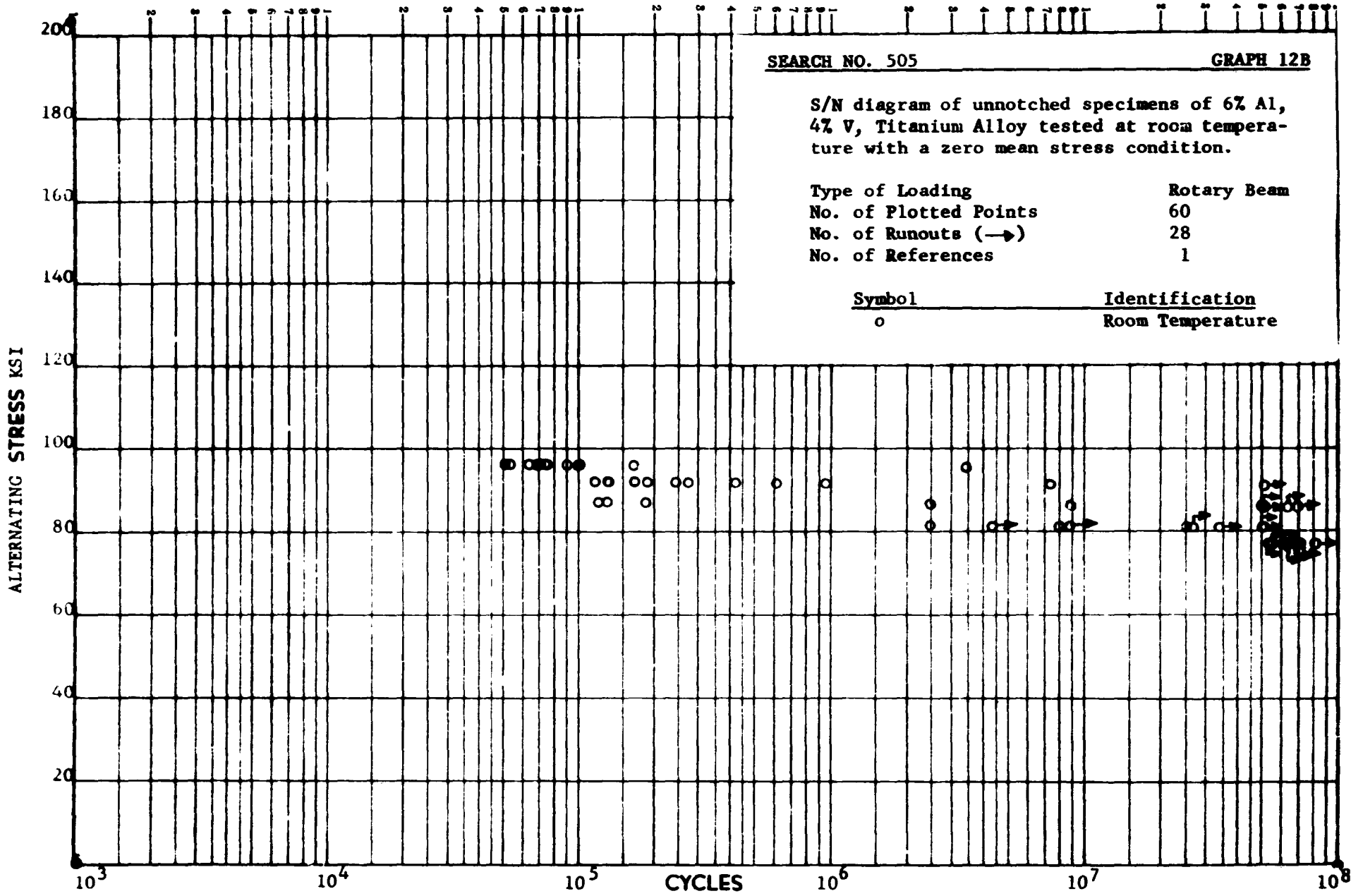

REFERENCES ---- GRAPH SERIES NO. 12 (A & B), SEARCH 505

Reference Number	Reference
069	Anon, "Room and Elevated Temperature Fatigue Characteristics of Ti-641-4V". Technical Service Department, Titanium Metals Corporation of America (December 1957)
098	Cummings, H.N.; "Investigation of Materials Fatigue Problems". Curtiss-Wright Corporation, Contract No. AF33(616) 2876, Report Numbers 1 to 10 (April 1955 through October 1956)