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Final Report

Cyclical Tests of Selected Space Shuttle TPS Metallic Materials in a Plasma Arc Tunnel

Volume II - Appendices - Data Tabulation

by

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MOFFETT FIELD, CALIFORNIA
N.S. VOJVODICH, CONTRACT TECHNICAL MONITOR
THERMAL PROTECTION BRANCH**

MCDONNELL DOUGLAS

Foreword

The work described herein was performed by the McDonnell Douglas Research Laboratories under NASA Contract NAS2-6601. The NASA Technical Monitor was N.S. Vojvodich, Research Scientist, Thermal Protection Branch, NASA Ames Research Center. This report is divided into two volumes. The first volume, NASA CR 114459, contains the main text describing the work performed and a discussion of the results. The second volume, the appendices, contains the calibration data, the model temperature histories, and the model physical measurements.

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and pages 1 through 96.

Appendix A: Heat flux and pressure profiles

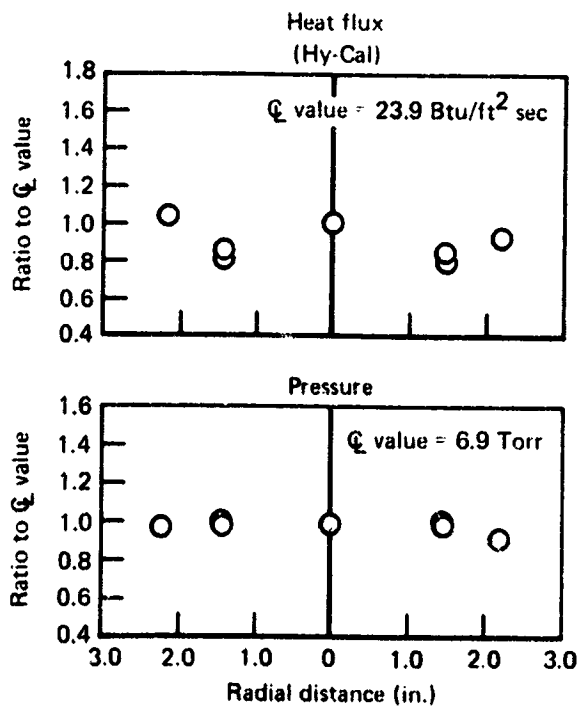


Fig. A-1 Heat flux and pressure calibration for samples DS-3 and DS-4 tested at 2000°F (cycles 1-40)

GP 73 0587-47

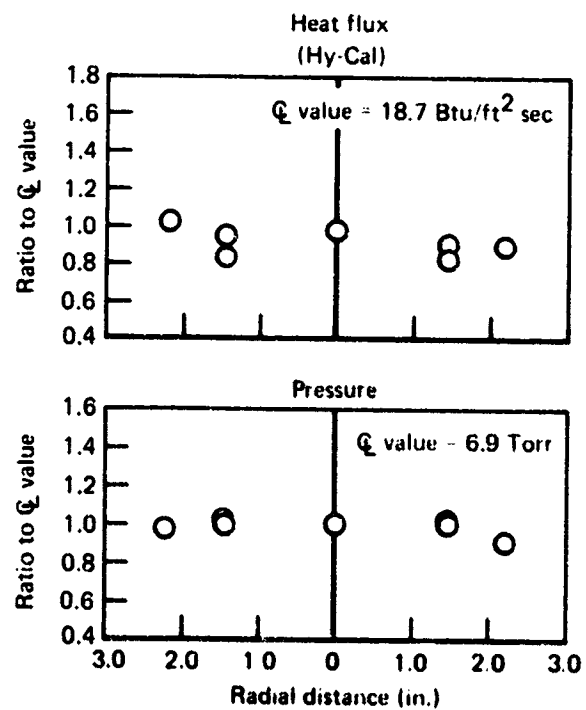


Fig. A-2 Heat flux and pressure calibration for samples DS-3 and DS-4 tested at 2000°F (cycles 41-100)

GP 73 0587-48

APPENDIX A: HEAT FLUX AND PRESSURE PROFILES

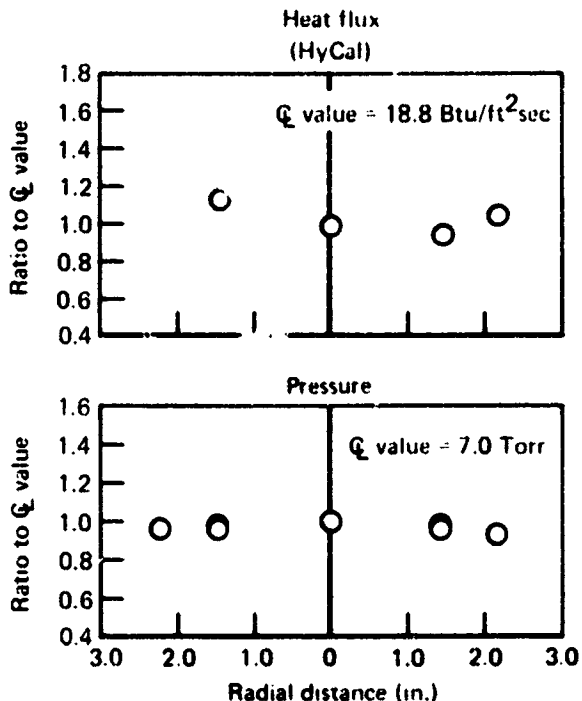


Fig. A-3 Heat flux and pressure calibration for samples TD-5 and TD-9 tested at 2000°F

GP73-0587-49

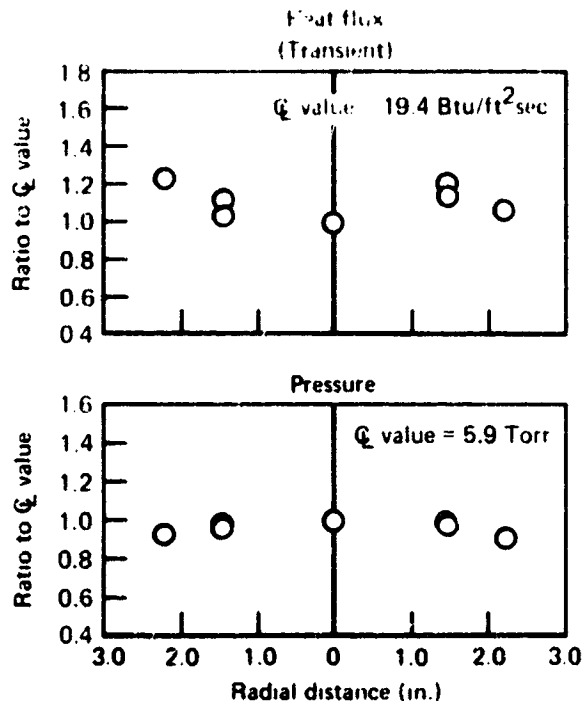


Fig. A-5 Heat flux and pressure calibration for samples TY-1 and TY-2 tested at 2200°F

GP73-0587-51

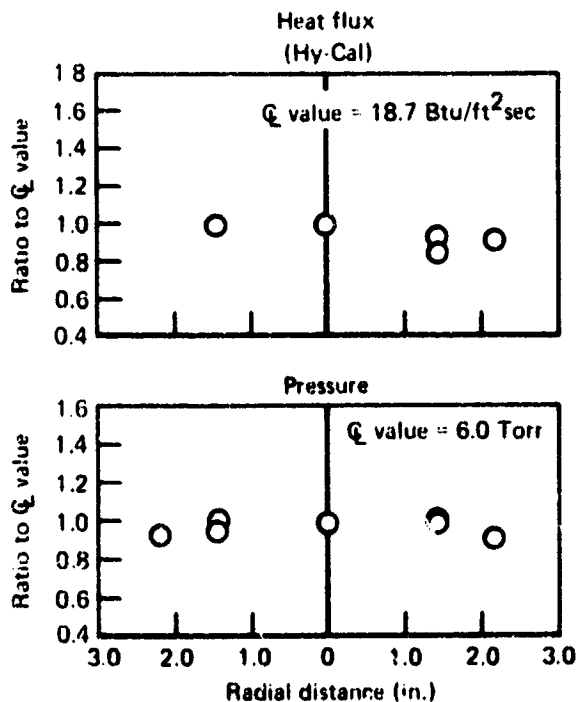


Fig. A-4 Heat flux and pressure calibration for samples TAL-1 and TAL-2 tested at 2200°F

GP73-0587-50

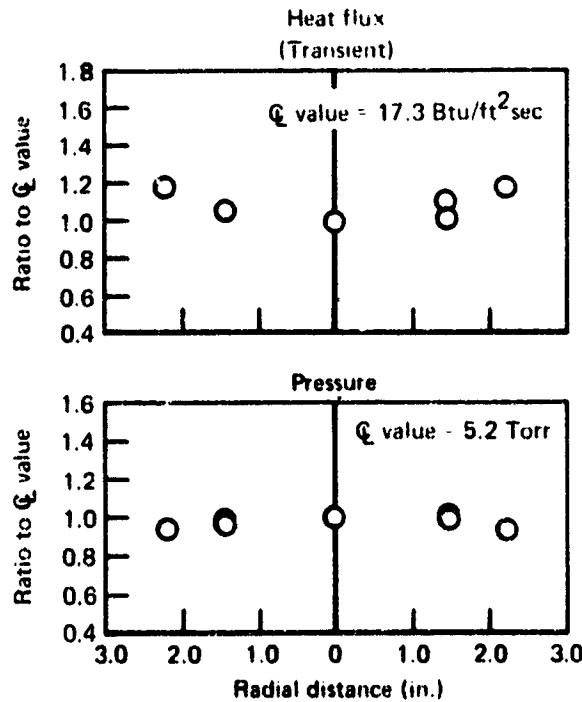


Fig. A-6 Heat flux and pressure calibration for samples HS-1 and HS-2 tested at 1800°F

GP73-0587-52

APPENDIX A: HEAT FLUX AND PRESSURE PROFILES

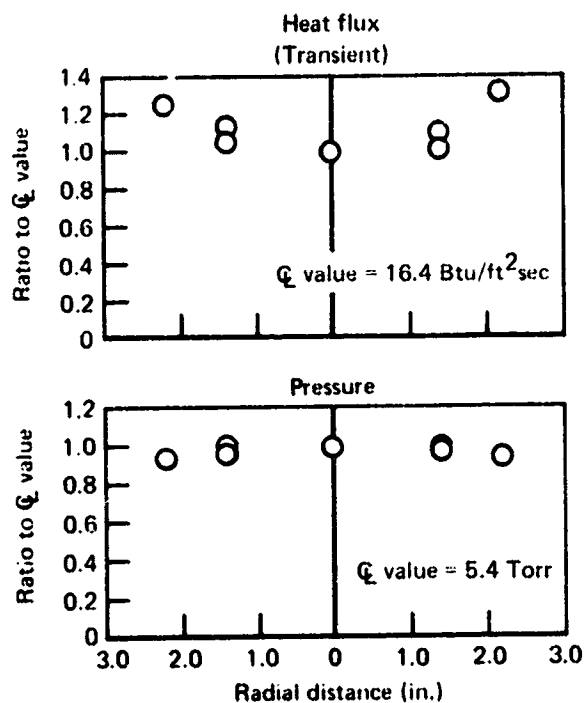


Fig. A-7 Heat flux and pressure calibration for samples X-1 and X-2 tested at 1800°F

GP73-0587-53

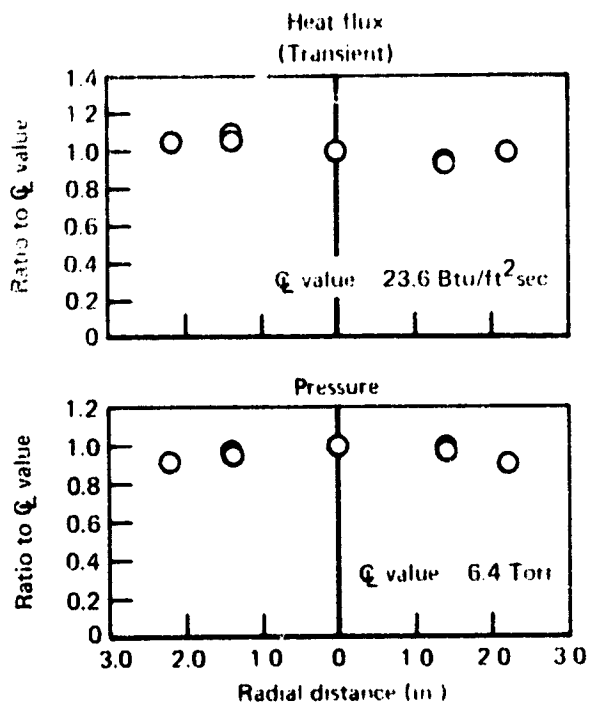


Fig. A-9 Heat flux and pressure calibration for samples DS-1 and DS-2 tested at 2000°F

GP73-0587-55

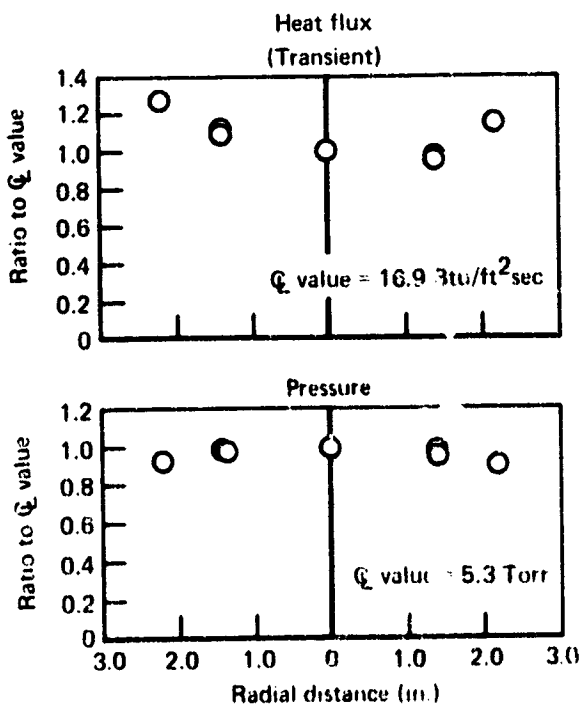


Fig. A-8 Heat flux and pressure calibration for samples TD-1 and TD-2 tested at 1800°F

GP73-0587-54

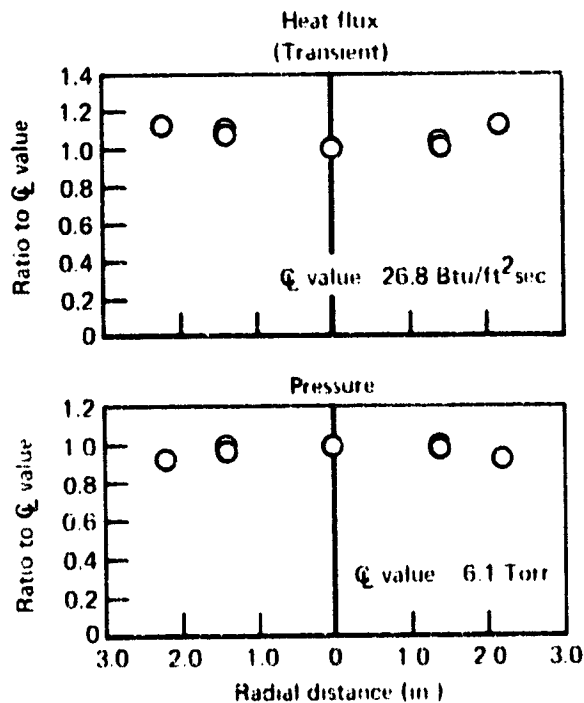


Fig. A-10 Heat flux and pressure calibration for samples TD-7 and TD-8 tested at 2200°F

GP73-0587-56

APPENDIX A: HEAT FLUX AND PRESSURE PROFILES

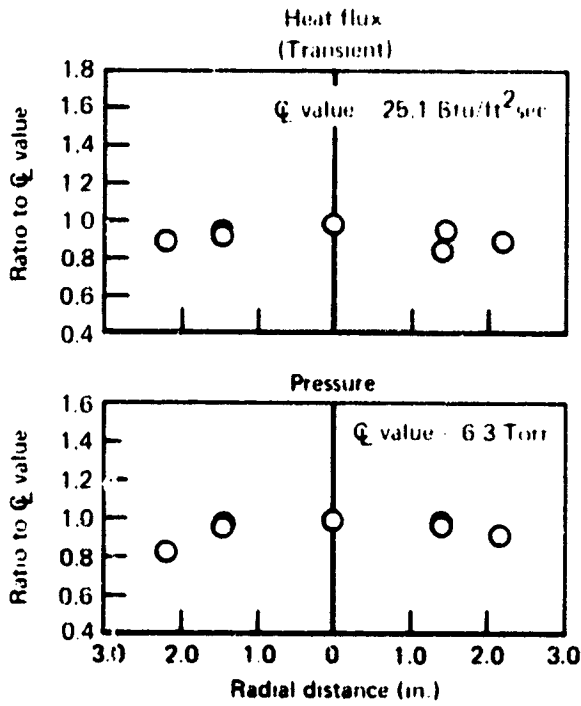


Fig. A-11 Heat flux and pressure calibration for samples DS-5 and DS-6 tested at 2000°F

GP73-0587-57

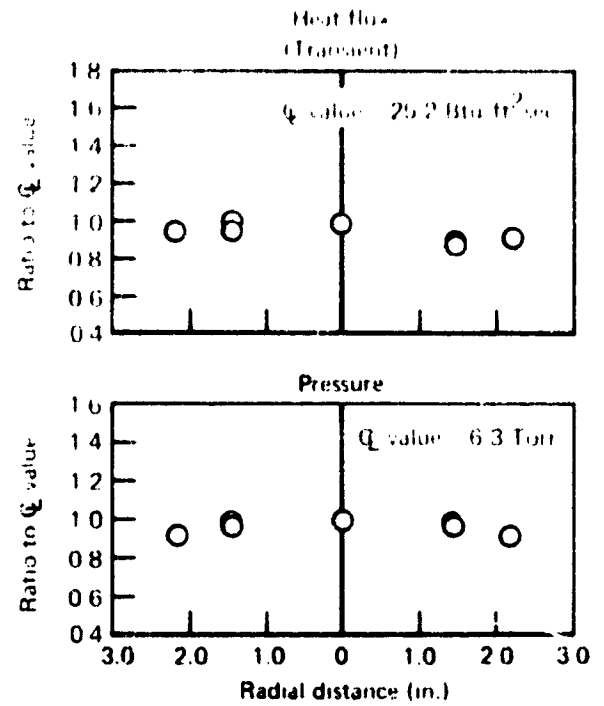


Fig. A-12 Heat flux and pressure calibration for sample HS-3 tested at 2000°F

GP73-0587-58

Appendix B: Model temperature histories

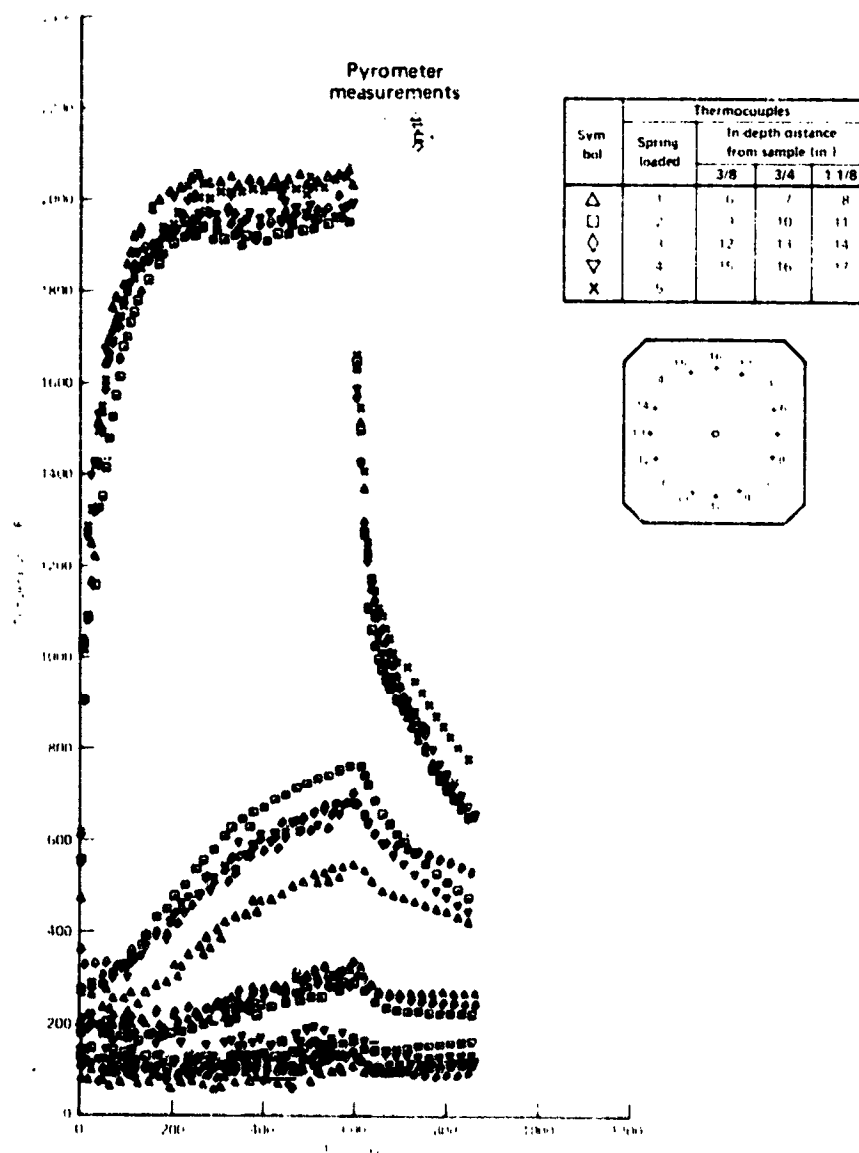


Fig. B-1 Typical temperature histories for DS-3 sample (cycle 27)

CP 73-0507 50

APPENDIX B: MODEL TEMPERATURE HISTORIES

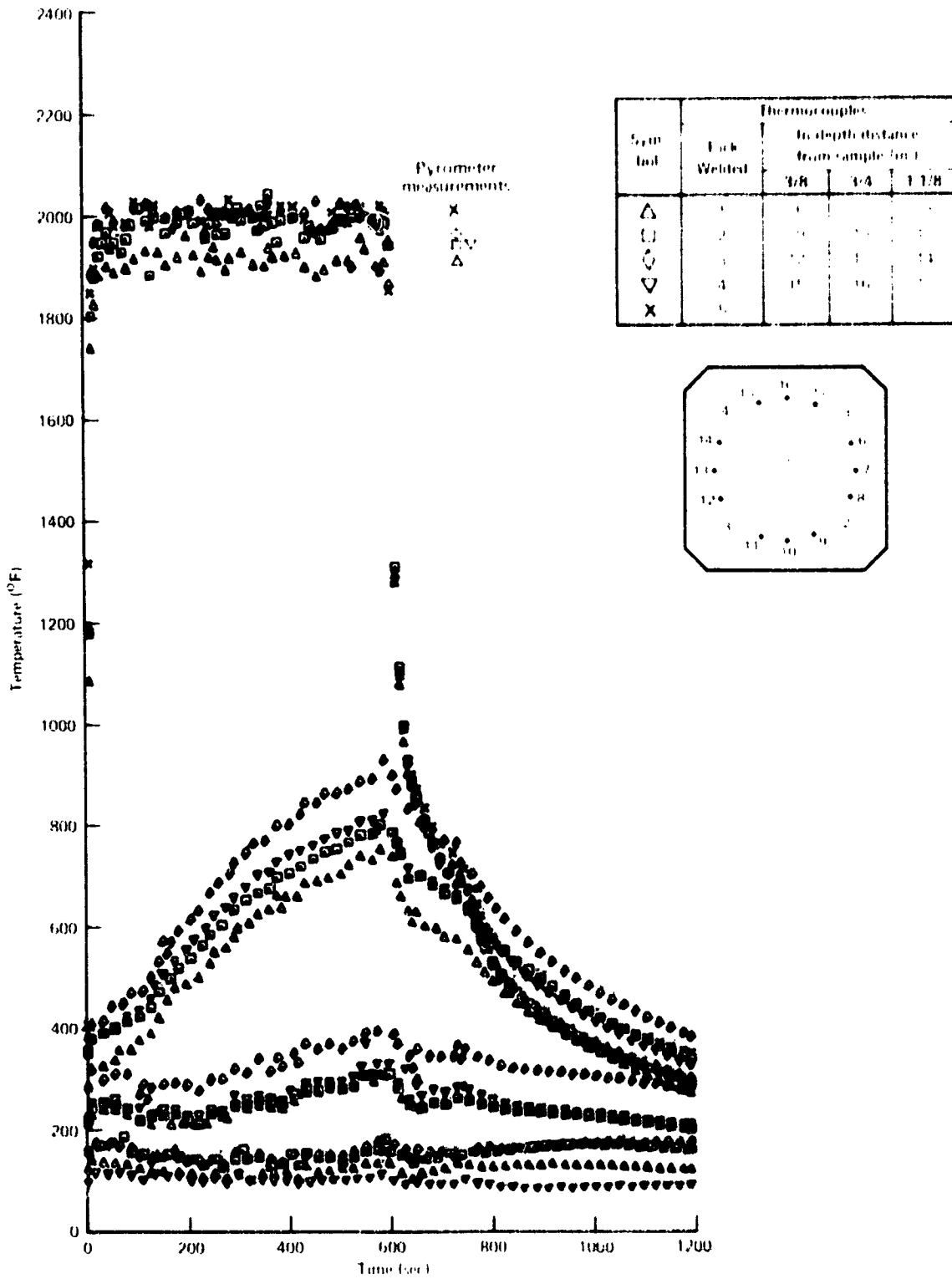


Fig. B-2 Typical temperature histories for DS-3 sample (cycle 50)

GP 73-0587-60

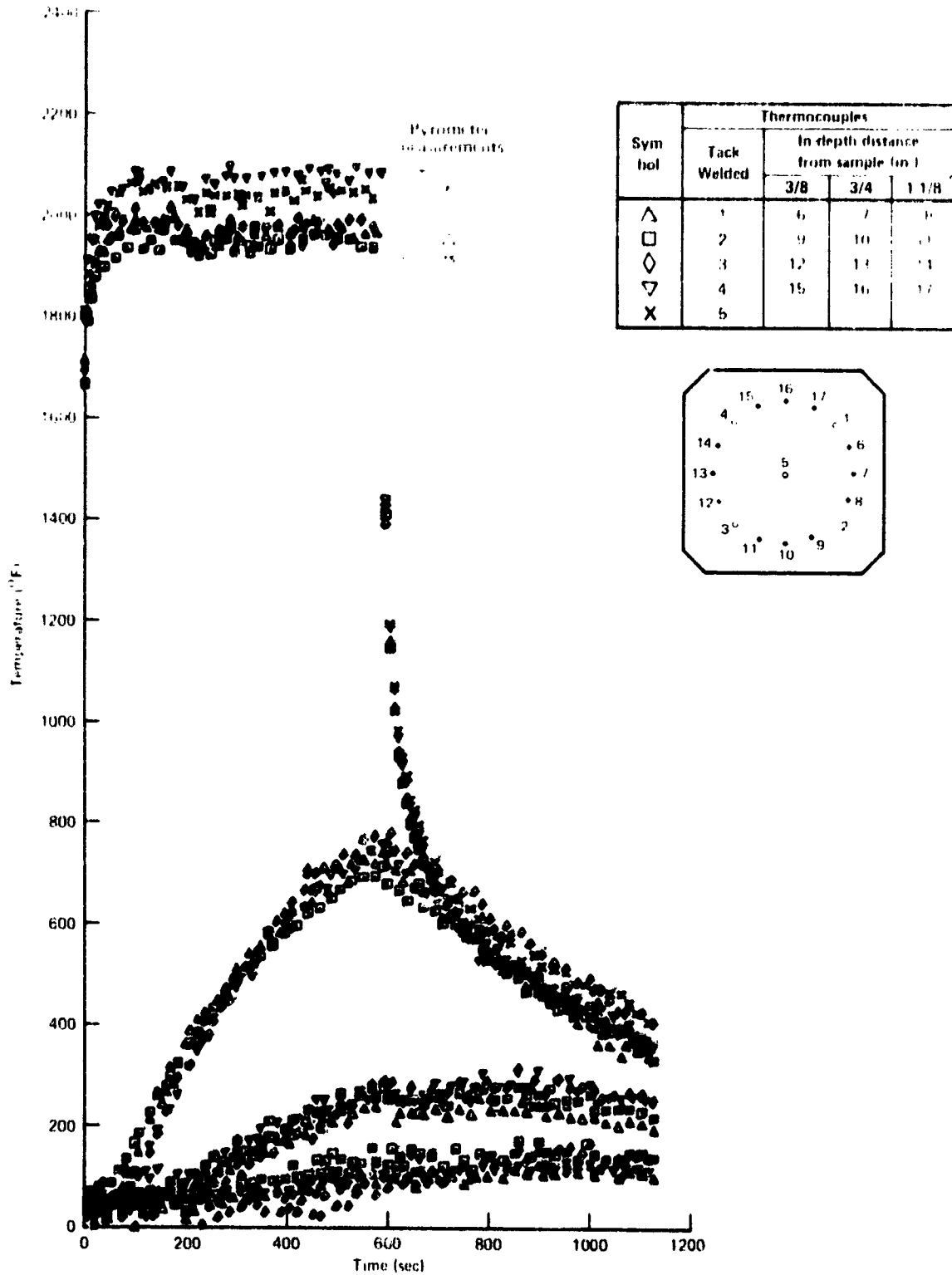


Fig. B-3 Typical temperature histories for DS-3 sample (cycle 76)

GP 73-0587-61

APPENDIX B: MODEL TEMPERATURE HISTORIES

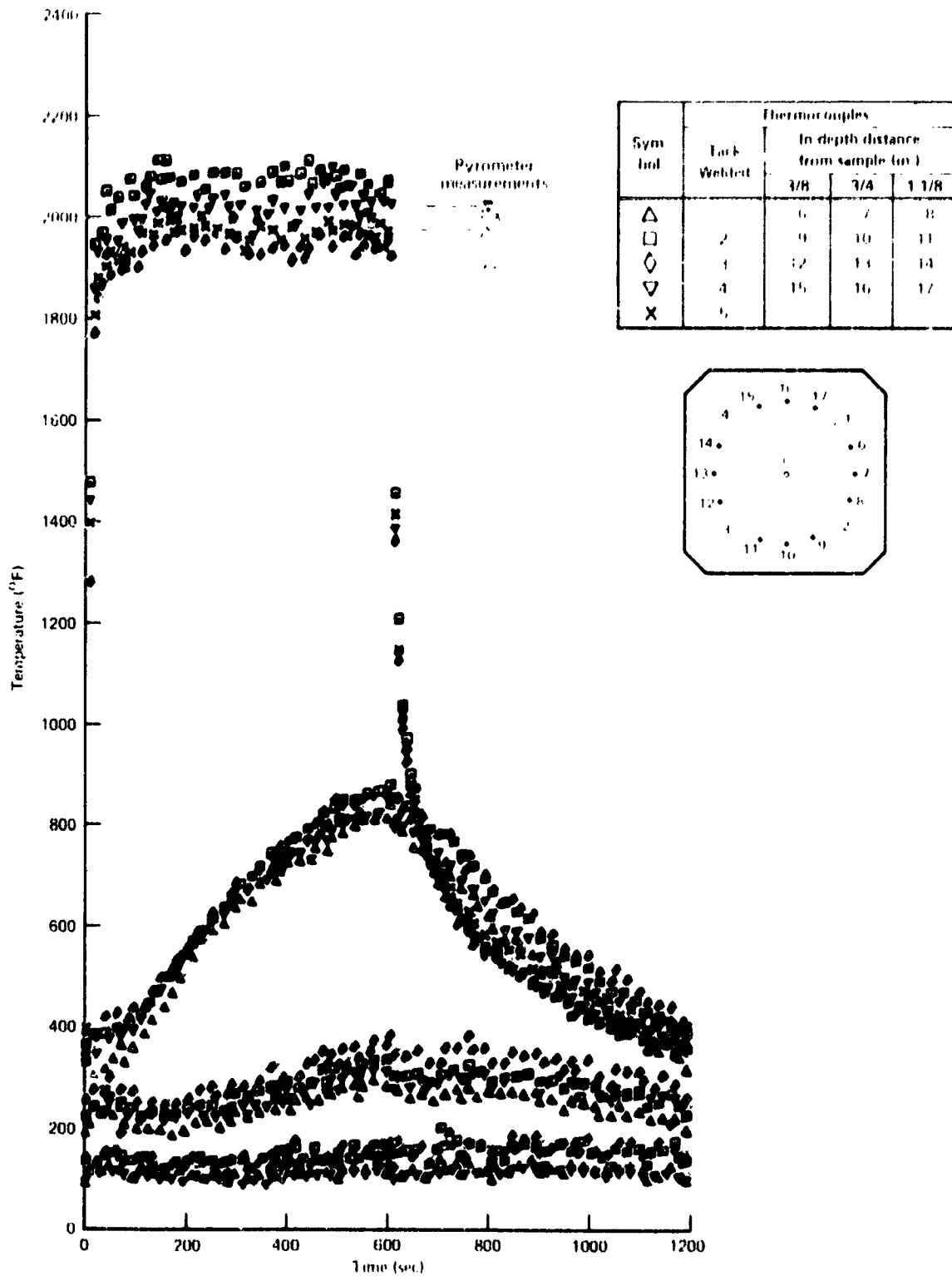


Fig. B-4 Typical temperature histories for DS-3 sample (cycle 98)

GP73 0587 62

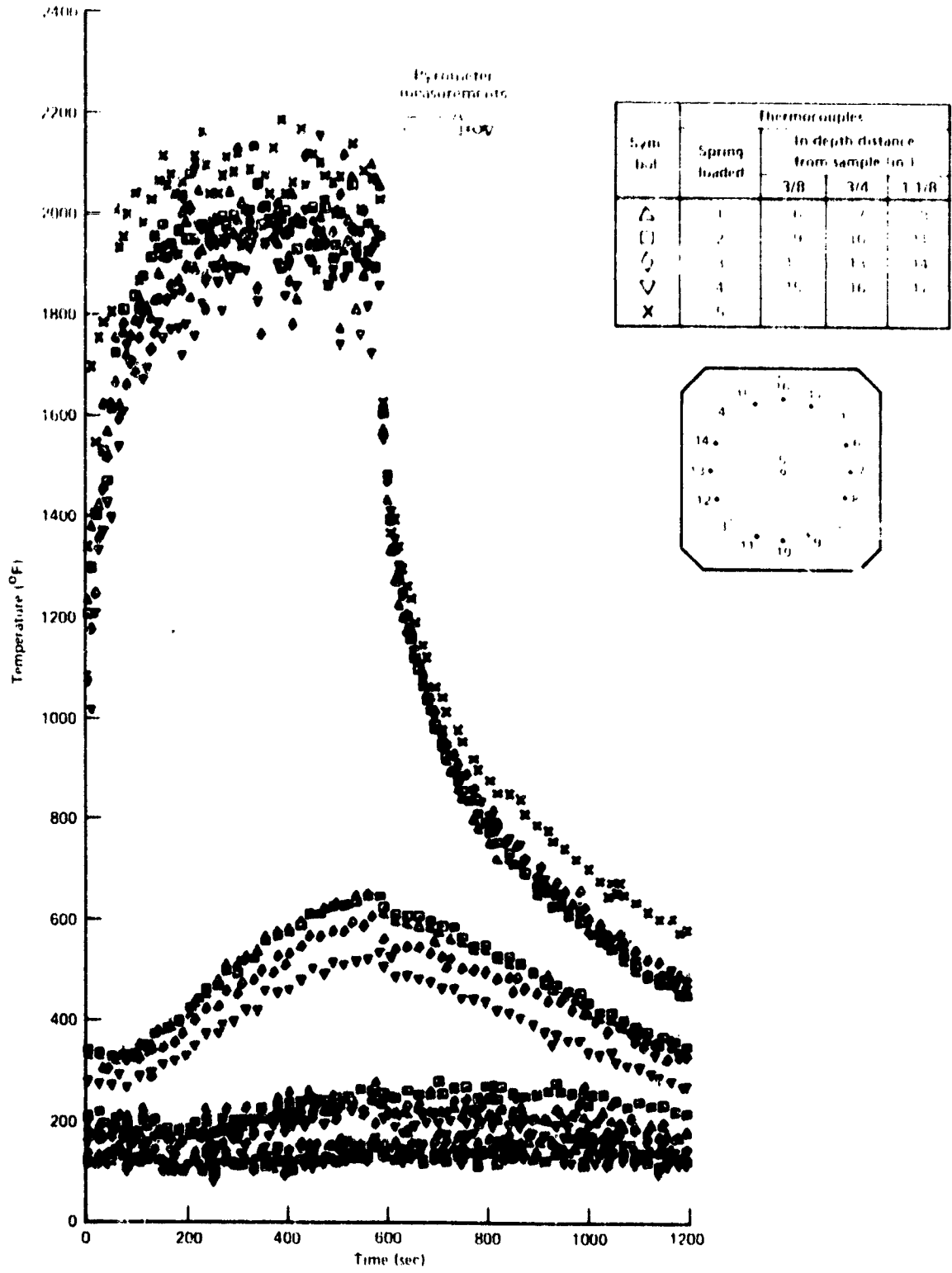


Fig. B-5 Typical temperature histories for DS-4 sample (cycle 27)

GP73 0587 83

APPENDIX B MODEL TEMPERATURE HISTORIES

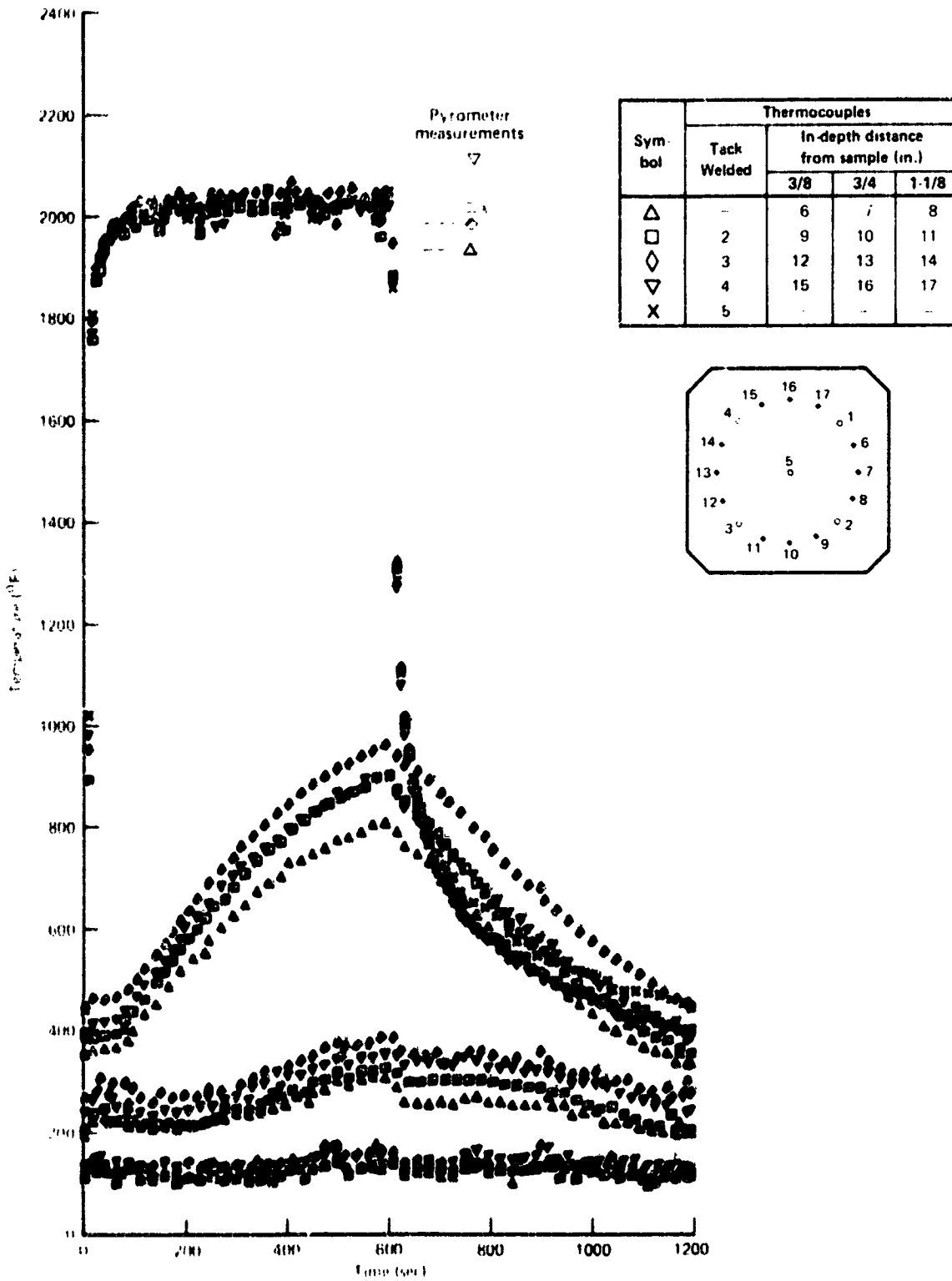


Fig. B-6 Typical temperature histories for DS-4 sample (cycle 50)

GP73 05R1 64

APPENDIX B: MODEL TEMPERATURE HISTORIES

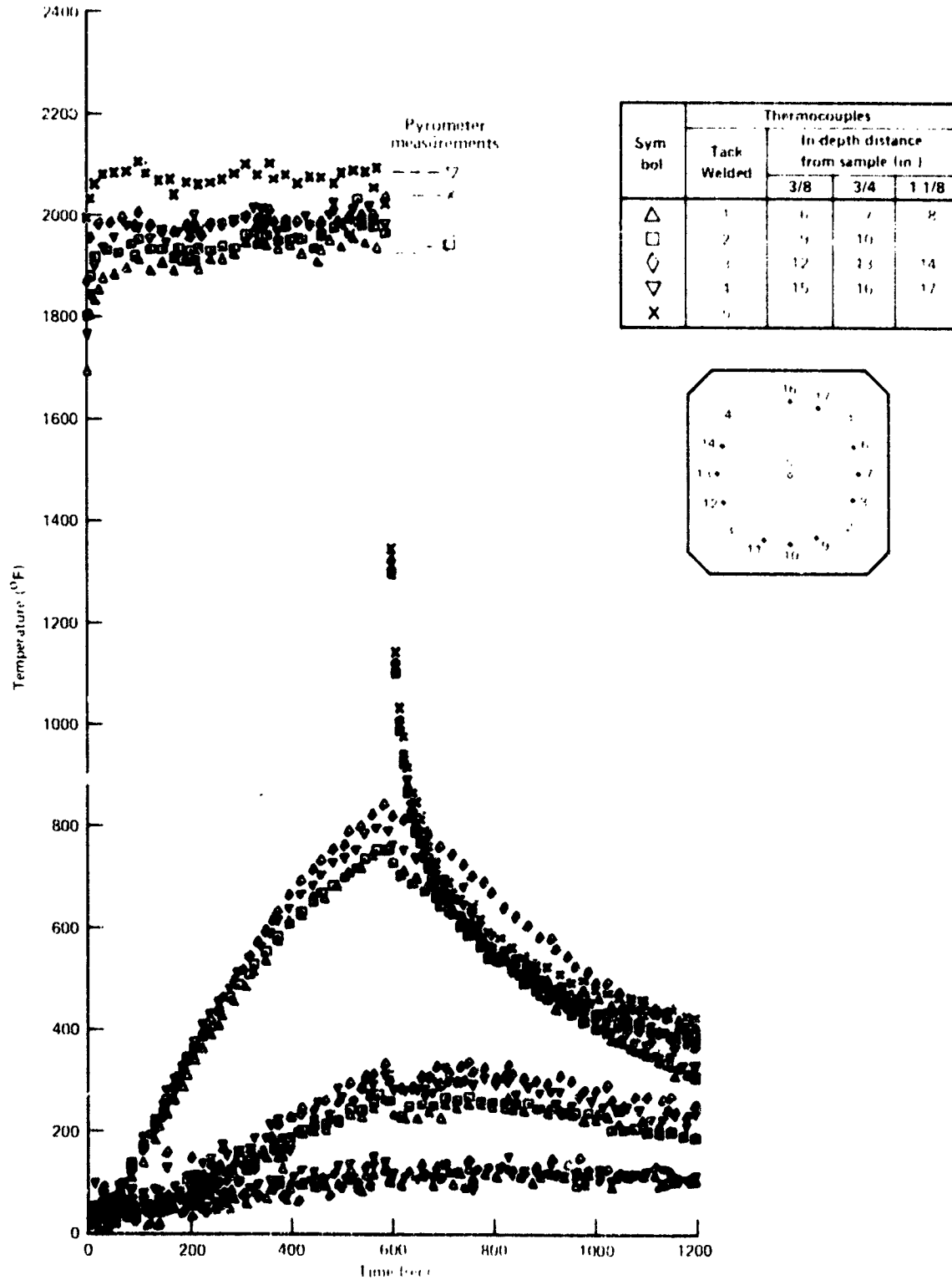


Fig. B-7 Typical temperature histories for DS-4 sample (cycle 76)

GP73 0587 55

APPENDIX B: MODEL TEMPERATURE HISTORIES

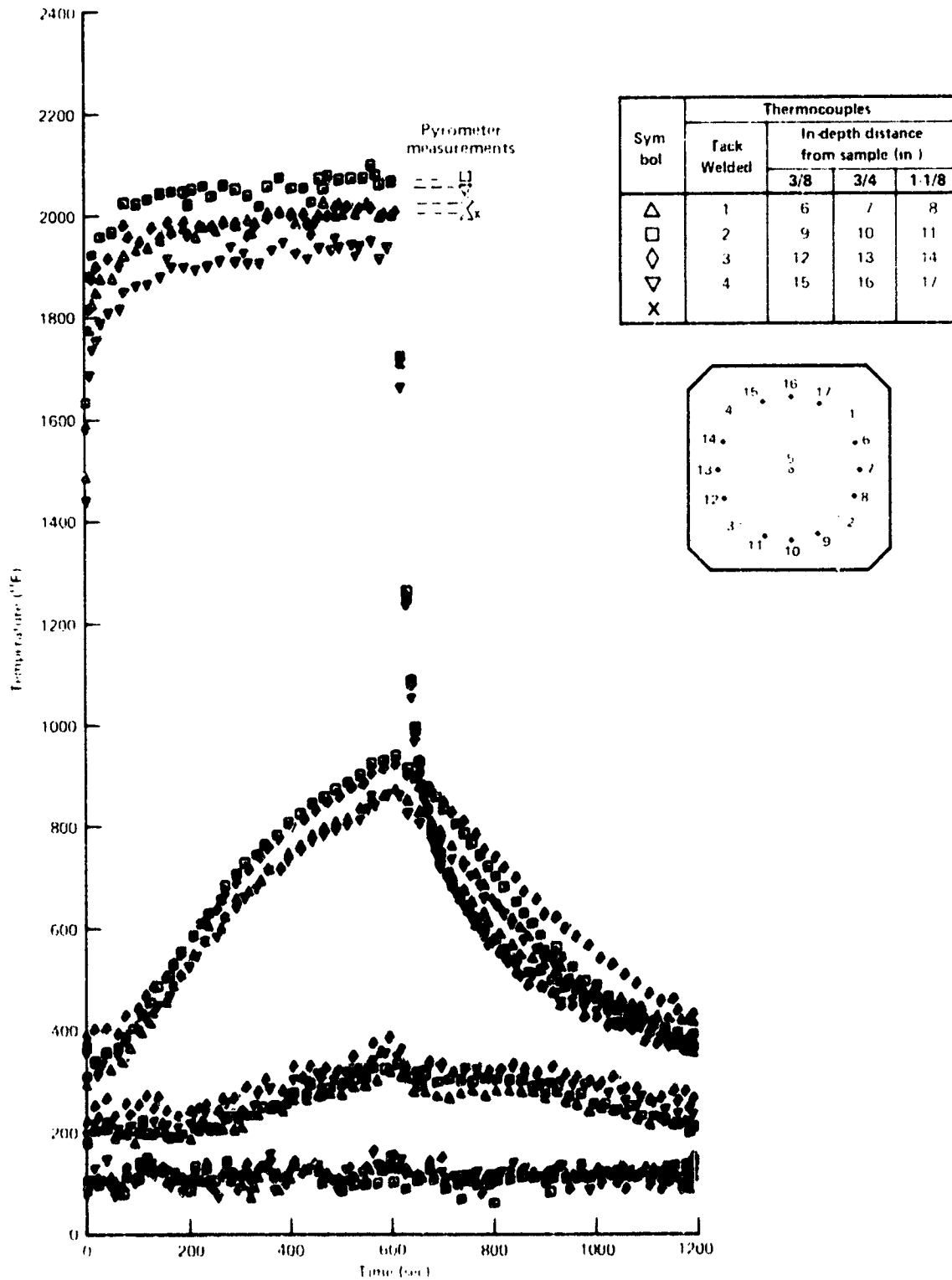


Fig. B-8 Typical temperature histories for DS-4 sample (cycle 98)

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APPENDIX B: MODEL TEMPERATURE HISTORIES

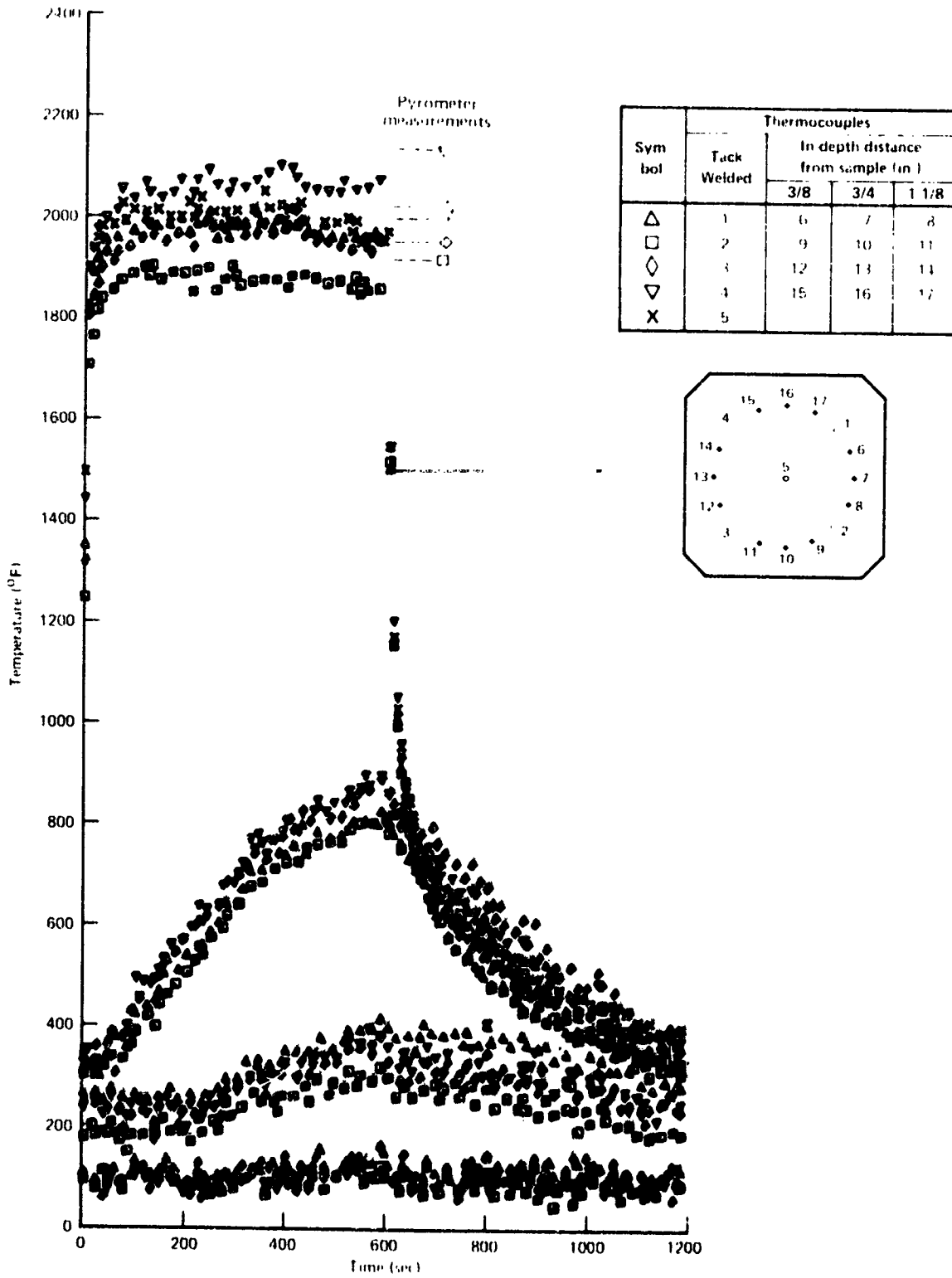


Fig. B-9 Typical temperature histories for TD-5 sample (cycle 23)

GP73 0587 67

APPENDIX B: MODEL TEMPERATURE HISTORIES

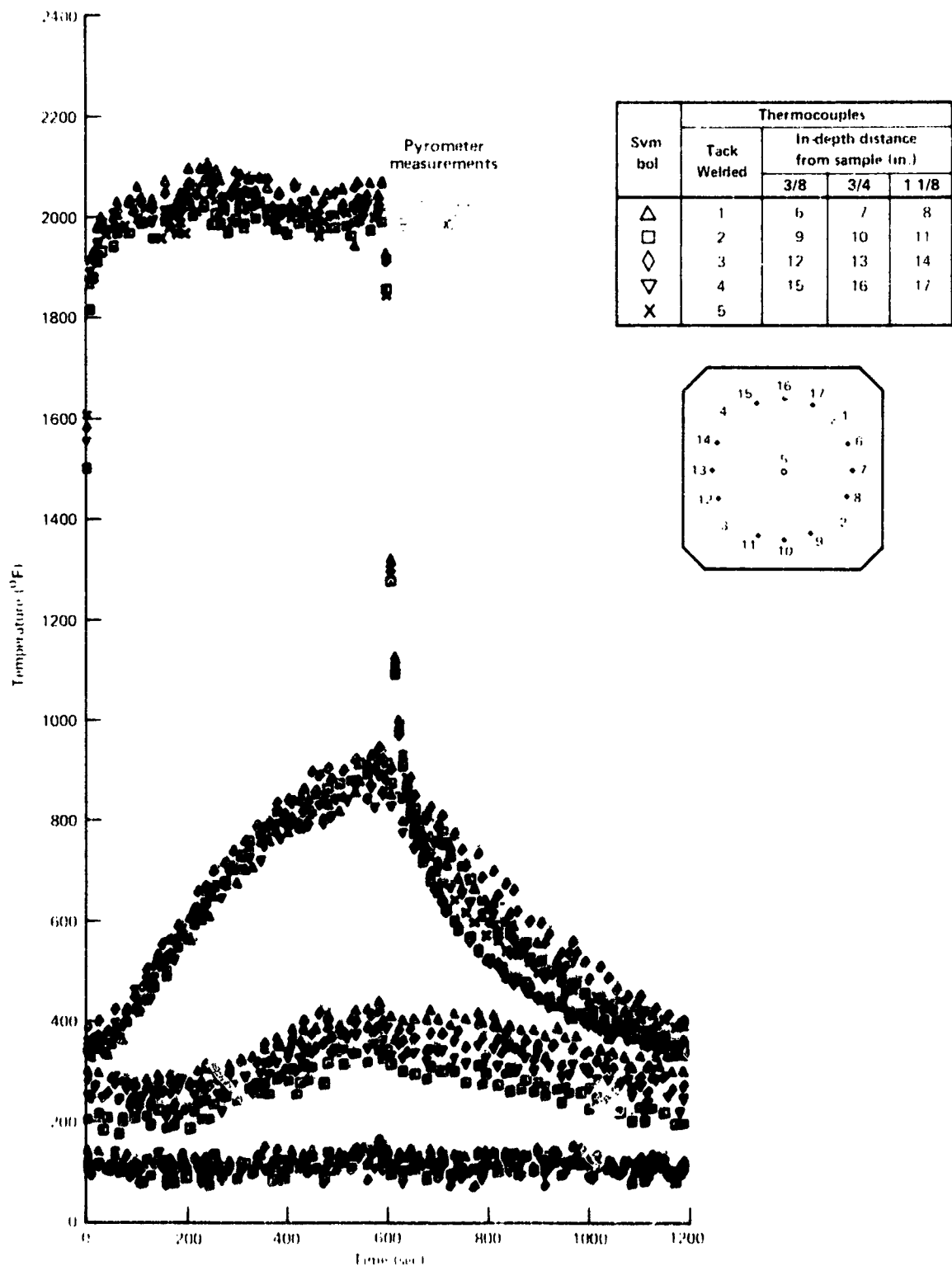


Fig. B-10 Typical temperature histories for TD-5 sample (cycle 49)

GP73 0507 60

APPENDIX B: MODEL TEMPERATURE HISTORIES

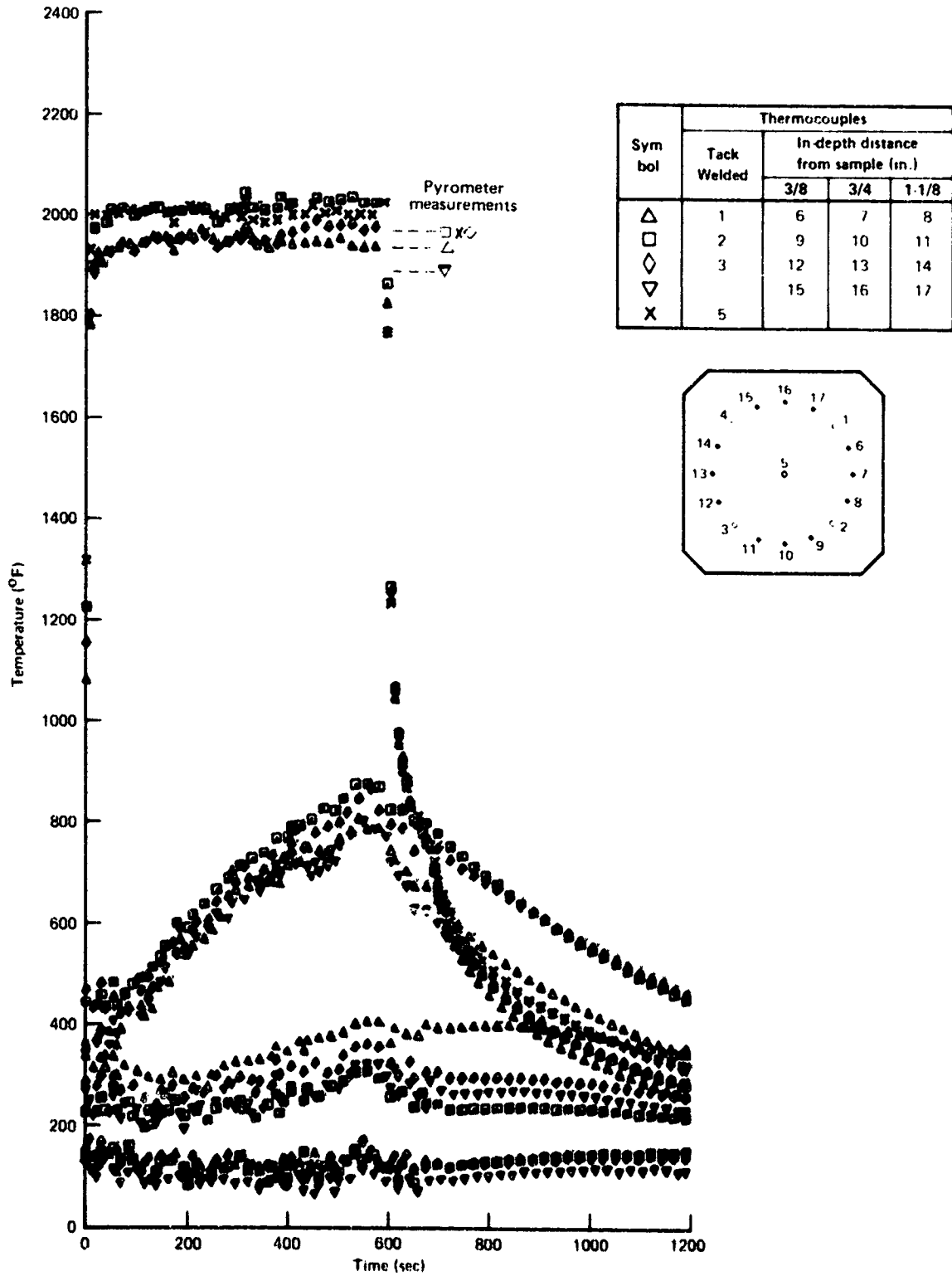


Fig. B-11 Typical temperature histories for TD-5 sample (cycle 75)

GP73-0287-69

APPENDIX B · MODEL TEMPERATURE HISTORIES

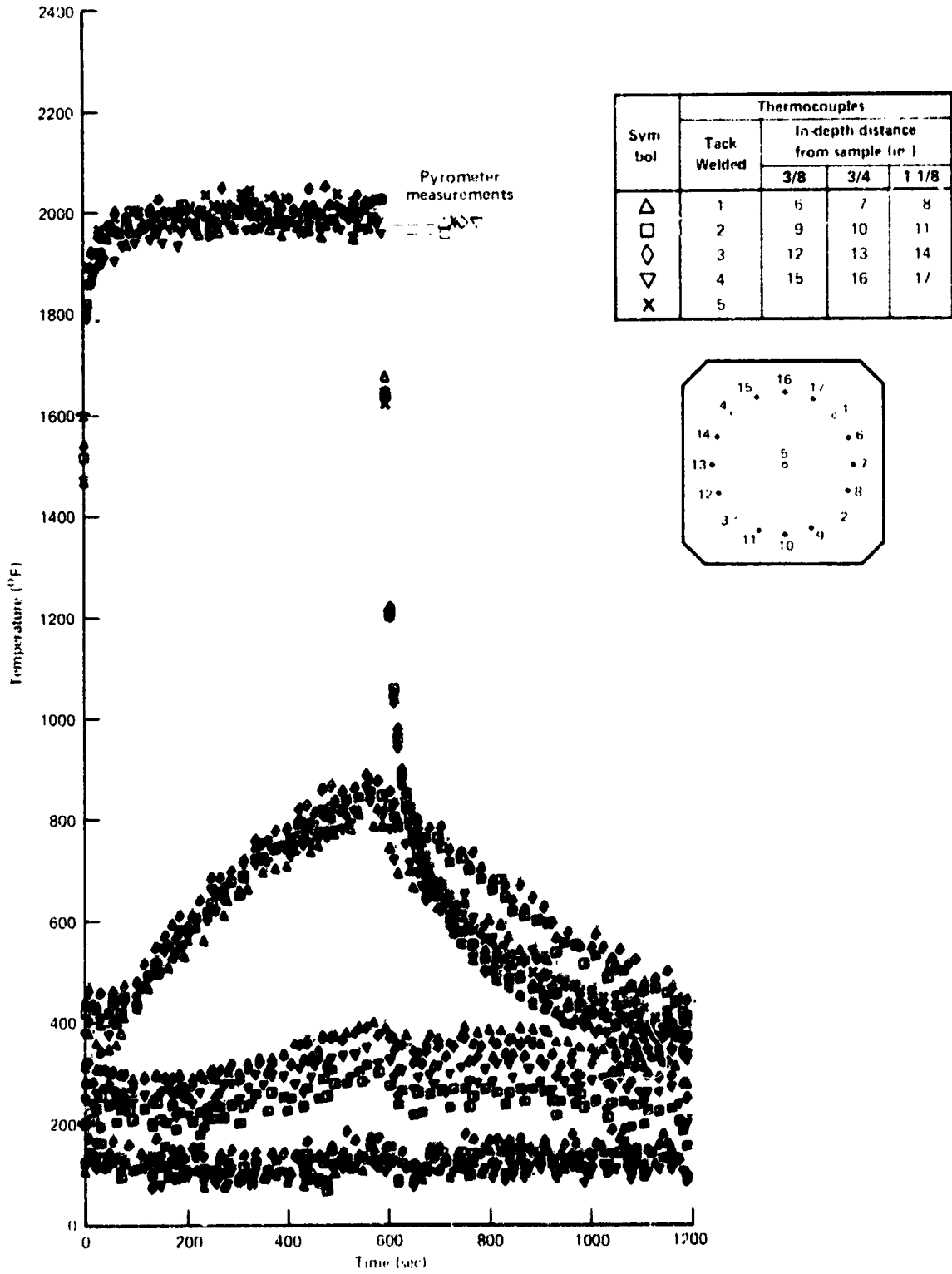


Fig. B-12 Typical temperature histories for TD-5 sample (cycle 100)

GP 73 0587 70

APPENDIX B: MODEL TEMPERATURE HISTORIES

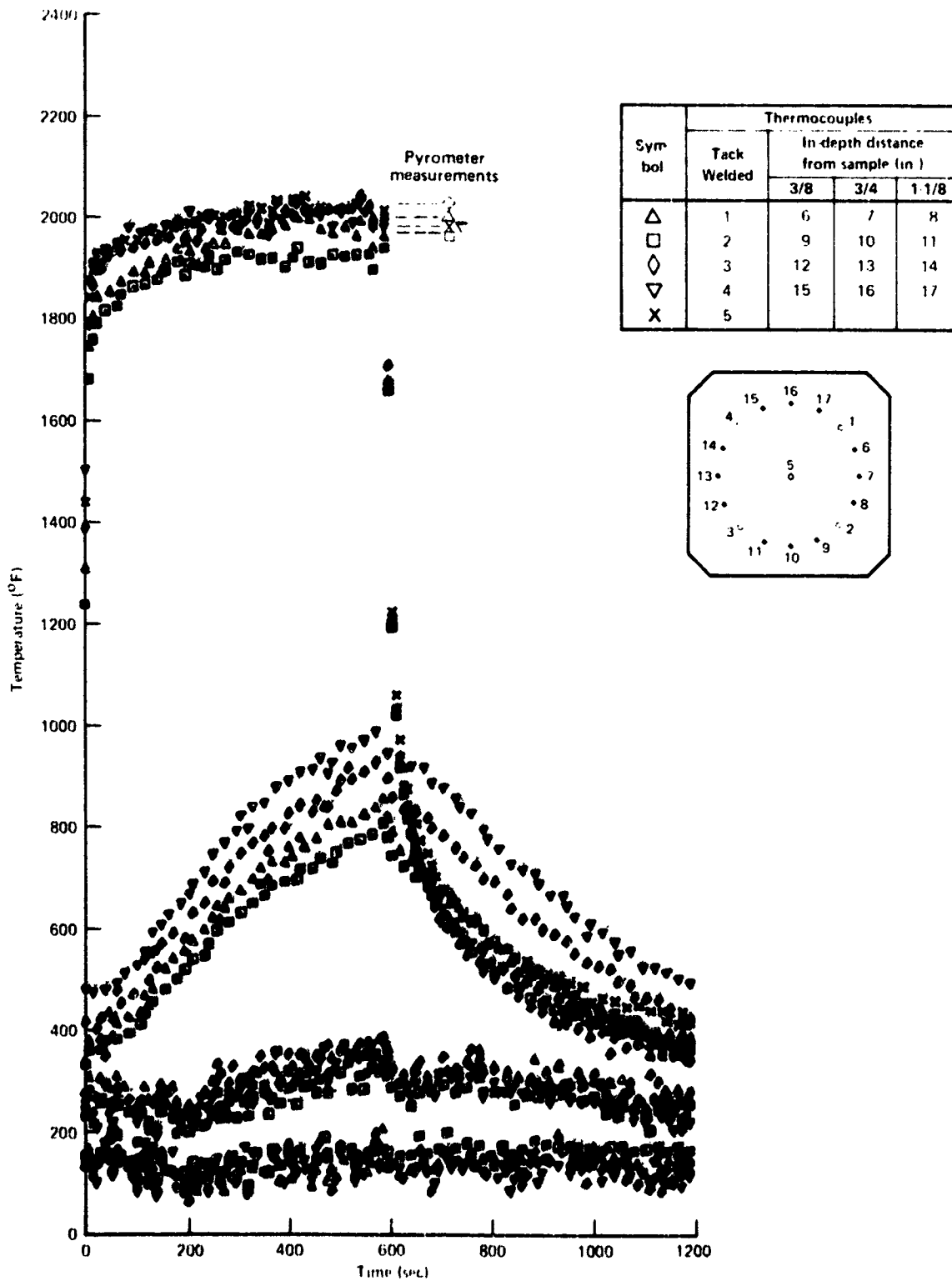


Fig. B-13 Typical temperature histories for TD-9 sample (cycle 23)

GP73-0587-1

APPENDIX B: MODEL TEMPERATURE HISTORIES

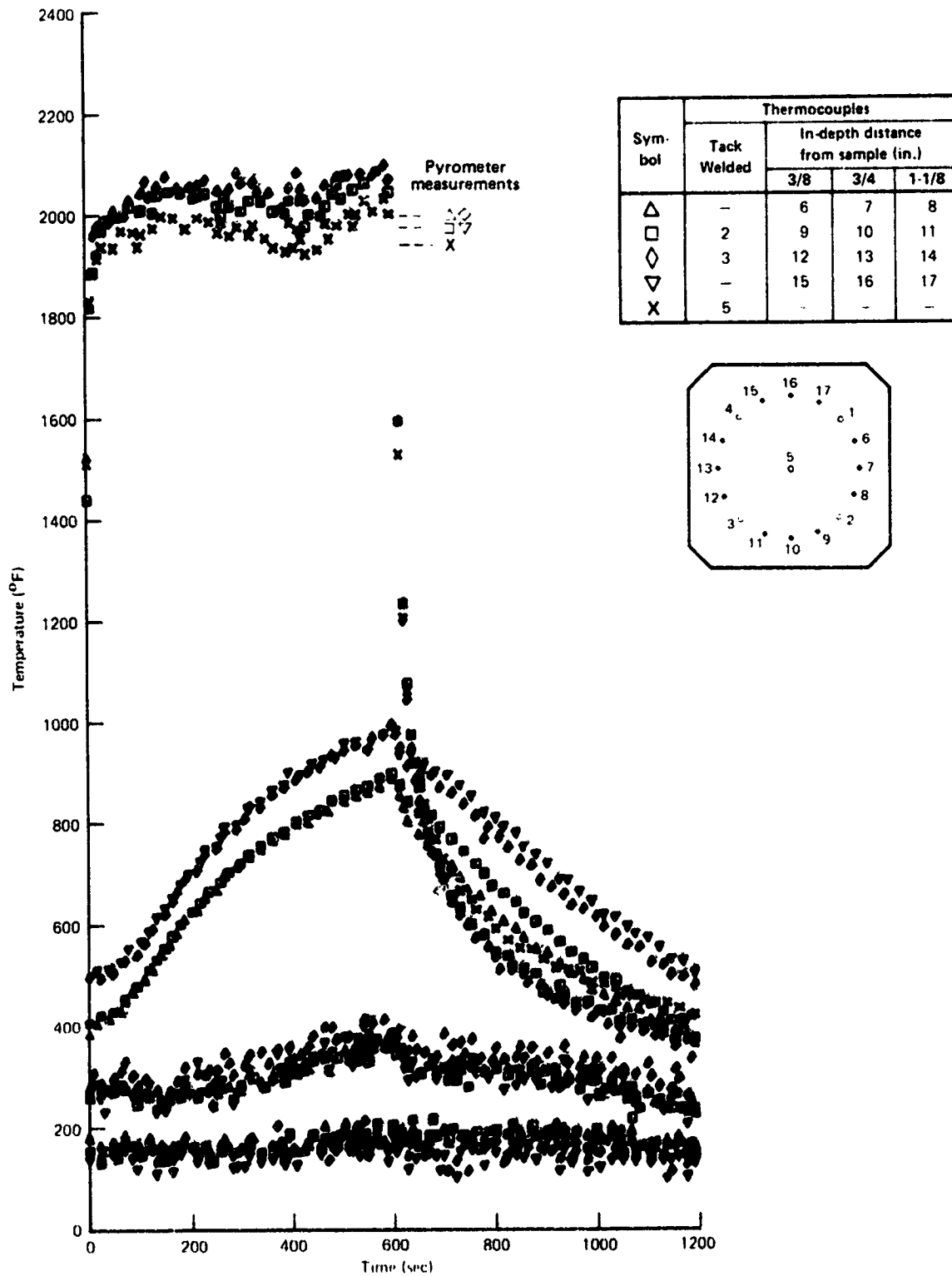


Fig. B-14 Typical temperature histories for TD-9 sample (cycle 49)

GP73 0587 72

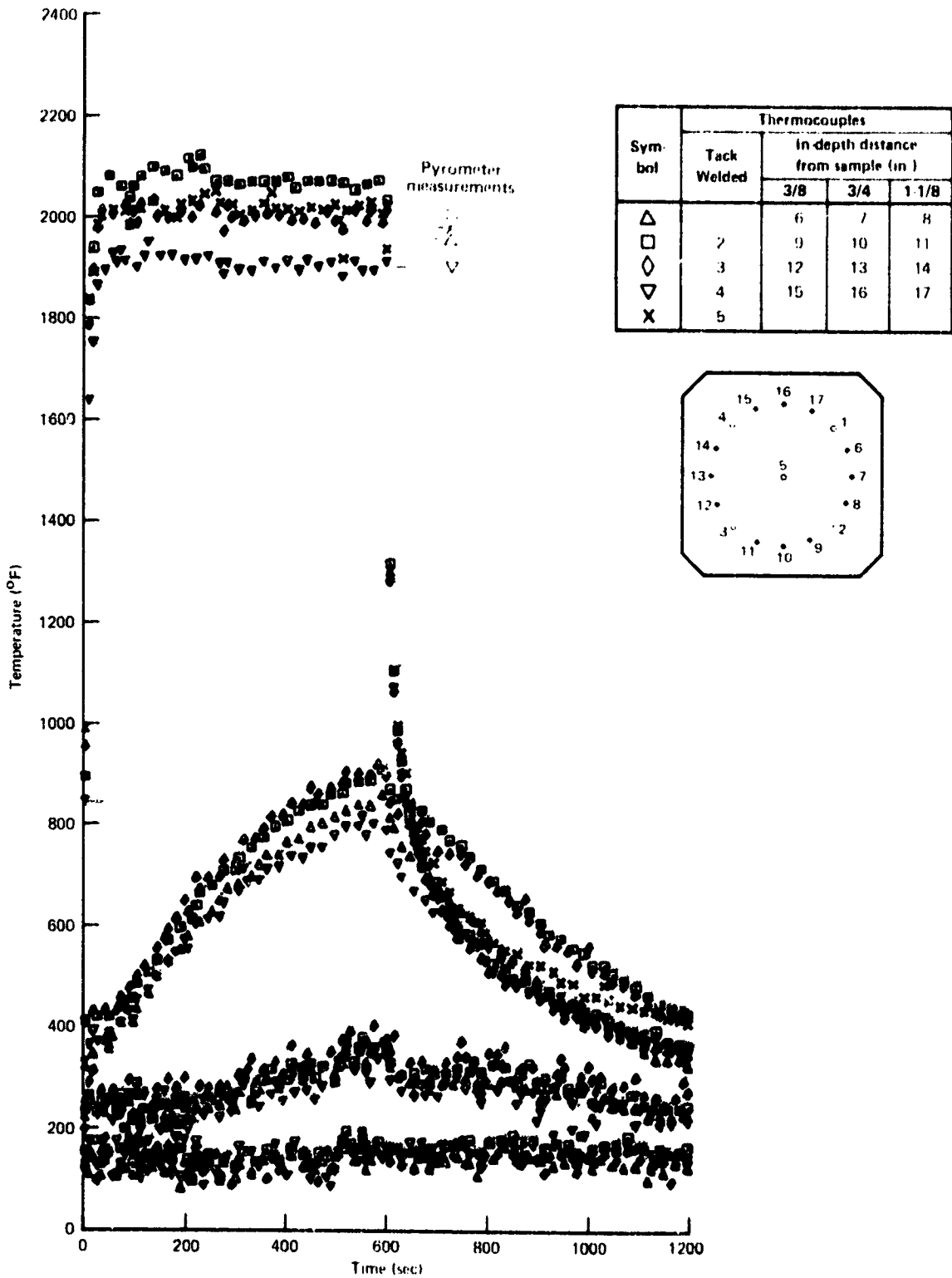


Fig. B-15 Typical temperature histories for TD-9 sample (cycle 75)

GPT 0580 71

APPENDIX B: MODEL TEMPERATURE HISTORIES

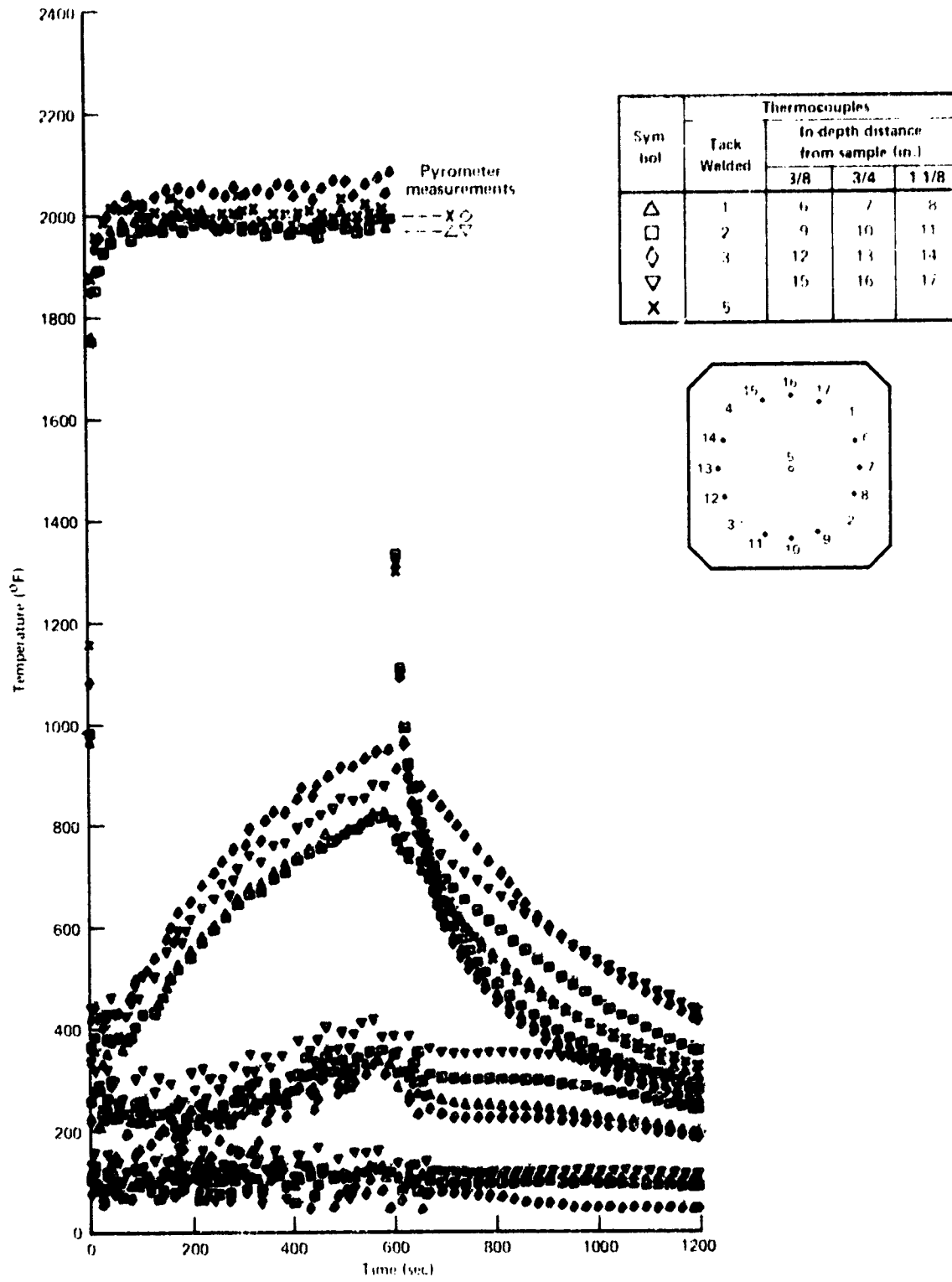


Fig. B-16 Typical temperature histories for TD-9 sample (cycle 100)

GP 11 0587 74

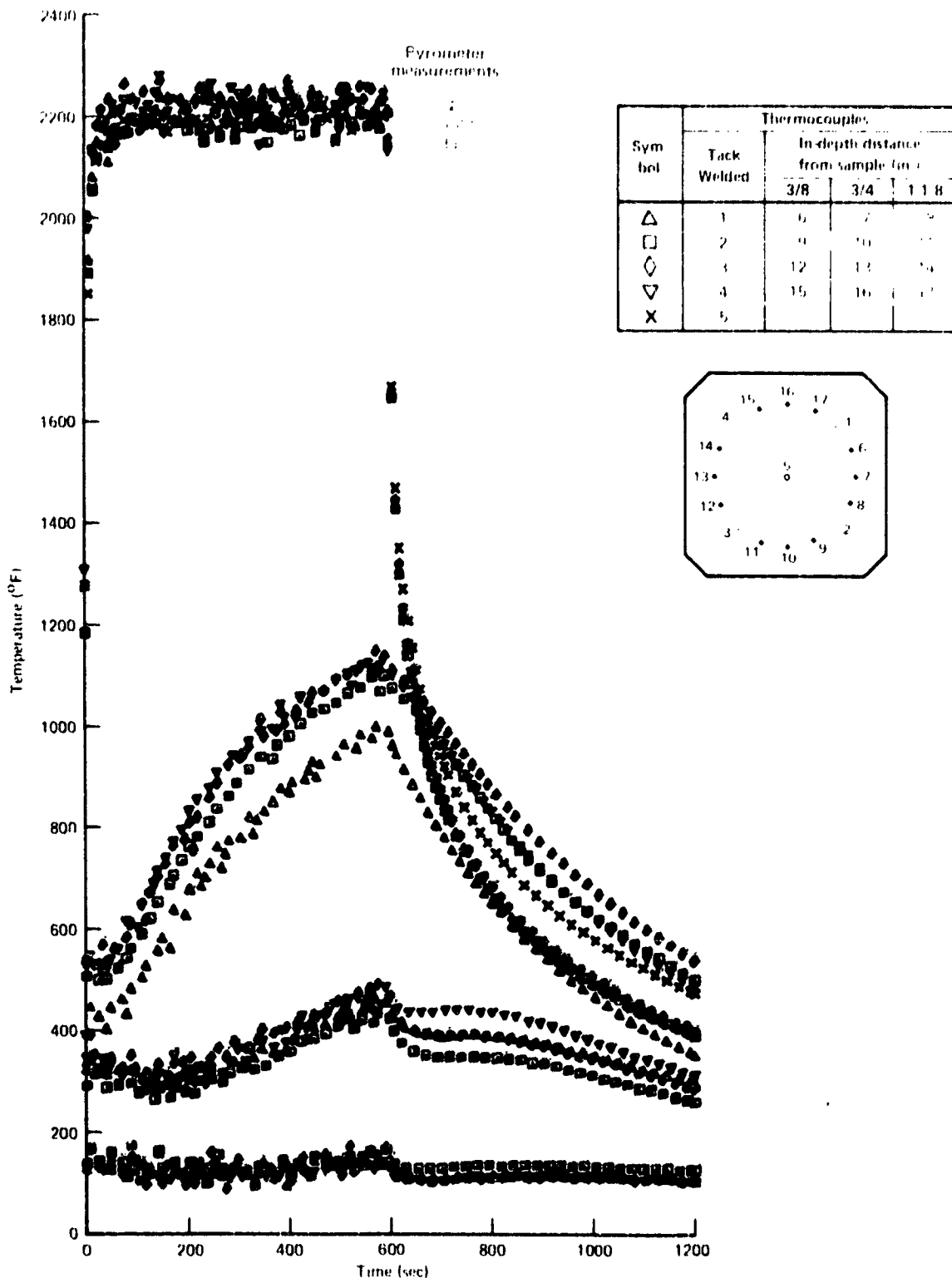


Fig. B-17 Typical temperature histories for TAL-1 sample (cycle 25)

GP73-0587 76

APPENDIX B: MODEL TEMPERATURE HISTORIES

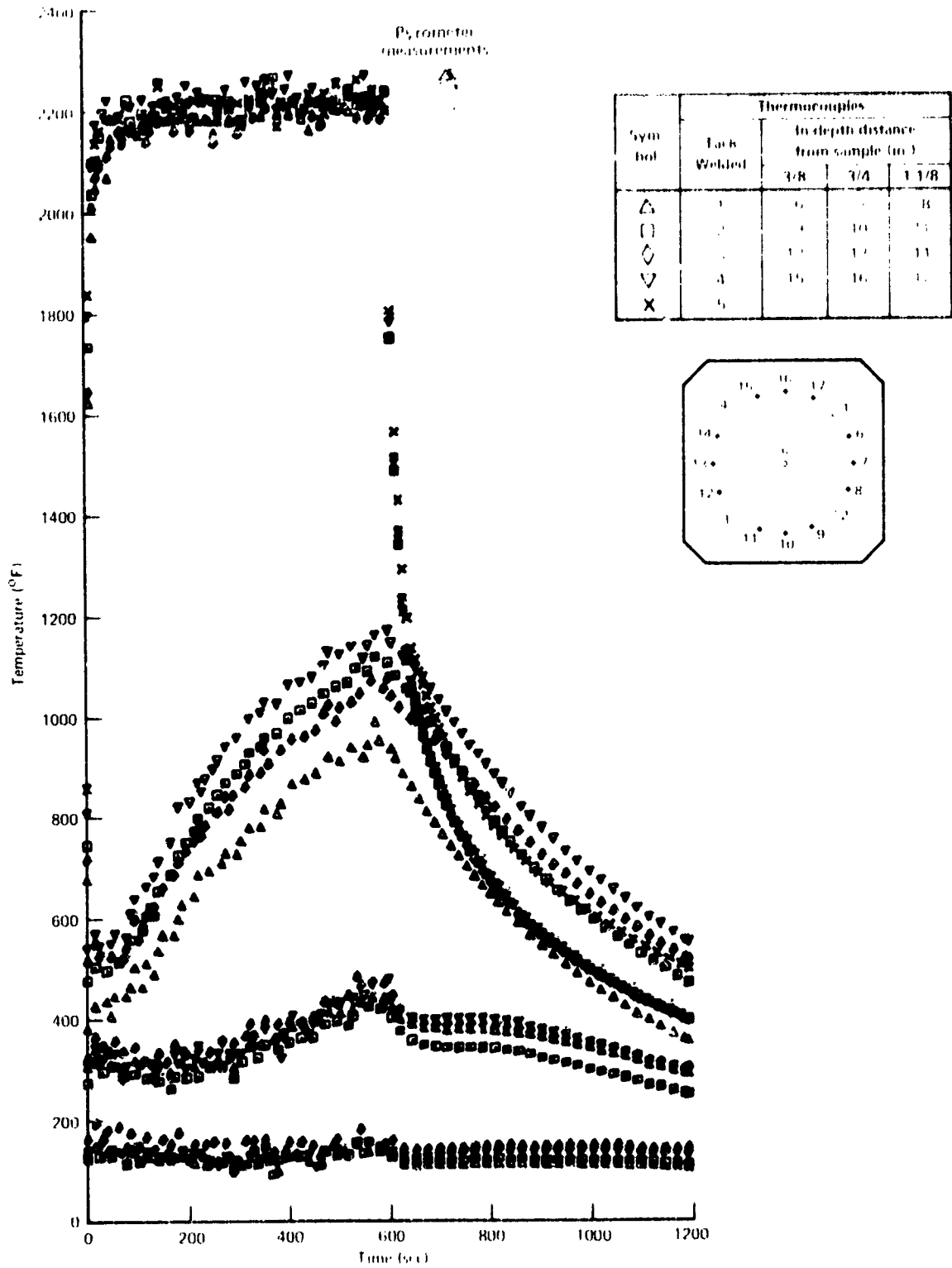


Fig. B-18 Typical temperature histories for TAL-1 sample (cycle 50)

OP73 0587 76

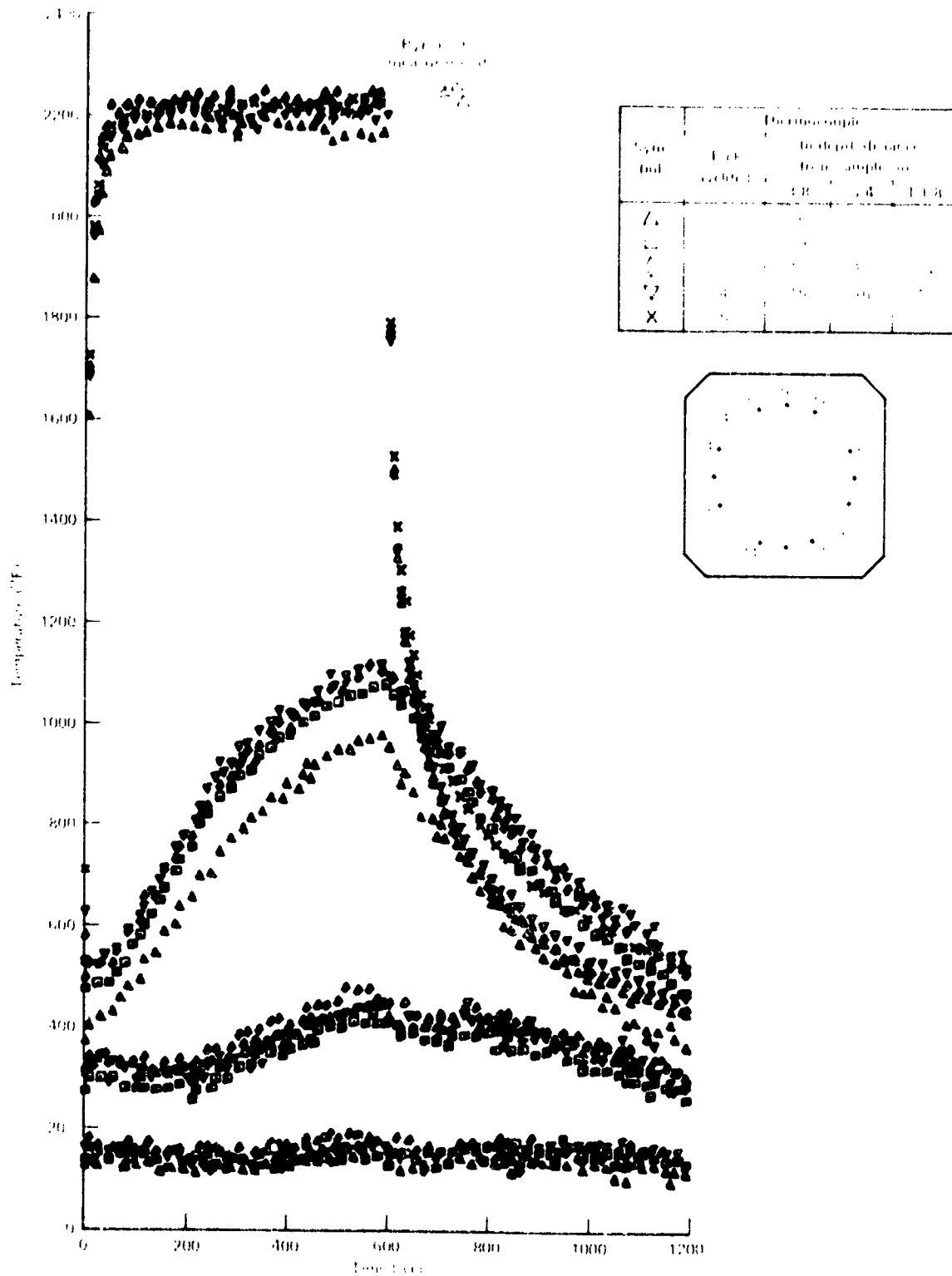


Fig. B-19 Typical temperature histories for TAL-1 sample (cycle 75)

APPENDIX B MODEL TEMPERATURE HISTORIES

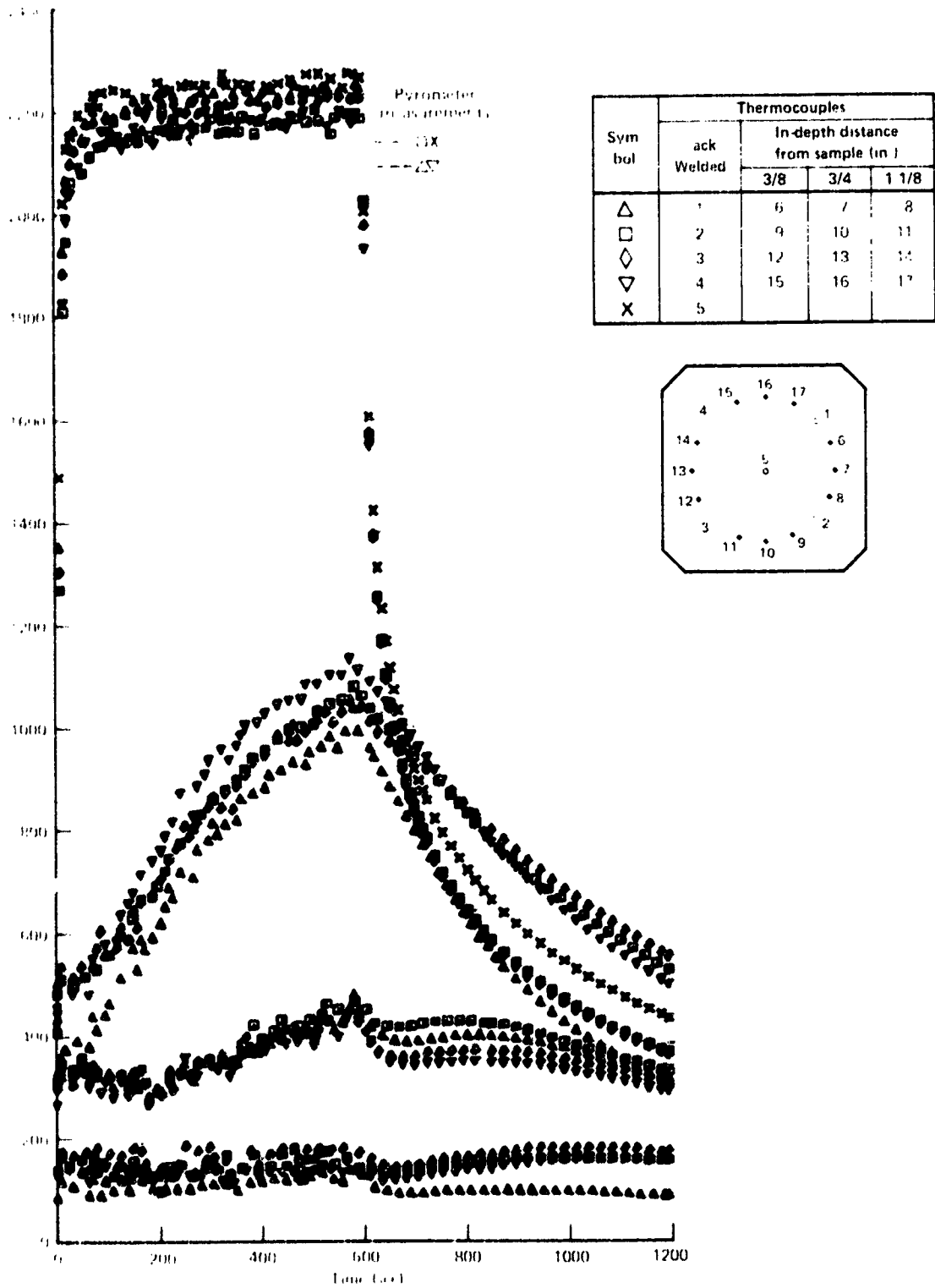


Fig. B-20 Typical temperature histories for TAL-1 sample (cycle 100)

GP11057-38

APPENDIX B: MODEL TEMPERATURE HISTORIES

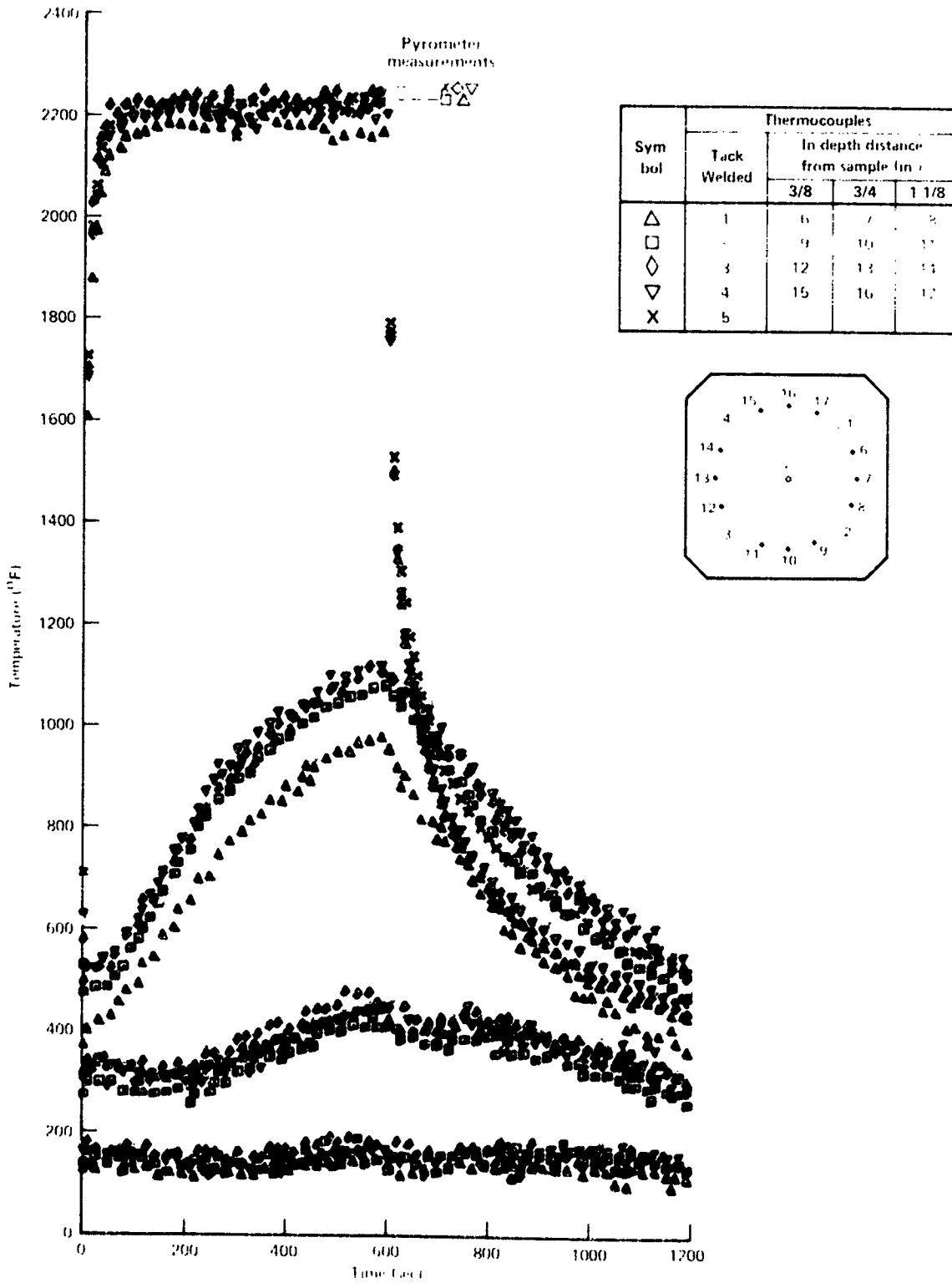


Fig. B-19 Typical temperature histories for TAL-1 sample (cycle 75)

GP73 0587-77

APPENDIX B: MODEL TEMPERATURE HISTORIES

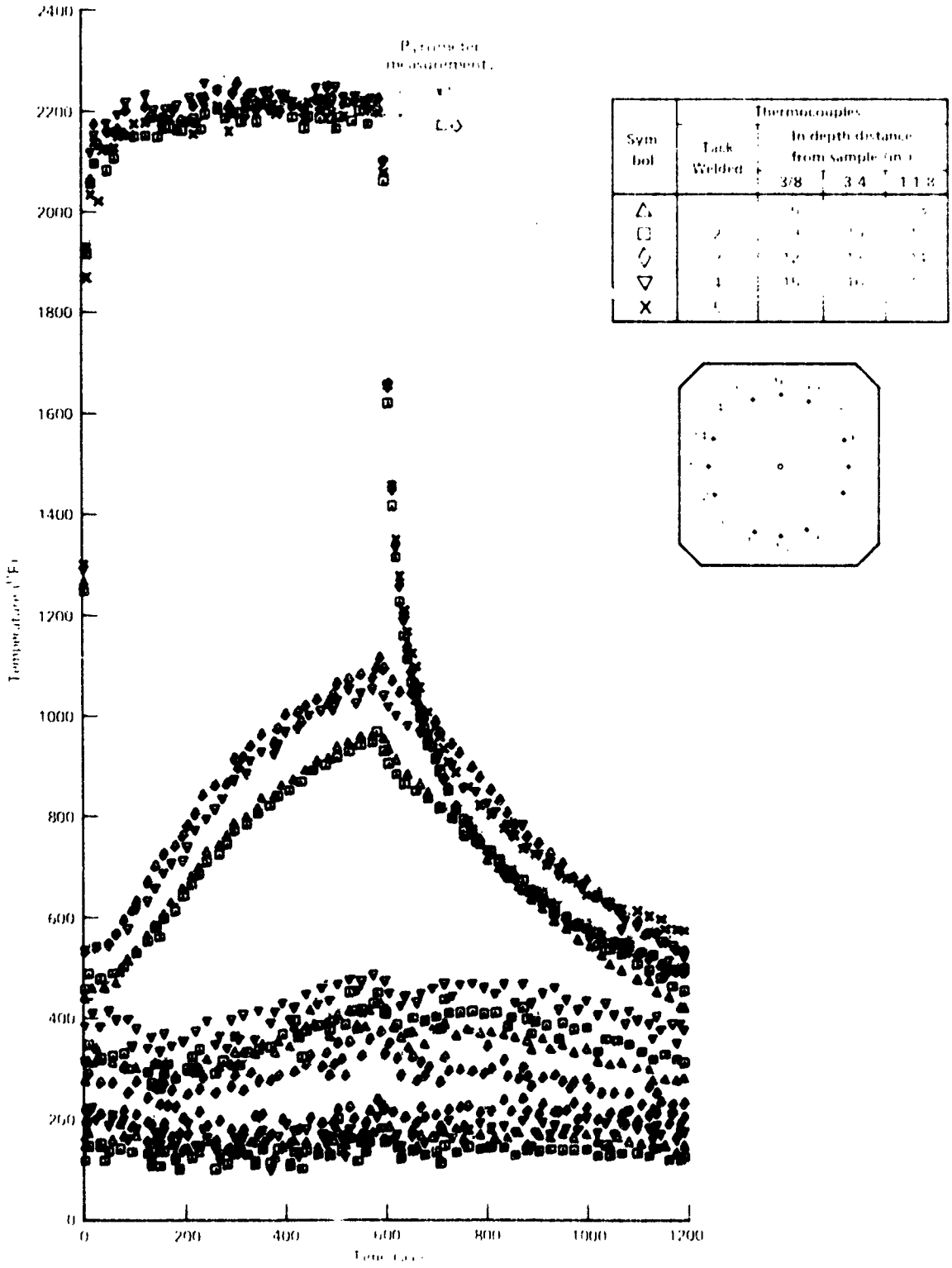


Fig. B-21 Typical temperature histories for TAL-2 sample (cycle 25)

GP73 0587 70

APPENDIX B: MODEL TEMPERATURE HISTORIES

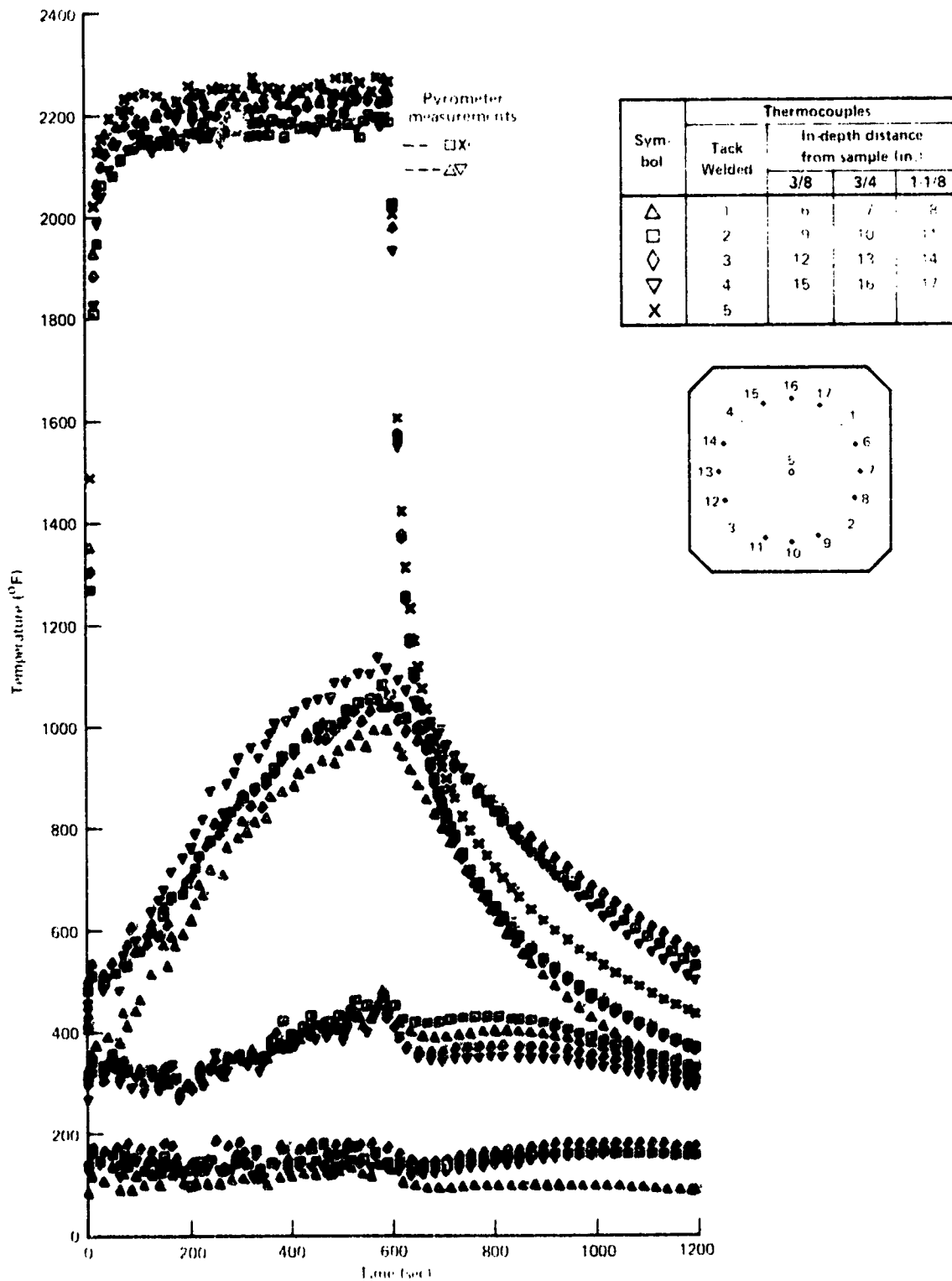


Fig. B-20 Typical temperature histories for TAL-1 sample (cycle 100)

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APPENDIX B. MODEL TEMPERATURE HISTORIES

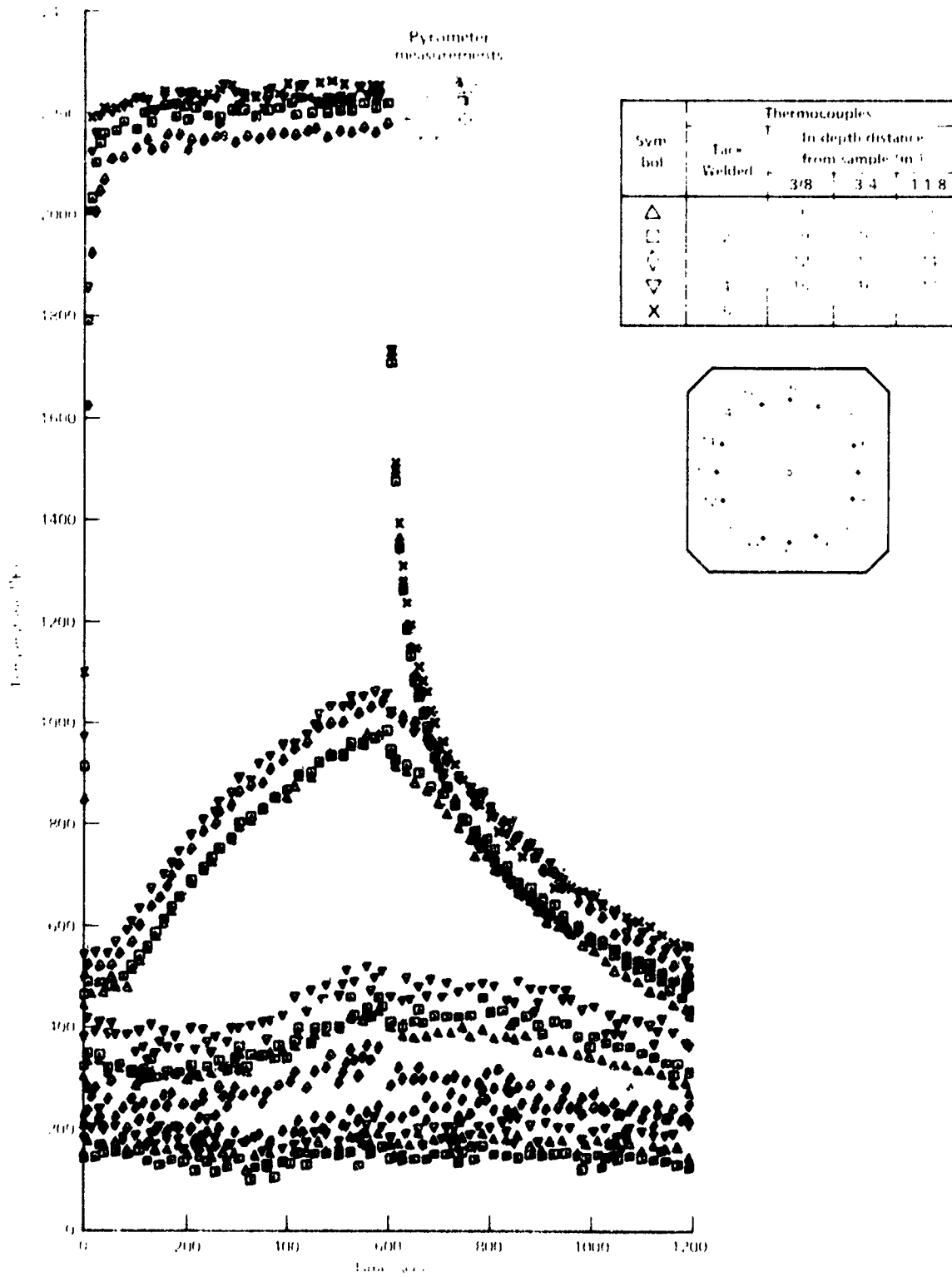


Fig. B-22 Typical temperature histories for TAL-2 sample (cycle 50)

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APPENDIX B: MODEL TEMPERATURE HISTORIES

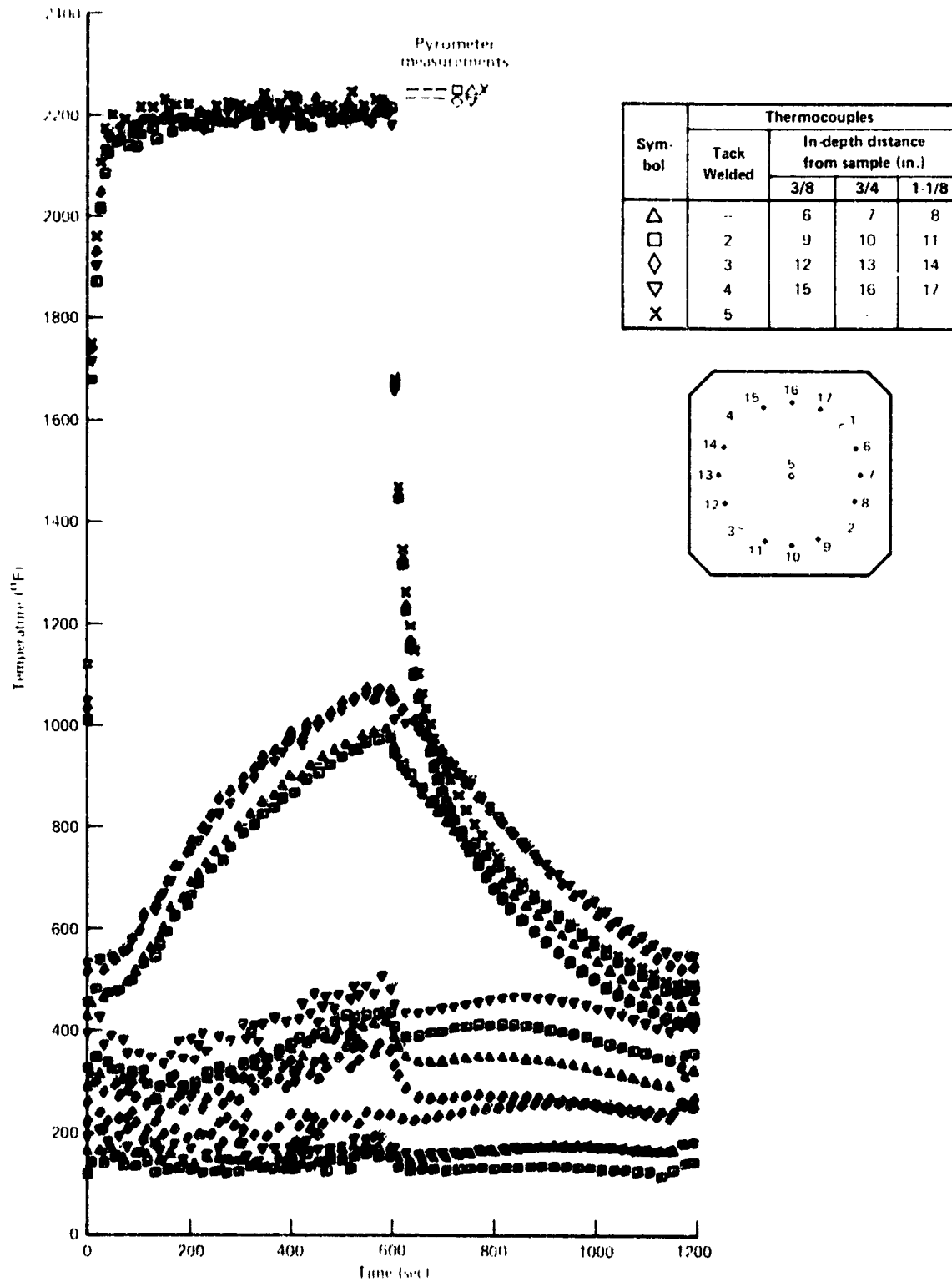


Fig. B-23 Typical temperature histories for TAL-2 sample (cycle 75)

GP73 0587 81

APPENDIX B: MODEL TEMPERATURE HISTORIES

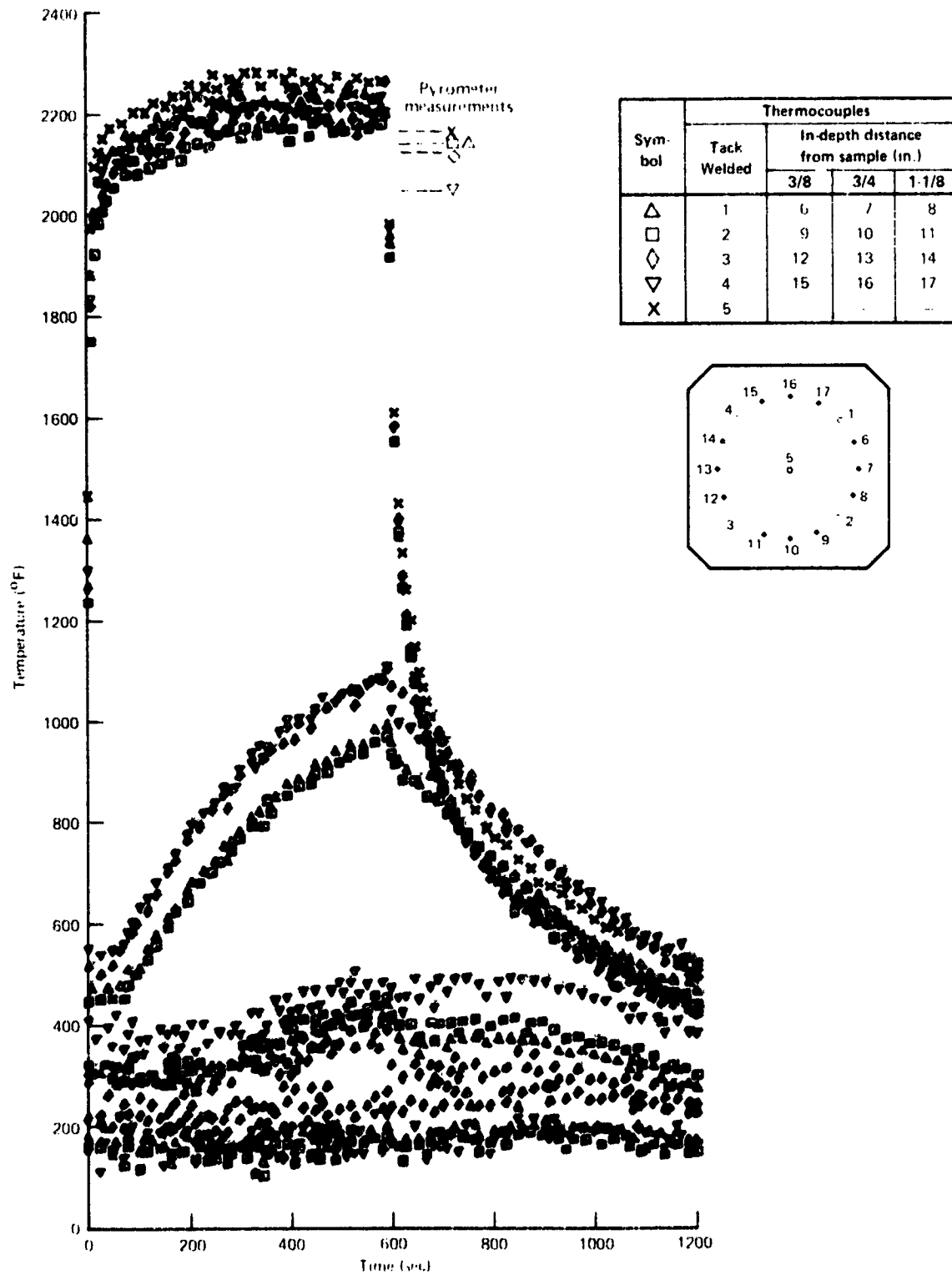


Fig. B-24 Typical temperature histories for TAL-2 sample (cycle 100)

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APPENDIX B MODEL TEMPERATURE HISTORIES

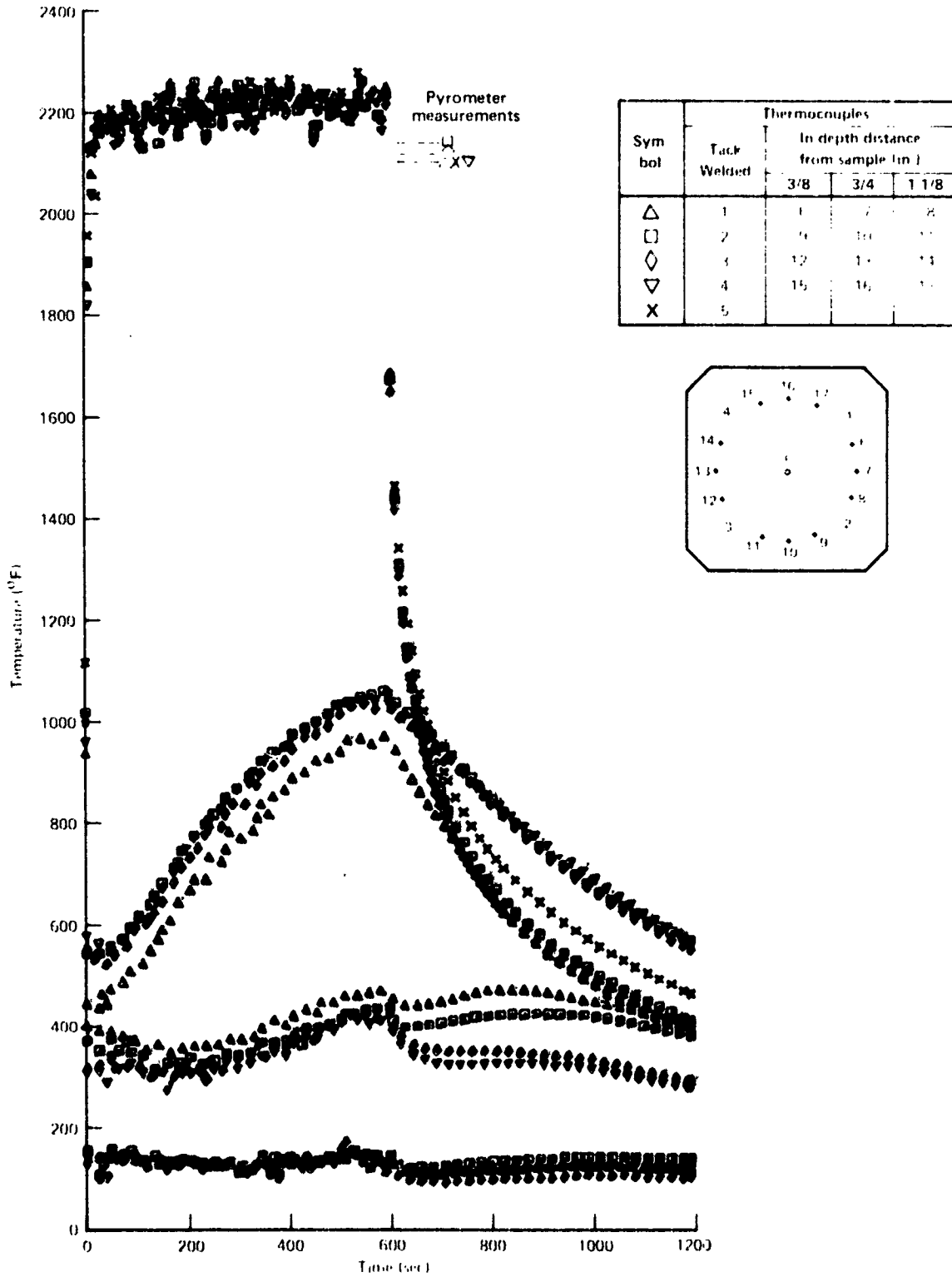


Fig. B-25 Typical temperature histories for TY-1 sample (cycle 25)

GP 73-0587-83

APPENDIX B: MODEL TEMPERATURE HISTORIES

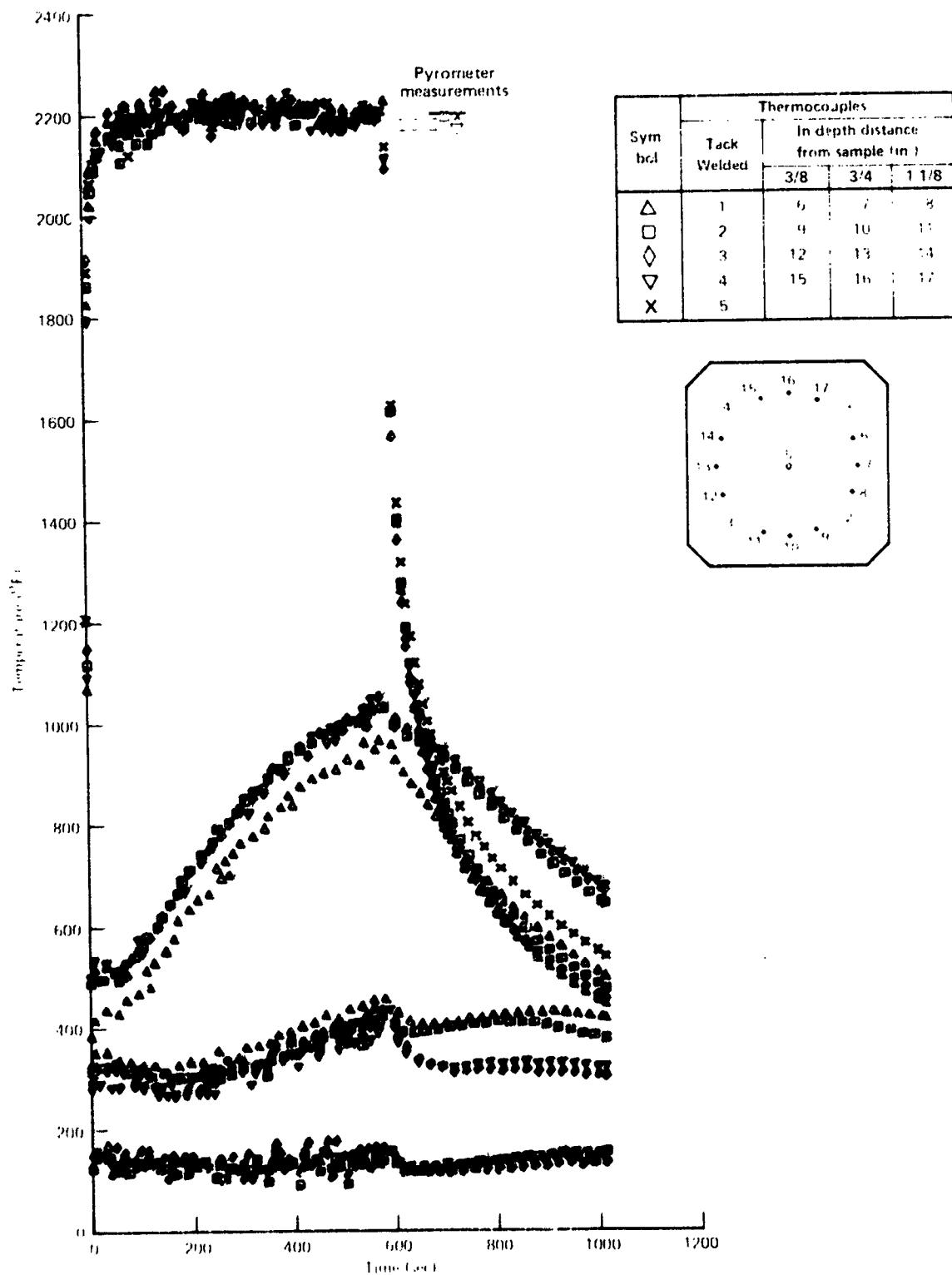


Fig. B-26 Typical temperature histories for TY-1 sample (cycle 50)

GP/JJ 05R7 84

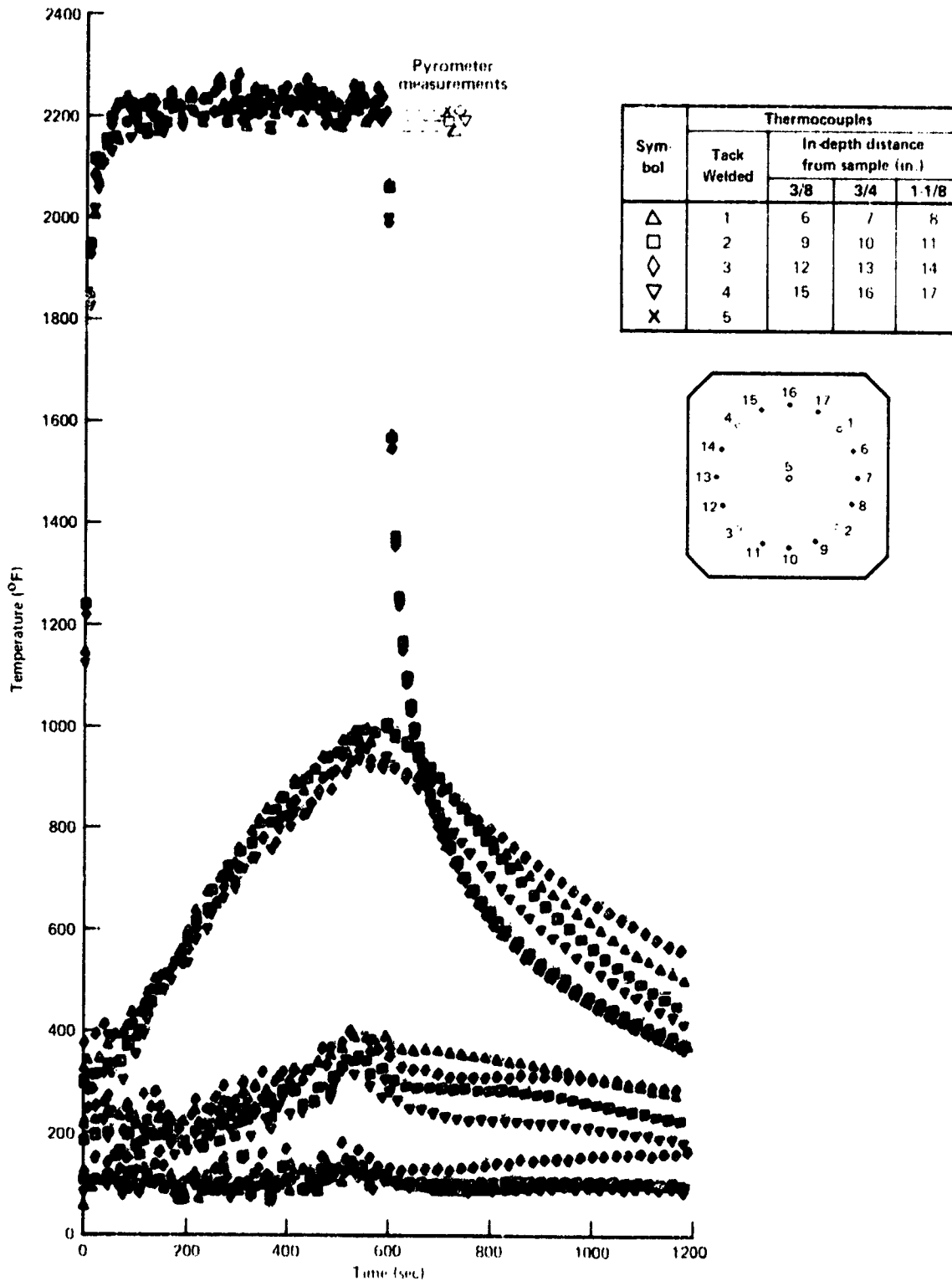


Fig. B-27 Typical temperature histories for TY-1 sample (cycle 75)

GP 73 058 185

APPENDIX B: MODEL TEMPERATURE HISTORIES

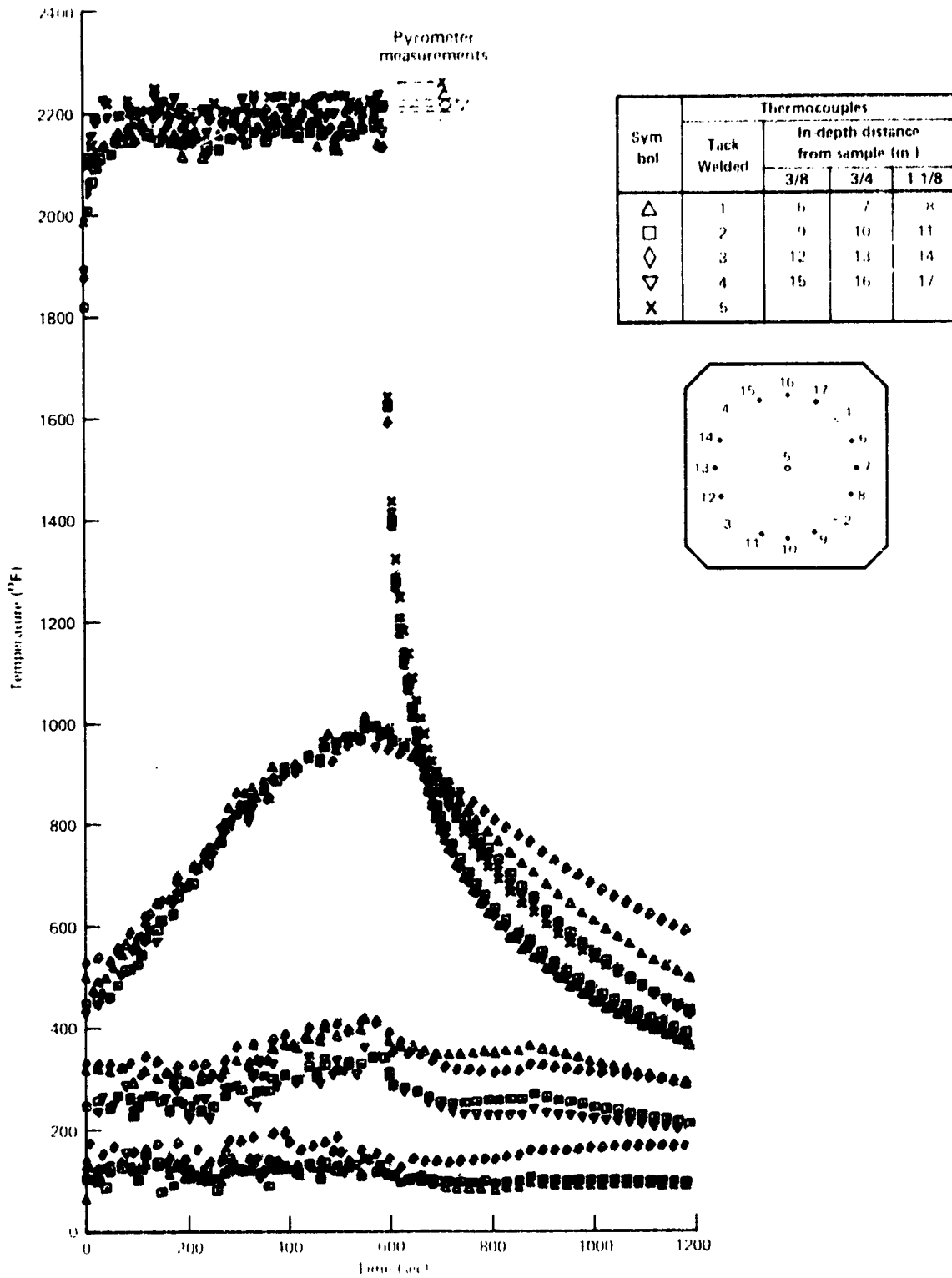


Fig. B-28 Typical temperature histories for TY-1 sample (cycle 100)

GPL 00 80 05

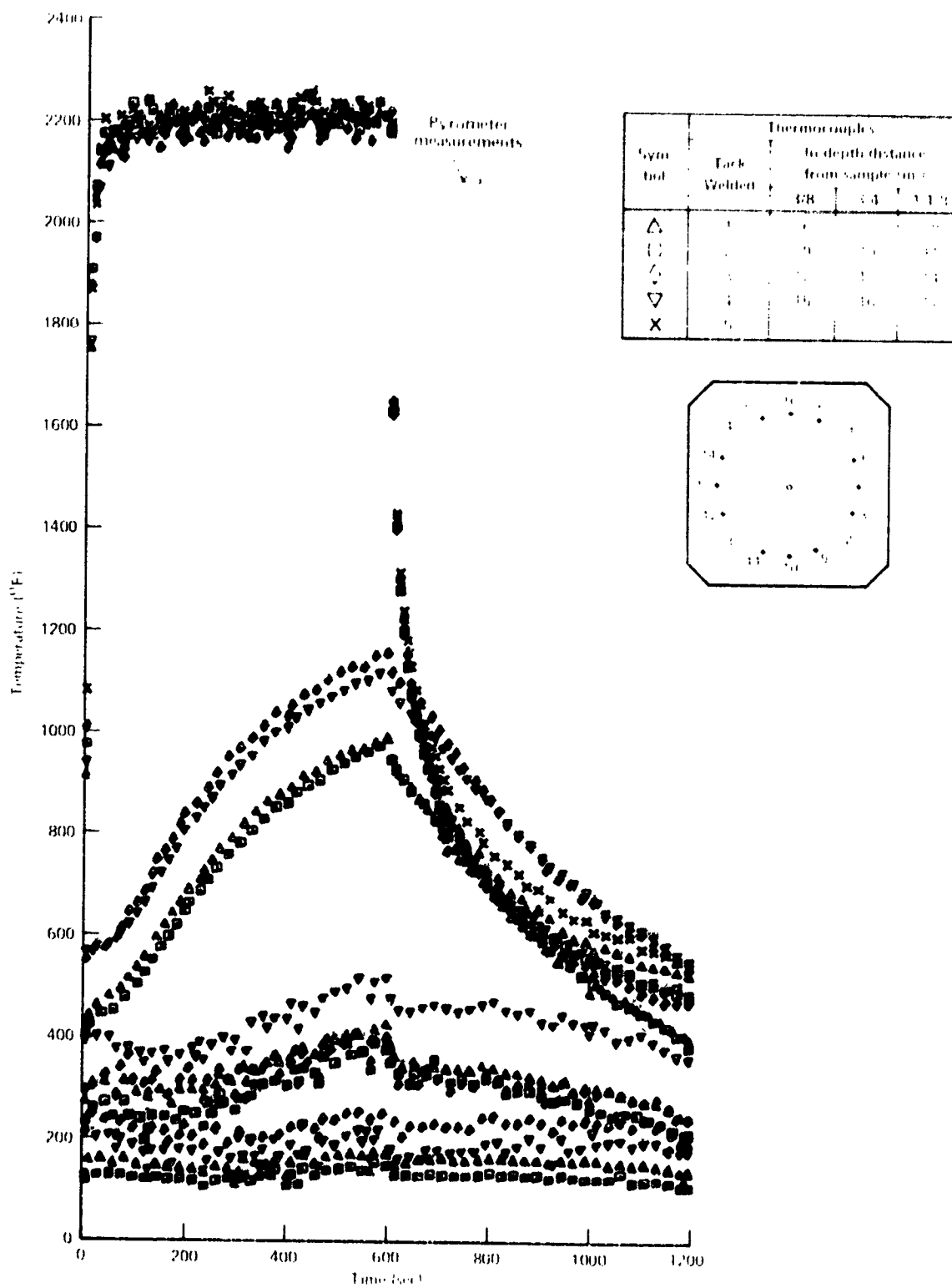


Fig. B-29 Typical temperature histories for TY-2 sample (cycle 25)

GP7A 0587 07

APPENDIX B: MODEL TEMPERATURE HISTORIES

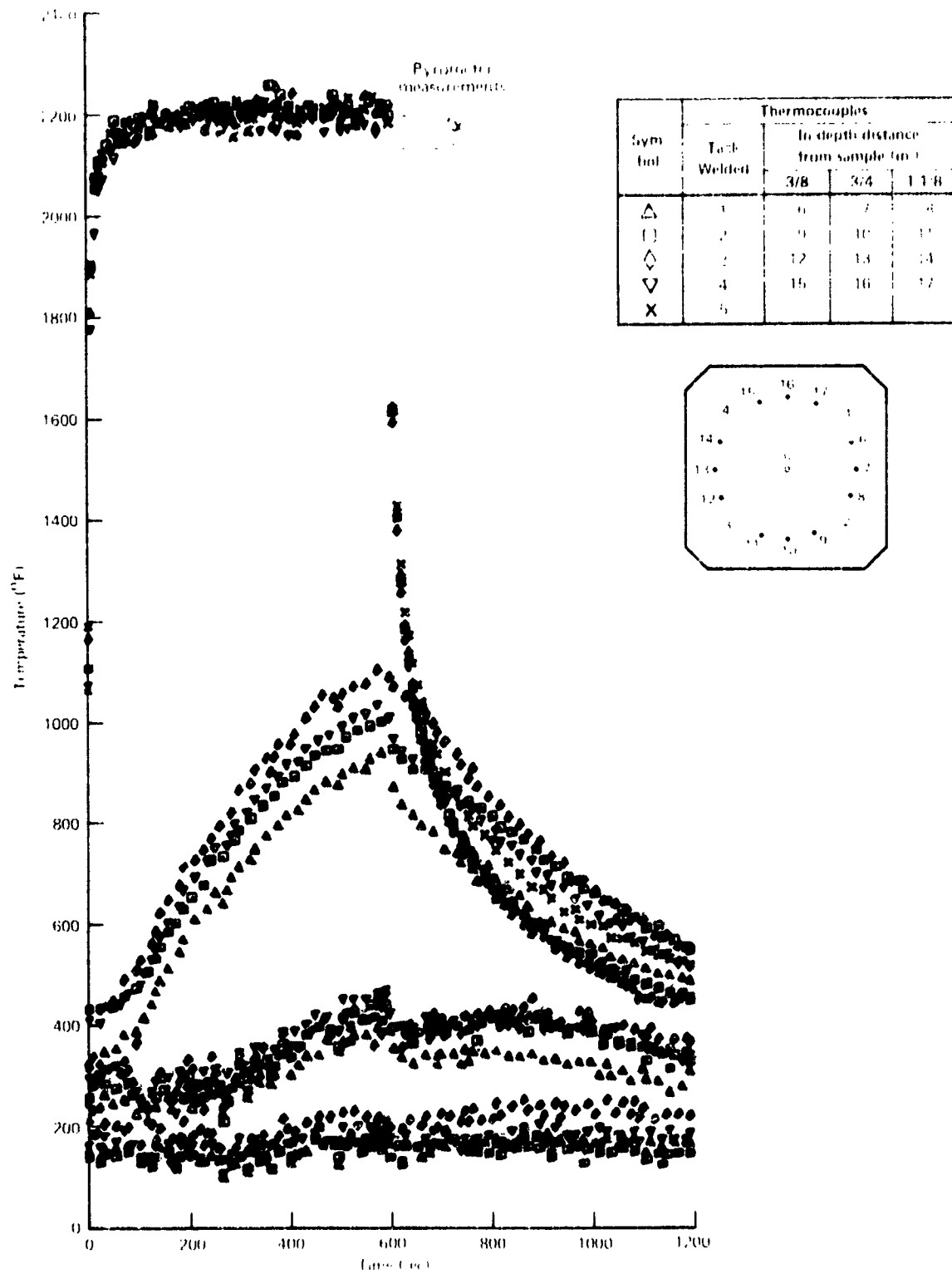


Fig. B-30 Typical temperature histories for TY-2 sample (cycle 50)

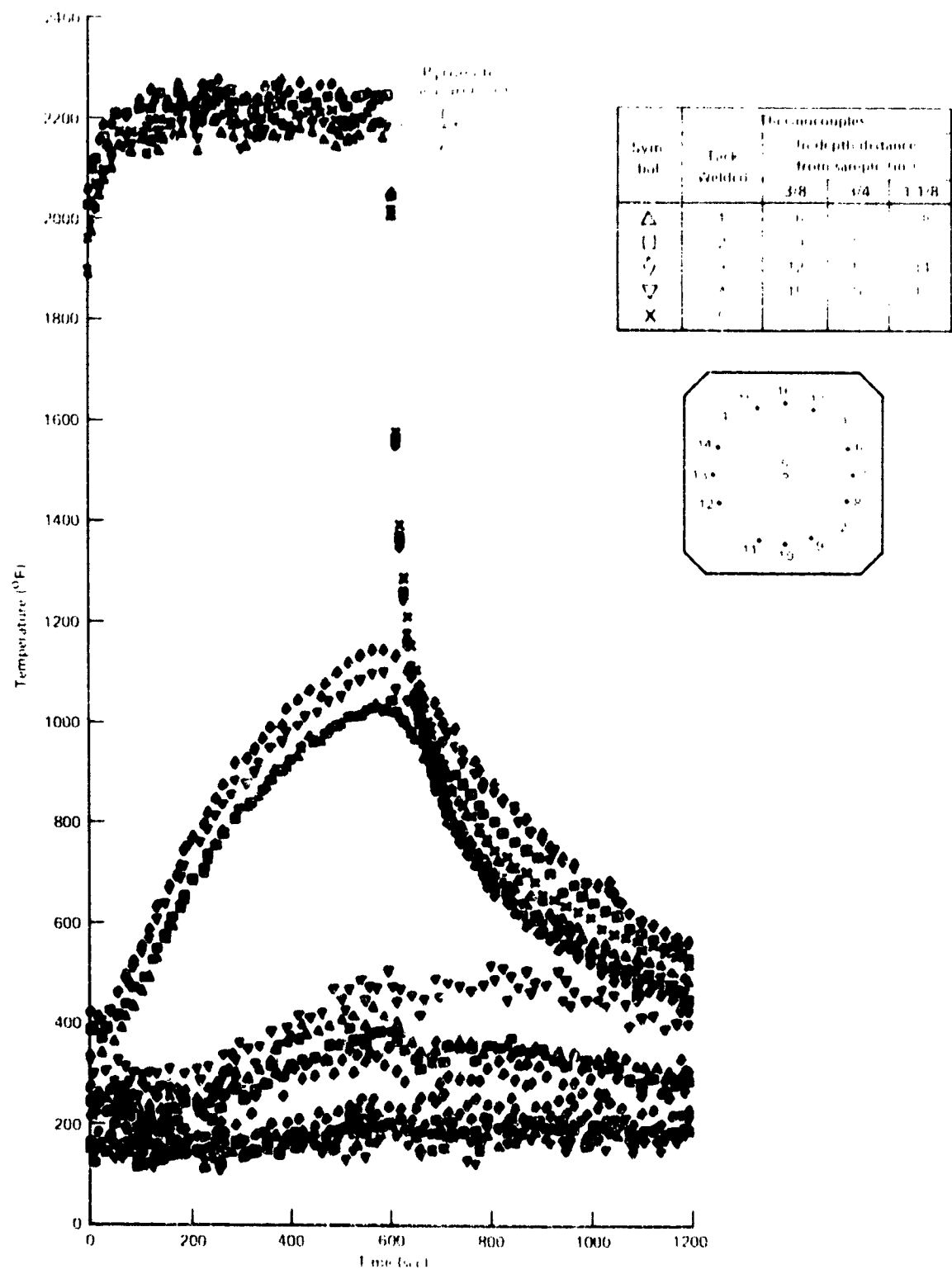


Fig. B-31 Typical temperature histories for TY-2 sample (cycle 75)

APPENDIX B MODEL TEMPERATURE HISTORIES

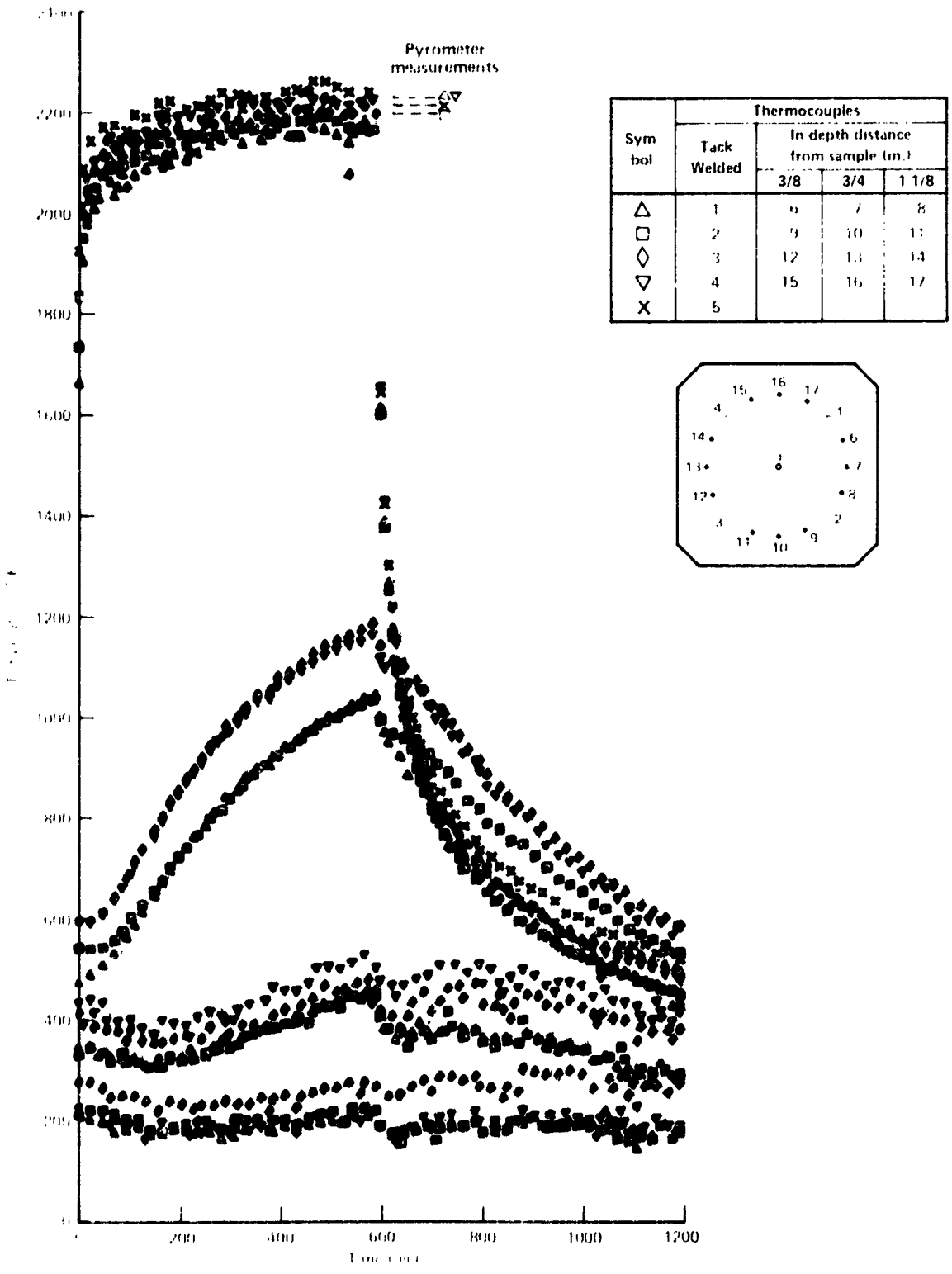


Fig. B-32 Typical temperature histories for TY-2 sample (cycle 100)

GP73 0587 00

APPENDIX B: MODEL TEMPERATURE HISTORIES

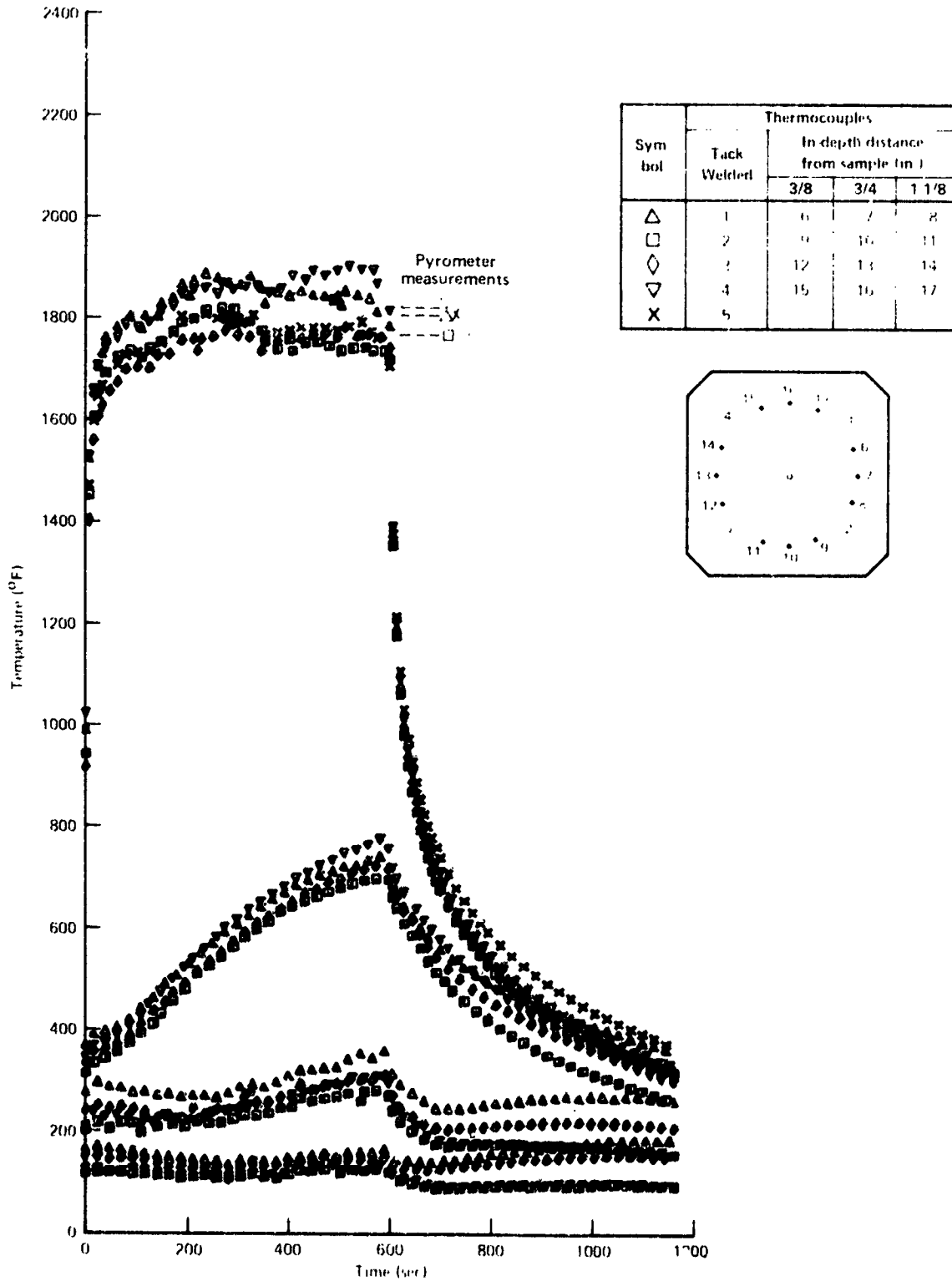


Fig. B-33 Typical temperature histories for HS-1 sample (cycle 25)

GP7.1-0587-91

APPENDIX B: MODEL TEMPERATURE HISTORIES

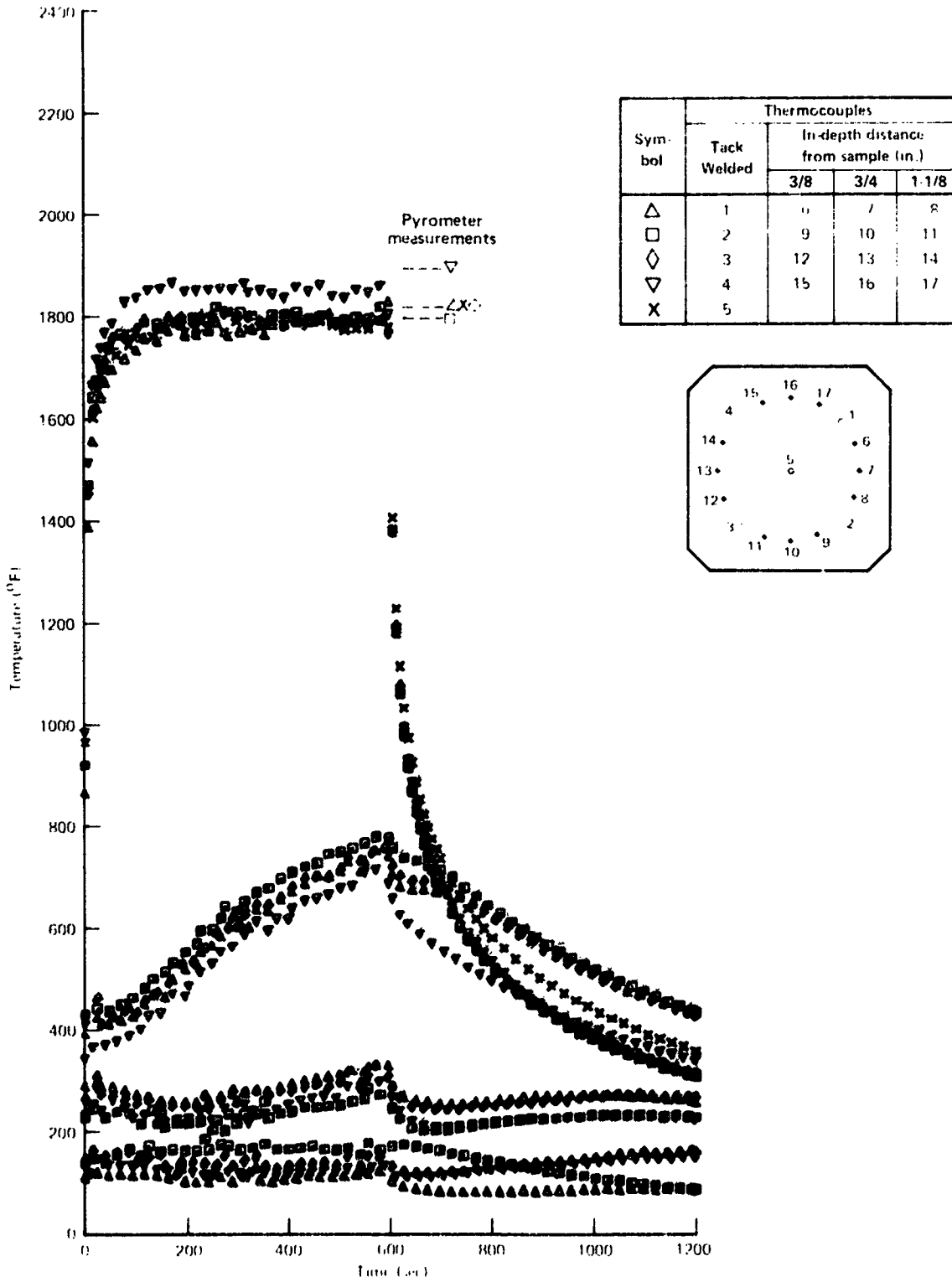


Fig. B-34 Typical temperature histories for HS-1 sample (cycle 50)

GP 73 0547 92

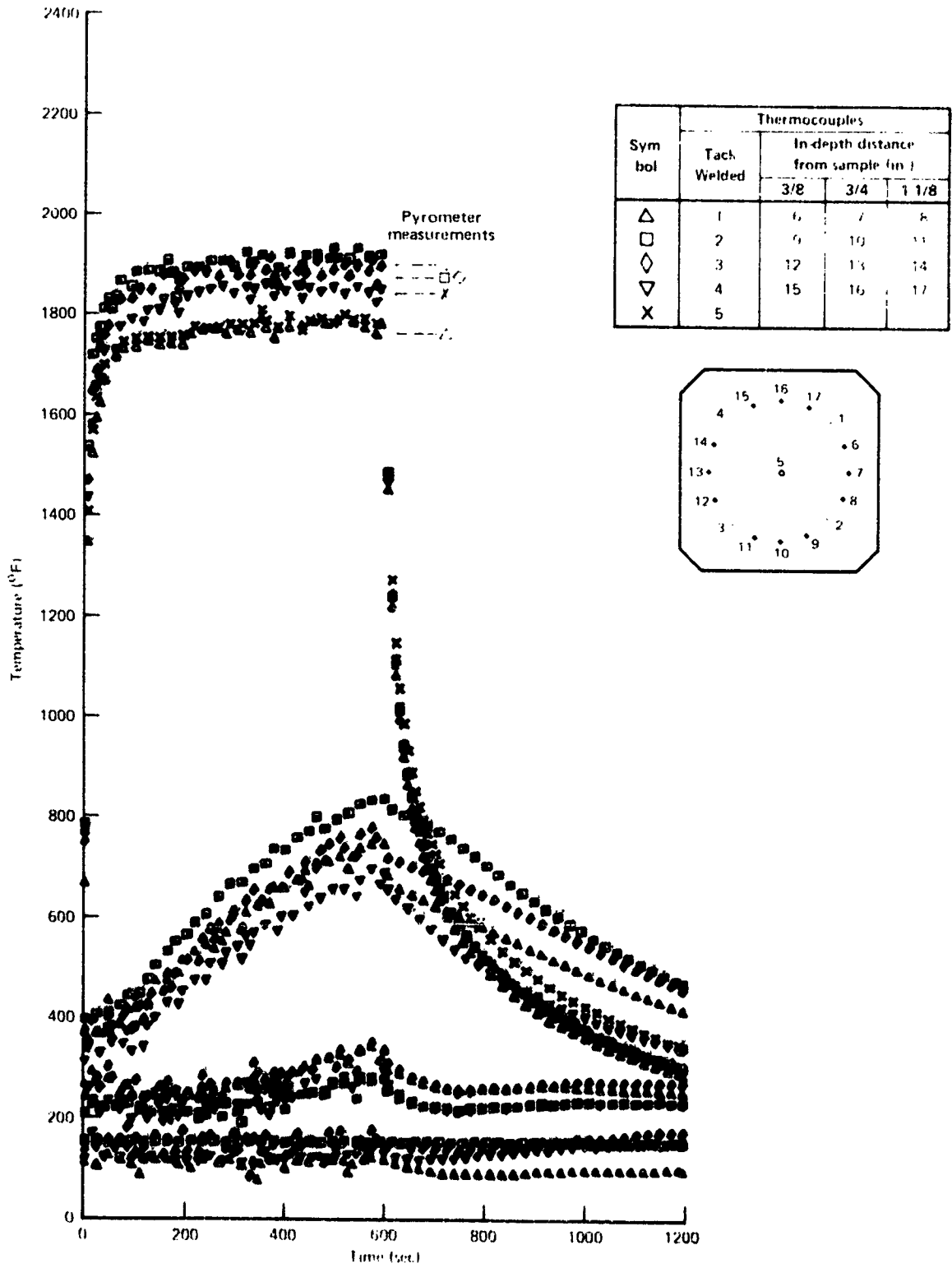


Fig. B-35 Typical temperature histories for HS-1 sample (cycle 75)

GP73-0587-93

APPENDIX B: MODEL TEMPERATURE HISTORIES

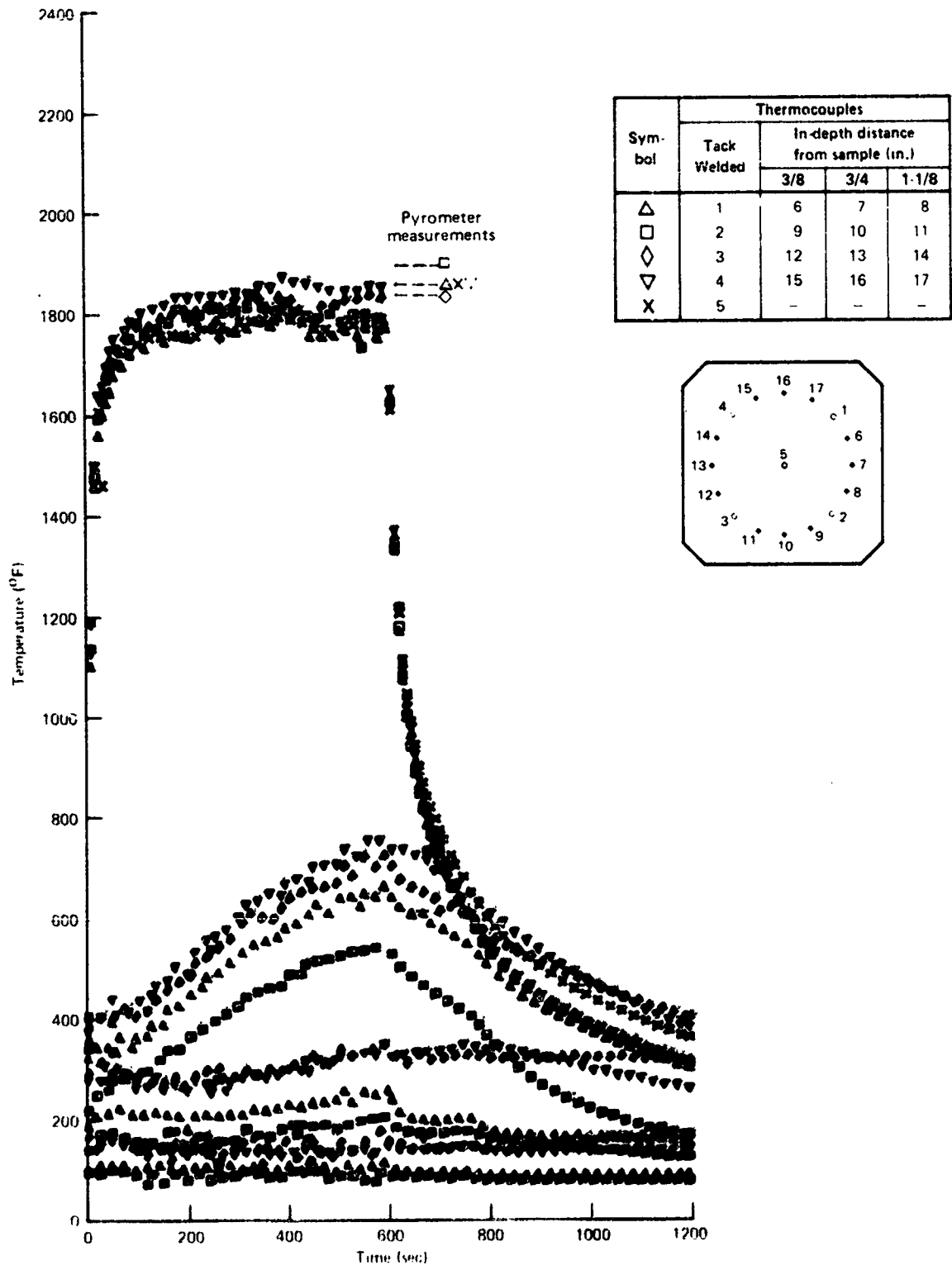


Fig. B-36 Typical temperature histories for HS-1 sample (cycle 100)

GP 73-0587-14

APPENDIX B: MODEL TEMPERATURE HISTORIES

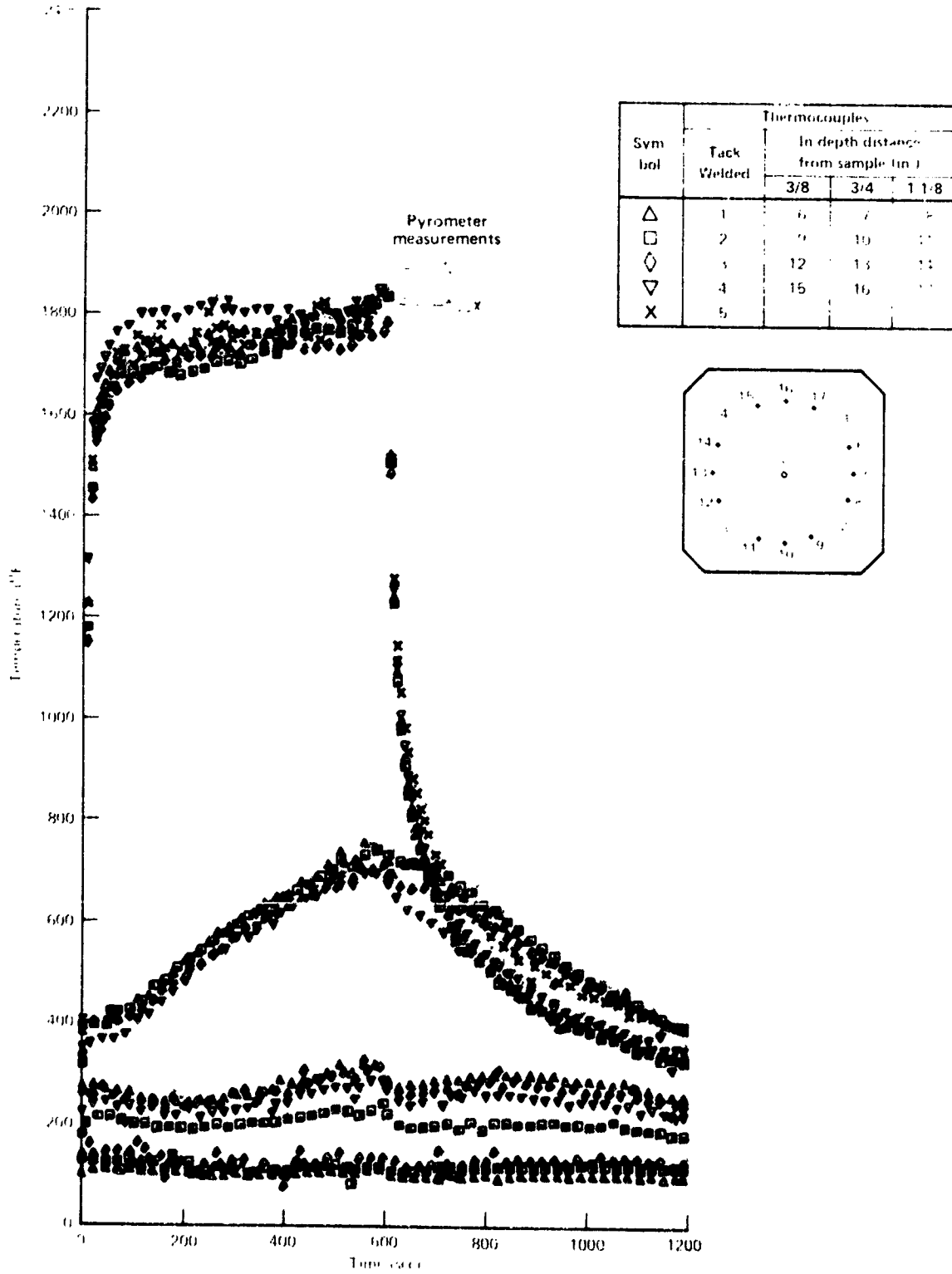


Fig. B-37 Typical temperature histories for HS-2 sample (cycle 25)

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APPENDIX B: MODEL TEMPERATURE HISTORIES

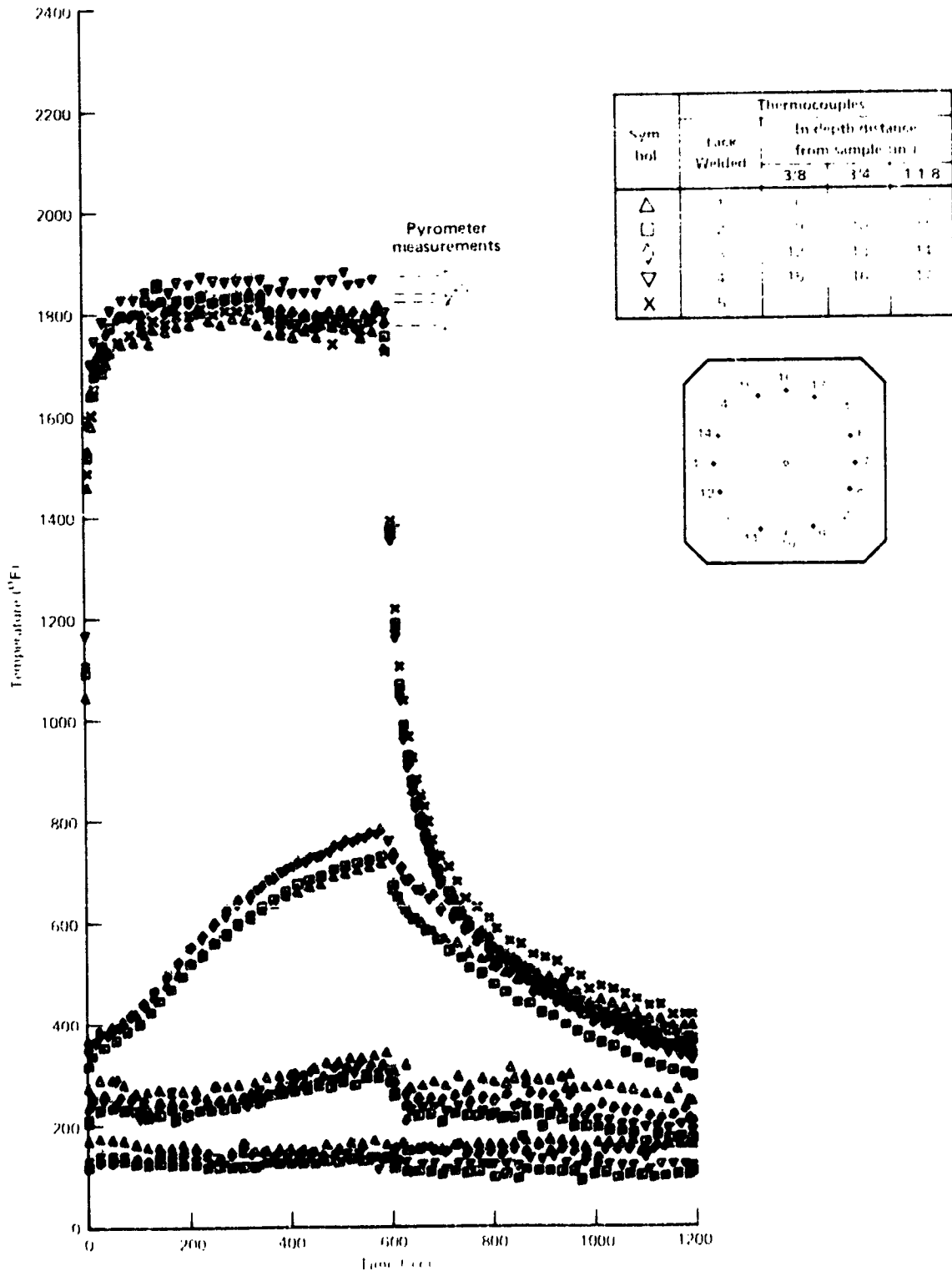


Fig. B-38 Typical temperature histories for HS-2 sample (cycle 50)

GP73 0587 96

APPENDIX B: MODEL TEMPERATURE HISTORIES

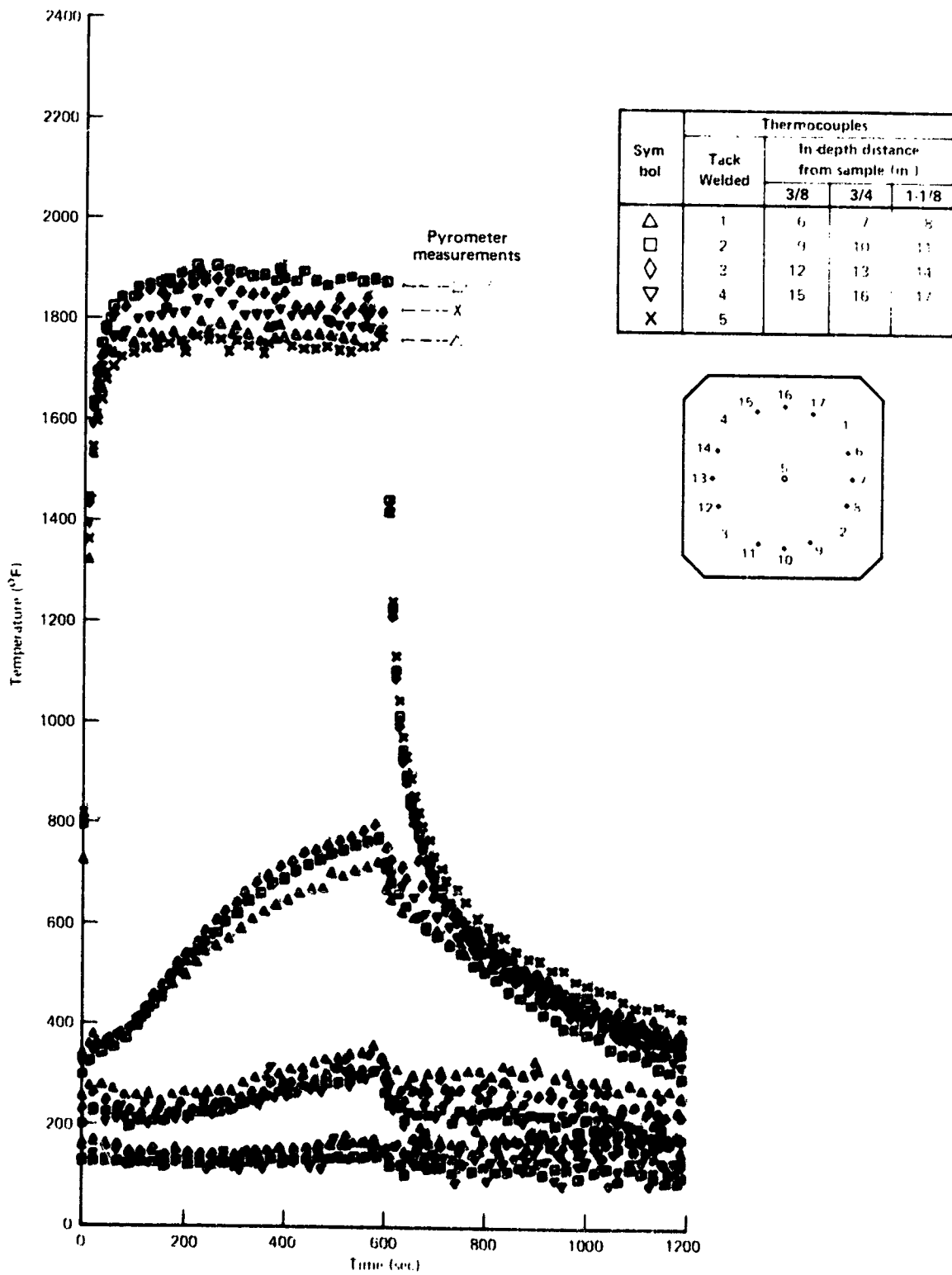


Fig. B-39 Typical temperature histories for HS-2 sample (cycle 75)

GP73 0587 97

APPENDIX B: MODEL TEMPERATURE HISTORIES

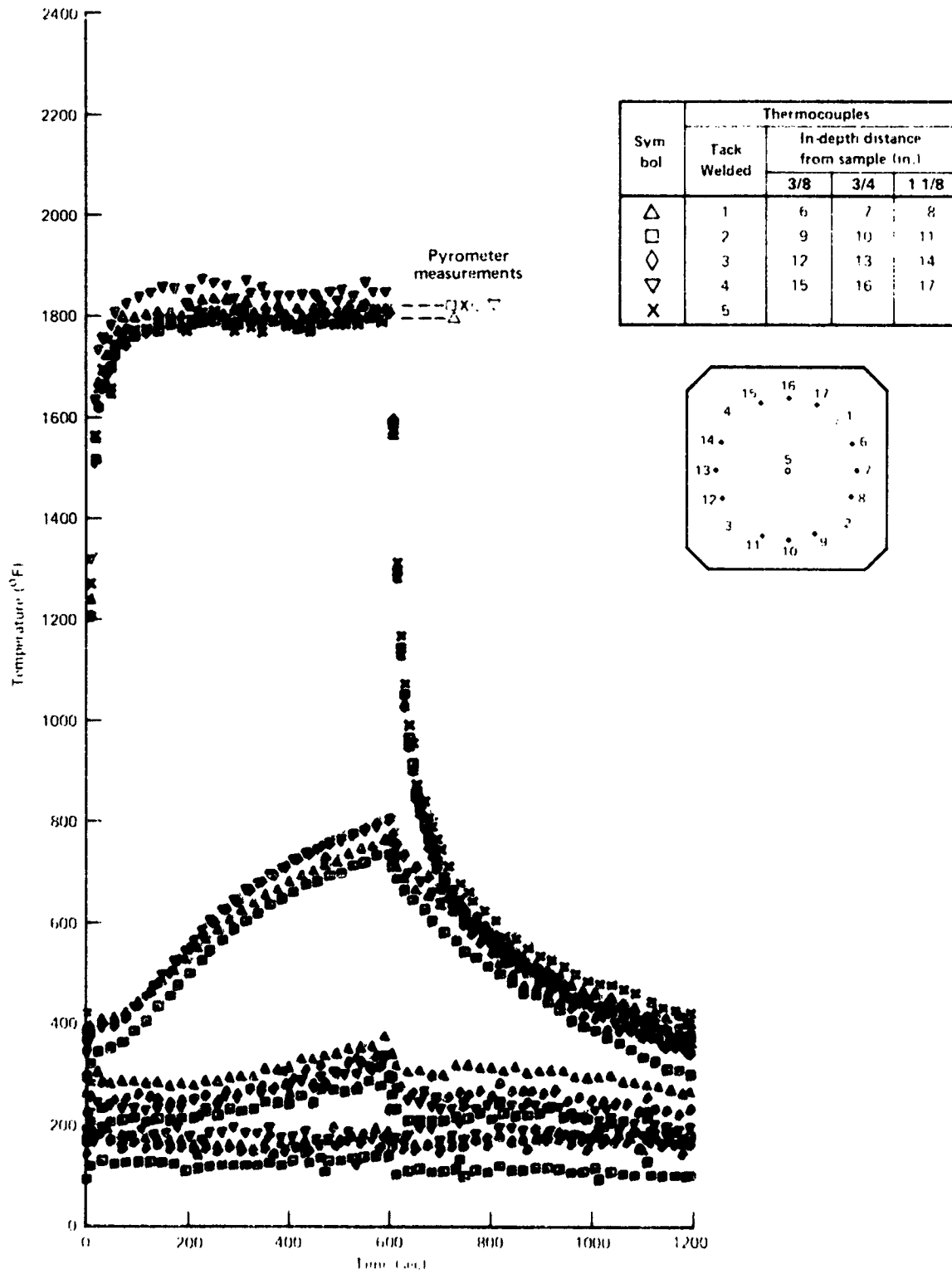


Fig. B-40 Typical temperature histories for HS-2 sample (cycle 100)

GP 105A-96

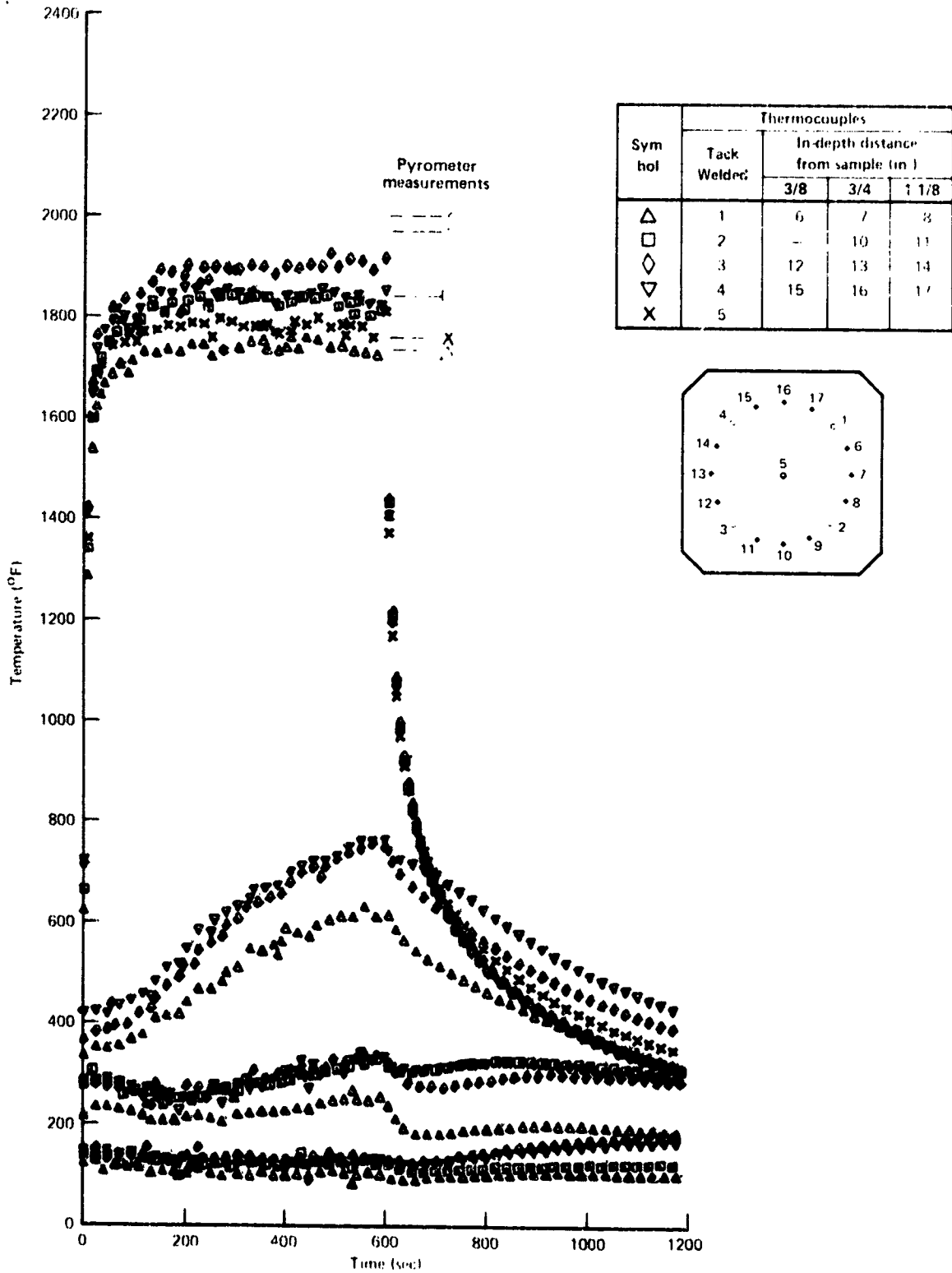


Fig. B-41 Typical temperature histories for X-1 sample (cycle 25)

GP 73-0587-09

APPENDIX B: MODEL TEMPERATURE HISTORIES

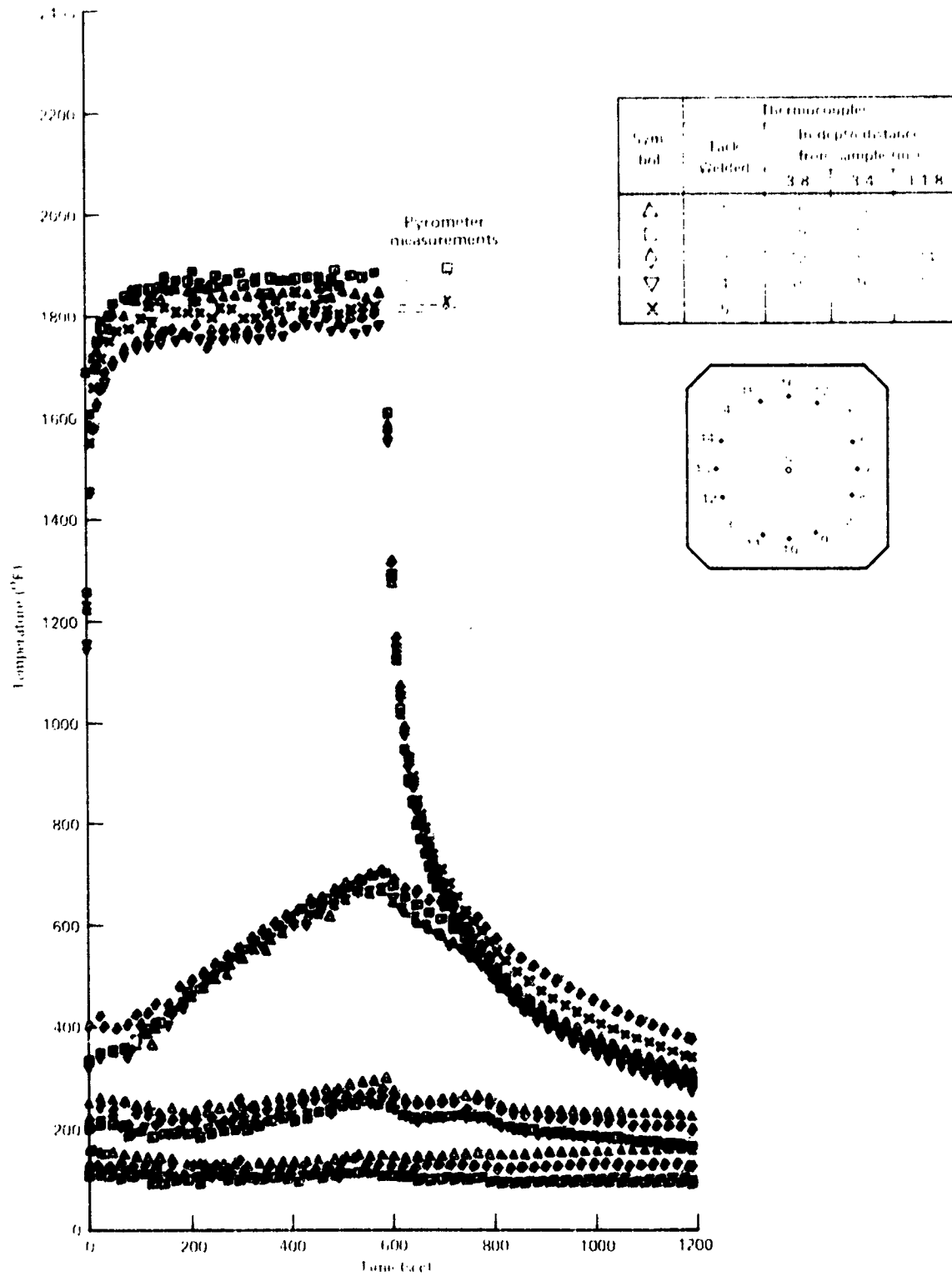


Fig. B-42 Typical temperature histories for X-1 sample (cycle 50)

GP/A 0587 100

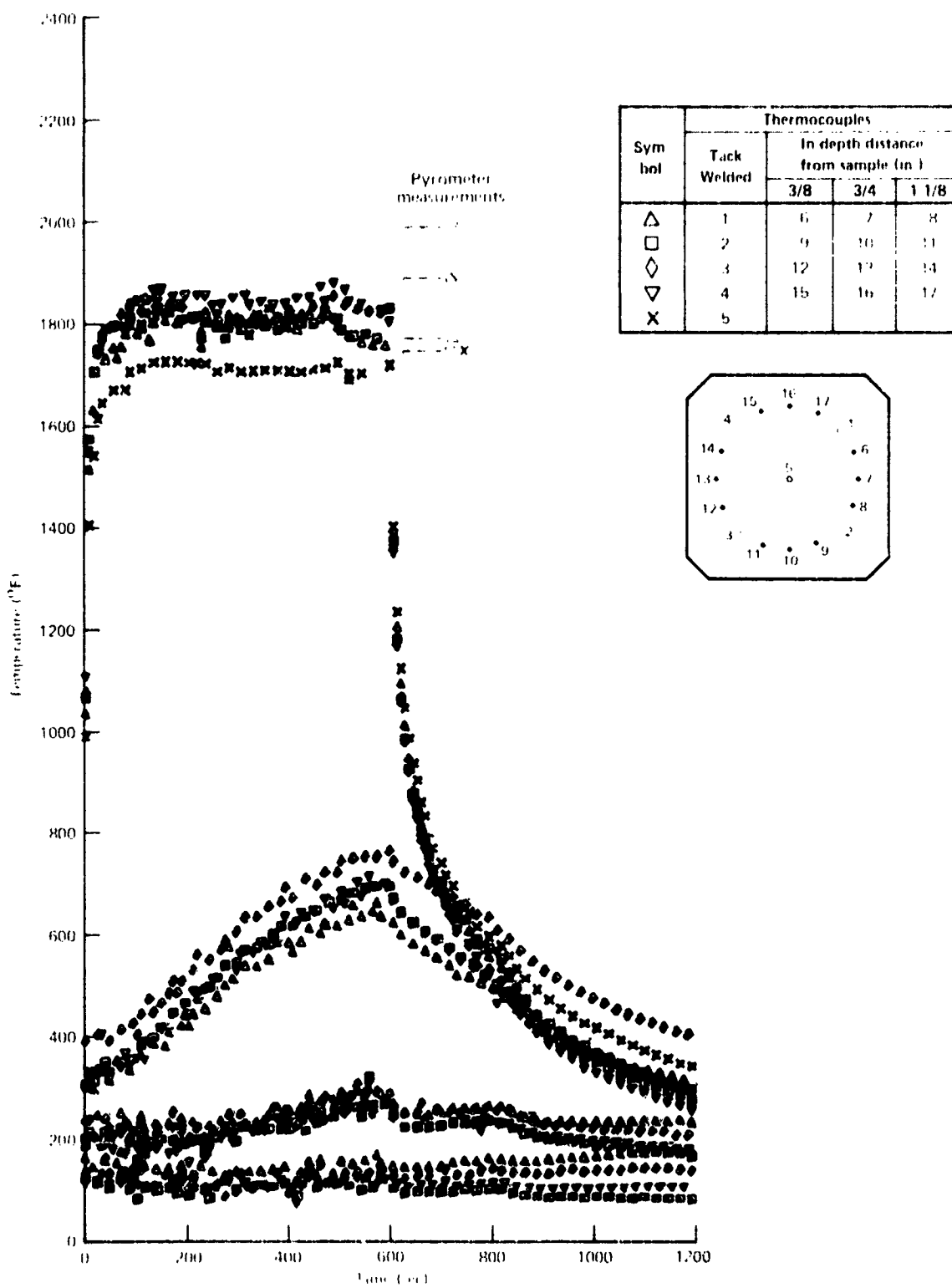


Fig. B-43 Typical temperature histories for X-1 sample (cycle 75)

0770-87-100

APPENDIX B: MODEL TEMPERATURE HISTORIES

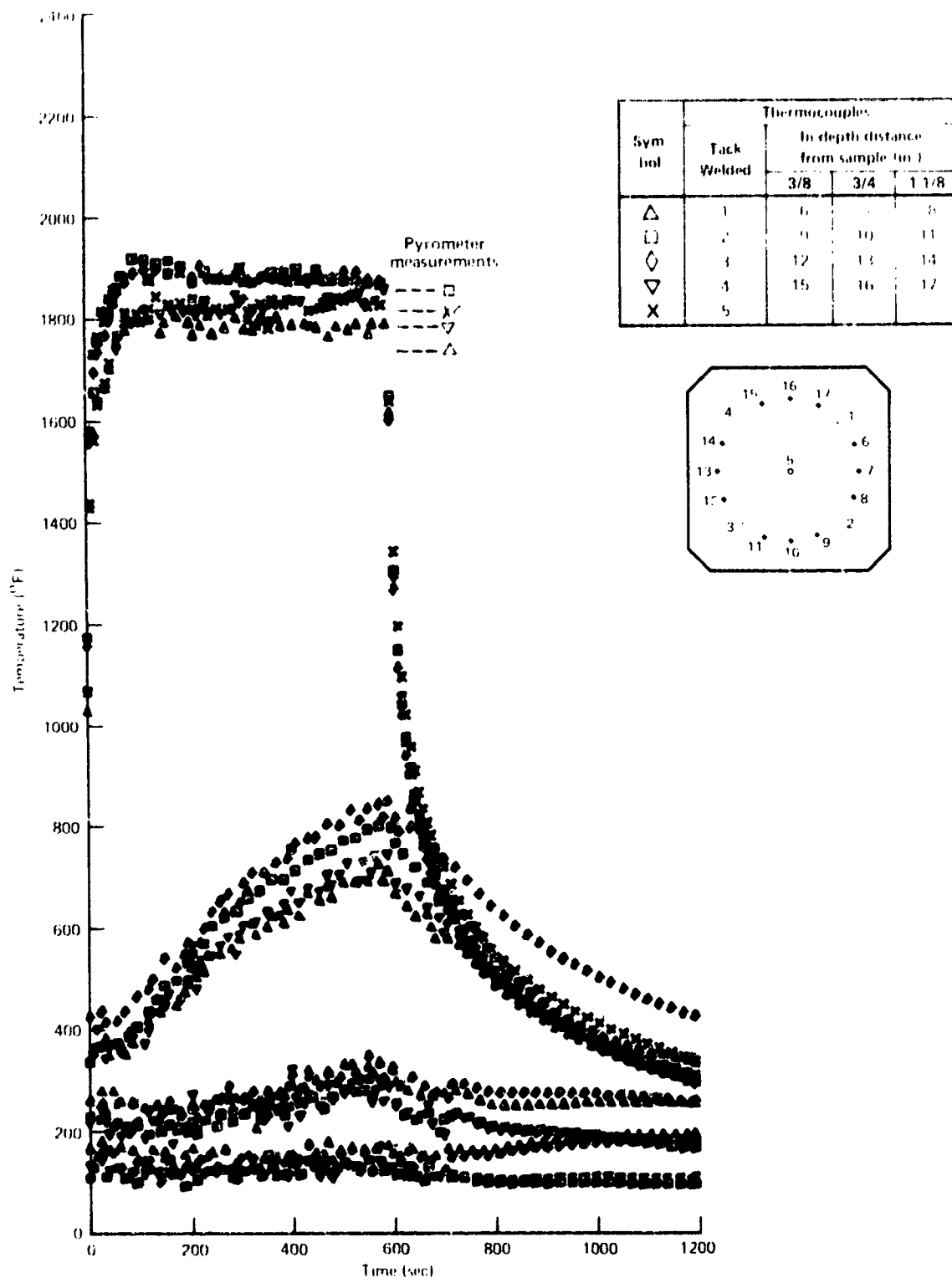


Fig. B-44 Typical temperature histories for X-1 sample (cycle 100)

GP 73 0587 102

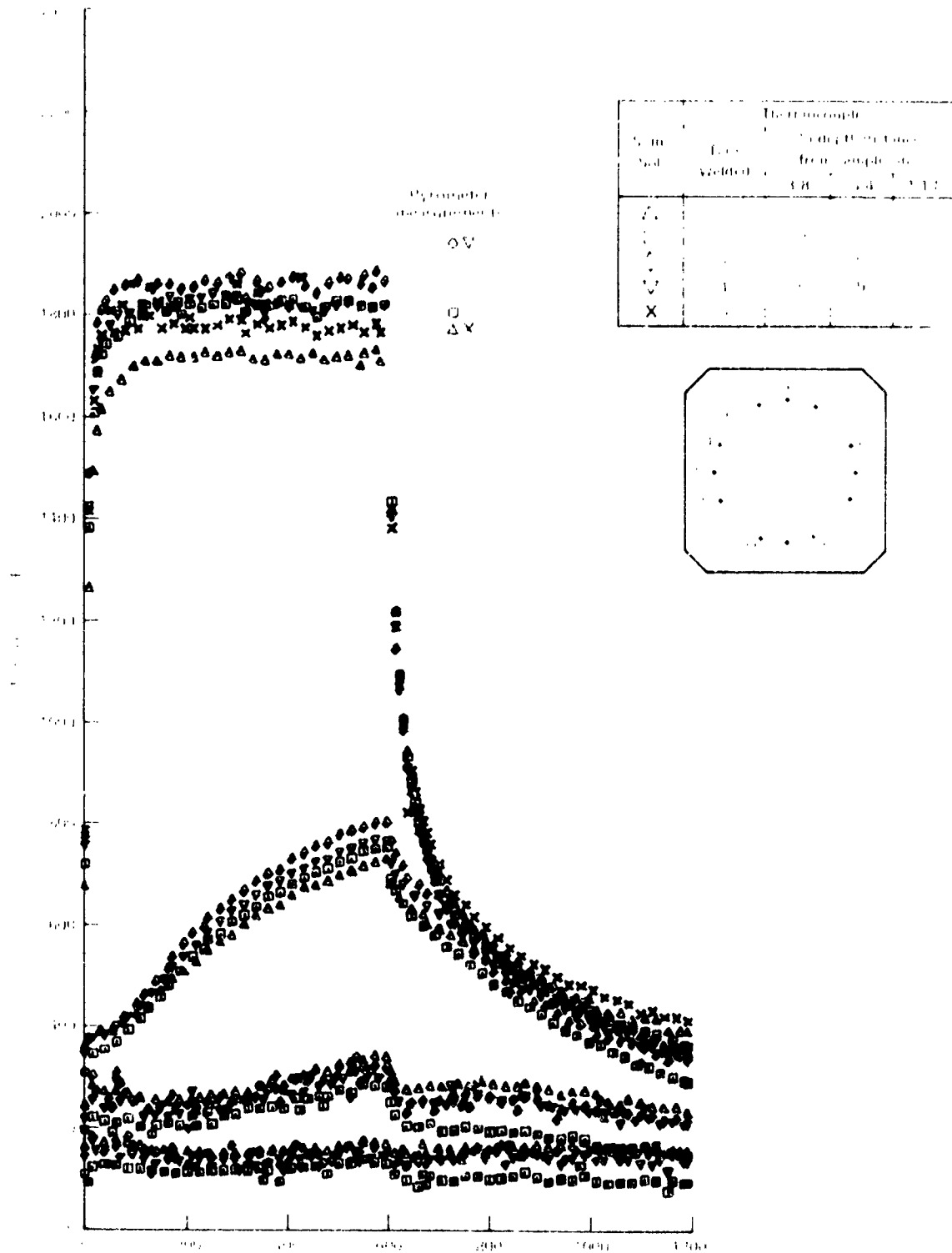


Fig. B-45 Typical temperature histories for X-2 sample (cycle 25)

APPENDIX B MODEL TEMPERATURE HISTORIES

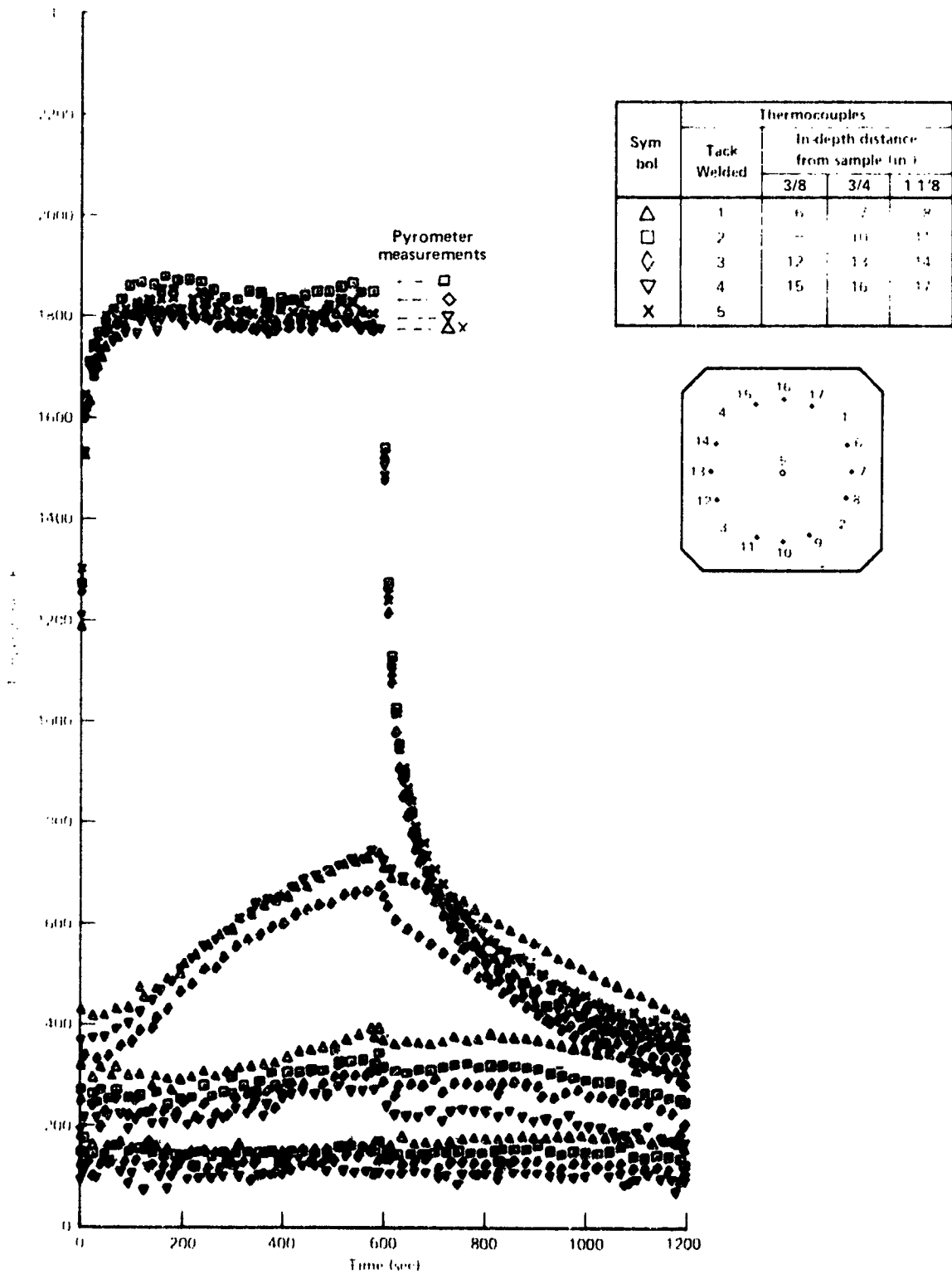


Fig. B-46 Typical temperature histories for X-2 sample (cycle 50)

GP73-0387 104

APPENDIX B: MODEL TEMPERATURE HISTORIES

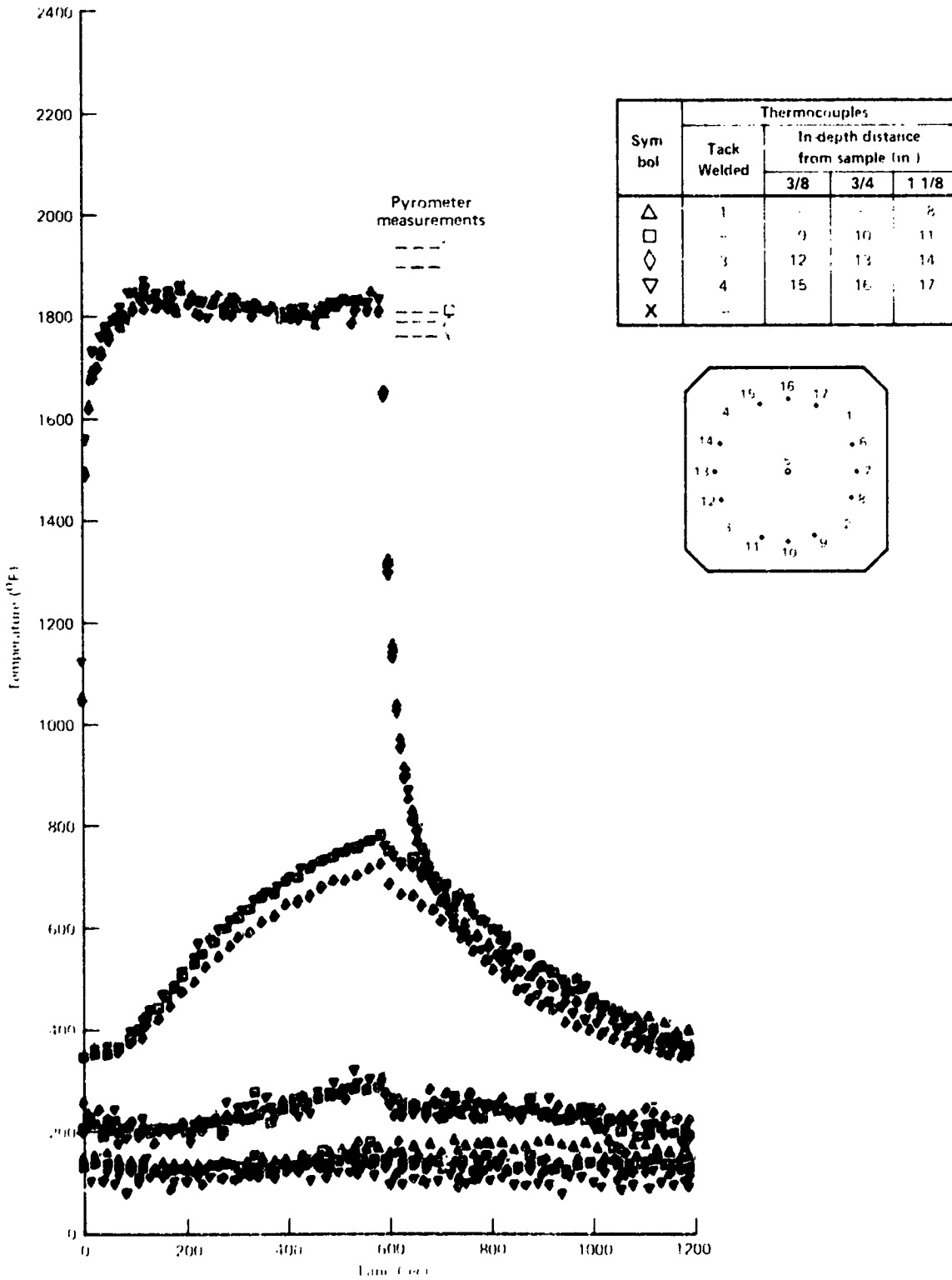


Fig. B-47 Typical temperature histories for X-2 sample (cycle 75)

GP73-0587 105

APPENDIX B: MODEL TEMPERATURE HISTORIES

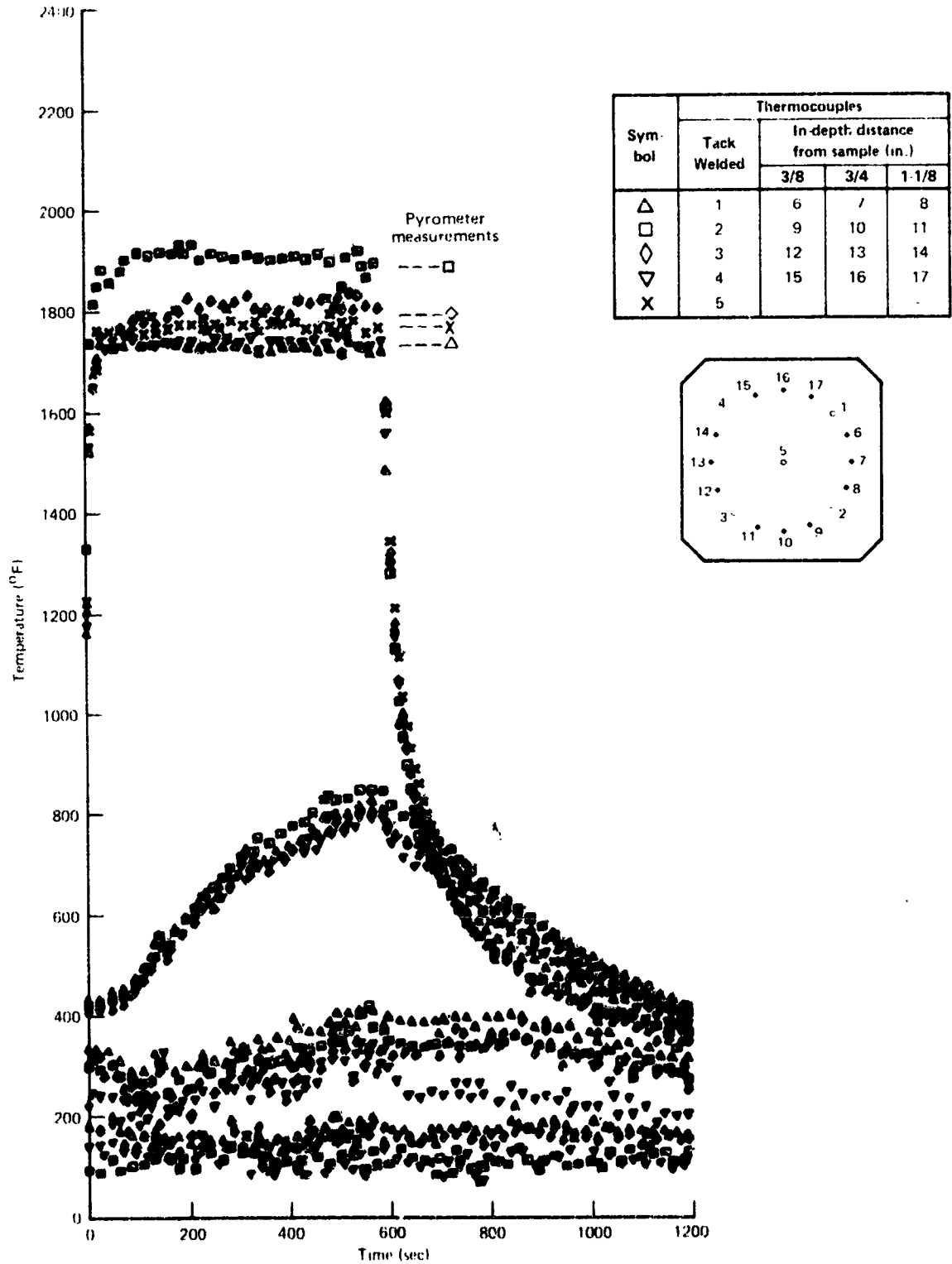


Fig. B-48 Typical temperature histories for X-2 sample (cycle 100)

GP73-0587-106

APPENDIX B: MODEL TEMPERATURE HISTORIES

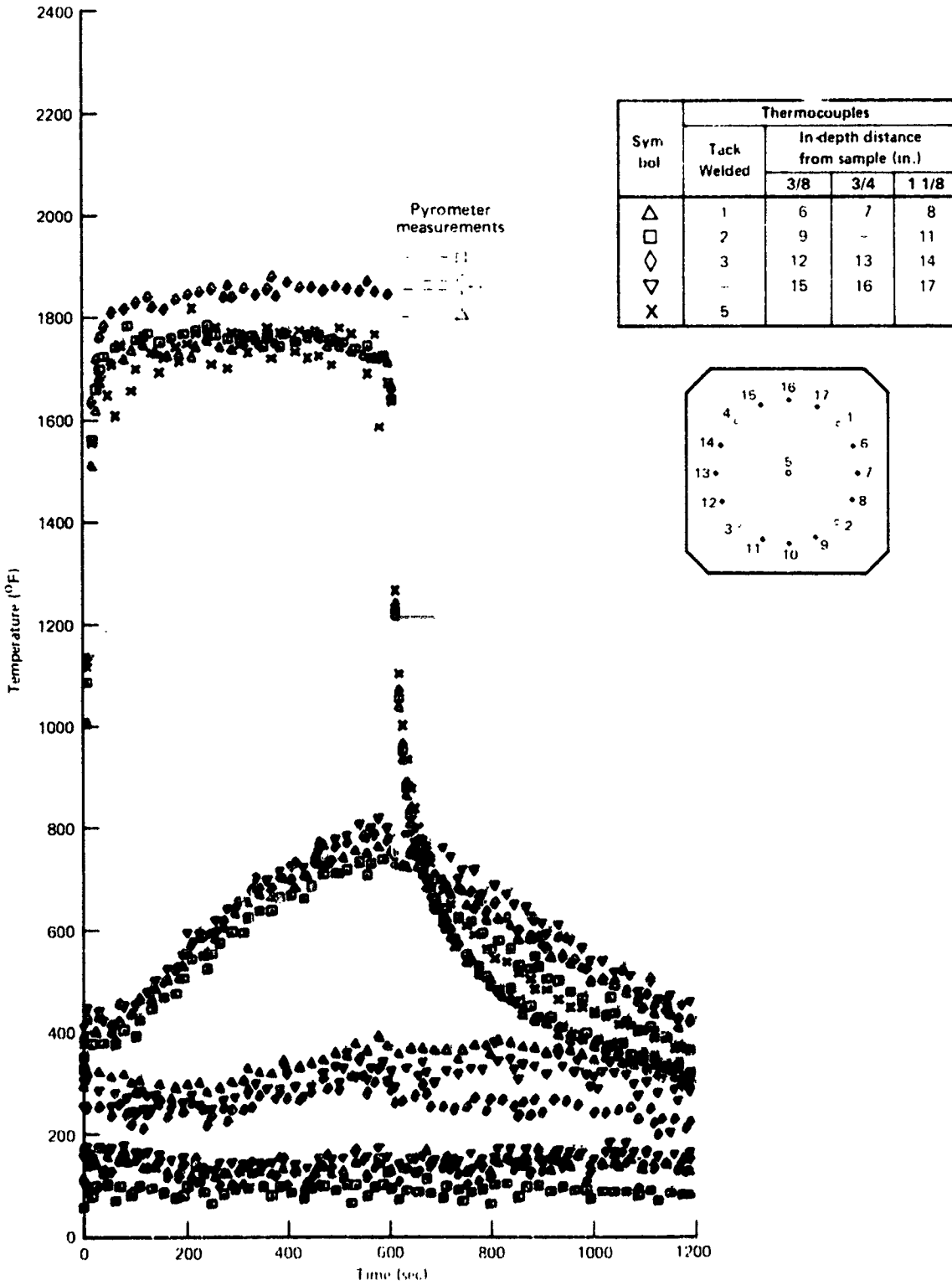


Fig. B-49 Typical temperature histories for TD-1 sample (cycle 22)

GP/10587-107

APPENDIX B: MODEL TEMPERATURE HISTORIES

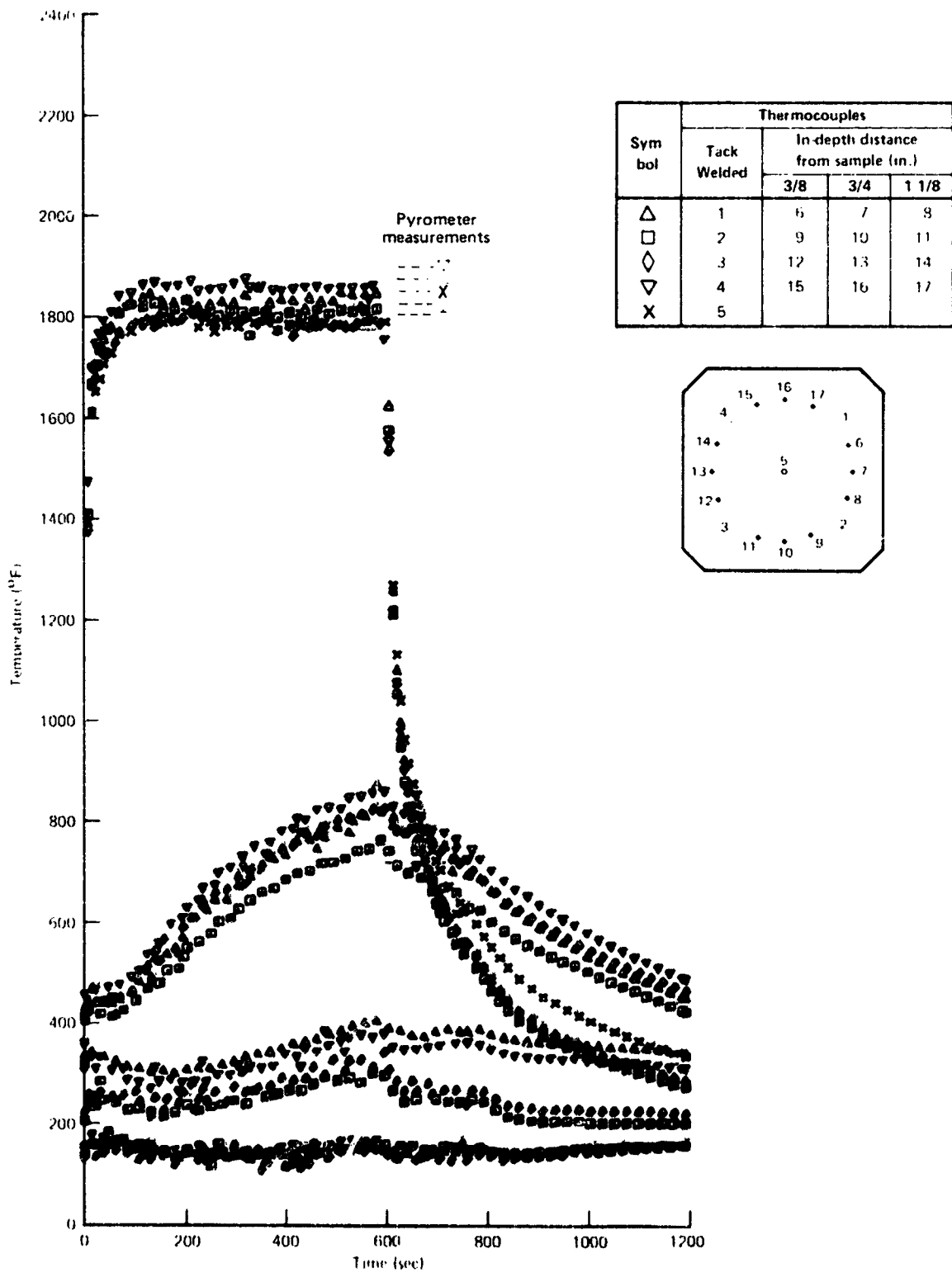


Fig. B-50 Typical temperature histories for TD-1 sample (cycle 50)

GP/J 0587 108

APPENDIX B: MODEL TEMPERATURE HISTORIES

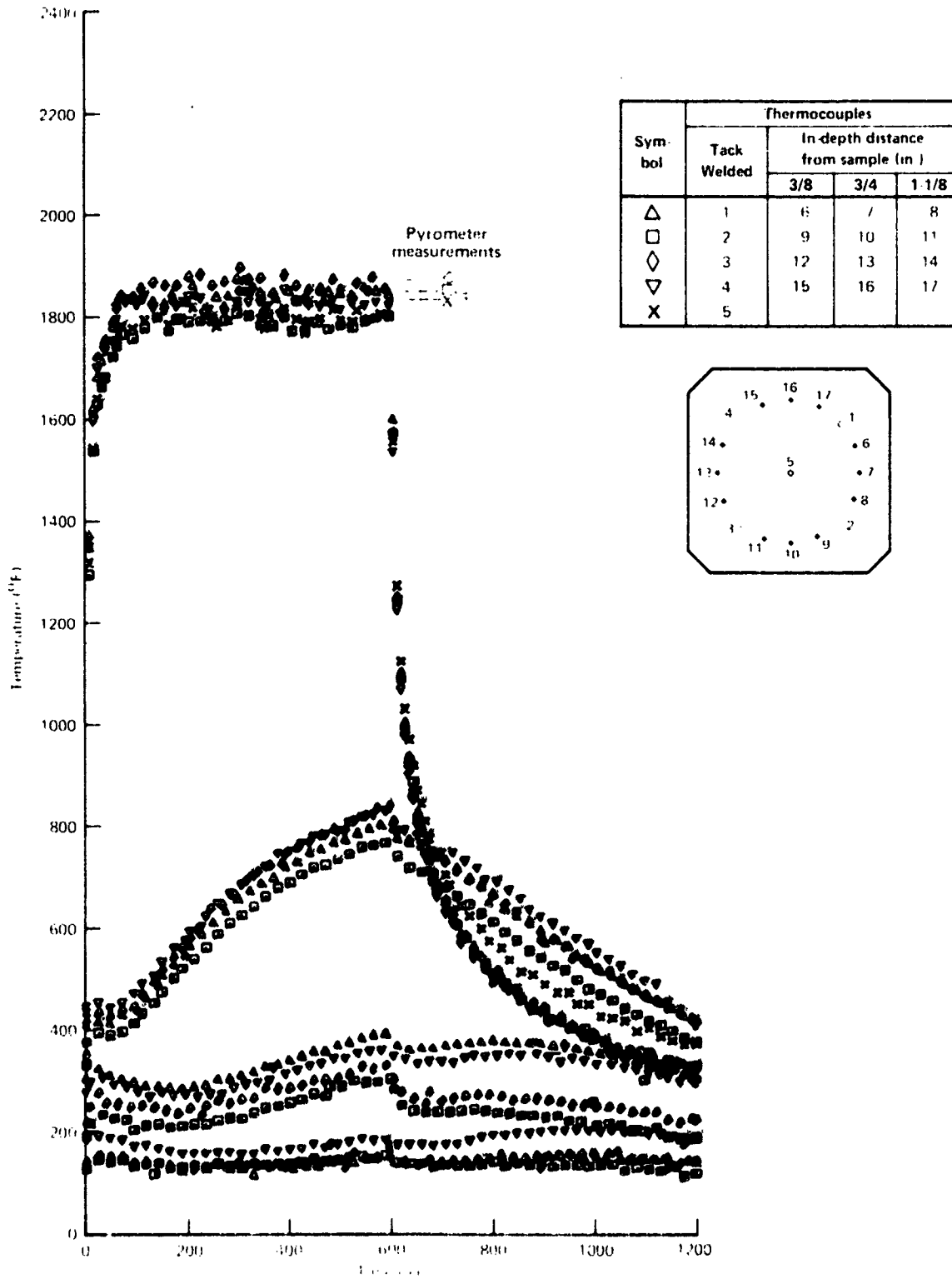


Fig. B-51 Typical temperature histories for TD-1 sample (cycle 75)

GP73 0587 109

APPENDIX B: MODEL TEMPERATURE HISTORIES

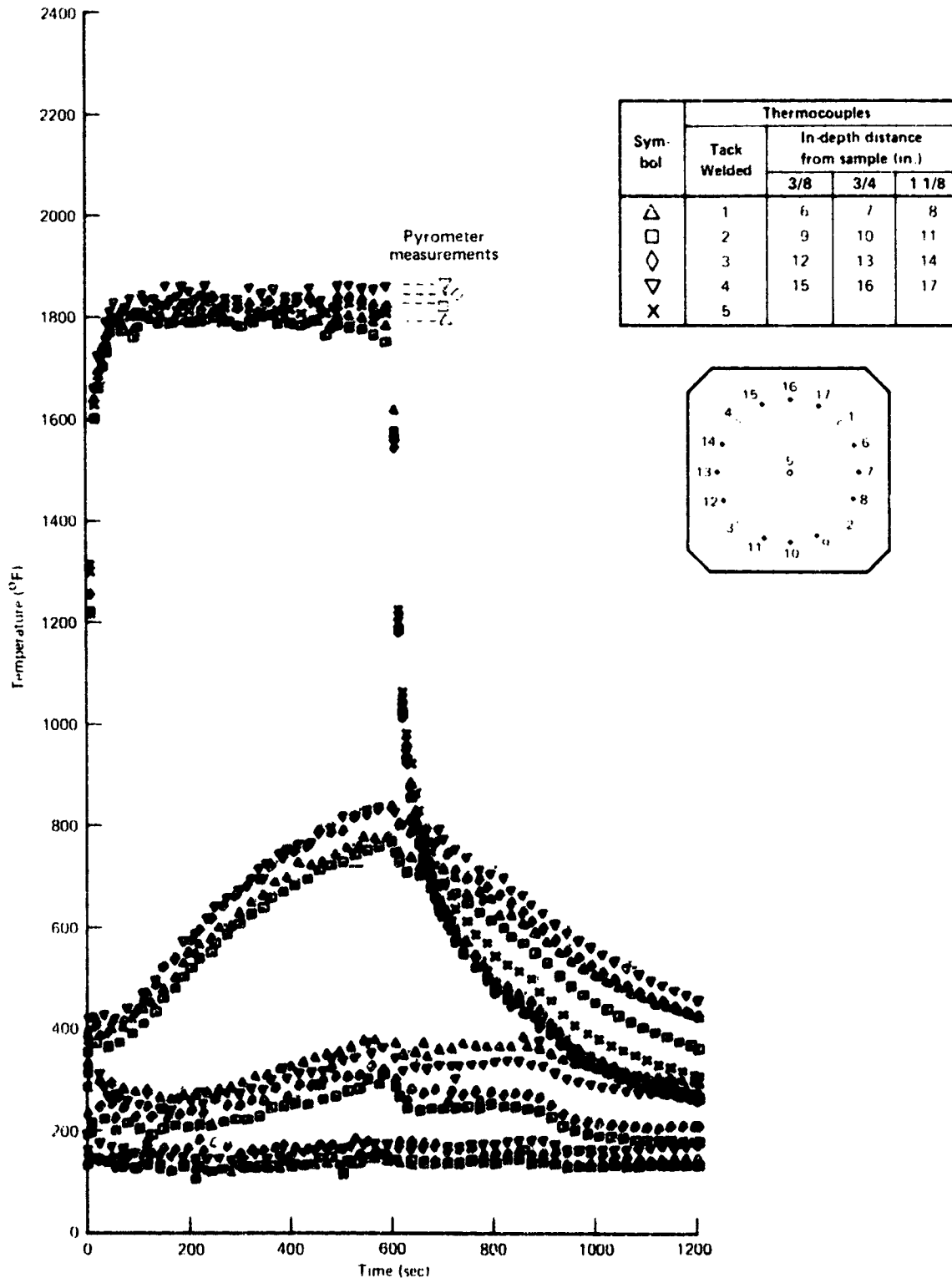


Fig. B-52 Typical temperature histories for TD-1 sample (cycle 100)

GP 73 (587-110)

APPENDIX B: MODEL TEMPERATURE HISTORIES

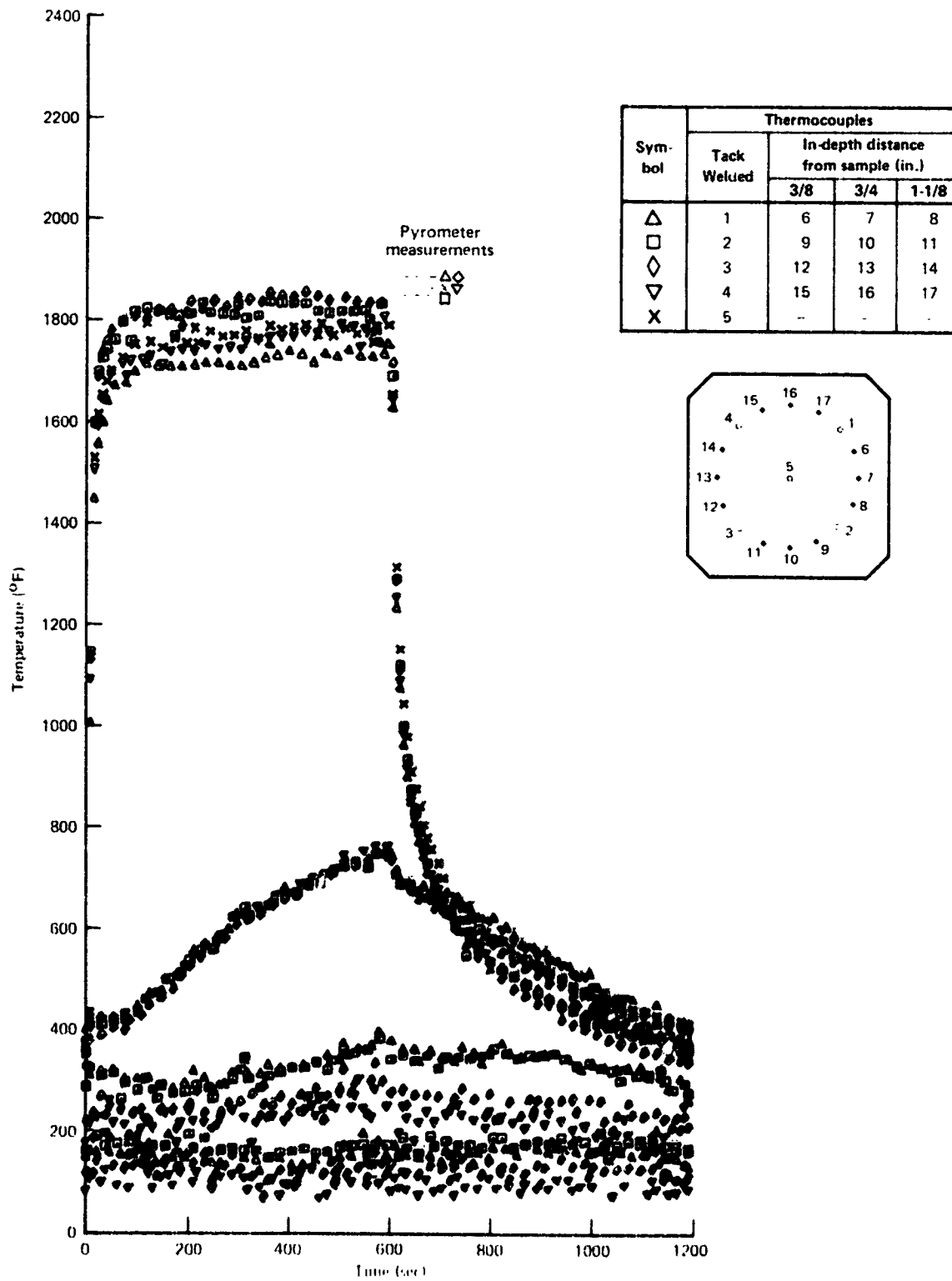


Fig. B-53 Typical temperature histories for TD-2 sample (cycle 22)

GE 71 0507 111

APPENDIX B: MODEL TEMPERATURE HISTORIES

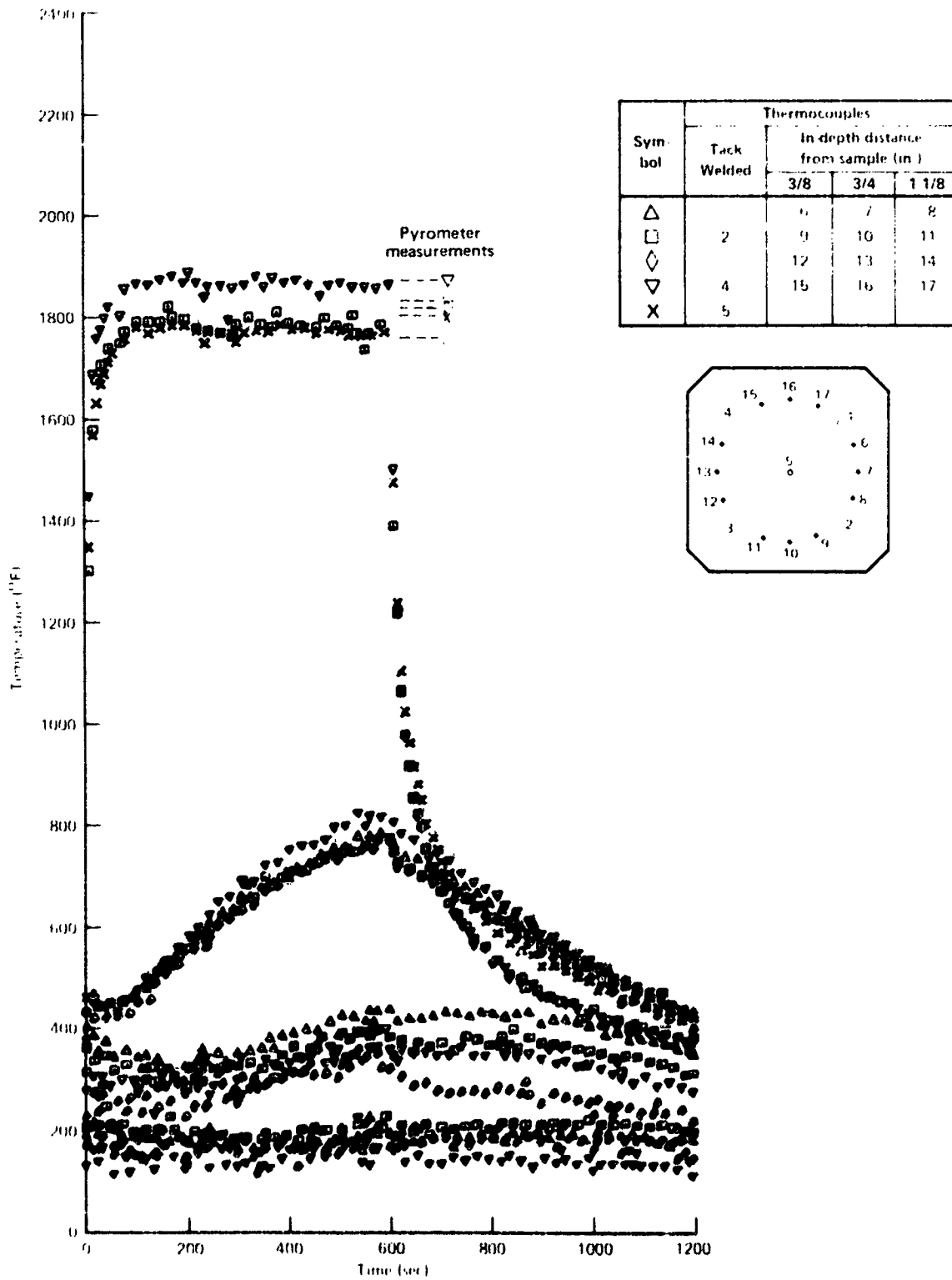


Fig. B-54 Typical temperature histories for TD-2 sample (cycle 50)

GP/3 0587 112

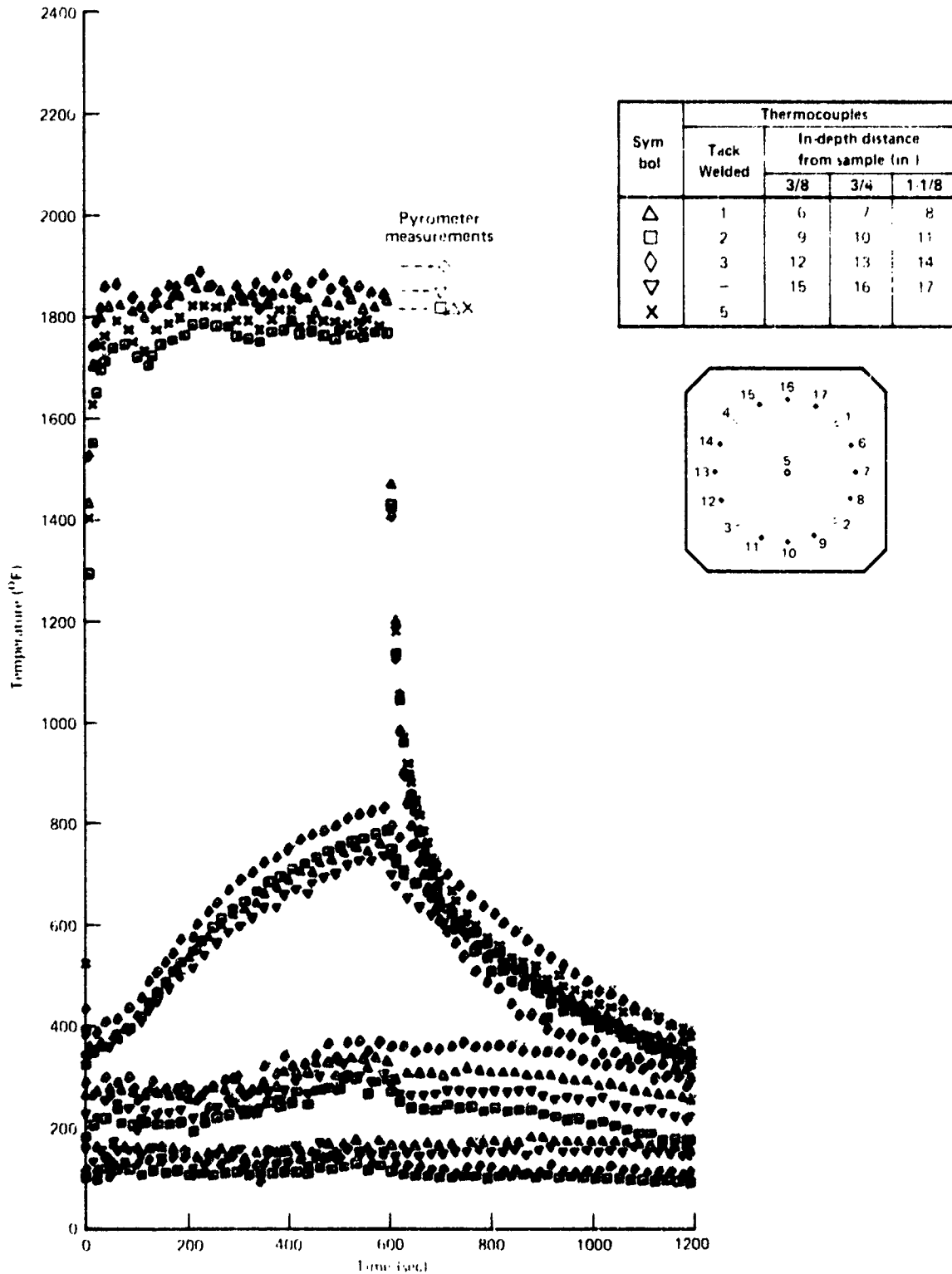


Fig. B-55 Typical temperature histories for TD-2 sample (cycle 75)

GP 73 0587 113

APPENDIX B- MODEL TEMPERATURE HISTORIES

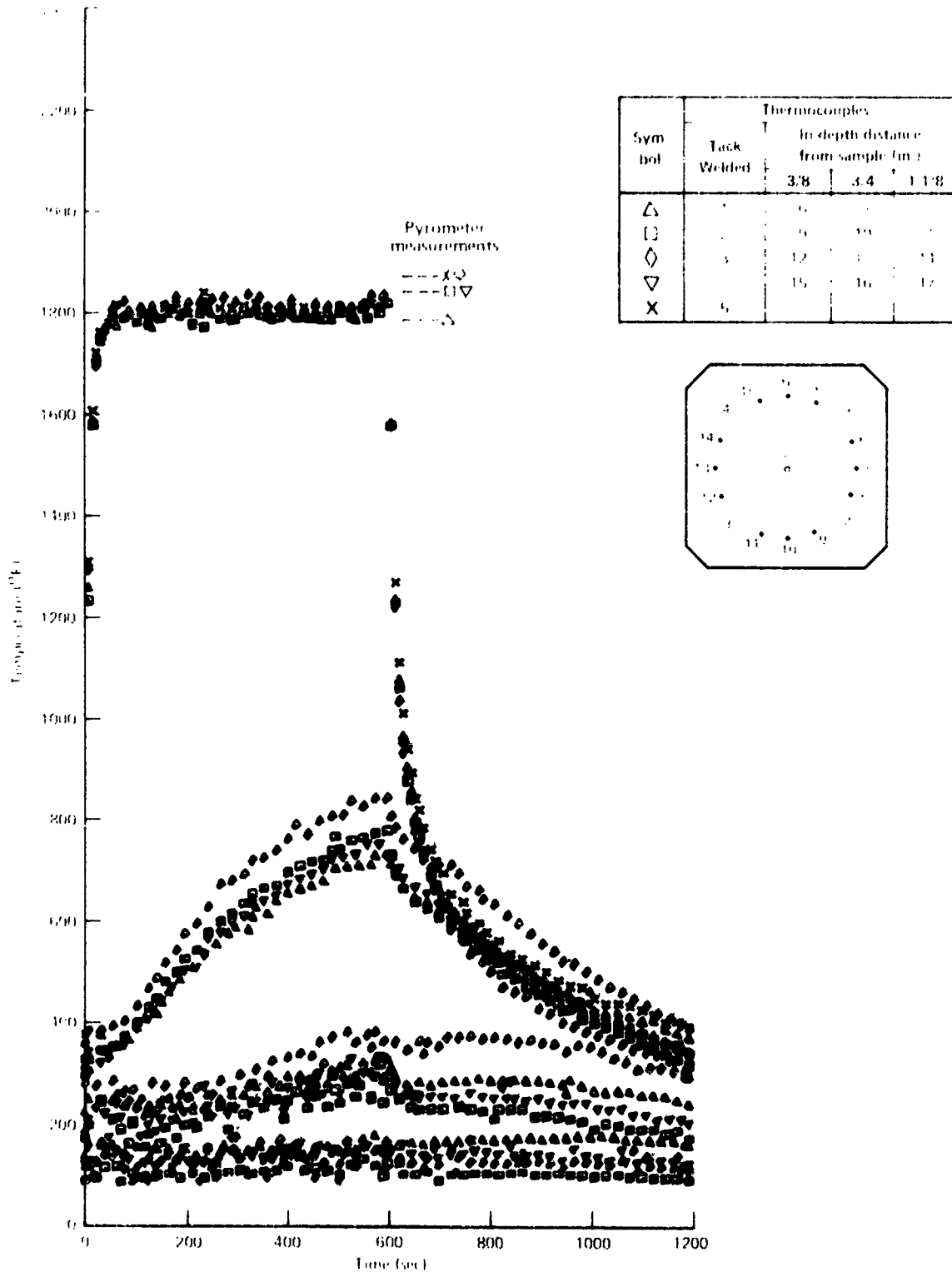


Fig. B-56 Typical temperature histories for TD-2 sample (cycle 100)

GP73 0587-114

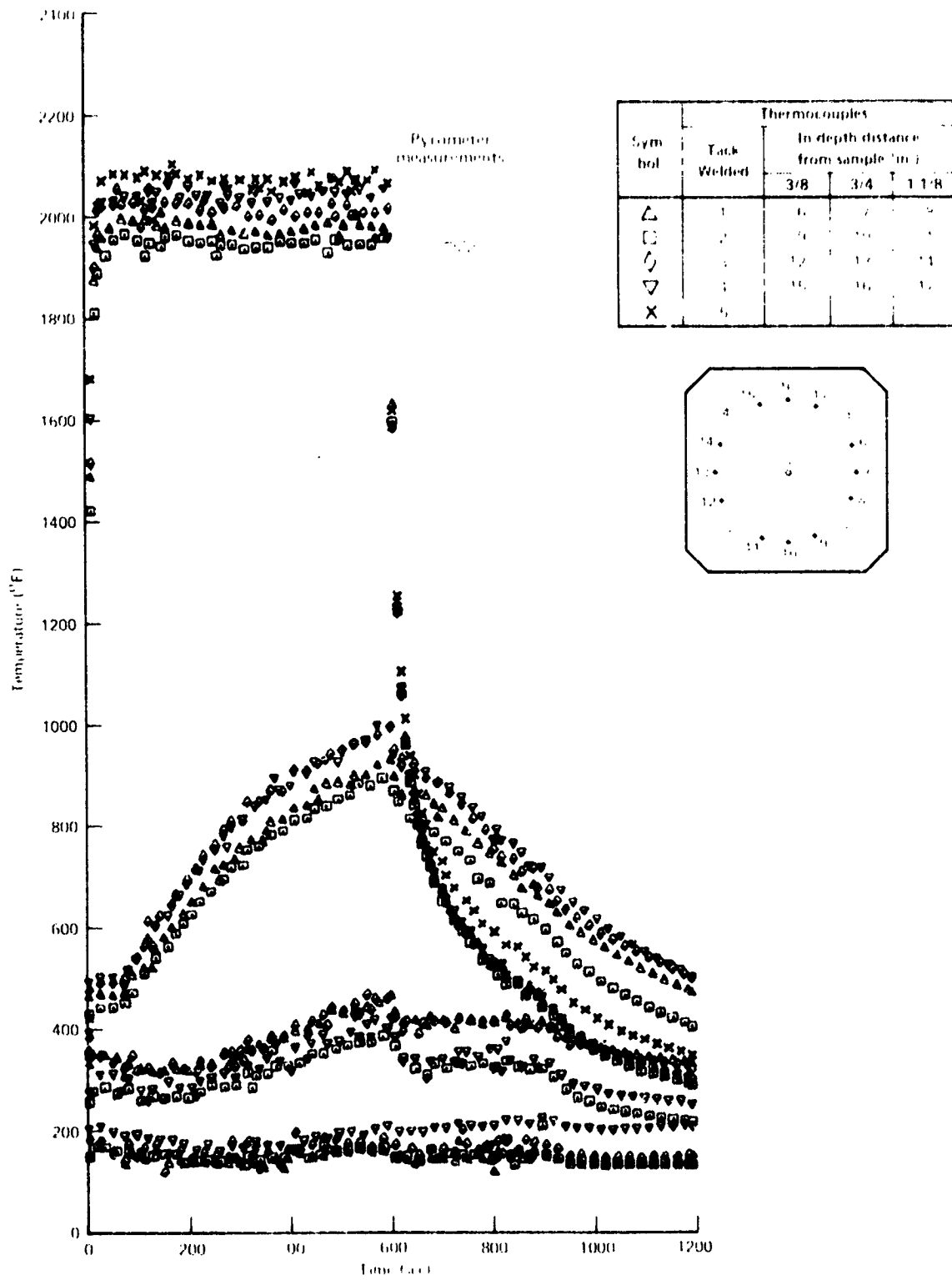


Fig. B-57 Typical temperature histories for DS-1 sample (cycle 25)

GP24087-115

APPENDIX B MODEL TEMPERATURE HISTORIES

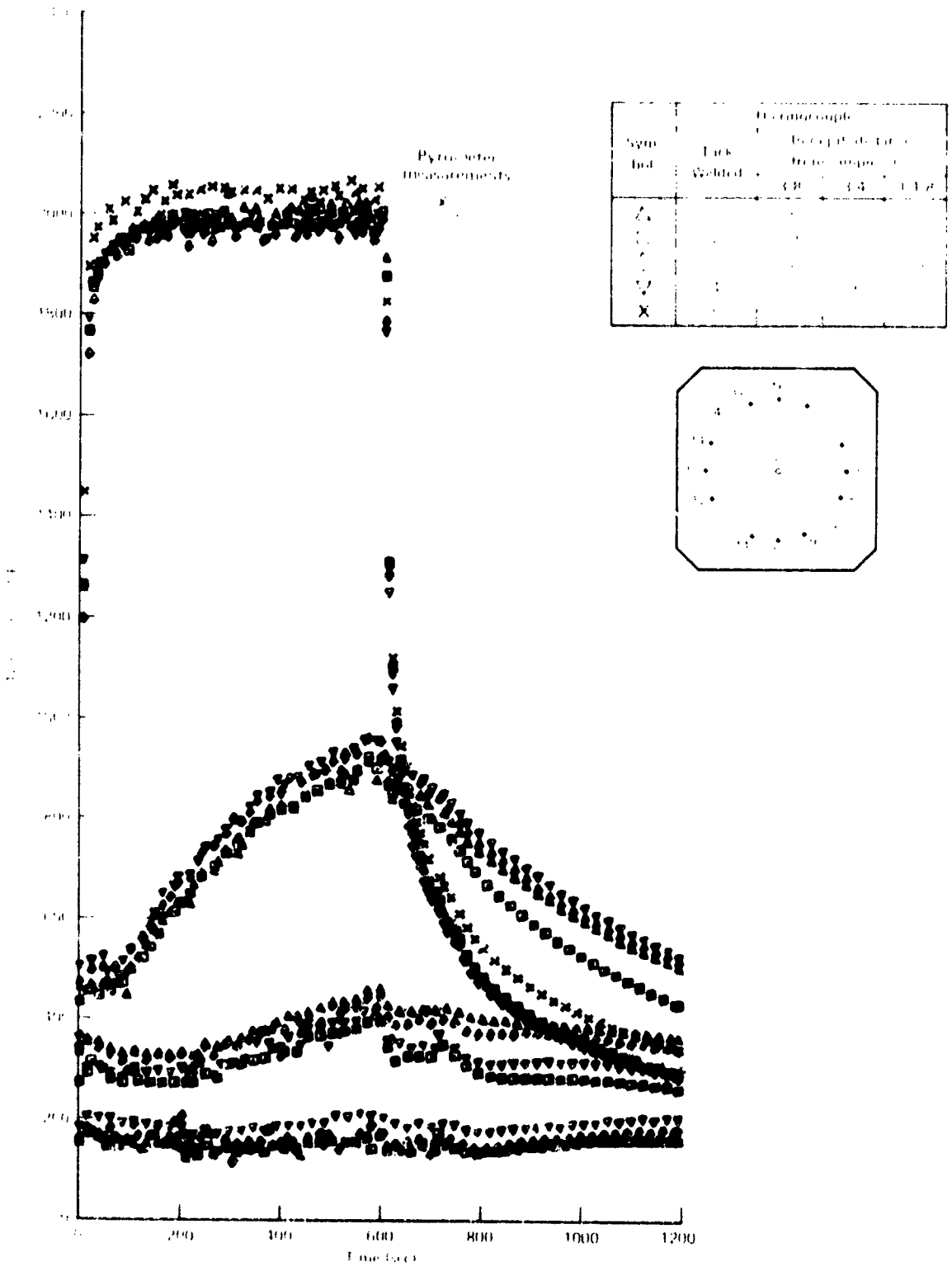


Fig. B-58 Typical temperature histories for DS-1 sample (cycle 50)

0011090-116

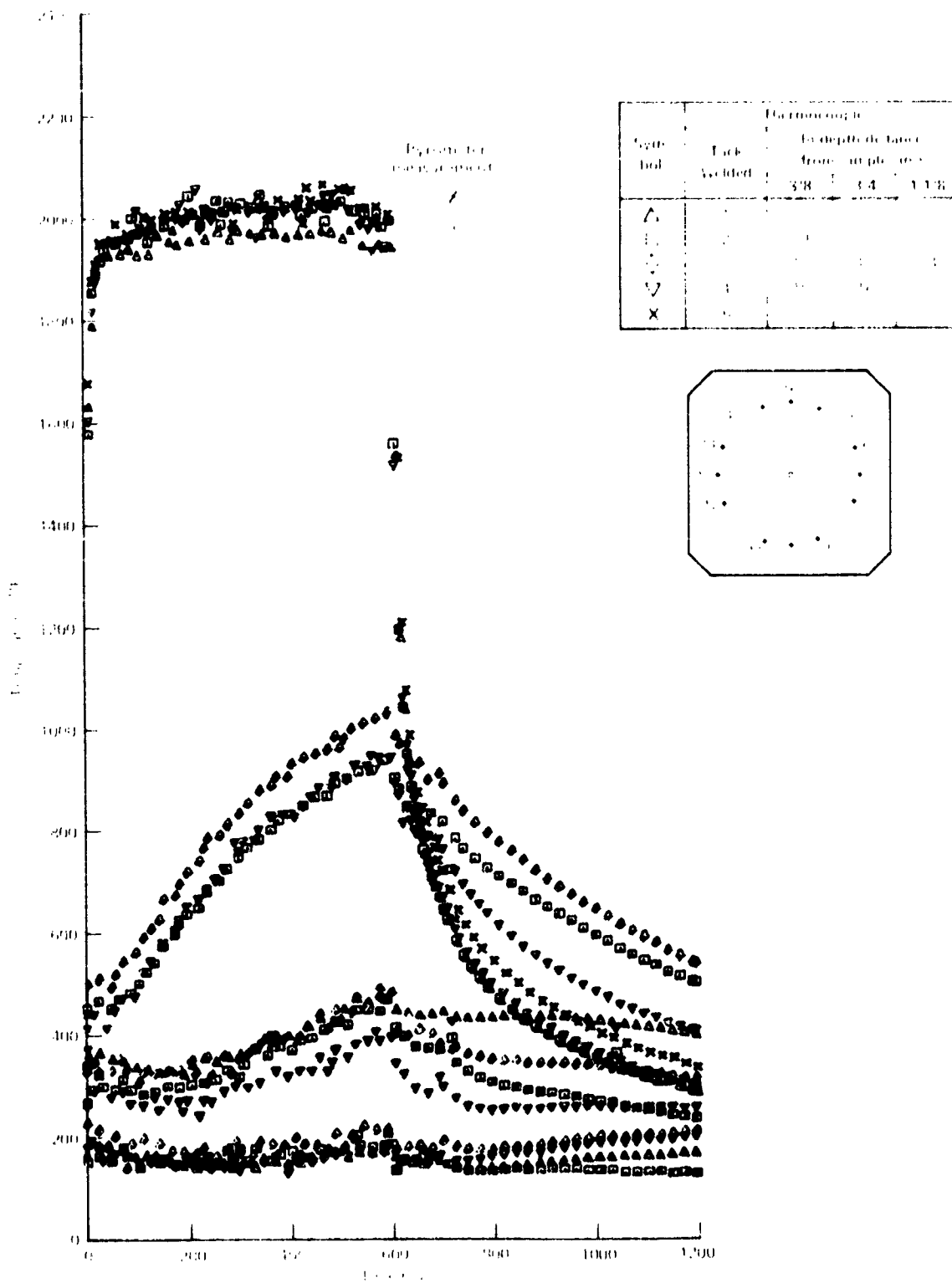


Fig. B-59 Typical temperature histories for DS-1 sample (cycle 75)

DS-1 SAMPLE

APPENDIX B: MODEL TEMPERATURE HISTORIES

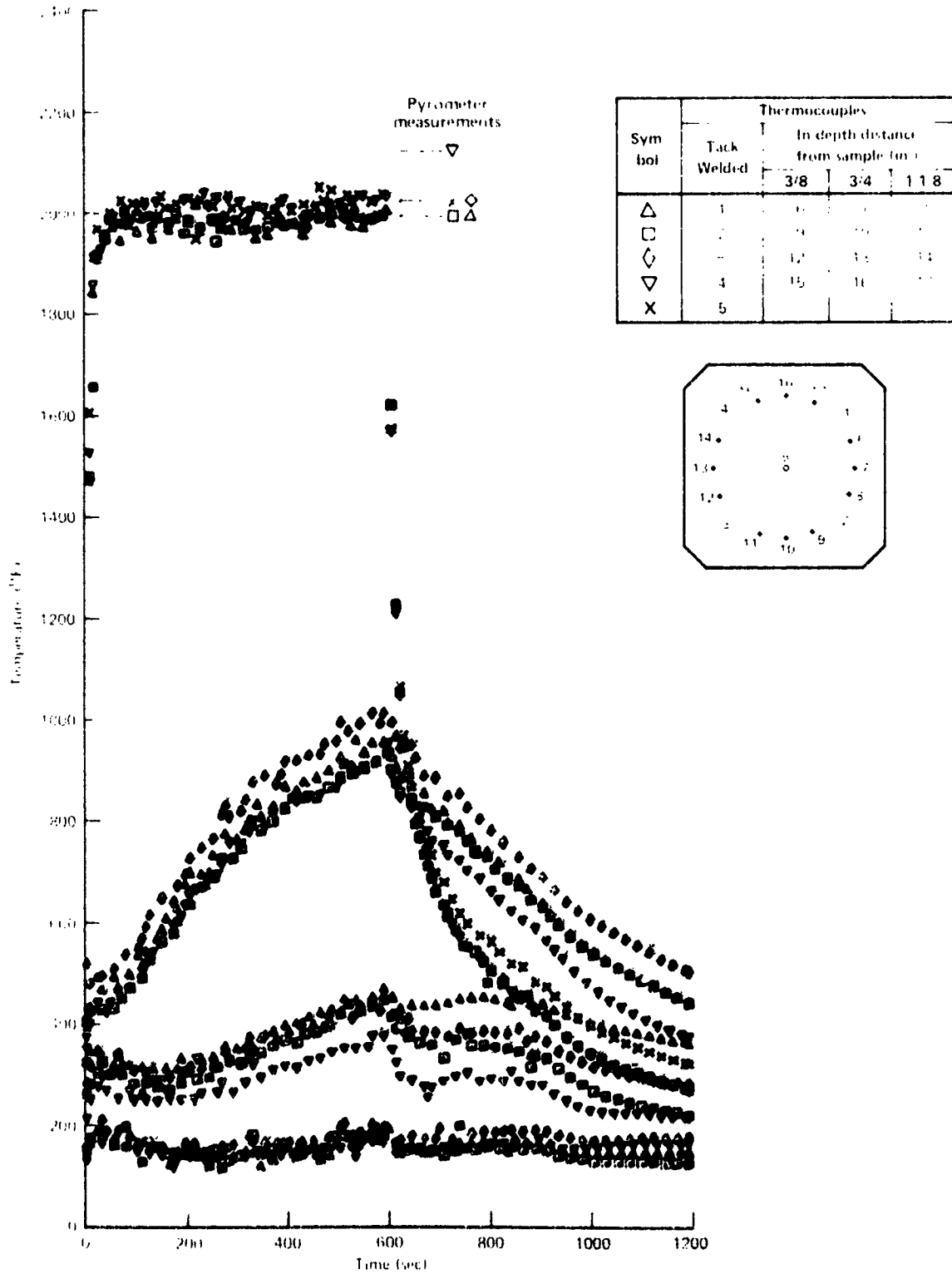


Fig. B-60 Typical temperature histories for DS-1 sample (cycle 100)

GP 73 0587 118

APPENDIX B: MODEL TEMPERATURE HISTORIES

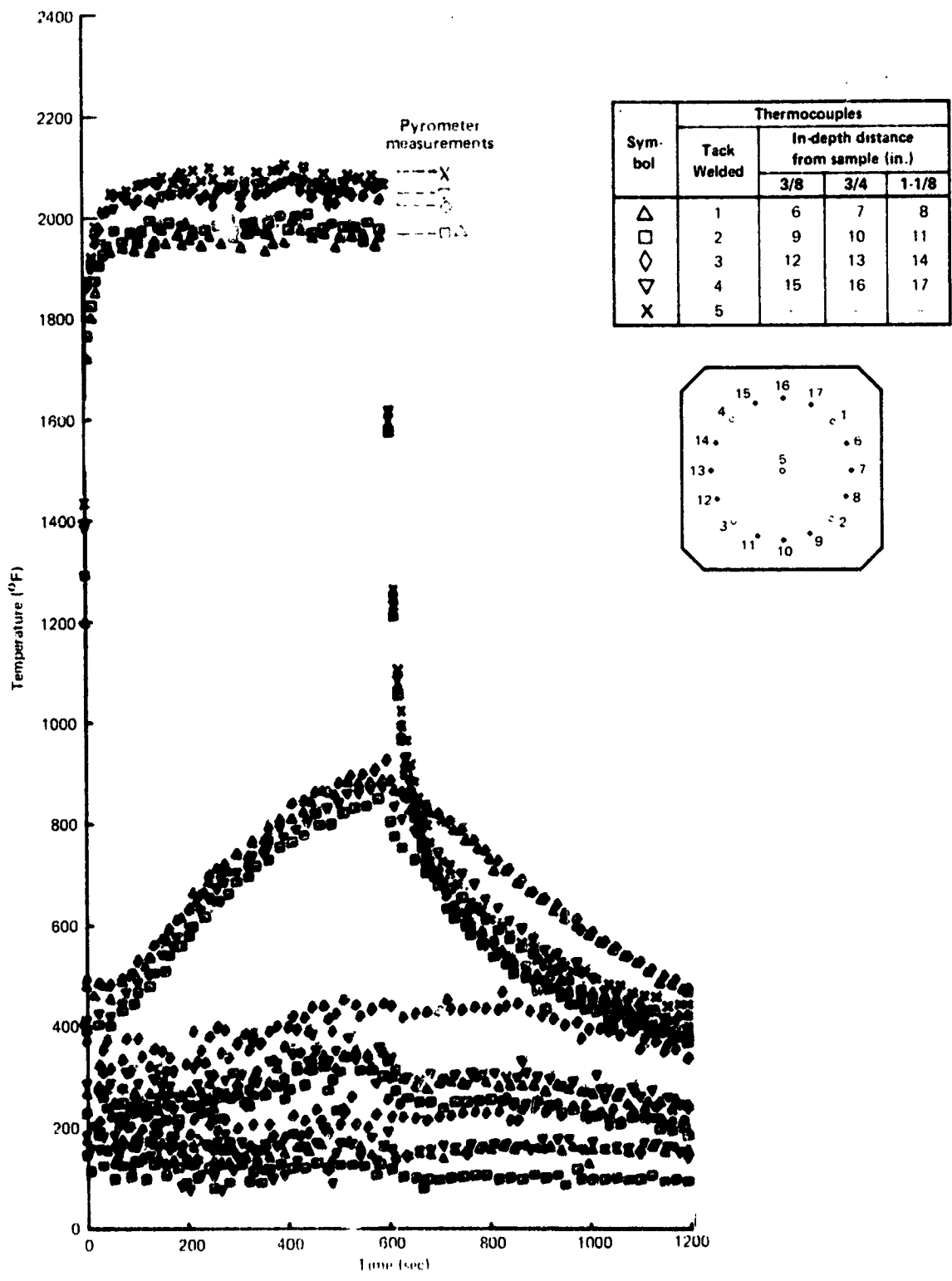


Fig. B-61 Typical temperature histories for DS-2 sample (cycle 25)

GP73-0587 119

APPENDIX B: MODEL TEMPERATURE HISTORIES

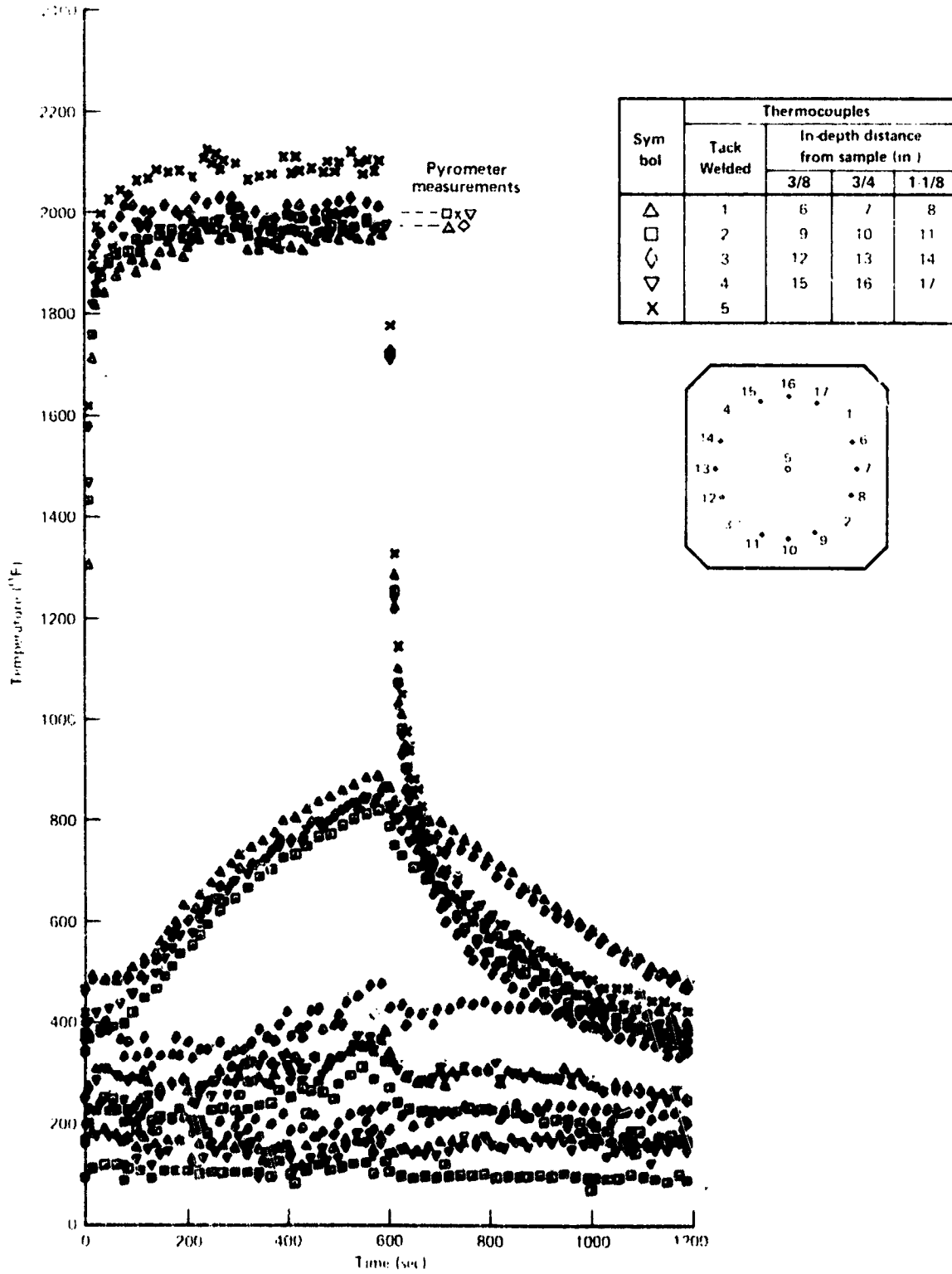


Fig. B-62 Typical temperature histories for DS-2 sample (cycle 50)

GP73-0587-120

APPENDIX B: MODEL TEMPERATURE HISTORIES

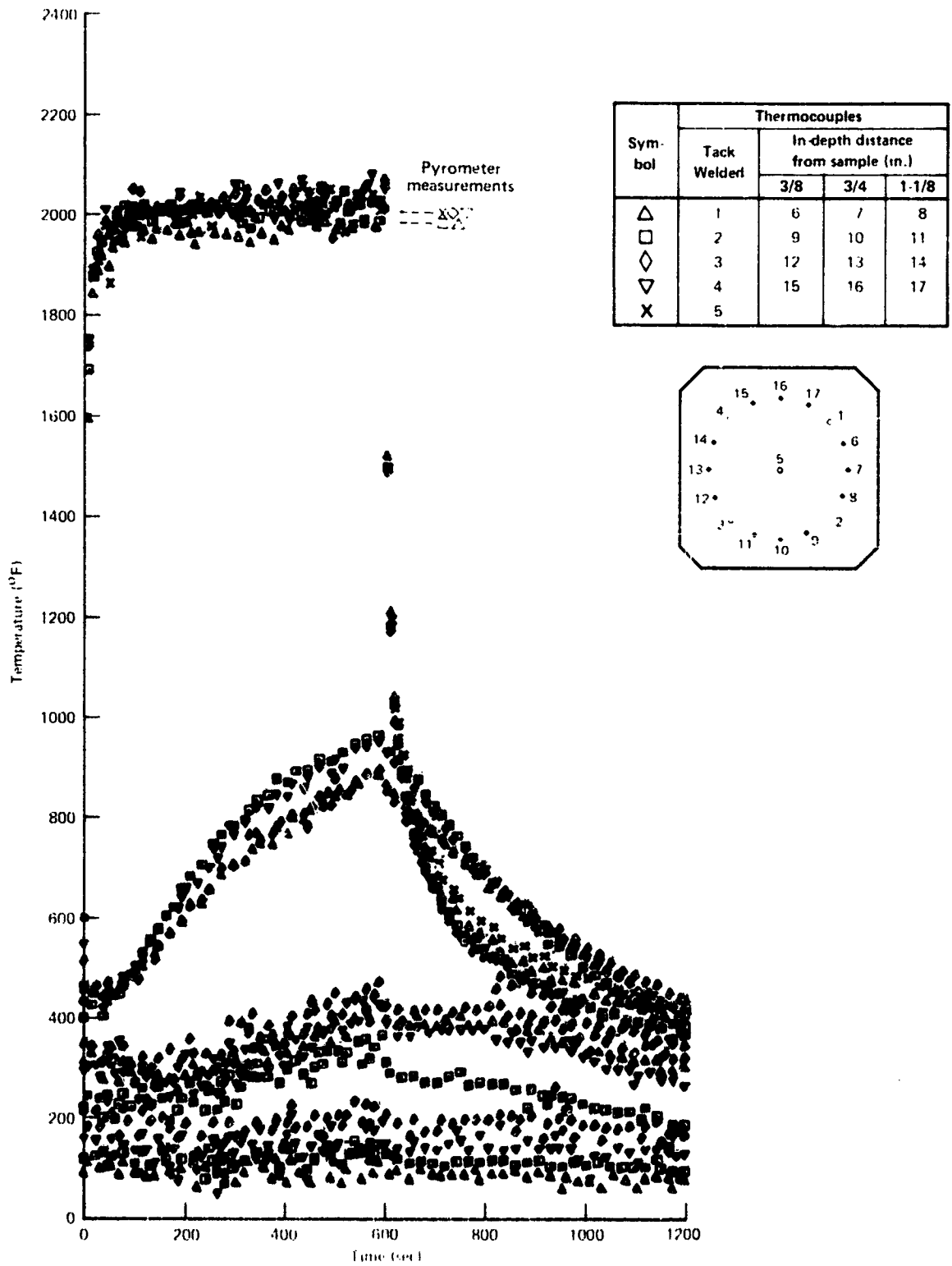


Fig. B-63 Typical temperature histories for DS-2 sample (cycle 75)

GP73 0-97 121

APPENDIX B: MODEL TEMPERATURE HISTORIES

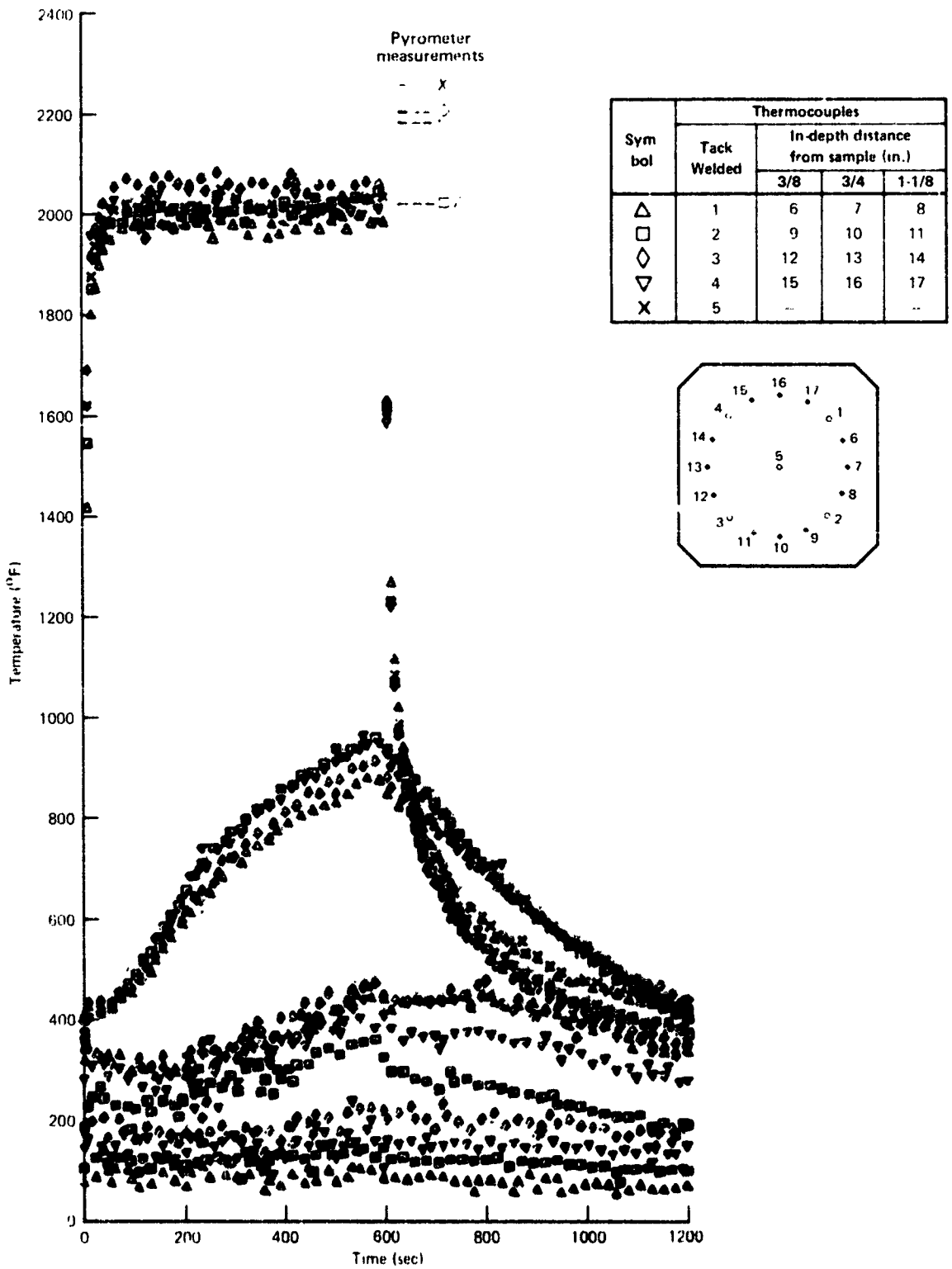


Fig. B-64 Typical temperature histories for DS-2 sample (cycle 100)

GP73 0387 122

APPENDIX B: MODEL TEMPERATURE HISTORIES

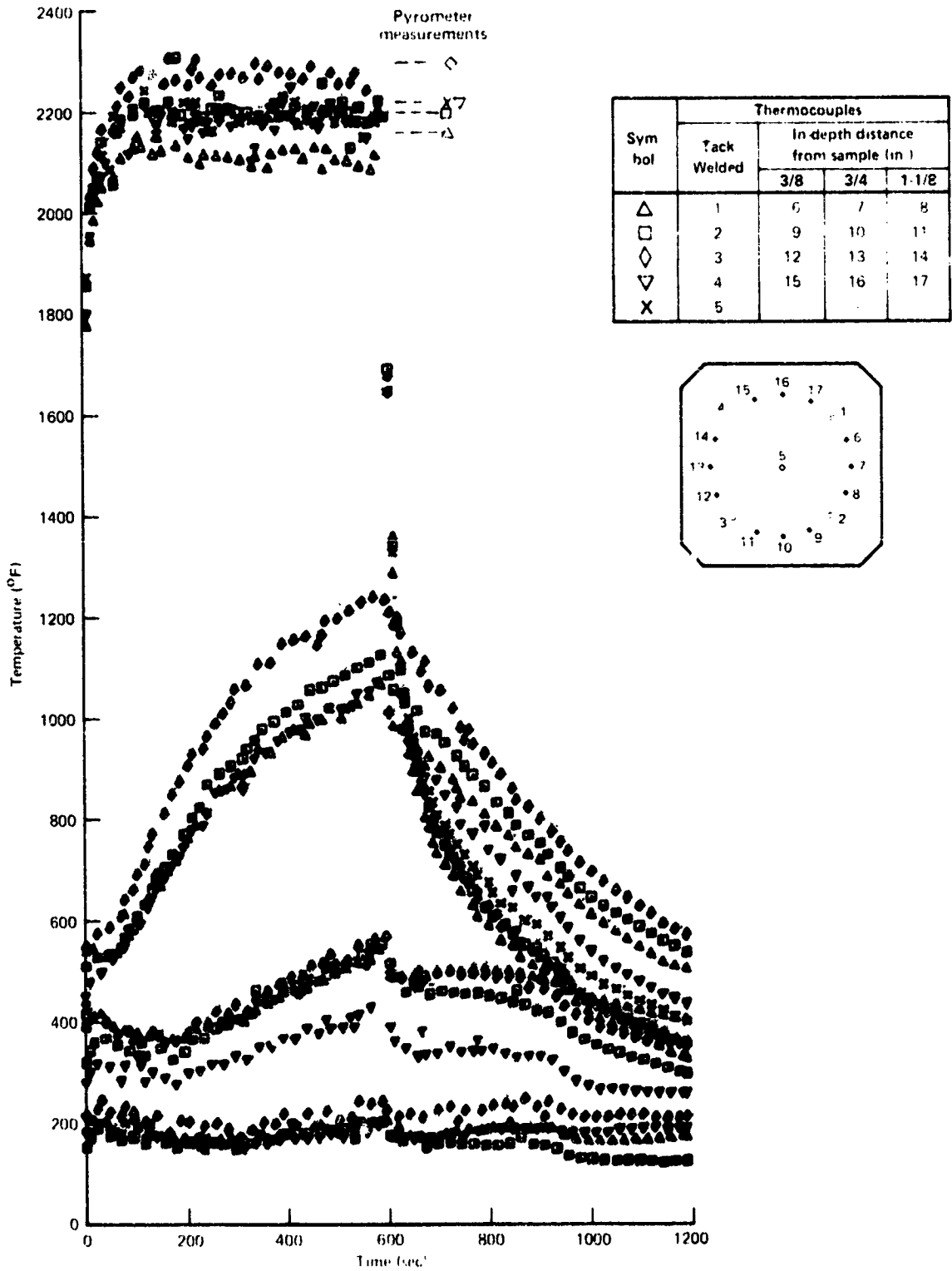


Fig. B-65 Typical temperature histories for TD-7 sample (cycle 15)

GP73 0587 123

APPENDIX B: MODEL TEMPERATURE HISTORIES

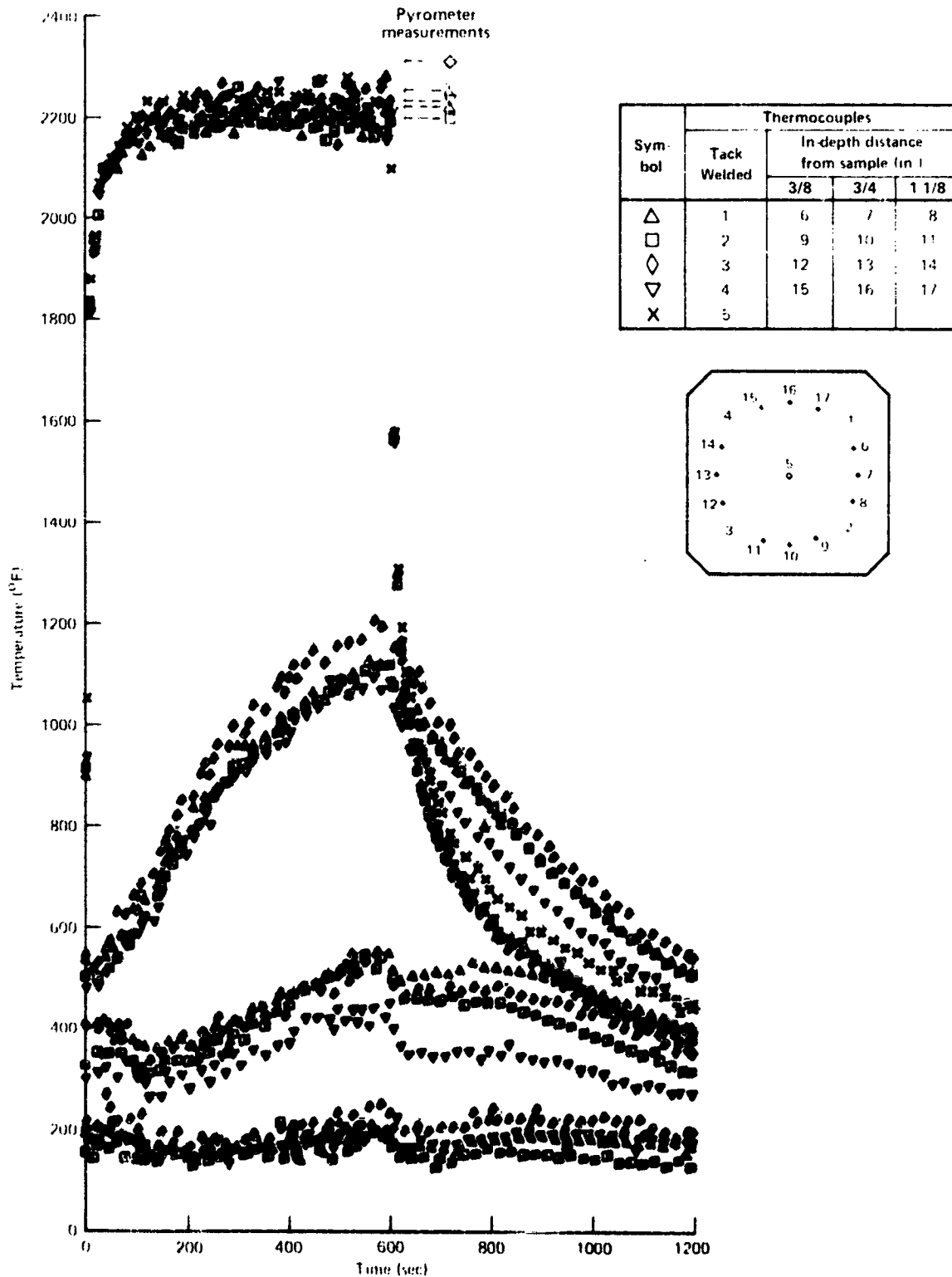


Fig. B-66 Typical temperature histories for TD-7 sample (cycle 30)

GP73-0587 124

APPENDIX B: MODEL TEMPERATURE HISTORIES

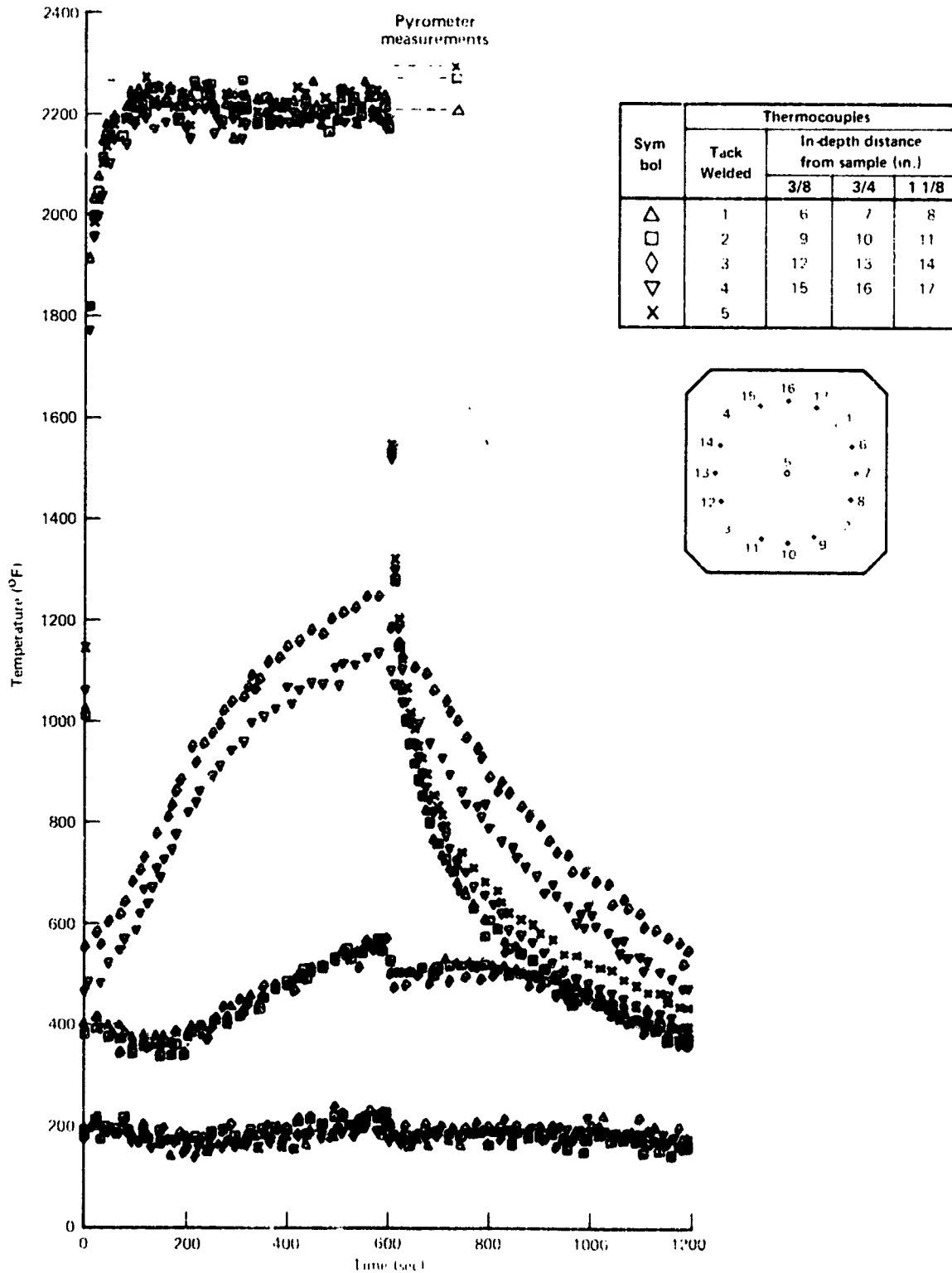


Fig. B-67 Typical temperature histories for TD-7 sample (cycle 50)

GP73 0587 126

APPENDIX B: MODEL TEMPERATURE HISTORIES

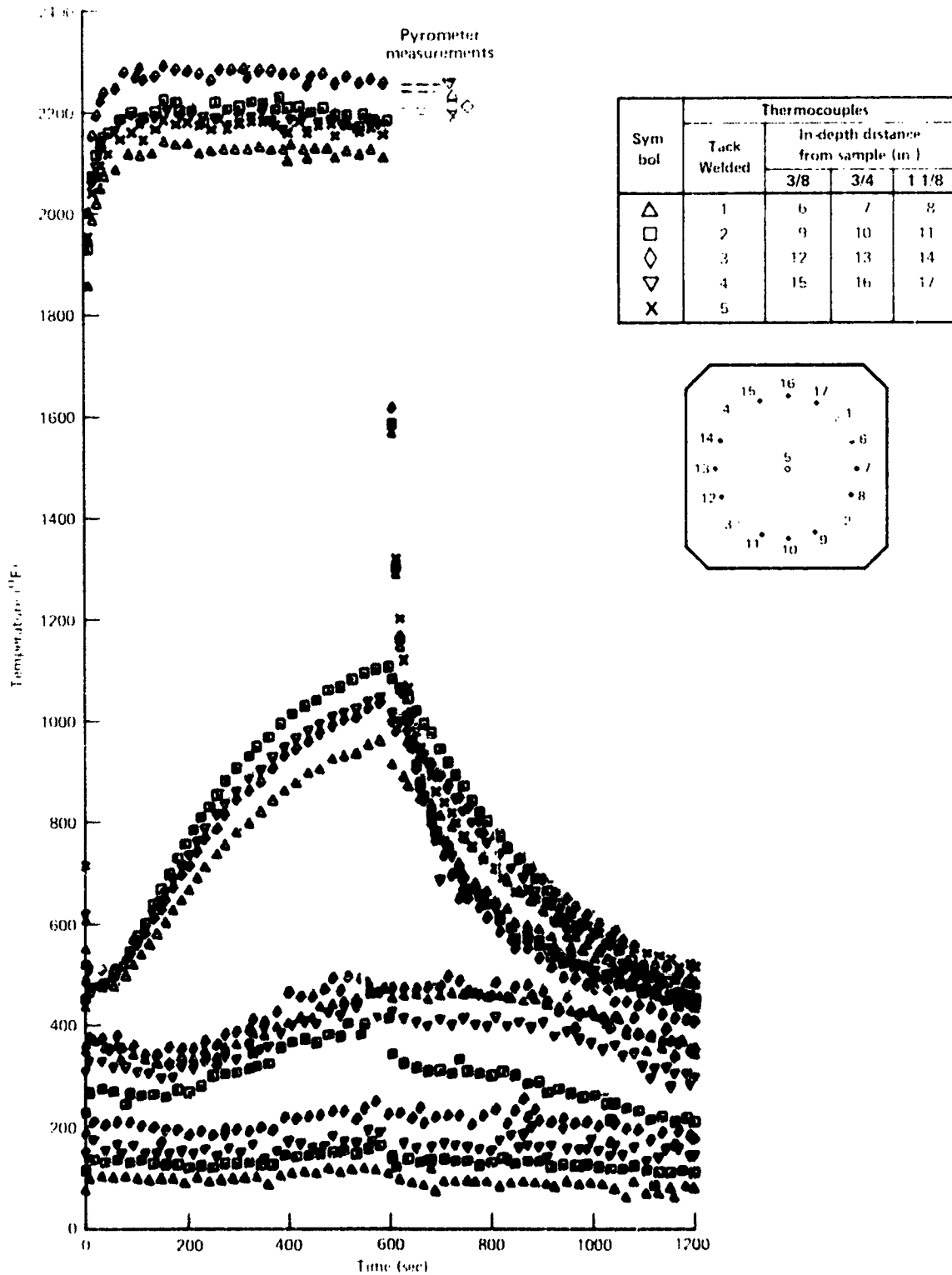


Fig. B-68 Typical temperature histories for TD-8 sample (cycle 15)

GP73 0587 126

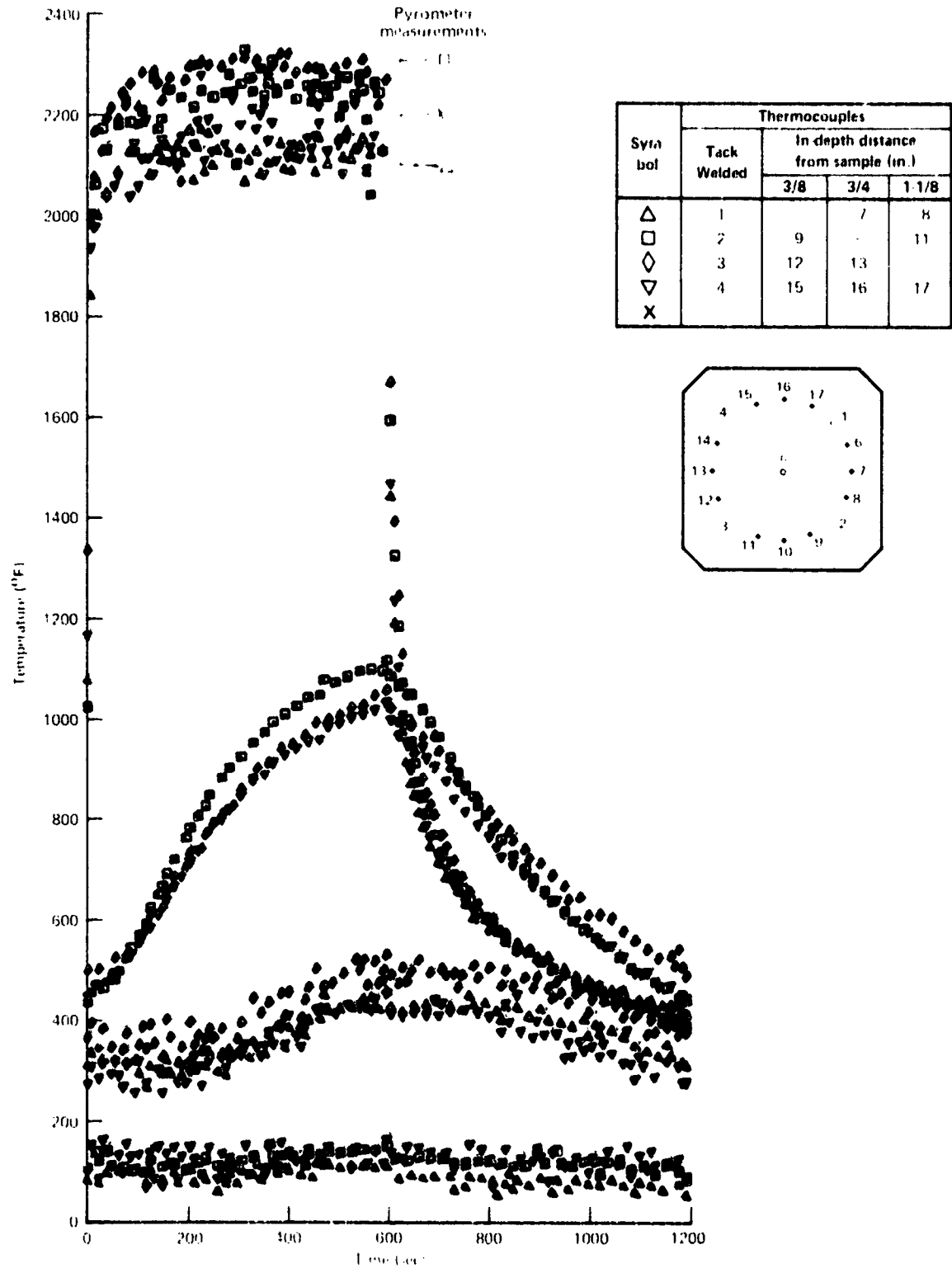


Fig. B-69 Typical temperature histories for TD-8 sample (cycle 30)

GP73-0587 127

APPENDIX B: MODEL TEMPERATURE HISTORIES

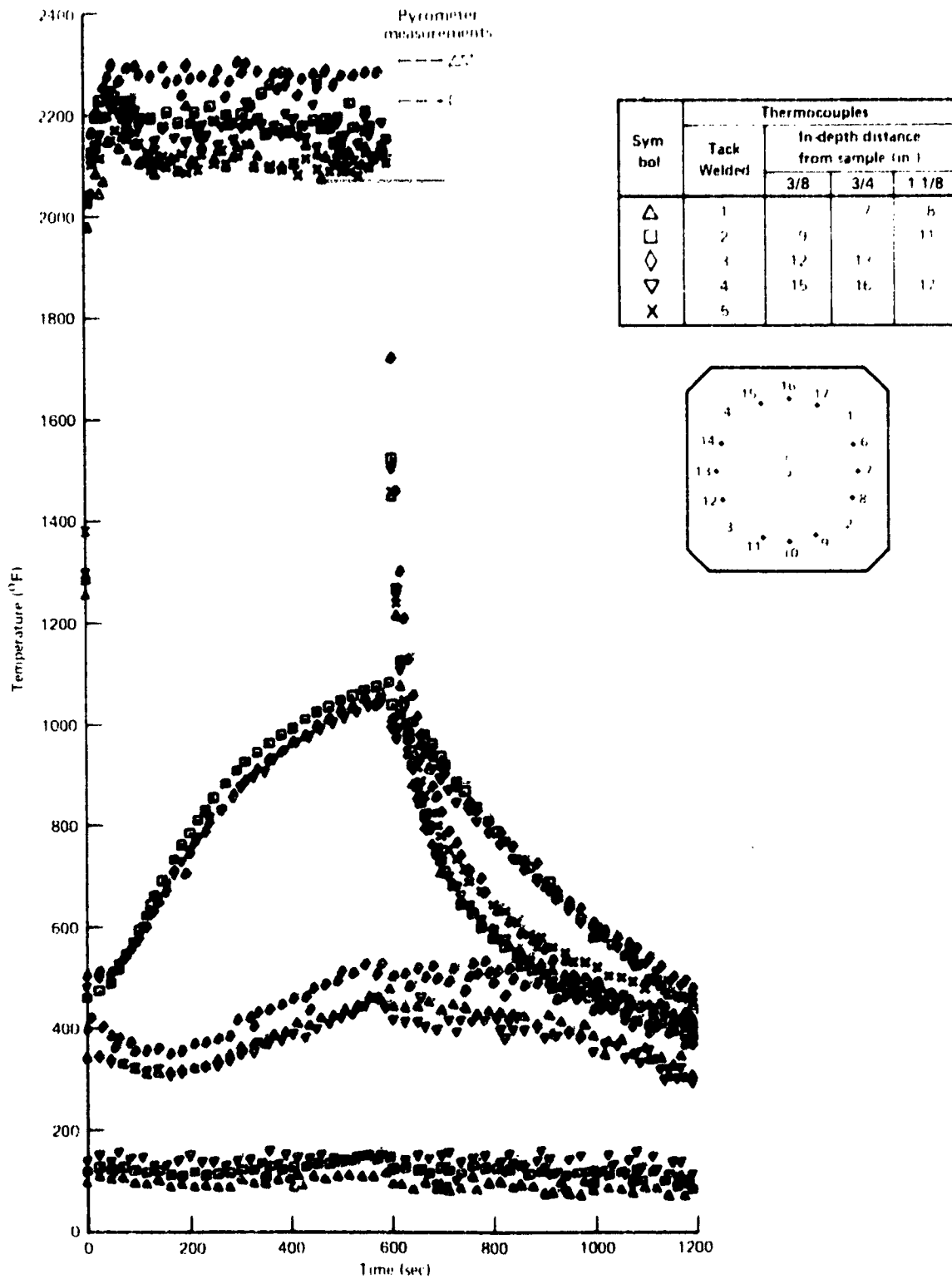


Fig. B-70 Typical temperature histories for TD-8 sample (cycle 50)

GP73-0987-128

APPENDIX B: MODEL TEMPERATURE HISTORIES

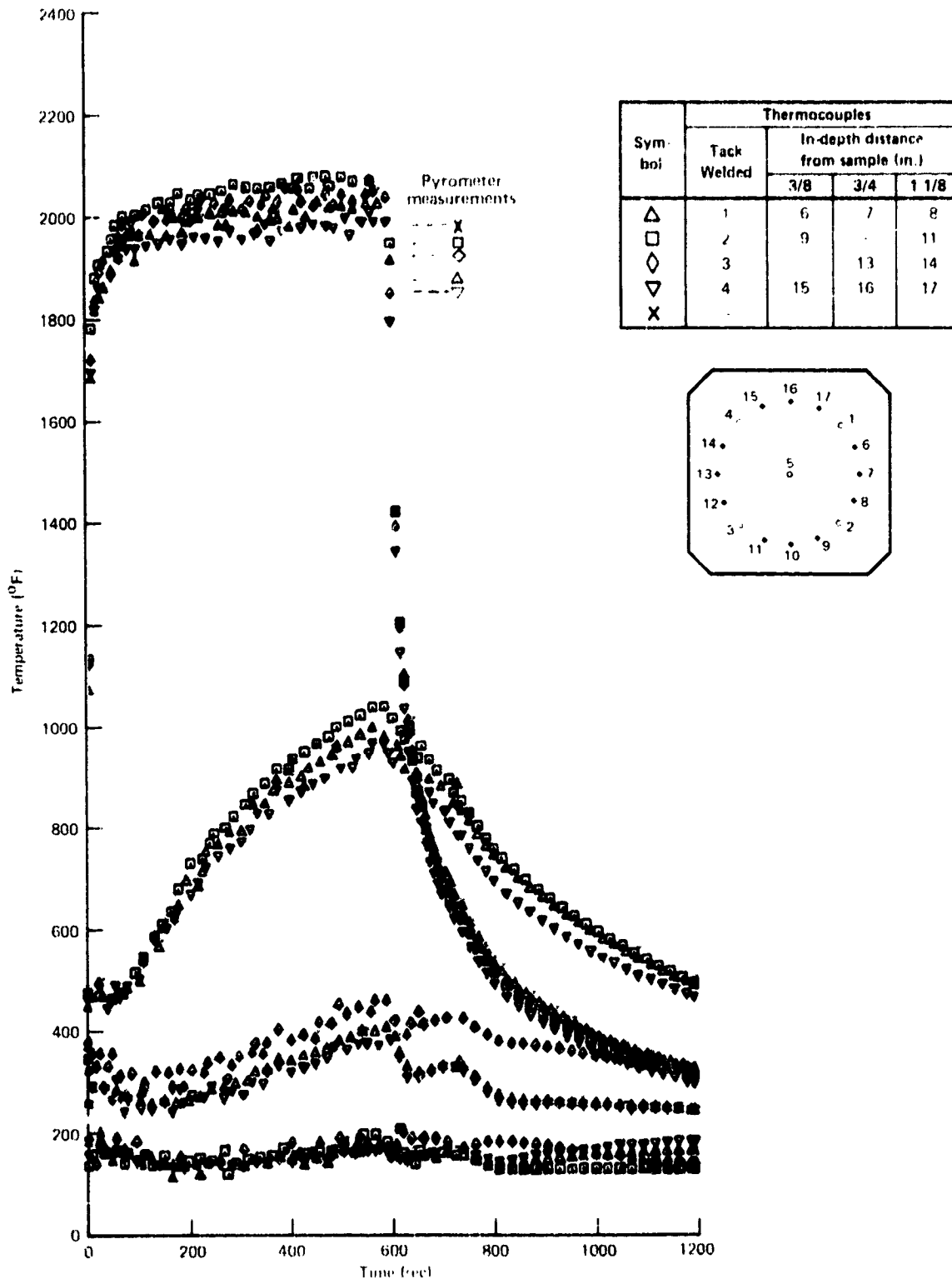


Fig. B-71 Typical temperature histories for DS-5 sample (cycle 25)

CP 730587-120

APPENDIX B MODEL TEMPERATURE HISTORICALS

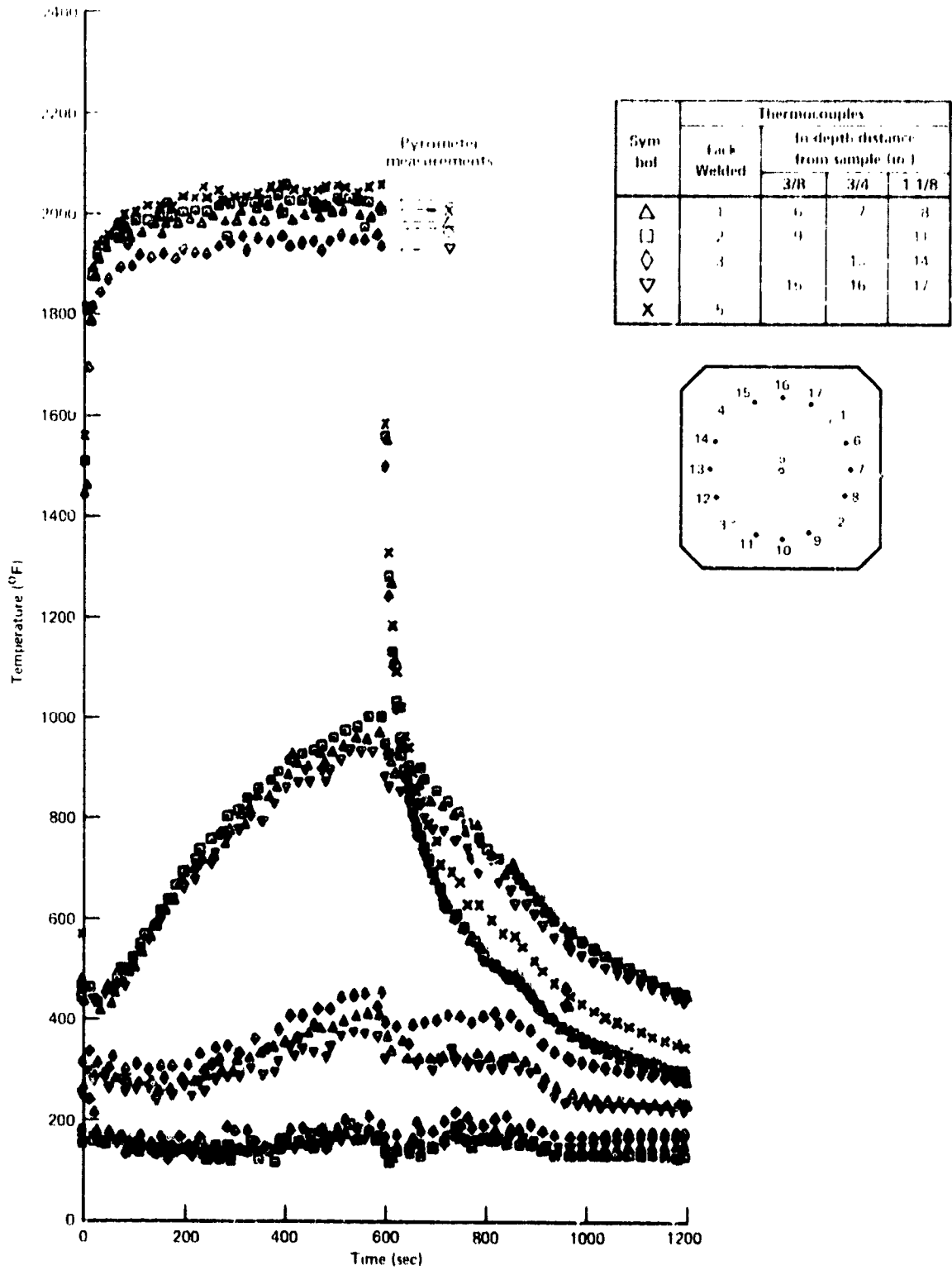


Fig. B-72 Typical temperature histories for DS-5 sample (cycle 50)

GP73 0587 130

APPENDIX B. MODEL TEMPERATURE HISTORIES

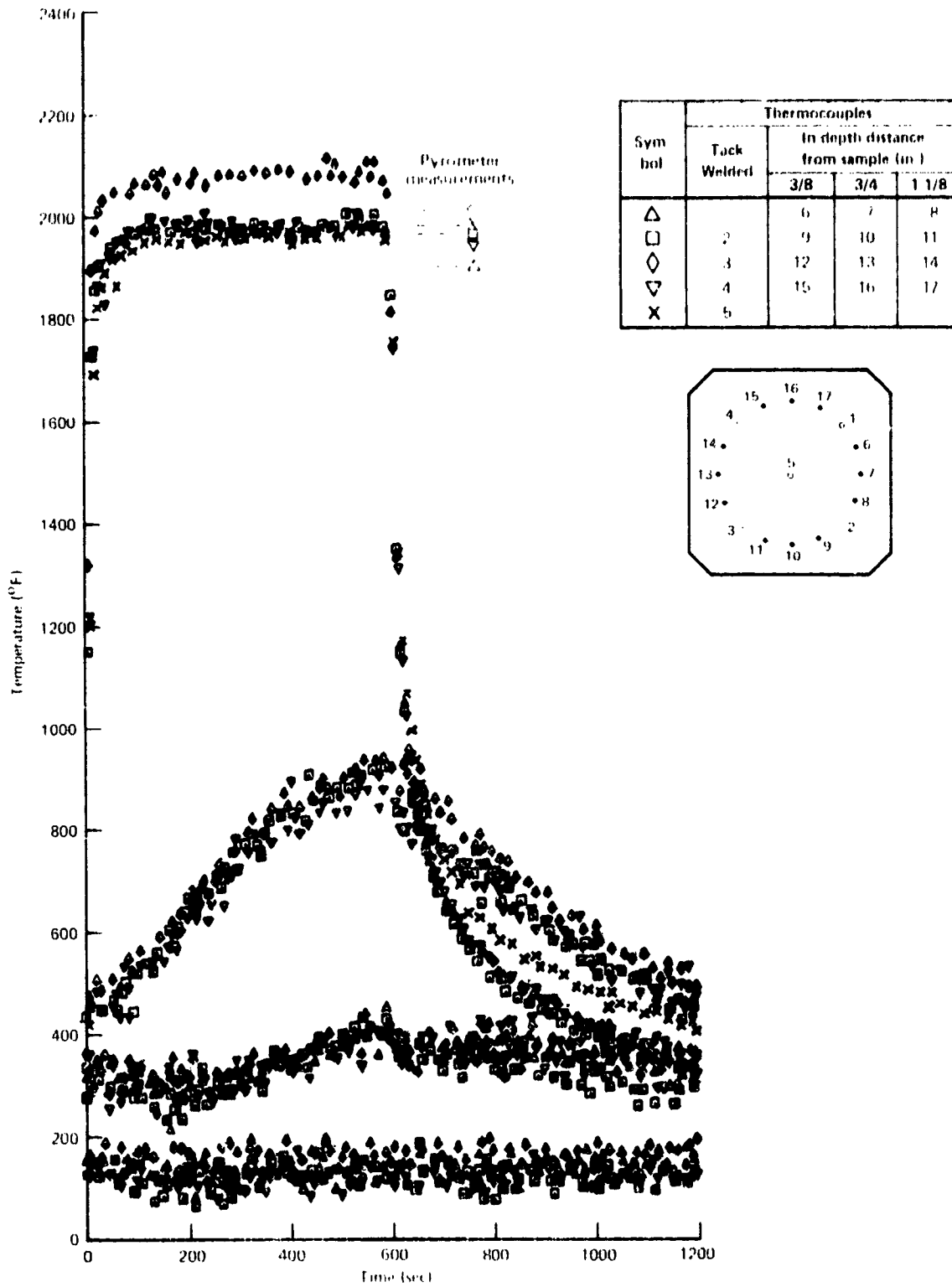
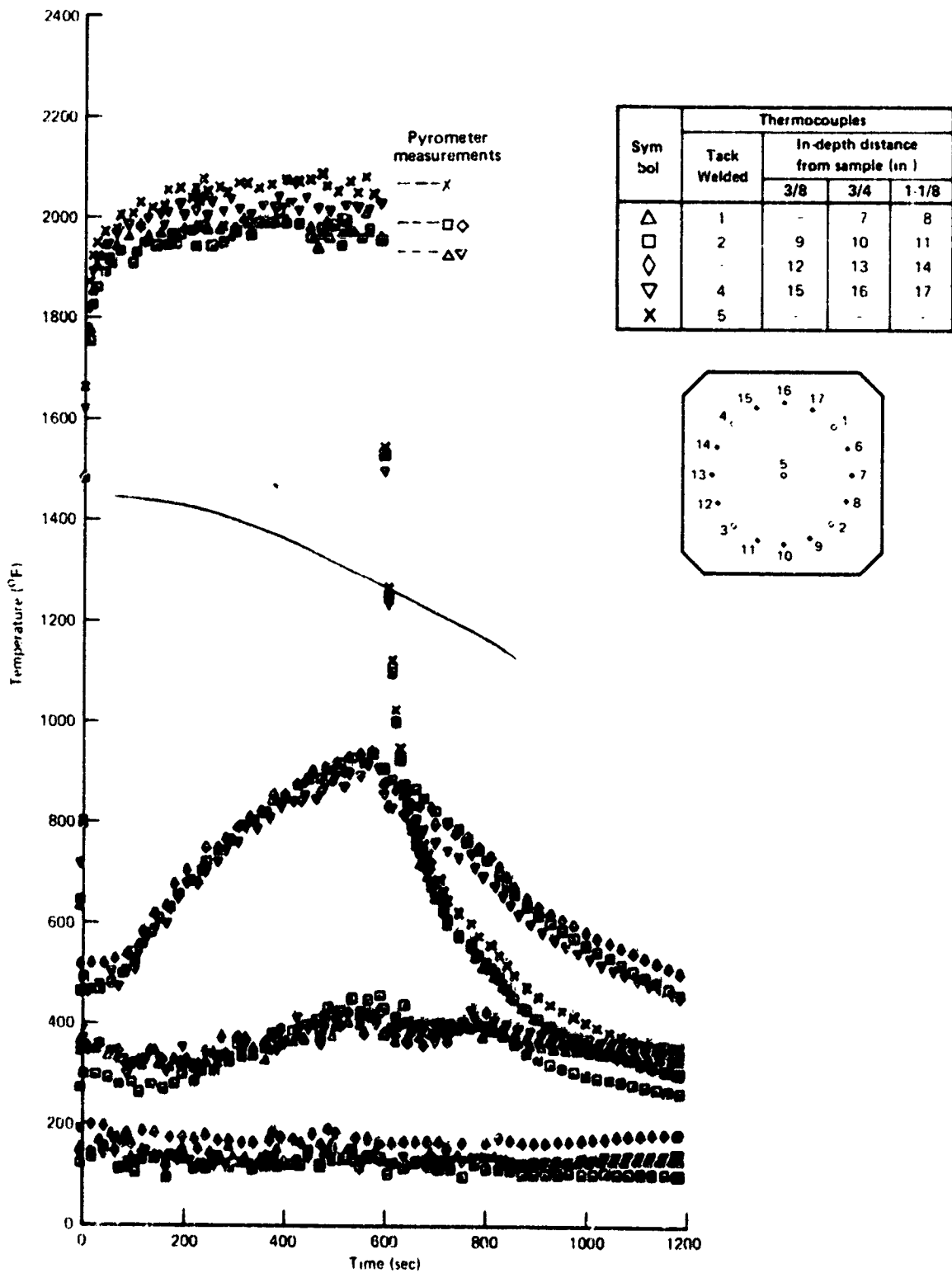


Fig. B-73 Typical temperature histories for DS-5 sample (cycle 73)

GP-3 0587 1.11

APPENDIX B: MODEL TEMPERATURE HISTORIES



• Fig. B-74 Typical temperature histories for DS-5 sample (cycle 100)

GP 73-0587 132

APPENDIX B: MODEL TEMPERATURE HISTORIES

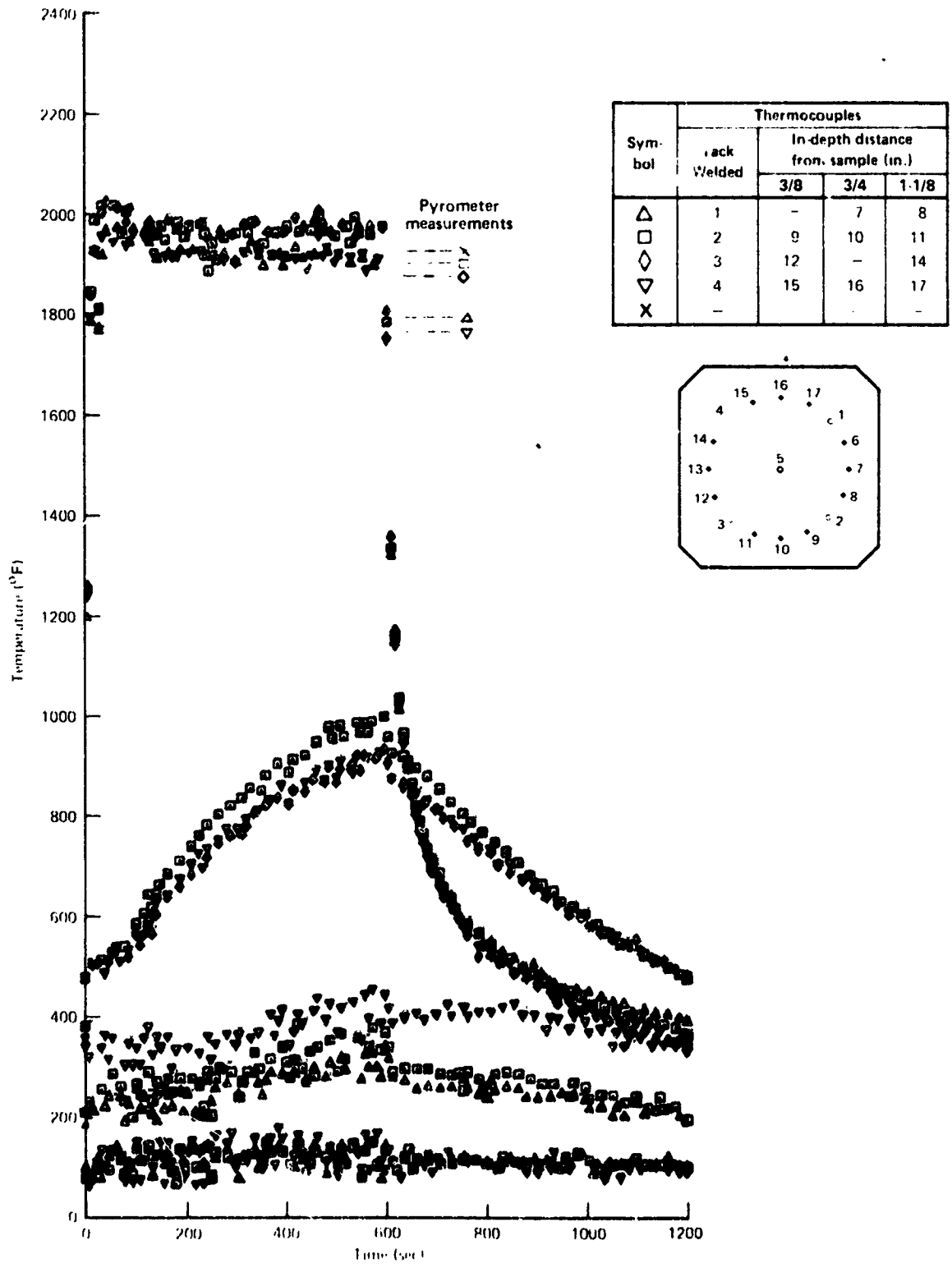


Fig. B-75 Typical temperature histories for DS-6 sample (cycle 25)

GP73-0587 1JJ

APPENDIX B: MODEL TEMPERATURE HISTORIES

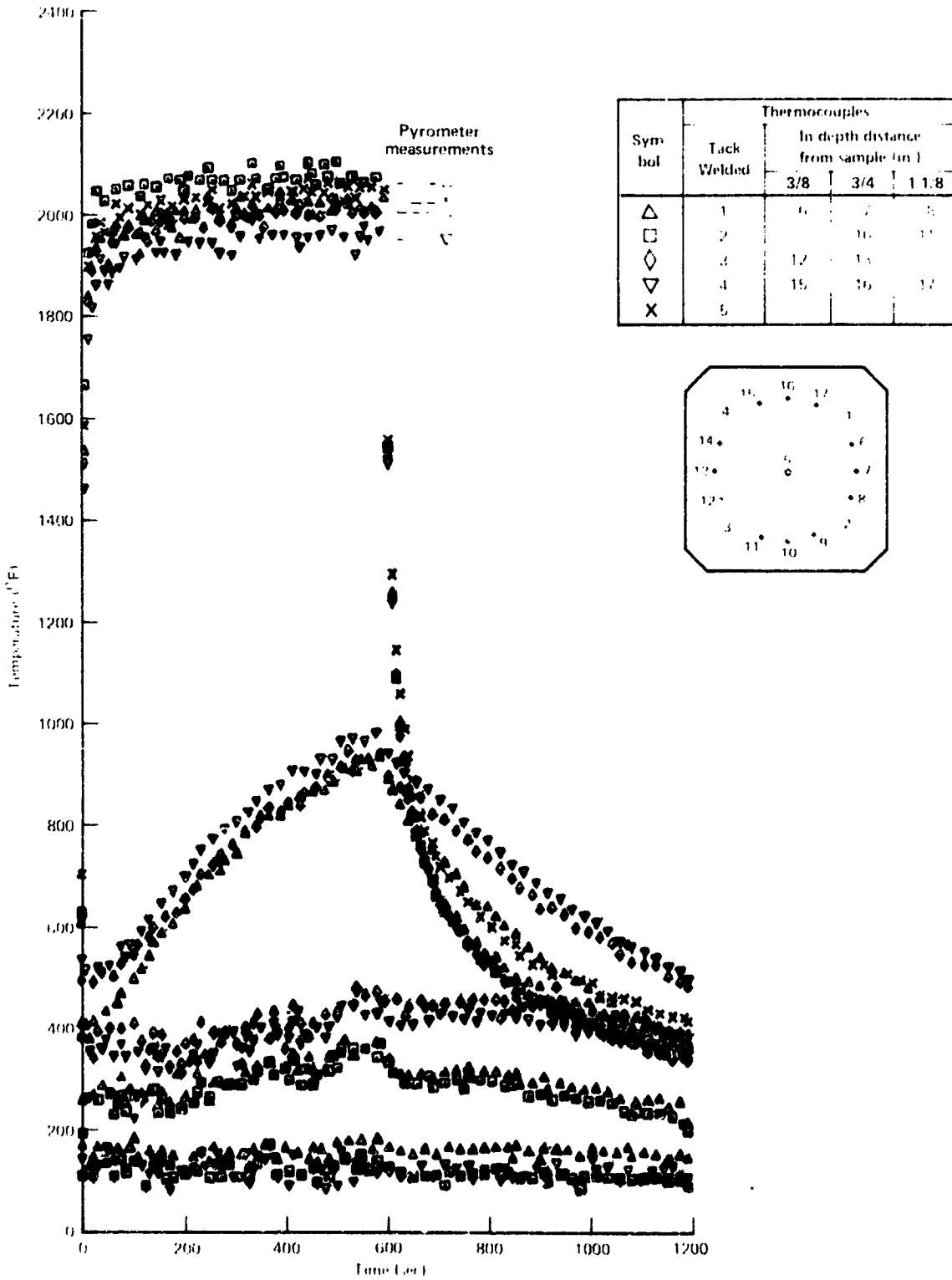


Fig. E-76 Typical temperature histories for DS-6 sample (cycle 50)

GP73-0587-134

APPENDIX B: MODEL TEMPERATURE HISTORIES

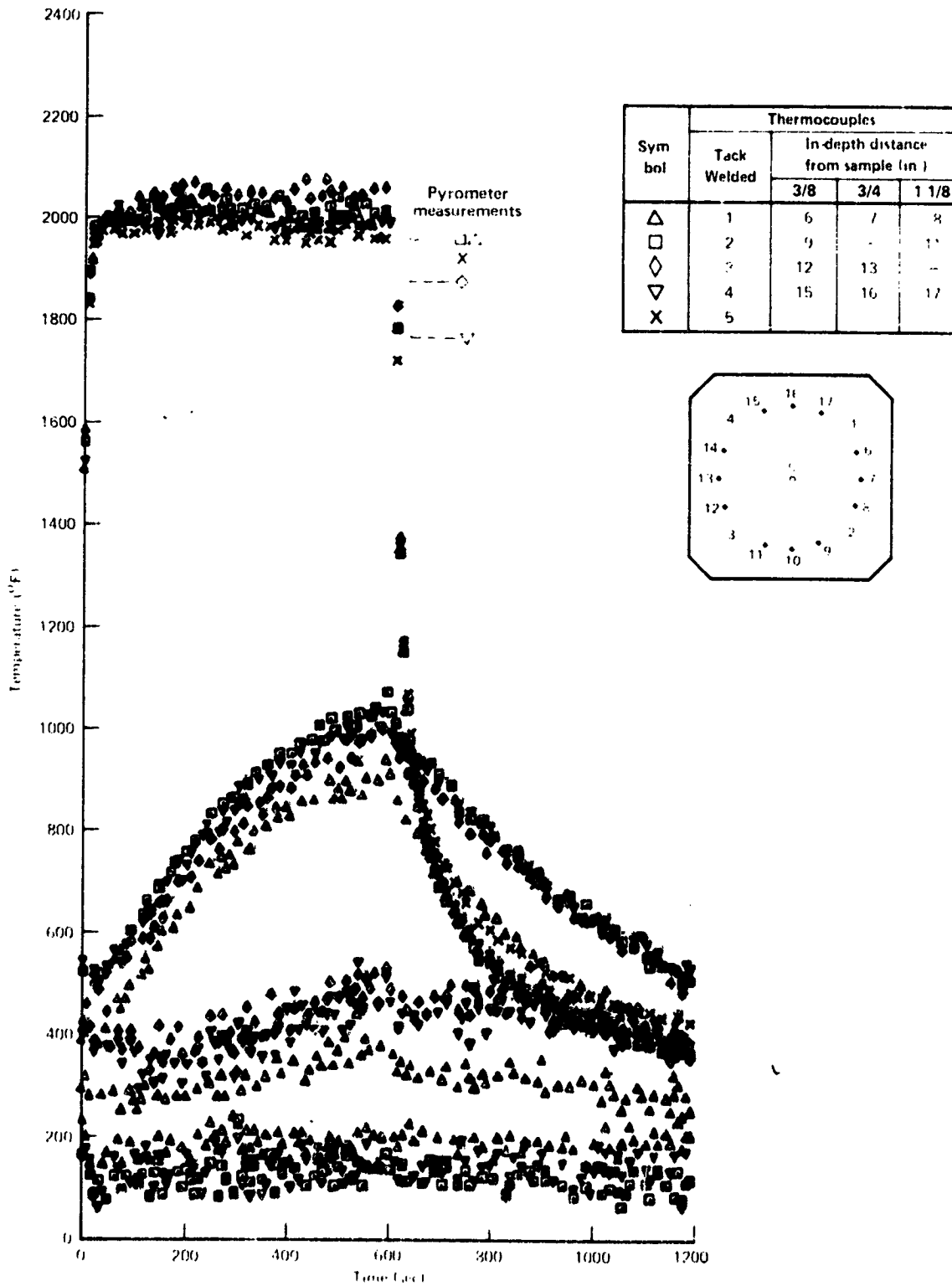


Fig. B-77 Typical temperature histories for DS-6 sample (cycle 73)

GP 73 0587 1 15

APPENDIX B: MODEL TEMPERATURE HISTORIES

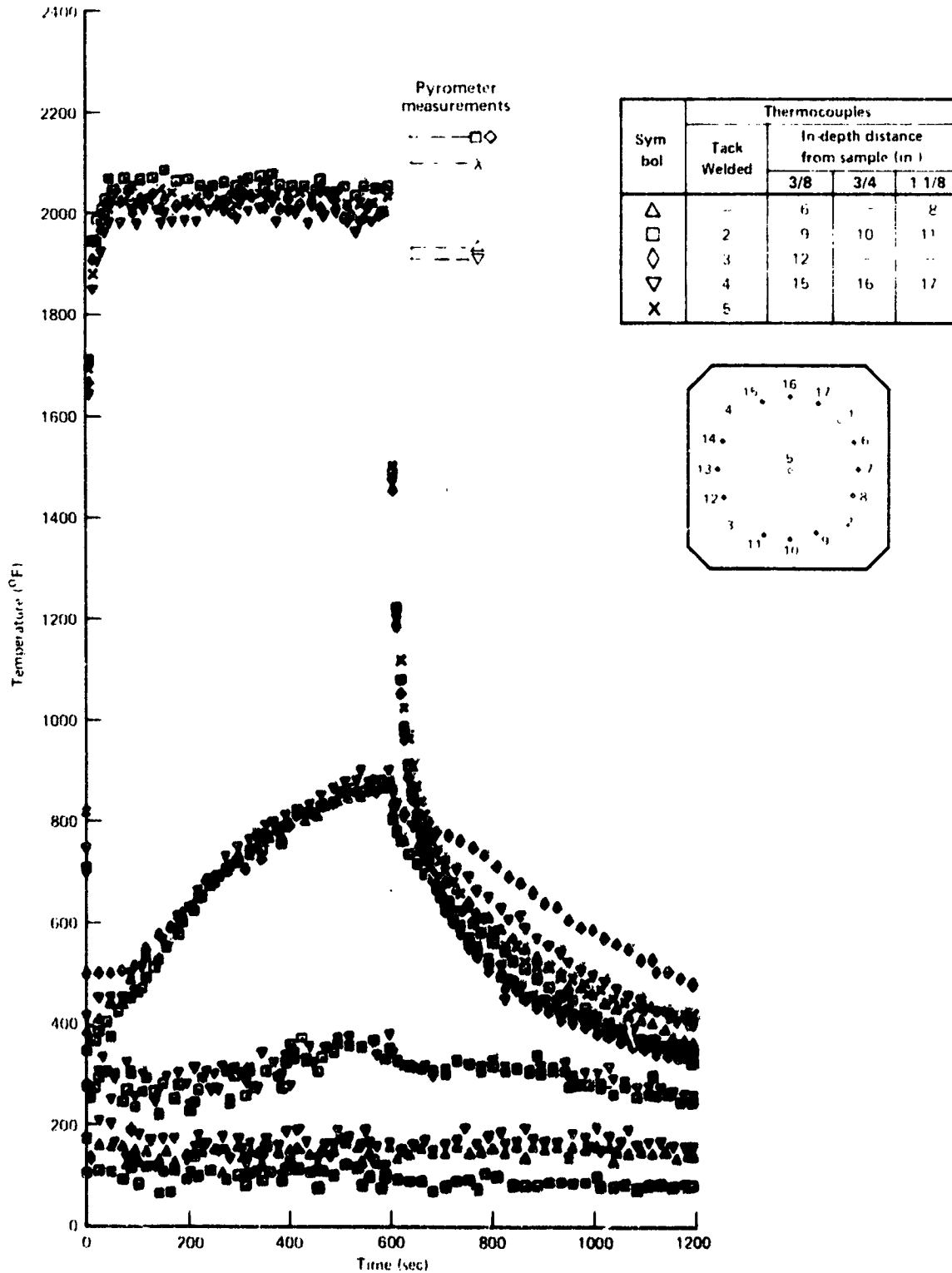


Fig. B-78 Typical temperature histories for DS-6 sample (cycle 100)

GP 73 058 7-136

APPENDIX B: MODEL TEMPERATURE HISTORIES

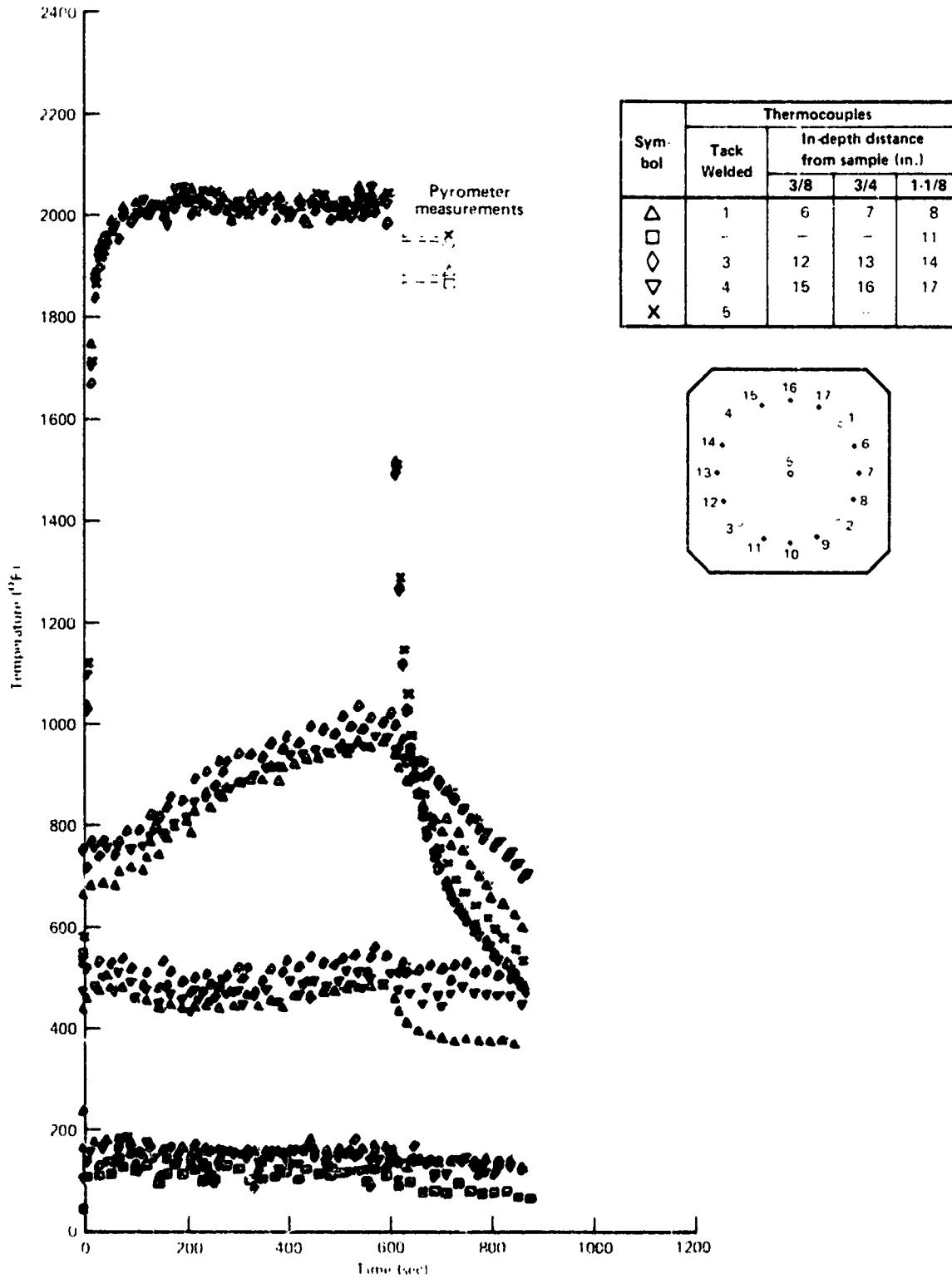


Fig. B-79 Typical temperature histories for HS-3 sample (cycle 15)

GP73 05R7 137

APPENDIX B: MODEL TEMPERATURE HISTORIES

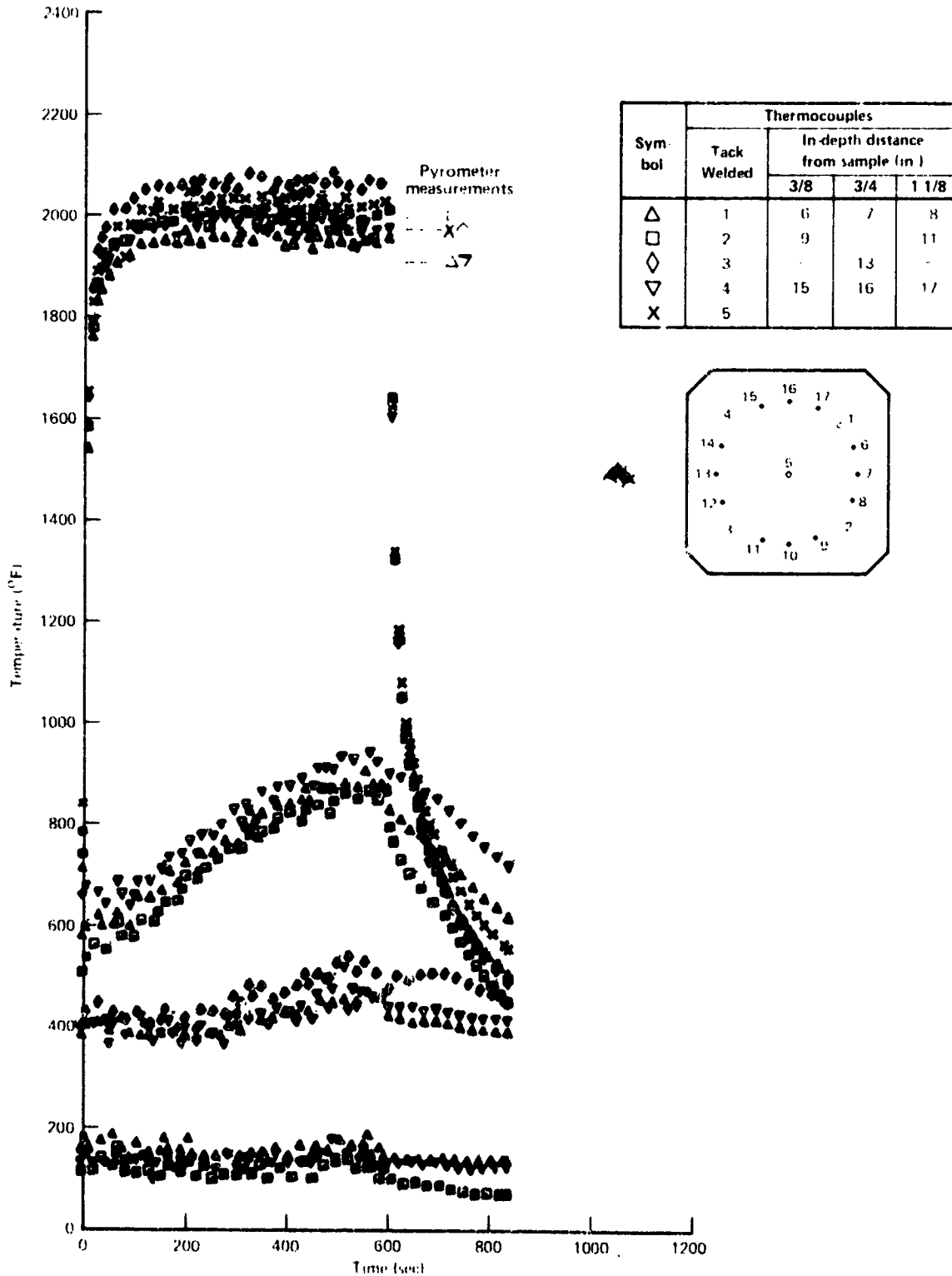


Fig. B-80 Typical temperature histories for HS-3 sample (cycle 30)

GP 73 05R 7 138

APPENDIX B: MODEL TEMPERATURE HISTORIES

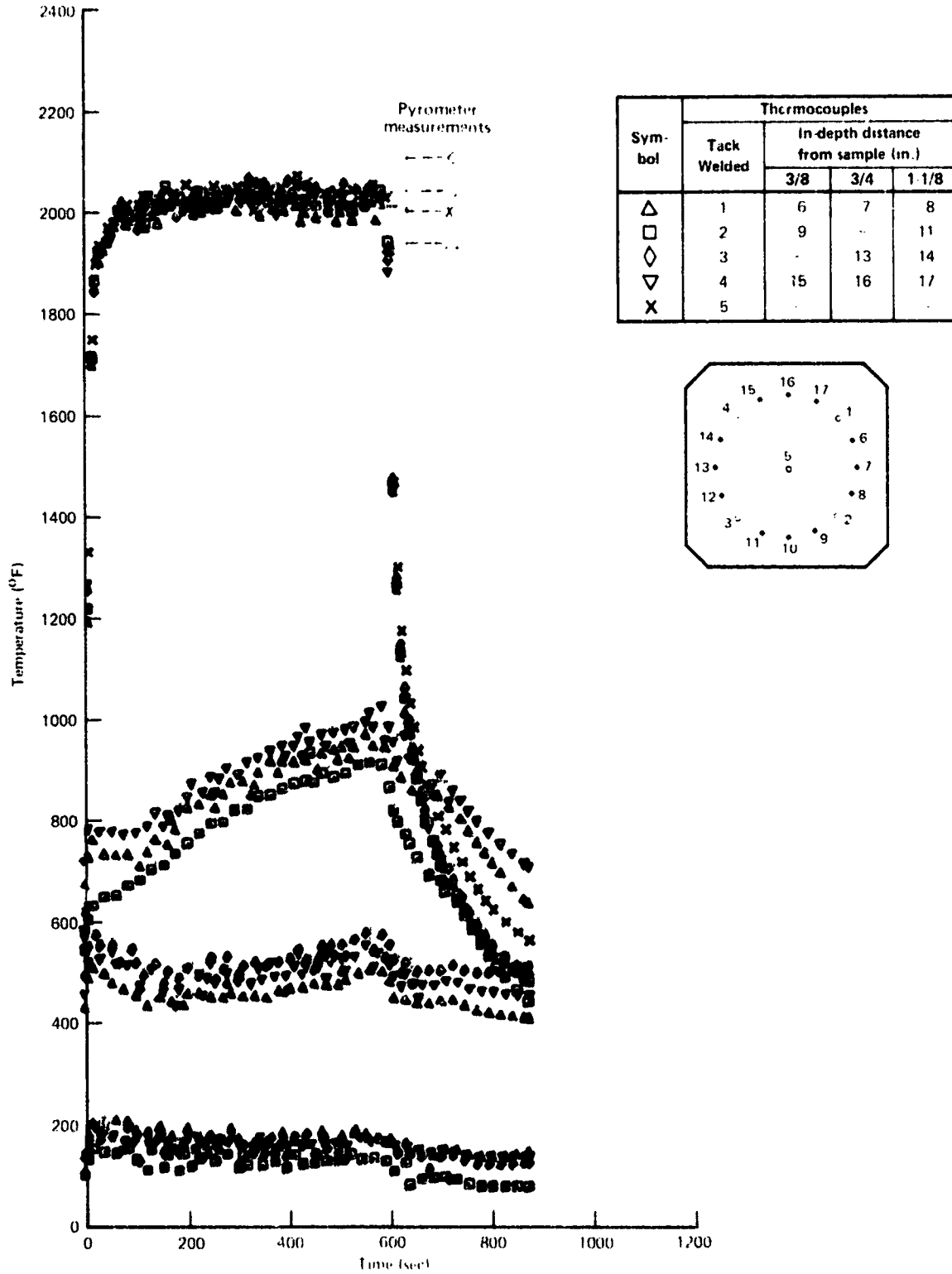


Fig. B-81 Typical temperature histories for HS-3 sample (cycle 50)

GP71 0587 139

Appendix C: Model weight and thickness changes

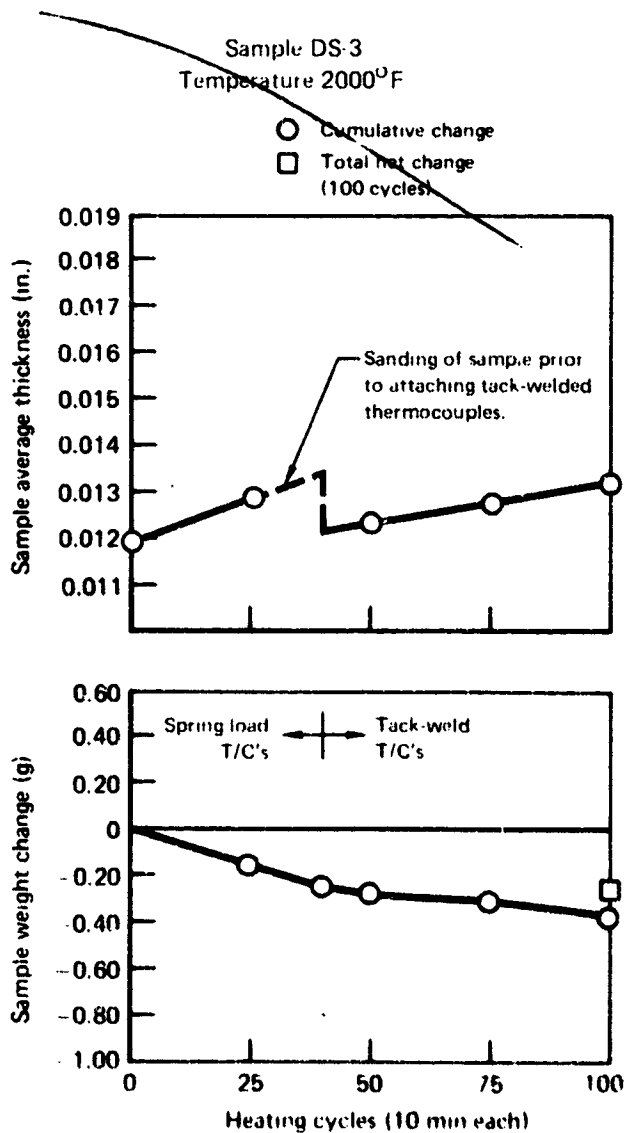


Fig. C-1 Sample weight and average thickness change

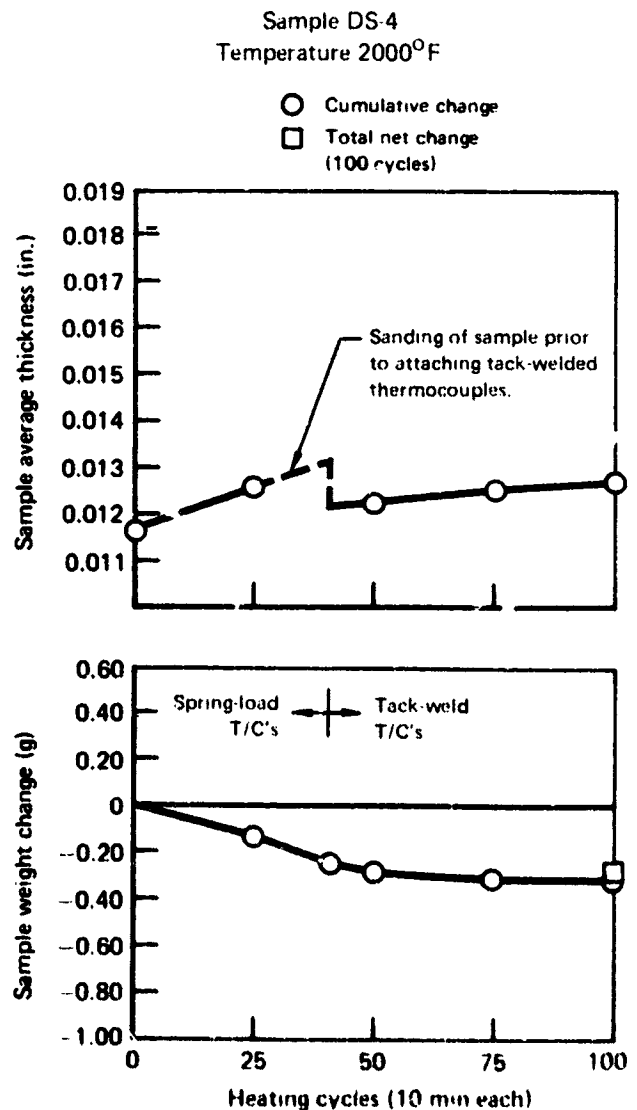


Fig. C-2 Sample weight and average thickness change

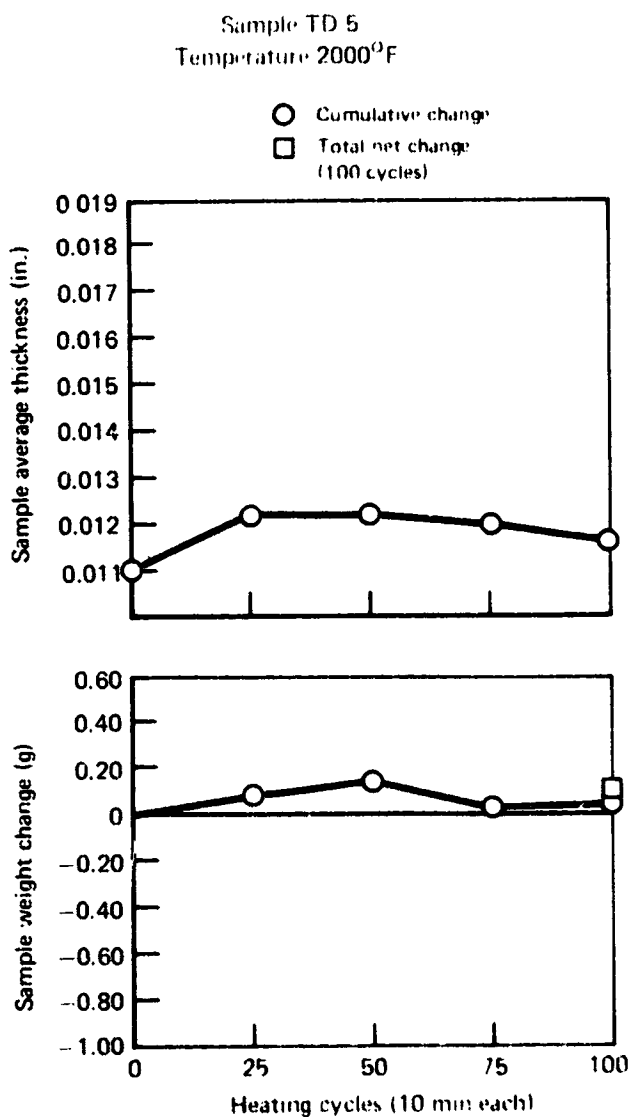


Fig. C-3 Sample weight and average thickness change

GP 73-0587 142

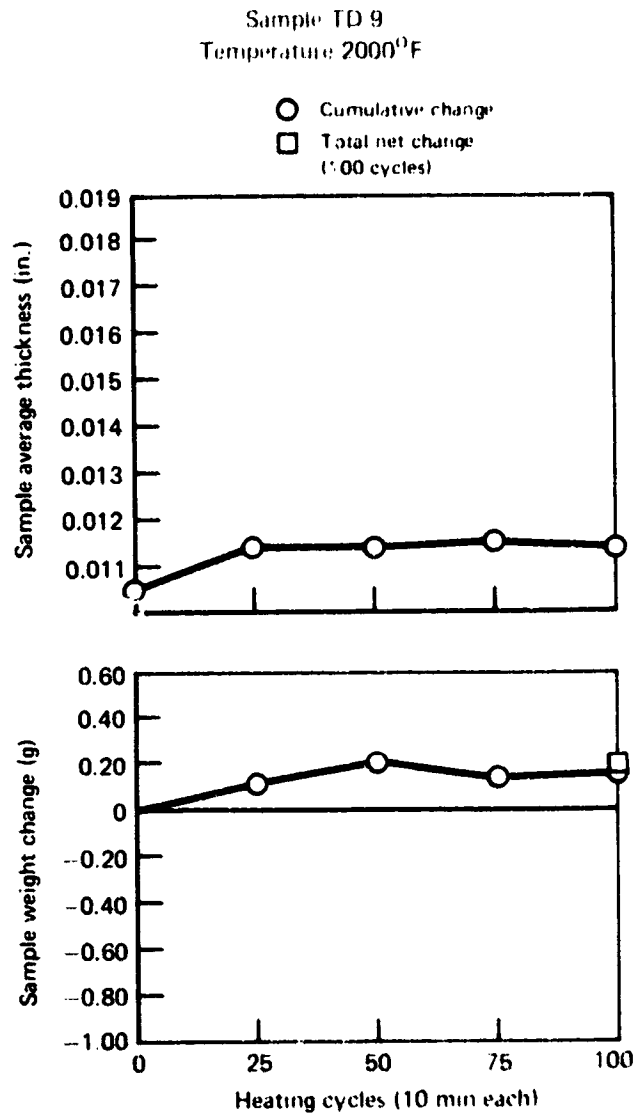


Fig. C-4 Sample weight and average thickness change

GP 73-0587 143

APPENDIX C: MODEL WEIGHT AND THICKNESS CHANGES

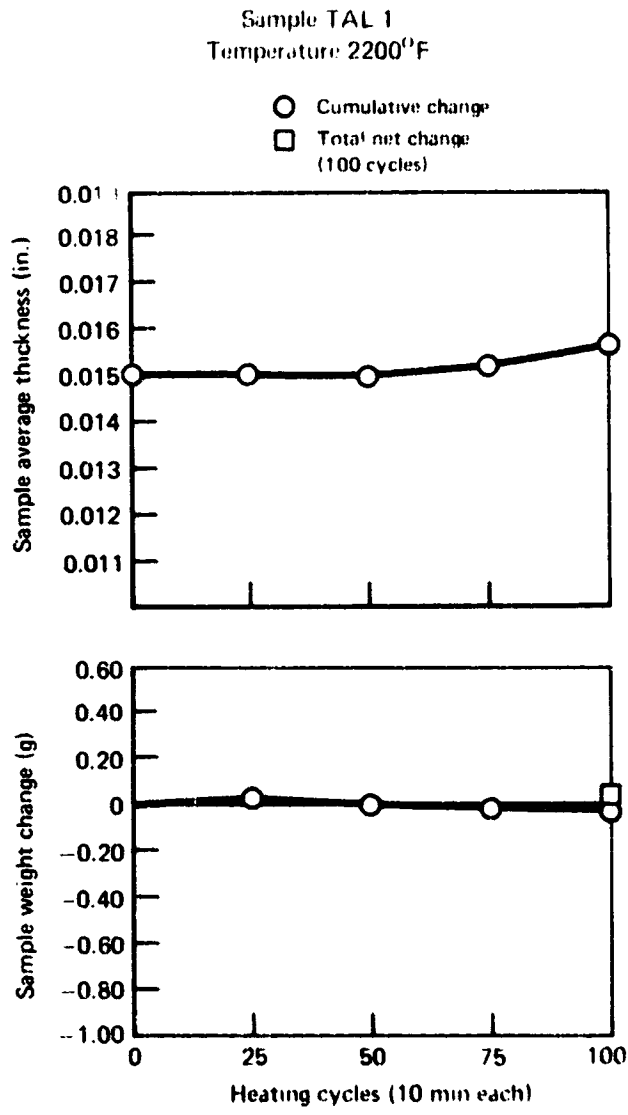


Fig. C-5 Sample weight and average thickness change

GP 73-0587-144

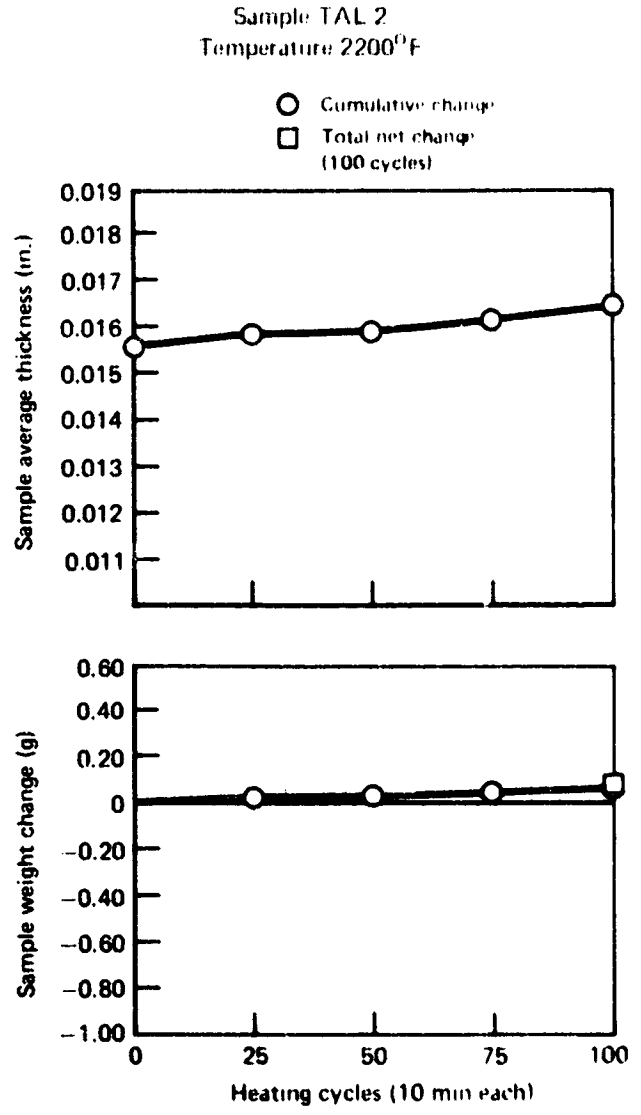


Fig. C-6 Sample weight and average thickness change

GP 73-0587-145

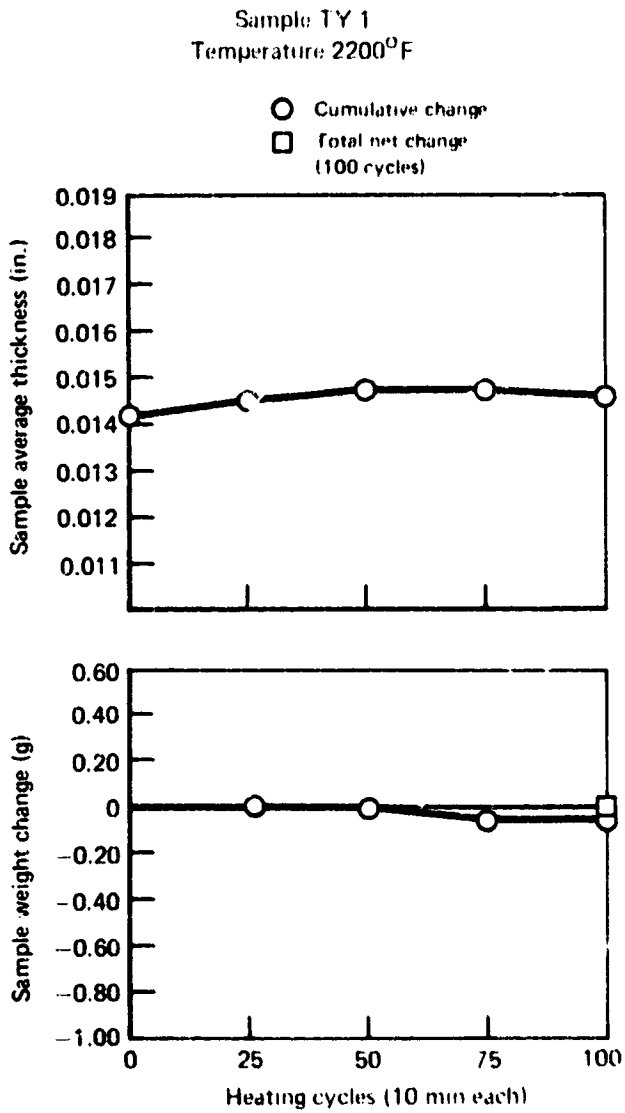


Fig. C-7 Sample weight and average thickness change

GP73-0587-146

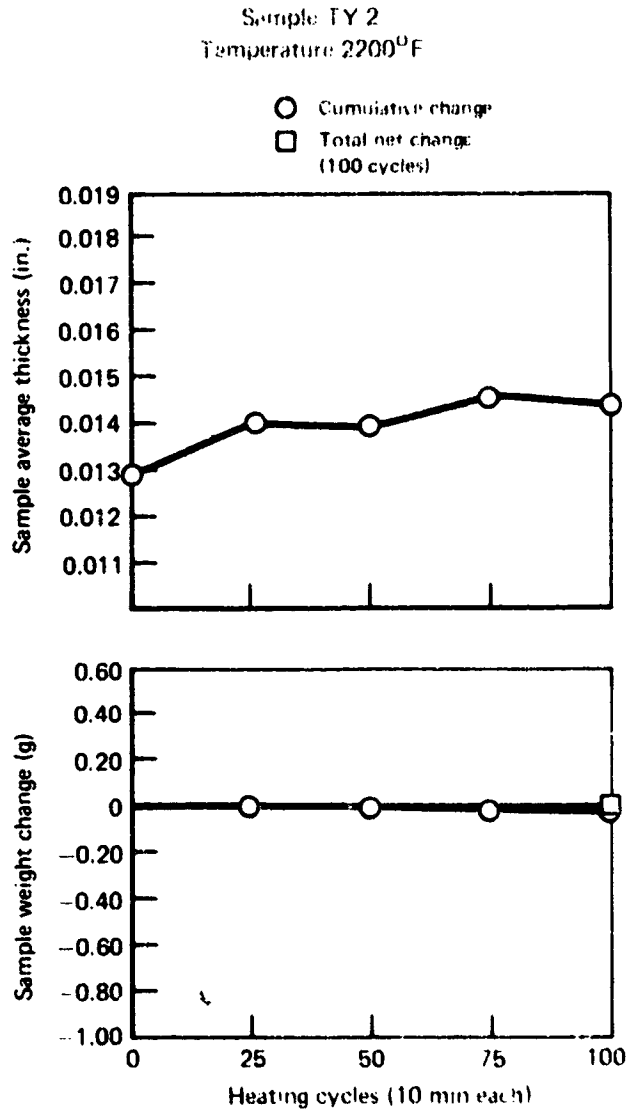


Fig. C-8 Sample weight and average thickness change

GP73-0587-147

APPENDIX C: MODEL WEIGHT AND THICKNESS CHANGES

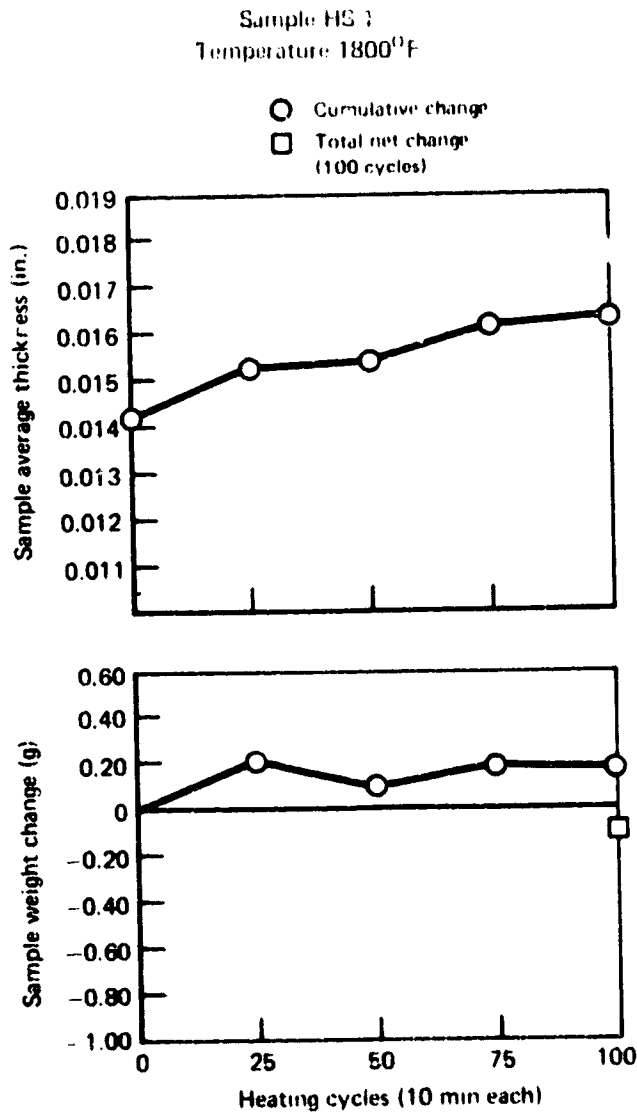


Fig. C-9 Sample weight and average thickness change

GP73-0587 148

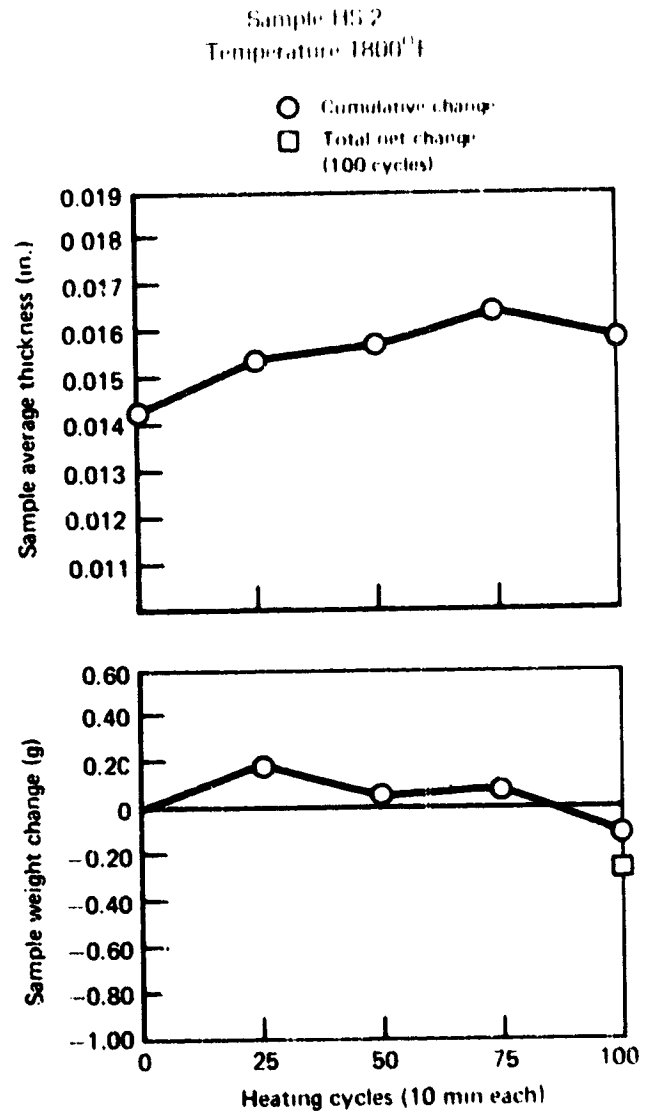


Fig. C-10 Sample weight and average thickness change

GP73-0587 149

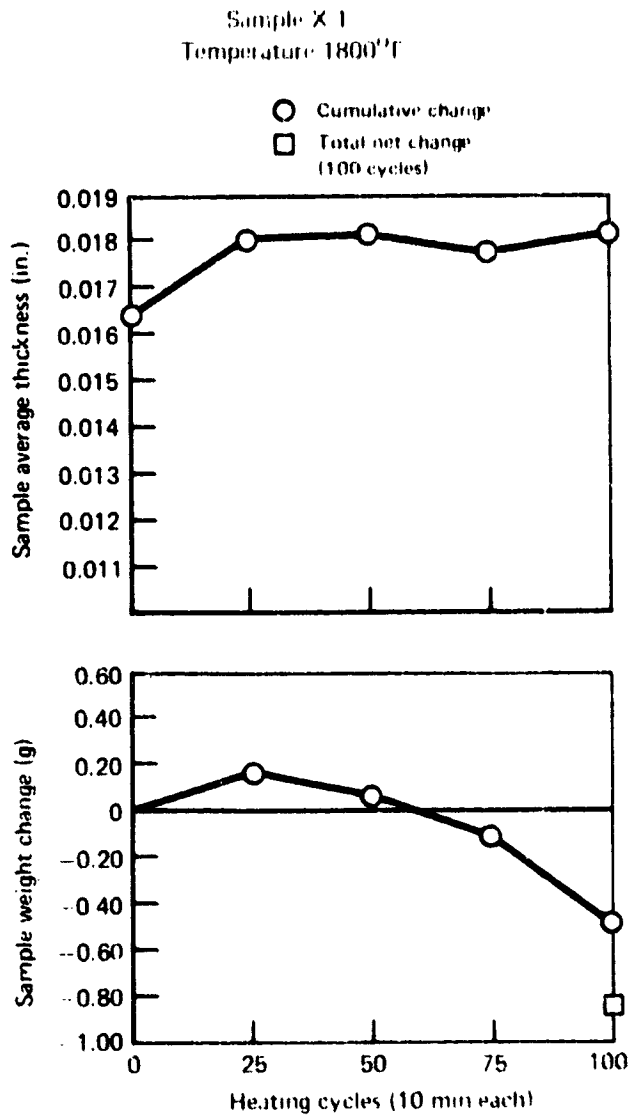


Fig. C-11 Sample weight and average thickness change

GP73-0587-11-0

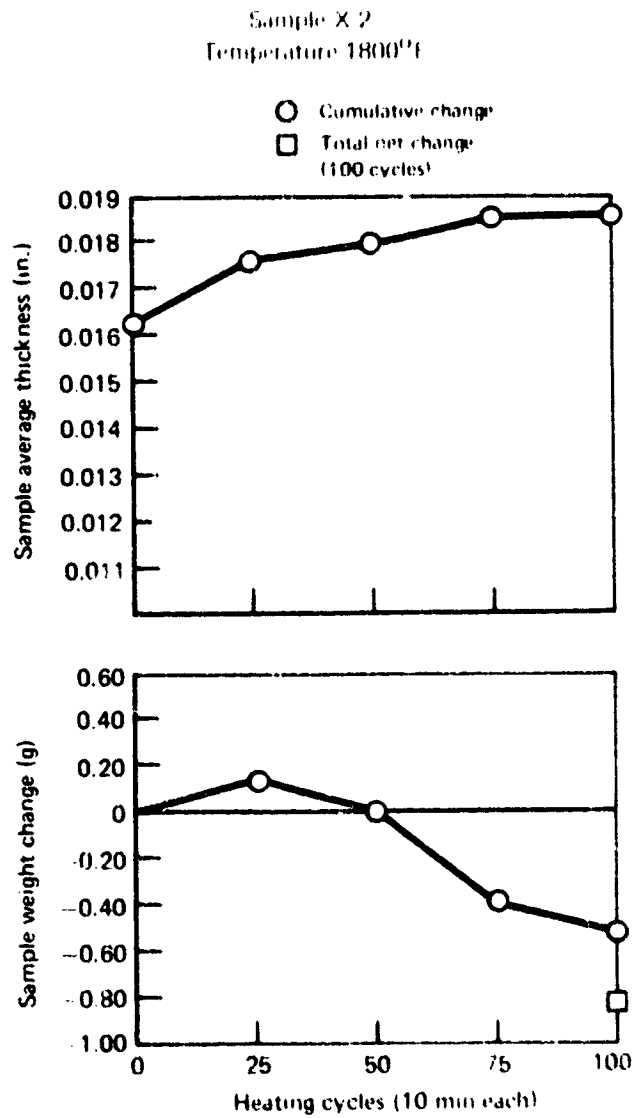


Fig. C-12 Sample weight and average thickness change

GP73-0587-15-1

APPENDIX C: MODEL WEIGHT AND THICKNESS CHANGES

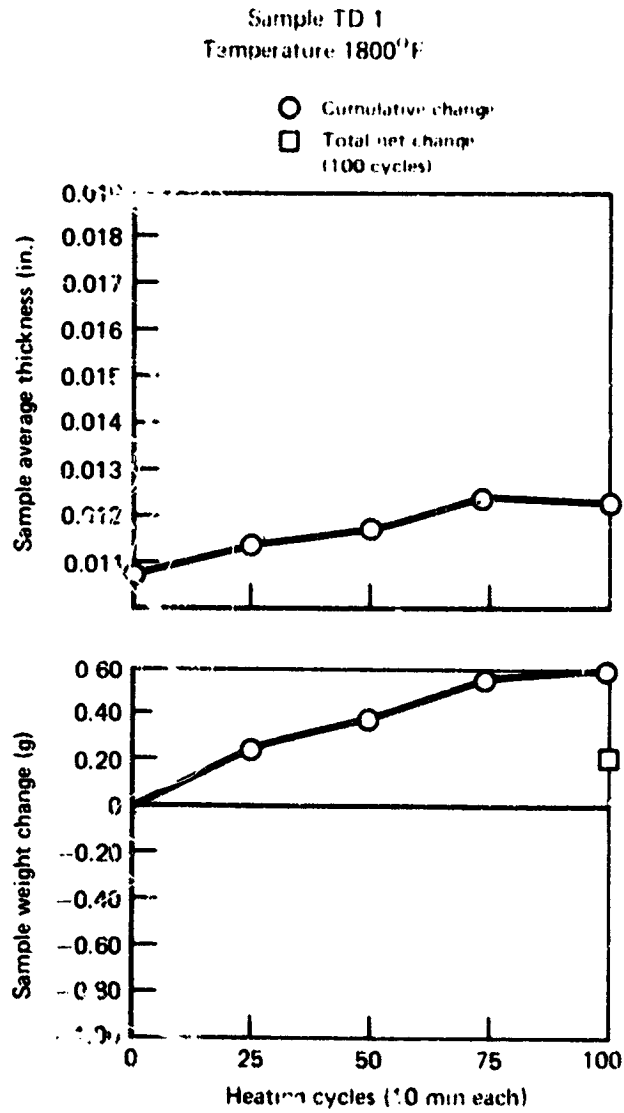


Fig. C-13 Sample weight and average thickness change

GP73-0587-152

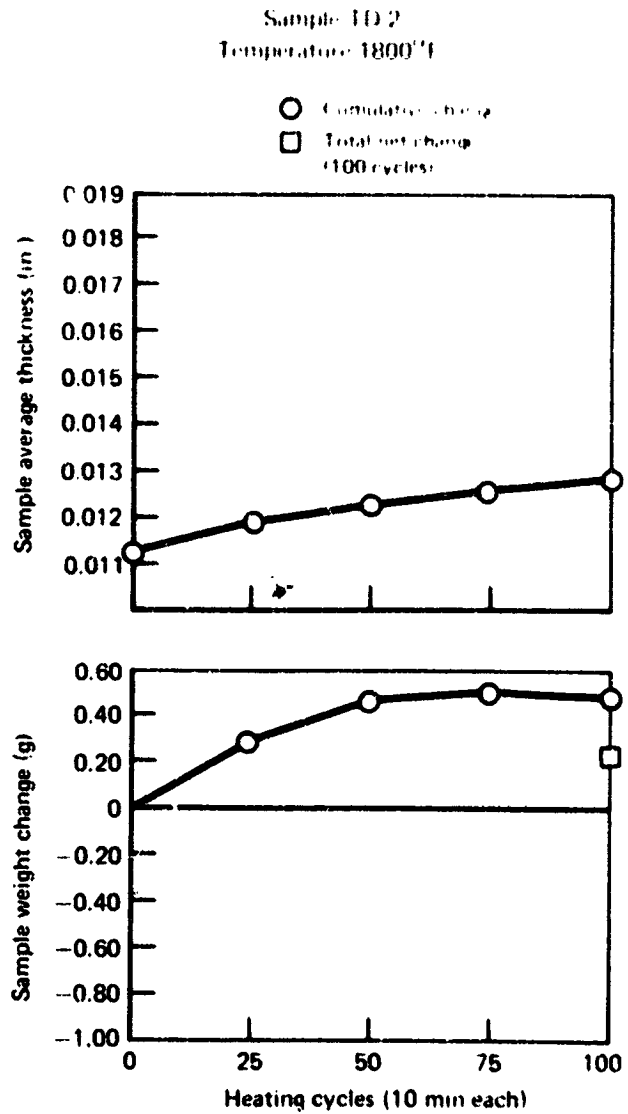


Fig. C-14 Sample weight and average thickness change

GP73-0587-153

APPENDIX C: MODEL WEIGHT AND THICKNESS CHANGES

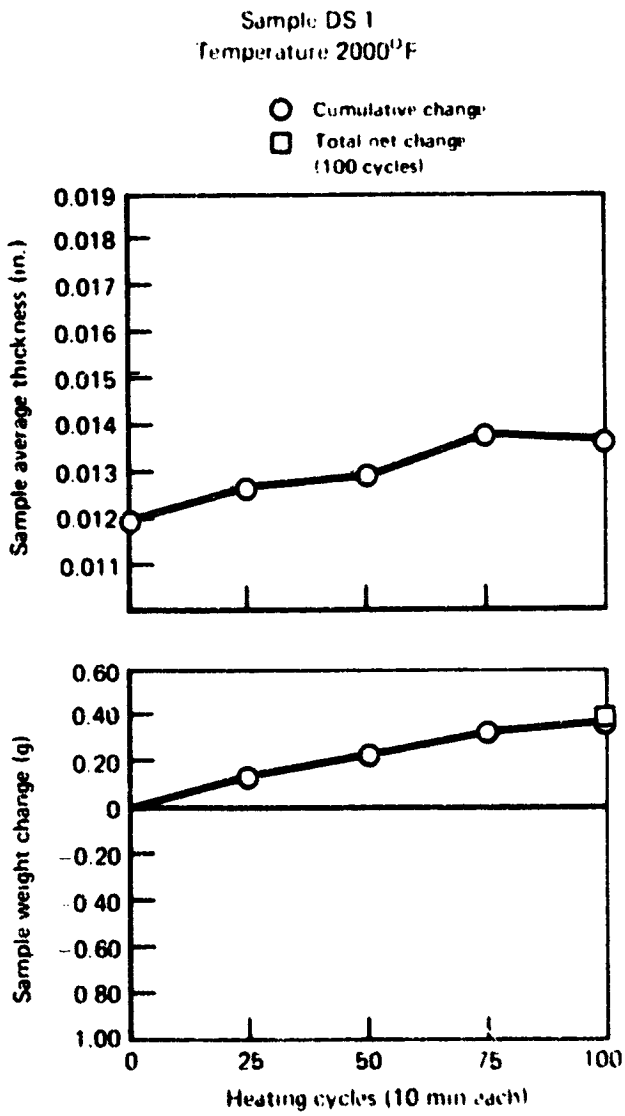


Fig. C-15 Sample weight and average thickness change

GP73 0587 154

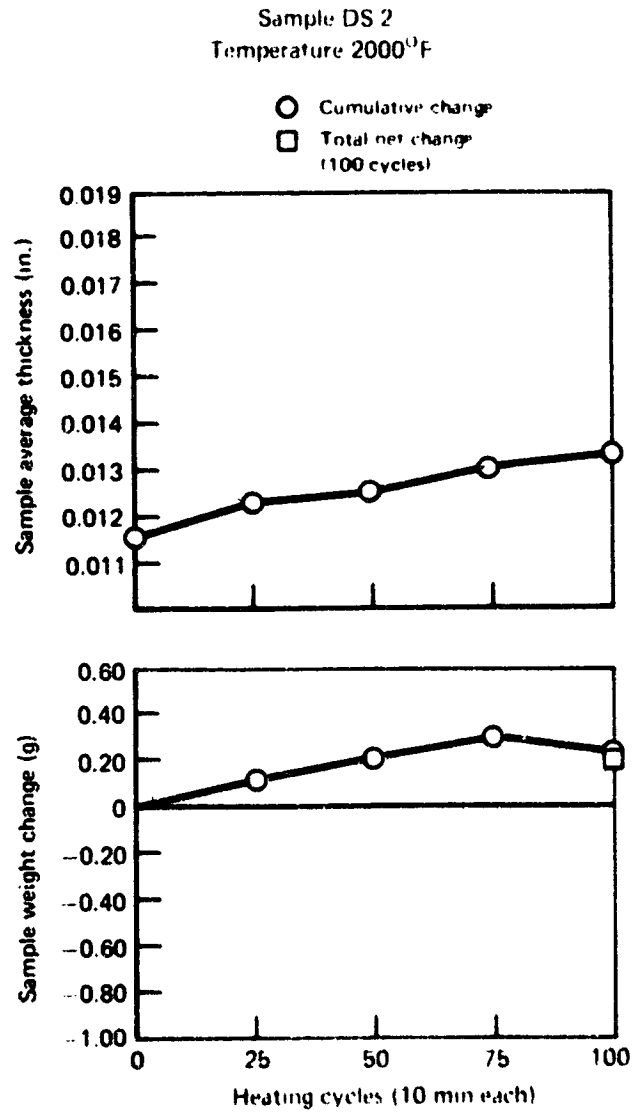


Fig. C-16 Sample weight and average thickness change

GP71 0587 155

APPENDIX C: MODEL WEIGHT AND THICKNESS CHANGES

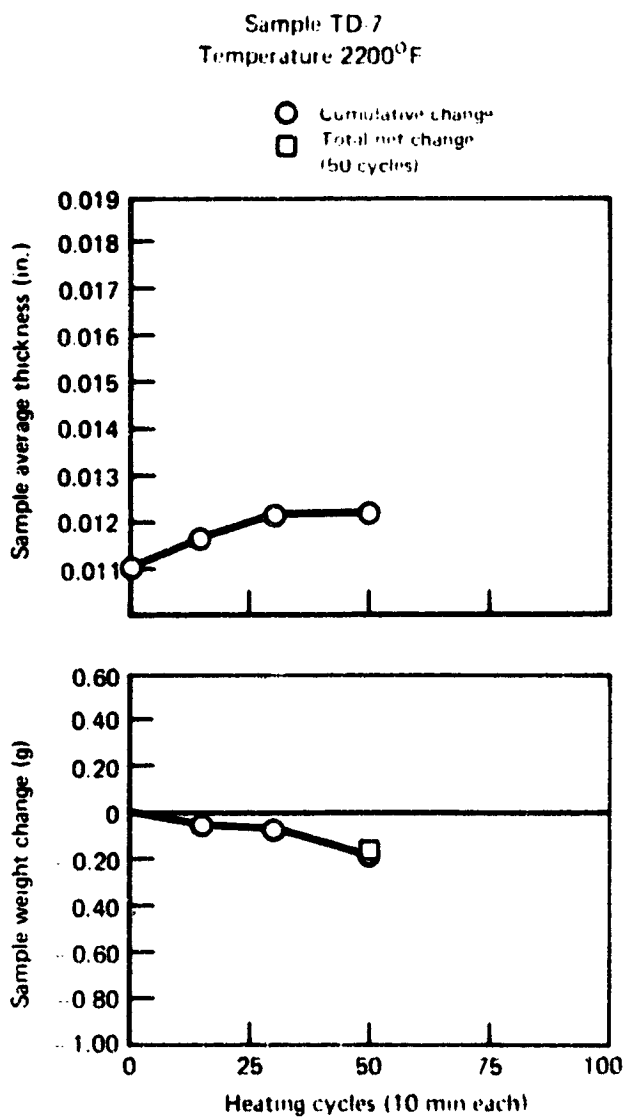


Fig. C-17 Sample weight and average thickness change

GP73 0587 156

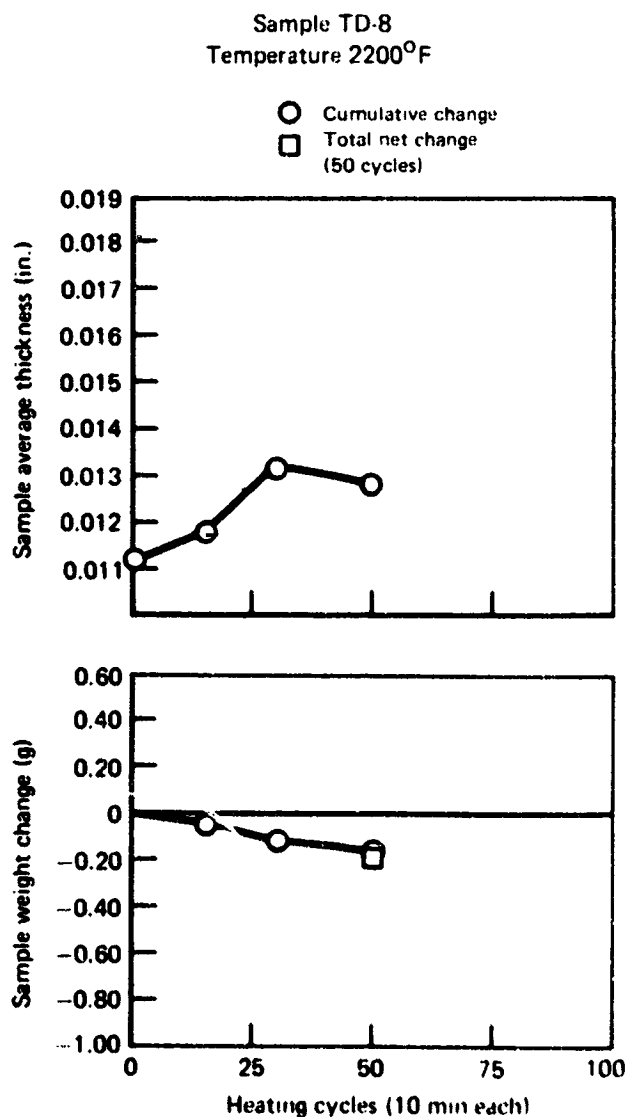


Fig. C-18 Sample weight and average thickness change

GP73 0587 157

APPENDIX C: MODEL WEIGHT AND THICKNESS CHANGES

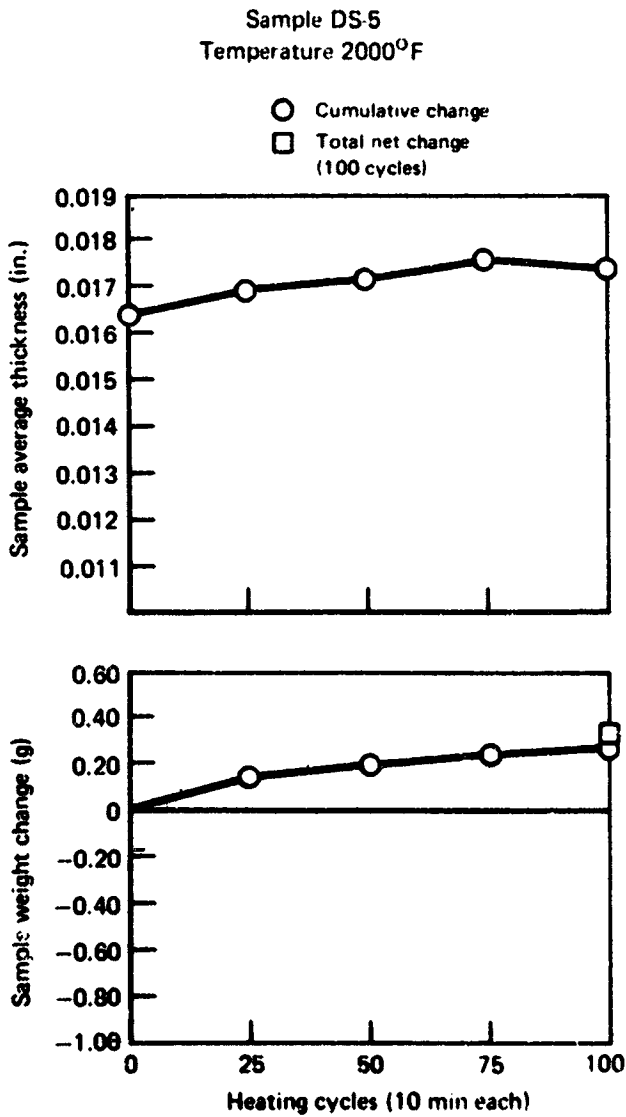


Fig. C-19 Sample weight and average thickness change

GP 73-0587-158

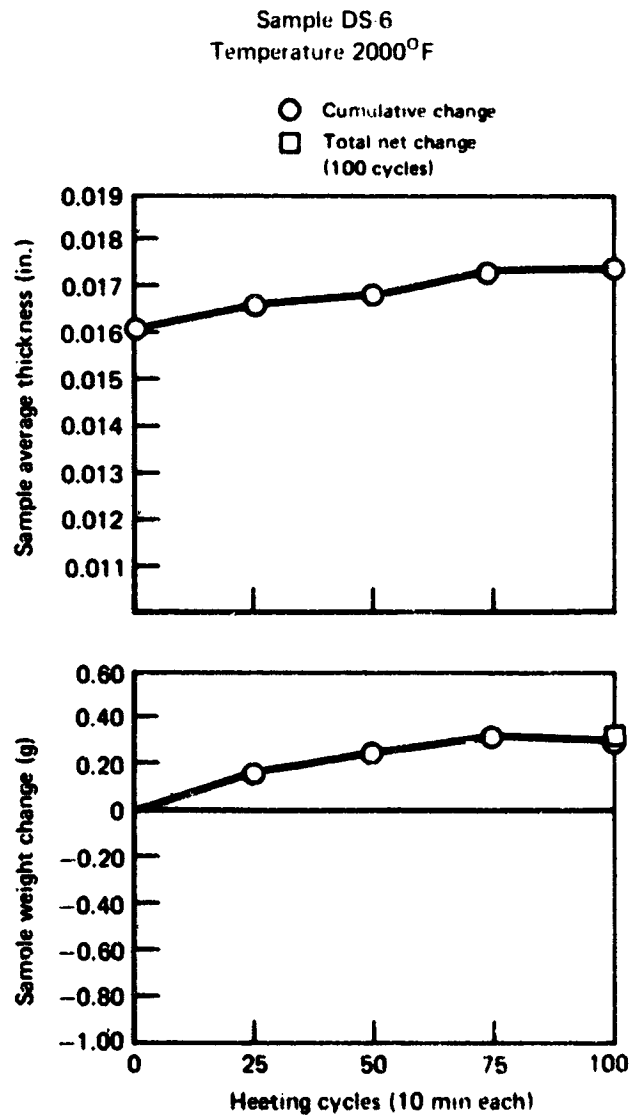


Fig. C-20 Sample weight and average thickness change

GP 73-0587-159

APPENDIX C: MODEL WEIGHT AND THICKNESS CHANGES

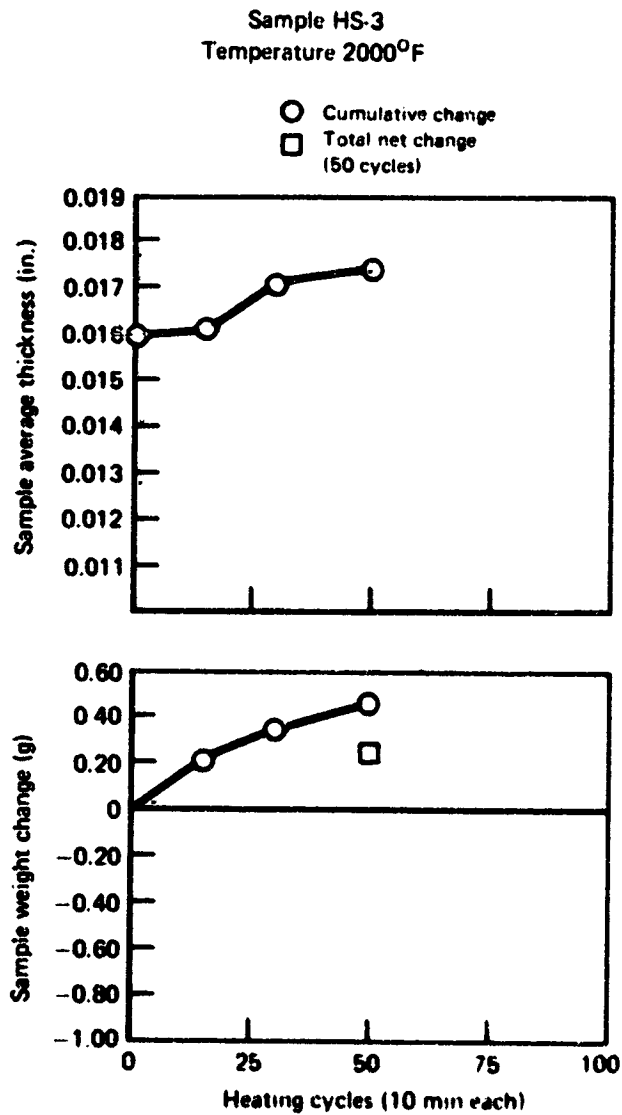


Fig. C-21 Sample weight and average thickness change

QP 73-0987-160