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SCIENTIFIC DIRECTOR'S REPORT

ANNEX 6.7

CONTAMINATION-DECONTAMINATION STUDIES

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1951

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Chief of Transportation Corps	70–74
Operations Research Office (Johns Hopkins University)	75–76

NAVY

Bureau of Aeronautics	77
Bureau of Medicine and Surgery	78
Bureau of Ships	79–80
Chief of Naval Operations	81
Commandant, Marine Corps	82
Naval Radiological Defense Laboratory	83–88

AIR FORCE

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Assistant for Materiel Program Control	99
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Director of Plans (AFOPD-P1)	102
Director of Requirements	103–104
Director of Research and Development	105–106
Eglin Air Force Base, Air Proving Ground	107–108
Ent Air Force Base, Air Defense Command	109–110
Kirtland Air Force Base, Special Weapons Command	111–113
Langley Air Force Base, Tactical Air Command	114–115
Maxwell Air Force Base, Air University	116–117
Offutt Air Force Base, Strategic Air Command	118–120
1009th Special Weapons Squadron	121
Rand Corporation	122–123
Scott Air Force Base, Air Training Command	124–125
Wright Air Development Center	126–128
Wright Air Materiel Command	129–130

ATOMIC ENERGY COMMISSION

Atomic Energy Commission, Washington	131–133
Los Alamos Scientific Laboratory, Report Library	134–148
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CONTAMINATION-DECONTAMINATION STUDIES

by

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U. S. Naval Radiological Defense Laboratory
San Francisco, California

Army Chemical Center
Maryland

August 1951

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Preface

These investigations were conducted by the United States Naval Radiological Defense Laboratory and the Army Chemical Corps. The studies were supported by funds supplied by Joint Task Force Three and were made possible by prior research sponsored by the Bureau of Ships, the Bureau of Yards and Docks, the Bureau of Aeronautics, and the Corps of Engineers.

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CONTENTS

Page

PREFACE v

ACKNOWLEDGMENTS vii

ABSTRACT 1

CHAPTER 1 INTRODUCTION 3

1.1 Objectives 3
1.2 Investigations 3
1.2.1 Contaminability-Decontaminability of Materials 3
1.2.2 Contamination-Decontamination Related to Surface Characteristics . 3
1.2.3 Industrial Decontamination Procedures 3
1.2.4 Evaluation of Decontamination Agents 3
1.2.5 Decontamination as a Function of Time 3
1.2.6 Influence of Prewetting on Decontamination Efficiency 3
1.2.7 Fractionation of the Contaminant in the Atomic Cloud or in the Contaminating Process 4
1.2.8 Preferential Removal of Contaminant Species in Decontamination Operations 4
1.3 Explanation of Objectives 4
1.3.1 Contaminability-Decontaminability of Materials 4
1.3.2 Contamination-Decontamination Related to Surface Characteristics . 4
1.3.3 Industrial Decontamination Procedures 5
1.3.4 Evaluation of Decontamination Agents 5
1.3.5 Decontamination as a Function of Time 5
1.3.6 Influence of Prewetting on Decontamination Efficiency 6
1.3.7 Fractionation of the Contaminant in the Atomic Cloud or in the Contaminating Process 6
1.3.8 Preferential Removal of Contaminant Species in Decontamination Operations 6

CHAPTER 2 EXPERIMENTAL PROCEDURES 7

2.1 Contamination of Samples 7
2.2 Removal of Materials from Aircraft and Preparation for Shipment to the Zone of the Interior 7
2.3 Experimental Procedures Employed in Each Investigation 8
2.3.1 Contaminability-Decontaminability of Materials 8
2.3.2 Contamination-Decontamination Related to Surface Characteristics . 9
2.3.3 Industrial Decontamination Procedures 13
2.3.4 Evaluation of Decontamination Agents 14
2.3.5 Decontamination as a Function of Time 15
2.3.6 Influence of Prewetting on Decontamination Efficiency 15
2.3.7 Fractionation of the Contaminant in the Atomic Cloud or in the Contamination Process 16
2.3.8 Preferential Removal of Contaminant Species in Decontamination Operations 16

[redacted]

[redacted]

CONTENTS (Continued)

Page

CHAPTER 3 RESULTS AND CONCLUSIONS 19

3.1 Results and Conclusions According to Investigation 19
3.1.1 Contaminability-Decontaminability of Materials 19
3.1.2 Contamination-Decontamination Related to Surface Characteristics . 23
3.1.3 Industrial Decontamination Procedures 29
3.1.4 Evaluation of Decontamination Agents 30
3.1.5 Decontamination as a Function of Time 32
3.1.6 Influence of Prewetting on Decontamination Efficiency 32
3.1.7 Fractionation of the Contaminant in the Atomic Cloud or in the Contaminating Process 36
3.1.8 Preferential Removal of Contaminant Species in Decontamination Operations 38
3.2 Conclusions 39

APPENDIX A POSITION OF EXPERIMENTAL MATERIALS ON AIRCRAFT . . 41

A.1 Abbreviations 41
A.2 Position of Materials Used by the USNRDL 42
A.3 Position of Materials Used by the ACC 45

APPENDIX B COMPOSITION, SURFACE CHARACTER, AND SOURCE OF EXPERIMENTAL MATERIALS 51

B.1 Materials Used in Individual Investigations 51
B.2 Composition and Source of Experimental Materials Used by the USNRDL . 51
B.2.1 Metals and Glass 51
B.2.2 Plastics and Protective Coatings 53
B.3 Surface Properties of Materials Used by the USNRDL 56
B.4 Source and Surface Characteristics of the Experimental Materials Used by the ACC 58

APPENDIX C CONTAMINABILITY AND DECONTAMINABILITY OF MATERIALS 59

C.1 Materials Exposed by USNRDL 59
C.2 Materials Exposed by ACC 71

APPENDIX D CONTAMINATION-DECONTAMINATION RELATED TO SURFACE CHARACTERISTICS 75

D.1 Fabrication and Measurement of Test Surfaces 75
D.2 Statistical Analysis of Data 76
D.2.1 Variance Due to Surface Characteristics Taken Individually . . 76
D.2.2 Variance Due to Surface Characteristics Interaction 77

APPENDIX E CONTAMINATION-DECONTAMINATION RELATED TO SURFACE CHARACTERISTICS 79

E.1 Derived Data from Dog, Easy, George, and Item Shots 79

[redacted]

CONTENTS (Continued)

Page

APPENDIX F CONTAMINATION-DECONTAMINATION RELATED TO SURFACE CHARACTERISTICS 89

F.1 Variance Due to Surface Characteristics Taken in Pairs 89
F.1.1 Initial Contamination 89
F.1.2 Per Cent Decontamination 89
F.1.3 Residual Contamination 89
F.1.4 Mean Values for Initial Contamination, Residual Contamination, and Per Cent Decontamination for All Shots Combined 90
F.2 Variance Due to Surface Characteristics Taken Three at a Time . . . 90
F.2.1 Initial Contamination 90
F.2.2 Per Cent Decontamination 91
F.2.3 Residual Contamination 91

APPENDIX G EVALUATION OF DECONTAMINATION AGENTS 93

G.1 Effectiveness of Decontamination Agents Employed by the ACC . . . 93
G.2 Evaluation of Decontamination Agents Employed by the USNRDL . . . 94

APPENDIX H DECONTAMINATION AS A FUNCTION OF TIME 97

H.1 Introduction 97
H.1.1 Dog Shot 97
H.1.2 Easy Shot 100
H.1.3 George Shot 103

APPENDIX I INFLUENCE OF PREWETTING ON DECONTAMINATION EFFICIENCY 105

APPENDIX J PREFERENTIAL REMOVAL OF CONTAMINANT SPECIES IN DECONTAMINATION OPERATIONS 109

J.1 Introduction 109
J.1.1 Dog Shot 109
J.1.2 Easy Shot 110
J.1.3 George Shot 116

APPENDIX K FRACTIONATION OF THE CONTAMINANT IN THE ATOMIC CLOUD OR IN THE CONTAMINATION PROCESS 117

APPENDIX L PERSONNEL LOGISTICS 119

L.1 Roster of Personnel 119
L.2 Shipping Schedules 121

[redacted]

ILLUSTRATIONS

Page

CHAPTER 2 EXPERIMENTAL PROCEDURES

2.1 Location and Position Number of USNRDL Panels—Wing 123
2.2 Location and Position Number of USNRDL Panels—Horizontal Stabilizer . 124
2.3 Location and Position Number of ACC Panels—Wing 125
2.4 Location and Position Number of ACC Panels—Horizontal Stabilizer . . 126
2.5 Attachment of Test Panels to Drone Aircraft 127
2.6 Attachment of USNRDL 1¼-in. Test Plates to Panels 128
2.7 Container Used to Ship Radioactive Test Panels 129
2.8 Decontamination Unit 130
2.9 Shielded Directional End-window Detector 131
2.10 Schematic Diagram of End-window Detector 132
2.11 Shielded Caves Employed in Making Autoradiographs 133
2.12 Apparatus Used to Measure Autoradiograph Film Density 134
2.13 Brushing Decontamination Apparatus 135
2.14 Brushing Technique Used in Investigation of Industrial Decontamination Procedures 136
2.15 Large Probe and Auxiliary Counting Equipment Used in Studies of Industrial Decontamination Procedures 137
2.16 Automatic Absorber Changer 138

CHAPTER 3 RESULTS AND CONCLUSIONS

3.1 Reproductions of Autoradiographs of Small Plates prior to Decontamination . 139
3.2 Reproductions of Autoradiographs of Small Plates after Decontamination . 140
3.3 Contaminant Distribution on and about Aluminum Building 141
3.4 Contaminant Distribution at Base of B–50 Hangar 142
3.5 Decontamination of Sea-blue Paint by Industrial Procedures 143
3.6 Decontamination of Aluminized Paint by Industrial Procedures . . . 144
3.7 Decontamination of Alclad Aluminum by Industrial Procedures . . . 145
3.8 Decontamination of OD Paint by Industrial Procedures 146
3.9 Reproduction of Autoradiograph of Panel before Decontamination—Position 22, Dog Shot, 24,000 ft (Plane 5) 147
3.10 Reproduction of Autoradiograph of Panel after Decontamination—Position 22, Dog Shot, 24,000 ft (Plane 5) 148
3.11 Reproduction of Autoradiograph of Panel before Decontamination—Position 18, Dog Shot, 20,000 ft (Plane 3) 149
3.12 Reproduction of Autoradiograph of Panel after Decontamination—Position 18, Dog Shot, 20,000 ft (Plane 3) 150
3.13 Decontamination as a Function of Time—OD Paint, Dog Shot, Contaminated at 16,000 ft 151
3.14 Decontamination as a Function of Time—Aluminum Surface, Dog Shot, Contaminated at 20,000 ft 152
3.15 Decontamination as a Function of Time—Aluminum Surface, Dog Shot, Contaminated at 28,000 ft 153

[redacted]

ILLUSTRATIONS (Continued)

Page

3.16 Decontamination as a Function of Time—Aluminum Surface, Easy Shot, Contaminated at 20,000 ft 154
3.17 Decontamination as a Function of Time—OD Paint, Easy Shot, Contaminated at 24,000 ft 155
3.18 Decontamination as a Function of Time—Aluminum Surface, Easy Shot, Contaminated at 30,000 ft 156
3.19 Decontamination as a Function of Time—Aluminum Surface, George Shot, Contaminated at 28,000 ft 157
3.20 Decay of Radioactive Material Deposited on Aircraft—Dog Shot . . . 158
3.21 Decay of Radioactive Material Deposited on Aircraft—Easy Shot . . . 159
3.22 Decay of Radioactive Material Deposited on Aircraft—George Shot . . . 160

APPENDIX J PREFERENTIAL REMOVAL OF CONTAMINANT SPECIES IN DECONTAMINATION OPERATIONS

J.1 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Dog Shot, Counted through 55.7-mg/sq cm Aluminum Absorber 161
J.2 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Dog Shot, Counted through 70.3-mg/sq cm Aluminum Absorber 162
J.3 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Dog Shot, Counted through 109-mg/sq cm Aluminum Absorber 163
J.4 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Dog Shot, Counted through 176-mg/sq cm Aluminum Absorber 164
J.5 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Dog Shot, Counted through 217-mg/sq cm Aluminum Absorber 165
J.6 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Dog Shot, Counted through 348-mg/sq cm Aluminum Absorber 166
J.7 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Dog Shot, Counted through 692-mg/sq cm Aluminum Absorber 167
J.8 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Dog Shot, Counted through 2,059-mg/sq cm Aluminum Absorber . . . 168
J.9 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 2.6-mg/sq cm Aluminum Absorber . . . 169
J.10 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 3.7-mg/sq cm Aluminum Absorber 170
J.11 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 4.6-mg/sq cm Aluminum Absorber 171
J.12 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 5.2-mg/sq cm Aluminum Absorber 172
J.13 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 7.9-mg/sq cm Aluminum Absorber 173
J.14 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 11.7-mg/sq cm Aluminum Absorber 174
J.15 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 13.0-mg/sq cm Aluminum Absorber 175

[redacted]

ILLUSTRATIONS (Continued)

		Page
J.16	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 16.3-mg/sq cm Aluminum Absorber	176
J.17	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 20.5-mg/sq cm Aluminum Absorber	177
J.18	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 28.5-mg/sq cm Aluminum Absorber	178
J.19	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 32.4-mg/sq cm Aluminum Absorber	179
J.20	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 55.7-mg/sq cm Aluminum Absorber	180
J.21	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 55.7-mg/sq cm Aluminum Absorber (Site Work)	181
J.22	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 83.2-mg/sq cm Aluminum Absorber (Site Work)	182
J.23	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 85.4-mg/sq cm Aluminum Absorber	183
J.24	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 112-mg/sq cm Aluminum Absorber	184
J.25	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 138-mg/sq cm Aluminum Absorber	185
J.26	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 208-mg/sq cm Aluminum Absorber	186
J.27	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 219-mg/sq cm Aluminum Absorber (Site Work)	187
J.28	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 287-mg/sq cm Aluminum Absorber	188
J.29	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 433-mg/sq cm Aluminum Absorber (Site Work)	189
J.30	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 446-mg/sq cm Aluminum Absorber	190
J.31	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 545-mg/sq cm Aluminum Absorber (Site Work)	191
J.32	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 692-mg/sq cm Aluminum Absorber	192
J.33	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 2,059-mg/sq cm Aluminum Absorber	193
J.34	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, George Shot, Counted through 83.2-mg/sq cm Aluminum Absorber (Site Work)	194
J.35	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, George Shot, Counted through 219-mg/sq cm Aluminum Absorber (Site Work)	195
J.36	Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, George Shot, Counted through 679-mg/sq cm Aluminum Absorber (Site Work)	196

[redacted]

ILLUSTRATIONS (Continued)

Page

J.37 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, George Shot, Counted through 1,610-mg/sq cm Aluminum Absorber (Site Work) 197

J.38 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, George Shot, Counted through 3,380-mg/sq cm Aluminum Absorber (Site Work) 198

TABLES

Page

CHAPTER 2 EXPERIMENTAL PROCEDURES

2.1 Materials Used by the ACC to Investigate Surface Characteristics . . . 10

2.2 Chemical Agents Used in Investigations of Decontamination Agents . . 11

2.3 Additives Used in Industrial Decontamination Procedures 13

CHAPTER 3 RESULTS AND CONCLUSIONS

3.1 Surfaces Exposed by the ACC Arranged in Ascending Order of Original Contamination 20

3.2 Decontaminability of Materials Exposed by the USNRDL 21

3.3 Surfaces Exposed by the ACC Arranged in Ascending Order of Residual Contamination 22

3.4 Initial Contamination on Materials Used to Study Surface Characteristics . 24

3.5 Per Cent Decontamination on Materials Used to Study Surface Characteristics 25

3.6 Residual Contamination on Materials Used to Study Surface Characteristics 26

3.7 Compilation of Results of Initial Contamination, Per Cent Decontamination, and Residual Contamination on Materials Used to Study Surface Characteristics 27

3.8 Initial Contamination, Per Cent Decontamination, and Residual Contamination Ratios Derived in Studies of Surface Characteristics 27

3.9 Effectiveness of Agents Used by the ACC, Combined Evaluation . . . 30

3.10 Agents Listed According to Efficiency of Groups 31

3.11 Comparison of Laboratory and Field Order-of-effectiveness Tests of Decontaminating Agents 31

3.12 Decontamination as a Function of Prewetting 33

3.13 Radiochemical Analysis of Material Exposed 36

3.14 Exponential Constants for Decay of Radioactive Material Deposited on Aircraft 38

3.15 Exponential Constants for Decay of Radioactive Material on Decontaminated and Nondecontaminated Surfaces 38

[redacted]

TABLES (Continued)

Page

APPENDIX A POSITION OF EXPERIMENTAL MATERIALS ON AIRCRAFT

A.1 Position of Materials, Dog Shot 46
A.2 Position of Materials, Easy Shot 47
A.3 Position of Materials, George Shot 48
A.4 Position of Materials, Item Shot 49

APPENDIX B COMPOSITION, SURFACE CHARACTER, AND SOURCE OF EXPERIMENTAL MATERIALS

B.1 Surface Properties 57

APPENDIX C CONTAMINABILITY AND DECONTAMINABILITY OF MATERIALS

C.1 Materials Exposed by USNRDL, Dog Shot 60
C.2 Materials Exposed by USNRDL, Easy Shot 64
C.3 Materials Exposed by USNRDL, George Shot 69
C.4 Ascending Order of Original Counts 71
C.5 Ascending Order of Residual Counts 72
C.6 Ascending Order of Per Cent Residual Counts 74

APPENDIX D CONTAMINATION-DECONTAMINATION RELATED TO SURFACE CHARACTERISTICS

D.1 Porosity Variance for Residual Contamination 76
D.2 Student's t Test 76
D.3 Roughness Variance for Residual Contamination 77
D.4 Student's t Test 77
D.5 Bartlett's Test of Homogeneity of Several Variances 78

APPENDIX E CONTAMINATION-DECONTAMINATION RELATED TO SURFACE CHARACTERISTICS

E.1 Dog Shot Data 79
E.2 Easy Shot Data 82
E.3 George Shot Data 85
E.4 Item Shot Data 86

APPENDIX G EVALUATION OF DECONTAMINATION AGENTS

G.1 Surfaces Contaminated at Dog and Easy Shots 93
G.2 Surfaces Contaminated at Easy and Item Shots 93
G.3 Materials Exposed at Dog Shot 94
G.4 Materials Exposed at Easy Shot 94
G.5 Materials Exposed at George Shot 95

[redacted]

TABLES (Continued)

Page

APPENDIX H DECONTAMINATION AS A FUNCTION OF TIME

H.1 Dog Shot Decontamination-Time Study, OD Paint 97
H.2 Dog Shot Decontamination-Time Study, Aluminum 98
H.3 Easy Shot Decontamination-Time Study, OD Paint 100
H.4 Easy Shot Decontamination-Time Study, Aluminum 101
H.5 George Shot Decontamination-Time Study, OD Paint 103
H.6 George Shot Decontamination-Time Study, Aluminum 104

APPENDIX I INFLUENCE OF PREWETTING ON DECONTAMINATION EFFICIENCY

I.1 Dog Shot Prewetting Effect, OD Paint 105
I.2 Dog Shot Prewetting Effect, Aluminum 106
I.3 Easy Shot Prewetting Effect, OD Paint 106
I.4 Easy Shot Prewetting Effect, Aluminum 107
I.5 George Shot Prewetting Effect, OD Paint 107
I.6 George Shot Prewetting Effect, Aluminum 107

APPENDIX J PREFERENTIAL REMOVAL OF CONTAMINANT SPECIES IN DECONTAMINATION OPERATIONS

J.1 Dog Shot Drone Data 109
J.2 Easy Shot Drone Data 110
J.3 George Shot Drone Data 116

APPENDIX K FRACTIONATION OF THE CONTAMINANT IN THE ATOMIC CLOUD OR IN THE CONTAMINATION PROCESS

K.1 Dog Shot Measurements 117
K.2 Easy Shot Measurements 117
K.3 George Shot Measurements 118

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Abstract

Experiments have been conducted in Operation Greenhouse on certain processes and materials associated with contamination and decontamination phenomena.

For this type of contaminating event, in which surfaces are contaminated by being carried by aircraft through an atomic cloud, information has been obtained which will assist in development of effective protective measures and recovery measures from contaminating atomic detonations. The contaminant which was deposited on surfaces mounted on drone planes was shown to be nonuniform under various contaminating conditions, both as to distribution and composition.

Data have been obtained on the contaminability and decontaminability of materials and on the relative importance of such surface characteristics as roughness, porosity, retentivity, and contact angle.

The relative behavior of various chemical agents as decontaminants has been determined and the use of industrial cleaning methods employing chemical additives to effect decontamination has been investigated.

Evidence of preferential removal of contaminants with decontamination was established.

The decrease in decontamination efficiency caused by aging and by wetting and drying a contaminated surface before decontamination was shown.

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Chapter 1

Introduction

1.1 OBJECTIVES

The experiments described in this report were designed to yield information on surface contamination resulting from atomic bomb detonations, on the nature of contamination and decontamination processes, and on the extent of correlation between field and laboratory contamination-decontamination studies.

1.2 INVESTIGATIONS

The project comprised eight experimental investigations.

1.2.1 Contaminability-Decontaminability of Materials

This experiment was designed to yield information concerning:

1. Differences in contamination and decontamination characteristics of materials exposed to aerosol contamination in the field.

2. The extent of correlation between the contamination-decontamination behavior of materials when exposed to an atomic cloud and when exposed to artificial contaminants.

1.2.2 Contamination-Decontamination Related to Surface Characteristics

The intent of this investigation was to determine whether extent of contamination and/or ease of decontamination would correlate with any of four selected physical surface characteristics independently of the chemistry of the surfaces. The characteristics studied were roughness, porosity, dye retentivity, and the hydrophobic-hydrophilic nature of the surface.

1.2.3 Industrial Decontamination Procedures

The purpose of this study was to test three general types of industrial chemical cleaning methods for their ability to remove radioactive contamination.

1.2.4 Evaluation of Decontamination Agents

The purpose of this experiment was twofold: (1) to determine the efficiency of a number of decontaminating agents selected by type and applied in conjunction with mechanical brushing [Army Chemical Corps (ACC)] and (2) to determine the relative efficiency of a limited number of agents which had been studied previously in the laboratory [United States Naval Radiological Defense Laboratory (USNRDL)].

1.2.5 Decontamination as a Function of Time

The objective of this investigation was to determine the efficiency of decontamination as a function of the time the contaminant remained on the surface.

1.2.6 Influence of Prewetting on Decontamination Efficiency

This experiment was designed to determine whether the decontamination achieved on materials contaminated by aerosols in the field is affected by wetting and drying the sample before decontamination is attempted.

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1.2.7 Fractionation of the Contaminant in the Atomic Cloud or in the Contaminating Process

The objective of this experiment was to determine the extent to which contaminants are either fractionated in the atomic cloud or in the process of deposition. Two methods of investigation were employed—radiochemical analysis and decay measurement.

1.2.8 Preferential Removal of Contaminant Species in Decontamination Operations

This study was designed to investigate possible fractionation of contaminant species in the process of decontamination. Two methods of investigation were utilized—radiochemical analysis and decay and absorption measurements.

1.3 EXPLANATION OF OBJECTIVES

When studying field problems in the laboratory it is necessary to establish the extent to which laboratory results may be relied upon to predict behavior in the field. In order for such a correlation to be found, it is essential that the laboratory studies be based upon an understanding of the nature of the field phenomena.

The contamination-decontamination research and development program at the ACC and at the USNRDL has proceeded along two lines: (1) investigation of the chemical, physical, and nuclear properties of contaminants from an exploded atomic bomb and the radiological hazard produced by them; and (2) study of means of protection against or recovery from contaminating attacks.

Operation Greenhouse afforded an opportunity to extend the scope of knowledge along these two lines and to make a comparison of laboratory and field experimental results. Information obtained by prosecution of Project 6.7 is needed for: (1) creation of more efficient field operational decontamination procedures; (2) selection or development of new materials having low contaminability and good decontaminability properties; and (3) provision of suitable design criteria for materials employed in military equipment and construction.

1.3.1 Contaminability-Decontaminability of Materials

Considerable emphasis has been placed in the past on the investigation of differences in the contaminability-decontaminability characteristics of materials exposed to liquid contaminants. Recently, prefatory studies have been made at USNRDL, where the contaminant was a dry aerosol rather than an aqueous solution or suspension. A USNRDL report will be issued shortly on the results of such studies.

The initiatory experiments have produced two types of artificial aerosol contaminants in the laboratory—alumina that is surface-coated with radioactive yttrium tracer and iron oxide which contains presumably homogeneously dispersed yttrium tracer. The median size was of the order of 0.3 μ. The aerosols have been applied to various materials by mild jet impaction, presumably simulating the deposition of atomic cloud aerosol contaminants on aircraft surfaces. For polyethylene, brass, stainless steel, Navy gray paint, and glass, no significant differences in contaminabilities were observed.

Studies were made on the rate and extent of removal of the particulate contaminant by several methods involving brushing or washing. In general, polyethylene showed poor decontaminability, glass decontaminated well, and the other materials fell between the two. Of the methods investigated, a method involving brushing under distilled water was found to give the most reproducible decontamination factors for materials and was used in a large number of Project 6.7 investigations.[1]

1.3.2 Contamination-Decontamination Related to Surface Characteristics

A number of agencies have indicated a requirement for evaluation of various surfaces to determine their relative merits as regards their resistance to contamination and their response to decontamination operations. Based on this

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[1] Unpublished work of J. Lai and D. Macdonald, Applied Research Branch, USNRDL.

requirement, a large number of surfaces have been tested. Results indicate large variation, not only among species (i.e., wood, brick, painted surfaces, etc.), but also among individual surfaces of a single species, depending on precise chemical formulation, processing, past history, and other considerations.[2-4] It has been suggested that a hard, smooth, nonporous, inert surface will have favorable contaminability-decontaminability characteristics.

An experimental study was therefore needed to verify the importance of these characteristics and to arrive at generalized criteria which determine the response of a surface to contamination. As a start towards such a study, an investigation was made to determine whether the extent of contamination and/or ease of decontamination correlated with any of the following surface characteristics: (1) surface roughness, (2) porosity, (3) dye retentivity, and (4) contact angle for water. Choice of these characteristics is discussed in Sec. 2.3.2.

1.3.3 Industrial Decontamination Procedures

Certain similarities exist between the contaminants resulting from a surface (or tower) burst of an atomic weapon and industrial atmospheric pollutants which soil materials.[5] Since these pollutants are removable by industrial cleaning methods, it was felt that effective industrial cleaning techniques could possibly be advantageously used in some decontamination operations.

This investigation was designed to determine the ability of three cleaning methods to decontaminate materials exposed to radioactive aerosol contamination in the field.

1.3.4 Evaluation of Decontamination Agents

Laboratory experiments have been conducted in which the decontaminating efficiency of various chemical agents has been tested. A wide variation in the relative efficiencies of these agents was noted. Little correlation with the chemical properties of the agents, e.g., their ionic state, pH, and chemical structure, has been established. Since the studies were conducted using simulated contaminants, it appeared desirable to carry out experiments using real contaminants (1) to investigate the correlation between decontamination efficiency and chemical type in conjunction with a brushing technique and (2) to establish the relative order of efficiency of several selected decontamination agents previously studied in the laboratory.

1.3.5 Decontamination as a Function of Time

The fission products encountered as contaminants in the field undergo chemical changes[6] as a result of their nuclear instability. The question arises as to whether the chemical changes affect the tenacity with which contaminants are held to surfaces. This may occur as a result of the decay process, in which the radioactive atoms become chemically activated. In this state they may form strong chemical bonds with the surface.

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[2] William W. Hawes and Leon Leventhal, "Survey of Decontamination. II. Decontaminability of Aircraft Paints," NRDL Report AD-64(C) (*Revised*), U. S. Naval Radiological Defense Laboratory, San Francisco, Calif., March 1949.

[3] William W. Hawes and Leon Leventhal, "Survey of Decontamination. III. Decontaminability of Metals and Alloys," NRDL Report AD-75(C) (*Revised*), U. S. Naval Radiological Defense Laboratory, San Francisco, Calif., March 1949.

[4] William W. Hawes, Bernard Singer, Edward C. Arbuckle, and Antonia M. Branch, "Survey of Decontamination. XI. Decontamination of Weathered Aircraft Paints," NRDL Report AD-154(C), U. S. Naval Radiological Defense Laboratory, San Francisco, Calif., August 1949.

[5] W. Shelberg and L. Werner, "Industrial Film and Radioactive Contamination," USNRDL Report AD-328(C), U. S. Naval Radiological Defense Laboratory, San Francisco, Calif., June 1951.

[6] H. F. Hunter and N. E. Ballou, "Simultaneous Slow Neutron Fission of U^{235} Atoms. I. Individual and Total Rates of Decay of the Fission Products," NRDL Report AD-65(C), U. S. Naval Radiological Defense Laboratory, San Francisco, Calif., February 1949.

Increased difficulty in removing contaminants may also be found if diffusion of the radioactive materials into surfaces occurs.

Measuring the efficiency of a decontaminating process at various times after contact of a contaminant with a surface will indicate whether the effects mentioned occur to a significant extent but will not, of course, distinguish their relative importance.

1.3.6 Influence of Prewetting on Decontamination Efficiency

Work performed at the USNRDL has suggested that wetting a surface contaminated with an aerosol and allowing drying to occur before chemical decontamination is performed may decrease perceptibly the efficiency of a decontamination procedure. Work was carried out on materials contaminated at Operation Greenhouse to determine whether this effect can be observed under field conditions.

1.3.7 Fractionation of the Contaminant in the Atomic Cloud or in the Contaminating Process

The yield and identity of fission products and their radioactivity at various times after slow fission are fairly well known.[7] The contaminants which deposit on surfaces flown through an atomic cloud are not necessarily the same as the original mixture of fission products. This effect may result from fractionation in the cloud and during the contaminating process or by the inclusion in cloud particles of induced activities from the bomb's nonfissile constituents or materials in the vicinity of the detonation.

Greenhouse Report, Annex 6.1 identifies the contaminants which existed at various altitudes, employing sampling techniques which ensured true, i.e., representative, sampling of the cloud.[8] Their endeavors should determine whether appreciable amounts of induced activities were present in the atomic cloud. In Project 6.7, measurements of decay and absorption characteristics and radiochemical analyses were utilized to indicate whether fractionation occurs in the cloud or in the contamination process.

1.3.8 Preferential Removal of Contaminant Species in Decontamination Operations

The discussion in Sec. 1.3.7 applies here. Owing to differences in the chemical properties of various groups of fission products, their reactions with chemical decontaminants (including water) varies with the group and leads to preferential decontamination. Although established for liquid-type mixed fission-product contaminants, preferential decontamination has not been demonstrated satisfactorily for aerosol-type contaminants. An observation reported by the Air Force, that the decay of residual radioactivity on certain decontaminated Sandstone drone aircraft differed from that on the untreated aircraft, suggests that fractional removal of aerosol contaminants may occur.

[7] *Ibid.*

[8] E. Engquist and T. C. Goodale, "Cloud Phenomena: Study of Particulate and Gaseous Matter," Greenhouse Report, Annex 6.1.

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Chapter 2

Experimental Procedures

2.1 CONTAMINATION OF SAMPLES

Exposure of samples to radioactive contamination was accomplished by mounting forty 1-ft-square panels on the drone aircraft, which were flown through the atomic cloud. The panels were 24-gauge anodized aluminum sheets 1 ft square upon which various coatings and samples were placed. Pressure sealing tape, manufactured by the Minnesota Mining and Manufacturing Company and designated No. 430 Pressure Sensitive Aluminum Tape, was used to fasten the panels to the underside of the wing and the upperside of the horizontal stabilizer. The position and position numbers are shown in Figs. 2.1 to 2.4. To each panel there was fastened a rip string which was tied to an aluminum loop. The rip string was placed beneath the tape on the leading edge of the panel in such a way that removal of the panels from the aircraft was accomplished by remote operation (see Sec. 2.2). Details of attachment are shown in Fig. 2.5.

Panels mounted on the right side of the aircraft were furnished by the ACC and those on the left by the USNRDL.

Six of the USNRDL panels consisted of 1-ft-square aluminum sheets upon which thirty-six 1¼-in.-square plates of various materials were fastened with pressure sealing tape as shown in Fig. 2.6. The position of the plates on the 1-ft-square panels is given in Sec. A.2. The remainder of the USNRDL experimental samples were in the form of coated aluminum sheets and were placed as shown in Sec. A.2.

The ACC samples were obtained by mounting three surfaces, 3¼ by 10¼ in., on the 24-gauge anodized aluminum sheet.

A list of all experimental materials employed, both by the ACC and the USNRDL, has been included as Appendix B. One material, Army olive-drab paint (OD paint), was chosen as a control surface and appears in most of the experiments performed. It is a reference material for comparison of experiments performed.

Eight drone aircraft were flown through the atomic cloud at altitudes between 16,000 and 30,000 ft on Dog and Easy Shots. After George Shot, three drones carrying Project 6.7 samples were recovered; they flew through the cloud at 24,000, 26,000, and 28,000 ft. The ACC obtained samples from seven drone aircraft flying at 16,000 to 28,000 ft on Item Shot. All drone aircraft were identically equipped with USNRDL samples. The ACC mounted their samples in a statistically randomized manner as determined by the Youden Square[1,2] (described in Sec. 2.3.2) and shown in Sec. A.3.

2.2 REMOVAL OF MATERIALS FROM AIRCRAFT AND PREPARATION FOR SHIPMENT TO THE ZONE OF THE INTERIOR

A procedure which utilized remote handling of contaminated test panels was developed for removal of materials from the aircraft and for preparation of the panels for shipment. Personnel were alternated on the job to reduce fatigue and individual exposure to radiation.

[1] "Latin and Youden Squares," *Technical News Bulletin of the National Bureau of Standards*, May 1950.

[2] W. Cochran and G. Cox, *Experimental Designs*, Chap. 13 (New York: John Wiley & Sons, Inc., 1950).

[redacted]

Two teams were organized and equipped for panel removal as follows:

- One tongman (team leader)
- One tongman (driver)
- Two polemen
- One 1½-ton truck, open bed
- Five sample carrying boxes
- Two 10-ft poles equipped with hooks
- Two 2-ft crucible tongs

From a position about 100 ft upwind from the drone aircraft a poleman walked to the drone and removed a test panel by hooking into the loop and pulling the rip string shown in Fig. 2.5. The panel was carried to the truck, where a tongman grasped the panel and placed it in a box on the truck. At intervals, panels were transported to another area where they were prepared for shipment.

A crew of four men equipped with 4-ft crucible tongs stripped any tape which remained on the panels and, with the aid of a scalpel mounted on a pole, cut and removed the rip string. The panels were put into special shipping containers, many of them leadlined, as shown in Fig. 2.7.

The radiation intensity at 1 ft from each box was noted and the boxes were loaded aboard a MATS C–54 and returned at 10 hr or 2 days post shot to the USNRDL or the ACC for experimental study.

2.3 EXPERIMENTAL PROCEDURES EMPLOYED IN EACH INVESTIGATION

The following constitutes the experimental procedures and techniques used in the individual investigations.

Experimental results are reported in terms of initial (or final) radioactivity or per cent removal of radioactivity. In determining per cent removal the USNRDL conducted initial and final counts in a time period small enough to make unnecessary any consideration of radioactive decay. The ACC, in comparing initial and residual activities, corrected all activities to shot plus 120 hr by assuming the decay follows the $t^{-1.2}$ law.

2.3.1 Contaminability-Decontaminability of Materials

Two different experimental approaches were used by the USNRDL in studying this problem.

2.3.1.1 Measurement of Contaminability-Decontaminability of Materials Exposed on Drone Aircraft

Two 1¼-in.-square plates of each of the following materials were exposed on each drone: copper, brass, alclad aluminum, stainless steel, OD paint, Navy 5H paint, Air Force AN–L–37–SB–AL paint, Navy 52–L–26–SB sea-blue lacquer, Navy AN–L–37 lacquer, phenolic varnish, acryloid varnish, silicone plastic, melamine plastic, cellulose acetate plastic, GE Cocoon stripcoat, and Stabond stripcoat. The compositions of these materials are reported in Sec. B.2. In regard to these specimens, no attempt was made to obtain materials having identical physical surface characteristics. This phase of the investigation represents a study of surfaces as normally obtained. Six plates of Navy 5H paint having three ratios of pigment to vehicle were prepared. Ten 1¼-in.-square plates of glass and twelve plates of steel representing five degrees of roughness for glass and six degrees for steel were mounted on each drone. The roughness of the surfaces of the plates were measured with a Brush Analyzer before being mounted on panels, and the roughness values are given in Sec. B.3. Eight 1¼-in.-square plates of brass (67 per cent copper, 33 per cent zinc) representing four degrees of hardness were mounted. Ten plates of stainless steel representing five degrees of hardness were also mounted. Hardness was measured with a Brinell Hardness Gauge and a Knoop Microhardness Indenter instrument. Hardness evaluations are listed in Sec. B.3.

All samples employed in this study were returned to the Zone of the Interior (ZI), where the amount of radioactivity on each sample was measured using a USNRDL Model 1A proportional counter.

After the amount of contamination on the specimen was measured, decontaminability was determined by use of a testing procedure in which the equipment shown in Fig. 2.8 was utilized. The plates were placed in 190-ml crystallizing dishes and covered with 1,000 ml of distilled water. A brush attached to a stirring motor was lowered to the point of contact with the samples. The contaminated samples were subjected to brushing at a stirrer speed of 20 rpm for a period of 5 min. The samples were then removed, rinsed once in distilled water, dried, and counted. The decontaminability of the sample was expressed in terms of per cent removal, as shown in Secs. C.1 and C.2.

2.3.1.2 Distribution of Contaminant on Materials Exposed to Fall-out

Several minutes after Dog Shot, portions of the atomic cloud passed over Eniwetok Island. Approximately 2 hr later, a rapid rise in background radiation was observed. This rise in background was due to dry fall-out from the radioactive cloud. It was noted that the entire island was contaminated with spotty concentrations of radioactivity.

It was decided that the fall-out presented an excellent opportunity to study field contamination of materials and objects. Two survey instruments, one measuring only gamma and one measuring beta plus gamma, were used. Since time did not permit an extensive survey, many of the data were obtained from single measurements.

Starting on D+1 day, measurements of the distribution of contamination were made in the following areas:

1. Roof of an aluminum building
2. Wooden building and surrounding area
3. Soil at various depths
4. Roof drainage near B–50 hangar
5. Drone-decontamination area
6. Roadways and trucks

2.3.2 Contamination-Decontamination Related to Surface Characteristics

The number of parameters that could be investigated by the ACC was limited by the available sample space. After consideration of the sample space available, the minimum size of a representative surface, the difference in the contaminating atmosphere from drone to drone and from one sample position to another on a single drone, and restrictions imposed by the nature of the test, it was determined that sampling had best be tailored to the framework of a Youden Square. This permitted the ACC to investigate three surface characteristics, each over three ranges of magnitude, and a fourth characteristic restricted to two ranges. The feasibility of finding or constructing surfaces incorporating all combinations of the selected parameters led to the final selection of the following characteristics:

1. Porosity (slightly porous, moderately porous, very porous)
2. Roughness (smooth, moderately rough, very rough)
3. Contact angle for water (small angle, intermediate angle, large angle)
4. Dye retentivity (nonretentive, retentive)

An effort was made to find or construct all combinations of these parameters, to constitute 54 different test surfaces. However, 9 of the 54 surfaces could not be procured, and these spaces were utilized as duplicates of the parameters available but with other materials. The materials used to investigate these surface characteristics are shown in Table 2.1. For convenience in referring to any surface, each surface has been assigned a Youden Square number. In addition, each surface has a characteristic number of four digits, each digit referring to a parameter (see Table 2.1).

The fabrication and measurement of the test surfaces is given in Sec. D.1. Each drone aircraft carried 20 panels for the ACC, each panel mounting three test surfaces, providing a total of 60 such surfaces. Fifty-four of these surfaces comprised a test set, and the remaining 6 served as spares in the event of losses during flight. The panels were exposed in a randomized manner and in such a fashion that no surface appeared in the same position on more than one drone. The randomization in position of a surface was determined through a statistical approach called the Youden Square. Section A.3 shows the location of each panel.

TABLE 2.1 MATERIALS USED BY THE ACC TO INVESTIGATE SURFACE CHARACTERISTICS

Nonretentivity / Contact Angle	LOW POROSITY			MEDIUM POROSITY			HIGH POROSITY		
	Surface Roughness			Surface Roughness			Surface Roughness		
	Low	Medium	High	Low	Medium	High	Low	Medium	High
Low	Mirawal (porcelain enamel steel, glossy finish)			Du Pont varnish, No. 7, dull			OD paint on plywood TT-E 485B		Glass cloth
	1111[a] 44[b]	1112 42	1113 29	1121 17	1122 28	1123 53	1131 13	1132 22	1133 50
Medium	Methyl methacrylate (Lucite)			Clear metal lacquer (Co-loidal-ac)			Linoleum (factory finish)		Transite (asbestos board)
	1211 32	1212 35	1213 31	1221 18	1222 6	1223 52	1231 21	1232 48	1233 47
High	Soft aluminum, 24S			Asphalt varnish (Rubberoid Corp.)			Linoleum (paraffin coated)	Asphalt saturated feltlike roofing	Air Force overcoat wool
	1311 41	1312 11	1313 27	1321 26	1322 20	1323 46	1331 16	1332 7	1333 36
Low	Porcelain metal enamel, dull finish			Satinspred (interior paint, aqueous resin)			Fir plywood		
	2111 37	2112 23	2113 4	2121 3	2122 12	2123 24	2131 15	2132 45	2133 10
Medium	Navy Cocoon, 52–C–44, strippable coating			OD paint TT–E 485B			Linoleum, benzene-washed to remove factory finish		
	2211 49	2212 14	2213 2	2221 40	2222 51	2223 9	2231 43	2232 5	2233 1
High	Goodyear gray rubber tile, stock No. 503			Dixon's exterior graphite paint			Leather (low contact angle)		Canvas ducking
	2311 25	2312 19	2313 8	2321 33	2322 30	2323 38	2331 34	2332 54	2333 39

(a) First digit indicates retentivity: 1=nonretentive, 2=retentive. Second digit indicates contact angle: 1=low, 2=medium, 3=high. Third digit indicates porosity: 1=low, 2=medium, 3=high. Fourth digit indicates surface roughness: 1=low, 2=medium, 3=high.

(b) Youden Square Index Number.

After contamination at the site, all panels except those used at the site were shipped to the ZI (ACC). Upon arrival at the ACC, each panel was monitored with a Beckman Model MX-4 ionization chamber to determine the appropriate autoradiographic exposure time. After autoradiography, each test surface was counted in five separate spots, each about 1⅛ in. in diameter, by a shielded, directional, end-window G-M tube (Figs. 2.9 and 2.10) connected to either a Tracerlab 100 or a Berkeley Model 2000 Scaler. The average of these five counts was corrected for coincidence and decay and then reduced to an arbitrary standard for relative comparison and evaluation. The effect of back-scattering was found to be negligible.

Following the initial autoradiography and counting, the panels were decontaminated and the radioactivity measurements performed again.

On a small fraction of the test surfaces, the radiation activity at the time of counting was much higher than expected. For this reason an attempt was made to use the autoradiographs for quantitative measurement of radiation on these most highly contaminated surfaces. Panels were placed in adjoining shielded cubicles (Fig. 2.11), and a number of autoradiographs were made simultaneously.

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An autoradiograph densitometer, as shown in Fig. 2.12, was developed for this determination, but it was found that improved techniques in this method will be required before such quantitative measurements will be dependable. A separate report will therefore be issued by the ACC on quantitative determination of contamination by autoradiography after additional study.

Decontamination was performed by uniform and reproducible application of agent solution and brushing action. Twelve agents were used in this phase to evaluate their relative decontamination efficiencies. The agents are listed in Table 2.2. The brushing machine (Fig. 2.13) brushes the surfaces in liquid media (detergent in water) by making one up and one down pass, each of 30 sec duration. The principal parts of the machine are a cylindrical brush, detergent spray nozzles, and panel holder; these are housed in a stainless-steel chamber 8 by 24 by 29 in. provided with a Lucite side window and mounted on four steel legs.

TABLE 2.2 CHEMICAL AGENTS USED IN INVESTIGATIONS OF DECONTAMINATION AGENTS[a]

NO.	NAME	DESCRIPTION		% ACTIVE CONTENT	COMPOSITION	CONCENTRATION USED (%)	MANUFACTURER
1	Versene	Anionic	Chelating	34	Trisodium salt of ethylene diamine tetraacetic acid	1.0	Bereworth Chemical Co.
2	Blendene	Anionic	Emulsifying and dispersing	100	Terpene fatty acid complex, ammonium salt	1.0	Glyco Products Co.
3	Aresklene 400	Anionic	Wetting and emulsifying	100	Dibutylphenyl phenol sodium disulphonate	0.25	Monsanto Chemical Co.
4	Breeze	Anionic	Synthetic detergent	...	Sodium salt of a fatty acid ester of a sulfoacetamide plus additives	0.3	Lever Bros.
5	Tergitol P-28	Anionic	Wetting	25	Sodium di (2-ethylhexyl) phosphate	1.0	Carbide and Carbon Chemical Co.
6	Sequestrene AA	Anionic	Sequestering	100	Disodium salt of ethylene diamine tetraacetic acid	1.0	Alrose Chemical Co.
7	Ethomeen 18/25	Cationic	Detergent	100	Tertiary amine with one fatty alkyl and two polyoxyethylene groups on the nitrogen	1.0	Armour and Co.
8	Ethomid HT/60	Nonionic	Detergent	100	Fatty acid amide substituted with *N*-polyoxyethylene groups	1.0	Armour and Co.
9	Chlorsol	Nonionic	Emulsifying	...	Polyoxyalkylene ester and sulphonates	1.0	E. F. Drew and Co.
10	Ethofat 242/25	Nonionic	Detergent	100	Rosin fatty acid ester of polyethylene glycol	1.0	Armour and Co.
11	Triton B1956	Nonionic	Emulsifying	100	Modified phthalic glycerol alkyd resin	0.1	Rohm and Haas Co.

[a] Agents 1 to 12 investigated by the ACC; agents 13 to 18 investigated by the USNRDL.

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TABLE 2.2 (*Continued*)

NO.	NAME	DESCRIPTION		% ACTIVE CONTENT	COMPOSITION	CONCENTRATION USED (%)	MANUFACTURER
12	TSPP	Anionic	Sequestering, dispersing, peptizing		Sodium tripolyphosphate ($Na_5P_3O_{10}$)	1.0	Westvaco Chemical Co.
13	Nytron	Essentially anionic	Detergent, wetting	35	Mixture of sulfonates, ketones, amine alkyl sulfamates, alkylidene materials	0.8	Allied Chemical Dye Corp., Solvay Process Div.
14	Tide	Essentially anionic	Detergent	20	16% alkyl aryl sulfonate, 4% alcohol sulfate, builders	0.8	Proctor and Gamble
15	Ultrawet DS	Anionic	Detergent, wetting agent	85	Alkyl benzene sodium sulfonate	0.8	Atlantic Refining Co.
16	Sodium hexametaphosphate		Complexing agent	..	$Na_{12}P_{10}O_{31}$		
17	Disodium ethylene diamine tetraacetic acid		Complexing agent	..		0.8	Acid purified and neutralized to disodium salt at USNRL
18	Tetrasodium ethylene diamine tetraacetic acid		Complexing agent	..		0.8	Acid purified and neutralized to tetrasodium salt at USNRDL

A 1/12-hp Boston Ratiomotor provides the motive power for imparting uniform travel and rotation of the brush. A 3/4-hp centrifugal pump supplies the detergent through four flat spray nozzles. The nozzles, which direct a spray upon the brush, have a solution output of 0.6 gpm at normal operating pressure.

The panels on each aircraft were considered as one complete set of surfaces to be studied and were therefore treated by one agent. In the over-all study, each agent was used on two such sets. Decontamination percentage was based on the over-all averages of each aircraft considered as one study and then totaled to make an over-all study.

A statistical study by an analysis of covariance showed that per cent removal was a reliable measure of decontamination efficiency. The F-test ratio of the mean squares in the covariance analysis (of initial and residual contamination) was 4.87 with 7 and 34 degrees of freedom, while the per cent removal analysis of the same data had a mean square ratio of 4.32 at 7 and 34 degrees of freedom. This difference in ratios is a very slight one and cannot be considered significant with these degrees of freedom. A complete report of the techniques, data, and interpretation of this study will be published by the ACC at a later date.

The over-all contamination-decontamination nature of the surfaces aside from their surface characteristics was also analyzed. For this study all data on one particular type of material were averaged and tabulated; they are shown in Sec. C.2.

A statistical study was made to determine significant differences in level of original contamination, level of residual contamination, and per cent removal for each surface parameter. Tests for interactions were also made by comparing variance for each parameter taken individually, two at a time, and three at a time. The method and techniques used for these evaluations are given in Sec. D.2.

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2.3.3 Industrial Decontamination Procedures

This study employed four surfaces: alclad aluminum; OD paint, TT–E 485B; sea-blue paint, 52–L–26; and aluminized paint, AN–L–37. Three chemical decontamination techniques were investigated. The techniques were hot solutions applied by brush, cold solutions applied by brush, and steam cleaning.

TABLE 2.3 ADDITIVES USED IN INDUSTRIAL DECONTAMINATION PROCEDURES

ADDITIVE	SOURCE
Tide	Orvus, a commercial product produced by Proctor and Gamble
Citric acid, sodium citrate, sodium tripolyphosphate	Technical-grade materials
Nacconol NR	USP-grade material manufactured by National Aniline Corporation
C–147	Type I nonphenolic Naval Aviation Supply Stock No. R51C1615. Formulation:
	Water 8–12%
	Hydrocarbons volatile with steam 74–80%
	Hydrocarbons absorbed by fuming sulfuric acid (% by volume of total hydrocarbons) 13–18%
	Potash soap 10–12%
	Free alkali as NaOH None
	Free acid as oleic acid 1.0% max
	Sodium chromate 0.7–0.9%
C–152	Naval Aviation Supply Stock No. R51C1313 material. Formulation:
	Sodium tetraphosphate 30%
	Sodium tetraborate 32%
	Soda ash 17%
	Sodium bicarbonate 12%
	Sodium hydroxide 8%
	Nacconol NR (sodium alkyl aryl sulfonate) 1%
Ethylene diamine tetraacetic acid	Chemical produced by Antara Products, General Dyestuff Corporation, and designated Antarane X–285
GI soap	Laundry soap, bar type, Federal Spec. P–S591

A number of chemical additives were used by the USNRDL in the different decontamination procedures. At least two surfaces were used in each operation. In steam cleaning, Tide, citric acid, C–152, and steam with C–147 were used. Tide, ethylene diamine tetraacetic acid, sodium citrate, sodium tripolyphosphate, and Nacconol NR were added during cold-solution brushing operations. When hot-solution brushing was carried out, sodium citrate, C–152, Tide, and Nacconol NR were used. Tables 2.2 and 2.3 list compositions and sources of additives used in this study.

Decontamination operations were carried out in the following manner:

1. Hot solutions applied with brushing. The chemical agent was dissolved in water and the solution heated to 180°F by inserting the nozzle of a steam gun into the container. Corrections were made for increase in solution volume due to steam condensation. The solution was applied to the sample surface by means of a long-handled window brush, as shown in Fig. 2.14. A standard brushing method was used throughout. Three strokes were made across the sample and three strokes were made vertically. The brush was then rinsed in fresh water and dipped into the bucket containing the decontaminating agent, and the process was repeated on the next sample.

After the second (or third) panel was decontaminated, the temperature of the solution was noted. The temperature at which the samples were said to be decontaminated was taken as the average of the before and after temperature readings. This temperature is to be taken as a guide to the average solution temperature and not the temperature of the solution in contact with the sample.

After application of the hot decontaminant, each sample was given a 15-sec fresh-water rinse. Control was maintained over the flow of rinse water so that 1 qt of water was delivered to each sample during the 15-sec rinse period.

Brushes were numbered 1 to 5. Brush 1 was used for the initial cleaning in each case, brush 2 for the second cleaning, etc., through five

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cleanings. The brushes were monitored periodically to be sure that they were not retaining activity which might be redeposited on the other samples. When a brush became contaminated, it was replaced.

2. Cold solutions applied with brushing. The decontamination technique used with cold liquids was similar to that used with hot liquids. The cold solutions were made up with tap water at an average temperature of 60°F.

3. Steam cleaning. Decontamination of the radioactive samples by steam cleaning was accomplished with a Kerrick Hydro-Steam Kleaner Model S–D. The Kerrick unit is a small, steam-operated, cleaning machine which, when attached to a steam supply where a pressure of 50 to 125 lb/sq in. is available, produces an atomized spray or pressure stream of steam-cleaning solution. Solutions were premixed in a large drum and drawn into the cleaner through a suction hose connected to a steam injector. The cleaning solution was heated by the steam and forced out through a steam-cleaning gun. The operation was carried out with the nozzle of the gun kept about 18 in. from the surface of the sample. Each surface was cleaned for 5 sec on each of five consecutive runs. The temperature of the cleaning solution at 18 in. averaged 160°F and had an impact pressure on the order of 3 lb/sq ft. After the steam-cleaning operation, the sample was given a fresh-water rinse.

4. Application of C–147. The use of C–147 was a special case. It was used according to Navy specification, i.e., the solution of C–147 was 1 part C–147 to 6 parts kerosene by volume. This solution was sprayed on the samples using a small portable garden weed spraying unit. The solution was allowed to remain on the samples for 3 min and then steamed off for 15 sec, using wet steam. There was no detergent metered into the steam, and the samples did not receive the usual 15-sec fresh-water rinse.

After they had been rinsed, all samples were dried in a metal box held at 160°F.

The radioactive samples were counted using an instrument developed by the Instruments Branch at the USNRDL. The instrument, shown in Fig. 2.15, consists of a large probe with a 1-ft-square sensitive area. The probe has a 0.5-mil aluminum window sealed by a 0.1- to 0.2-mil coating of varnish. The varnish seal seemed to be adequate in sealing the small pin holes found in aluminum foil. The probe was supplied with a mixture of 90 per cent carbon dioxide and 10 per cent argon at a flow rate of 3 cc/min. A microammeter was placed in series with standards made up in the laboratory. The experimental error is estimated as being approximately ±15 per cent.

2.3.4 Evaluation of Decontamination Agents

Under the sample contaminating conditions which were contemplated at Operation Greenhouse, some radioactive particles could be expected to penetrate with considerable velocity the static layer of air usually considered to be present on the surfaces of flying aircraft. The particles striking the test surfaces could be mechanically lodged or imbedded.

The degree to which the impingement would influence subsequent retention of particles was not known. Consequently in these decontamination studies two methods were used; the methods represented wide differences in the amount of mechanical work applied to the contaminated surfaces during the decontamination process.

The work conducted at the ACC was designed to study the decontamination efficiency of various agents used in conjunction with the brushing of surfaces. At the USNRDL, the work was concerned with the relations existing between laboratory and field use of decontaminants. The decontamination process at the USNRDL employed only mild agitation of the decontaminant solution.

2.3.4.1 Efficiency of Decontamination Agents

The agents (detergents) were chosen by the ACC so as to provide representatives of basic types of agents presently used in commercial synthetic detergents. As a consequence of their characteristic chemical structures, these agents give one or more of the following actions: sequestering, emulsifying, chelating, peptizing, wetting, dispersing, etc. (see Table 2.2).

The agents were used at the concentration suggested by the manufacturers. Versene and Sequestrene AA, both salts of ethylene diamine tetraacetic acid, were used at different pH values, Versene at a pH of 8, and Sequestrene AA at a pH of 5 (with sodium hydroxide). Breeze, one of the agents used, is a commercial synthetic detergent complete with additives. The remaining agents are in general usage as detergent additives and/or for the specific actions mentioned above.

Based on the experience of detergent manufacturers in dealing with problems of soft-surface detergency, emphasis was placed on the anionic and nonionic detergents.

The agents, at the concentrations listed, were prepared just prior to use and thoroughly mixed. All were used at room temperature.

2.3.4.2 Relations Between Results of Laboratory and Field Studies of Decontamination

The decontamination efficiencies of six chemical agents were investigated at the USNRDL. Three agents were tested using OD paint surfaces, and three were used with aluminum surfaces. Test surfaces were contaminated on the Dog, Easy, and George Shots.

The decontamination procedure consisted in placing an individual sample in 250 ml of a given reagent and stirring for 20 min. All solution concentrations were 0.8 per cent. After stirring was complete, the sample was removed, rinsed with 250 ml of distilled water, dried under heat, and counted.

The chemical agents used with the aluminum surface were the tetrasodium salt of ethylene diamine tetraacetic acid, Nytron, and Tide.

The OD paint surfaces were decontaminated with disodium ethylene diamine tetraacetic acid, Ultrawet DS, and sodium hexametaphosphate.

The sources of the agents tested are given in Table 2.2.

2.3.5 Decontamination as a Function of Time

Aluminum and OD paint surfaces were exposed on the Dog, Easy, and George Shots by the USNRDL. On Dog and Easy Shots, specimens were contaminated at altitudes from 16,000 to 30,000 ft; experimental specimens recovered after George Shot were from 24,000-, 26,000-, and 30,000-ft altitudes.

The decontamination procedure explained in Sec. 2.3.1.1 was employed in this study.

All experimentation on material exposed at Dog Shot was conducted at the ZI, since the high levels of radioactivity resulting from fallout after the shot made it impossible to avoid further uncontrolled contamination of the samples. Decontamination operations started 2 days post shot and continued to 79 days post shot.

After the Easy and George Shots, it was possible to carry out decontamination at the site. The first point in time after Easy Shot was $1\frac{1}{5}$ days; Easy Shot material was studied at intervals through 31 days post shot.

The shortest time lapse between contamination and decontamination was realized after George Shot; OD paint surfaces were decontaminated $1\frac{1}{2}$ hr after the detonation. Decontamination was continued until 213 hr post shot.

The results of these investigations have been included as Appendix H.

2.3.6 Influence of Prewetting on Decontamination Efficiency

Four $1\frac{1}{4}$-in. squares of aluminum and four squares of OD paint were exposed on each drone aircraft and used in this study. The plates were exposed in panel 3, as shown in Appendix A.

At some time within 2 to 6 hr after contamination, all the plates on panel 3 were covered, with the exception of two aluminum and two OD paint specimens. An atomizer was then employed to thoroughly spray the four exposed surfaces with water.

All the plates for this study were returned to the USNRDL and the decontaminability (evaluated by the method of Sec. 2.3.1.1) of the prewet specimens compared with the decontaminability of the untreated specimens. Table 3.12 summarizes the results of this study.

2.3.7 Fractionation of the Contaminant in the Atomic Cloud or in the Contamination Process

Two materials, OD paint and aluminum, and two methods of investigation, radiochemical analysis and decay measurements, were used by the USNRDL in this investigation.

Specimens were obtained at altitudes ranging from 16,000 to 30,000 ft (in 2,000-ft increments) on the Dog and Easy Shots. George Shot samples were contaminated at 24,000, 26,000, and 28,000 ft.

Measurements of the radioactive decay of the contaminated surfaces extended from 56 to 652 hr post shot on Dog Shot specimens and from 1.3 to 85 hr post shot on George Shot material. The activity measurements were made using a USNRDL Model 1A proportional counter.

The results of radiochemical analyses of interest to this section of the report are summarized in the portions of Table 3.13 entitled "Aluminum" and "OD Paint."

Methods for analysis of specific isotopes were those outlined by Ballou, Glendenin, and Hume [3] as modified by the Analytical Group of the Laboratory. All samples were counted with a G–M tube and Berkeley Scaler. Corrections were applied for coincidence and background, but no attempt was made to correct for back-scattering or self-absorption. Solutions for analysis were prepared by leaching the activity from aluminum and OD paint samples with hot 3N nitric acid. The plates were then rinsed, and the solutions were transferred to 25-ml volumetric flasks and made up to volume. By counting plates before and after leaching, it was found that this method removed from 95 to 98 per cent of the activity. Solutions which were to be used for iodine analysis were prepared by first adding iodide carrier and sodium hypochlorite in order to avoid the loss of gaseous iodine. All solutions were assayed for gross activity by pipetting small aliquots to stainless-steel disks for counting. In some cases, notably those for decontaminated samples, it was found necessary to employ as many as four plates for one solution. All results, however, are reported in terms of counts per minute per plate. Decontaminated samples were prepared by the present standardized laboratory method of water wash with brushing (as explained in Sec. 2.3.1.1).

On Dog Shot, analyses were carried out for barium, the rare earths, iodine, and zirconium. All activities were corrected to D+10 days (see Table 3.13).

Analyses for barium and total rare earths were carried out on material contaminated on the Easy and George Shots. By considering errors in weighing, total counts, total time of counting, and pipetting, a probable determinate error of approximately 5 per cent (in the typical case, 10 ± 0.5 per cent) was estimated. Errors of the same order of magnitude may be expected for all other activity determinations.

2.3.8 Preferential Removal of Contaminant Species in Decontamination Operations

Both decay and absorption measurements and radiochemical analysis were used by the USNRDL to investigate possible fractionation of aerosol contaminant in decontamination. The surfaces studied in the decay measurements were OD paint; the radiochemical analyses were carried out on aluminum.

In the decay measurements, one sample was decontaminated, while another (similar) sample was left untreated. The decay rates, through various absorbers, were then followed. At the ZI a USNRDL Model 1A proportional counter was used to follow decay, and at the site a similar counter equipped with an automatic absorber changer (as described later) was used.

After Dog Shot all material was returned to the ZI, and decontamination of the sample was accomplished 48 hr post shot. Decay was followed for approximately 900 hr.

[3] N. Ballou, L. Glendenin, and D. Hume, "A Manual of the Radiochemical Determination of Fission Product Activities," Report CN-2815, June 1945.

After the Easy and George Shots, four samples were removed from the first panel received from the drone aircraft. Three plates were decontaminated by brushing under water as described in Sec. 2.3.1.1. One of the decontaminated plates was immediately placed in an automatic absorber changer–counter arrangement, shown in Fig. 2.16. The untreated plate was placed in an identical counter.

These counters, designed by D. F. Covell of the USNRDL, permit automatic counting and recording of data for a sample through five consecutive absorbers. The absorber changer utilizes the driving mechanism from the Tracerlab Model S–C sample changer as a driver. It was intended for this changer to operate with standard (2½ by 3 in.) size absorbers and sample mount cards used in the USNRDL; consequently the Tracerlab equipment was modified from a 25-sample device (14.4° index) to a 5-sample device (72° index). Absorbers are mounted in slots on the periphery of a 14-in. aluminum wheel which is interposed between the detector and the sample and which is rotated by the driver. The drive mechanism is wired so as to be controlled by a Streeter-Amet Recorder, which in turn operates from the USNRDL Model 1A proportional scaler.

Samples were decontaminated 2½ hr after detonation on Easy Shot and 1½ hr after contamination on George Shot.

The decontaminated samples not used at the site were returned to the ZI, where similar decay measurements were initiated. On Easy Shot material, decay was followed for approximately 350 hr, and decay was followed for 300 hr on samples exposed at the George Shot.

Radiochemical analyses on aluminum samples and decontaminated aluminum samples were carried out as described in Sec. 2.3.7. Results are listed in portions of Table 3.13 denoted as "Aluminum" and "Aluminum Decontaminated." The aluminum samples were decontaminated 18 days post shot on Dog Shot material, 19 days post shot on Easy Shot specimens, and 7 days post shot on George Shot materials.

Exponential constants describing the decay rates of the decontaminated and nondecontaminated surfaces were derived and are included in Table 3.15.

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Chapter 3

Results and Conclusions

3.1 RESULTS AND CONCLUSIONS ACCORDING TO INVESTIGATION

The detailed results and conclusions are discussed in this section for each experimental study. A general discussion is found in Sec. 3.2.

It is expected that the results obtained in these studies will be specific for this type of contaminant and contaminating event.

Studies conducted under Greenhouse Project 6.1 show that cloud activity was associated with particles ranging in size from less than 0.1 μ to greater than 200 μ. Generally, particles greater than 20 μ were not found on the collecting surfaces of the cloud-sampling devices used. This may be assumed to define the limits of particle size collected on test panels. However, the actual particle-size frequency-distribution curve is expected to be different for contaminants deposited on exterior panel samples than that for contaminants collected by the efficient cloud-sampling devices.

The shape of the particles varied, as observed by examination under an electron microscope. Uniformly spherical and highly irregular shaped particles were observed. In some cases the particulate matter appeared to be associated with water droplets at the time of collection.

Penetration of the surface by the contaminant particle was found to be shallow in the case of two soft materials tested. Fir-plywood and leather surfaces were cut by a microtome and lost 50 to 70 per cent of the initial contamination in the external 100-μ layer; 70 to 90 per cent was lost in the external 200-μ layer.

3.1.1 Contaminability-Decontaminability of Materials

The results of the contamination-decontamination studies on materials flown through the atomic cloud and materials exposed to fall-out are given in Sec. 3.1.1.1.

3.1.1.1 Measurement of Contaminability-Decontaminability of Materials Exposed on Drone Aircraft

After materials had been returned to USNRDL and examined, it was noted that frequently two adjacent samples of the same material exhibited great difference in initial contamination. This is seen in Sec. C.1, where data derived in this study have been collected.

Autoradiographic studies indicated that these differences were due to two factors: (1) accumulation of active particulates under and along the edges of the masking tape and (2) nonuniformity in distribution of the contaminant over the small sample surfaces. Figure 3.1 is a reproduction made from an autoradiograph of six typical samples.

Results obtained to date at USNRDL indicate that in almost every case the two factors just noted tend to mask any intrinsic contamination behavior of the materials exposed by USNRDL.

The mean values of the original contamination of each material used in the ACC studies of Sec. 2.3.2 are given in Table 3.1. The surface characteristics of the materials have not been considered in this table. Wide variations in the original contamination existed between samples of the same material (cf. Appendix E). Although these variations were similar from one material to another, it is felt that the listing should be considered as only indicative.

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Table 3.1 SURFACES EXPOSED BY THE ACC ARRANGED IN ASCENDING ORDER OF ORIGINAL CONTAMINATION[a]

MATERIAL	ORIGINAL ACTIVITY ($c/m \times 10^{-3}$)	PER CENT REMOVAL	RESIDUAL ACTIVITY ($c/m \times 10^{-2}$)
Linoleum coated with paraffin	2,474	80.6	481
Methyl methacrylate plastic	2,741	70.9	843
Mirawal (porcelain enamel steel)	3,066	74.3	750
Asphalt varnish	3,854	71.0	1,177
Linoleum, factory finish	4,336	65.0	1,517
Linoleum, benzene-washed to remove factory finish	4,694	58.6	1,916
Exterior graphite paint	4,820	55.0	2,194
Satinspred (interior paint, aqueous resin)	5,037	57.8	2,219
Goodyear gray rubber tile	6,005	63.5	2,130
Clear metal lacquer	6,049	74.6	1,654
Aluminum	6,438	57.5	2,561
Du Pont varnish	7,380	65.5	2,521
Fir plywood	7,536	67.8	2,422
Asphalt-saturated felt	7,940	62.8	2,946
OD paint	8,228	59.2	3,483
Canvas ducking	9,250	64.2	3,406
Glass cloth	10,617	75.4	2,614
Navy Cocoon strippable coating	11,611	68.1	3,616
Air Force overcoat wool	14,532	55.2	6,505

[a] Values listed for each material are the mean values found for all samples of that material.

At the USNRDL, the measurements of decontaminability of material revealed several interesting effects. Rough surfaces of glass and steel did not decontaminate nearly so well as smooth surfaces of glass and steel. For example, in the Dog Shot experiments, untreated glass surfaces retained 5 per cent of the initial contamination after decontamination, whereas ground-glass surfaces retained 26 per cent (average of 16 samples); polished steel surfaces retained 29 per cent of the initial contamination, whereas ground-steel surfaces retained 44 per cent (average of 16 samples). It may be noted that no significant variation in decontaminability was observed among the rough surfaces. This suggests that a significant range of surface roughness lies between the smooth and the first roughened surface. The same behavior is seen on the glass samples exposed on the Easy Shot. Surface-roughness measurements are reported in Sec. B.3. Another range of surface roughness was studied by the ACC and is reported in Sec. 3.1.2.

The decontaminability of the materials exposed by the USNRDL at three shots (Dog, Easy, and George) is summarized in Table 3.2, where materials are listed in decreasing order of per cent decontamination achieved. It is seen that on all three shots, five materials—cellulose acetate plastic, acryloid varnish, stainless steel, Navy 5H paint, and phenolic varnish—consistently are among the eight most readily decontaminable materials. Four materials—melamine plastic, copper, Stabond, and sea-blue lacquer—consistently are among the eight materials showing the poorest decontaminability.

Owing to the wide variation found from sample to sample for any of the materials (cf. Sec. C.1), great care must be exercised in drawing conclusions from these data as to differences in the decontaminabilities of the materials. The data suggest that such differences exist but that important variables were uncontrolled. Variables such as nature of the contaminant, presence of films and scratches on the surfaces, and sample attach-

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Table 3.2 DECONTAMINABILITY OF MATERIALS EXPOSED BY THE USNRDL

CONTAMINATED AT DOG SHOT[a]	CONTAMINATED AT EASY SHOT[a]	CONTAMINATED AT GEORGE SHOT[b]
Cellulose acetate plastic (91)	Alclad aluminum (90)	Acryloid varnish (87)
Acryloid varnish (88)	Stainless steel (89)	Stainless steel (84)
Clear lacquer (84)	Acryloid varnish (85)	Cellulose acetate plastic (84)
Stainless steel (82)	OD paint (88)	Alclad aluminum (81)
Navy 5H paint (79)	Brass (87)	OD paint (80)
Aluminized paint (78)	Navy 5H paint (85)	Navy 5H paint (79)
GE Cocoon (78)	Cellulose acetate plastic (84)	Silicone plastic (77)
Phenolic varnish (77)	Phenolic varnish (84)	Phenolic varnish (76)
Alclad aluminum (76)	Clear lacquer (83)	Brass (75)
Silicone plastic (75)	Copper (82)	Melamine plastic (74)
OD paint (73)	Melamine plastic (78)	Aluminized paint (73)
Sea-blue lacquer (68)	Stabond (76)	Copper (70)
Melamine plastic (75)	Silicone plastic (75)	Clear lacquer (62)
Stabond (63)	Aluminized paint (75)	Stabond (56)
Copper (53)	Sea-blue lacquer (74)	Sea-blue lacquer (54)
Brass (51)	GE Cocoon (71)	GE Cocoon (41)

[a] Per cent decontamination is noted in parentheses, in each case the average of 16 values.
[b] Average of 6 values.

ment by use of tape (see Fig. 3.2) may have been significant in these experiments.

The mean values of the residual contamination of each material used in the ACC studies of Sec. 2.3.2 are listed in Table 3.3. The surface characteristics of the materials are not considered in this table. Wide variations in residual contamination existed between samples of the same material (see Appendix E). Although these variations were similar from one material to another, it is felt that the listing should be considered as only indicative.

3.1.1.2 Distribution of Contaminant on Materials Exposed to Fall-out

After the fall-out on Dog Shot, survey of buildings and grounds on Eniwetok revealed the following:

1. Distribution of contamination in soil. A light rain (0.01 in.) fell on Eniwetok Island during the evening of D-Day. To determine whether the rain had carried any of the surface contamination to below ground level, on D+1 day an undisturbed section of the beach was selected and layers of sand approximately ⅛ in. deep were successively scraped away from an area about 1 ft square. Measurements of beta-plus-gamma activity were taken after each layer was removed. The following data were obtained:

Reading 1 ft above beach—10.5 mr/hr

Depth (in.)	Level at 1.25 in. (mr/hr)
0	13.25
⅛	13.50
¼	13.50
⅜	15.2
½	15.9
¾	14
1	13
1¼	11
2	10
4	7
8	4
12	3

The probe was partially shielded from the background radiation at a depth of 1 in. and greater.

2. Variation of radiation with height above the beach. On D+1 day, beta-plus-gamma measurements at increasing heights above a

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[redacted]

Table 3.3 SURFACES EXPOSED BY THE ACC ARRANGED IN ASCENDING ORDER OF RESIDUAL CONTAMINATION[a]

MATERIAL	ORIGINAL ACTIVITY ($c/m \times 10^{-2}$)	PER CENT REMOVAL	RESIDUAL ACTIVITY ($c/m \times 10^{-2}$)
Linoleum coated with paraffin	2,474	80.6	481
Mirawal (porcelain enamel steel)	3,066	74.3	750
Methyl methacrylate plastic	2,741	70.9	843
Asphalt varnish	3,854	71.0	1,177
Linoleum, factory finish	4,336	65.0	1,517
Clear metal lacquer	6,049	74.6	1,654
Linoleum, benzene-washed to remove factory finish	4,694	58.6	1,916
Goodyear gray rubber tile	6,005	63.5	2,130
Exterior graphite paint	4,820	55.0	2,194
Satinspred (interior paint, aqueous resin)	5,037	57.8	2,219
Fir plywood	7,536	67.8	2,422
Du Pont varnish	7,380	65.5	2,521
Aluminum	6,438	57.5	2,561
Glass cloth	10,617	75.4	2,614
Asphalt-saturated felt	7,940	62.8	2,946
Canvas ducking	9,250	64.2	3,406
OD paint	8,228	59.2	3,483
Navy Cocoon strippable coating	11,611	68.1	3,616
Air Force overcoat wool	14,532	55.2	6,506

[a] Values listed for each material are the mean values found for all samples of that material.

clear beach area were taken with the following results:

HEIGHT ABOVE BEACH	LEVEL (mr/hr)
1 in.	13.5
1 ft	16.5
2 ft	15.25
3 ft	14.0

3. Contamination distribution around a wooden building. The Service Club, a wooden building located at the extreme northern end of the island, was selected for a study of contamination distribution. It was located at an isolated spot away from any other building and also had representative porches, concrete walks, and appendages that are normal to the average residence. The following rather general qualitative statements can be made in regard to contamination on D+1 day:

(a) Cracks in concrete slabs read double the readings taken on smooth concrete surfaces.

(b) Runoff or contaminant which had been washed off a surface and redeposited on the ground tended to concentrate.

(c) Where roof runoff dripped into sand, the average reading was two to three times that of sand unaffected by runoff drippings. Where the runoff collected on both sand and concrete, the sand surveyed higher by a factor of 2.

(d) A patch of grass growing in sand under the runoff from the roof read double the reading of the sand.

(e) The building roof (painted corrugated iron) was down to background level after the rain.

(f) Water puddles on concrete gave approximately two times average reading of dry concrete.

4. Contamination distribution on roof of an aluminum building. The roof investigated was corrugated aluminum in new condition, very shiny with a slick feeling as if it had a fine film of oil covering it. Figure 3.3 shows the distribution of contaminant on the roof

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and on the sand beneath the overhang on D+2 day. For comparison, the roof of the Officers' Club was monitored. This roof was made of asphalt paper laid lengthwise in approximately 3-ft strips. Its general reading was background, as were the readings taken on the aluminum roof. All measurements taken on the three types of roof surfaces read the island background, which was lower than the readings taken at ground level over the sand. One section of the island of about 1,000-sq ft area was heavily foliaged with large-leaved shrubs beginning at ground level. In an open area within this shrubbery, the background read double the general island background.

5. Roof drainage from B–50 hangar. The B–50 hangar was constructed in the shape of a Quonset building about 200 ft long and 150 ft wide with a maximum height of about 50 ft. On D+1 day, after the rain, a survey was made along the base of the building to determine the concentration of activity from a large surface area. Results of the survey are shown in Fig. 3.4.

6. Drone-decontamination area. A parking mat for drone decontamination was made on the southern end of the island bordering on the lagoon such that the prevailing wind would carry all airborne contamination out into the lagoon. The coral sand acted as an excellent sponge for water, for after every heavy rain no puddles of water were seen standing anywhere on the island. However, the drone-decontamination area was sprayed with oil and in low spots heavy road oil had collected in puddles. Drainage was poor to negligible. After the drones had been decontaminated, the following data were collected in the area on D+3 day:

Background	60 mr/hr gamma
Surface readings of oily sand	400 mr/hr gamma
Readings of oil puddles at 4 in. from surface	500 mr/hr gamma

7. Roadways and trucks. The paved roads, smooth asphalt, read background on D+2 day, whereas the sand at edge of roads read approximately three times background. The motor-pool area, which was an oiled surface of rocks and sand, read approximately two times background. Two trucks were surveyed under the fenders and wherever pickup might be expected. One of the trucks was newly painted and clean on the underside, while the other was in average condition. No indication of any readings above background was found. It was learned that the trucks traveled on dry surfaces during and after the fall-out.

8. Shoes. After the day's work on D+1 day, three types of shoe sole were surveyed with the following results (average of several readings in each case):

Leather	10
Composition (new)	7
Smooth rubber tennis shoes	5

3.1.2 Contamination-Decontamination Related to Surface Characteristics

3.1.2.1 Compilation of Youden Square Values

Table 2.1 is an illustration of the variations of surface characteristics studied by the ACC. Tables 3.4 to 3.6 give the results of this study (in terms of Table 2.1) for initial contamination, per cent decontamination, and residual contamination for Dog, Easy, and Item Shots. Table 3.7 gives the over-all results for all shots in terms of Table 2.1. The sums (Σ) for the rows and columns of these tables are also shown as they were used in the statistical evaluation. Tables 3.4 to 3.7 were derived from the data included in Appendix E.

3.1.2.2 Variance Due to Surface Characteristics Taken Individually

The statistical techniques used by the ACC to evaluate the data in terms of the surface characteristics are reported in Sec. D.2. The results of this evaluation for initial contamination, per cent decontamination, and residual contamination for the individual action and the interaction of surface characteristics will now be reported.

(*a*) *Initial Contamination*. Porosity shows a trend (i.e., at about the 65 per cent confi-

TABLE 3.4 INITIAL CONTAMINATION ON MATERIALS USED TO STUDY SURFACE CHARACTERISTICS
(Values Given in Counts Per Minute × 10^{-3})[a]

		LOW POROSITY			MEDIUM POROSITY			HIGH POROSITY			TOTALS	SHOT[b]
		Roughness (R)			Roughness (R)			Roughness (R)				
		Low	Med	High	Low	Med	High	Low	Med	High		
Nonretentivity (T_N) Contact Angle (A)	Low	328	272	328	118	434	597	.....	.....	1,297	3,374	D
		1,170	360	1,520	730	1,640	2,450	.....	.....	2,180	10,050 } 41,953	E
		1,920	2,520	779	3,300	6,870	6,000	.....	.....	7,140	28,529	I
	Med	182	161	154	184	392	513	136	.....	.....	1,722	D
		661	859	846	1,020	1,680	1,730	1,040	.....	.....	7,836 } 30,708	E
		1,130	1,570	2,660	2,990	4,570	5,070	3,160	.....	.....	21,150	I
	High	194	160	354	220	162	220	115	1,200	222	2,847	D
		1,280	957	1,290	909	782	640	899	2,500	5,720	14,977 } 55,824	E
		3,960	2,390	8,730	1,750	3,140	3,740	1,460	4,240	8,590	38,000	I
Retentivity (T_R) Contact Angle (A)	Low	.....	.....	.....	160	201	393	521	796	1,330	3,401	D
		.....	.....	.....	746	1,360	2,050	1,710	1,740	2,470	10,076 } 37,717	E
		.....	.....	.....	3,130	2,350	4,720	4,600	4,290	5,150	24,240	I
	Med	738	834	3,410	194	499	742	124	184	2,200	8,925	D
		1,870	2,950	4,310	1,830	1,940	2,920	742	931	1,010	18,503 } 74,098	E
		4,900	5,220	10,600	3,680	4,820	8,560	3,220	2,080	3,590	46,670	I
	High	120	946	653	289	245	356	.....	.....	1,330	3,939	D
		685	1,710	1,860	1,210	1,040	1,310	.....	.....	2,740	10,555 } 41,994	E
		3,200	4,000	4,840	3,670	3,180	3,160	.....	.....	5,450	27,500	I
Σ		22,338	24,909	42,334	26,130	35,305	45,171	17,727	17,961	50,419	282,294	
		89,581			106,606			86,107				
TOTALS		$\Sigma R_L = 66,195$; $\Sigma R_M = 78,175$; $\Sigma R_H = 137,924$			$\Sigma A_L = 79,670$; $\Sigma A_M = 104,806$; $\Sigma A_H = 97,818$			$\Sigma T_N = 128,485$; $\Sigma T_R = 153,809$				

[a] Each numerical value is the mean obtained for all surfaces having the characteristics noted and which were contaminated on the indicated shot.

[b] D = Dog; E = Easy; I = Item.

dence level).[1] Materials appear to be most easily contaminated at the high porosities and become more difficult to contaminate at lower porosities. The variations in contamination would be from low to medium to high porosity in the ratio 1 to 1 to 1.21 (see Table 3.8). Refer to Sec. F.1 for explanation of ratios. Table 3.4 shows that low porosity might have been affected by the complete absence of any surfaces in the low porosity—low contact angle—retentive group.

[1] Indicates that this trend probably will occur 65 per cent of the time. In this particular case, the trend is not very significant. For this and the following section, the higher the per cent the greater the significance.

Roughness shows a trend (i.e., at about an 80 per cent confidence level between low and medium roughness and 95 per cent between medium and high roughness). Surfaces seem to be more easily contaminated at high roughnesses and more difficult to contaminate at lower roughnesses. The variations in contamination would be from low to medium to high roughness in the ratio 1 to 1.27 to 1.95.

Contact angle shows no definite trend (i.e., at about the 55 per cent confidence level). This indicates that contact angle does not have a marked effect on contaminability.

Retentivity shows a trend (i.e., at about the 85 per cent confidence level). Materials appear to be more easily contaminated if their surfaces are dye retentive. The variations in

[redacted]

Table 3.5 PER CENT DECONTAMINATION ON MATERIALS USED TO STUDY SURFACE CHARACTERISTICS
(Values Given in Counts Per Minute × 10^{-2})[a]

		Low Porosity			Medium Porosity			High Porosity			Totals		Shot[b]
		Roughness (R)			Roughness (R)			Roughness (R)					
		Low	Med	High	Low	Med	High	Low	Med	High			
Nonretentivity (T_N) Contact Angle (A)	Low	95	75	71	77	71	55	.....	.....	80	524		D
		89	76	91	80	69	67	.....	.....	78	550	1,585	E
		91	71	83	61	62	69	.....	.....	74	511		I
	Med	95	79	67	88	81	75	70	.....	.....	555		D
		92	73	62	86	75	74	73	.....	.....	535	1,581	E
		88	65	58	89	62	66	63	.....	.....	491		I
	High	85	41	48	77	79	60	74	55	78	597		D
		87	57	54	79	81	74	78	59	64	633	1,804	E
		61	37	64	85	64	61	83	62	57	574		I
Retentivity (T_R) Contact Angle (A)	Low	.....	.....	.....	61	54	59	68	64	66	372		D
		.....	.....	.....	71	68	57	67	73	70	406	1,143	E
		.....	.....	.....	54	67	46	72	62	64	365		I
	Med	69	60	67	77	64	69	46	60	9[illegible]	608		D
		65	74	52	71	60	57	66	67	58	570	1,711	E
		68	61	76	61	56	57	44	65	45	533		I
	High	73	81	69	54	71	67	.....	.....	52	467		D
		77	85	70	55	69	71	.....	.....	56	483	1,350	E
		51	67	57	32	59	64	.....	.....	70	400		I
	Σ	1,186	1,002	989	1,258	1,212	1,148	804	567	1,008	9,174		
		3,177			3,618			2,379					
Totals		$\Sigma R_L = 3{,}248$			$\Sigma A_L = 2{,}728$			$\Sigma T_N = 4{,}970$					
		$\Sigma R_M = 2{,}781$			$\Sigma A_M = 3{,}292$			$\Sigma T_R = 4{,}204$					
		$\Sigma R_H = 3{,}145$			$\Sigma A_H = 3{,}154$								

[a] Each numerical value is the mean obtained for all surfaces having the characteristics noted and which were contaminated on the indicated shot.

[b] D = Dog; E = Easy; I = Item.

retentivity would be from nonretentive to retentive in the ratio 1 to 1.25.

(*b*) *Per Cent Decontamination.* Porosity shows a trend (i.e., at about the 65 per cent confidence level between low and medium and 55 per cent between medium and high). Materials are more easily decontaminated at the low porosities and become more difficult to decontaminate at the high porosities. The variations in per cent decontamination would be from low to medium to high porosity in the ratio 1.07 to 1.01 to 1.

Roughness shows a trend (i.e., at about the 65 per cent confidence between low and medium and 55 per cent between medium and high). Materials are more easily decontaminated at low surface roughness and become more difficult to decontaminate at high surface roughness. The variations in per cent decontamination are from low to medium to high roughness in the ratio 1.10 to 1 to 1.

Contact angle shows a slight trend (i.e., at about the 55 per cent confidence level between low and medium and 60 per cent between medium and high). Decontamination is easier with surfaces having low contact angles and becomes more difficult at the high contact angle surfaces. The variations in per cent decontamination are from low to medium to high contact angle in the ratio 1.06 to 1.04 to 1.

[redacted]

[redacted]

TABLE 3.6 RESIDUAL CONTAMINATION ON MATERIALS USED TO STUDY SURFACE CHARACTERISTICS
(Values Given in Counts Per Minute $\times 10^{-2}$)[a]

		LOW POROSITY			MEDIUM POROSITY			HIGH POROSITY			TOTALS		SHOT[b]
		Roughness (R)			Roughness (R)			Roughness (R)					
		Low	Med	High	Low	Med	High	Low	Med	High			
Nonretentivity (T_N) Contact Angle (A)	Low	27	96	92	41	91	193	.....	.....	288	828	12,428	D
		130	86	140	148	511	810	.....	.....	486	2,311		E
		170	730	779	1,300	2,590	1,880	.....	.....	1,840	9,289		I
	Med	12	47	68	34	87	92	59	.....	.....	399	9,009	D
		50	229	322	138	415	442	278	.....	.....	1,874		E
		134	557	1,110	335	1,720	1,700	1,180	.....	.....	6,736		I
	High	72	75	168	46	42	63	34	346	736	1,582	21,145	D
		169	414	594	192	146	165	198	1,010	2,040	4,928		E
		1,550	1,510	3,130	266	1,140	1,470	249	1,590	3,730	14,635		I
Retentivity (T_R) Contact Angle (A)	Low	.....	.....	.....	59	85	218	191	328	191	1,072	13,932	D
		.....	.....	.....	218	439	891	558	475	734	3,315		E
		.....	.....	.....	1,450	766	2,530	1,300	1,630	1,860	9,536		I
	Med	173	338	694	64	238	263	61	96	99	2,026	27,044	D
		660	771	2,081	540	780	1,263	254	311	424	7,084		E
		1,551	2,020	2,560	1,450	2,140	3,710	1,810	733	1,960	17,934		I
	High	24	157	252	121	105	153	.....	.....	568	1,380	16,378	D
		160	259	559	541	321	380	.....	.....	1,208	3,428		E
		1,570	1,320	2,090	2,510	1,320	1,130	.....	.....	1,630	11,570		I
	Σ	6,452	8,609	14,639	9,453	12,936	17,353	6,172	6,519	17,794	99,927		
		29,700			39,742			30,485					
TOTALS		$\Sigma R_L = 22{,}077$			$\Sigma A_L = 26{,}351$			$\Sigma T_N = 42{,}482$					
		$\Sigma R_M = 28{,}064$			$\Sigma A_M = 36{,}053$			$\Sigma T_R = 57{,}345$					
		$\Sigma R_H = 49{,}786$			$\Sigma A_H = 37{,}523$								

[a] Each numerical value is the mean obtained for all surfaces having the characteristics noted and which were contaminated on the indicated shot.

[b] D = Dog; E = Easy; I = Item.

Dye retentiveness as a surface characteristic shows a trend (i.e., at about the 80 per cent confidence level). Surfaces are more easily decontaminated when nonretentive as compared to retentive. The variations in per cent decontamination would be from nonretentive to retentive in the ratio 1.13 to 1.

(c) *Residual Contamination.* Porosity shows a trend (i.e., at about the 70 per cent confidence level). Mean residual contamination increases with the increase in porosity. The variations for residual contamination are from low to medium to high porosity in the ratio 1 to 1.12 to 1.28. It is interesting to note that this trend for residual contamination is similar to the trend for initial contamination, while an opposite trend exists for per cent decontamination.

Roughness shows a significant trend (i.e., at about the 85 per cent confidence level between low and medium roughness and 95 per cent between medium and high roughness). Mean residual contamination increases with the increase in roughness. The variations for residual contamination are from low to medium to high roughness in the ratio 1 to 1.36 to 2.11. As with porosity, the trends for residual contamination and initial contamination are parallel, while the trend of per cent decontamination is opposite.

Contact angle shows a slight trend (i.e., at about the 60 per cent confidence level between

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Table 3.7 COMPILATION OF RESULTS OF INITIAL CONTAMINATION, PER CENT DECONTAMINATION, AND RESIDUAL CONTAMINATION ON MATERIALS USED TO STUDY SURFACE CHARACTERISTICS[a]

		LOW POROSITY			MEDIUM POROSITY			HIGH POROSITY		
		Roughness (R)			Roughness (R)			Roughness (R)		
		Low	Medium	High	Low	Medium	High	Low	Medium	High
Nonretentivity (T_N)	Contact Angle (A) Low	1,139[b]	1,051	876	1,383	2,981	3,016	......	.....	3,539
		92[c]	74	82	73	67	64	......	.....	77
		109[d]	304	337	496	1,064	961	......	.....	871
	Medium	658	863	1,220	1,398	2,214	2,438	1,445	.....	.....
		92	72	62	88	73	72	69	.....	.....
		65	278	500	169	741	745	506	.....	.....
	High	1,811	1,169	3,458	960	1,361	1,533	825	2,647	4,844
		78	45	55	80	75	65	78	59	66
		597	666	1,297	168	443	566	160	982	2,169
Retentivity (T_R)	Contact Angle (A) Low	......	......	......	1,345	1,304	2,388	2,277	2,275	2,983
		......	......	......	62	63	54	69	66	67
		......	......	......	576	430	1,213	683	811	928
	Medium	2,503	3,001	6,107	1,901	2,420	4,074	1,362	1,065	2,207
		67	65	65	70	60	61	52	64	66
		795	1,043	1,778	685	1,053	1,745	708	380	828
	High	1,335	2,319	2,451	1,723	1,488	1,609	......	.....	3,173
		67	78	65	47	66	67	......	.....	59
		585	579	967	1,057	582	554	......	.....	1,135

[a] These values are the means obtained on all surfaces having the characteristics noted and which were contaminated on the Dog, Easy, and Item Shots. Data included are drawn from Tables 3.4 to 3.6.

[b] Top figure in set of three is the initial contamination in counts per minute $\times 10^{-2}$.

[c] Middle figure in set of three is the per cent decontamination.

[d] Bottom figure in set of three is the residual contamination in counts per minute $\times 10^{-2}$.

Table 3.8 INITIAL CONTAMINATION, PER CENT DECONTAMINATION, AND RESIDUAL CONTAMINATION RATIOS DERIVED IN STUDIES OF SURFACE CHARACTERISTICS[a]

CHARACTERISTIC	INITIAL CONTAMINATION			PER CENT DECONTAMINATION			RESIDUAL CONTAMINATION		
	Surface Value			Surface Value			Surface Value		
	Low	Medium	High	Low	Medium	High	Low	Medium	High
Porosity	1.00	1.00	1.21	1.07	1.01	1.00	1.00	1.12	1.28
Roughness	1.00	1.27	1.95	1.10	1.00	1.00	1.00	1.36	2.11
Contact angle	1.00	1.07	1.00	1.06	1.04	1.00	1.00	1.11	1.16
Retentivity									
Nonretentive		1.00			1.13			1.00	
Retentive		1.25			1.00			1.41	

[a] Ratios derived from measurements on all materials exposed on the Dog, Easy, and Item Shots. The surface values are normalized for each characteristic and separately for initial contamination, per cent decontamination, and residual contamination. See Sec. F.1.4 for actual values obtained.

[redacted]

low and medium contact angle and 65 per cent between medium and high contact angle). The variations for contact angle are from low to medium to high contact angle in the ratio 1 to 1.11 to 1.16. As in the case of porosity and roughness (although it is less pronounced) the contact angle variation for initial contamination and residual contamination is similar and the trend for per cent decontamination is opposite.

Dye retentivity shows a trend (i.e., at about the 90 per cent confidence level). Mean residual contamination is greater for dye-retentive surfaces, in the ratio 1.00 to 1.41. Again the trend is in the same direction as for initial contamination, with greater divergence in the values of residual contamination because the trend for per cent decontamination is in the opposite direction.

3.1.2.3 Variance Due to Surface Characteristics Interaction

The Students t test (cf. Sec. D.2), repeated for each combination of the variables, showed that the four properties are independent variables. The six possible combinations (porosity–retentivity, porosity–contact angle, porosity–roughness, roughness–retentivity, roughness–contact angle, and contact angle–retentivity) were considered for initial contamination, per cent decontamination, or residual contamination. Investigation of Sec. F.1 for these combinations shows definite trends, but the analysis shows that these variations are not due to interaction but merely are the product of the two single variations of the characteristics investigated. Therefore if the ratios of the combinations of any two characteristics are of interest, then multiply the ratios of the characteristics taken individually. For example, comparing per cent decontamination of nonretentive–medium contact angle surfaces to the per cent decontamination of retentive–low contact angle surfaces, the values from Table 3.8 are (1.13) (1.04) to (1) (1.06), or 1.11 to 1.

To test for variance of the four characteristics taken three at a time, the procedure used for testing two at a time was followed. As might be expected, the results were similar to those of two characteristics at a time. There were no significant interactions occurring between the possible combinations (porosity–roughness–contact angle, porosity–roughness–dye retentivity) taken three at a time for initial contamination, per cent decontamination, or residual contamination. Investigation of Sec. F.2 shows definite trends, but the analysis shows that these variations are not due to interaction but merely are the product of the three single variations of the characteristics investigated.

The same procedure for comparing combinations of two characteristics taken at a time is followed for three characteristics at a time. For example, to compare for residual contamination of low porosity–medium contact angle–high roughness to medium porosity–low contact angle–medium roughness, the values from Table 3.8 are (1) (1.11) (2.11) to (1.12) (1) (1.36), or 1.54 to 1.

The values in Secs. F.1 and F.2 on initial contamination, residual contamination, and per cent decontamination represent the mean of the results of Dog, Easy, and Item Shots combined. Bartlett's test of homogeneity[2] was made for each table listed in Appendix F for characteristics taken two or three at a time. These tables are included to provide a picture of the variability found for all of the combinations and to show the general trends which were found. It should always be kept in mind that the variances are the product of the individual variances as previously shown. Examination of any one table enables the combinations of characteristics within the table to be arranged in order; for example, for initial contamination as dependent upon roughness and retentivity, Sec. F.1.1 would rank the combinations for contaminability (from most difficult to contaminate to the most easily contaminated) as follows:

Low roughness–nonretentive
Medium roughness–nonretentive
Low roughness–retentive
Medium roughness–retentive
High roughness–nonretentive
High roughness–retentive

[2] W. Cochran and G. Cox, *Experimental Designs*, Chap. 13 (New York: John Wiley & Sons, Inc., 1950).

It should be noted that medium roughness–nonretentive and low roughness–retentive do not differ in mean counts and should be considered as being similar in contaminability. Caution should be exercised in this type of interpretation regarding contaminability that is dependent on contact angle and porosity because of inability to produce surfaces having certain combinations of characteristics.

Of the four surface parameters tested, only roughness and porosity show effects of high statistical significance.

The effect of contact angle showed a slight trend in the direction of lower contamination and easier decontamination at lower contact angle. Similarly, there appears to be a trend favoring the nonporous surfaces for improved performance against contamination. However, neither of these trends is of a high order of statistical significance. Moreover, even accepting the trend as real, the magnitude of the effect is small, so that both contact angle and porosity can be discounted as criteria for contaminability or decontaminability under the conditions of the test.

Although the data show a high level of statistical significance for the effect of dye retentivity in both the contamination and decontamination phase, again the magnitude of the effect is too small to be material in surface selection. Only roughness shows an appreciable effect, although even for this parameter the effect is of modest proportions. Examination of Table 3.8 shows that, between smooth surfaces and very rough ones, the effect is 1.00 to 1.95 in the contaminating phase and 1.00 to 2.11 for residual contamination. It is suggested that there may be parameters other than those here studied which are more important than any of these four parameters.

A very interesting phenomenon was observed on the fir-plywood panels (Figs. 3.11 and 3.12). A distinct difference of contamination and decontamination was observed according to the growth-ring structure of the wood. The dark and more resinous portion of the plywood contaminated to a lesser degree than the softer more fibrous portion. After decontamination, the light portion of the wood retained most of the radioactive material. This behavior of the wood panels suggests that some of the surface characteristics for wood depended on the ring structure of the wood. Comparison of surface characteristics of the light and dark portion of the wood may be an approach to the determination of parameters that are important in the contamination–decontamination nature of the surfaces.

3.1.3 Industrial Decontamination Procedures

Contrasting the results of the methods as such and not considering the additives, it is noted that, for the first cleaning, the hot solution brushing proved most effective in the four surfaces studied. However, prolonged treatment with cold solutions gave cleaning efficiencies comparable to those obtained by use of hot solutions. The results would indicate that, knowing the decontamination efficiency of one of the methods on a surface, it is not possible to predict the decontamination efficiency of the method on another surface. The relative order of efficiency remained approximately the same for the surface tested.

Consideration of the data of this study, summarized in Figs. 3.5 to 3.8, reveals that in many cases the efficacies of the tested industrial method of decontamination are quite dependent upon (1) the chemical additive employed and (2) the surface being decontaminated.

Figures 3.5 to 3.8 show that an increase in decontamination efficiency was obtained by more than one cleaning, particularly in the case of the cold solution brushing. In general, the first two steps set the order of magnitude of the final result. The same behavior has been observed with liquid-type contaminants.[3,4] It is suggested that the difference in cleaning efficiency is primarily due to a slower rate of reaction in the cold rather than to

[3] P. Tompkins and O. Bizzell, "Working Surfaces for Radiochemical Laboratories—Glass, Stainless Steel, and Lead," *Industrial and Engineering Chemistry*, XLII (1950), 1469.

[4] P. Tompkins and O. Bizzell, "Working Surfaces for Radiochemical Laboratories—Paints, Plastics, and Floor Materials," *Industrial and Engineering Chemistry*, XLII (1950), 1475.

some intrinsic advantage in repeated treatment with cold solutions.

On the whole, Tide was found to be among the better additives of those studied, although differences were not great and other additives gave nearly comparable cleaning efficiencies.

3.1.4 Evaluation of Decontamination Agents

The work conducted at the ACC was designed to study the decontamination efficiency of various agents used in conjunction with the brushing of surfaces. At the USNRDL, the work was concerned with the relations existing between laboratory and field use of decontaminants.

3.1.4.1 Efficiency of Decontamination Agents

The agents (detergents) that were evaluated are listed in Table 2.2. For this evaluation, per cent removal was the basis on which comparisons were made. To ensure validity of this technique, an analysis of covariance between "initial activity" and "activity after decontamination" was made. This analysis revealed in this particular case that there was no significant difference in the measurement of variability as computed by the method of covariance or by utilizing the more direct per cent decontamination technique (see Table 3.9).

Each of the 12 agents was used on 71 to 106 surfaces involving all the 54 variations in surface characteristics. Two evaluations were made: (1) the effectiveness of agents on surfaces decontaminated in Dog Shot and on half the surfaces contaminated at Easy Shot and (2) on the remaining half of Easy and all of Item Shot surfaces (see Sec. G.1). A rank-correlation coefficient[5] of 0.906 was found between agents of each evaluation, indicating that the individual evaluations should be incorporated into one.

An analysis of the combined evaluation led to Table 3.10, in which the agents are listed in six significantly different groups with the corresponding ratio of effectiveness between groups.

This grouping shows the following results:

1. Of the agents tested, the anionic types in general are the most efficient decontaminants.
2. Nonionic-type agents apparently show variable efficiency.
3. Of the agents tested, Versene, Sequestrene AA, and Breeze are the most efficient decontaminants.

Autoradiographs were made both before and after decontamination of all test panels. Figures 3.9 to 3.12 are typical illustrations of the

[5] A degree of significant difference.

TABLE 3.9 EFFECTIVENESS OF AGENTS USED BY THE ACC, COMBINED EVALUATION[a]

AGENTS[b]	NUMBER OF SURFACES	TOTAL INITIAL ACTIVITY (c/m × 10^{-2})	TOTAL FINAL ACTIVITY (c/m × 10^{-2})	MEAN INITIAL ACTIVITY (c/m × 10^{-2})	MEAN FINAL ACTIVITY (c/m × 10^{-2})	PER CENT DECONTAMINATION
Versene	83	227,891	36,935	2,740	445	84
Sequestrene AA	71	75,642	17,642	1,060	248	77
Breeze	103	131,205	31,593	1,270	307	76
TSPP	83	164,864	46,751	1,990	563	72
Chlorsol	106	196,332	58,000	1,850	547	70
Aresklene 400	93	248,142	76,088	2,670	818	69
Ethomid HT/60	90	72,193	24,231	802	269	66
Tergitol P-28	96	178,688	60,481	1,860	630	66
Blendene	97	248,550	84,875	2,560	875	66
Ethomeen 18/25	84	21,500	7,711	256	92	64
Triton	81	119,284	45,068	1,470	556	62
Ethofat 242/25	90	164,591	69,997	1,830	778	58

[a] The mean of the two evaluations listed in Sec. G.1.
[b] Formulation of agents is listed in Table 2.2.

TABLE 3.10 AGENTS LISTED ACCORDING TO EFFICIENCY OF GROUPS

GROUP	NAME	pH	IONIC TYPE[a]	RATIO
I	Versene	8	AN	1.46
II	Sequestrene AA	5	AN	1.33
II	Breeze	6	AN	1.33
	TSPP	9	AN	
III	Chlorsol	6	NON	1.23
	Aresklene 400	5	AN	
	Ethomid HT/60	6	NON	
IV	Tergitol P-28	7	AN	1.15
	Blendene	8	AN	
	Ethomeen 18/25	7	CAT	
V	Triton	6	NON	1.08
VI	Ethofat 242/25	6	NON	1.00

[a] AN, anionic; CAT, cationic; NON, nonionic.

results obtained. An examination of the before and after autoradiographs shows that some spots have disappeared entirely, whereas others have apparently decreased in radiation intensity.

The pertinent facts regarding these autoradiographs are tabulated below.

FIG. NO.	HOURS EXPOSED	SURFACES, LEFT TO RIGHT
3.9	17	Aluminum 41[a], Linoleum benzene 1, Asphalt varnish 20
3.10	44	Same as Fig. 3.9
3.11	17	Aluminum 27, Fir plywood 15, Rubber tile 8
3.12	44	Same as Fig. 3.11

[a] Numbers are Youden Square Numbers.

It would be expected that after condensation of bomb debris the radioactive particles formed would be chemically inert.[6] However, the high efficiency of such sequestering agents as Versene and Sequestrene AA, alkaline and acidic salts of ethylene diamine tetraacetic acid, indicates that some reaction does take place. In general terms, the test indicates that an agent for radiological decontamination should consist of an anionic detergent with a sequestering additive.

[6] L. R. Bunney and N. E. Ballou, "The Chemical Species of the Elements Resulting from an Atomic Bomb Detonation in Air," USNRDL Report AD-325(C), U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.

3.1.4.2 Relations between Results of Laboratory and Field Studies of Decontamination Agents

The decontamination efficiency of six agents was evaluated using surfaces contaminated with particulate-type contaminants both in the laboratory and in the field (see Sec. G.2). As shown in Table 3.11, the relative decontamination efficiency of the agents is the same when tested against artificially contaminated materials as when tested against materials contaminated at Operation Greenhouse.

The data lend considerable support to the use of the laboratory results to predict the relative efficiency of reagents used in the field. However, the laboratory results obtained from tests devised to predict field behavior of agents with a specific contaminant cannot necessarily be relied upon to predict behavior of agents with other contaminants having different properties, such as those resulting from other types of bursts.

TABLE 3.11 COMPARISON OF LABORATORY AND FIELD ORDER-OF-EFFECTIVENESS TESTS OF DECONTAMINATING AGENTS

AGENTS	PER CENT DECONTAMINATION			
	Lab	Dog	Easy	George
	OD Paint			
Tide[a]	93.0	74.7	83.5	88.3
4Na-EDTA[b]	80.6	58.3	73.1	64.2
Nytron[c]	60.9	33.2	42.4	44.0
	Aluminum			
Na-polyphos[d]	93.1	55.0	78.1	59.7
2Na-EDTA[e]	91.1	47.1	71.7	47.8
Ultrawet DS[f]	64.5	33.7	58.3	38.9

[a] Tide: Possibly 16 per cent alkyl aryl sulfonate and 4 per cent alcohol sulfate plus other builders.

[b] 4Na-EDTA: The tetrasodium salt of ethylene diamine tetraacetic acid.

[c] Nytron: A mixture of sulfonates, ketones, amine alkyl sulfamates and alkylidene materials.

[d] Na-polyphos: Sodium hexametaphosphate ($Na_{12}P_{10}O_{31}$).

[e] 2Na-EDTA: The disodium salt of ethylene diamine tetraacetic acid.

[f] Ultrawet DS: Alkyl benzene sodium sulfonate.

[redacted]

They are not reliable, at present, in predicting accurately the absolute efficiency of removal of contaminants.

3.1.5 Decontamination as a Function of Time

Figures 3.13 to 3.19 have been included as illustrations of typical results obtained in this investigation (see Appendix H for compilation of data).

As shown in the figures, frequently large differences were found in per cent removal from duplicate samples. Possible reasons for these differences have been included in Sec. 3.1.1.1 and may be briefly stated as: (1) accumulation of active particulates beneath attaching tape (cf. Figs. 3.1 and 3.2); (2) imperfections of sample surface; (3) films on surfaces; (4) nature of the contaminant; and (5) manner of deposition of contaminant.

The data derived so far are not conclusive in determining the influence on decontamination of the time that the contaminant has remained on the surface. However, examination of Appendix H reveals the following:

1. For the material contaminated on Dog Shot, the 79-day decontamination was generally less effective in removing contamination than were earlier decontaminations. Of the 16 cases studied, 12 definitely show this tendency, 2 possibly do, and 2 possibly do not. This effect is illustrated by Figs. 3.13 to 3.15. Differences in maximum and minimum decontamination varied by as much as 30 per cent.

2. If any decrease in aerosol decontamination with time occurs, it appears from the Dog Shot data that this effect begins around 20 days post contamination. This effect is seen in 14 cases out of the 16 studied on surfaces exposed on Dog Shot.

3. Consideration of the data derived on all materials exposed on the Dog, Easy, and George Shots, for the period of approximately 1 to 20 days, indicates that no conclusions may be drawn regarding the influence of time during this period. The data derived were contradictory; increases and decreases in decontamination efficiencies appear for the same periods on different samples.

3.1.6 Influence of Prewetting on Decontamination Efficiency

The results of this investigation are consistent with the idea that there is a decrease in decontamination efficiency when aerosol-contaminated surfaces are wetted and dried before decontamination. However, contamination and decontamination values obtained on duplicate samples are fairly divergent (see Appendix I), and it is felt that the data are not not conclusive. Some factors suspected to contribute to poor reproducibility on duplicate samples are discussed briefly in Sec. 3.1.1.1.

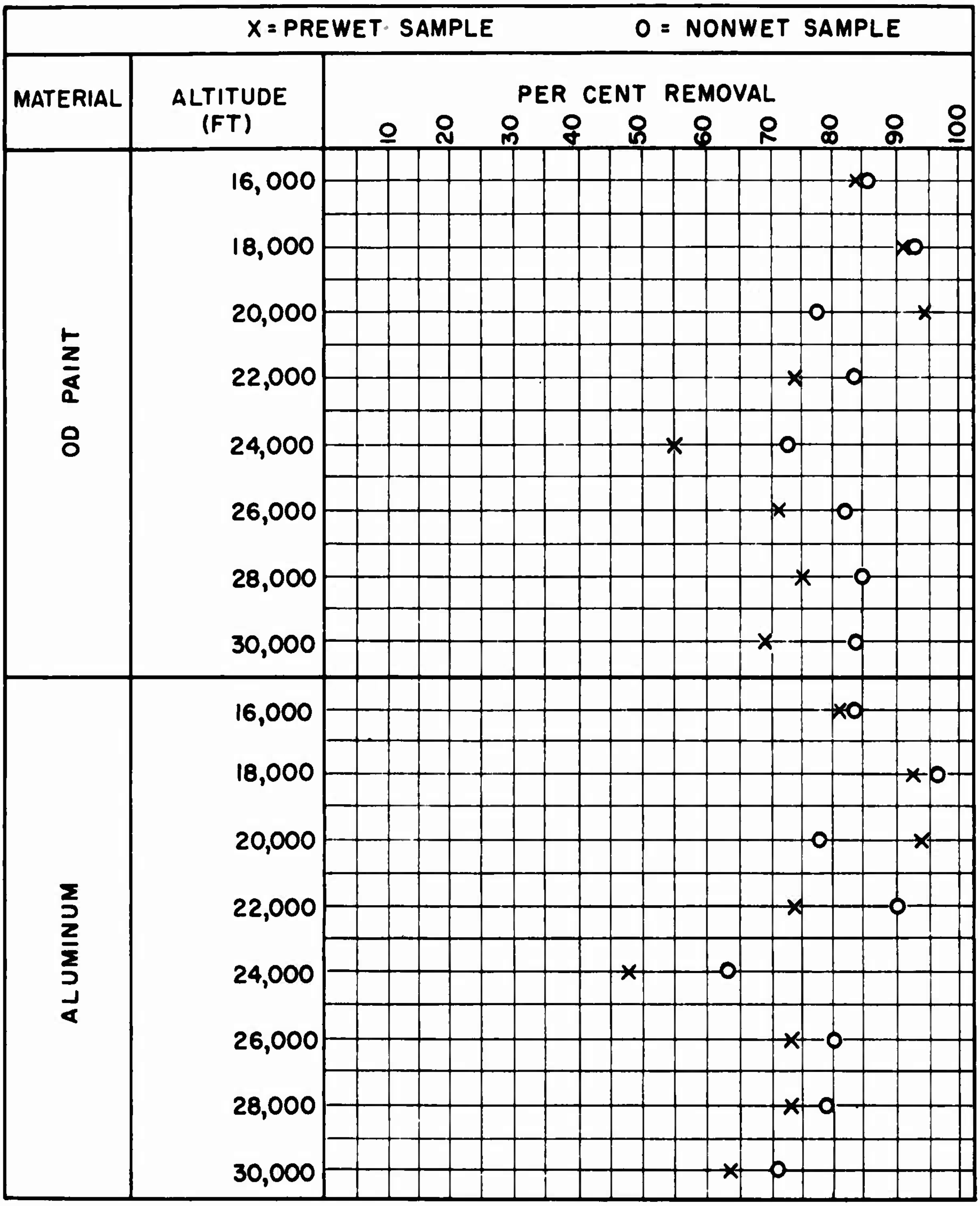
This study has been summarized in Table 3.12. It is seen that on Dog Shot, prewetting decreased decontamination by amounts varying from 2 to 13 per cent. Results obtained on the material contaminated on the Easy and George Shots are similar to, but show a smaller prewetting effect than, results obtained on surfaces exposed at Dog Shot.

It will be noted that for each shot prewetting of a few surfaces appeared to *increase* the extent of subsequent decontamination of one of the samples. This is illustrated by the surfaces contaminated at 20,000 ft on Dog Shot.

[redacted]

[redacted]

TABLE 3.12A DECONTAMINATION AS A FUNCTION OF PREWETTING, DOG SHOT



[redacted]

TABLE 3.12B DECONTAMINATION AS A FUNCTION OF PREWETTING, EASY SHOT

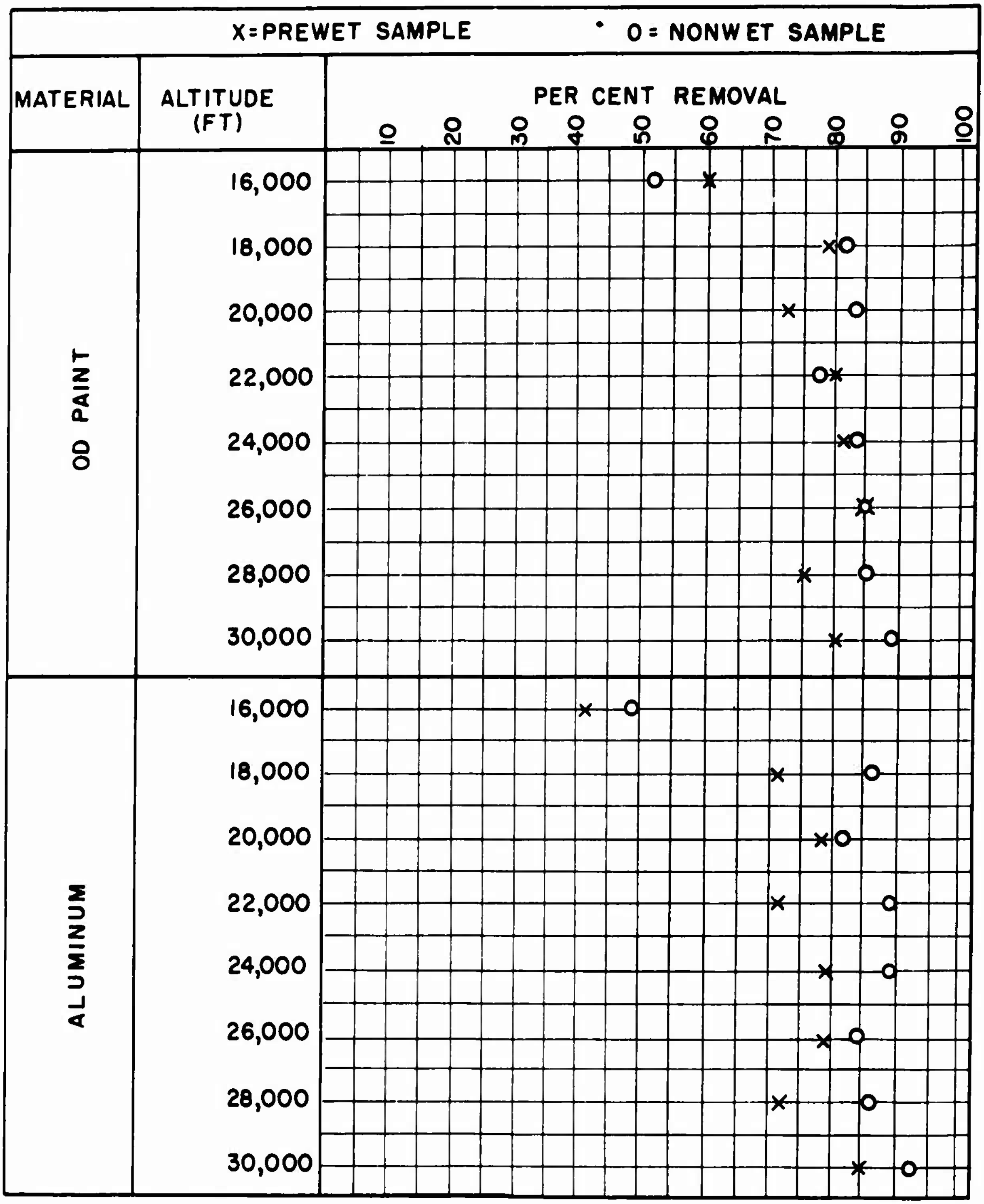
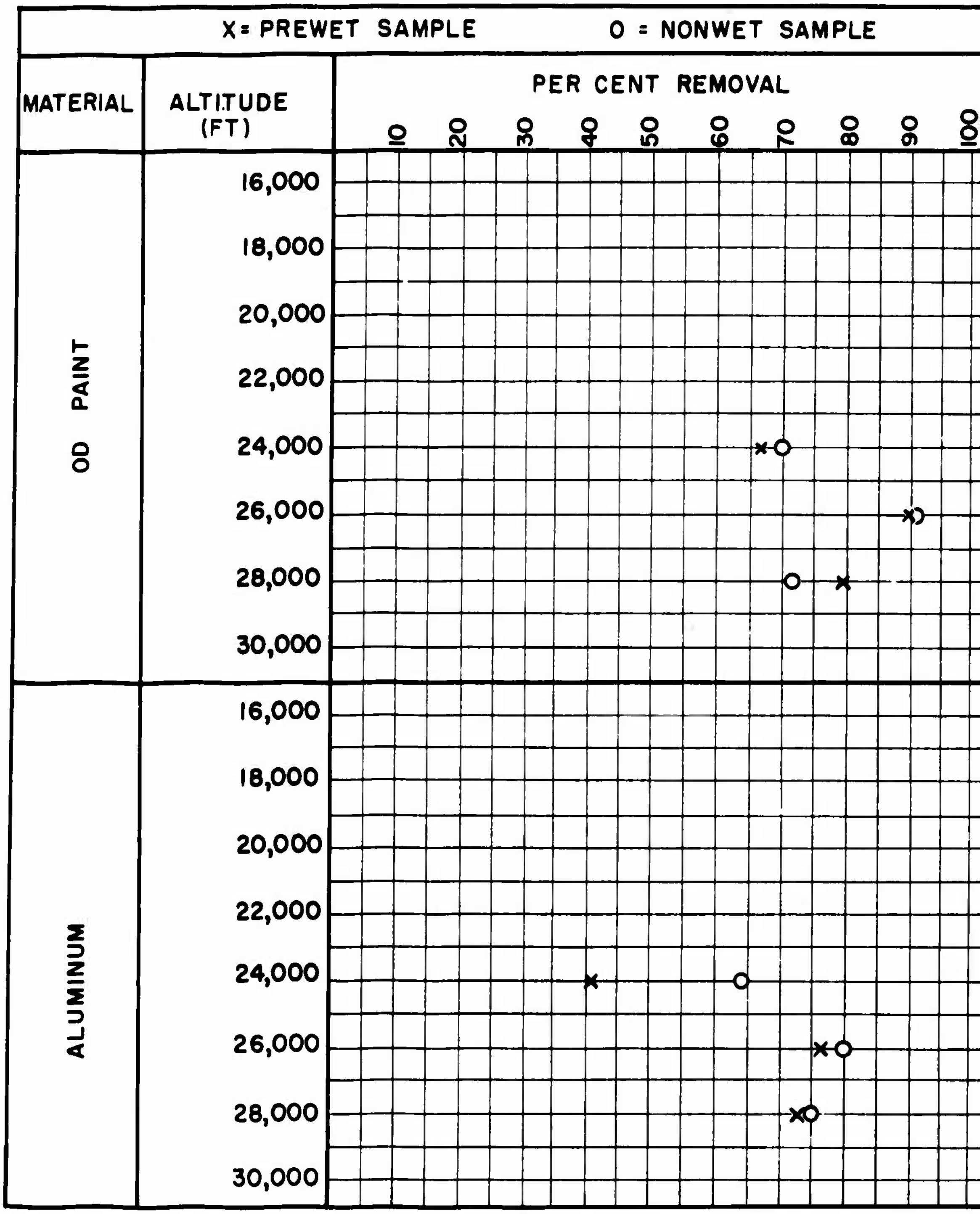


TABLE 3.12C DECONTAMINATION AS A FUNCTION OF PREWETTING, GEORGE SHOT



[redacted]

3.1.7 Fractionation of the Contaminant in the Atomic Cloud or in the Contaminating Process

Data obtained in this study indicate that the composition of contaminants retained on surfaces of aircraft is not identical at all altitudes. It does not, of course, distinguish between fractionation in the contaminating event or differences in the composition of the contaminant at various altitudes. Since the latter effect is known to occur, one may expect it to account for at least a portion of the observed fractionation.

The data in Table 3.13 show that barium, the rare earths, and perhaps iodine and zirconium may vary in their relative amounts on surfaces of planes flown at different altitudes. In some cases, differences in radiochemical composition appear, depending on the nature of the surface exposed.

TABLE 3.13 RADIOCHEMICAL ANALYSIS OF MATERIAL EXPOSED, DOG SHOT

MATERIAL	ALTITUDE (ft × 10⁻³)	TOTAL ACTIVITY (c/m)	BARIUM ACTIVITY		RARE-EARTH ACTIVITY		IODINE ACTIVITY		ZIRCONIUM ACTIVITY	
			c/m	% of Total[a]	c/m	% of Total	c/m	% of Total	c/m	% of Total
	16	1,260,000	100,000	8	325,000	26	37,000	3	24,400	2
	18	1,490,000	83,000	6			81,000	5		
	20	114,000								
Aluminum	22	63,500	15,700	25					2,620	4
	24	27,300	7,000	26						
	26	107,000	9,400	9			3,450	3		
	28	73,000	7,600	10	22,300	31				
	30	61,600	11,800	19	17,400	28	1,900	3	550	1
	16	605,000	47,000	8	84,600	14				
	18	630,000	24,700	4			21,600	3		
	20	45,000	3,400	8						
Decontaminated	22	24,000	2,950	12					410	2
aluminum	24	19,000	2,200	12						
	26	74,900	800	1			600	1		
	28	47,000	2,800	6	5,750	12				
	30	44,000	6,200	13						
	16	855,000	58,200	7	230,000	27				
	18	1,210,000	95,000	8			66,700	6		
	20	86,700	8,000	9						
	22	130,000	17,100	13					2,700	2
OD paint	24	26,000	3,200	12						
	26	94,400	13,900	15			2,880	3		
	28	63,500	6,700	11	16,900	27				
	30	69,000	6,000	9						

[a] Total activities were counted at slightly lower geometries than were the separated activities. Hence percentage values reported are not absolute.

[redacted]

[redacted]

TABLE 3.13—*Continued*

RADIOCHEMICAL ANALYSIS OF MATERIAL EXPOSED, EASY SHOT

MATERIAL	ALTITUDE ($ft \times 10^{-3}$)	TOTAL ACTIVITY (c/m)	BARIUM ACTIVITY		RARE-EARTH ACTIVITY	
			c/m	% of Total	c/m	% of Total
Aluminum	16	9,860	1,930	20	4,800	49
	18	41,700	10,300	25	28,800	69
	20	65,300	13,100	20	39,000	60
	22	99,000	24,400	25	61,500	62
	24	88,500	18,800	21	52,800	60
	26	60,700	13,100	22	40,500	67
	28	65,500	16,000	24	38,300	58
	30	62,500	12,600	20	44,300	71
Decontaminated aluminum	16	7,180	1,320	18	4,050	56
	18	9,780	1,150	12	6,880	70
	20	13,700	910	7	9,050	66
	22	26,300	3,430	13	17,500	67
	24	23,200	2,130	9	21,300	92
	26	8,830	1,400	16	6,850	78
	28	16,400	2,930	18	9,980	61
	30	11,800	940	8	7,850	67
OD paint	16	10,400	1,540	15	7,750	75
	18	33,200	6,850	21	23,500	71
	20	76,500	13,200	17	51,500	67
	22	92,200	18,800	20	52,500	57
	24	115,000	22,000	19	82,000	71
	26	46,000	9,380	20	30,000	65
	28	51,700	11,700	23	41,000	79
	30	89,000	16,500	19	66,000	74

TABLE 3.13—*Continued*

RADIOCHEMICAL ANALYSIS OF MATERIAL EXPOSED, GEORGE SHOT

MATERIAL	ALTITUDE ($ft \times 10^{-3}$)	TOTAL ACTIVITY (c/m)	BARIUM ACTIVITY		RARE-EARTH ACTIVITY	
			c/m	% of Total	c/m	% of Total
Aluminum	24	102,000	5,160	5	46,700	46
	26	234,000	24,300	10	98,400	42
	28	280,000	28,900	10	106,000	38
Decontaminated aluminum	24	44,500	3,800	9	10,900	25
	26	147,000	14,500	10	63,600	43
	28	133,000	11,800	9	63,300	48
OD paint	24	174,000	5,900	3	60,800	35
	26	208,000	19,000	9	126,000	61
	28	883,000	51,600	6	390,000	44

[redacted]

Reference to Table 3.14 further supports the idea of the heterogeneous nature of the contaminant deposited on aircraft surfaces. As shown in Table 3.14, exponential constants over comparable periods of time varied between 1.0 and 1.3. The exponential constants have been derived from graphs showing the decay of the material deposited on aircraft; the graphs are included as Figs. 3.20, 3.21, and 3.22. A relation between radiochemical composition and contaminability-decontaminability undoubtedly exists, but it has not been established by these studies.

TABLE 3.14 EXPONENTIAL CONSTANTS FOR DECAY OF RADIOACTIVE MATERIAL DEPOSITED ON AIRCRAFT

ALTITUDE ($ft \times 10^{-3}$)	CONSTANTS[a]		
	Dog Shot[b]	Easy Shot[c]	George Shot[d]
16	1.3	1.3	
18	1.3	1.2	
20	1.1	1.2	
22	1.1	1.2	
24	1.2	1.2	
26	1.0	1.2	
28	1.0	1.2	1.0

[a] The exponential constant is expressed as k; k is defined by $A = A_0 t^{-k}$, where A is activity at time t and A_0 is the initial activity.

[b] Constants derived for period 56 to 652 hr after detonation.

[c] Constants derived for period 42 to 750 hr after detonation.

[d] Constant derived for period 1.3 to 84.6 hr after detonation.

Appendix K presents, in tabular form, the data obtained in following the decay of the radioactive material deposited on aircraft.

3.1.8 Preferential Removal of Contaminant Species in Decontamination Operations

Examination of the data in Table 3.13 shows that preferential removal of contaminant species did occur in the decontamination process. It is seen that the per cent of the total activity contributed by barium on the decontaminated samples is about one-half that on the untreated samples. Analysis of rare earths on the Easy Shot showed a significant increase in the percentage of rare earths remaining on the decontaminated surfaces. No significant trends were observed on the George Shot.

Preferential removal was also indicated by the results of the radioactive-decay-rate studies, which have been included as Table 3.15. (Table 3.15 is derived from the complete data given in Sec. J.1.) On George and Easy Shots the exponential constant representing decay was greater for decontaminated material than for untreated samples by approximately 0.1 or less. For Dog Shot the constant was greater for decontaminated surfaces than for untreated surfaces by approximately 0.2 to 0.3. Graphs showing the decay of the contami-

TABLE 3.15 EXPONENTIAL CONSTANTS FOR DECAY OF RADIOACTIVE MATERIAL ON DECONTAMINATED AND NONDECONTAMINATED SURFACES

DOG SHOT			DOG SHOT		
Aluminum Absorber (mg/sq cm)	Constants[a][b]		Aluminum Absorber (mg/sq cm)	Constants[a][b]	
	Nondecontaminated OD Paint	Decontaminated OD Paint		Nondecontaminated OD Paint	Decontaminated OD Paint
55.7	1.2	1.5	217	1.3	1.6
70.3	1.2	1.5	348	1.4	1.5
109	1.3	1.6	692	1.0	1.2
176	1.3	1.6	2,059	0.90	1.1

[a] Constant is defined as k in the equation $A = A_0 t^{-k}$, where A is activity at time t and A_0 is the initial activity.

[b] Constants derived for period 55 to 263 hr after detonation.

[redacted]

TABLE 3.15—*Continued*

EASY SHOT

Aluminum Absorber (mg/sq cm)	Constants[c]	
	Nondecontaminated OD Paint	Decontaminated OD Paint
2.6	1.2	1.3
3.7	1.2	1.3
4.6	1.2	1.3
5.2	1.2	1.3
7.9	1.3	1.3
11.7	1.3	1.3
13.0	1.3	1.3
16.3	1.3	1.4
20.5	1.3	1.4
28.5	1.3	1.4

Aluminum Absorber (mg/sq cm)	Constants[d]	
	Nondecontaminated OD Paint	Decontaminated OD Paint
55.7		1.2 (7.2–15 hr)
		1.7 (15–80 hr)
	1.2 (80–180 hr)	1.4 (80–180 hr)
	0.85 (180–316 hr)	1 [illegible] (180–316 hr)
83.2		[illegible].3 (7.2–12 hr)
		1.7 (12–80 hr)
	1.2 (80–150 hr)	1.4 (80–150 hr)
	0.83 (160–300 hr)	1.4 (160–300 hr)
219		1.4 (7.2–15 hr)
		2.2 (15–80 hr)
	1.4 (80–130 hr)	1.4 (80–130 hr)
	0.99 (130–300 hr)	1.4 (130–300 hr)
433		1.3 (7.2–12 hr)
	0.95 (80–150 hr)	1.9 (12–30 hr)
	1.2 (150–300 hr)	2.3 (32–80 hr)
545		1.3 (7.2–12 hr)
		2.1 (12–24 hr)
		2.3 (26–49 hr)

[c] Constants derived for period 52 to 265 hr.

[d] Constants preceding parentheses derived over time periods noted in parentheses.

TABLE 3.15—*Continued*

GEORGE SHOT

Aluminum Absorber (mg/sq cm)	Constants[e]		Aluminum Absorber (mg/sq cm)	Constants[e]	
	Nondecontaminated OD Paint	Decontaminated OD Paint		Nondecontaminated OD Paint	Decontaminated OD Paint
83.2	1.5	1.5	1,610	1.1	1.2
219	1.8	1.9	3,380	1.2	1.1
679	1.8	1.9			

[e] Constants derived for period 8.5 to 85 hr.

nants on the surfaces are included in Appendix J.

It is not likely that the change in the decay rate observed in these experiments will prove to be operationally significant. Of greater significance is the fact that the values of the exponential constant under various conditions fall in the wide range 0.8 to 2.3 and are frequently significantly different from the usual value assumed, i.e., 1.2.

3.2 CONCLUSIONS

Appreciable differences were noted in the amounts of contamination found on the various materials exposed on drone aircraft. However, the physical condition of the surfaces, the way in which they were exposed, and perhaps other factors had a profound effect on both the levels of contamination and the extent of decontamination achieved and, frequently, appeared to be controlling factors.

[redacted]

A correlation between surface roughness (and to a lesser extent porosity and dye retentivity) and the contamination-decontamination properties of surfaces was established for this type of contaminating event. The information obtained in this study is considered to be of value in specifying materials for military purposes in radiological defense.

Data on the use of common industrial cleaning methods and agents indicate that these methods and agents also are effective in radiological decontamination. The military use of industrial methods for decontaminating is suggested.

Studies of chemical agents as decontaminants have assisted in the selection of efficient agents for field use. They have also provided valuable information on the chemical nature of substances which act as efficient decontaminating agents. The use of laboratory tests to predict field behavior of decontaminating agents has been supported by the results of the studies on decontaminants.

Measurable decreases in decontamination efficiency appeared with increased time of standing before decontamination. The effect is not considered to be operationally important, however, for this type of contaminating event for short times such as a few days after contamination.

The effect of wetting and drying a contaminated surface before decontamination was found to be sufficiently small so that it is not likely to be of operational significance. The distinctive nature of the contaminating event precludes generalization of the conclusion to other types of bursts in which the effect is predicted to be more important.

The heterogeneous nature of the contaminant deposited on drone-aircraft surfaces was confirmed. Gross decay rates should be considered to fall within a range of decay rates rather than being represented by a single rate.

The preferential removal of contaminant species as a result of a decontamination operation was demonstrated. Alteration of decay rates as a result of decontamination is not of greater magnitude than the alteration of rates observed at various times after fission and is often of lesser magnitude.

[redacted]

Appendix A

Position of Experimental Materials on Aircraft

A.1 ABBREVIATIONS

The abbreviations listed below are used throughout all the following appendixes.

Df(t)	Decontamination as a function of time study
FC	Study of fractionation of contaminant in the atomic cloud or in the contaminating process
PRC	Study of preferential removal of contaminant species in decontamination operations
IPW	Study of the influence of prewetting on decontamination-efficiency study
TDA	Testing of decontaminating-agents study
CD	Study of the contaminability-decontaminability of materials
Rfns I	Surface-roughness influence on contaminability-decontaminability investigation (part of CD)
Hdns I	Surface-hardness influence on contaminability-decontaminability investigation (part of CD)
Al Alum	Alclad aluminum
St Steel and SS	Stainless steel
OD Paint	Army olive-drab paint, No. TT–E 485B
Navy Paint Navy Pt Navy 5H	Navy paint, No. 5H
Clear Lacquer and Cl Lac	Clear lacquer, No. 52–L–26
Sea-blue Lacquer and SB Lacquer	Sea-blue lacquer, No. 52–L–26–SB
PVI	Pigment-volume-variation influence on contaminability-decontaminability investigation (part of CD)
Al Paint	Aluminized paint, AN–L–37–SB–AL
Cell Ace	Cellulose acetate plastic, commercial type
Mel Res	Glass-cloth melamine-resin plastic, high-pressure laminate
Sil Res	Glass-cloth silicone-resin plastic, high-pressure laminate
Strpc't	Strippable coating
Cocoon	GE Cocoon, a strippable coating
Stbd	Stabond, a strippable coating
Phen Var	Phenolic varnish, Mare Island Paint Laboratory, No. B–72
Acryl Var	Acryloid varnish, Mare Island Paint Laboratory, No. 80B

NOTE: In the hardness, roughness, and pigment-volume investigations, materials have been fabricated to exhibit different degrees of a surface property. The degree of the property has been indicated by italicized letters or numbers (cf. Sec. B.3).

[redacted]

[redacted]

A.2 POSITION OF MATERIALS USED BY THE USNRDL

PANEL 1

LEADING EDGE					
1–11[a] *Df(t)* OD Paint	1–21 *Df(t)* OD Paint	1–31 *Df(t)* OD Paint	1–41 *Df(t)* Aluminum	1–51 *Df(t)* Aluminum	1–61 *Df(t)* Aluminum
1–12 *Df(t)* OD Paint	1–22 *Df(t)* OD Paint	1–32 *Df(t)* OD Paint	1–42 *Df(t)* Aluminum	1–52 *Df(t)* Aluminum	1–62 *Df(t)* Aluminum
1–13 *Df(t)* OD Paint	1–23 *Df(t)* OD Paint	1–33 *Df(t)* OD Paint	1–43 *Df(t)* Aluminum	1–53 *Df(t)* Aluminum	1–63 *Df(t)* Aluminum
1–14 *Df(t)* OD Paint	1–24 *Df(t)* OD Paint	1–34 *Df(t)* OD Paint	1–44 *Df(t)* Aluminum	1–54 *Df(t)* Aluminum	1–64 *Df(t)* Aluminum
1–15 *Df(t)* OD Paint	1–25 *Df(t)* OD Paint	1–35 *Df(t)* OD Paint	1–45 *Df(t)* Aluminum	1–55 *Df(t)* Aluminum	1–65 *Df(t)* Aluminum
1–16 *Df(t)* OD Paint	1–26 *Df(t)* OD Paint	1–36 *Df(t)* OD Paint	1–46 *Df(t)* Aluminum	1–56 *Df(t)* Aluminum	1–66 *Df(t)* Aluminum

[a] For panels 1 to 6, the numbers above the abbreviations designate a particular 1¼-in. plate.

PANEL 2

LEADING EDGE					
2–11 *Df(t)* OD Paint	2–21 *Df(t)* OD Paint	2–31 *Df(t)* OD Paint	2–41 *Df(t)* Aluminum	2–51 *Df(t)* Aluminum	2–61 *Df(t)* Aluminum
2–12 *Df(t)* OD Paint	2–22 *Df(t)* OD Paint	2–32 *Df(t)* OD Paint	2–42 *Df(t)* Aluminum	2–52 *Df(t)* Aluminum	2–62 *Df(t)* Aluminum
2–13 *Df(t)* OD Paint	2–23 *Df(t)* OD Paint	2–33 *Df(t)* OD Paint	2–43 *Df(t)* Aluminum	2–53 *Df(t)* Aluminum	2–63 *Df(t)* Aluminum
2–14 *Df(t)* OD Paint	2–24 *Df(t)* OD Paint	2–34 *Df(t)* OD Paint	2–44 *Df(t)* Aluminum	2–54 *Df(t)* Aluminum	2–64 *Df(t)* Aluminum
2–15 *Df(t)* OD Paint	2–25 *Df(t)* OD Paint	2–35 *Df(t)* OD Paint	2–45 *Df(t)* Aluminum	2–55 *Df(t)* Aluminum	2–65 *Df(t)* Aluminum
2–16 *Df(t)* OD Paint	2–26 Spare OD Paint	2–36 FC OD Paint	2–46 FC OD Paint	2–56 Spare Aluminum	2–66 *Df(t)* Aluminum

[redacted]

[redacted]

PANEL 3

LEADING EDGE					
3–11 *Df(t)* OD Paint	3–21 PRC OD Paint	3–31 PRC OD Paint	3–41 PRC OD Paint	3–51 PRC OD Paint	3–61 *Df(t)* Aluminum
3–12 *Df(t)* OD Paint	3–22 *Df(t)* OD Paint	3–32 *Df(t)* OD Paint	3–42 *Df(t)* Aluminum	3–52 *Df(t)* Aluminum	3–62 *Df(t)* Aluminum
3–13 *Df(t)* OD Paint	3–23 *Df(t)* OD Paint	3–33 *Df(t)* OD Paint	3–43 *Df(t)* Aluminum	3–53 *Df(t)* Aluminum	3–63 *Df(t)* Aluminum
3–14 *Df(t)* OD Paint	3–24 *Df(t)* OD Paint	3–34 *Df(t)* OD Paint	3–44 *Df(t)* Aluminum	3–54 *Df(t)* Aluminum	3–64 *Df(t)* Aluminum
3–15 *Df(t)* OD Paint	3–25 *Df(t)* OD Paint	3–35 IPW OD Paint	3–45 IPW Aluminum	3–55 *Df(t)* Aluminum	3–65 *Df(t)* Aluminum
3–16 IPW OD Paint	3–26 IPW OD Paint	3–36 IPW OD Paint	3–46 IPW Aluminum	3–56 IPW Aluminum	3–66 IPW Aluminum

PANEL 4

LEADING EDGE					
4–11 PRC or FC OD Paint	4–21 PRC or FC OD Paint	4–31 PRC or FC Aluminum	4–41 PRC or FC Aluminum	4–51 TDA OD Paint	4–61 TDA OD Paint
4–12 PRC OD Paint	4–22 PRC OD Paint	4–32 PRC or FC Aluminum	4–42 PRC or FC Aluminum	4–52 TDA OD Paint	4–62 TDA OD Paint
4–13 PRC or FC OD Paint	4–23 PRC or FC OD Paint	4–33 PRC or FC Aluminum	4–43 PRC or FC Aluminum	4–53 TDA Aluminum	4–63 TDA Aluminum
4–14 PRC or FC OD Paint	4–24 PRC or FC OD Paint	4–34 PRC or FC Aluminum	4–44 PRC or FC Aluminum	4–54 TDA Aluminum	4–64 TDA Aluminum
4–15 CD Metal 1 Copper	4–25 CD Metal 2 Brass	4–35 CD Metal 3 Al Alum	4–45 CD Metal 4 St Steel	4–55 CD Paint 1 OD Paint	4–65 CD Paint 1 OD Paint
4–16 CD Copper	4–26 CD Brass	4–36 CD Al Alum	4–46 CD St Steel	4–56 CD Navy Pt	4–66 CD Navy Pt

[redacted]

PANEL 5

LEADING EDGE					
5–11 CD Lacquer 1 Cl Lac	5–21 CD Lacquer 1 Cl Lac	5–31 CD Lacquer 2 SB Lac	5–41 CD Lacquer 2 SB Lac	5–51 CD Paint 3 Al Paint	5–61 CD Paint 3 Al Paint
5–12 CD Plastic 1	5–22 CD Plastic 1	5–32 CD Plastic 2	5–42 CD Plastic 2	5–52 CD Plastic 3	5–62 CD Plastic 3
5–13 CD Strpc't 1 Cocoon	5–23 CD Strpc't 1 Cocoon	5–33 CD Strpc't 2 Stbd	5–43 CD Strpc't 2 Stbd	5–53 CD Varnish 1 Phen Var	5–63 CD Varnish 1 Phen Var
5–14 CD Rfns I *Clear* Glass	5–24 CD Rfns I *Clear* Glass	5–34 CD Rfns I *4X* Glass	5–44 CD Rfns I *4X* Glass	5–54 CD Varnish 2 Acryl Var	5–64 CD Varnish 2 Acryl Var
5–15 CD Rfns I *600* Glass	5–25 CD Rfns I *600* Glass	5–35 CD Rfns I *302* Glass	5–45 CD Rfns I *302* Glass	5–55 CD Rfns I *FFF* Glass	5–65 CD Rfns I *FFF* Glass
5–16 PVI *13.5*	5–26 PVI *13.5*	5–36 PVI *31.8*	5–46 PVI *31.8*	5–56 PVI *38.4*	5–66 PVI *38.4*

PANEL 6

LEADING EDGE					
6–11 CD Hdns I *805* Brass	6–21 CD Hdns I *805* Brass	6–31 CD Hdns I *630* Brass	6–41 CD Hdns I *630* Brass	6–51 CD Hdns I *415* Brass	6–61 CD Hdns I *415* Brass
6–12 CD Hdns I *1025* Brass	6–22 CD Hdns I *1025* Brass	6–32 CD Hdns I *38* SS	6–42 CD Hdns I *38* SS	6–52 CD Hdns I *45* SS	6–62 CD Hdns I *45* SS
6–13 CD Hdns I *50* SS	6–23 CD Hdns I *50* SS	6–33 CD Hdns I *Q* SS	6–43 CD Hdns I *Q* SS	6–53 CD Hdns I *A* SS	6–63 CD Hdns I *A* SS
6–14 CD Rfns I *Blank* SS	6–24 CD Rfns I *Blank* SS	6–34 CD Rfns I *4X* SS	6–44 CD Rfns I *4X* SS	6–54 CD Rfns I *600* SS	6–64 CD Rfns I *600* SS
6–15 CD Rfns I *302* SS	6–25 CD Rfns I *302* SS	6–35 CD Rfns I *FFF* SS	6–45 CD Rfns I *FFF* SS	6–55 CD Rfns I *FF* SS	6–65 CD Rfns I *FF* SS
6–16 TDA Aluminum	6–26 TDA Aluminum	6–36 TDA Aluminum	6–46 TDA OD Paint	6–56 TDA OD Paint	6–66 TDA OD Paint

Panels 7, 8, 9: All Surfaces Alclad Aluminum

Panels 10, 11, 12: All Surfaces Aluminized Paint (AN–L–37)

Panels 13, 14, 15: All Surfaces Sea-blue Paint (52–L–26)

Panels 33, 34, 35: All Surfaces OD Paint (TT–E 485B)

A.3 POSITION OF MATERIALS USED BY THE ACC

Tables A.1 to A.4 list the positions of the materials used by the ACC in the Dog, Easy, George, and Item Shots. The numbers given refer to Youden Square Index Numbers. Consult Table 2.1 for the correlation of index number and material.

[redacted]

Table A.1 POSITION OF MATERIALS, DOG SHOT

PANEL POSITION NUMBER	ALTITUDE (ft)							
	30,000	28,000	26,000	24,000	22,000	20,000	18,000	16,000
16	Missing 8–46–25	6–50–13	7–47–19	5–44–48	1– 2– 3	2–49–31	Missing 3–48–37	4–45–50
17	Missing 10–47–31	49–32–18	42–43–54	37–28–15	Missing 4– 5– 6	22–51–41	27–13–44	Missing 32–17–54
18	18–48–18	48–40–41	9–48–49	47–32–33	7– 8– 9	27–15– 8	Missing 36–16–17	38–24–25
19	38–23–13	24– 3–11	31–17– 2	17–54–14	10–11–12	45–36– 9	52–43–15	1–48–10
20	4–30–49	45–17–34	18–27–38	40– 6–23	13–14–15	18–40–53	23–50– 5	35–53–19
21	29– 7–51	10– 7–42	3–15–50	53–46–34	16–17–18	35–26–10	41–35– 8	47–37–26
22	14–41–17	46–27– 2	51–34–16	41– 1–20	19–20–21	4–48–19	24– 7–18	36–13–22
23	45–33– 3	30–20–12	41– 6–18	26–10– 7	22–23–24	48–43–30	11–46–43	5–48–49
24	15–24–52	Decay 47–29–43	52–23–44	42– 2–35	25–26–27	20–28–11	4–25–19	30–27– 8
25	19–43–37	18– 1–23	10–36– 1	48–22–16	28–29–30	7–50–44	30–18–51	39–15– 9
26	20– 6–48	51–19– 5	11–29–37	49– 9–29	31–32–33	29–42–52	7–45–14	Missing 40– 7–18
27	34–54–50	21– 8–35	24–46– 5	11–30–24	37–38–39	6–13–54	47–21– 9	18–29–20
28	Aging[a] 28–32–53	Aging 9–33–37	Aging 22–30–45	Aging 52–36– 8	Aging 34–35–36	Aging 3–34–12	Aging 40–31–20	Aging 46– 2–28
29	Aging 42–11– 2	Aging 28– 4–54	Aging 35– 7–48	Aging 21–38–18	Aging 49–50–51	Aging 1–16– 7	Aging 48–28–53	Aging 14–33–52
30	Aging 1–23–44	Aging 1–23–44	Aging 1–23–44	Aging 1–23–44	Aging 1–23–44	Aging 1–23–44	Aging 1–23–44	Aging 1–23–44
36	1–21–40	26–52–38	33–12–39	Missing 14–50–43	40–41–42	Missing 47–23–37	54–32– 2	12– 7–41
37	9–22–27	48–53–15	53–13–21	4– 7–51	43–44–45	21–24–33	26–33–39	31–42– 3
38	Missing 5– 7–35	Missing 31–39–22	42– 8–25	27–31–12	46–47–48	18–14–38	12–22– 6	16–23–51
39	Missing 36–39–16	Missing 16–25– 7	26–32–14	13–18–45	52–53–54	39–46–25	49– 1–34	6–11–43
40	Missing 44–12–26	36–44–14	Missing 40– 4–20	25–39– 3	7–48–18	5–17–32	10–29–38	Missing 21–34–44

[a] Aging studies, not included in evaluation of Dog Shot.

[redacted]

Table A.2 POSITION OF MATERIALS, EASY SHOT

PANEL POSITION NUMBER	ALTITUDE (ft)							
	30,000	28,000	26,000	24,000	22,000	20,000	18,000	16,000
16	Missing 1–16–7	Missing 42–11–2	49–50–51	35–7–48	28–4–54	31–38–18	14–33–52	48–28–53
17	Missing 18–40–53	4–30–49	13–14–15	18–27–38	Missing 45–17–34	40–6–23	35–53–19	23–50–5
18	39–46–25	36–39–16	52–53–54	Missing 26–32–14	16–25–7	13–18–45	6–11–43	Missing 49–1–34
19	Missing 21–24–33	Missing 9–22–27	43–44–45	53–13–21	48–53–15	4–7–51	31–43–3	26–33–39
20	3–34–12	28–32–53	34–35–33	22–30–45	9–33–37	52–36–8	46–2–28	40–31–20
21	29–42–52	20–6–48	31–32–33	11–29–37	51–19–5	49–9–29	40–7–18	7–45–14
22	2–43–31	8–46–25	1–2–3	7–47–19	6–50–13	5–44–48	4–45–50	3–48–37
23	22–51–41	10–47–31	4–5–6	54–43–28	49–32–18	37–28–15	32–17–54	27–13–44
24	1–23–44	Missing 1–23–44	1–23–44	1–23–44	Missing 1–23–44	1–23–44	Missing 1–23–44	1–23–44
25	5–17–32	44–12–26	7–48–18	40–4–20	Decay 36–44–14	25–39–3	Missing 21–34–44	Missing 10–29–38
26	18–14–38	5–7–35	46–47–48	42–8–25	31–39–22	27–31–12	16–23–51	Missing 12–22–6
27	45–36–9	38–23–13	10–11–12	Missing 31–17–2	24–3–11	17–54–14	1–48–10	52–42–15
28	27–15–8	18–48–18	Missing 7–8–9	9–48–49	48–40–41	47–32–33	Missing 38–24–25	Missing 36–16–17
29	7–50–44	19–43–37	28–29–30	10–36–1	18–1–23	48–22–16	39–15–9	30–18–51
30	20–28–11	15–24–52	25–26–27	52–23–44	47–29–43	42–2–35	30–27–8	4–25–19
36	Missing 47–23–37	1–21–40	40–41–42	33–12–39	Decay 26–52–38	19–50–43	Missing 12–7–41	54–32–2
37	6–13–54	34–54–50	37–38–39	Missing 24–46–5	21–8–35	11–30–24	18–29–20	11–46–43
38	Missing 48–43–30	Missing 45–33–3	22–23–24	41–6–18	30–20–12	26–10–7	5–48–49	Missing 11–46–43
39	4–48–19	14–41–17	19–20–21	Missing 51–34–16	Missing 46–27–2	41–1–20	Missing 36–13–22	Missing 24–7–18
40	35–26–10	Missing 29–7–51	16–17–18	Missing 3–15–50	Missing 10–7–42	Missing 53–46–34	Missing 47–37–26	Missing 41–35–8

[redacted]

Table A.3 POSITION OF MATERIALS, GEORGE SHOT

PANEL POSITION NUMBER	ALTITUDE (ft)							
	30,000	28,000	26,000	24,000	22,000	20,000	18,000	16,000
16		6–13–54	47–21– 9	37–38–39				
17		3–34–12	40–31–20	34–35–36				
18		48–43–30	11–46–43	Missing 22–23–24				
19		20–28–11	4–25–19	25–26–27				
20		45–36– 9	52–42–15	10–11–12				
21		18–14–38	12–22– 6	46–47–48				
22		1–16–17	Decay 48–28–53	49–50–51				
23		18–40–53	23–50– 5	13–14–15				
24		35–26–10	41–35– 8	16–17–18				
25		4–48–19	Missing 24– 7–18	19–20–21				
26		47–23–37	54–32– 2	40–41–42				
27		21–24–33	26–33–39	43–44–45				
28		39–46–25	49– 1–34	52–53–54				
29		5–17–32	Missing 10–29–38	7–48–18				
30		1–23–44	1–23–44	1–23–44				
36		7–50–44	30–18–51	Missing 28–29–30				
37		27–15– 8	Missing 36–16–17	Missing 7– 8– 9				
38		22–51–41	Missing 27–13–44	Missing 4– 5– 6				
39		2–49–31	3–48–37	Missing 1– 2– 3				
40		Missing 29–42–52	7–45–14	Missing 31–32–33				

[redacted]

Table A.4 POSITION OF MATERIALS, ITEM SHOT

PANEL POSITION NUMBER	ALTITUDE (ft)							
	30,000	28,000	26,000	24,000	22,000	20,000	18,000	16,000
16		6–50–13	7–47–19	2–49–31	8–46–25	Missing 4–45–50	7–47–19	5–44–48
17		49–32–18	Missing 54–43–28	22–51–41	10–47–31	Missing 32–17–54	Missing 54–43–28	Missing 37–28–15
18		48–40–41	9–48–49	27–15– 8	18–48–18	Missing 38–24–25	9–48–49	47–32–33
19		24– 3–11	31–17– 2	45–36– 9	38–23–13	1–48–10	31–17– 2	Missing 17–54–14
20		45–17–43	18–27–38	18–40–53	4–30–49	35–53–19	18–27–38	40– 6–23
21		10– 7–42	3–15–50	35–26–10	29– 7–51	47–37–26	3–15–50	53–46–34
22		46–27– 2	51–34–16	4–48–19	14–41–17	36–13–22	51–34–16	41– 1–20
23		30–20–12	41– 6–18	48–43–30	45–33– 3	5–48–49	41– 6–18	26–10– 7
24		47–29–43	52–23–44	20–28–11	15–24–52	30–27– 8	52–23–44	42– 4–35
25		18– 1–23	10–36– 1	7–50–44	19–43–37	39–15– 9	10–36– 1	48–22–16
26		51–19– 5	Decay 11–29–37	29–42–52	20– 6–48	40– 7–18	11–29–37	49– 9–29
27		9–33–37	22–30–45	3–34–12	28–32–53	46– 2–28	22–30–45	52–36– 8
28		21– 8–35	24–46– 6	6–13–54	34–54–50	18–29–20	24–46– 5	11–30–24
29		26–52–38	33–12–39	47–23–37	1–21–40	12– 7–41	33–12–39	19–50–43
30		48–53–15	53–13–21	21–24–33	9–22–27	31–42– 3	53–13–21	4– 7–51
36		31–39–22	42– 8–25	18–14–38	5– 7–35	16–23–51	Missing 42– 8–25	27–31–12
37		28– 4–54	35– 7–48	1–16– 7	42–11– 2	Missing 14–33–52	Missing 35– 7–48	21–38–18
38		16–25– 7	26–32–14	Missing 39–46–25	36–39–16	Missing 6–11–43	26–32–14	13–18–45
39		36–60–14	40– 4–20	Missing 5–17–32	Missing 44–12–26	Missing 21–34–44	40– 4–20	25–39– 3
40		Missing 49–32–18	58–59–60	Missing 1–23–44	Missing 1–23–44	Missing 1–23–44	58–59–60	58–59–60

[redacted]

Appendix B

Composition, Surface Character, and Source of Experimental Materials

B.1 MATERIALS USED IN INDIVIDUAL INVESTIGATIONS

Materials	*Investigation*
Copper, brass, alclad aluminum, stainless steel, OD paint, Navy paint, aluminized paint, clear lacquer, sea-blue lacquer, phenolic varnish, acryloid varnish, cellulose acetate plastic, melamine plastic, silicone plastic, GE Cocoon coating, Stabond coating, glass	Contaminability-decontaminability of materials
Mirawal, Du Pont varnish, OD paint, glass cloth, Lucite, metal lacquer, linoleum, Transite, 2SO aluminum, asphalt varnish, paraffin, felt, wool, porcelain enamel, protein-base paint, plywood, Navy Cocoon, rubber tile, graphite paint, leather, canvas ducking	Several physical characteristics affecting decontamination
Alclad aluminum, sea-blue lacquer, OD paint, aluminized lacquer	Industrial decontamination procedures
Mirawal, Du Pont varnish, OD paint, glass cloth, Lucite, metal lacquer, linoleum, Transite, 2SO aluminum, asphalt varnish, paraffin, felt, wool, porcelain enamel, protein-base paint, plywood, Navy Cocoon, rubber tile, graphite paint, leather, canvas ducking	Evaluation of decontamination agents, efficiency of decontamination agents
Aluminum, OD paint	Evaluation of decontamination agents, relation between results of laboratory and field studies of decontamination agents
Aluminum, OD paint	Decontamination as a function of time
Aluminum, OD paint	Influence of prewetting on decontamination efficiency
Aluminum, OD paint	Fractionation of contaminant in the atomic cloud or in the contamination process
Aluminum, OD paint	Preferential removal of contaminant species in decontamination operations

B.2 COMPOSITION AND SOURCE OF EXPERIMENTAL MATERIALS USED BY THE USNRDL

B.2.1 Metals and Glass[1]

B.2.1.1 Aluminum

Tests performed indicated that the surface was not alclad. This material was the called "aluminum" in the majority of the Greenhouse tests. Sward and Brinell hardness tests, as well as Brush Analysis tests for roughness, were applied. Spectrochemical analysis showed the following substances present: zinc, 0.001 to 0.01 per cent; iron and sili-

[1] See Sec. B.3 for roughness and hardness test results.

[redacted]

con, 0.01 to 0.1 per cent; copper and manganese, 0.1 to 1 per cent; magnesium, 1 to 10 per cent.

B.2.1.2 Copper

Sward, Brinell, and Brush Analysis tests were carried out on this material. The spectrochemical analysis indicated the following substances present: between 0.001 and 0.1 per cent calcium, less than 0.001 per cent iron, between 0.1 and 1 per cent magnesium.

B.2.1.3 Brass

Brinell, Sward, Knoop, and Brush Analysis tests were conducted on this material. Spectrochemical analysis showed that silver and iron were present in an amount between 0.001 and 0.01 per cent, magnesium between 0.01 and 0.1 per cent, zinc between 1 and 10 per cent, and copper greater than 10 per cent. This material was also employed in the "hardness" investigation (part of C–D of materials study). The identification numbers are Naval Supply stock numbers. Sward, Brinell, and Brush Analysis tests were made on these materials, but only one (805) was tested with the Knoop indenter. The spectrochemical tests showed that, with one exception, the hardness samples had the same chemical composition as that of the brass listed above. The exception (brass 415), contains a slightly larger percentage of iron and also magnesium in an amount between 0.01 and 0.1 per cent.

B.2.1.4 Alclad Aluminum (Al Alum)[2]

Brinell, Sward, Knoop, and Brush Analysis tests were carried out on this material. Spectrochemical analysis showed zinc present in an amount between 0.001 and 0.01 per cent, silicon and iron present in amounts between 0.01 and 0.1 per cent, copper and manganese in amounts between 0.1 and 1 per cent, and magnesium in an amount between 1 and 10 per cent.

B.2.1.5 Stainless Steel (St Steel)

This material was used for hardness and roughness investigations (part of C–D of materials study) as well as being one of the materials of the C–D study. Five different hardnesses of this material were obtained, three of which were manufactured to specific hardnesses (in Rockwell hardnesses units) and two others resulted from annealing and quenching. Six different roughness samples of this material were also ordered. They were ground with the following abrasives:

1. No. 4X, which is a natural aluminum oxide grain as rated by Titmus Optical Company.
2. No. 600, which designates a screen silicon carbide grain size as supplied by Carborundum Company of America.
3. No. 302, which is a synthetic aluminum oxide finishing abrasive as graded by American Optical Company.
4. No. FFF, which is a silicon carbide abrasive grain as graded by Carborundum Company of America.
5. FF, for which we do not have precise information. According to the information we have, this abrasive is a mixture of two or more different grain sizes. It was supplied by the Pacific Abrasive Company.

Sward, Brinell, and Knoop tests were run on the five hardness variations and the Brush Analysis test was applied to the six roughness variations. These tests were also run on an untreated sample. Spectrochemical analysis of the five hardness samples and the untreated sample showed no significant differences in composition. The following elements were found present in the percentages indicated: copper, magnesium, molybdenum and silicon, 0.01 to 0.1 per cent; manganese, 1 to 10 per cent; nickel, chromium, and iron, 10 per cent or greater.

B.2.1.6 Glass

The Knoop, Sward, and Brush Analysis tests were applied to this material. Spectrochemical analysis showed the following elements present between the following limits: chromium and copper, less than 0.001 per cent; iron, aluminum, calcium, and magnesium, 0.001 to 0.01 per cent; sodium, 1 to 10 per cent. Five roughness variations were also made up with the same abrasives as those used for stainless steel (see above). Sward and Brush Analysis tests were applied to all five

[2] Parentheses enclose abbreviations used (see Sec. A.1).

[redacted]

variations. A Knoop hardness test was also applied to one of them (4X).

B.2.2 Plastics and Protective Coatings

B.2.2.1 Army Olive-drab Paint (OD Paint)

Brush Analysis, Sward, and Knoop tests were applied to this material. Its detailed properties may be found in Federal Standard Stock Catalog TT–E 485B, Amendment–1, 1 September 1949. It is the Type IV enamel described in the above specification. The enamel was reduced with 15 parts by volume of mineral spirits and sprayed on the panels. A single coat was applied. The contact angle measured 80 deg, and the dye absorption was 14.

B.2.2.2 Navy 5H Paint (Navy Paint and Navy 5H)

[Frequently designated as MIL–P–15130 (Ships)]

Brush Analysis, Sward, and Knoop tests were applied to this material. The formulation and method of application were as follows:

FORMULATION

Composition	*Code*	*Quantity per 100 gal*
Titanium dioxide	TT–T–425, III	75 lb
Zinc oxide	52–Z–7	225 lb
Magnesium silicate	52M2, B	136 lb
Alkyd resin sol (60%)	TT–R–266, I, B	76 gal
Petroleum spirits	TT–T–291, I	22 gal
Lead naphthenate drier	TT–D–643, I	2 qt
Cobalt naphthenate drier	TT–D–643, II	1 qt
Manganese naphthenate drier	TT–D–643, III	1 qt
Formula 101 black tint		0.8 gal

Method of Application

The 1- by 1-in. aluminum plates were prepared as follows:

1. One coat BuShips 117 (wash primer as metal conditioner) 0.5 mil applied 12–27–50; overnight dry
2. One coat 5H (8 grind) 1 mil applied 12–29–50
3. One coat 5H (8 grind) 1 mil applied 1–2–51

Three pigment volume variations were made up using the same pigment but in varying ratios to the vehicle. Thus when the material dried the number of pigment atoms per unit area differed among the four substances. The material was obtained from John Saroyan, Chief, Mare Island Paint Laboratory, Mare Island Naval Shipyard, Vallejo, Calif.

B.2.2.3 Aluminized Sea-blue Paint (Al Paint)

(Frequently designated as AN–L–37–SB–AL)

Knoop, Sward, and Brush Analysis tests were applied to this material. The formulation and method of application were as follows:

FORMULATION

Composition	*Per Cent by Weight*
Aluminum paste (AN–TT–A–461a) (66.7% solids)	0.91
Titanium dioxide (Du Pont No. R–610)	1.70
Prussian blue	0.86
Carbon black	0.12
Iron red	0.57
5- to 6-in. R.S. nitrocellulose (dry) (Hercules Powder Co.)	2.21
Ethyl methacrylate polymer (Du Pont No. P–2)	9.65
Tricresyl phosphate (Monsanto Chemical Co.)	3.11
Ethyl alcohol	1.78
Ethyl acetate	13.40
n-Butyl acetate	5.12
Methyl isobutyl ketone	36.07
Toluene	24.50
TOTAL	100

Total nonvolatile components (18.83 per cent) made up as follows:

Component	*Per Cent by Weight*
Nitrocellulose	11.74
Ethyl methacrylate	51.25
Tricresyl phosphate	16.52
Aluminum paste solids	3.24
Titanium dioxide	9.03
Prussian blue	4.57
Carbon black	0.64
Iron red	3.01

This coating was prepared by mixing 32 g of the specification aluminum paste with 1 gal of the AN–L–37 sea-blue lacquer (package consistency).

[redacted]

Method of Application

This material was thinned, 1 to 1 by volume, with Specification AN–TT–T–256 thinner and sprayed over anodized alclad panels. Two coats were applied with 1 hr drying in air between each coat. The coat thickness was 1.5 mils per application. This material was made up by the Mare Island Paint Laboratory.

B.2.2.4 AN–L–37 Clear Lacquer (Cl Lac)

(Frequently designated as AN–L–37)

Knoop, Sward, and Brush Analysis tests were applied to this material. The formulation and method of application were as follows:

FORMULATION

Composition	*Per Cent by Weight*
5- to 6-in. R.S. nitrocellulose (Hercules Powder Co.) (65% solids in ethyl alcohol)	3.4
Ethyl methacrylate polymer (Du Pont No. P–2)	9.7
Tricresyl phosphate (Monsanto Chemical Co.)	3.1
Methyl isobutyl ketone	36.4
Ethyl acetate	13.5
n-Butyl acetate	5.2
Toluene	28.7
TOTAL	100

Total nonvolatile components (15.0 per cent) made up as follows:

Component	*Per Cent by Weight*
Nitrocellulose	14.7
Ethyl methacrylate	64.7
Tricresyl phosphate	20.6

Method of Application

This material was thinned, 1 to 1 by volume, with Specification AN–TT–T–256 thinner and applied over phosphate-treated alclad panels. Two coats were applied, with 1 hr air dry between each coat. The phosphate (wash primer) treatment added a film of 0.5 mil thickness. Each application of the AN–L–37 Clear added a film of 1.0 mil thickness. This material was made up by the Mare Island Paint Laboratory.

B.2.2.5 52–L–26 Sea-blue Lacquer (SB Lac)

(Frequently designated as 52–L–26)

Brush Analysis, Sward, and Knoop tests were applied to this material. The formulation and method of application follow. The breakdown of alkyd resin listed in the formulation is phthalic anhydride 45 per cent by weight and cocoanut oil 33 per cent by weight.

FORMULATION

Composition	*Per Cent by Weight*
Duraplex ND–77B (100% alkyd resin) (Resinous Products Division, Rohm and Haas Co.)	17.6
½-in. R.S. nitrocellulose (dry) (Hercules Powder Co.)	8.8
Tricresyl phosphate (Monsanto Chemical Co.)	3.6
Methyl isobutyl ketone	21.7
Methyl isobutyl carbinol	5.6
Isopropyl alcohol	2.9
Ethyl alcohol	4.8
Toluene	18.2
Xylene	11.7
Petroleum naphtha	5.1
TOTAL	100

Total nonvolatile components (30.0 per cent) made up as follows:

Component	*Per Cent by Weight*
Duraplex ND–77B	58.7
Nitrocellulose	29.3
Tricresyl phosphate	12.0

Method of Application

This material was thinned, 1 to 1 by volume, with Specification AN–TT–T–256 thinner and applied over previously primed, anodized alclad panels. Two coats were applied, with 1 hr air dry between coatings. No information is available as to the primer-coat thickness. The film thickness added by each spraying was 1.8 mil. This material was made up by the Mare Island Paint Laboratory.

B.2.2.6 Phenolic Varnish 80–B (Phen Var)

[Varnish, Spar, Water-resisting (For. No. 80) Specification (MIL–V–1174)]

Brush Analysis, Sward, and Knoop tests were applied to this material. The formulation and method of application were:

[redacted]

FORMULATION

Composition	*Quantity per 100 gal*
Phenolic resin (Bakelite 254) (52R10)	88 lb
Treated oil, M.I. Formula 673 (linseed oil)	24 gal
Tung oil (Fed. TT-O-395)	18 gal
Petroleum spirits (TT-T-291, I)	37 gal
Xylol (MIL-N-15178)	9 gal
Dipentine (TT-D-376)	5 gal
Lead naphthenate drier (TT-D-651a, I)	5 pt
Cobalt naphthenate drier (TT-D-651a, II)	1 qt

Method of Application

The 1- by 1-in. aluminum plates were prepared as follows:

1. One coat BuShips Formula 117 (wash primer as metal conditioner) applied 12-27-50, approximately 0.5 mil; overnight dry
2. One coat 80-B varnish, approximately 1 mil, applied 12-29-50
3. One coat 80-B varnish, approximately 1 mil, applied 1-2-51

This material was made up by the Mare Island Paint Laboratory.

B.2.2.7 Acryloid Varnish (Acryl Var)

Brush Analysis, Sward, and Knoop tests were applied to this material. The formulation and method of application were as follows:

Formulation

Acryloid B-72 is a 40 per cent solution in toluol of an acrylic ester polymer produced by the Resinous Products Division, Rohm and Haas Co., Philadelphia, Penn.

Method of Application

The 1- by 1-in. aluminum plates were prepared as follows:

1. One coat BuShips Formula 117 (wash primer as metal conditioner) approximately 0.5 mil; overnight dry; applied 1-15-51
2. One coat B-72 (acryloid solution), approximately 1 mil, applied 1-16-51
3. One coat B-72 (acryloid solution), approximately 1 mil, applied 1-17-51

This material was made up by the Mare Island Paint Laboratory.

B.2.2.8 Cellulose Acetate (Cell Ace)

Brush Analysis, Knoop, Brinell, and Sward tests were carried out on this material. Cellulose acetate is prepared by treating cellulose with acetic acid and acetic anhydride in the presence of a catalyst such as sulfuric acid. Cellulose triacetate is formed. This is soluble in acids, forming a heavy dope. Water is added partially to hydrolize or deactivate the cellulose triacetate. Cellulose acetate is then precipitated in water, washed and dried. The cellulose acetate used in these tests was obtained through the Navy from the Du Pont company. The material was made up by R. R. Winans, Rigid Plastics Section, Mechanical Branch, Code 944, Naval Material Laboratory, Brooklyn, N. Y.

B.2.2.9 Melamine Plastic (Mel Res)

Brush Analysis, Knoop, Sward, and Brinell tests were applied to this material. The laminated melamine material is produced from a glass cloth impregnated with a melamine formaldehyde resin and laminated at 1,200 to 2,000 lb/sq in. This material was made up by the Naval Material Laboratory, whose address is given in the preceding paragraph.

B.2.2.10 Silicone Resin (Sil Res)

Brush Analysis, Knoop, Sward, and Brinell tests were applied to this material. The silicone glass material is made in a manner similar to the melamine just mentioned. A silicone resin is used for impregnation. This material is reported to have been fabricated using Dow-Corning D. C. 2103 resin, catalyst triethanolamine, 1,500-lb/sq in. pressure at 330°F. The material was fabricated by the Naval Material Laboratory.

B.2.2.11 GE Cocoon (Cocoon)

Brush Analysis, Knoop, and Sward tests were applied. This material is a strippable one and is a vinyl chloride copolymer. It was obtained from the R. M. Hollingshead Corpora-

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tion, Camden 2, N. J., from whom more information may be obtained.

B.2.2.12 Stabond

Brush Analysis and Sward tests were applied. This material gives a strippable coating and is primarily a synthetic rubber with a carrier of methyl ethyl ketone. It was obtained from American Latex Products Corporation, Hawthorne, California, from whom more information may be obtained.

B.3 SURFACE PROPERTIES OF MATERIALS USED BY THE USNRDL

The hardness and roughness characteristics of the materials used by the USNRDL were determined using the Brinell, the Knoop, and the Sward rocker tests for hardness, and the Brush Analysis technique for surface roughness.

The Brinell and the Knoop hardness tests, which are both indentation methods, measure hardness by the amount of penetration (size of hole at surface) by some object under some standard load. In the Brinell test the indenter is a ball, and in the Knoop test the indenter is a diamond. The load capable of making a measurable indentation in one sample may shatter another. For this reason, the hardness values of various substances are classified first by the load and then by the respective value within the class. A higher value within the load class indicates a greater hardness. The Brinell numbers given are accurate to ± 7.0. Knoop test results are accurate to ± 5 per cent at loads of 100 g or greater; a precision of ± 20 per cent is estimated with loads of less than 100 g.

The Sward hardness test is primarily used to measure the hardness of protective coatings, e.g., paints and varnishes. The measurement is made with a rocking device, the oscillations being affected by the friction on the rocker, i.e., the extent to which the rocker has penetrated the surface. Hence the harder the surface the greater the value of swing or Sward number. Values listed in Table B.1 for this measurement were obtained from surfaces of different area, one area being 4 by 6 in. and the other being 1 by 1 in. Measurements on the first area are good to within ± 2 Sward numbers, and measurements on the second are good to within ± 5 Sward numbers.

The Brush Analysis is a statistical presentation of the height of various portions of the surface above the median plane of the surface. Surfaces having greater roughnesses will have greater Brush Analysis numbers.

The values given by applying the three tests just described to the materials used are given in Table B.1.

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Table B.1 SURFACE PROPERTIES

MATERIAL	HARDNESS TESTS: Brinell — Brinell No.	Load (kg)	Knoop — Knoop No.[a]	Load (g)	Sward Rocker — Sward No.[b]	ROUGHNESS TEST: Brush Analysis (μin.)
Aluminum	79.6	500	147	1,500	26[c]	2
Copper	47.5	500			17[c]	11; 19 (2 samples tested)
Brass	79.6	500	145	500	31[c]	1.2
Alclad aluminum	140	500[d]	70	500	64[c]	2
Stainless steel	104	500	211	2,000	39[c]	20 across grain 3 with grain
OD paint			34	200	4[c]	40
Navy 5H paint			2.4	25	9[c]	9
Aluminum paint			19	100	16[c]	5
Clear lacquer			9.3	25	17[c]	6
Sea-blue lacquer			3.4	25	15[c]	4.5
Phenolic varnish			8.9	50	25[c]	2.5
Acryloid varnish			19	100	25[c]	5
Cellulose acetate	115		12	100	18[c]	0.5
Melamine plastic	125 Rockwell R scale, ½ ball	60	Dark portion 98 Light portion 54	 300 300	27[c]	2
Silicone plastic	118		Dark portion 25 Light portion 12	 100 100	13[c]	22
GE Cocoon			0.6	10	1[c]	7
Stabond			Not suitable for indentation		4[c]	15
ROUGHNESS VARIATION						
Glass						
Clear			464	2,000	61[c]	1
4X			483	2,000	40[c]	10
600					39[c]	17
302					18[c]	30
FFF					26[c]	35
Stainless steel						
Blank	96	500	217	2,000		20 across grain 3 with grain
FF	100	500			41[c]	20
FFF	100	500			43[c]	18
302	109	500				15
4X	109	500	208	2,000	51[c]	10
600	100	500			37[c]	9
HARDNESS VARIATION						
Brass						
415	69.1	500			23[c]	25 across grain 7 with grain
630	50.3	500			33[c]	7
805	53.4	500	87	500	45[c]	9 across grain 7 with grain
1025	85.7	500			18[c]	10

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Table B.1—*Continued*

MATERIAL	HARDNESS TESTS					ROUGHNESS TEST
	Brinell		Knoop		Sward Rocker	Brush Analysis (μin.)
	Brinell No.	Load (kg)	Knoop No.[a]	Load (g)	Sward No.[b]	
HARDNESS VARIATION						
Stainless steel						
38–40	331	3,000			14[c]	80
45	363	3,000			15[c]	75
50	477	3,000			15[c]	80
Quenched	514	3,000			13[c]	80
Annealed	179	3,000			16[c]	90
PIGMENT-VOLUME VARIATION, NAVY PAINT						
500–2 (13%)[f]			1.1	10	12[e]	5.5
500–3 (35%)			6.1	50	12[e]	10
500–4 (38%)			2.9	10	10[e]	45

[a] Each Knoop number is the average of 5 determinations.
[b] Sward numbers are the average of 3 determinations.
[c] Tested on 1- by 1-in. plate.
[d] Converted from Rockwell 15 T scale (sample too thin for accurate test).
[e] Tested on 4- by 6-in. plate.
[f] Figures in parentheses give approximate percentage volume of pigment to total volume.

B.4 SOURCE AND SURFACE CHARACTERISTICS OF THE EXPERIMENTAL MATERIALS USED BY THE ACC

MATERIAL	CONTACT ANGLE[a] (deg)	DYE ADSORPTION
Mirawal, white porcelain enamel produced by Baltimore Porcelain Steel Company, Baltimore, Md.	45	None
Du Pont varnish, 76 Dull	60	None
Glass cloth, Owens-Corning Fiberglas Corporation, Toledo, Ohio, stock No. 161	0	None
Lucite, commercial methyl methacrylate plastic	70	None
Metal lacquer, commercial clear metal lacquer sold under the trade name of Co-loidal-ac	70	None
Linoleum, brown linoleum manufactured by Armstrong Cork Co., Lancaster, Pa.		
Regular factory finish	80	None
Factory finish removed	50	Some
Transite, board ⅛ in. thick	0	Some
2SO aluminum	90	None
Paraffin	125	None
Felt, commercial saturated roofing felt	95	None
Asphalt varnish, commercial asphalt varnish, produced by Ruberoid Co., New York, N. Y.	85	None
Wool, Air Force overcoat wool	125	None
Porcelain enamel	25	None
Protein-base paint, commercial product sold under name Satin-spred	45	Some
Plywood, Douglas fir	0	Some
Navy Cocoon, strippable coating made by R. M. Hollingshead Corporation, Camden, N. J.	90	Some
Rubber tile, Goodyear gray rubber tile	110	Some
Graphite paint, commercial exterior graphite paint manufactured by Joseph Dixon Co., Jersey City, N. J.	90	Some
Leather, flexible	60	Some
Canvas ducking, material known as Indantone	115	Some

[a] The contact angle is the value obtained with distilled water.

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Appendix C

Contaminability and Decontaminability of Materials

C.1 MATERIALS EXPOSED BY USNRDL

The initial contaminabilities of the materials exposed, at different drone plane altitudes, by the USNRDL and the activities remaining after decontamination were both measured in counts per minute. From these values, the average percentage decontamination for each of the materials exposed has been calculated. Because of the short time interval between the measurement of the initial and the residual contaminations, no correction for decay of the radioactive contaminant was considered necessary.

The results obtained by the USNRDL for the Dog, Easy, and George Shots are given in Tables C.1 to C.3.

TABLE C.1 MATERIALS EXPOSED BY USNRDL, DOG SHOT

Altitude (ft × 10^{-2})	Copper: Initial c/m (× 10^{-4})	Copper: Final c/m (× 10^{-4})	Copper: Per Cent Removal	Brass: Initial c/m (× 10^{-4})	Brass: Final c/m (× 10^{-4})	Brass: Per Cent Removal	Alclad Aluminum: Initial c/m (× 10^{-4})	Alclad Aluminum: Final c/m (× 10^{-4})	Alclad Aluminum: Per Cent Removal
16	160	87.9	45	128	62.7	51	105	10.1	90
	133	68.3	49	140	72.5	48	123	18.9	85
18	292	128	56	357	166	53	250	26.6	89
	340	137	60	357	171	52	292	44.9	85
20	16.3	7.52	54	17.5	8.71	50	23.0	5.06	78
	16.0	5.95	63	25.3	10.4	59	16.1	3.95	75
22	9.56	3.41	64	13.2	7.11	46	11.6	2.95	75
	7.50	2.96	61	9.90	5.28	47	8.85	2.69	70
24	2.67	2.11	21	2.19	1.27	42	3.14	1.25	60
	2.85	1.98	31	2.83	1.56	39	2.28	0.86	62
26	13.4	6.25	53	12.3	5.15	58	8.92	2.96	67
	12.6	5.51	56	12.1	5.62	53	10.8	3.34	67
28	16.8	5.06	70	14.4	5.14	64	15.5	2.00	87
	13.4	4.18	69	16.8	4.98	70	13.6	2.07	85
30	8.87	4.99	44	6.25	3.47	44	4.90	1.66	66
	10.0	5.51	45	6.36	3.70	42	5.59	1.49	73
			Av 53 ± 11			Av 51 ± 6			Av 76 ± 9

Altitude (ft × 10^{-2})	Stainless Steel: Initial c/m (× 10^{-4})	Stainless Steel: Final c/m (× 10^{-4})	Stainless Steel: Per Cent Removal	OD Paint: Initial c/m (× 10^{-4})	OD Paint: Final c/m (× 10^{-4})	OD Paint: Per Cent Removal	Navy Paint: Initial c/m (× 10^{-4})	Navy Paint: Final c/m (× 10^{-4})	Navy Paint: Per Cent Removal
16	147	11.1	92	103	24.1	77	77.8	8.35	89
	133	10.2	92	95.7	23.5	76	58.5	8.75	85
18	358	14.9	96	275	21.8	92	157	19.4	88
	220	11.8	95	222	21.1	90	178	13.2	87
20	17.2	2.14	88	16.2	3.08	81	14.4	2.24	84
	15.6	2.91	81	13.9	3.12	78	15.7	4.29	73
22	10.9	1.85	83	8.40	1.66	80	8.15	1.97	76
	8.46	1.20	86	6.05	2.44	60	7.54	1.95	74
24	2.08	0.70	66	2.28	0.78	66	2.37	0.54	77
	2.19	0.58	73	2.67	1.12	58	2.19	0.73	67
26	6.87	1.99	71	9.61	3.00	69	7.12	1.81	75
	8.27	1.53	81	10.9	3.69	66	8.54	1.95	77
28	21.1	2.74	87	9.61	1.71	82	11.9	1.96	84
	16.2	2.35	85	6.62	1.64	75	8.29	1.81	78
30	4.73	1.09	77	5.06	1.79	65	3.61	1.02	72
	3.68	1.33	64	6.07	2.46	59	3.65	0.94	74
			Av 78 ± 8			Av 73 ± 9			Av 79 ± 6

Altitude (ft × 10^{-2})	Clear Lacquer: Initial c/m (× 10^{-4})	Clear Lacquer: Final c/m (× 10^{-4})	Clear Lacquer: Per Cent Removal	Sea-Blue Lacquer: Initial c/m (× 10^{-4})	Sea-Blue Lacquer: Final c/m (× 10^{-4})	Sea-Blue Lacquer: Per Cent Removal	Aluminized Paint: Initial c/m (× 10^{-4})	Aluminized Paint: Final c/m (× 10^{-4})	Aluminized Paint: Per Cent Removal
16	145	4.04	97	112	22.3	80	159	12.6	92
	168	4.68	97	99.5	22.3	78	140	11.8	92
18	115	4.68	94	135	22.7	83	123	5.72	95
	112	5.82	95	155	18.3	88	133	7.95	94
20	8.88	1.17	87	7.60	1.63	79	10.8	2.38	78
	16.4	4.46	73	7.72	1.55	80	8.74	1.29	85
22	14.4	1.12	92	9.12	2.38	62	9.98	1.44	85
	11.7	1.31	89	9.36	3.08	70	8.76	1.05	88
24	3.37	0.83	75	3.68	0.74	72	2.97	0.81	83
	2.71	0.74	73	4.42	1.04	68	3.01	0.77	84
26	15.7	3.65	77	10.7	7.84	27	9.35	6.46	31
	15.4	3.30	79	10.1	7.71	23	8.06	5.88	27
28	6.67	1.64	75	10.4	2.90	72	8.89	1.19	87
	6.78	0.67	90	8.62	2.39	72	11.0	1.80	84
30	3.59	0.97	73	4.26	1.31	69	3.60	1.08	70
	3.34	0.77	77	4.07	1.38	56	3.55	1.19	66
			Av 84 ± 9			Av 68 ± 12			Av 78 ± 14

[redacted]

TABLE C.1—*Continued*

ALTITUDE (ft×10⁻³)	CELLULOSE ACETATE			MELAMINE RESIN			SILICONE RESIN		
	Initial c/m (×10⁻⁴)	Final c/m (×10⁻⁴)	Per Cent Removal	Initial c/m (×10⁻⁴)	Final c/m (×10⁻⁴)	Per Cent Removal	Initial c/m (×10⁻⁴)	Final c/m (×10⁻⁴)	Per Cent Removal
16	118	1.81	88	185	52.0	72	123	27.1	78
	116	2.09	88	176	50.8	71	127	18.8	85
18	135	2.34	98	139	41.4	70	106	16.2	85
	143	0.80	99	141	29.6	79	107	12.2	89
20	4.47	0.32	93	3.95	1.29	67	5.36	1.37	74
	4.88	0.31	94	5.32	1.81	66	5.25	1.49	72
22	7.20	0.90	87	7.50	1.55	79	7.36	1.30	82
	6.60	0.88	87	6.40	1.16	82	8.13	1.56	81
24	1.62	0.14	92	1.49	0.88	41	1.51	0.56	63
	1.36	0.14	89	1.56	0.88	44	2.14	0.78	84
26	6.31	0.86	86	6.67	2.28	66	10.7	2.89	73
	5.96	1.15	81	8.15	2.80	66	10.4	3.15	70
28	7.30	0.44	94	5.80	1.07	82	3.87	0.79	79
	7.00	0.57	92	6.20	0.74	88	3.83	1.49	72
30	4.51	0.76	83	5.42	3.73	31	4.30	1.73	60
	3.75	0.66	82	6.20	4.05	35	4.12	2.03	51
			Av 91±6			Av 65±14			Av 75±7
	GE COCOON			STABOND			PHENOLIC VARNISH		
16	176	26.7	85	183	6.83	96	118	11.4	
	137	16.8	88	160	87.5	45	128	10.3	92
18	86.6	11.8	86	103	25.5	75	117	9.22	92
	163	20.1	88	107	27.0	75	145	7.83	95
20	14.8	3.73	75	14.8	5.30	64	18.1	5.71	78
	14.8	3.35	79	24.8	8.97	64	15.4	3.73	76
22	23.5	3.07	87	11.7	3.70	68	10.5	2.85	73
	21.9	4.60	79	14.8	5.26	54	9.46	1.29	86
24	4.80	0.67	86	3.40	1.31	61	2.66	0.99	63
	4.53	0.82	82	3.22	1.25	61	1.86	0.46	84
26	19.6	5.05	58	13.3	4.90	63	10.8	3.00	72
	12.0	1.50	87	12.7	4.30	66	8.53	1.39	84
28	7.22	1.79	77	8.93	2.76	69	8.57	1.26	85
	7.89	2.76	69	10.2	3.35	67	10.4	3.12	70
30	9.01	2.92	68	9.52	6.28	34	11.9	7.13	40
	6.19	2.57	58	11.2	6.61	41	6.61	2.34	65
			Av 79±9			Av 63±10			Av 77±11
	ACRYLOID VARNISH			GLASS (CLEAR)			GLASS (4X)		
16	92	7.71	92	151	5.56	96	232	38.9	83
	130	10.9	88	132	2.62	98	150	33.4	78
18	125	1.72	99	129	1.31	99	140	14.6	90
	99.2	2.62	97	158	0.97	99	115	11.4	90
20	14.6	1.66	87	13.6	0.29	98	7.20	2.05	72
	10.1	0.86	91	13.7	0.46	97	6.70	1.82	73
22	8.36	1.02	88	7.02	0.25	96	2.80	0.68	86
	8.88	1.01	89	7.25	0.23	97	3.04	0.68	88
24	1.62	0.20	88	2.39	0.13	94	1.61	0.63	61
	2.40	0.47	80	2.03	0.09	96	1.34	0.56	58
26	8.34	1.24	86	5.50	0.36	93	7.78	2.44	69
	8.94	1.30	85	5.50	0.29	95	7.28	0.09	99
28	16.3	1.66	90	16.9	1.66	90	6.40	2.20	66
	20.6	1.98	90	7.90	0.94	88	7.60	2.30	70
30	3.10	0.55	82	4.80	0.39	92	3.45	2.28	34
	3.40	0.92	72	2.54	0.23	91	3.77	2.10	44
			Av 88±4			Av 95±3			Av 73±13

[redacted]

Table C.1—*Continued*

Altitude (ft × 10⁻³)	Glass (600) Initial c/m (×10⁻⁴)	Glass (600) Final c/m (×10⁻⁴)	Glass (600) Per Cent Removal	Glass (302) Initial c/m (×10⁻⁴)	Glass (302) Final c/m (×10⁻⁴)	Glass (302) Per Cent Removal	Glass (FFF) Initial c/m (×10⁻⁴)	Glass (FFF) Final c/m (×10⁻⁴)	Glass (FFF) Per Cent Removal
16	180	40.3	78	184	43.0	77	159	34.0	79
	239	49.0	80	180	34.5	81	211	51.4	76
18	147	18.8	87	85.5	8.37	90	100	7.22	93
	82.5	13.0	84	158	0.97	99	119	9.83	92
20	5.79	1.57	73	6.23	1.33	79	4.24	0.95	78
	6.78	1.82	73	7.31	1.71	77	4.74	1.18	75
22	4.46	0.78	83	4.11	0.86	79	3.30	0.72	76
	5.49	1.01	82	5.92	1.33	78	3.91	0.96	75
24	1.50	0.56	63	1.16	0.36	69	1.25	0.41	67
	1.49	0.53	64	1.43	0.44	69	1.30	0.42	68
26	11.4	3.64	68	10.1	4.65	60	11.3	4.29	60
	12.0	3.08	74	11.8	3.52	70	11.1	2.85	70
28	9.30	2.30	75	5.34	1.49	72	3.50	0.78	78
	10.5	2.20	79	5.91	1.06	82	5.23	1.10	79
30	7.60	2.92	62	6.72	2.68	60	6.94	2.41	65
	7.10	2.63	63	6.33	2.44	61	6.14	2.27	63
			Av 74 ± 7			Av 75 ± 7			Av 75 ± 7
	Navy Paint (13.5%)			**Navy Paint (31.8%)**			**Navy Paint (38.4%)**		
16	153	16.2	89	146	16.2	89	127	13.4	89
	166	18.3	89	152	12.9	91	160	15.9	90
18	99.8	10.5	89	95.0	8.13	91	111	10.1	91
	117	10.3	91	96.9	9.40	90	116	13.1	89
20	8.63	1.47	83	14.1	2.36	83	10.6	1.99	82
	14.4	2.57	82	18.2	2.82	84	11.6	2.40	79
22	8.88	1.36	85	6.29	1.17	81	5.39	0.85	84
	8.80	1.18	87	7.16	1.46	79	5.01	0.73	85
24	2.40	0.57	76	3.18	0.80	75	3.67	1.18	68
	2.12	0.48	77	3.46	0.86	75	3.54	1.21	66
26	11.2	2.24	80	11.1	2.05	82	7.96	1.91	76
	12.2	2.08	83	10.8	2.13	80	9.81	2.44	75
28	7.76	1.42	82	6.27	1.25	80	8.24	2.18	74
	6.46	1.24	81	7.14	1.29	82	9.68	2.82	71
30	4.72	1.19	75	4.92	1.25	75	4.72	1.36	71
	4.96	1.19	76	4.86	1.03	79	5.03	1.30	74
			Av 83 ± 4			Av 82 ± 4			Av 79 ± 7
	Brass (415)			**Brass (630)**			**Brass (805)**		
16	92.6	55.8	40	104	66.7	37	113	62.7	45
	113	69.0	39	117	83.1	29	130	101	22
18	146	119	17	147	117	20	215	187	13
	130	103	21	178	151	15	163	156	4
20	8.34	4.77	43	6.73	4.00	41	18.4	11.7	36
	8.01	4.48	44	8.08	4.73	41	11.0	7.50	32
22	6.60	2.49	62	7.44	2.23	70	6.50	2.41	63
	7.52	4.05	46	7.24	2.19	70	7.17	2.98	61
24	3.12	2.25	28	2.71	1.93	29	2.04	1.35	34
	2.91	2.03	30	2.81	1.91	32	2.65	1.74	34
26	7.65	3.85	50	8.68	4.25	51	9.02	4.56	49
	7.85	3.85	51	6.76	3.17	53	9.96	4.48	55
28	6.78	3.13	54	4.18	1.50	64	5.12	2.50	51
	5.93	2.43	59	5.27	1.86	65	5.14	1.76	66
30	4.34	2.97	32	4.29	3.18	26	3.69	2.39	35
	3.58	2.32	35	4.46	3.10	30	4.47	2.97	34
			Av 41 ± 10			Av 42 ± 16			Av 40 ± 14

TABLE C.1—*Continued*

ALTITUDE (ft×10^{-3})	BRASS (1025) Initial c/m (×10^{-4})	Final c/m (×10^{-4})	Per Cent Removal	STAINLESS STEEL (38) Initial c/m (×10^{-4})	Final c/m (×10^{-4})	Per Cent Removal	STAINLESS STEEL (45) Initial c/m (×10^{-4})	Final c/m (×10^{-4})	Per Cent Removal
16	117	93.6	45	131	102	22	140	94.3	33
	93.2	64.7	31	136	102	25	138	106	23
18	187	117	37	73.7	38.0	48	75.5	48.3	36
	149	125	16	78.0	58.4	25	82.1	57.0	31
20	7.72	4.90	37	5.14	3.71	28	4.45	3.67	18
	4.64	2.18	53	7.70	5.08	26	6.23	3.64	42
22	5.37	1.89	65	12.0	5.85	51	7.53	4.21	44
	5.78	2.33	60	13.0	6.76	48	10.4	5.49	50
24	2.59	1.64	37	2.93	2.15	27	49.2	39.5	20
	2.25	1.66	26	4.65	3.69	21	97.1	77.2	21
26	8.59	2.99	65	13.5	8.83	35	18.4	11.6	37
	6.20	3.27	47	18.7	10.7	43	16.7	10.2	39
28	4.08	1.86	54	13.8	3.07	78	21.2	8.93	58
	4.52	1.65	67	19.1	6.14	68	21.6	10.7	50
30	2.31	1.72	26	8.24	6.10	26	8.44	6.77	20
	3.01	2.36	22	8.28	6.40	23	6.65	5.46	18
			Av 43 ± 15			Av 37 ± 14			Av 36 ± 8

ALTITUDE (ft×10^{-3})	STAINLESS STEEL (50) Initial c/m	Final c/m	Per Cent Removal	STAINLESS STEEL (A) Initial c/m	Final c/m	Per Cent Removal	STAINLESS STEEL (Q) Initial c/m	Final c/m	Per Cent Removal
16	153	147	4	79.5	43.6	45	71.7	61.7	14
	112	99.7	11	73.1	41.7	43	108	87.2	19
18	102	99.9	2	67.3	40.8	39			
	112	91.0	19	83.1	39.4	53	66.3	59.2	11
20	11.1	7.32	34	18.1	5.71	68	4.66	3.71	20
	4.30	2.88	33	15.4	3.73	76	4.66	4.52	3
22	10.7	6.74	37	7.92	3.04	62	33.5	15.1	55
	14.3	6.51	54	7.19	2.66	63	27.6	13.8	50
24	7.72	6.18	20	1.61	1.14	29	6.98	5.95	15
	6.74	5.15	23	1.55	1.16	25	6.51	5.38	18
26	11.3	9.21	18	5.95	3.44	42	12.6	6.95	45
	18.1	11.6	31	9.03	5.60	38	17.0	12.9	24
28	9.46	5.96	37	7.48	3.88	48	19.8	10.6	47
	12.6	5.88	53	6.41	2.58	44	11.7	7.46	36
30	5.03	4.71	6	4.53	3.46	24	8.44	6.68	21
	6.75	6.23	8	4.98	3.60	28	11.7	8.58	22
			Av 24 ± 14			Av 45 ± 12			Av 27 ± 13

ALTITUDE (ft×10^{-3})	STAINLESS STEEL (CLEAR) Initial c/m	Final c/m	Per Cent Removal	STAINLESS STEEL (4X) Initial c/m	Final c/m	Per Cent Removal	STAINLESS STEEL (600) Initial c/m	Final c/m	Per Cent Removal
16	63.3	13.4	79	89.7	33.9	62	96.2	32.4	66
	64.0	10.8	83	95.9	33.4	65	90.6	34.6	62
18	107	9.73	91	154	28.5	81	102	20.1	80
	129	13.3	90	107	21.8	80	121	24.3	80
20	6.35	1.78	72	1.82	1.19	35	5.23	1.90	64
	8.45	2.70	68	1.84	1.17	36	5.61	2.23	60
22	8.26	1.96	76	9.60	2.78	71	4.92	1.93	61
	11.1	2.26	80	6.82	2.23	67	5.62	2.12	62
24	1.87	0.90	52	1.82	1.19	35	1.65	1.13	39
	1.38	0.67	50	1.84	1.17	36	2.14	1.35	37
26	5.31	1.79	67	7.22	3.72	48	8.07	4.49	44
	5.96	2.45	59	6.65	3.40	49	9.41	5.09	46
28	5.19	1.45	72	4.98	1.69	66	8.64	3.11	64
	5.29	1.25	77	8.23	2.68	68	7.10	2.41	66
30	3.16	1.55	51	4.39	2.43	45	4.16	2.55	49
	3.04	1.13	63	4.19	1.25	70	4.21	2.51	40
			Av 71 ± 11			Av 57 ± 13			Av 56 ± 13

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TABLE C.1—*Continued*

ALTITUDE (ft × 10^{-3})	STAINLESS STEEL (302) Initial c/m (× 10^{-4})	STAINLESS STEEL (302) Final c/m (× 10^{-4})	STAINLESS STEEL (302) Per Cent Removal	STAINLESS STEEL (FFF) Initial c/m (× 10^{-4})	STAINLESS STEEL (FFF) Final c/m (× 10^{-4})	STAINLESS STEEL (FFF) Per Cent Removal	STAINLESS STEEL (FF) Initial c/m (× 10^{-4})	STAINLESS STEEL (FF) Final c/m (× 10^{-4})	STAINLESS STEEL (FF) Per Cent Removal
16	91.4	34.2	63	100	36.6	63	53.4	19.8	63
	80.6	29.5	63	82.0	29.8	64	58.9	19.4	67
18	104	26.7	74	122	30.2	75	108	27.1	75
	112	26.6	76	103	26.7	74	97.8	29.0	70
20	6.15	2.18	65	8.84	2.95	67	5.36	2.16	60
	8.37	2.51	70	6.33	2.34	63	5.70	2.26	60
22	4.25	1.68	60	3.96	1.38	65	3.63	1.37	62
	4.56	1.68	63	3.90	1.53	61	3.13	1.45	54
24	2.35	1.57	33	2.34	1.43	39	2.43	1.55	36
	2.18	1.49	32	2.21	1.47	35	2.22	1.31	41
26	7.66	3.86	50	7.36	4.08	45	5.00	3.17	37
	6.71	3.03	55	5.46	3.26	40	7.30	3.78	48
28	4.23	1.52	64	4.36	1.58	64	5.36	2.27	58
	4.80	2.02	58	5.81	2.12	64	4.90	1.77	64
30	4.38	2.96	32	4.42	2.83	36.	3.67	2.19	40
	4.20	2.65	37	3.75	2.39	36	3.82	1.96	49
			Av 56 ± 12			Av 56 ± 13			Av 55 ± 10

TABLE C.2 MATERIALS EXPOSED BY USNRDL, EASY SHOT

ALTITUDE (ft × 10^{-3})	COPPER Initial c/m (× 10^{-4})	COPPER Final c/m (× 10^{-4})	COPPER Per Cent Removal	BRASS Initial c/m (× 10^{-4})	BRASS Final c/m (× 10^{-4})	BRASS Per Cent Removal	ALCLAD ALUMINUM Initial c/m (× 10^{-4})	ALCLAD ALUMINUM Final c/m (× 10^{-4})	ALCLAD ALUMINUM Per Cent Removal
16	0.70	0.15	78	0.61	0.12	80	0.49	0.14	97
	0.84	0.15	82	0.49	0.09	81	0.42	0.18	96
18	5.32	0.81	85	5.52	0.82	85	5.90	0.58	90
	6.16	2.16	65	4.86	0.80	84	5.26	1.07	80
20	8.49	0.48	94	9.85	0.72	93	10.0	1.02	90
	12.4	2.08	83	11.2	0.96	91	11.6	0.97	92
22	7.10	0.58	92	7.40	0.52	93	6.99	0.56	92
	8.98	2.29	74	7.08	0.65	91	5.61	0.95	83
24	6.64	0.43	94	7.60	0.36	95	6.74	0.34	95
	6.70	0.98	85	7.47	1.28	83	5.51	0.53	90
26	6.59	0.52	92	6.49	0.35	95	7.04	0.64	91
	13.4	0.66	95	6.88	0.79	89	6.69	0.54	92
28	3.52	0.49	84	3.97	0.25	94	4.08	0.19	95
	3.88	0.83	79	4.43	0.36	92	3.29	0.29	91
30	8.37	3.92	54	6.60	2.50	62	9.32	2.00	79
	7.84	1.33	83	9.04	0.82	91	5.79	1.15	80
			Av 82 ± 8			Av 87 ± 6			Av 90 ± 4

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TABLE C.2—*Continued*

ALTITUDE (ft × 10^{-3})	STAINLESS STEEL			OD PAINT			NAVY PAINT		
	Initial c/m (× 10^{-4})	Final c/m (× 10^{-4})	Per Cent Removal	Initial c/m (× 10^{-4})	Final c/m (× 10^{-4})	Per Cent Removal	Initial c/m (× 10^{-4})	Final c/m (× 10^{-4})	Per Cent Removal
16	0.54	0.09	82	0.54	0.19	65	0.39	0.10	74
	0.47	0.09	81	0.68	0.19	73	0.44	0.14	68
18	5.83	0.44	92	4.95	0.68	86	5.75	0.58	90
	5.82	0.54	91	5.86	0.59	90	5.96	0.67	89
20	9.08	0.41	95	14.0	1.17	92	11.9	0.88	93
	10.1	0.45	95	8.46	0.84	90	9.77	0.76	92
22	7.93	0.66	92	10.6	0.76	93	9.12	1.51	83
	6.67	1.21	82	10.1	0.81	92	7.74	3.53	54
24	8.95	0.66	93	11.2	1.57	86	8.87	0.73	92
	5.95	0.78	87	10.9	1.03	91	7.35	1.16	84
26	7.37	0.43	94	7.99	0.60	92	6.64	0.41	94
	6.04	0.72	88	8.14	0.64	92	6.45	0.39	94
28	4.25	0.21	95	2.61	0.24	91	2.92	0.32	89
	3.37	0.29	91	3.64	0.28	92	5.26	0.39	93
30	7.78	2.87	63	6.60	0.51	92	5.84	1.16	80
	6.38	0.28	96	6.50	0.55	92	6.15	0.55	91
			Av 89 ± 6			Av 88 ± 5			Av 85 ± 8

ALTITUDE (ft × 10^{-3})	CLEAR LACQUER			SEA-BLUE LACQUER			ALUMINIZED PAINT		
16	5.12	0.30	94	6.65	0.44	93	3.01	1.36	55
	6.75	0.42	94	4.27	0.35	92	3.20	1.34	58
18	24.4	4.80	80	19.1	2.75	86	17.4	2.47	86
	20.0	2.00	90	16.9	5.90	65	19.2	2.30	88
20	59.8	9.53	84	53.5	23.8	54	77.2	16.2	79
	77.8	30.0	61	44.5	13.4	47	81.3	26.6	67
22	67.7	15.1	78	83.1	31.5	62	96.5	38.8	60
	69.0	16.4	76	118	66.2	44	94.8	43.0	55
24	105	19.0	82	72.1	44.5	38	80.2	23.5	71
	96.9	22.2	77	76.4	26.5	65	92.4	20.9	77
26	90.2	6.27	93	99.9	13.1	87	94.2	27.9	70
	109	7.54	93	80.6	11.8	85	91.3	7.74	92
28	80.2	5.69	93	97.1	13.5	86	86.0	13.4	84
	68.9	4.56	93	47.8	9.10	81	48.5	6.73	86
30	133	54.0	59	84.3	15.6	81	59.1	5.60	91
	87.8	14.7	83	86.0	11.7	86	60.5	12.8	79
			Av 83 ± 9			Av 74 ± 13			Av 75 ± 11

ALTITUDE (ft × 10^{-3})	CELLULOSE ACETATE			MELAMINE RESIN			SILICONE RESIN		
16	1.40	0.27	81	1.25	0.70	44	2.64	0.96	64
	1.70	0.41	76	1.14	0.54	53	2.96	1.09	63
18	13.2	1.23	91	6.03	0.84	86	10.4	1.58	85
	13.9	1.26	91	6.02	1.30	78	8.70	1.41	84
20	35.2	5.22	85	30.1	5.79	81	46.7	14.3	69
	37.4	4.93	87	27.2	8.12	70	54.9	17.1	69
22	36.2	5.52	85	25.5	5.63	78	37.0	9.03	76
	40.5	5.60	86	25.3	5.90	77	32.7	10.3	68
24	46.5	10.2	78	20.4	4.55	78	49.6	15.5	69
	54.0	7.91	85	31.2	9.63	69	53.1	18.3	66
26	47.2	1.93	96	88.3	1.53	98	37.4	4.62	88
	59.3	2.07	97	27.8	1.51	95	36.5	4.55	88
28	29.8	1.61	95	22.5	2.27	90	27.0	4.85	82
	30.6	1.52	95	18.6	2.29	88	28.0	4.40	84
30	33.2	1.16	65	33.2	2.75	92	32.9	4.96	85
	35.3	1.67	53	54.4	17.8	67	43.5	14.7	66
			Av 84 ± 8			Av 78 ± 7			Av 75 ± 9

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Table C.2—*Continued*

ALTITUDE (ft×10⁻³)	Initial c/m (×10⁻⁴)	Final c/m (×10⁻⁴)	Per Cent Removal	Initial c/m (×10⁻⁴)	Final c/m (×10⁻⁴)	Per Cent Removal	Initial c/m (×10⁻⁴)	Final c/m (×10⁻⁴)	Per Cent Removal
	GE COCOON			STABOND			PHENOLIC VARNISH		
16	13.7	6.01	56	8.50	2.62	69	4.64	1.48	68
	19.5	7.17	63	8.70	3.25	63	3.58	0.39	89
18	30.8	3.50	89	32.2	4.95	85	28.6	1.66	94
	40.3	3.74	91	34.4	6.76	80	23.0	1.89	92
20	86.2	16.0	81	25.0	9.20	63	65.7	29.2	55
	77.0	17.5	77	80.2	21.5	73	47.3	11.3	76
22	75.5	21.1	72	106	31.1	71	107	32.6	70
	90.4	39.1	57	101	26.5	74	81.4	7.68	91
24	22.6	7.87	65	83.5	18.3	78	66.1	18.2	72
	26.6	8.52	68	71.6	19.5	73	64.9	0.56	99
26	93.8	17.4	81	88.8	15.3	83	67.6	6.08	91
	107	46.2	57	83.7	13.4	84	62.6	5.53	91
28	61.4	16.0	74	39.6	7.37	81	54.8	4.91	91
	64.0	32.7	49	41.9	7.67	82	49.2	4.69	90
30	75.0	16.0	79	84.1	19.7	77	102	8.73	91
	81.1	14.5	82	78.3	19.8	75	79.0	9.50	88
			Av 71 ± 11			Av 76 ± 6			Av 84 ± 10
	ACRYLOID VARNISH			GLASS (CLEAR)			GLASS (4X)		
16	2.22	0.76	66	2.16	0.39	82	2.12	0.67	68
	2.98	0.99	67	2.22	0.23	90	2.32	0.55	76
18	20.4	1.18	94	16.9	0.46	97	7.33	1.12	85
	20.6	1.20	94	22.7	0.54	98	9.10	1.18	87
20	54.9	7.96	85	38.5	1.14	97	18.3	4.31	76
	47.4	7.23	85	40.0	1.82	95	30.7	6.69	78
22	83.6	5.29	94	77.6	7.73	90	57.0	9.12	84
	87.8	6.98	92	63.6	0.88	99	56.6	11.1	80
24	69.5	6.34	91	49.2	0.14	99	45.7	9.58	79
	69.9	7.15	90	31.0	0.14	99	34.6	6.21	82
26	52.5	3.44	94	82.7	1.20	99	44.6	6.06	86
	60.0	4.14	93	79.2	0.90	99	40.0	5.68	86
28	60.4	4.97	92	47.9	1.02	98	27.1	4.14	85
	49.8	2.53	95	46.7	0.93	98	22.2	4.27	81
30	75.0	6.88	91	65.2	3.01	95	28.6	6.87	76
	71.4	8.84	88	39.0	2.26	94	39.0	8.42	78
			Av 88 ± 6			Av 95 ± 4			Av 80 ± 4
	GLASS (600)			GLASS (302)			GLASS (FFF)		
16	3.55	0.79	78	3.50	0.55	84	1.18	0.24	80
	3.25	0.68	78	3.00	0.55	86	3.60	1.33	63
18	6.76	0.52	93	6.36	0.48	92	6.98	0.60	91
	6.49	0.33	95	13.3	0.82	94	5.86	0.47	92
20	33.5	6.94	79	24.2	4.63	81	20.1	2.76	86
	33.3	7.00	78	22.6	4.31	81	18.4	3.85	79
22	76.0	20.2	73	64.5	17.5	73	53.6	9.60	82
	71.9	16.7	77	70.0	11.0	84	48.7	7.10	85
24	94.3	11.2	88	81.4	12.7	84	55.1	9.52	83
	103	17.9	83	70.4	10.3	85	56.8	9.67	83
26	101	12.2	88	80.8	11.4	86	79.7	9.80	82
	96.0	11.6	88	90.6	13.3	85	66.6	9.30	86
28	36.1	5.07	86	26.9	4.44	83	28.0	3.94	86
	35.0	5.31	85	31.4	4.70	85	25.2	3.54	86
30	35.0	8.36	76	44.9	7.16	84	26.0	8.09	69
	36.3	6.32	83	43.2	7.34	83	38.5	7.99	79
			Av 83 ± 5			Av 84 ± 3			Av 82 ± 5

[redacted]

TABLE C.2—*Continued*

ALTITUDE (ft×10⁻³)	NAVY PAINT (13.5%)			NAVY PAINT (31.8%)			NAVY PAINT (38.4%)		
	Initial c/m (×10⁻⁴)	Final c/m (×10⁻⁴)	Per Cent Removal	Initial c/m (×10⁻⁴)	Final c/m (×10⁻⁴)	Per Cent Removal	Initial c/m (×10⁻⁴)	Final c/m (×10⁻⁴)	Per Cent Removal
16	4.52	1.20	72	3.48	1.95	44	3.99	0.75	81
	3.57	1.16	67	3.49	1.14	67	3.45	1.04	70
18	16.3	1.06	93	20.4	1.32	94	15.4	1.04	93
	15.7	3.53	78	18.7	1.84	90	16.7	1.44	91
20	54.9	8.95	84	44.1	7.44	83	40.6	6.82	83
	45.6	8.19	82	47.5	6.82	86	37.9	7.24	81
22	117	51.8	56	80.4	11.7	85	72.9	9.36	87
	120	57.1	52	83.1	10.2	88	72.8	12.5	83
24	125	21.1	83	124	13.3	89	85.1	13.7	84
	139	32.7	77	98.9	11.6	88	83.6	11.7	86
26	95.3	7.40	92	67.5	4.11	94	74.9	7.00	91
	91.9	6.30	93	65.7	4.50	93	67.4	7.30	89
28	80.3	2.30	97	63.4	5.12	92	67.1	7.18	89
	76.2	5.30	97	62.5	5.01	92	52.8	6.49	88
30	61.3	9.25	85	57.5	9.45	84	45.8	10.5	77
	66.8	12.0	82	69.9	11.0	84	46.0	10.8	77
			Av 80 ± 10			Av 85 ± 7			Av 84 ± 5

ALTITUDE (ft×10⁻³)	BRASS (415)			BRASS (630)			BRASS (805)		
16	23.5	7.50	68	2.48	0.90	64	1.88	0.59	69
	19.2	6.60	66	1.99	0.81	59	1.88	0.74	61
18	165	26.5	84	12.8	1.84	86	15.0	2.46	84
	182	33.7	81	14.2	2.08	85	16.4	3.07	81
20	219	18.2	92	17.2	2.17	88	17.7	2.58	85
	169	17.6	90	18.2	2.48	86	15.0	2.51	83
22	387	88.9	77	44.1	6.78	85	53.4	9.01	83
	392	91.5	77	37.4	5.70	85	49.6	7.97	84
24	298	26.8	91	31.0	3.20	90	27.6	3.11	89
	461	39.2	91	32.9	3.10	91	27.3	2.55	91
26	361	56.1	85	39.2	4.88	88	23.1	3.09	87
	392	54.6	86	28.6	4.68	84	31.6	4.19	87
28	164	25.5	84	13.1	2.25	83	19.1	3.42	82
	125	23.2	81	13.9	2.39	83	29.1	4.52	84
30	177	14.9	92	27.7	3.05	89	27.4	4.19	85
	161	16.4	90	25.0	2.76	89	24.0	2.60	89
			Av 83 ± 6			Av 83 ± 6			Av 83 ± 4

ALTITUDE (ft×10⁻³)	BRASS (1025)			STAINLESS STEEL (38)			STAINLESS STEEL (45)		
16	1.84	0.61	67	5.98	4.23	29			
	2.08	0.61	71	6.27	4.67	26	5.33	2.30	57
18	8.15	1.21	85	23.5	8.83	63	16.5	6.02	64
	6.98	1.01	86	19.6	6.23	68	22.6	8.28	63
20	9.97	1.35	86	8.97	3.35	63	16.8	6.03	64
	9.89	1.44	85	7.01	2.59	63	9.99	3.02	70
22	35.1	6.07	83	48.0	18.9	61	36.5	14.9	59
	32.6	5.35	84	41.0	16.9	66	25.4	9.52	63
24	16.5	2.31	86	20.4	4.55	78	26.8	7.30	73
	17.3	2.41	86	31.2	9.63	69	35.9	11.9	67
26	28.1	5.50	80	45.8	14.8	68	51.0	16.7	67
	28.7	2.39	92	42.2	13.4	68	53.4	16.5	69
[illegible]	11.8	2.00	83	41.4	13.5	67	38.3	12.9	66
	15.1	2.29	85	29.8	8.50	73	60.8	19.0	69
[illegible]	13.5	1.66	88	16.3	5.22	68	24.3	7.40	70
	13.7	1.14	92	13.9	4.29	69	32.9	8.55	74
			Av 84 ± 4			Av 62 ± 9			Av 66 ± 4

TABLE C.2—*Continued*

ALTITUDE $(\text{ft}\times10^{-3})$	STAINLESS STEEL (50) Initial c/m $(\times10^{-4})$	STAINLESS STEEL (50) Final c/m $(\times10^{-4})$	STAINLESS STEEL (50) Per Cent Removal	STAINLESS STEEL (A) Initial c/m $(\times10^{-4})$	STAINLESS STEEL (A) Final c/m $(\times10^{-4})$	STAINLESS STEEL (A) Per Cent Removal	STAINLESS STEEL (Q) Initial c/m $(\times10^{-4})$	STAINLESS STEEL (Q) Final c/m $(\times10^{-4})$	STAINLESS STEEL (Q) Per Cent Removal
16	5.13	3.62	29	2.02	1.13	44	3.04	1.69	44
	4.47	3.02	32	2.25	1.28	43	3.58	2.28	36
18	14.1	5.82	59	8.84	2.59	71	35.6	15.0	58
	17.2	6.17	64	10.2	2.90	71	38.9	15.0	61
20	13.5	4.71	71	13.0	3.50	73	14.3	4.93	66
	12.1	3.89	68	10.6	2.44	76	10.2	3.77	63
22	25.2	10.7	57	32.3	11.8	64	42.6	18.6	56
	21.0	9.28	56	29.0	11.3	61	36.3	14.1	61
24	22.6	7.87	65	25.6	5.97	77	24.8	6.62	75
	26.6	8 52	68	28.9	6.91	77	32.0	11.3	65
26	17.7	6.55	63	19.0	4.21	78	44.2	14.2	68
	23.3	6.22	73	17.5	5.17	71	40.8	13.4	67
28	30.5	9.18	70	15.9	5.05	68	60.0	20.2	67
	37.9	9.70	74	13.5	5.84	57	17.3	6.86	60
30	39.7	13.8	71	23.1	6.71	71	29.7	8.87	70
	39.2	10.4	72	19.2	5.40	69	31.2	8.36	73
			Av 62 ± 9			Av 67 ± 9			Av 62 ± 7

ALTITUDE $(\text{ft}\times10^{-3})$	STAINLESS STEEL (CLEAR) Initial c/m $(\times10^{-4})$	STAINLESS STEEL (CLEAR) Final c/m $(\times10^{-4})$	STAINLESS STEEL (CLEAR) Per Cent Removal	STAINLESS STEEL (4X) Initial c/m $(\times10^{-4})$	STAINLESS STEEL (4X) Final c/m $(\times10^{-4})$	STAINLESS STEEL (4X) Per Cent Removal	STAINLESS STEEL (600) Initial c/m $(\times10^{-4})$	STAINLESS STEEL (600) Final c/m $(\times10^{-4})$	STAINLESS STEEL (600) Per Cent Removal
16	1.93	0.52	73	3.27	0.75	77	2.32	0.61	74
	2.03	0.50	75	2.76	0.62	78	2.15	0.60	72
18	11.6	2.12	82	15.0	2.37	84	15.2	2.89	81
	13.7	1.11	92	15.1	1.77	88	14.3	2.56	88
20	14.2	1.60	89	15.5	1.70	89	20.9	3.24	84
	17.3	1.50	91	18.0	1.80	90	14.2	2.43	83
22	21.7	2.35	89	20.8	2.49	88	22.4	3.34	85
	20.7	1.56	92	24.1	3.08	87	25.9	5.10	80
24	28.1	2.75	90	38.0	3.64	90	44.6	7.28	84
	21.2	1.91	91	34.6	3.35	90	43.7	9.90	78
26	16.7	1.26	92	19.3	2.27	88	21.1	3.13	85
	16.8	1.14	93	18.3	2.38	87	16.2	2.11	87
28	12.7	1.87	85	15.8	1.95	88	14.5	2.61	88
	15.4	1.53	90	16.0	2.02	87	14.5	3.07	79
30	21.7	1.80	92	19.9	2.12	89	16.3	2.32	86
	24.9	2.98	88	17.1	1.94	89	14.2	2.44	87
			Av 88 ± 4			Av 87 ± 3			Av 82 ± 3

ALTITUDE $(\text{ft}\times10^{-3})$	STAINLESS STEEL (302) Initial c/m $(\times10^{-4})$	STAINLESS STEEL (302) Final c/m $(\times10^{-4})$	STAINLESS STEEL (302) Per Cent Removal	STAINLESS STEEL (FFF) Initial c/m $(\times10^{-4})$	STAINLESS STEEL (FFF) Final c/m $(\times10^{-4})$	STAINLESS STEEL (FFF) Per Cent Removal	STAINLESS STEEL (FF) Initial c/m $(\times10^{-4})$	STAINLESS STEEL (FF) Final c/m $(\times10^{-4})$	STAINLESS STEEL (FF) Per Cent Removal
16	2.77	0.93	66	1.90	0.64	68	2.28	0.72	68
	2.21	0.78	65	2.39	0.72	70	1.80	0.78	57
18	8.49	1.91	77	10.4	2.58	75	10.5	3.53	67
	10.3	2.99	71	9.80	2.39	76	10.5	2.93	72
20	17.9	1.92	91	17.6	2.79	84	18.5	3.31	82
	16.2	2.11	97	15.8	2.62	83	16.5	3.69	78
22	17.5	3.50	80	31.7	7.36	77	30.2	10.0	67
	18.7	3.75	80	30.2	7.48	75	35.6	12.2	66
24	33.9	3.22	90	38.3	3.31	91	32.4	3.13	90
	28.1	2.35	92	33.4	3.14	91	34.4	4.97	86
26	20.5	3.74	82	20.8	3.24	89	20.5	5.25	74
	20.9	2.71	87	19.5	3.57	82	21.8	4.75	78
28	13.1	2.13	84	15.5	2.34	85	14.1	2.24	79
	14.4	2.45	83	16.8	2.96	82	12.1	2.22	82
30	12.7	1.45	89	16.2	2.01	88	15.3	2.11	86
	17.7	1.87	89	12.4	1.62	87	14.3	2.33	84
			Av 82 ± 7			Av 81 ± 6			Av 76 ± 8

[redacted]

TABLE C.3 MATERIALS EXPOSED BY USNRDL, GEORGE SHOT

Altitude (ft × 10^{-3})	Copper: Initial c/m (× 10^{-4})	Copper: Final c/m (× 10^{-4})	Copper: Per Cent Removal	Brass: Initial c/m (× 10^{-4})	Brass: Final c/m (× 10^{-4})	Brass: Per Cent Removal	Alclad Aluminum: Initial c/m (× 10^{-4})	Alclad Aluminum: Final c/m (× 10^{-4})	Alclad Aluminum: Per Cent Removal
24	22.4	8.17	64	12.2	3.30	73	6.39	1.21	81
	22.1	8.72	61	14.3	5.06	65	7.10	2.46	65
26	105	40.1	61	23.3	2.75	88	30.3	2.55	92
	26.6	6.65	75	34.3	9.40	73	31.8	3.32	90
28	33.9	7.68	77	69.6	10.9	84	19.1	3.19	83
	25.8	4.76	82	36.3	11.8	67	19.6	5.26	73
			Av 70 ± 8			Av 75 ± 7			Av 81 ± 8
	Stainless Steel			**OD Paint**			**Navy Paint**		
24	7.32	1.36	81	6.03	1.54	74	4.99	1.71	66
	8.93	2.22	75	8.09	2.03	75	6.46	1.84	78
26	27.1	1.27	95	31.7	3.60	89	23.8	1.81	92
	24.8	0.95	96	22.4	2.57	89	38.9	2.33	94
28	27.6	6.52	76	25.0	7.57	70	24.4	6.02	75
	23.5	4.97	79	15.2	2.62	83	17.3	4.74	73
			Av 84 ± 8			Av 80 ± [illegible]			Av 79 ± 10
	Clear Lacquer			**Sea-Blue Lacquer**			**Aluminized Paint**		
24	12.9	7.70	40	16.4	8.60	48	19.0	8.70	54
	25.5	15.6	39	12.4	8.20	34	12.1	3.60	70
26	91.3	9.90	89	81.7	9.50	88	47.1	4.00	92
	138	13.4	90	76.7	10.3	87	44.2	6.20	86
28	26.3	7.60	71	69.9	46.7	33	35.9	12.6	65
	59.4	33.4	44	49.7	33.3	33	32.7	9.40	71
			Av 62 ± 19			Av 54 ± 22			Av 73 ± 11
	Cellulose Acetate			**Melamine Resin**			**Silicone Resin**		
24	10.6	2.30	78	36.3	14.2	61	33.9	16.5	51
	8.90	2.40	73	42.0	20.3	52	25.6	8.78	66
26	41.1	1.70	96	47.1	8.00	83	50.9	5.90	88
	37.3	1.50	96	38.1	7.20	81	51.2	4.50	91
28	26.8	5.70	79	30.6	4.86	84	29.1	4.05	86
	19.6	3.60	82	25.4	4.63	88	30.8	6.12	80
			Av 84 ± 9			Av 74 ± 13			Av 77 ± 12
	GE Cocoon			**Stabond**			**Phenolic Varnish**		
24	58.0	47.9	17	63.3	41.1	35	28.4	11.7	59
	22.6	17.4	22	67.5	54.8	19	19.5	4.86	75
26	72.2	40.7	44	52.0	13.4	74	39.2	4.28	89
	69.8	20.0	71	47.4	11.5	76	64.8	19.6	70
28	31.4	21.2	32	35.4	12.6	64	23.5	3.71	84
	38.2	16.1	58	39.4	11.7	70	21.6	3.88	82
			Av 41 ± 7			Av 56 ± 19			Av 76 ± 9
	Acryloid Varnish			**Glass (Clear)**			**Glass (4x)**		
24	16.1	2.71	83	15.7	1.23	92	36.6	4.55	88
	12.3	2.63	79	18.8	2.22	88	45.3	4.84	89
26	25.7	1.80	93	36.6	0.95	97	30.4	1.80	94
	28.2	1.50	95	41.3	0.66	98	28.5	1.80	94
28	23.0	2.94	87	25.2	0.77	97	28.3	1.64	94
	21.0	3.27	84	30.6	0.97	97	33.7	2.32	93
			Av 87 ± 5			Av 95 ± 3			Av 92 ± 2

• [redacted]

[redacted]

TABLE C.3—*Continued*

ALTITUDE (ft × 10^{-3})	Initial c/m (× 10^{-4})	Final c/m (× 10^{-4})	Per Cent Removal	Initial c/m (× 10^{-4})	Final c/m (× 10^{-4})	Per Cent Removal	Initial c/m (× 10^{-4})	Final c/m (× 10^{-4})	Per Cent Removal
	GLASS (600)			GLASS (302)			GLASS (FFF)		
24	39.8	7.30	82	82.5	6.20	93	60.3	4.40	93
	43.5	8.00	82	50.3	10.6	79	45.3	7.80	83
26	32.2	2.40	93	33.4	2.10	94	36.1	1.58	96
	101	76.6	92	34.6	1.80	95	36.9	1.61	96
28	57.4	3.10	95	41.4	6.00	86	53.0	7.10	87
	28.5	4.40	85	27.1	1.80	94	16.5	1.30	92
			Av 88 ± 5			Av 90 ± 5			Av 91 ± 4
	NAVY PAINT (13.5%)			NAVY PAINT (31.8%)			NAVY PAINT (38.4%)		
24	26.3	11.7	56	34.0	7.20	79	41.0	6.90	83
	22.6	5.90	74	28.4	4.80	83	33.5	5.70	83
26	29.3	2.18	93	33.7	2.13	94	35.3	2.16	94
	36.0	2.28	94	35.4	2.49	93	34.2	2.30	93
28	36.7	3.90	89	31.2	4.01	87	37.1	7.60	80
	38.3	6.40	83	34.5	10.6	69	30.4	4.07	87
			Av 89 ± 11			Av 84 ± 7			Av 87 ± 5
	BRASS (415)			BRASS (630)			BRASS (805)		
24	18.0	6.26	65	23.1	9.57	59	18.0	6.18	66
	18.5	8.32	55	22.0	6.47	70	19.0	6.20	67
26	35.2	5.80	84	39.1	7.93	80	34.7	5.50	84
	35.3	5.55	84	35.6	7.97	78	32.4	4.94	85
28	49.4	9.79	80	42.5	8.00	81	38.3	2.69	80
	54.8	10.5	81	47.2	9.75	79	50.9	11.7	77
			Av 75 ± 10			Av 74 ± 7			Av 76 ± 7
	BRASS (1025)			STAINLESS STEEL (38)			STAINLESS STEEL (45)		
24	20.1	5.62	72	28.6	19.7	31	24.0	15.5	35
	18.4	4.79	74	25.7	15.6	39	36.1	24.4	32
26	35.0	8.03	77	40.5	16.3	60	54.3	22.0	59
	30.1	3.40	88	58.9	21.5	73	45.3	18.3	60
28	60.2	16.5	73	52.4	22.2	59	53.3	20.6	61
	101	35.1	65	57.5	23.0	60	63.7	26.5	58
			Av 75 ± 10			Av 52 ± 11			Av 51 ± 11
	STAINLESS STEEL (50)			STAINLESS STEEL (A)			STAINLESS STEEL (Q)		
24	31.3	24.7	21	18.8	12.1	36	33.9	21.7	36
	28.2	25.6	9	23.9	16.0	33	25.4	19.1	25
26	50.8	24.2	52	28.4	8.63	70	53.0	28.4	46
	64.4	27.4	57	28.1	9.84	65	47.8	24.9	48
28	50.4	21.5	57	38.2	8.80	77	48.5	24.9	49
	53.1	23.2	56	33.3	6.60	80	56.1	28.2	50
			Av 42 ± 18			Av 60 ± 17			Av 42 ± 8
	STAINLESS STEEL (CLEAR)			STAINLESS STEEL (4X)			STAINLESS STEEL (600)		
24	14.8	2.87	80	9.70	2.46	75	15.6	3.33	79
	12.8	1.41	89	18.3	3.07	83	7.74	3.23	58
26	15.9	6.48	59	27.3	2.15	92	24.9	2.85	89
	21.6	2.86	87	23.3	2.72	88	24.9	3.64	85
28	56.2	4.40	92	41.9	10.2	76	26.7	8.31	69
	39.8	6.40	84	29.9	6.26	79	31.2	9.41	70
			Av 82 ± 8			Av 82 ± 6			Av 75 ± 9

[redacted]

TABLE C.3—*Continued*

ALTITUDE (ft × 10^{-3})	STAINLESS STEEL (302) Initial c/m (× 10^{-4})	STAINLESS STEEL (302) Final c/m (× 10^{-4})	STAINLESS STEEL (302) Per Cent Removal	STAINLESS STEEL (FFF) Initial c/m (× 10^{-4})	STAINLESS STEEL (FFF) Final c/m (× 10^{-4})	STAINLESS STEEL (FFF) Per Cent Removal	STAINLESS STEEL (FF) Initial c/m (× 10^{-4})	STAINLESS STEEL (FF) Final c/m (× 10^{-4})	STAINLESS STEEL (FF) Per Cent Removal
24	18.8	7.34	61	19.9	8.04	60	17.2	9.38	45
	19.9	6.15	69	18.0	7.60	58	17.9	9.77	45
26	26.1	2.72	90	27.2	4.13	85	26.1	5.11	80
	30.1	3.43	89	27.3	6.01	78	27.2	3.32	88
28	31.0	6.75	78	29.9	7.82	74	40.2	13.4	67
	18.4	3.55	81	45.5	18.2	60	43.4	27.8	36
			Av 78 ± 9			Av 69 ± 10			Av 60 ± 18

C.2 MATERIALS EXPOSED BY ACC

The initial contamination (in counts per minute) and the residual contamination (in counts per minute) of the various materials exposed by the ACC, together with the per cent contamination removed and the per cent residual contamination, are reported in Tables C.4 to C.6. The value given for each quantity is the mean value from all the shots for a given surface having the stated properties. Decay corrections were made assuming the validity of the $t^{-1.2}$ law.

The results obtained by the ACC are arranged in (1) ascending order of original counts, (2) ascending order of residual counts, and (3) ascending order of per cent residual counts.

TABLE C.4 ASCENDING ORDER OF ORIGINAL COUNTS

RANK	SURFACE[a]	YOUDEN NUMBER	MATERIAL	ORIGINAL c/m (× 10^{-2})	PER CENT REMOVAL	RESIDUAL c/m (× 10^{-2})	PER CENT RESIDUAL
1	1211	32	Methyl methacrylate, low roughness	1,973	90.1	196	9.93
2	1331	16	Linoleum coated with paraffin, low roughness	2,474	80.6	481	19.4
3	1212	35	Methyl methacrylate, medium roughness	2,590	67.8	833	32.2
4	1113	29	Mirawal, porcelain enamel steel, high roughness	2,627	61.5	1,011	38.5
5	1321	26	Asphalt varnish, low roughness	2,879	82.5	504	17.5
6	1112	42	Mirawal, porcelain enamel steel, medium roughness	3,152	71.1	912	28.9
7	2232	5	Linoleum, benzene-washed to remove factory finish, medium roughness	3,195	64.3	1,140	35.7
8	1111	44	Mirawal, porcelain enamel steel, low roughness	3,418	90.4	327	9.57
9	1312	11	Aluminum, medium roughness	3,507	43.0	1,999	57.0
10	1213	31	Methyl methacrylate, high roughness	3,660	59.0	1,500	41.0
11	2122	12	Satinspred, interior paint, medium roughness	3,911	67.0	1,290	33.0
12	2311	25	Goodyear gray rubber tile, low roughness	4,005	56.2	1,754	43.8
13	2121	3	Satinspred, interior paint, low roughness	4,036	57.2	1,727	42.8
14	1322	20	Asphalt varnish, medium roughness	4,084	67.5	1,328	32.5
15	2231	43	Linoleum, benzene-washed to remove factory finish, low roughness	4,086	48.0	2,125	52.0

[a] Cf. Table 2.1.

[redacted]

TABLE C.4—*Continued*

RANK	SURFACE[a]	YOUDEN NUMBER	MATERIAL	ORIGINAL c/m ($\times 10^{-2}$)	PER CENT REMOVAL	RESIDUAL c/m ($\times 10^{-2}$)	PER CENT RESIDUAL
16	1121	17	Du Pont varnish, low roughness	4,148	64.1	1,489	35.9
17	1221	18	Clear metal lacquer, low roughness	4,194	87.9	507	12.1
18	1231	21	Linoleum, factory finish, low roughness	4,336	65.0	1,517	35.0
19	2322	30	Exterior graphite paint, medium roughness	4,465	60.9	1,746	39.1
20	1323	46	Asphalt varnish, high roughness	4,600	63.1	1,698	36.9
21	2323	38	Exterior graphite paint, high roughness	4,826	65.5	1,663	34.5
22	2321	33	Exterior graphite paint, low roughness	5,169	38.6	3,172	61.4
23	1311	41	Aluminum, low roughness	5,434	67.0	1,791	33.0
24	2221	40	OD paint, low roughness	5,704	64.0	2,054	36.0
25	1221	6	Clear metal lacquer, low roughness	6,642	66.5	2,222	33.5
26	2312	19	Goodyear gray rubber tile, medium roughness	6,656	73.9	1,736	26.1
27	2233	1	Linoleum, benzene-washed to remove factory finish, high roughness	6,800	63.5	2,483	36.5
28	2132	45	Fir plywood, medium roughness	6,826	64.4	2,433	35.6
29	2131	15	Fir plywood, low roughness	6,831	70.0	2,049	30.0
30	2123	24	Satinspred, interior paint, high roughness	7,163	49.2	3,639	50.8
31	2222	51	OD paint, medium roughness	7,259	56.5	3,158	43.5
32	1222	52	Clear metal lacquer, medium roughness	7,313	69.5	2,234	30.5
33	2313	8	Goodyear gray rubber tile, high roughness	7,353	60.5	2,901	39.5
34	2211	49	Navy Cocoon strippable coating, low roughness	7,508	68.2	2,384	31.8
35	1332	7	Asphalt-saturated felt, medium roughness	7,940	62.8	2,946	37.2
36	1122	28	Du Pont varnish, medium roughness	8,944	64.3	3,192	35.7
37	2133	10	Fir plywood, high roughness	8,950	68.9	2,785	31.1
38	2212	14	Navy Cocoon strippable coating, medium roughness	9,004	65.2	3,129	34.8
39	1123	53	Du Pont varnish, high roughness	9,047	68.1	2,883	31.9
40	2333	39	Canvas ducking, high roughness	9,250	64.2	3,406	35.8
41	1313	27	Aluminum, high roughness	10,374	62.5	3,892	37.5
42	1133	50	Glass cloth, high roughness	10,617	75.4	2,614	24.6
43	2223	9	OD paint, high roughness	12,222	57.2	5,236	42.8
44	1333	36	Air Force overcoat wool, high roughness	14,532	55.2	6,506	44.8
45	2213	2	Navy Cocoon strippable coating, high roughness	18,320	70.9	5,335	29.1

[a] Cf. Table 2.1.

TABLE C.5 ASCENDING ORDER OF RESIDUAL COUNTS

RANK	SURFACE[a]	YOUDEN NUMBER	MATERIAL	ORIGINAL c/m ($\times 10^{-2}$)	PER CENT REMOVAL	RESIDUAL c/m ($\times 10^{-2}$)	PER CENT RESIDUAL
1	1211	32	Methyl methacrylate, low roughness	1,973	90.1	196	9.93
2	1111	44	Mirawal, porcelain enamel steel, low roughness	3,418	90.4	327	9.57
3	1331	16	Linoleum coated with paraffin, low roughness	2,474	80.6	481	19.4
4	1321	26	Asphalt varnish, low roughness	2,879	82.5	504	17.5
5	1221	18	Clear metal lacquer, low roughness	4,194	87.9	507	12.1
6	1212	35	Methyl methacrylate, medium roughness	2,590	67.8	833	32.2

[a] Cf. Table 2.1.

[redacted]

[redacted]

TABLE C.5—*Continued*

RANK	SURFACE[a]	YOUDEN NUMBER	MATERIAL	ORIGINAL c/m ($\times 10^{-2}$)	PER CENT REMOVAL	RESIDUAL c/m ($\times 10^{-2}$)	PER CENT RESIDUAL
7	1112	42	Mirawal, porcelain enamel steel, medium roughness	3,152	71.1	912	28.9
8	1113	29	Mirawal, porcelain enamel steel, high roughness	2,627	61.5	1,011	38.5
9	2232	5	Linoleum, benzene-washed to remove factory finish, medium roughness	3,195	64.3	1,140	35.7
10	2122	12	Satinspred, interior paint, medium roughness	3,911	67.0	1,290	33.0
11	1322	20	Asphalt varnish, medium roughness	4,084	67.5	1,328	32.5
12	1121	17	Du Pont varnish, low roughness	4,148	64.1	1,489	35.9
13	1213	31	Methyl methacrylate, high roughness	3,660	59.0	1,500	41.0
14	1231	21	Linoleum, factory finish, low roughness	4,336	65.0	1,517	35.0
15	2323	38	Exterior graphite paint, high roughness	4,826	65.5	1,663	34.5
16	1323	46	Asphalt varnish, high roughness	4,600	63.1	1,698	36.9
17	2121	3	Satinspred, interior paint, low roughness	4,036	57.2	1,727	42.8
18	2312	19	Goodyear gray rubber tile, medium roughness	6,656	73.9	1,736	26.1
19	2322	30	Exterior graphite paint, medium roughness	4,465	60.9	1,746	39.1
20	2311	25	Goodyear gray rubber tile, low roughness	4,005	56.2	1,754	43.8
21	1311	41	Aluminum, low roughness	5,434	67.0	1,791	33.0
22	1312	11	Aluminum, medium roughness	3,507	43.0	1,999	57.0
23	2131	15	Fir plywood, low roughness	6,831	70.0	2,049	30.0
24	2221	40	OD paint, low roughness	5,704	64.0	2,054	36.0
25	2231	43	Linoleum, benzene-washed to remove factory finish, low roughness	4,086	48.0	2,125	52.0
26	1221	6	Clear metal lacquer, low roughness	6,642	66.5	2,222	33.5
27	1222	52	Clear metal lacquer, medium roughness	7,313	69.5	2,234	30.5
28	2211	49	Navy Cocoon strippable coating, low roughness	7,508	68.2	2,384	31.8
29	2132	45	Fir plywood, medium roughness	6,826	64.4	2,433	35.6
30	2233	1	Linoleum, benzene-washed to remove factory finish, high roughness	6,800	63.5	2,483	36.5
31	1133	50	Glass cloth, high roughness	10,617	75.4	2,614	24.6
32	2133	10	Fir plywood, high roughness	8,950	68.9	2,785	31.1
33	1123	53	Du Pont varnish, high roughness	9,047	68.1	2,883	31.9
34	2313	8	Goodyear gray rubber tile, high roughness	7,353	60.5	2,901	39.5
35	1332	7	Asphalt-saturated felt, medium roughness	7,940	62.8	2,946	37.2
36	2212	14	Navy Cocoon strippable coating, medium roughness	9,004	65.2	3,129	34.8
37	2222	51	OD paint, medium roughness	7,259	56.5	3,158	43.5
38	2321	33	Exterior graphite paint, low roughness	5,169	38.6	3,172	61.4
39	1122	28	Du Pont varnish, medium roughness	8,944	64.3	3,192	35.7
40	2333	39	Canvas ducking, high roughness	9,250	64.2	3,406	35.8
41	2123	24	Satinspred, interior paint, high roughness	7,163	49.2	3,639	50.8
42	1313	27	Aluminum, high roughness	10,374	62.5	3,892	37.5
43	2223	9	OD paint, high roughness	12,222	57.2	5,236	42.8
44	2213	2	Navy Cocoon strippable coating, high roughness	18,320	70.9	5,335	29.1
45	1333	36	Air Force overcoat wool, high roughness	14,532	55.2	6,506	44.8

[a] Cf. Table 2.1.

[redacted]

[redacted]

Table C.6 ASCENDING ORDER OF PER CENT RESIDUAL COUNTS

Rank	Surface[a]	Youden number	Material	Original c/m (×10⁻²)	Per cent removal	Residual c/m (×10⁻²)	Per cent residual
1	1111	44	Mirawal, porcelain enamel steel, low roughness	3,418	90.4	327	9.57
2	1211	32	Methyl methacrylate, low roughness	1,973	90.1	196	9.93
3	1221	18	Clear metal lacquer, low roughness	4,194	87.9	507	12.1
4	1321	26	Asphalt varnish, low roughness	2,879	82.5	504	17.5
5	1331	16	Linoleum coated with paraffin, low roughness	2,474	80.6	481	19.4
6	1133	50	Glass cloth, high roughness	10,617	75.4	2,614	24.6
7	2312	19	Goodyear gray rubber tile, medium roughness	6,656	73.9	1,736	26.1
8	1112	42	Mirawal, porcelain enamel steel, medium roughness	3,152	71.1	912	28.9
9	2213	2	Navy Cocoon strippable coating, high roughness	18,320	70.9	5,335	29.1
10	2131	15	Fir plywood, low roughness	6,831	70.0	2,049	30.0
11	1222	52	Clear metal lacquer, medium roughness	7,313	69.5	2,234	30.5
12	2133	10	Fir plywood, high roughness	8,950	68.9	2,785	31.1
13	2211	49	Navy Cocoon strippable coating, low roughness	7,508	68.2	2,384	31.8
14	1123	53	Du Pont varnish, high roughness	9,047	68.1	2,883	31.9
15	1212	35	Methyl methacrylate, medium roughness	2,590	67.8	833	32.2
16	1322	20	Asphalt varnish, medium roughness	4,084	67.5	1,328	32.5
17	1311	41	Aluminum, low roughness	5,434	67.0	1,791	33.0
18	2122	12	Satinspred, interior paint, medium roughness	3,911	67.0	1,290	33.0
19	1221	6	Clear metal lacquer, low roughness	6,642	66.5	2,222	33.5
20	2323	38	Exterior graphite paint, high roughness	4,826	65.5	1,663	34.5
21	2212	14	Navy Cocoon strippable coating, medium roughness	9,004	65.2	3,129	34.8
22	1231	21	Linoleum, factory finish, low roughness	4,336	65.0	1,517	35.0
23	2132	45	Fir plywood, medium roughness	6,826	64.4	2,433	35.6
24	2232	5	Linoleum, benzene-washed to remove factory finish, medium roughness	3,195	64.3	1,140	35.7
25	1122	28	Du Pont varnish, medium roughness	8,944	64.3	3,192	35.7
26	2333	39	Canvas ducking, high roughness	9,250	64.2	3,406	35.8
27	1121	17	Du Pont varnish, low roughness	4,148	64.1	1,489	35.9
28	2221	40	OD paint, low roughness	5,704	64.0	2,054	36.0
29	2233	1	Linoleum, benzene-washed to remove factory finish, high roughness	6,800	63.5	2,483	36.5
30	1323	46	Asphalt varnish, high roughness	4,600	63.1	1,698	36.9
31	1332	7	Asphalt-saturated felt, medium roughness	7,940	62.8	2,946	37.2
32	1313	27	Aluminum, high roughness	10,374	62.5	3,892	37.5
33	1113	29	Mirawal, porcelain enamel steel, high roughness	2,627	61.5	1,011	38.5
34	2322	30	Exterior graphite paint, medium roughness	4,465	60.9	1,746	39.1
35	2313	8	Goodyear gray rubber tile, high roughness	7,353	60.5	2,901	39.5
36	1213	31	Methyl methacrylate, high roughness	3,660	59.0	1,500	41.0
37	2121	3	Satinspred, interior paint, low roughness	4,036	57.2	1,727	42.8
38	2223	9	OD paint, high roughness	12,222	57.2	5,236	42.8
39	2222	51	OD paint, medium roughness	7,259	56.5	3,158	43.5
40	2311	25	Goodyear gray rubber tile, low roughness	4,005	56.2	1,754	43.8
41	1333	36	Air Force overcoat wool, high roughness	14,532	55.2	6,506	44.8
42	2123	24	Satinspred, interior paint, high roughness	7,163	49.2	3,639	50.8
43	2231	43	Linoleum, benzene-washed to remove factory finish, low roughness	4,086	48.0	2,125	52.0
44	1312	11	Aluminum, medium roughness	3,507	43.0	1,999	57.0
45	2321	33	Exterior graphite paint, low roughness	5,169	38.6	3,172	61.4

[a] Cf. Table 2.1.

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Appendix D

Contamination-Decontamination Related to Surface Characteristics

D.1 FABRICATION AND MEASUREMENT OF TEST SURFACES

Since time limitations prohibited an extensive study of methods of measuring these characteristics, a practical approach was made to the problem by the National Bureau of Standards in conjunction with the ACC to determine the surface characteristics as follows:

1. Porosity

Inasmuch as materials involved in buildings, machinery, etc., vary widely in this characteristic, it was decided to group materials into three classes based on general knowledge of the materials. Materials such as metals, plastics, porcelain enamels, rubber tile, and certain sprayed coatings (because they are put down in numerous very thin coatings) were considered essentially nonporous. Films obtained by solvent evaporation, such as paint films, were considered moderately porous.

2. Surface Roughness

Surface roughness was also considered a characteristic that varies greatly in practice, and a visual inspection was used to divide materials into three classes.

Paint, varnish, and lacquer films were obtained in three degrees of roughness. Smooth surfaces were obtained by simply brushing the material on a metal surface. Moderately rough surfaces were prepared by applying a single coat of the material to a metal, covering the wet film with a layer of sand that had been screened to pass a No. 80 sieve but to remain on a No. 100 sieve, shaking off the excess sand, and covering the sand with two layers of the paint, etc. Some difficulty was experienced with this technique in some finishes; lacquer, for example, dried too rapidly to permit a smooth coating of sand to stick to the surface. This difficulty was overcome by using a different material to hold the sand, but the selection of the proper material was sometimes difficult because the second coat of the desired surface coating would exert a lifting action on the coating that held the sand. Rough surfaces were obtained by the same method as used for moderately rough surfaces but employing coarser sand, 40 to 60 mesh.

The porcelain enamels were obtained in three surface roughnesses by a somewhat similar technique. Experiments carried out with the Pemco Corporation and the Baltimore Porcelain Steel Company developed a method of incorporating sand of the desired size in the enamel before firing and made it possible to obtain porcelain enamels of the desired roughness. The first two degrees of roughness were obtained on rubber-tile surfaces by means of a sanding wheel. The coarse roughness on rubber tile was obtained by forcing a 40-mesh screen into the surface with a hydraulic press.

3. Surface Retentivity

This surface feature presented another problem in measurement. The action of the material in absorbing or not absorbing dye was used to classify the material as retentive or nonretentive. Although there might have been some instances of specific adsorption, it was thought that this measurement would bear some relation to the adsorption of radio-

[redacted]

active particles. Fluorescein was chosen as the dye, but experiments with other dyes gave the same relative results. The material to be tested was scrubbed with a water solution of the dye and then thoroughly rinsed. A rough quantitative measure of the amount of adsorption was determined by noting the distance at which fluorescence became visible, in centimeters, from an ultra-violet light source.

4. Hydrophilic-Hydrophobic Nature

The hydrophilic-hydrophobic nature of the surface was measured by applying a drop of distilled water to the surface under consideration and projecting the image of the contact angle onto a calibrated screen. Care was taken to obtain the advancing angle because it seemed important to consider the nature of the dry surface rather than the surface covered with a film of water. The materials were arbitrarily divided into three classes: (a) materials with contact angles of less than 40 deg, (b) materials with contact angles between 60 to 70 deg, and (c) materials with contact angles greater than 80 deg.

D.2 STATISTICAL ANALYSIS OF DATA

D.2.1 Variance Due to Surface Characteristics Taken Individually

To test for significant differences in variances between the three levels of porosity, roughness, and contact angle and the two levels of retentivity, the Student's t test was utilized to compare the levels within any one characteristic. The following two examples illustrate the technique followed.

To test the variance of the residual contamination due to low, medium, and high porosity, Tables D.1 and D.2 were prepared. In these tables:

P—porosity; R—roughness; L—low; M—medium; H—high

N—number of surfaces tested

$\bar{X}$—arithmetic mean of characteristic X (e.g., of porosity P, of roughness R)

XX—two characteristics being compared for significance of difference (e.g., P_MP_H or R_LR_H)

ΣX—sum, in hundreds of counts, of the residual activity on all surfaces of characteristic X

ΣX^2—sum of the squares, in hundreds of counts, of the residual activity on all surfaces of characteristic X

d.f.—degrees of freedom

p—probability of a t occurring by chance. If
$0.15>p>0.10$, the difference is significant,
$0.10>p>0.05$, the difference is highly significant,
$0.05>p>0.00$, the difference is very highly significant.

TABLE D.1 POROSITY VARIANCE FOR RESIDUAL CONTAMINATION

	ΣP	ΣP^2	N	$\bar{P}$
P_L	29,700	46,123,482	45	660
P_M	39,742	66,070,180	54	736
P_H	30,485	49,084,697	36	847

TABLE D.2 STUDENT'S t TEST

	t	d. f.	p	CONCLUSION
P_LP_M	0.353	97	$0.40>p>0.35$	No significant difference
P_MP_H	0.456	88	$0.35>p>0.30$	No significant difference
P_LP_H	0.956	79	$0.20>p>0.15$	No significant difference

From this test it may be concluded that the variances in porosity are not significant enough to be able to be called a *major* factor affecting the residual contamination. However, the numbers under $\bar{P}$ in Table D.1 indicate a trend, i.e., increase in porosity is accompanied by increase in residual contamination.

The second example investigates the variances of residual contamination on surfaces of low, medium, and high roughness. The t test led to Tables D.3 and D.4 (see above for explanation of symbols):

Table D.3 ROUGHNESS VARIANCE FOR RESIDUAL CONTAMINATION

	ΣR	ΣP^2	N	$\bar{R}$
R_L	22,077	28,038,157	45	491
R_M	28,064	36,652,186	42	668
R_H	49,786	96,718,016	48	1,037

Table D.4 STUDENT'S t TEST

	t	$d.f.$	p	Conclusion
R_LR_M	0.956	85	$0.20>p>0.15$	No significant difference
R_MR_H	1.432	88	$0.10>p>0.05$	Highly significant differences
R_LR_H	2.271	91	$0.01>p>0.005$	Very highly significant differences

From this test it may be concluded that the variances in surface roughness appear to be significant enough to be called major factors affecting residual contamination, particularly the difference between medium and high roughness. One way to express this relationship would be to say that residual contamination varies with roughness (from low to medium to high) in the ratio of 1 to 1.36 to 2.11, meaning that for every unit count of residual contamination on a low-roughness surface there would be 1.36 counts on a medium-rough surface and 2.11 counts on a surface of high roughness.

Following this plan of attack, conclusions pertinent to surface parameters taken individually were obtained.

D.2.2 Variance due to Surface Characteristics Interaction

An investigation was made of all possible combinations of the four surface characteristics to determine whether or not an "interaction" occurs between characteristics which significantly affect initial contamination, per cent decontamination, and residual contamination.

The variance within any pair of characteristics taken together was ascertained. For example, the variance due to the combined characteristics of low roughness and nonretentivity for the same surface was determined. From this result the variance due to *each* individual characteristic was eliminated, the resulting figure being the variance due to an "interaction" of the two. As an example, the ratio for initial contamination of low-porosity to high-porosity surfaces was 1 to 1.21 (see Table 3.8) and for nonretentive to retentive surfaces was 1 to 1.25, so that the initial contamination of low-porosity–nonretentive surfaces compared with that of high-porosity–retentive surfaces would be expected to be in the ratio (1)(1) to (1.21)(1.25) or 1 to 1.51. From Sec. F.1 the determined ratio of initial contamination between low-porosity–nonretentive surfaces and high-porosity–retentive surfaces is 1,360 to 2,200, or 1 to 1.62. The difference between the ratios 1 to 1.62 and 1 to 1.51, i.e., 0.11, is the variance due to the interaction between the pairs of characteristics being investigated. Is it due to an interaction between porosity and retentivity or merely a normal statistical variance? Bartlett's test for homogeneity of several estimates of variance was used to answer questions of this type. If no significant variances were found between the possible combinations within a group, for example, the six possible combinations of three degrees of roughness and three degrees of retentivity, there was no interaction between the characteristics. If there was a significant difference, the possibilities within the group were investigated by examination of smaller groups. If the smaller group consisted of two factors only, Student's t test was used.

The following test for interaction between roughness and retentivity for significant differences in per cent of decontamination will serve as an example.

Explanation of Table D.5:

i=characteristics being compared for significance of variance

S_i^2=variance between i due to interaction
F_i=degree of freedom of characteristics i
k=number of groups tested for "interaction" variance
S'^2=variance of all groups
C=chi-square coefficient from degrees of freedom
χ^2=chi-square test for significance
p=probability of a greater value than χ^2 occurring
T=retentive
T_N=nonretentive

$$S'^2=\frac{\Sigma(F_iS_i^2)}{\Sigma F_i}=107.4$$

$$C=1+\frac{1}{3(k-1)}\left(\sum\frac{1}{F_i}-\frac{1}{\Sigma F_i}\right)=1.12$$

$$\chi^2=\frac{1}{C}\left[(\Sigma F_i)\ln S'^2-\Sigma(F_i\ln S_i^2)\right]=2.88$$

TABLE D.5 BARTLETT'S TEST OF HOMOGENEITY OF SEVERAL VARIANCES

(Test for Interaction Variances Between Roughness and Retentivity)

i	S_i^2	F_i	$F_iS_i^2$	ln S_i^2	F_i ln S_i^2
R_LT_N	95	23	2,185	4.55388	104.7
R_MT_N	137	20	2,740	4.91998	98.4
R_HT_N	104	23	2,392	4.64439	106.8
R_LT	133	20	2,660	4.89035	97.8
R_MT	63	20	1,260	4.14313	82.9
R_HT	114	23	2,622	4.73620	108.9
Sum		129	13,859	27.88793	599.6

By reference to a chi-square table it is determined that $80>p>70$, and therefore there is no significant variance. Hence the six variances may be regarded as homogeneous.

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Appendix E

Contamination-Decontamination Related to Surface Characteristics

E.1 DERIVED DATA FROM DOG, EASY, GEORGE, AND ITEM SHOTS

Tables E.1 to E.4 give the data derived in the contamination-decontamination studies related to surface characteristics of the materials exposed in the Dog, Easy, George, and Item Shots.

In each table the following code system is used for the decontaminating agents employed:

No.	*Agent*	*No.*	*Agent*
1	Triton B1956	7	Ethofat 242/25
2	Breeze	8	TSPP
3	Sequestrene AA	9	Blendene
4	Ethomeen 18/25	10	Chlorsol
5	Versene	11	Tergitol P-28
6	Ethomid HT/60	12	Aresklene 400

Information on these decontaminating agents, and the concentrations in which they were used, is given in Table 2.2.

Table 2.1 should be consulted for the actual surfaces corresponding to the numbers given under the heading Youden Square Index Number in each table.

TABLE E.1 DOG SHOT DATA

DRONE ALTITUDE ($ft \times 10^{-3}$)	DECON. AGENT (Code No.)	READING	ACTIVITY (CORRECTED) ($c/m \times 10^{-3}$) Youden Square Index Number							
			1	2	3	4	5	6	7	8
16	8	Initial	2,580		1,380	5,810	2,860	1,420	2,440	4,290
		Final	922		824	1,450	935	122	1,120	700
18	7	Initial	1,150	1,870		11,000		1,250	6,210	
		Final	834	739		2,850		362	3,650	
20	6	Initial		3,520		858	109	368	989	1,260
		Final		1,010		308	77	97	472	660
22	5	Initial	226	2,040	348				1,010	806
		Final	37	397	44				319	152
24	4	Initial	91	1,360	86	321			412	154
		Final	39	719	68	182			180	46
26	3	Initial	184	1,720	98		87	280	2,930	351
		Final	84	490	35		66	75	395	235
28	2	Initial	426	8,410			355	643	1,440	694
		Final	202	855			146	108	457	165
30	1	Initial	173		110	607		279	423	
		Final	132		97	550		69	255	

[redacted]

TABLE E.1—*Continued*

DRONE ALTITUDE (ft × 10^{-3})	DECON. AGENT (Code No.)	READING	ACTIVITY (CORRECTED) (c/m × 10^{-2}) Youden Square Index Number							
			9	10	11	12	13	14	15	16
16	8	Initial	5,720	7,140	1,260	2,350	1,200		5,720	800
		Final	867	1,870	703	1,270	1,260		1,790	314
18	7	Initial		2,970	3,450	2,030	4,680	3,660	6,180	
		Final		1,730	2,880	1,640	1,450	2,640	1,720	
20	6	Initial	1,000	1,360	163		199	924	513	
		Final	279	629	74		68	547	138	
22	5	Initial	1,090	1,720	255	323				172
		Final	178	440	54	47				40
24	4	Initial	432	556	83	141	39	1,230	312	55
		Final	230	315	42	111	19	241	156	18
26	3	Initial	710	765	141	140	127	459	406	118
		Final	297	264	129	97	29	307	54	44
28	2	Initial		2,250			219			
		Final		648			90			
30	1	Initial	480				114	722	854	
		Final	329				82	258	405	

DRONE ALTITUDE (ft × 10^{-3})	DECON. AGENT (Code No.)	READING	17	18	19	20	21	22	23	24
16	8	Initial		1,590	3,290	1,460		2,300	2,700	3,630
		Final		115	630	228		139	1,140	703
18	7	Initial		4,410	5,930			1,320	3,450	5,270
		Final		855	1,310			503	2,020	3,260
20	6	Initial	128	210	674	175	92	340		513
		Final	64	49	136	49	45	223		414
22	5	Initial	125	203	498	206	152	297	501	532
		Final	12	13	55	30	23	31	26	76
24	4	Initial	60					124	244	181
		Final	22					42	113	75
26	3	Initial	96	154	2,310		104		349	306
		Final	43	30	219		21		75	197
28	2	Initial	233	239	811		179		1,100	
		Final	65	36	117		99		183	
30	1	Initial	65	114	436	1,060	151	207	412	433
		Final	42	44	259	46	106	129	213	329

DRONE ALTITUDE (ft × 10^{-3})	DECON. AGENT (Code No.)	READING	25	26	27	28	29	30	31	32
16	8	Initial	2,320	1,300	3,600		4,070	2,760	936	
		Final	250	246	1,910		1,130	187	165	
18	7	Initial	5,840	608	5,410		2,110	3,140		509
		Final	2,050	144	2,930		1,730	1,230		24
20	6	Initial	159	402	286	565	355	274	201	133
		Final	51	92	172	150	132	164	172	5
22	5	Initial	149	225	320	488	453	234	190	232
		Final	11	39	76	50	13	11	20	7
24	4	Initial	36	82	141	250	237	122	59	52
		Final	15	39	112	74	117	24	32	8
26	3	Initial	135	144	188		380		166	192
		Final	17	28	130		54		49	13
28	2	Initial		248	951					302
		Final		31	330					25
30	1	Initial			238		314	350		
		Final			188		142	219		

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TABLE E.1—*Continued*

DRONE ALTITUDE (ft × 10⁻³)	DECON. AGENT (Code No.)	READING	ACTIVITY (CORRECTED) (c/m × 10⁻²) Youden Square Index Number							
			33	34	35	36	37	38	39	40
16	8	Initial			1,840	7,600	2,200	2,550	5,930	
		Final			250	3,950	365	228	3,540	
18	7	Initial	1,100	1,780				1,850	2,660	
		Final	629	1,020				1,250	629	
20	6	Initial	320		155	2,820		329	1,780	204
		Final	230		49	9,830		260	950	78
22	5	Initial	297				1,830	346	2,200	142
		Final	21				22	34	678	13
24	4	Initial	185	154	68		81		625	52
		Final	46	119	27		35		247	30
26	3	Initial	285	100		1,610	124	215	734	
		Final	96	28		488	55	112	347	
28	2	Initial		302	261			497		343
		Final		145	66			207		157
30	1	Initial	356	168			134	393		228
		Final	210	102			11	154		111

DRONE ALTITUDE (ft × 10⁻³)	DECON. AGENT (Code No.)	READING	41	42	43	44	45	46	47	48
16	8	Initial	1,020	2,000	1,030		6,610		6,460	2,910
		Final	135	758	253		1,600		245	2,070
18	7	Initial		4,370	237	5,430	3,050	959		
		Final		1,400	212	310	2,370	820		
20	6	Initial	311	189	156	200	1,130	172		368
		Final	153	56	74	479	473	48		131
22	5	Initial	152	192	162	380	958	338	1,010	
		Final	20	48	13	21	145	66	102	
24	4	Initial	80	109			446	78	568	173
		Final	40	55			226	30	161	49
26	3	Initial	145	488	886	133		183	6,710	
		Final	66	246	100	12		82	204	
28	2	Initial	382	381			1,570	331		517
		Final	103	74			499	89		289
30	1	Initial	92		88		674			327
		Final	52		57		299			132

DRONE ALTITUDE (ft × 10⁻³)	DECON. AGENT (Code No.)	READING	49	50	51	52	53	54	55	56	57
16	8	Initial	4,790	8,760	2,490		4,250			4,050	
		Final	670	670	328		3,370			1,700	
18	7	Initial	1,290	6,900	6,230	6,040		1,670	3,520		4,290
		Final	826	2,180	2,040	1,570		926	2,760		846
20	6	Initial	522	1,650	709	757	803	806		878	146
		Final	76	337	575	179	258	256		120	29
22	5	Initial				590	596	831	816	261	312
		Final				24	53	117	285	172	65
24	4	Initial	124		234		207	544	307		47
		Final	35		150		61	221	182		10
26	3	Initial	400	738	384	410	408	338		287	155
		Final	135	113	168	79	131	93		121	31
28	2	Initial	2,010	1,750	921	557	899			576	329
		Final	296	393	149	80	463			269	52
30	1	Initial	632	1,050	246	249		663		253	142
		Final	321	309	148	96		272		171	48

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TABLE E.2 EASY SHOT DATA

ACTIVITY (CORRECTED) (c/m × 10^{-3}) — Youden Square Index Number

DRONE ALTITUDE (ft × 10^{-3})	DECON. AGENT (Code No.)	READING	1	2	3	4	5	6	7
16	4	Initial	108	573	93	294	90		353
		Final	33	175	71	161	47		138
18	3	Initial	435	3,880	310	133	226	343	1,800
		Final	172	808	112	149	63	69	504
20	2	Initial	935– 858	4,010	720	290	745	1,460	2,720–2,690
		Final	180– 210	2,640	232	660	216	245	853–1,150
22	1	Initial	167		1,760	4,590	342	263	4,250
		Final	107		539	1,340	924	1,210	1,350
24	12	Initial	1,600–2,000			3,660		2,390	2,770–3,900
		Final	1,000– 739			1,160		332	1,030–1,060
26	10	Initial	1,080–1,100	2,590	1,050	2,160	933	1,730	2,170
		Final	370– 350	1,940	232	508	330	308	1,180
28	11	Initial	442			1,480	456	1,200	1,700
		Final	138			700	180	308	961
30	9	Initial	9,030	10,500	541	3,220	646	2,020	2,640
		Final	407	484	121	602	415	435	1,900

DRONE ALTITUDE (ft × 10^{-3})	DECON. AGENT (Code No.)	READING	8	9	10	11	12	13	14
16	4	Initial				84		43	769
		Final				51		19	181
18	3	Initial	822	1,730	1,340	389			4,000
		Final	73	536	563	107			723
20	2	Initial	1,970	2,640	3,340	694	1,070	787	3,640
		Final	493	977	657	167	400	290	1,230
22	1	Initial	2,270	5,100		1,990	1,970	1,920	
		Final	528	2,090		1,170	717	716	
24	12	Initial	2,650		2,840	1,110	1,990	1,930	
		Final	829		1,140	453	631	668	
26	10	Initial			2,050	1,220	1,560	981	4,020
		Final			831	320	443	362	1,010
28	11	Initial	1,280		2,750		793	723	2,310
		Final	486		810		231	168	712
30	9	Initial	2,200	2,200	2,490	1,210	769	1,410	
		Final	944	1,450	402	631	210	261	

DRONE ALTITUDE (ft × 10^{-3})	DECON. AGENT (Code No.)	READING	15	16	17	18	19	20	21
16	4	Initial	214			52	233	64	
		Final	72			15	37	30	
18	3	Initial	975	433	277	445– 489	1,060	348	
		Final	263	104	44	41– 14	105	22	
20	2	Initial	1,370	760	603	737– 696	1,343	839	765
		Final	167	209	127	116– 88	137	99	169
22	1	Initial	4,040	1,240		1,360–1,510	2,960	1,280	1,270
		Final	1,460	259		496– 381	261	158	372
24	12	Initial				1,150–1,690	2,540	1,570	1,690
		Final				74– 256	620	410	646
26	10	Initial	2,100	1,550	1,480	1,740–1,240	1,600	1,090	1,040
		Final	301	277	123	50– 115	180	75	121
28	11	Initial	875	512	521	957– 846	1,590	396	446
		Final	244	139	48	126– 79	260	148	80
30	9	Initial	2,370		770	1,320	2,330	669	
		Final	1,400		399	78	470	222	

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Table E.2—*Continued*

Drone Altitude ($ft \times 10^{-3}$)	Decon. Agent (Code No.)	Reading	Activity (corrected) ($c/m \times 10^{-3}$) Youden Square Index Number						
			22	23	24	25	26	27	28
16	4	Initial		192– 297		50	57	130	197
		Final		140– 136		23	32	87	77
18	3	Initial		1,000				557	828
		Final		84				103	129
20	2	Initial	1,039	1,440–1,880	1,460	615	1,060	1,310	1,750
		Final	291	281– 475	469	107	70	479	433
22	1	Initial	2,570	3,000	3,830	1,120			3,110
		Final	1,320	1,230	2,020	227			1,250
24	12	Initial	2,230	2,760–2,930		1,050		2,380	2,510
		Final	780	681– 812		326		1,180	677
26	10	Initial	1,950	1,820–1,780	1,860	976	1,320	1,640	1,740
		Final	315	304– 358	561	142	305	563	490
28	11	Initial		1,430	1,050	463	657		1,020
		Final		393	514	161	276		409
30	9	Initial	817	1,810		524	1,450	1,730	1,960
		Final	353	600		132	279	1,150	623
			29	30	31	32	33	34	35
16	4	Initial		159	98	151	197		
		Final		20	46	7	21		
18	3	Initial	839	472	381	394	802		268
		Final	42	154	78	22	435		66
20	2	Initial	1,370	1,350	993	825	1,410		946
		Final	109	233	202	91	280		236
22	1	Initial		2,170	1,930	1,120	1,820		1,100
		Final		764	986	124	1,190		367
24	12	Initial	2,200	1,510			1,830		1,170
		Final	258	512			777		300
26	10	Initial	1,820	1,160					
		Final	190	338					
28	11	Initial		460	594	509		335	659
		Final		228	143	35		125	100
30	9	Initial	1,370		1,080	967		383	1,010
		Final	102		474	18		151	303
			36	37	38	39	40	41	42
16	4	Initial		51		652	49		73
		Final		34		329	22		47
18	3	Initial				2,920	376		378
		Final				699	65		26
20	2	Initial	7,770	600	1,190	3,270	6,530	1,580	640
		Final	1,720	114	280	1,110	2,260	150	93
22	1	Initial		1,260		2,730–3,460	1,660	1,340	
		Final		371		463–2,420	648	411	
24	12	Initial	4,180	1,050	2,160	3,490	2,580	1,540	1,980
		Final	2,910	287	600	1,400	568	195	173
26	10	Initial		2,030	1,300	1,010	1,060	1,350	1,370
		Final		188	446	870	126	84	102
28	11	Initial	5,220	587	692	3,190	565	1,080	
		Final	1,500	187	273	1,180	88	85	
30	9	Initial			1,220	3,930		810	735
		Final			299	2,400		87	76

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TABLE E.2—*Continued*

DRONE ALTITUDE (ft × 10⁻³)	DECON. AGENT (Code No.)	READING	ACTIVITY (CORRECTED) (c/m × 10⁻²) Youden Square Index Number						
			43	44	45	46	47	48	49
16	4	Initial	70	47– 37	336	78		165– 152	
		Final	23	27– 24	113	7		78– 69	
18	3	Initial	244		1,620	570		744–1,400	1,020
		Final	96		417	85		182– 34	27
20	2	Initial	1,069	601– 703	2,130		7,910	1,900–2,110	1,620
		Final	157	42– 47	506		552	495– 480	388
22	1	Initial	1,260	4,020				2,320	3,270–2,210
		Final	726	913				532	1,130– 859
24	12	Initial	1,350	1,160–2,570	2,210		2,990	3,440	
		Final	403	71– 68	715		618	843	
26	10	Initial		976		1,310	2,300	1,520–1,900	2,280
		Final		30		297	376	525– 501	705
28	11	Initial	462	688		412	3,550	1,980–1,480	1,270
		Final	119	52		202	528	485– 406	564
30	9	Initial		941	2,380	833		2,490	1,400
		Final		30	625	236		1,540	948
			50	51	52	53	54	60	
16	4	Initial	745	189	141	199	371		
		Final	165	78	54	80	106		
18	3	Initial	2,360	1,270	1,310	1,380	2,100		
		Final	724	220	336	254	680		
20	2	Initial	2,410	2,590	1,930		2,710		
		Final	320	966	362		465		
22	1	Initial	3,860	3,700		4,340	3,270		
		Final	740	1,590		1,680	1,140		
24	12	Initial			3,360	4,640	3,670		
		Final			901	1,420	1,260		
26	10	Initial	3,070	1,990	2,160	2,670	3,820		
		Final	379	674	402	814	868		
28	11	Initial	1,730		1,370	1,480	206		
		Final	324		393	609	546		
30	9	Initial	1,100	1,890	1,850		2,760	285	
		Final	753	1,150	647		1,000	78	

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TABLE E.2—*Continued*

DRONE ALTITUDE ($ft \times 10^{-3}$)	DECON. AGENT (Code No.)	READ-ING	ACTIVITY (CORRECTED) ($c/m \times 10^{-3}$) Youden Square Index Number						
			22	23	24	25	26	27	28
16	4	Initial		192– 297		50	57	130	197
		Final		140– 136		23	32	87	77
18	3	Initial		1,000				557	828
		Final		84				103	129
20	2	Initial	1,039	1,440–1,880	1,460	615	1,060	1,310	1,750
		Final	291	281– 475	469	107	70	479	433
22	1	Initial	2,570	3,000	3,830	1,120			3,110
		Final	1,320	1,230	2,020	227			1,250
24	12	Initial	2,230	2,760–2,930		1,050		2,380	2,510
		Final	780	681– 812		326		1,180	677
26	10	Initial	1,950	1,820–1,780	1,860	976	1,320	1,640	1,740
		Final	315	304– 358	561	142	305	563	490
28	11	Initial		1,430	1,050	463	657		1,020
		Final		393	514	161	276		409
30	9	Initial	817	1,810		524	1,450	1,730	1,960
		Final	353	600		132	279	1,150	623
			29	30	31	32	33	34	35
16	4	Initial		159	98	151	197		
		Final		20	46	7	21		
18	3	Initial	839	472	381	394	802		268
		Final	42	154	78	22	435		66
20	2	Initial	1,370	1,350	993	825	1,410		946
		Final	109	233	202	91	280		236
22	1	Initial		2,170	1,930	1,120	1,820		1,100
		Final		764	986	124	1,190		367
24	12	Initial	2,200	1,510			1,830		1,170
		Final	258	512			777		300
26	10	Initial	1,820	1,160					
		Final	190	338					
28	11	Initial		460	594	509		335	659
		Final		228	143	35		125	100
30	9	Initial	1,370		1,080	967		383	1,010
		Final	102		474	18		151	303
			36	37	38	39	40	41	42
16	4	Initial		51		652	49		73
		Final		34		329	22		47
18	3	Initial				2,920	376		378
		Final				699	65		26
20	2	Initial	7,770	600	1,190	3,270	6,530	1,580	640
		Final	1,720	114	280	1,110	2,260	150	93
22	1	Initial		1,260		2,730–3,460	1,660	1,340	
		Final		371		463–2,420	648	411	
24	12	Initial	4,180	1,050	2,160	3,490	2,580	1,540	1,980
		Final	2,910	287	600	1,400	568	195	173
26	10	Initial		2,030	1,300	1,010	1,060	1,350	1,370
		Final		188	446	870	126	84	102
28	11	Initial	5,220	587	692	3,190	565	1,080	
		Final	1,500	187	273	1,180	88	85	
30	9	Initial			1,220	3,930		810	735
		Final			299	2,400		87	76

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TABLE E.3 GEORGE SHOT DATA

DRONE ALTITUDE ($ft \times 10^{-3}$)	DECON. AGENT (Code No.)	READING	ACTIVITY (CORRECTED) ($c/m \times 10^{-2}$) Youden Square Index Number											
			1	2	3	4	5	6	7	8	9	10	11	12
24	8	Initial										46	21	25
		Final										30	16	21
26	6	Initial		586	19	116	45	130	64	250	163		83	82
		Final		159	12	49	25	34	34	92	55		55	40
28	7	Initial		77	22	327	65	57		49	87	186	61	41
		Final		19	14	46	28	25		26	29	48	37	28
			13	14	15	16	17	18	19	20	21	22	23	24
24	8	Initial	72	47	31	36	60	47	25	30	51			
		Final	30	20	17	22	27	25	11	15	26			
26	6	Initial		83	127			25	71	24	27	62	162	
		Final		28	40			31	21	13	14	16	58	
28	7	Initial	24	466	40		39	24	62	17	21	51	112	70
		Final	12	71	16		11	60	15	56	78	14	44	36
			25	26	27	28	29	30	31	32	33	34	35	36
24	8	Initial	13	59	37							42	13	244
		Final	13	55	37							25	4	91
26	6	Initial	29	36				24	41	43	65		48	
		Final	15	69				12	19	3	21		17	
28	7	Initial	21	20	32	63		24	32	20	22	31	40	1,050
		Final	92	54	24	25		96	16	2	6	14	15	192
			37	38	39	40	41	42	43	44	45	46	47	48
24	8	Initial	23	10	35	7	7	20	12	13	44	6	46	43
		Final	15	2	21	3	4	14	6	6	32	3	37	39
26	6	Initial	18		408	36	53	57	34		84	30	65	37
		Final	8		44	16	23	19	20		28	10	21	16
28	7	Initial	101	32	350		23		26	27	104	25	80	45
		Final	21	10	80		8		14	6	30	8	26	21
			49	50	51	52	53	54	55	56	57	58	59	60
24	8	Initial	16	114	16	28	22	45	57	50	5	40	31	11
		Final	7	15	4	17	9	15	33	43	3	20	22	4
26	6	Initial		277	48	145		116				74	175	68
		Final		36	21	21		26				41	63	9
28	7	Initial	34	72	58			104	55	49		83	102	32
		Final	13	28	25			32	36	26		34	36	7

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Table E.4 ITEM SHOT DATA

Drone Altitude ($ft \times 10^{-3}$)	Decon. Agent (Code No.)	Reading	Activity (corrected) ($c/m \times 10^{-2}$) Youden Square Index Number 1	2	3	4	5	6	7
16	4	Initial	1,400		430	2,350	851	1,610	1,940
		Final	500		250	730	330	185	850
18	12	Initial	2,280	11,200	2,800	2,620	1,940	2,710	4,370
		Final	1,020	1,370	1,370	1,050	909	660	1,260
20	5	Initial	3,720	12,100	3,580		3,850		7,920–6,880
		Final	349	1,450	67		507		2,120–1,700
22	1	Initial	12,900	8,080	11,900	15,800	2,170	13,700	14,800–4,860
		Final	9,370	3,490	6,870	8,340	851	7,080	8,040–1,580
24	11	Initial	690	4,770	540	3,780		2,480	3,350–1,460
		Final	83	1,440	350	1,850		400	1,800– 100
26	9	Initial	2,220	11,100	1,490	3,480	2,270	4,800	1,860–1,600
		Final	1,450	5,970	529	1,180	1,000	1,520	649– 881
28	10	Initial	1,900	16,350	1,150	1,780	1,400	2,120	1,760–2,380
		Final	940	1,640	712	740	800	470	440–1,220
			8	**9**	**10**	**11**	**12**	**13**	**14**
16	4	Initial	1,480	1,960	2,070	1,470	480	380	
		Final	390	500	510	780	250	150	
18	12	Initial		5,970	4,180	2,450	2,470	2,380	2,180
		Final		1,950	1,510	1,950	1,110	743	25
20	5	Initial	5,610	9,110	7,350		4,300	4,180	
		Final	391	1,230	1,640		975	423	
22	1	Initial	13,800	22,800	12,600	3,960		9,970	18,200
		Final	8,940	14,100	5,630	2,430		5,660	8,600
24	11	Initial	2,940	6,680	2,440	2,260	860	1,820	1,460
		Final	1,100	2,460	1,000	1,320	500	320	180
26	9	Initial	2,580	10,200	4,880		4,410	1,550	1,880
		Final	735	3,920	1,900		960	299	781
28	10	Initial	2,660	3,240	2,520	1,830	1,580	1,030	2,370
		Final	1,000	1,820	868	1,070	800	492	510
			15	**16**	**17**	**18**	**19**	**20**	**21**
16	4	Initial		950		410	1,950	1,380	300
		Final		150		22	250	206	47
18	12	Initial	3,460	1,620	2,100	2,760–2,350	2,930	1,440	2,000
		Final	781	331	388	257– 182	585	214	565
20	5	Initial	4,820	1,170		2,980–4,460	5,330	3,050	
		Final	295	142		190– 184	375	398	
22	1	Initial	14,200	2,640	8,770	10,300–9,580	12,600	12,500	12,300
		Final	4,800	696	3,970	1,610–1,290	6,570	6,310	5,700
24	11	Initial	1,500	680		1,300– 830	2,020	1,530	1,380
		Final	458	19		379– 40	467	574	230
26	9	Initial	1,800	1,360	1,430	2,100–2,260	1,410	1,140	1,920
		Final	591	64	485	91– 71	610	29	211
28	10	Initial	1,820	1,770	904	986–1,130	1,810	920	1,090
		Final	850	340	368	145– 210	380	260	410

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TABLE E.4—*Continued*

DRONE ALTITUDE ($ft \times 10^{-3}$)	DECON. AGENT (Code No.)	READING	ACTIVITY (CORRECTED) ($c/m \times 10^{-2}$)						
			Youden Square Index Number						
			22	23	24	25	26	27	28
16	4	Initial	1,210	1 870	1,790	360	1,710	390	
		Final	270	632	660	120	240	250	
18	12	Initial	2,350	2,750	3,100		1,250	2,740	
		Final	978	1,180	1,660		143	1,640	
20	5	Initial	5,370	3,180			4,500	5,890	5,650
		Final	523	330			531	1,080	415
22	1	Initial	18,300	14,500	14,500	9,140		15,500	16,600
		Final	8,640	6,900	9,760	5,140		13,000	8,210
24	11	Initial	1,860	5,490	2,340		1,250	3,050	3,530
		Final	895	2,890	720		350	2,080	1,200
26	9	Initial	4,290	4,750	4,250	1,330	865	3,530	
		Final	1,160	1,570	1,020	359	18	2,230	
28	10	Initial	1,490	2,170	2,310	1,980	917	2,570	1,710
		Final	503	810	1,360	680	315	1,600	540
			29	30	31	32	33	34	35
16	4	Initial	1,400	1,410	350	1,430	1,690	1,340	1,370
		Final	380	230	97	40	284	382	270
18	12	Initial	2,360	1,940	2,150	1,270	2,550	1,530	
		Final	952	719	670	32	1,910	450	
20	5	Initial	4,540	4,620	3,180				2,560
		Final	1,190	448	396				566
22	1	Initial	14,500	9,990	9,060	13,100	12,500	15,000	2,330
		Final	5,400	6,870	4,900	507	11,300	8,900	1,030
24	11	Initial	2,980	1,260	1,200		1,660	450	1,120
		Final	988	433	702		530	260	530
26	9	Initial		2,240	1,750	710	2,570	2,770	799
		Final		270	1,280	13	420	900	404
28	10	Initial	1,640	790	933	945	1,040		1,250
		Final	620	250	297	78	600		540
			36	37	38	39	40	41	42
16	4	Initial	3,890		560	930	1,700	2,810	1,710
		Final	1,080		88	260	424	695	390
18	12	Initial	4,560	2,460	2,530	5,880	1,190	2,450	
		Final	4,110	916	589	1,750	390	1,040	
20	5	Initial	11,100	4,170		9,350	4,420	3,590	3,940
		Final	5,060	201		1,380	368	345	1,070
22	1	Initial	7,910	13,100	10,900	6,760	15,400	13,600	4,260
		Final	3,020	4,840	5,270	2,830	7,470	7,390	1,490
24	11	Initial	11,300	2,290	1,350		1,390	1,150	2,200
		Final	3,900	1,180	140		716	495	667
26	9	Initial	18,700		2,510	7,780	1,060	2,750	1,860
		Final	8,190		368	3,000	160	448	331
28	10	Initial	2,670	1,580	1,100	1,980	1,300	1,350	1,160
		Final	720	520	320	547	615	460	435

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TABLE E.4—*Continued*

DRONE ALTITUDE (ft × 10^{-3})	DECON. AGENT (Code No.)	READING	ACTIVITY (CORRECTED) (c/m × 10^{-3}) Youden Square Index Number 43	44	45	46	47	48
16	4	Initial	1,430	1,460	670	1,530	2,410	1,620
		Final	410	149	190	164	336	355
18	12	Initial		2,210	2,690	2,420	4,020	4,660
		Final		122	1,220	458	646	676
20	5	Initial				4,820	6,460	3,800–5,610
		Final				360	1,440	1,560–1,770
22	1	Initial	11,300		14,100	10,100	9,930	8,020–9,310
		Final	7,130		5,740	7,040	4,280	4,880–6,310
24	11	Initial	958	1,550	2,530		6,350	1,410–1,770
		Final	532	215	1,010		1,310	650– 631
26	9	Initial		2,480	3,860	2,680	394	938–3,300
		Final		196	910	530	139	287–1,030
28	10	Initial	1,250–1,140		1,880	909	1,790	1,770–1,670
		Final	540– 428		693	286	700	979–1,060

DRONE ALTITUDE (ft × 10^{-3})	DECON. AGENT (Code No.)	READING	49	50	51	52	53	54	58	59	60
16	4	Initial	1,710	2,870	2,160	1,750	2,530		410	850	860
		Final	210	290	680	240	426		160	360	180
18	12	Initial	4,910	6,430	2,690	2,720	3,700		882	1,690	1,430
		Final	952	1,110	1,300	570	830		331	570	161
20	5	Initial	8,240		3,160		6,770				
		Final	692		182		492				
22	1	Initial	10,600	20,800	15,600	15,900	16,800	15,100			
		Final	5,230	6,910	7,600	5,370	7,310	8,040			
24	11	Initial	1,870	3,780	3,140	3,380	4,450	2,590			
		Final	682	1,120	1,410	1,380	1,290	760			
26	9	Initial	4,280	4,670	4,620	4,950	5,590		1,140	2,040	881
		Final	2,430	1,040	2,830	2,040	1,920		416	1,040	132
28	10	Initial	2,660	4,300	2,340	1,730	2,200	1,640			1,180
		Final	625	595	960	603	893	510			150

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Appendix F

Contamination-Decontamination Related to Surface Characteristics

F.1 VARIANCE DUE TO SURFACE CHARACTERISTICS TAKEN IN PAIRS

The interactions of pairs of surface parameters are tabulated below. Activities are given in counts per minute ($\times 10^{-2}$) and represent the arithmetic mean of the values obtained from the Dog, Easy, and Item Shots.

F.1.1 Initial Contamination

SURFACE CHARACTERISTIC		POROSITY		
		Low	Med	High
Roughness	Low	1,489	1,452	1,477
	Med	1,661	1,961	1,996
	High	2,822	2,510	3,361
Contact Angle	Low	1,022	2,069	2,769
	Med	2,392	2,407	1,535
	High	2,074	1,446	2,872

SURFACE CHARACTERISTIC		DYE RETENTIVITY	
		Nonretentive	Retentive
Porosity	Low	1,360	2,936
	Med	1,920	2,028
	High	2,660	2,200
Roughness	Low	1,202	1,778
	Med	1,755	1,967
	High	2,615	3,131

SURFACE CHARACTERISTIC		CONTACT ANGLE		
		Low	Med	High
Dye Retentivity	Nonreten.	1,998	1,462	2,068
	Reten.	2,095	2,744	2,000
Roughness	Low	1,536	1,544	1,331
	Med	1,903	1,913	1,777
	High	2,560	3,221	2,845

F.1.2 Per Cent Decontamination

SURFACE CHARACTERISTIC		POROSITY		
		Low	Med	High
Roughness	Low	79	70	67
	Med	67	67	64
	High	66	63	67
Contact Angle	Low	82	64	70
	Med	71	70	63
	High	65	67	66

SURFACE CHARACTERISTIC		DYE RETENTIVITY	
		Nonretentive	Retentive
Porosity	Low	72	68
	Med	73	61
	High	70	63
Roughness	L.w	81	62
	Med	66	66
	High	68	63

SURFACE CHARACTERISTIC		CONTACT ANGLE		
		Low	Med	High
Dye Retentivity	Nonreten.	76	66	67
	Reten.	64	63	64
Roughness	Low	74	74	70
	Med	68	67	64
	High	69	65	63

F.1.3 Residual Contamination

SURFACE CHARACTERISTIC		POROSITY		
		Low	Med	High
Roughness	Low	430	525	514
	Med	574	719	724
	High	976	964	1,186
Contact Angle	Low	250	790	823
	Med	743	856	605
	High	782	562	1,112

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Surface characteristic		Dye retentivity: Nonretentive	Dye retentivity: Retentive
Porosity	Low	462	213
	Med	595	877
	High	938	782
Roughness	Low	2,838	727
	Med	640	697
	High	931	782

Surface characteristic		Contact angle: Low	Med	High
Dye retentivity	Nonreten.	592	429	783
	Reten.	774	100	780
Roughness	Low	466	488	514
	Med	652	699	650
	High	862	1,119	1,114

F.1.4 Mean Values for Initial Contamination, Residual Contamination, and Per Cent Decontamination for All Shots Combined

Surface characteristic	Initial contamination ($c/m \times 10^{-2}$)			Per cent decontamination			Residual contamination ($c/m \times 10^{-2}$)		
	Low	Medium	High	Low	Medium	High	Low	Medium	High
Porosity	1,991	1,974	2,392	71	67	66	660	736	847
Roughness	1,471	1,861	2,873	72	66	66	491	668	1,037
Contact Angle	2,043	2,183	2,038	70	69	66	676	751	782
Retentivity									
Nonretentive	1,862			72			617		
Rententive	2,330			64			869		

The table given here, modified so that the lowest value in each group of figures has the value 1.00, appears in Sec. 3.1.2.2 as Table 3.8.

F.2 VARIANCE DUE TO SURFACE CHARACTERISTICS TAKEN THREE AT A TIME

The interactions of surface parameters taken three at a time are tabulated in Secs. F.2.1 to F.2.3. Activities are given in counts per minute ($\times 10^{-2}$) and represent the arithmetic mean of the values obtained from the Dog, Easy, and Item Shots.

F.2.1 Initial Contamination

Surface characteristic		Porosity Low: Roughness Low	Low: Roughness Medium	Low: Roughness High	Medium: Roughness Low	Medium: Roughness Medium	Medium: Roughness High	High: Roughness Low	High: Roughness Medium	High: Roughness High
Contact Angle	Low	1,139	1,051	876	1,364	2,142	2,702	2,277	2,275	3,261
	Medium	1,580	1,932	3,664	1,650	2,317	3,256	1,404	1,065	2,267
	High	1,573	1,694	2,954	1,341	1,425	1,571	825	2,647	4,008
Dye Retentivity	Nonretentive	1,203	1,028	1,851	1,247	2,186	2,329	1,135	2,647	4,192
	Retentive	1,919	2,610	4,279	1,657	1,737	2,690	1,820	1,670	2,808

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Surface Characteristic			Porosity: Low	Porosity: Medium	Porosity: High	Roughness: Low	Roughness: Medium	Roughness: High
Contact Angle	Nonretentive	Low	1,022	2,460	3,539	1,261	2,016	2,477
		Medium	803	2,016	1,445	1,167	1,539	1,829
		High	2,146	1,285	2,772	1,198	1,726	3,278
	Retentive	Low		1,679	2,512	1,811	1,790	2,686
		Medium	3,870	2,798	1,565	1,922	2,162	4,149
		High	2,002	1,607	3,173	1,529	1,854	2,411

F.2.2 Per Cent Decontamination

Surface Characteristic		Porosity Low, Roughness: Low	Med	High	Porosity Med, Roughness: Low	Med	High	Porosity High, Roughness: Low	Med	High
Contact Angle	Low	92	74	82	67	65	59	69	66	72
	Med	79	69	64	79	66	66	60	64	66
	High	72	61	60	64	70	66	78	59	63
Dry Retentivity	Nonretentive	87	64	66	80	72	67	74	59	72
	Retentive	67	71	65	60	63	61	60	65	64

Surface Characteristic			Porosity: Low	Porosity: Medium	Porosity: High	Roughness: Low	Roughness: Medium	Roughness: High
Contact Angle	Nonretentive	Low	82	68	77	82	71	74
		Medium	75	77	69	83	72	67
		High	59	73	68	79	59	62
	Retentive	Low	. .	60	67	66	65	60
		Medium	66	64	61	63	63	64
		High	70	60	59	57	72	64

F.2.3 Residual Contamination

Surface Characteristic		Porosity Low, Roughness: Low	Med	High	Porosity Med, Roughness: Low	Med	High	Porosity High, Roughness: Low	Med	High
Contact Angle	Low	109	304	337	536	754	1,087	683	811	900
	Med	430	660	1,139	854	897	1,245	607	380	828
	High	591	622	1,132	613	512	560	160	982	1,652
Dry Retentivity	Nonretentive	257	416	711	278	749	757	333	982	1,520
	Retentive	690	811	1,373	772	688	1,1[illegible]0	696	596	964

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SURFACE CHARACTERISTIC			POROSITY			ROUGHNESS		
			Low	Medium	High	Low	Medium	High
Contact Angle	Nonretentive	Low	250	840	871	303	684	723
		Med	281	551	506	247	509	622
		High	854	392	1,104	308	697	1,344
	Retentive	Low	. . .	740	807	629	620	1,070
		Med	120	116	639	729	825	2,562
		High	710	731	1,135	821	580	886

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Appendix G

Evaluation of Decontamination Agents

G.1 EFFECTIVENESS OF DECONTAMINATION AGENTS EMPLOYED BY THE ACC

Tables G.1 and G.2 list the results of the tests of decontamination agents carried out by the ACC. The formulations of the evaluated agents are given in Table 2.2.

TABLE G.1 SURFACES CONTAMINATED AT DOG AND EASY SHOTS

AGENT	NUMBER OF SURFACES	TOTAL ACTIVITY		MEAN ACTIVITY		PER CENT DECONTAMINATION
		Initial c/m ($\times 10^{-2}$)	Final c/m ($\times 10^{-2}$)	Initial c/m ($\times 10^{-2}$)	Final c/m ($\times 10^{-2}$)	
Versene	39	13,584	6,926	348	178	49
Sequestrene AA	46	26,859	5,618	584	122	79
Breeze	29	31,383	7,024	1,082	242	78
TSPP	45	11,001	4,836	244	108	56
Chlorsol	44	22,561	4,100	513	93	82
Aresklene 400	48	30,180	11,640	629	242	61
Ethomid HT/60	39	118,096	56,847	3,028	1,458	52
Tergitol P-28	41	152,086	39,988	3,709	975	74
Blendene	43	73,933	29,241	1,719	680	60
Ethomeen 18/25	49	84,486	20,683	1,724	422	76
Triton	45	54,270	15,745	1,206	350	71
Ethofat 242/25	42	98,420	29,783	2,343	709	70

TABLE G.2 SURFACES CONTAMINATED AT EASY AND ITEM SHOTS

AGENT	NUMBER OF SURFACES	TOTAL ACTIVITY		MEAN ACTIVITY		PER CENT DECONTAMINATION
		Initial c/m ($\times 10^{-2}$)	Final c/m ($\times 10^{-2}$)	Initial c/m ($\times 10^{-2}$)	Final c/m ($\times 10^{-2}$)	
Versene	42	105,700	38,142	2,520	908	64
Sequestrene AA	57	104,346	25,975	1,830	456	75
Breeze	42	43,865	10,618	1,040	253	76
TSPP	39	10,499	2,875	269	74	73
Chlorsol	39	205,330	32,835	5,260	842	84
Aresklene 400	42	42,013	12,591	1,000	300	70
Ethomid HT/60	51	46,495	13,150	912	258	72
Tergitol P-28	42	12,778	6,763	304	161	47
Blendene	54	174,617	55,634	3,230	1,030	68
Ethomeen 18/25	57	111,846	37,317	1,960	655	67
Triton	51	124,418	44,736	2,440	877	64
Ethofat 242/25	51	149,722	46,305	2,940	908	69

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G.2 EVALUATION OF DECONTAMINATION AGENTS EMPLOYED BY THE USNRDL

Tables G.3 to G.5 summarize the results obtained by the USNRDL in evaluations of decontamination agents. In these tables the following designations are used:

4Na-EDTA	Tetrasodium salt of ethylene diamine tetraacetic acid
Nytron	Mixture of sulfonates, ketones, amine alkyl sulfamates, and alkylidene materials
Tide	Possibly 16 per cent alkyl aryl sulfonate and 4 per cent alcohol sulfate plus other builders
2Na-EDTA	Disodium salt of ethylene diamine tetraacetic acid
Ultrawet DS	Alkyl benzene sodium sulfonate
Na-polyphos	Sodium hexametaphosphate ($Na_{12}P_{10}O_{31}$)

TABLE G.3 MATERIALS EXPOSED AT DOG SHOT

DRONE ALTITUDE (ft × 10⁻³)	PER CENT ACTIVITY REMOVED					
	From OD Paint			From Aluminum		
	By 4Na-EDTA	By Nytron	By Tide	By 2Na-EDTA	By Ultrawet DS	By Na-polyphos
16	60.7	23.4	88.6	57.5	38.4	55.2
	73.0	35.8	93.0	44.8	21.2	38.6
18	66.5	48.0	90.5	45.0	32.6	74.0
	71.5	53.5	88.4	73.1	25.7	70.7
20	38.3	12.8	49.9	57.8	29.8	55.0
	56.8	39.8	73.2	68.7	60.5	75.6
22	64.5	40.2	73.0	47.2	45.8	67.9
	65.0	38.8	84.7	54.0	43.5	59.9
24	45.5	27.3	59.3	33.8	33.0	55.3
	57.8	30.1	73.2	29.0	25.0	32.0
26	41.0	18.4	58.0	31.3	18.3	32.8
	57.2	24.7	79.0	23.6	19.8	43.5
28	68.0	39.0	71.1	37.7	40.0	57.8
	69.3	48.9	82.8	55.7	64.1	63.0
30	43.7	21.2	56.8	53.1	13.4	57.3
	55.0	29.2	74.2	41.9	28.3	42.1
	Av 58.3	Av 33.2	Av 74.7	Av 47.1	Av 33.7	Av 55.0

TABLE G.4 MATERIALS EXPOSED AT EASY SHOT

DRONE ALTITUDE (ft × 10⁻³)	PER CENT ACTIVITY REMOVED					
	From OD Paint			From Aluminum		
	By 4Na-EDTA	By Nytron	By Tide	By 2Na-EDTA	By Ultrawet DS	By Na-polyphos
16	55.1	31.2	58.7	45.7	34.8	39.8
	56.2	26.4	70.0	46.9	31.0	40.2
18	71.2	43.7	83.2	71.0	52.8	83.2
	81.8	47.5	86.8	79.7	63.0	70.2
20	69.1	22.7	81.4	79.2	43.8	77.8
	75.3	43.4	85.2	73.9	73.0	88.0
22	74.5	37.6	86.0	62.7	63.7	68.7
	81.7	46.8	92.7	83.5	63.7	84.4
24	78.2	50.0	86.9	68.2	64.8	89.7
	80.3	52.5	92.1	83.3	71.4	94.1
26	73.2	45.1	86.2	82.9	53.1	91.0
	79.4	52.5	86.7	78.2	71.0	88.0
28	71.0	43.9	83.6	80.0	68.6	74.2
	73.2	44.0	85.0	77.2	71.4	88.1
30	75.0	43.5	87.4	62.9	52.8	89.5
	74.6	47.7	84.8	73.1	54.0	83.8
	Av 73.1	Av 42.4	Av 83.5	Av 71.7	Av 58.3	Av 78.1

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TABLE G.5 MATERIALS EXPOSED AT GEORGE SHOT

DRONE ALTITUDE ($ft \times 10^{-3}$)	PER CENT ACTIVITY REMOVED					
	From OD Paint			From Aluminum		
	By 4Na–EDTA	By Nytron	By Tide	By 2Na–EDTA	By Ultrawet DS	By Na-polyphos
24	56.5	20.7	81.0	32.4	18.3	41.5
	50.1			39.2		
26	71.2	55.6	92.6	57.8	51.5	82.2
	75.1	61.5	92.3	62.8	47.8	66.2
28		39.2	88.9		26.8	
	68.2	42.9	86.5	46.8	50.0	55.5
	Av 64.2	Av 44.0	Av 88.3	Av 47.8	Av 38.9	Av 59.7

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Appendix H

Decontamination as a Function of Time

H.1 INTRODUCTION

The results obtained in the study on decontamination as a function of time are given in Tables H.1 to H.6. Each listed value was obtained from a separate specimen.

H.1.1 Dog Shot

All experimental work was conducted at the ZI.

TABLE H.1 DOG SHOT DECONTAMINATION-TIME STUDY, OD PAINT

DRONE ALTITUDE ($ft \times 10^{-3}$)	TIME AFTER DETONATION (days)	ACTIVITY					
		Run No. 1			Run No. 2		
		Initial c/m ($\times 10^{-4}$)	Final c/m ($\times 10^{-4}$)	Per Cent Removed	Initial c/m ($\times 10^{-4}$)	Final c/m ($\times 10^{-4}$)	Per Cent Removed
16	2	900	90.9	90	600	74.4	88
	3	320	60.6	81	450	61.4	86
	4	280	43.6	84	300	49.5	87
	5	320	62.5	79	200	43.4	78
	6	140	24.3	83	165	24.1	85
	7	110	30.0	73	110	17.9	84
	23	33.5	3.04	91	28.7	3.34	81
	79	5.11	1.46	71	4.74	1.45	69
18	2	950	140	85	950	105	89
	3	600	33.5	95	570	31.0	95
	4	430	43.6	90	400	34.8	92
	5	280	30.9	89	250	32.5	87
	6	250	29.1	88	210	24.9	88
	7	240	30.5	87	185	19.4	90
	23	38.5	6.53	83	44.6	4.47	67
	79	10.7	1.75	84	8.77	2.14	76
20	2	48.3	8.92	82	59.2	10.8	82
	3	36.4	4.90	87	37.4	9.94	79
	4	26.5	5.99	77	30.2	7.57	75
	5	23.5	6.54	72	18.8	5.30	72
	6	17.9	5.26	71	17.5	5.05	71
	7	11.1	3.46	69	12.8	3.69	71
	23	4.40	0.65	85	5.00	0.75	85
	79	1.44	0.38	62	1.10	0.35	68
22	2	59.7	11.6	81	46.5	8.40	82
	3	38.5	9.50	75	32.8	5.70	83
	4	23.3	5.62	76	22.6	5.15	77
	5	16.1	2.84	82	19.6	3.84	80
	6	21.1	4.38	79	13.5	3.65	73
	7	10.7	3.45	76	11.0	2.63	78
	23	2.95	0.40	80	2.41	0.48	80
	79	0.41	0.13	68	0.58	0.17	71

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TABLE H.1—*Continued*

DRONE ALTITUDE (ft × 10^{-3})	TIME AFTER DETONATION (days)	ACTIVITY					
		Run No. 1			Run No. 2		
		Initial c/m (× 10^{-4})	Final c/m (× 10^{-4})	Per Cent Removed	Initial c/m (× 10^{-4})	Final c/m (× 10^{-4})	Per Cent Removed
24	2	18.2	5.85	68	15.5	6.60	58
	3	13.7	5.49	60	12.1	3.65	70
	4	13.5	3.86	71	7.76	2.82	64
	5	7.06	2.72	61	6.18	2.33	62
	6	4.15	1.28	69	4.92	1.48	70
	7	3.31	1.31	60	3.74	1.28	66
	23	1.10	0.30	73	0.75	0.25	67
	79	0.20	0.12	40	0.20	0.08	60
26	2	51.2	13.4	84	52.8	10.2	81
	3	39.6	9.04	77	54.7	10.7	80
	4	26.4	6.82	74	26.0	5.29	78
	5	24.6	6.07	75	16.3	4.54	72
	6	17.2	6.74	61	13.6	5.00	63
	7	14.7	3.88	74	28.9	3.83	87
	23	2.81	0.80	72	2.70	0.90	67
	79	0.49	0.14	71	0.54	0.17	69
28	2	50.0	12.6	75	42.4	8.13	81
	3	37.0	6.47	83	32.4	7.32	78
	4	31.9	3.40	84	24.0	3.19	87
	5	21.5	4.48	79	18.0	3.80	78
	6	14.6	2.71	81	11.7	2.46	79
	7	10.4	2.32	78	10.6	2.11	80
	23	2.50	0.50	80	2.56	0.37	85
	79	0.49	0.14	71	0.49	0.13	72
30	2	30.4	8.20	73	27.2	7.85	71
	3	20.5	8.40	59	18.2	4.18	77
	4	12.5	3.77	70	13.5	4.12	70
	5	10.2	3.62	65	12.4	3.65	73
	6	8.37	2.63	69	7.98	2.66	67
	7	6.17	2.60	58	6.13	1.85	70
	23	2.10	0.50	76	1.39	0.30	78
	79	0.32	0.11	66	0.41	0.12	71

TABLE H.2 DOG SHOT DECONTAMINATION-TIME STUDY, ALUMINUM

DRONE ALTITUDE (ft × 10^{-3})	TIME AFTER DETONATION (days)	ACTIVITY					
		Run No. 1			Run No. 2		
		Initial c/m (× 10^{-4})	Final c/m (× 10^{-4})	Per Cent Removed	Initial c/m (× 10^{-4})	Final c/m (× 10^{-4})	Per Cent Removed
16	2	1,000	155	85	1,000	160	84
	3	380	110	71	380	85.0	78
	4	310	75.4	76	290	62.8	78
	5	350	68.5	80	470	81.1	83
	6	180	36.8	80	220	41.1	81
	7	165	32.2	80	165	26.6	84
	23	22.9	7.87	66	35.9	8.02	78
	79	9.84	4.71	52	7.83	3.33	57

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Table H.2—*Continued*

DRONE ALTITUDE $(ft \times 10^{-3})$	TIME AFTER DETONATION (days)	ACTIVITY					
		Run No. 1			Run No. 2		
		Initial c/m $(\times 10^{-4})$	Final c/m $(\times 10^{-4})$	Per Cent Removed	Initial c/m $(\times 10^{-4})$	Final c/m $(\times 10^{-4})$	Per Cent Removed
18	2		470			240	
	3	900	90.0	90	850	180	79
	4	570	38.0	93	800	190	76
	5	380	75.0	80	420	74.3	82
	6	405	25.8	94	305	25.6	92
	7	305	21.4	93	250	39.7	84
	23	41.1	8.61	79	45.3	5.40	88
	79	8.93	2.82	68	10.3	3.12	70
20	2	51.3	6.66	87	75.0	11.7	84
	3	33.8	6.38	81	47.2	10.1	79
	4	25.9	7.02	73	46.5	14.2	69
	5	20.9	5.05	76	20.2	5.81	71
	6	18.4	5.11	72	31.6	6.56	79
	7	13.0	3.78	71	12.9	2.88	78
	23	3.50	0.50	86	3.80	1.15	70
	79	0.67	0.25	63	0.69	0.27	61
22	2	70.3	18.0	74	48.1	9.02	81
	3	33.7	6.88	80	74.7	16.4	78
	4	26.3	4.37	83	36.1	5.12	86
	5	19.0	3.70	80	27.8	4.64	83
	6	16.4	3.57	79	19.4	3.90	80
	7	11.1	3.46	69	12.8	3.69	71
	23	3.73	0.91	76	3.36	0.76	77
	79	0.72	0.30	58	0.65	0.28	57
24	2	18.2	6.72	63	14.3	5.60	61
	3	16.6	5.94	64	9.71	3.94	59
	4	5.82	3.27	44	6.25	3.24	48
	5	5.97	1.96	67	6.19	2.66	56
	6	5.67	2.23	61	3.80	1.70	55
	7	6.12	2.11	66	3.74	1.67	55
	23	1.00	0.80	20	0.95	0.71	25
	79	0.24	0.15	38	0.25	0.15	40
26	2	80.9	22.4	72	62.2	15.9	74
	3	56.0	15.8	72	39.5	11.8	70
	4	39.9	10.9	72	58.5	11.0	81
	5	39.9	14.1	65	30.6	11.1	64
	6	23.8	5.55	77	22.2	7.46	66
	7	17.3	6.23	64	15.5	7.55	51
	23	4.40	2.10	52	4.42	2.10	52
	79	1.05	0.71	32	0.83	0.47	43
28	2	44.3	10.7	76	52.5	9.74	82
	3	36.5	8.13	85	48.1	7.41	90
	4	24.8	3.40	86	24.9	5.24	79
	5	36.6	7.18	74	27.7	7.50	80
	6	15.4	3.38	78	20.4	5.26	74
	7	12.9	3.20	75	28.8	5.89	80
	23	4.40	0.75	83	4.90	1.87	62
	79	0.64	0.27	58	0.67	0.27	60
30	2	20.8	8.53	59	45.8	16.3	64
	3	17.1	7.32	57	16.8	6.54	61
	4	17.3	8.86	49	16.4	6.57	60
	5	14.3	6.59	54	18.4	7.82	58
	6	9.93	3.77	64	12.[illegible]	5.01	58
	7	7.23	3.48	52	7.47	2.86	62
	23	2.36	1.42	40	2.51	1.46	42
	79	0.59	0.34	42	0.61	0.42	31

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H.1.2 Easy Shot

The experimental work conducted at the site is noted by a superscript ([a]). All other work was done at the ZI.

TABLE H.3 EASY SHOT DECONTAMINATION-TIME STUDY, OD PAINT

DRONE ALTITUDE ($ft \times 10^{-3}$)	TIME AFTER DETONATION (days)	ACTIVITY: Run No. 1 Initial c/m ($\times 10^{-4}$)	Run No. 1 Final c/m ($\times 10^{-4}$)	Run No. 1 Per Cent Removed	Run No. 2 Initial c/m ($\times 10^{-4}$)	Run No. 2 Final c/m ($\times 10^{-4}$)	Run No. 2 Per Cent Removed
16	1.2[a]	4.40	2.08	53	4.70	3.80	19
	1.8	25.7	12.0	53	18.5	9.50	51
	2.2	18.5	8.45	54	14.9	5.60	62
	2.3[a]	19.9	8.30	58	12.9	3.05	58
	2.4	10.7	5.40	50	11.7	5.80	50
	3.3[a]	1.77	1.08	39	1.53	1.20	22
	4.8[a]	1.03	0.67	35	1.07	0.43	60
	5						
	8	2.90	1.30	55	2.88	1.10	62
	31	0.59	0.08	87	0.67	0.09	87
18	1.2[a]	19.1	4.05	79	20.6	3.54	83
	1.8	77.3	12.7	84	79.2	17.2	78
	2.2	53.3	9.40	82	63.8	13.2	79
	2.3[a]	9.33	1.65	82	9.39	1.35	86
	2.4	49.7	8.00	84	43.4	11.4	74
	3.3[a]	6.86	1.64	76	8.44	2.23	74
	4.8[a]	4.93	0.95	53	5.54	1.72	69
	5	21.0	9.80	53	28.0	9.40	66
	8	16.5	7.40	55	16.8	7.60	55
	31						
20	1.2[a]	61.3	37.0	40	35.3	6.03	83
	1.8	184	31.4	83	154	30.5	80
	2.2	152	29.6	81	98.2	26.3	73
	2.3[a]	16.3	4.57	72	19.8	6.94	65
	2.4	161	25.2	84	187	25.0	87
	3.3[a]	11.7	2.05	82	11.9	4.68	60
	4.8[a]	10.0	2.73	73	9.69	2.21	77
	5	41.9	12.1	71	57.7	17.8	69
	8	49.7	11.0	78	25.7	8.80	66
	31	5.53	0.18	97	8.18	0.25	97
22	1.8	243	45.3	81	176	46.2	74
	2.2	221	22.5	90	218	25.1	88
	2.4	229	31.5	86	215	25.4	88
	5	65.4	14.9	77	82.2	25.1	70
	8	59.1	10.6	82	47.0	8.10	83
	31	17.6	2.71	85	9.34	1.05	89
24	1.2[a]	39.4	22.2	44	90.3	18.3	80
	1.8	314	37.3	88	187	38.3	79
	2.2	227	27.2	88	178	20.5	88
	2.3[a]	20.2	3.04	85	32.7	5.87	82
	2.4	156	17.2	89	145	19.1	88
	3.3[a]	20.0	12.6	35	19.0	3.35	82
	4.8[a]	22.6	5.40	76	15.7	4.04	74
	5	68.9	16.8	76	60.4	17.6	71
	8	49.5	10.4	75	48.7	6.50	87
	31	7.55	0.85	89	8.02	0.91	89

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Table H.3—*Continued*

Drone Altitude (ft × 10^{-3})	Time After Detonation (days)	Activity					
		Run No. 1			Run No. 2		
		Initial c/m (× 10^{-4})	Final c/m (× 10^{-4})	Per Cent Removed	Initial c/m (× 10^{-4})	Final c/m (× 10^{-4})	Per Cent Removed
26	1.2[a]	31.6	3.37	89	36.4	5.86	84
	1.8	105	16.0	85	126	21.0	85
	2.2	120	18.2	85	66.1	18.2	79
	2.3[a]	13.9	2.67	81	15.1	3.30	78
	2.4	62.9	19.7	69	105	29.5	72
	3.3[a]	12.8	4.63	64	9.15	1.91	79
	4.8[a]	5.67	1.20	79	5.65	1.06	81
	5	33.6	6.00	82	33.8	4.10	88
	8	27.4	3.40	88	24.4	3.50	86
	31	7.20	0.90	87	5.49	0.78	86
28	1.2[a]	20.4	5.82	71	21.9	3.83	83
	1.8	98.0	14.4	85	70.4	18.0	84
	2.2	53.0	8.20	85	56.0	7.30	87
	2.3[a]	7.11	1.72	76	7.56	2.44	68
	2.4	61.3	9.40	85	49.0	8.80	82
	3.3[a]	5.74	1.08	81	6.36	1.89	70
	4.8[a]	5.13	0.75	85	4.69	0.76	84
	5	18.4	11.8	36	34.1	5.84	83
	8	16.8	3.40	80	14.3	3.10	78
	31	5.18	0.54	90	3.80	0.95	75
30	1.8	185	18.4	90	192	10.1	95
	2.2	132	12.4	91	150	13.7	91
	2.4	233	19.7	91	82.4	10.3	87
	5	40.3	8.38	78	55.9	7.60	86
	8	30.7	4.50	85	29.1	4.30	85
	31	5.92	0.32	95	8.22	0.46	95

Table H.4 EASY SHOT DECONTAMINATION-TIME STUDY, ALUMINUM

Drone Altitude (ft × 10^{-3})	Time After Detonation (days)	Activity					
		Run No. 1			Run No. 2		
		Initial c/m (× 10^{-4})	Final c/m (× 10^{-4})	Per Cent Removed	Initial c/m (× 10^{-4})	Final c/m (× 10^{-4})	Per Cent Removed
16	1.2[a]	2.50	1.18	53	4.30	1.76	59
	1.8	18.1	8.50	53	25.3	14.7	42
	2.2	9.70	4.60	53	12.9	4.70	64
	2.3[a]	1.53	0.93	37	1.67	1.24	26
	2.4	7.10	4.50	47	7.90	4.10	48
	3.3[a]	1.33	1.06	20	0.86	0.68	21
	4.8[a]	0.81	0.48	41	1.07	0.60	45
	5						
	8						
	31	0.54	0.09	84	0.48	0.07	85
18	1.2[a]	21.4	3.25	85	24.7	2.88	88
	1.8	80.6	12.4	86	131	17.9	86
	2.2	[illegible]	16.1	85	65.9	10.5	84
	2.3[a]	10.6	2.00	81	8.66	3.01	65
	2.4	62.3	10.6	83	59.2	9.00	85
	3.3[a]	10.9	2.37	78	9.88	2.48	75
	4.8[a]	5.74	3.51	39	5.87	1.83	79
	5	44.2	7.30	83	26.0	8.00	69
	8	23.1	5.10	78	15.3	3.10	79
	31						

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TABLE II.4—*Continued*

DRONE ALTITUDE (ft × 10⁻³)	TIME AFTER DETONATION (days)	ACTIVITY					
		Run No. 1			Run No. 2		
		Initial c/m (× 10⁻⁴)	Final c/m (× 10⁻⁴)	Per Cent Removed	Initial c/m (× 10⁻⁴)	Final c/m (× 10⁻⁴)	Per Cent Removed
20	1.2[a]	27.5	4.35	84	28.7	4.40	85
	1.8	112	21.7	81	132	22.7	83
	2.2	97.4	17.4	82	89.0	16.4	82
	2.3[a]	16.7	3.43	78	14.7	3.02	80
	2.4	84.0	15.2	82	93.0	13.8	85
	3.3[a]	11.1	2.76	75	10.9	3.03	72
	4.8[a]	6.92	2.06	70	5.84	1.51	74
	5	69.2	11.6	83	61.9	9.84	84
	8	35.8	6.50	82	38.2	5.60	85
	31	5.67	0.31	95	5.58	0.20	96
22	1.8	336	41.7	88	314	38.1	88
	2.2	330	29.3	91	195	28.1	86
	2.4	228	25.4	89	200	27.2	86
	5	95.4	14.0	85	85.5	14.5	83
	8	60.8	19.7	68	70.3	12.2	83
	31	13.0	17.2	87	11.2	1.45	87
24	1.2[a]	58.7	8.67	85	67.9	17.5	74
	1.8	233	25.5	89	330	44.1	87
	2.2	162	25.0	85	154	17.7	88
	2.3[a]	19.7	3.68	81	22.9	4.25	81
	2.4	119	20.0	83	149	15.2	90
	3.3[a]	17.3	2.94	83	19.2	11.9	48
	4.8[a]	19.2	11.0	38	16.4	2.52	85
	5	63.0	14.1	78	78.7	15.2	81
	8	55.5	9.10	86	48.7	5.80	88
	31	11.2	0.48	96	9.86	0.40	96
26	1.2[a]	28.8	2.94	90	24.3	3.75	85
	1.8	100	20.7	80	132	18.4	86
	2.2	82.0	18.6	77	66.4	9.60	86
	2.3[a]	20.7	4.10	80	12.7	2.72	79
	2.4	60.0	11.3	81	65.0	11.4	82
	3.3[a]	8.81	1.38	84	6.91	2.52	64
	4.8[a]	4.35	0.75	83	4.59	0.60	87
	5	28.6	4.83	83	28.5	12.6	56
	8	27.3	4.40	84	23.6	3.90	83
	31	4.46	1.04	77	6.55	1.72	74
28	1.2[a]	20.1	2.75	86	24.3	3.65	85
	1.8	56.5	9.60	83	66.8	7.30	89
	2.2	40.2	6.20	85	79.3	10.8	86
	2.3[a]	14.9	4.38	66	8.40	1.98	76
	2.4	53.2	6.60	88	49.8	6.40	87
	3.3[a]	6.01	1.38	77	59.6	1.32	78
	4.8[a]	4.57	0.92	80	7.66	4.25	45
	5	25.8	5.03	77	19.7	3.63	82
	8	20.7	12.9	76	42.9	6.60	85
	31	5.08	1.01	80	4.60	0.48	89
30	1.8	212	12.6	94	136	11.0	89
	2.2	123	14.3	88	220	39.0	82
	2.4	81.4	8.90	89	65.0	8.40	87
	5	47.6	7.70	84	59.1	7.80	87
	8	35.2	10.0	72	24.6	2.80	89
	31	7.53	0.79	90	6.31	1.38	78

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H.1.3 George Shot

The experimental work conducted at the site is noted by a superscript ([a]). All other work was done at the ZI.

TABLE H.5 GEORGE SHOT DECONTAMINATION-TIME STUDY, OD PAINT

DRONE ALTITUDE ($ft \times 10^{-3}$)	TIME AFTER DETONATION (hr)	ACTIVITY					
		Run No. 1			Run No. 2		
		Initial c/m ($\times 10^{-4}$)	Final c/m ($\times 10^{-4}$)	Per Cent Removed	Initial c/m ($\times 10^{-4}$)	Final c/m ($\times 10^{-4}$)	Per Cent Removed
24	5.75[a]	62.0	37.8	39	142.3	14.9	90
	11.5[a]	21.5	11.75	45	16.3	6.42	61
	23.5[a]	11.9	3.20	73	8.93	3.68	59
	35[a]	8.18	4.42	46	11.7	5.93	49
	38	32.0	53.2	35	50.1	16.7	67
	42	57.9	23.9	59	41.7	17.4	58
	52[a]	9.62	6.52	32	5.44	3.24	40
	54	52.0	16.6	68	31.3	11.7	63
	213	6.04	1.58	74	5.34	2.26	58
26	5.75[a]	346	117	66	319	156	51
	11.5[a]	200	46.1	77	170	54.4	68
	23.5[a]	62.2	9.90	84	66.3	14.9	78
	35[a]	23.6	4.77	80	30.1	7.23	76
	38	409	35.6	91	463	25.8	94
	42	193	20.4	89	236	32.5	86
	52[a]	16.7	2.94	82	30.4	5.87	81
	54	197	31.8	84	106	10.8	90
	213	74.6	3.55	95	37.3	31.2	92
28	1.5[a]	485	86.6	82	448	94.8	79
	2.25[a]	300	60.9	80	272	73.0	73
	2.5[a]	194	36.6	81	240	49.0	80
	3.25[a]	155	33.3	79	254	10.4	59
	3.75[a]	201	60.2	70	97.8	21.6	78
	5.75[a]	142	54.8	61	146	54.3	63
	11.5[a]	128	49.3	61	155	91.2	41
	23.5[a]	68.8	23.4	66	27.1	9.84	64
	38	144	29.4	79	170	28.4	83
	42	110	17.5	84	186	55.5	70
	54	74.5	17.9	76	115	17.5	85
	213	26.7	4.81	82	32.6	4.22	84

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TABLE H.6 GEORGE SHOT DECONTAMINATION-TIME STUDY, ALUMINUM

DRONE ALTITUDE (ft × 10^{-3})	TIME AFTER DETONATION (hr)	ACTIVITY					
		Run No. 1			Run No. 2		
		Initial c/m (× 10^{-4})	Final c/m (× 10^{-4})	Per Cent Removed	Initial c/m (× 10^{-4})	Final c/m (× 10^{-4})	Per Cent Removed
24	5.75[a]	84.2	50.1	41	65.1	39.1	40
	11.5[a]	26.2	14.2	46	26.8	14.1	47
	23.5[a]	14.2	7.30	48	20.7	11.9	43
	35[a]	13.2	8.50	36	8.92	4.16	53
	38	42.7	19.5	54	60.7	31.8	48
	42	44.1	25.5	42	48.3	21.8	55
	52[a]	619	351	43	7.25	3.28	55
	54	48.1	24.6	49	38.4	18.1	53
	213	6.94	2.33	66	7.20	2.54	65
26	5.75[a]	151	39.7	74	151	42.4	72
	11.5[a]	72.7	20.4	72	221	50.4	77
	23.5[a]	85.9	21.6	75	69.0	22.8	67
	35[a]	66.7	42.2	37	76.3	43.4	43
	38	236	29.0	82			
	42	392	77.5	80	495	61.4	82
	52[a]	28.6	1.33	95	16.2	4.30	73
	54	137	24.0	82	174	31.1	82
	213	35.3	5.44	85	74.7	4.64	94
28	2.25[a]	346	76.4	78	378	109.7	71
	2.5[a]	266	73.6	72	273	70.2	74
	3.25[a]	223	96.8	57	248	74.8	70
	3.75[a]	175	56.6	68	142	42.2	71
	5.75[a]	101	35.6	65	90.5	36.0	60
	11.5[a]	73.1	25.2	66	54.6	23.0	58
	23.5[a]	21.5	8.94	58	18.8	6.93	63
	35[a]	14.1	5.00	65	13.0	4.36	66
	38	165	38.7	77	359	38.9	89
	42	201	60.3	70	216	76.1	65
	52[a]	9.83	3.46	65	6.88	2.91	58
	54	79.0	27.5	65	111	29.0	74
	213	17.2	6.23	66	26.2	6.51	75

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Appendix I

Influence of Prewetting on Decontamination Efficiency

The data obtained in the study concerned with the influence of prewetting on decontamination efficiency are given in Tables I.1 to I.6.

TABLE I.1 DOG SHOT PREWETTING EFFECT, OD PAINT

DRONE ALTITUDE (ft × 10^{-3})	PREWET Activity Initial c/m (× 10^{-4})	PREWET Activity Final c/m (× 10^{-4})	PREWET % Removed	PREWET Av % Removed	NONWET Activity Initial c/m (× 10^{-4})	NONWET Activity Final c/m (× 10^{-4})	NONWET % Removed	NONWET Av % Removed
16	180	27.5	85	82	140	22.0	84	85
	180	37.0	79		176	24.0	86	
18	600	60.0	90	91	605	47.7	92	92
	500	46.9	91		600	48.6	92	
20	15.0	0.62	96	94	37.5	8.50	77	77
	15.5	1.40	91		32.9	7.86	76	
22	7.40	1.70	77	74	10.3	1.82	82	83
	7.70	2.30	70		10.5	1.83	83	
24	3.43	1.62	53	55	3.09	0.84	73	72
	3.73	1.45	57		3.18	1.13	70	
26	21.0	6.50	69	71	27.4	4.50	84	82
	23.0	6.50	71		24.0	4.80	80	
28	12.1	3.32	73	75	11.7	1.95	83	85
	9.80	2.38	76		10.8	1.45	87	
30	13.7	3.92	71	68	7.99	1.93	76	78
	11.8	4.31	64		9.37	1.96	79	

TABLE I.2 DOG SHOT PREWETTING EFFECT, ALUMINUM

DRONE ALTITUDE (ft × 10⁻³)	PREWET Activity Initial c/m (× 10⁻⁴)	Final c/m (× 10⁻⁴)	% Removed	Av % Removed	NONWET Activity Initial c/m (× 10⁻⁴)	Final c/m (× 10⁻⁴)	% Removed	Av % Removed
16	255	43.3	83	81	240	37.5	85	84
	190	41.3	78		220	40.0	82	
18	750	25.0	93	92	700	13.5	98	97
	670	65.0	90		800	30.0	96	
20	31.8	0.72	98	98	37.6	7.73	79	77
	21.1	0.73	97		39.6	10.2	75	
22	10.2	3.20	69	74	13.8	1.91	86	85
	12.3	2.60	79		17.0	2.92	83	
24	3.76	2.14	43	47	4.55	1.78	61	62
	3.59	1.80	50		4.35	1.65	62	
26	21.0	5.50	74	74	24.6	6.60	73	74
	25.0	6.60	74		24.0	6.20	74	
28	14.9	3.51	76	73	14.9	3.51	76	73
	12.7	3.88	69		12.7	3.88	69	
30	21.7	7.03	68	62	10.1	3.17	69	71
	12.6	5.65	55		13.7	3.72	73	

TABLE I.3 EASY SHOT PREWETTING EFFECT, OD PAINT

DRONE ALTITUDE (ft × 10⁻³)	PREWET Activity Initial c/m (× 10⁻⁴)	Final c/m (× 10⁻⁴)	% Removed	Av % Removed	NONWET Activity Initial c/m (× 10⁻⁴)	Final c/m (× 10⁻⁴)	% Removed	Av % Removed
16	8.40	3.69	56	60	25.7	12.0	53	52
	10.5	3.92	63		18.5	9.5	51	
18	54.7	11.6	79	79	77.3	12.7	84	81
	45.9	10.2	78		79.2	17.2	78	
20	107.1	29.9	72	72	184.0	31.4	83	82
	98.4	21.5	72		154.0	30.5	80	
22	206.7	52.4	75	79	243.0	45.3	81	78
	150.8	27.4	82		176.0	46.2	74	
24	159.0	29.6	81	82	314.0	37.3	88	84
	132.7	22.8	83		187.0	38.3	79	
26	86.8	14.2	84	85	105.0	16.0	85	85
	74.8	10.9	86		126.0	31.0	85	
28	74.9	22.2	70	75	98.0	14.4	85	85
	52.0	11.1	79		70.4	18.0	84	
30	82.1	17.3	79	80	185.0	18.4	90	93
	104.7	21.4	80		192.0	10.1	95	

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TABLE I.4 EASY SHOT PREWETTING EFFECT, ALUMINUM

DRONE ALTITUDE (ft × 10^{-3})	PREWET Activity Initial c/m (× 10^{-4})	PREWET Activity Final c/m (× 10^{-4})	PREWET Activity % Removed	PREWET Activity Av % Removed	NONWET Activity Initial c/m (× 10^{-4})	NONWET Activity Final c/m (× 10^{-4})	NONWET Activity % Removed	NONWET Activity Av % Removed
16	8.74	4.09	53	42	18.1	8.5	53	48
	6.44	4.42	31		25.3	14.7	42	
18	61.3	17.0	72	72	89.6	12.4	86	86
	53.8	15.0	72		131.0	17.9	86	
20	92.8	23.1	75	78	112.0	21.7	81	82
	140.0	27.4	80		132.0	22.7	83	
22	166.3	50.2	70	71	336.0	38.1	88	88
	146.5	42.4	71		314.0	25.5	88	
24	136.9	30.6	78	79	233.0	25.5	89	88
	122.3	24.4	80		230.0	44.1	87	
26	84.4	15.0	82	79	105.0	20.7	80	83
	77.0	18.2	76		132.0	18.4	86	
28	83.8	24.1	71	72	56.5	9.6	83	86
	74.8	21.0	72		66.8	7.3	89	
30	70.1	10.9	84	80	212.0	12.6	94	92
	109.3	27.0	75		136.0	11.0	89	

TABLE I.5 GEORGE SHOT PREWETTING EFFECT, OD PAINT

DRONE ALTITUDE (ft × 10^{-3})	PREWET Activity Initial c/m (× 10^{-4})	PREWET Activity Final c/m (× 10^{-4})	PREWET Activity % Removed	PREWET Activity Av % Removed	NONWET Activity Initial c/m (× 10^{-4})	NONWET Activity Final c/m (× 10^{-4})	NONWET Activity % Removed	NONWET Activity Av % Removed
24	44.4	16.0	64	67	63.4	18.8	70	70
	39.4	11.7	70		49.7	15.4	69	
26	191.4	19.0	90	90	132.3	12.3	91	91
	128.3	14.5	89		118.7	11.8	90	
28	143.6	27.7	81	79	168.1	55.0	67	71
	145.8	34.3	77		154.0	37.9	75	

TABLE I.6 GEORGE SHOT PREWETTING EFFECT, ALUMINUM

DRONE ALTITUDE (ft × 10^{-3})	PREWET Activity Initial c/m (× 10^{-4})	PREWET Activity Final c/m (× 10^{-4})	PREWET Activity % Removed	PREWET Activity Av % Removed	NONWET Activity Initial c/m (× 10^{-4})	NONWET Activity Final c/m (× 10^{-4})	NONWET Activity % Removed	NONWET Activity Av % Removed
24	44.4	16.5	63	40	52.5	24.4	53	64
	40.7	26.7	34		90.3	23.9	74	
26	198.4	52.2	76	77	168.7	37.4	78	80
	190.4	43.5	77		174.8	33.7	81	
28	192.8	50.3	69	73	140.7	29.6	79	75
	142.8	34.2	76		146.1	41.6	71	

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Appendix J

Preferential Removal of Contaminant Species in Decontamination Operations

J.1 INTRODUCTION

The decay-rate data derived from decontaminated and nondecontaminated surfaces flown through an atomic cloud are given in this section. Counting was carried out through a series of aluminum absorbers as noted. The data have been plotted, and the resulting graphs appear in the figures designated in the last column of each table.

J.1.1 Dog Shot

Samples were taken from a drone airplane which flew through the bomb cloud at 30,000 ft. All experimental work was conducted at the ZI.

TABLE J.1 DOG SHOT DRONE DATA

MATERIAL	ABSORBER (mg/sq cm)	COUNTS PER MINUTE ($\times 10^{-3}$) AT NOTED TIMES AFTER DETONATION								
		55 hr	58 hr	96 hr	100 hr	143 hr	216 hr	262 hr	676 hr	Fig.
Nondecontaminated OD paint	55.7	26.4	24.2	12.5	11.6	7.62		3.94	1.22	J.1
	70.3	22.5	21.0	10.2	9.57	6.04	3.78	3.19	1.03	J.2
	109	15.0	14.0	6.73	6.19	4.02	2.52	2.13	0.913	J.3
	176	8.00	7.12	3.44	3.07	2.18	1.27	1.08	0.502	J.4
	217	5.38	4.97	2.27	2.01	1.31	0.837	0.718	0.286	J.5
	348	2.25	1.97	0.941	0.810	0.532	0.345	0.308	0.142	J.6
	692	0.670	0.607	0.374	0.318	0.224	0.221	0.134		J.7
	2,059	0.370	0.352	0.213	0.209	0.152	0.094	0.056		J.8
		53 hr	59 hr	95 hr	98 hr	145 hr	216 hr	265 hr	676 hr	Fig.
Decontaminated OD paint	55.7	9.96	9.61	4.02	3.83	2.09	1.24	0.953	0.319	J.1
	70.3	8.61	8.34	3.34	3.24	1.84	1.00	0.780	0.247	J.2
	109	5.84	5.63	2.18	2.10	1.20	0.643	0.552	0.108	J.3
	176	3.42	3.34	1.21	1.20	0.636	0.347	0.296	0.067	J.4
	217	2.85	2.12	0.796	0.808	0.438	0.254	0.242	0.041	J.5
	348	1.13	0.990	0.392	0.405	0.220	0.136	0.100		J.6
	692	0.410	0.373	0.184		0.112	0.069			J.7
	2,059	0.259	0.235	0.130	0.124	0.086	0.053	0.042		J.8

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J.1.2 Easy Shot

Samples were taken from a drone airplane which had been flown through the bomb cloud at 30,000 ft. All experimental work was conducted at the ZI unless otherwise noted.

Where it was apparent that decay constants could not be obtained from data extending over appreciable time intervals, i.e., where straight lines of adequate length could not be drawn, only the points obtained are given in the graphs.

TABLE J.2 EASY SHOT DRONE DATA

MATERIAL	ABSORBER (mg/sq cm)	COUNTS PER MINUTE ($\times 10^{-3}$) AT NOTED TIMES AFTER DETONATION							
		41 hr	42 hr	43 hr	44 hr	45 hr	47 hr	48 hr	Fig.
Nondecontaminated OD paint	2.6	936					768		J.9
	3.7	847					742		J.10
	4.6	808					713		J.11
	5.2	801							J.12
	7.9		759				650		J.13
	11.7		687					578	J.14
	13.0		656					568	J.15
	16.3		613					534	J.16
	20.5			578				489	J.17
	28.5			510					J.18
	32.4			455					J.19
	55.7			358					J.20
	85.4			249					J.23
	112			200					J.24
	138				149				J.25
	208				87.1				J.26
	287				48.3				J.28
	446				20.8				J.30
	692				9.06				J.32
	2,059					4.58			J.33
		49 hr	50 hr	51 hr	52 hr	53 hr	54 hr	55 hr	Fig.
	2.6						668		J.9
	3.7						625		J.10
	4.6						607		J.11
	5.2							579	J.12
	7.9							551	J.13
	11.7							474	J.14
	13.0							461	J.15
	16.3								J.16
	20.5								J.17
	28.5	418							J.18
	32.4	387							J.19
	55.7	301							J.20
	85.4		197						J.23
	112			144					J.24
	138			114					J.25
	208				63.7				J.26
	287				34.3				J.28
	446				14.7				J.30
	692				8.12				J.32
	2,059					4.12			J.33

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TABLE J.2—*Continued*

MATERIAL	ABSORBER (mg/sq cm)	COUNTS PER MINUTE ($\times 10^{-3}$) AT NOTED TIMES AFTER DETONATION							
		56 hr	57 hr	58 hr	59 hr	60 hr	60 hr	61 hr	Fig.
Nondecontaminated OD paint	2.6						603		J.9
	3.7						588		J.10
	4.6						563		J.11
	5.2						549		J.12
	7.9						512		J.13
	11.7							449	J.14
	13.0							420	J.15
	16.3	43[illegible]						400	J.16
	20.5	387						362	J.17
	28.5	317						297	J.18
	32.4		294					271	J.19
	55.7		212						J.20
	85.4		150						J.23
	112		115						J.24
	138			88.5					J.25
	208			51.3					J.26
	287			28.4					J.28
	446			13.4					J.30
	692				6.90				J.32
	2,059					4.70			J.33
		62 hr	63 hr	123 hr	124 hr	125 hr	126 hr	263 hr	Fig.
	2.6			261				104	J.9
	3.7			238				93.0	J.10
	4.6			234				89.0	J.11
	5.2			232				86.0	J.12
	7.9			203					J.13
	11.7			173					J.14
	13.0			168					J.15
	16.3				152				J.16
	20.5				149				J.17
	28.5				111				J.18
	32.4				105				J.19
	55.7	191			76.8				J.20
	85.4	135			50.0				J.23
	112	101			37.0				J.24
	138	79.6			28.8				J.25
	208	44.0				15.3			J.26
	287	23.6				8.18			J.28
	446	10.5				3.54			J.30
	692	6.21				2.61			J.32
	2,059		3.75				1.71		J.33

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TABLE J.2—*Continued*

MATERIAL	ABSORBER (mg/sq cm)	COUNTS PER MINUTE (×10⁻³) AT NOTED TIMES AFTER DETONATION							
		264 hr	266 hr	267 hr	268 hr	741 hr	743 hr	744 hr	Fig.
Nondecontaminated OD paint	2.6					34.8			J.9
	3.7					34.0			J.10
	4.6					32.4			J.11
	5.2					31.6			J.12
	7.9	79.6				30.0			J.13
	11.7	70.3				25.8			J.14
	13.0	67.2				25.5			J.15
	16.3	62.2				25.3			J.16
	20.5	56.6				21.3			J.17
	28.5	48.5				19.0			J.18
	32.4		43.9			16.5			J.19
	55.7		32.2				12.3		J.20
	85.4		22.2				8.96		J.23
	112		16.3				6.76		J.24
	138			12.5			5.49		J.25
	208			6.99			3.29		J.26
	287			3.65			1.74		J.28
	446			1.05			0.847		J.30
	692				1.10			0.676	J.32
	2,059				0.719			0.243	J.33
		41 hr	42 hr	43 hr	44 hr	45 hr	47 hr	48 hr	Fig.
Decontaminated OD paint	2.6	120					94.0		J.9
	3.7	104					89.6		J.10
	4.6	99.2					87.0		J.11
	5.2	97.3							J.12
	7.9		91.5				79.2		J.13
	11.7		80.8					69.2	J.14
	13.0		78.7					68.0	J.15
	16.3		72.0					62.8	J.16
	20.5			67.6				57.3	J.17
	28.5			58.8					J.18
	32.4			55.2					J.19
	55.7			42.9					J.20
	85.4			31.0					J.23
	112			24.5					J.24
	138				19.7				J.25
	208				14.1				J.26
	287				6.95				J.28
	446				3.14				J.30
	692				1.46				J.32
	2,059					0.73			J.33

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TABLE J.2—*Continued*

MATERIAL	ABSORBER (mg/sq cm)	COUNTS PER MINUTE ($\times 10^{-3}$) AT NOTED TIMES AFTER DETONATION							
		49 hr	50 hr	51 hr	52 hr	53 hr	54 hr	55 hr	Fig.
	2.6						77.7		J.9
	3.7						75.3		J.10
	4.6						71.9		J.11
	5.2							69.9	J.12
	7.9							64.9	J.13
	11.7							56.8	J.14
	13.0							55.0	J.15
	16.3								J.16
	20.5								J.17
	28.5	50.0							J.18
	32.4	47.4							J.19
	55.7	35.5							J.20
	85.4		25.2						J.23
	112			18.3					J.24
	138			14.6					J.25
	208				8.58				J.26
	287				4.80				J.28
	446				2.17				J.30
	692				1.22				J.32
Decontaminated OD paint	2,059					0.62			J.33
		56 hr	57 hr	58 hr	59 hr	60 hr	60 hr	61 hr	Fig.
	2.6						73.0		J.9
	3.7						66.8		J.10
	4.6						64.8		J.11
	5.2						63.0		J.12
	7.9						59.4		J.13
	11.7							50.9	J.14
	13.0							50.1	J.15
	16.3	50.5						46.1	J.16
	20.5	45.4						41.4	J.17
	28.5	39.7						35.0	J.18
	32.4		36.3					32.9	J.19
	55.7		26.7						J.20
	85.4		19.0						J.23
	112		14.5						J.24
	138			11 5					J.25
	208			6.23					J.26
	287			3.81					J.28
	446			1.81					J.30
	692				1.14				J.32
	2,059					0.55			J.33

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TABLE J.2—*Continued*

MATERIAL	ABSORBER (mg/sq cm)	COUNTS PER MINUTE ($\times 10^{-3}$) AT NOTED TIMES AFTER DETONATION							
		62 hr	63 hr	123 hr	124 hr	125 hr	126 hr	263 hr	Fig.
Decontaminated OD paint	2.6			28.9				10.7	J.9
	3.7			27.1				9.98	J.10
	4.6			26.3				9.55	J.11
	5.2			25.4				9.25	J.12
	7.9			23.2					J.13
	11.7			20.0					J.14
	13.0			19.6					J.15
	16.3				17.6				J.16
	20.5				15.7				J.17
	28.5				12.8				J.18
	32.4				11.8				J.19
	55.7	24.4			8.08				J.20
	85.4	16.8			5.44				J.23
	112	12.8			4.06				J.24
	138	8.56			3.11				J.25
	208	5.64				1.65			J.26
	287	3.16				0.948			J.28
	446	1.53				0.448			J.30
	692	0.994				0.351			J.32
	2,059		0.550				0.238		J.33
		264 hr	266 hr	267 hr	268 hr	741 hr	743 hr	744 hr	Fig.
	2.6					3.67			J.9
	3.7					3.39			J.10
	4.6					3.30			J.11
	5.2					3.29			J.12
	7.9	8.52				3.02			J.13
	11.7	7.38				2.57			J.14
	13.0	7.06				2.53			J.15
	16.3	6.27				2.31			J.16
	20.5	5.70				2.02			J.17
	28.5	4.68				1.81			J.18
	32.4		4.28			1.67			J.19
	55.7		2.96				1.18		J.20
	85.4		2.02				0.851		J.23
	112		1.43				0.581		J.24
	138			1.16			0.503		J.25
	208			0.625			0.305		J.26
	287			0.362			0.189		J.28
	446			0.196			0.108		J.30
	692				0.124			0.0602	J.32
	2,059				0.077				J.33

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Table J.2—*Continued*

MATERIAL	ABSORBER (mg/sq cm)	COUNTS PER MINUTE ($\times 10^{-3}$) AT NOTED TIMES AFTER DETONATION [a]							
		82 hr	92 hr	98 hr	115 hr	125 hr	138 hr	152 hr	Fig.
Nondecontaminated OD paint	55.7	102	90.9	89.6	69.3	59.3	57.0	50.3	J.21
	83.2	72.9	64.1	63.4	48.8	42.3	44.9	35.5	J.22
	219	20.7	17.2	16.5	12.8	10.6	10.4	9.51	J.27
	433	4.70	3.99	3.87	3.16	2.70	2.70	2.56	J.29
		176 hr	199 hr	220 hr	246 hr	268 hr	294 hr	316 hr	Fig.
	55.7	41.0	36.3	34.1	31.5	28.6	26.1	24.2	J.21
	83.2	29.2	26.0	24.5	22.6	20.7	18.7	17.4	J.22
	219	7.53	6.87	6.48	5.95	5.46	4.94	4.63	J.27
	433	2.20	1.86	1.65	1.46	1.36	1.22	1.13	J.29
Decontaminated OD paint		7.2 hr	8.0 hr	9.2 hr	9.7 hr	10.2 hr	11.6 hr	12.3 hr	Fig.
	55.7	347	292	247	237	219	187	172	J.21
	83.2	298	252	207	198	186	156	145	J.22
	219	141	131	110	103	94.9	79.0	69.7	J.27
	433	56.9	52.8	46.8	41.5	39.8	31.5	29.1	J.29
	545	35.7	33.8	27.4	25.9	24.2	20.1	18.8	J.31
		13.4 hr	14 hr	15 hr	16.5 hr	18 hr	19.5 hr	20.8 hr	Fig.
	55.7	156	145	140	115	99.5	87.8	79.7	J.21
	83.2	131	120	107	92.5	81.9	72.4	64.6	J.22
	219	64.5	60.0	53.2	44.8	38.3	33.1	29.4	J.27
	433	26.1	23.6	20.4	17.5	14.7	12.7	10.7	J.29
	545		15.1	13.1	11.0	9.29	7.91	6.91	J.31
		22.3 hr	23.6 hr	26 hr	29 hr	32 hr	39 hr	42 hr	Fig.
	55.7	70.7	65.2	50.3	43.4	37.6	28.1	24.9	J.21
	83.2	58.2	51.5	42.6	34.5	29.1	21.6	20.6	J.22
	219	25.5	22.7	17.8	13.9	11.5	7.93	6.91	J.27
	433	9.00	8.17	6.31	4.87	3.92	2.56	2.17	J.29
	545	6.05	5.27	3.90	3.07	2.57	1.67	1.41	J.31
		45 hr	49 hr	54 hr	62 hr	69 hr	78 hr	84 hr	Fig.
	55.7	22.1	19.3	16.5	13.3	11.4	8.59	8.30	J.21
	83.2	17.8	15.7	12.6	9.67	8.20	6.13	5.45	J.22
	219	5.87	4.88	3.84	3.06	2.40	1.69	1.53	J.27
	433	1.77	1.49	1.14	0.860	0.698	0.451		J.29
	545	1.18	1.01						J.31
		91 hr	102 hr	125 hr	141 hr	152 hr	176 hr	198 hr	Fig.
	55.7	6.95	5.89	4.64	3.99	3.35	2.84	2.42	J.21
	83.2	4.86	4.15	3.18	2.81	2.36	1.99	1.67	J.22
	219	1.30	1.18	0.908	0.828	0.725	0.617	0.524	J.27
	433		0.398	0.430	0.349	0.305	0.268	0.201	J.29
		223 hr	244 hr	266 hr	291 hr	314 hr	338 hr	367 hr	Fig.
	55.7	2.06	1.80	1.65	1.49	1.22	1.10	1.16	J.21
	83.2	1.44	1.22	1.12	1.01	0.842	0.791	0.760	J.22
	219	0.444	0.357	0.302	0.284	0.231	0.215		J.27
	433	0.168							J.29

[a] Experimental work done at site.

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J.1.3 George Shot

Samples were taken from a drone airplane flown through the atomic cloud at 28,000 ft. Unless otherwise noted, all experimental work was done at the site.

TABLE J.3 GEORGE SHOT DRONE DATA

MATERIAL	ABSORBER (mg/sq cm)	COUNTS PER MINUTE ($\times 10^{-3}$) AT NOTED TIMES AFTER DETONATION					
		8.8 hr	9.7 hr	12.1 hr	15.6 hr	20 hr	Fig.
Nondecontaminated OD paint	83.2	1,210	1,140	786	685	512	J.34
	219	628	590	380	334	222	J.35
	679	106	100	57.8	46.3	28.8	J.36
	1,610	18.2	16.6	10.7	9.00	7.07	J.37
	3,380	16.4	15.0	9.6	8.15	6.36	J.38
		25 hr	30 hr	36 hr	47 hr	54 hr	Fig.
	83.2	311	234	168	138	90.4	J.34
	219	115	85.2	59.6	40.1	29.0	J.35
	679	16.3	12.1	7.91	5.55	3.96	J.36
	1,610	4.80	4.37	3.50	2.88	2.23	J.37
	3,380	4.33	4.00	3.05	2.50	1.98	J.38
		60 hr	71 hr	76 hr	85 hr	314 hr	Fig.
	83.2	80.9	60.2	53.8	45.4	6.72[a]	J.34
	219	23.1	17.9	15.2	12.6	1.54[a]	J.35
	679	3.27	2.57	2.32	1.96	0.254[a]	J.36
	1,610	2.08	1.72	1.63	1.45	0.200[a]	J.37
	3,380	1.76	1.53	1.38	1.26	0.180[a]	J.38
		9.1 hr	10.3 hr	11.5 hr	15.9 hr	20 hr	Fig.
Decontaminated OD paint	83.2	138	120	105	65.8	47.2	J.34
	219	73.8	64.1	55.2	33.1	22.2	J.35
	679	12.3	10.8	9.05	5.30	3.28	J.36
	1,610	1.91	1.66	1.46	0.953	0.727	J.37
	3,380	1.75	1.49	1.32	0.863	0.660	J.38
		28 hr	36 hr	42 hr	48 hr	55 hr	Fig.
	83.2	27.0	17.8	14.7	12.1	9.50	J.34
	219	11.3	6.96	5.26	4.11	3.18	J.35
	679	1.83	1.02	0.752	0.602	0.461	J.36
	1,610	0.516	0.390	0.331	0.292	0.250	J.37
	3,380	0.460	0.317	0.292	0.264	0.250	J.38
		62 hr	72 hr	78 hr	85 hr		Fig.
	83.2	7.82	6.05	5.10	4.53		J.34
	219	2.47	1.82	1.53	1.35		J.35
	679	0.370	0.325	0.254	0.230		J.36
	1,610	0.218		0.179	0.169		J.37
	3,380	0.191	0.177	0.160	0.153		J.38

[a] Experimental work done at the ZI.

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Appendix K

Fractionation of the Contaminant in the Atomic Cloud or in the Contamination Process

The rate of decay of the radioactive materials deposited on drone aircraft is given in Tables K.1 to K.3. Each activity given in the tables is, unless otherwise noted, the mean of four to seven measurements taken within 2 hr of the noted time.

The Dog and Easy Shot measurements were carried out at the ZI. George Shot measurements were made at the site.

TABLE K.1 DOG SHOT MEASUREMENTS

DRONE ALTITUDE ($ft \times 10^{-3}$)	COUNTS PER MINUTE ($\times 10^{-4}$) AT NOTED TIMES AFTER DETONATION								
	56 hr	59 hr	96 hr	100 hr	144 hr	168 hr	215 hr	238 hr	652 hr
16	308	303	164	145	93.9	78.1	52.5	46.2	14.8
18	344	338	203	189	118	95.0	64.7	61.0	17.5
20	30.6	27.9	18.6	16.9	12.2	10.1	7.12	6.22	2.34
22	13.7	13.6	8.15	7.45	5.45	4.54	3.18	2.70	1.11
24	6.31	6.06	3.72	3.47	2.38	1.99	1.35	1.19	0.495
26	6.23	6.00	3.51	3.27	2.22	1.82	1.26	1.07	
28	26.5	26.1	16.0	14.7	10.6	9.07	6.42	5.72	2.40

TABLE K.2 EASY SHOT MEASUREMENTS

DRONE ALTITUDE ($ft \times 10^{-3}$)	COUNTS PER MINUTE ($\times 10^{-4}$) AT NOTED TIMES AFTER DETONATION								
	42 hr	55 hr	60 hr	67 hr	87 hr	104 hr	130 hr	263 hr	750 hr
16	7.07	7.12	5.95	5.49	3.91	2.98	2.14	0.808	0.207
18	27.2	25.2	22.0	19.8	14.3	11.6	8.49	3.63	1.00
20	63.1	58.7	53.0	47.1	35.1	28.1	21.0	8.73	2.34
22	74.5	68.7	61.3	54.4	42.1	34.0	24.8	11.1	3.20
24	74.4	69.6	62.6	56.5	42.3	33.9	24.5	10.5	2.91
26	63.5	58.3	51.5	45.1	32.4	25.6	18.7	7.70	2.34
28	22.2	20.4	18.0	15.9	11.9	9.54	7.01	3.10	0.890

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Table K.3 GEORGE SHOT MEASUREMENTS

DRONE ALTITUDE ($ft \times 10^{-3}$)	COUNTS PER MINUTE ($\times 10^{-4}$) AT NOTED TIMES AFTER DETONATION						
	1.3 hr	1.5 hr	2.2 hr	3.0 hr	4.0 hr	4.6 hr	5.1 hr
28	(~1,850)[a]	(~1,540)[a]	(~1,200)[a]	740[b]	580[b]	480	420
	5.8 hr	6.4 hr	6.9 hr	8.0 hr	9.1 hr	10.0 hr	11.4 hr
	370[b]	340[b]	310[b]	280[b]	240[b]	230	210
	12.5 hr	15.6 hr	20 hr	23 hr	28 hr	30 hr	36 hr
	190	143[b]	122[b]	102[b]	78.4	76.9	61.6
	42 hr	46 hr	54 hr	60 hr	71 hr	77 hr	85 hr
	63.3[b]	62.7[b]	43.6[b]	38.6[b]	35.4[b]	31.2[b]	25.5[b]

[a] Great uncertainty in this value because of coincidence loss at high counting rate.
[b] Value shown is mean of two measurements taken within 30 min of time noted.

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Appendix L

Personnel Logistics

L.1 ROSTER OF PERSONNEL

Badger, Frank S., Pvt. Post-shot location: ACC
Responsible for the statistical validity of the ACC procedures and results.

Baum, Sanford. Post-shot location: USNRDL
At the ZI did work on decontamination as a function of time (responsible for Figs. 3.13 to 3.19) and on the contaminability-decontaminability of materials. Aided in plotting decay and absorption data.

Bigger, Michael M. Post-shot location: USNRDL
Worked on chemical methods of decontamination, setting up and operating test equipment. At the test site, aided in installation and removal of test panels.

Chambers, Henry A. Post-shot location: ACC
At the ZI was responsible for the counting procedures and techniques employed with the ACC work.

Gatto, Arthur C., Pvt. Post-shot location: ACC
Carried out decontamination operations on the ACC test surfaces.

Gevantman, Lewis H. Post-shot location: USNRDL
Evaluated the influence of prewetting on ease of decontamination.

Gordon, Malcolm G. Post-shot location: ACC
Supervised all phases of the ACC work at the ZI.

Graham, Lloyd J. Post-shot location: USNRDL
Aided in the experimental work on testing of decontamination agents.

Greendale, Allen E. Post-shot location: USNRDL
Conducted early decay and absorption measurements at the test site. Carried out work with experimental samples 1 hr after contamination.

Headley, Francis E., Capt. Post-shot location: ACC
Assisted in the ACC work at the Forward Area.

Klapper, Harold. Post-shot location: ACC
At the ZI carried out autoradiographic studies on materials exposed by the ACC.

Lane, William B. Post-shot location: USNRDL
At the ZI carried out work on testing of decontamination agents. In this capacity, is responsible for Table 3.11 and Sec. G.2.

Lai, John R. Post-shot location: USNRDL
Carried out radiochemical analyses on returned specimens. Analyzed an extremely large volume of decay and absorption data and was responsible for Tables 3.14 and 3.15 and Figs. 3.20 to 3.22.

Macdonald, Douglas. Post-shot location: USNRDL
Conducted early measurements on decontamination as a function of time. Manipulated experimental materials 1 hr after contamination.

Mackin, James L. Post-shot location: USNRDL
Conducted radiochemical analyses on the returned materials and is responsible for Table 3.13.

Pestaner, James F. Post-shot location: USNRDL
At the test site made some early contamination-decontamination measurements. Upon return to ZI, conducted autoradiographic studies on small samples (responsible for Figs. 3.1 and 3.2).

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Pierce, John A., Capt. Post-shot location: ACC
Was responsible at the Forward Area for all phases of the ACC portion of Project 6.7.

Price, J. R., Lt. Post-shot location: ACC
Was responsible for the calibration and maintenance of the counting equipment employed at the ACC.

Prostak, Arnold S. Post-shot location: ACC
Conducted autoradiographic work at the ACC.

Rinnert, Heinz R. Post-shot location: USNRDL
Responsible for the counting operations in the investigation of chemical methods of decontamination and for Figs. 3.5 through 3.8.

Sam, Daniel. Post-shot location: USNRDL
Aided in evaluating the influence of prewetting on decontamination efficiency.

Schuert, Edward A. Post-shot location: USNRDL
After the fall-out on Dog Shot, initiated and carried out impromptu studies on the distribution of contamination. At the ZI set up counting equipment used in the investigation of chemical methods of decontamination. Responsible for Figs. 3.3 and 3.4.

Seid, Paul E., Pvt. Post-shot location: ACC
Conducted decontamination operations on the ACC test panels.

Shirasawa, Taheo H. Post-shot location: USNRDL
Conducted decontamination and autoradiographic operations in the study of chemical methods of decontamination.

Singer, Bernard. Post-shot location: USNRDL
At the ZI coordinated the experimental work on returned materials. Directed and scheduled the efforts of the entire group of chemists working on materials returned to the ZI.

Sinclair, Kenneth. Post-shot location: USNRDL
Aided in the design of experimental counting equipment. At the test site, maintained the counting equipment employed by Project 6.7.

Sinnreich, Simon R., Lt. Col. Post-shot location: ACC
Was responsible for the planning and proper execution of all phases of the ACC endeavor in Project 6.7.

Soule, Richard R. Post-shot location: USNRDL
Worked on chemical methods of decontamination and aided in the installation and removal of test samples. At the site, constructed air-sampling devices used by another project.

Strom, Peter O., Jr. Post-shot location: USNRDL
Working at the ZI, he carried out measurements of decontamination as a function of time and on the contaminability-decontaminability of materials.

Wellhouser, Harry N. Post-shot location: USNRDL
Was responsible for the studies on industrial methods of decontamination. In this capacity, scheduled experiments and arranged for equipment and supplies necessary to the investigation.

Werner, Louis B. Post-shot location: USNRDL
As Project Officer for Project 6.7 was responsible for the planning and execution of the entire endeavor at the test site. Directed the handling and packing of contaminated Dog Shot experimental material.

Zigman, Paul E. Post-shot location: USNRDL
Assisted in detailed experimental planning of Project 6.7. Compiled lists of equipment and supplies and assured shipment of materials to test site. Measured decay and absorption characteristics of experimental samples at the test site. Assumed complete responsibility for the assembly and compilation of data and writing of the final report.

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L.2 SHIPPING SCHEDULE

	ACC	*USNRDL*
Forward		
Sea Lift (tons)	3.2	22.5
Sea Lift (cu ft)	197	1,800
Air Lift (lb)	5,024	4,840
Air Lift (cu ft)	139	260
Return		
Sea Lift (tons)	2.6	20.9
Sea Lift (cu ft)	149	1,617
Air Lift (lb)	5,752	3,329
Air Lift (cu ft)	119	158

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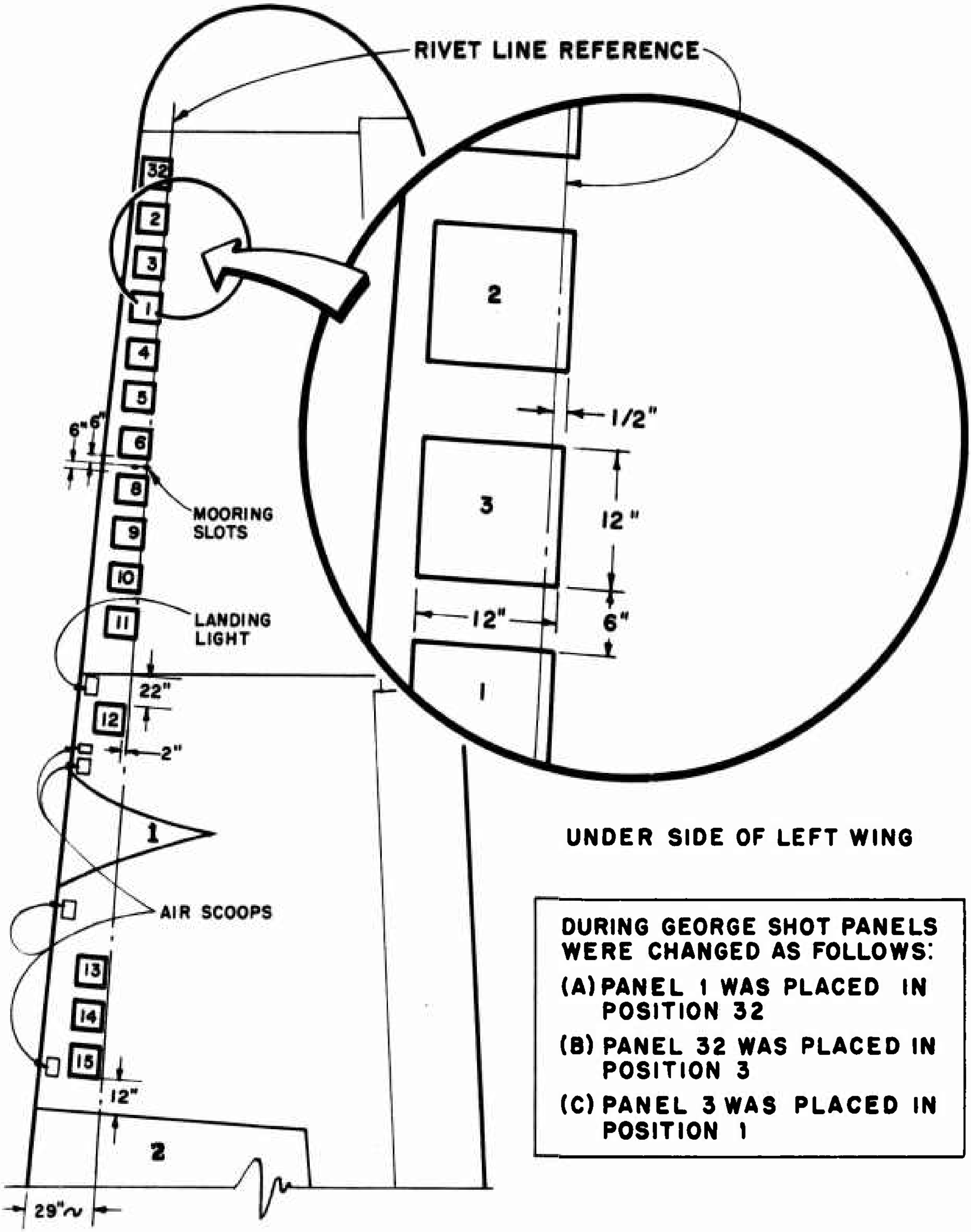

FIG. 2.1 Location and Position Number of USNRDL Panels—Wing

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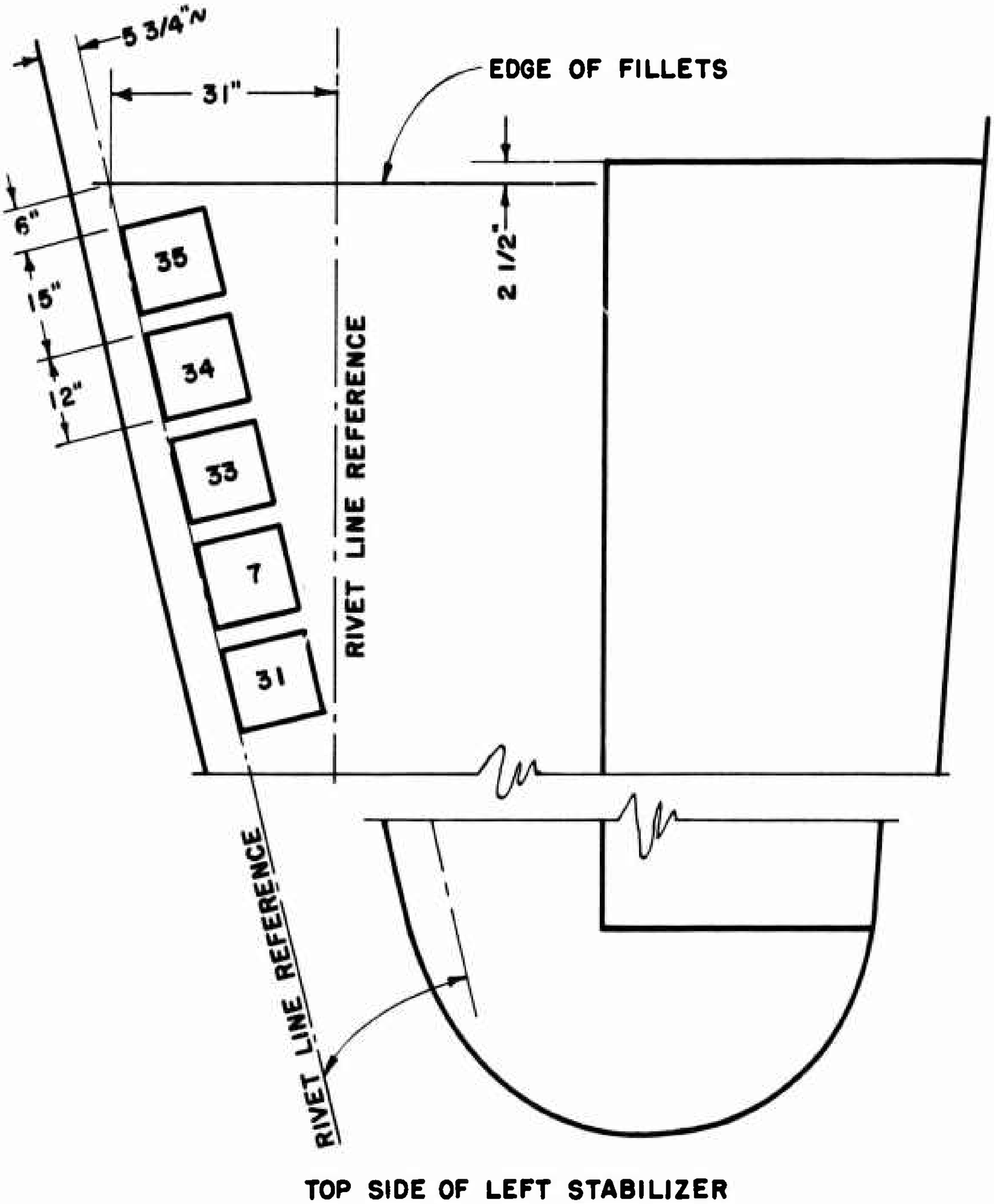

FIG. 2.2 Location and Position Number of USNRDL Panels—Horizontal Stabilizer

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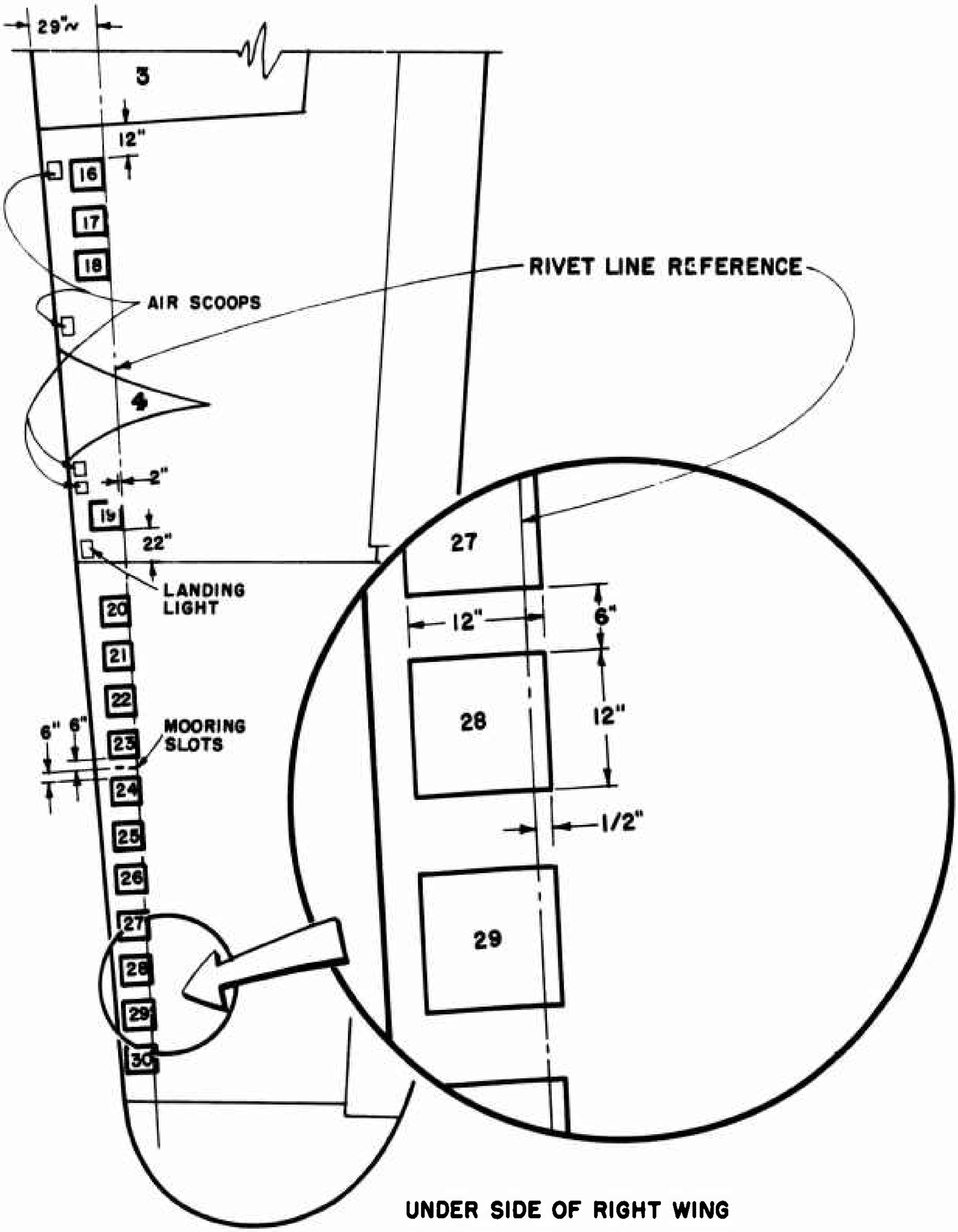

FIG. 2.3 Location and Position Number of ACC Panels—Wing

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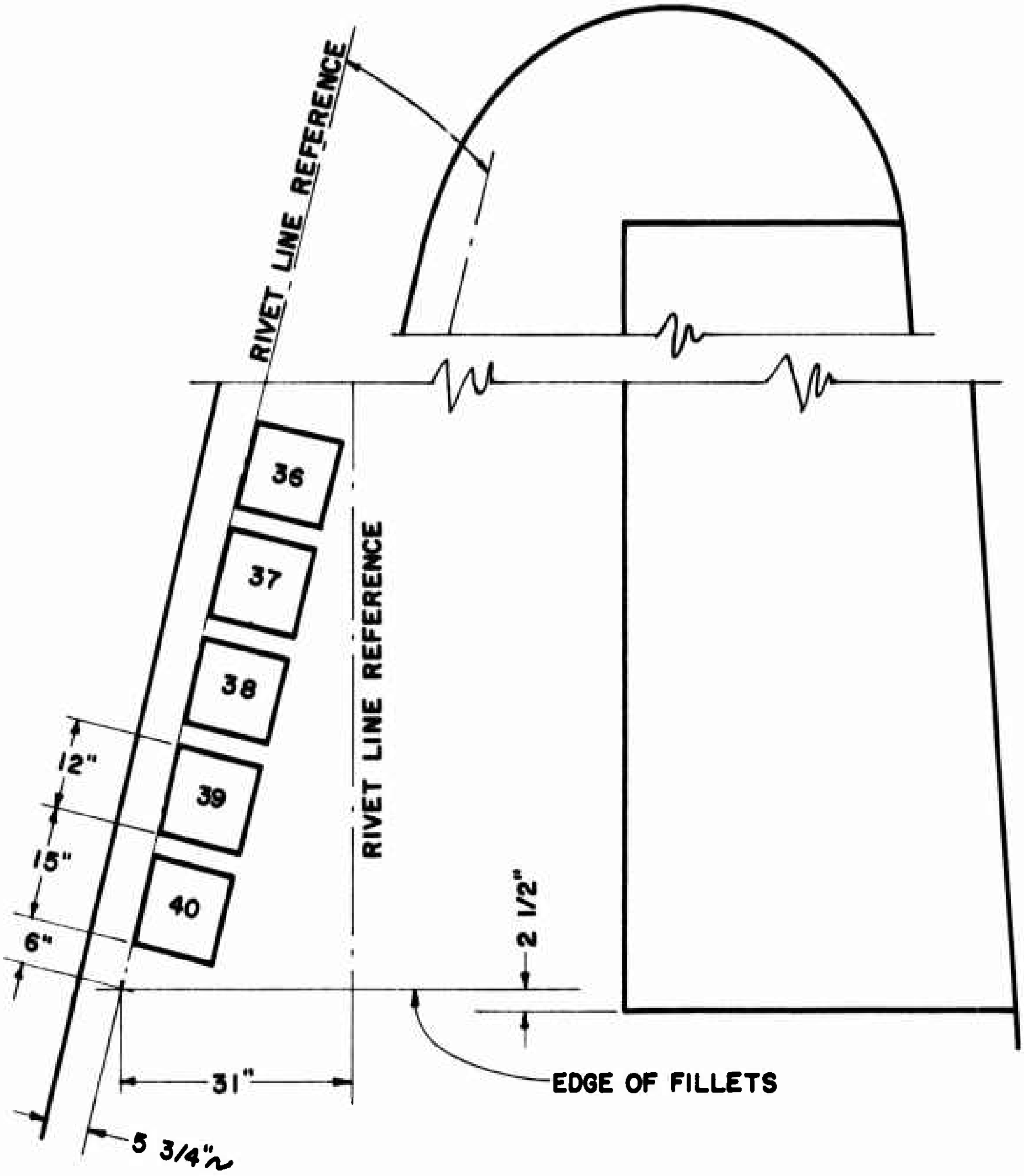

TOP SIDE OF RIGHT STABILIZER

FIG. 2.4 Location and Position Number of ACC Panels—Horizontal Stabilizer

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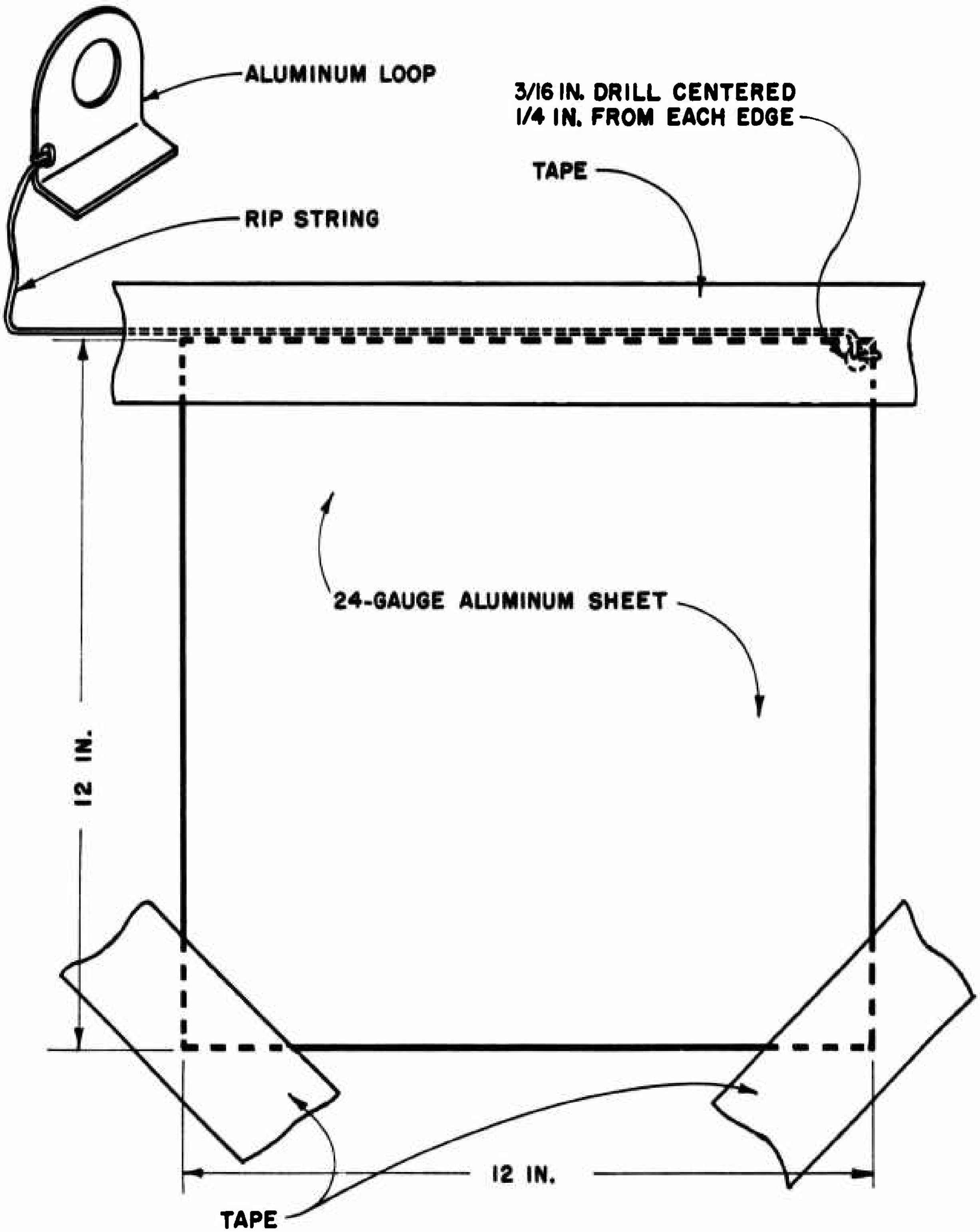

FIG. 2.5 Attachment of Test Panels to Drone Aircraft

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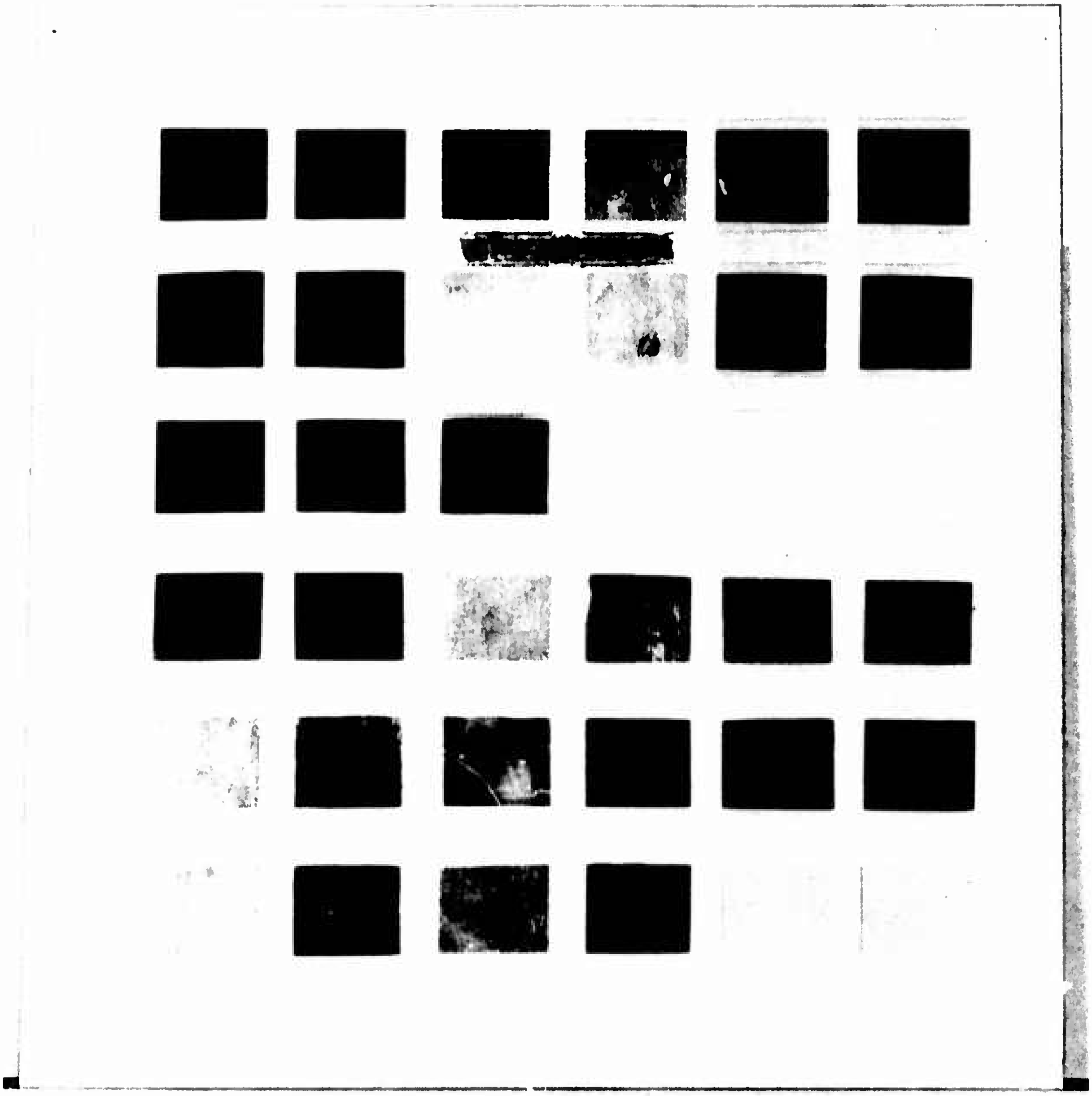

FIG. 2.6 Attachment of USNRDL 1¼-in. Test Plates to Panels

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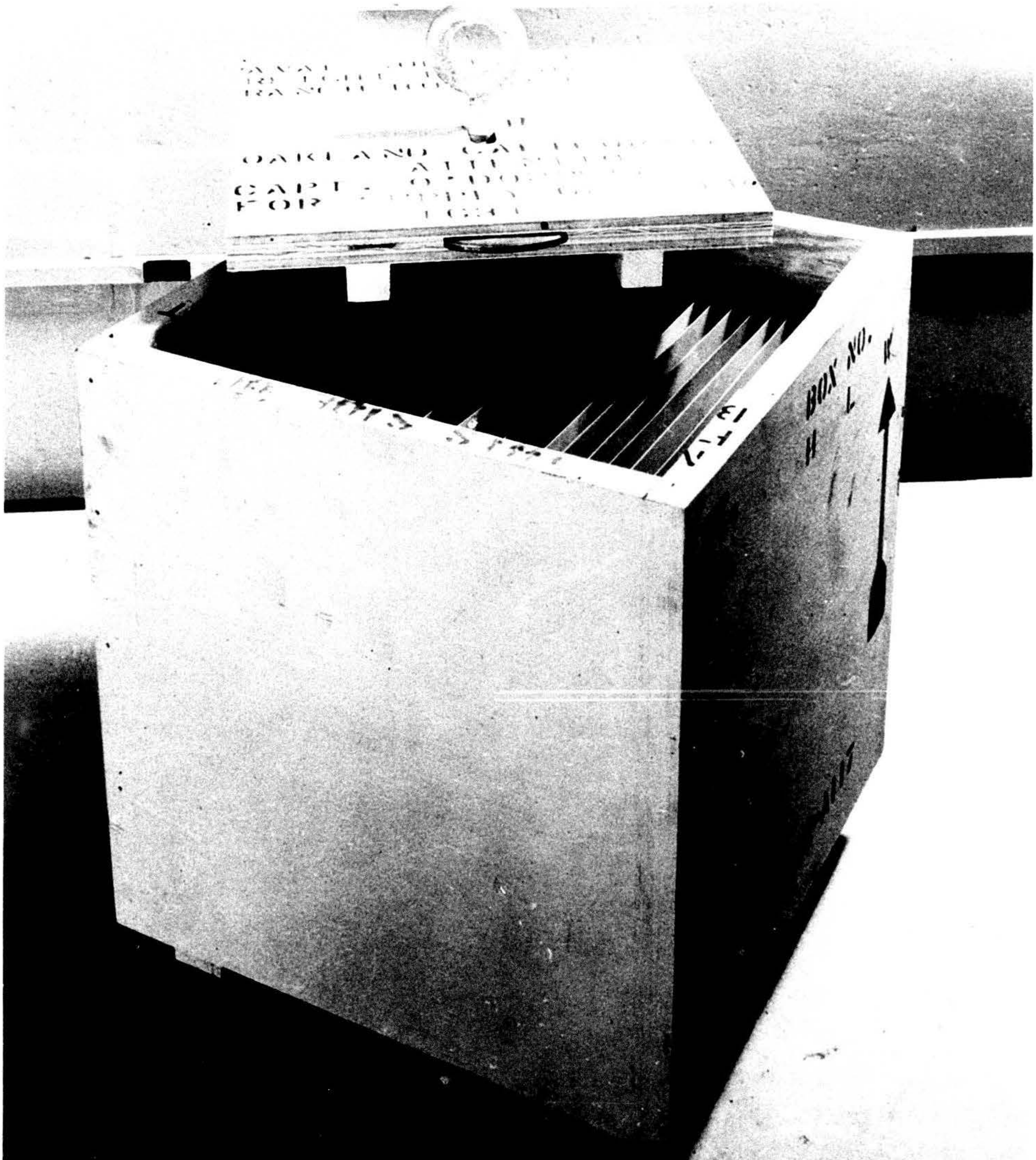

FIG. 2.7 Container Used to Ship Radioactive Test Panels

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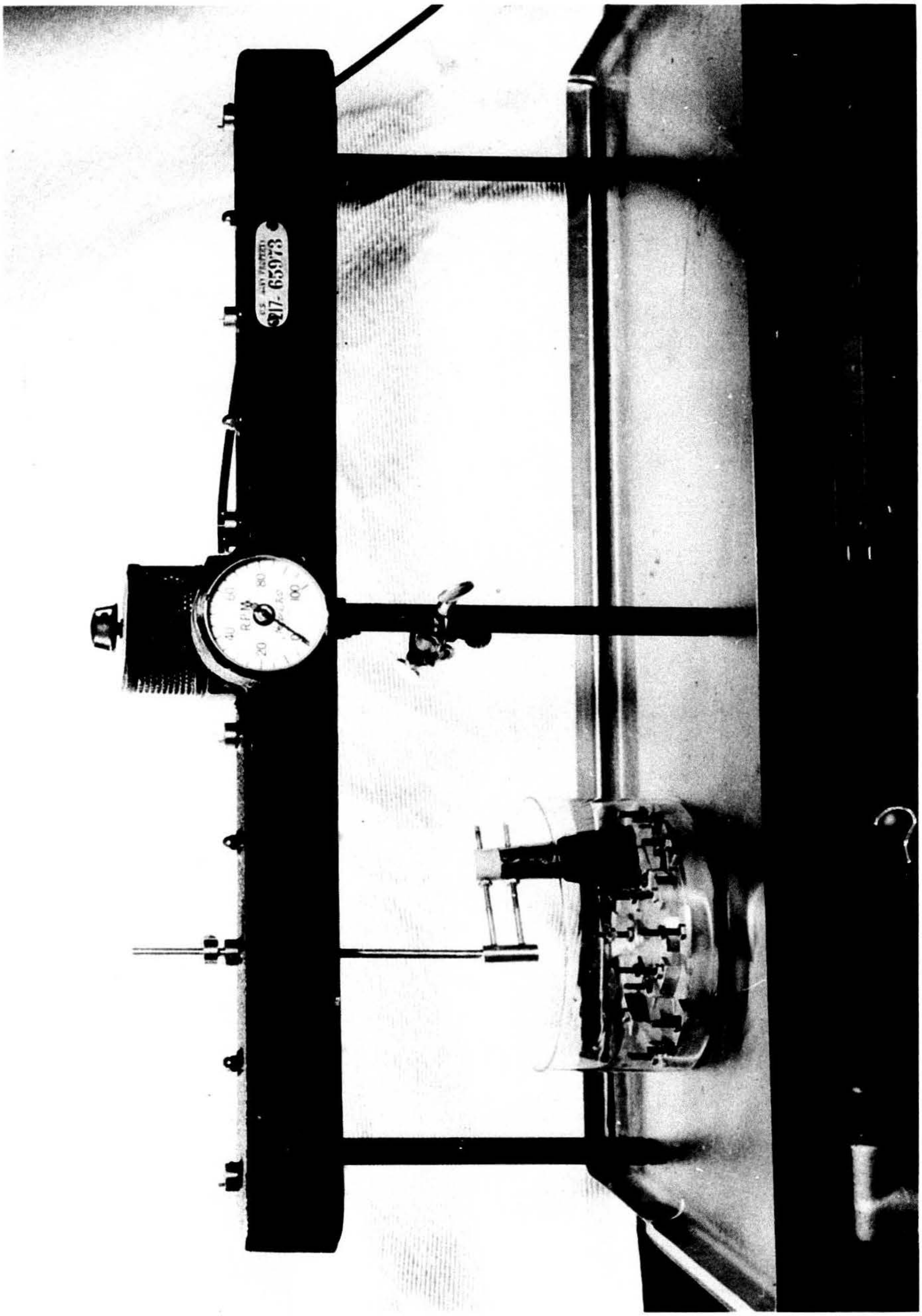

FIG. 2.8 Decontamination Unit

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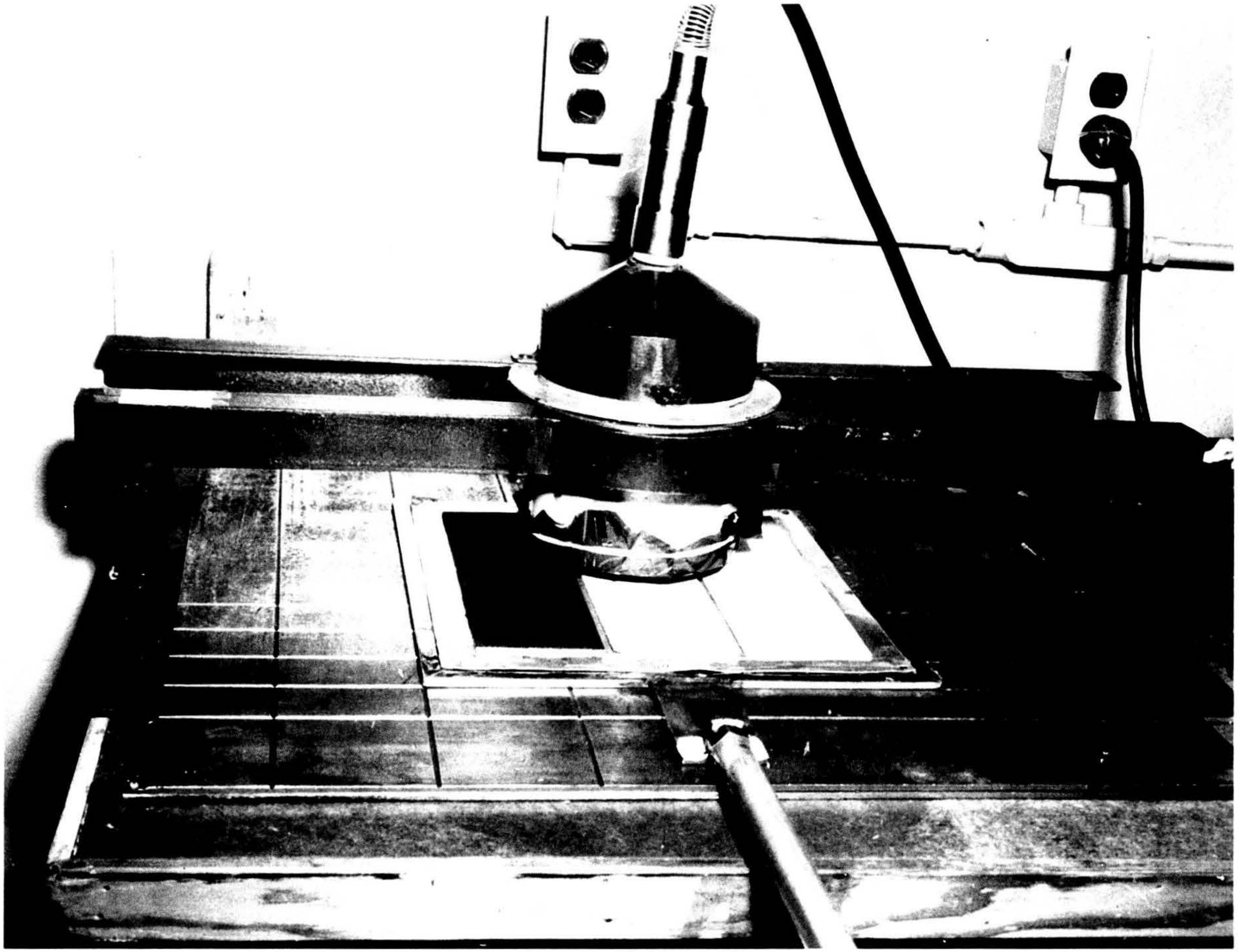

FIG. 2.9 Shielded Directional End-window Detector

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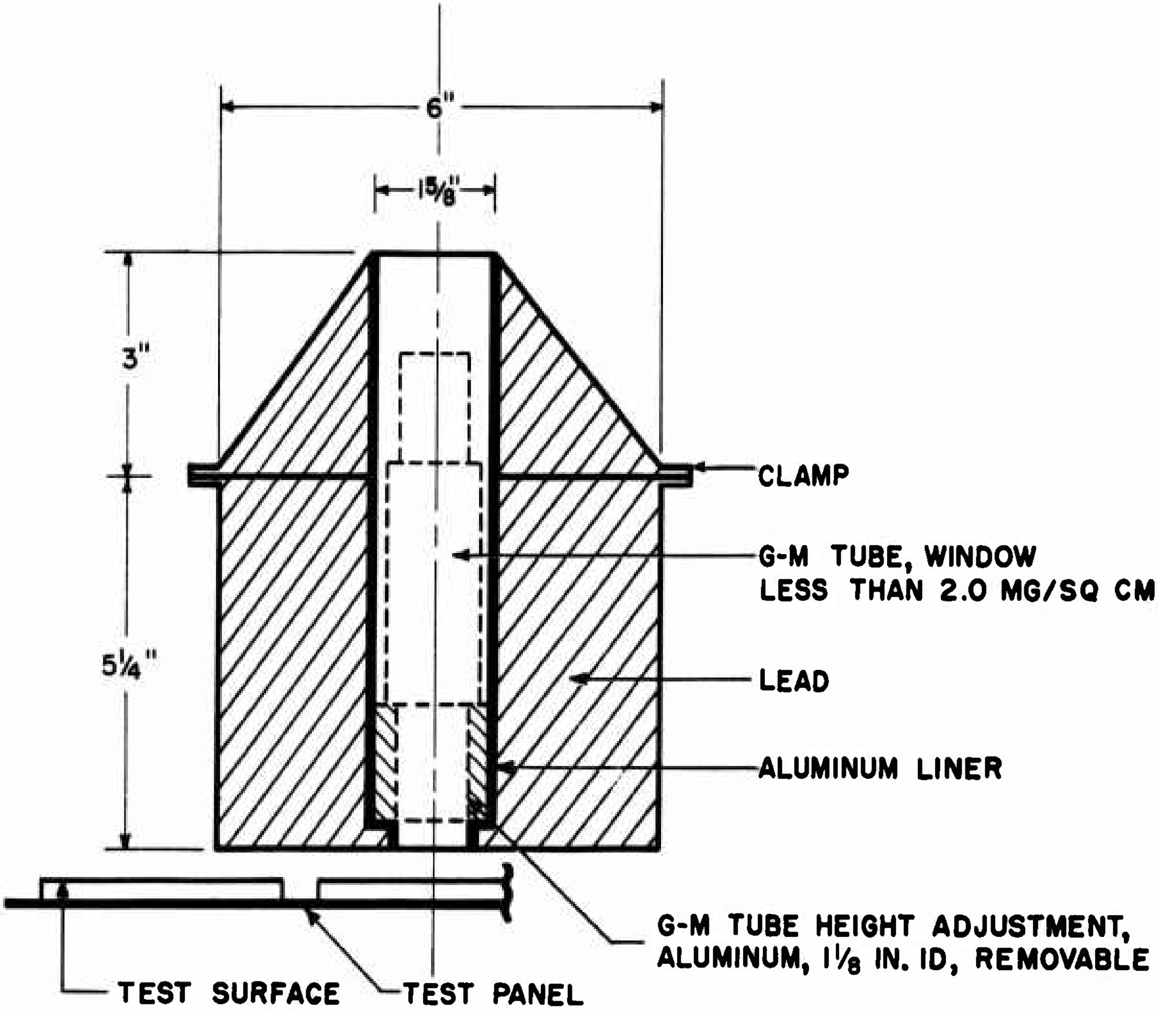

Fig. 2.10 Schematic Diagram of End-window Detector

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FIG. 2.11 Shielded Caves Employed in Making Autoradiographs

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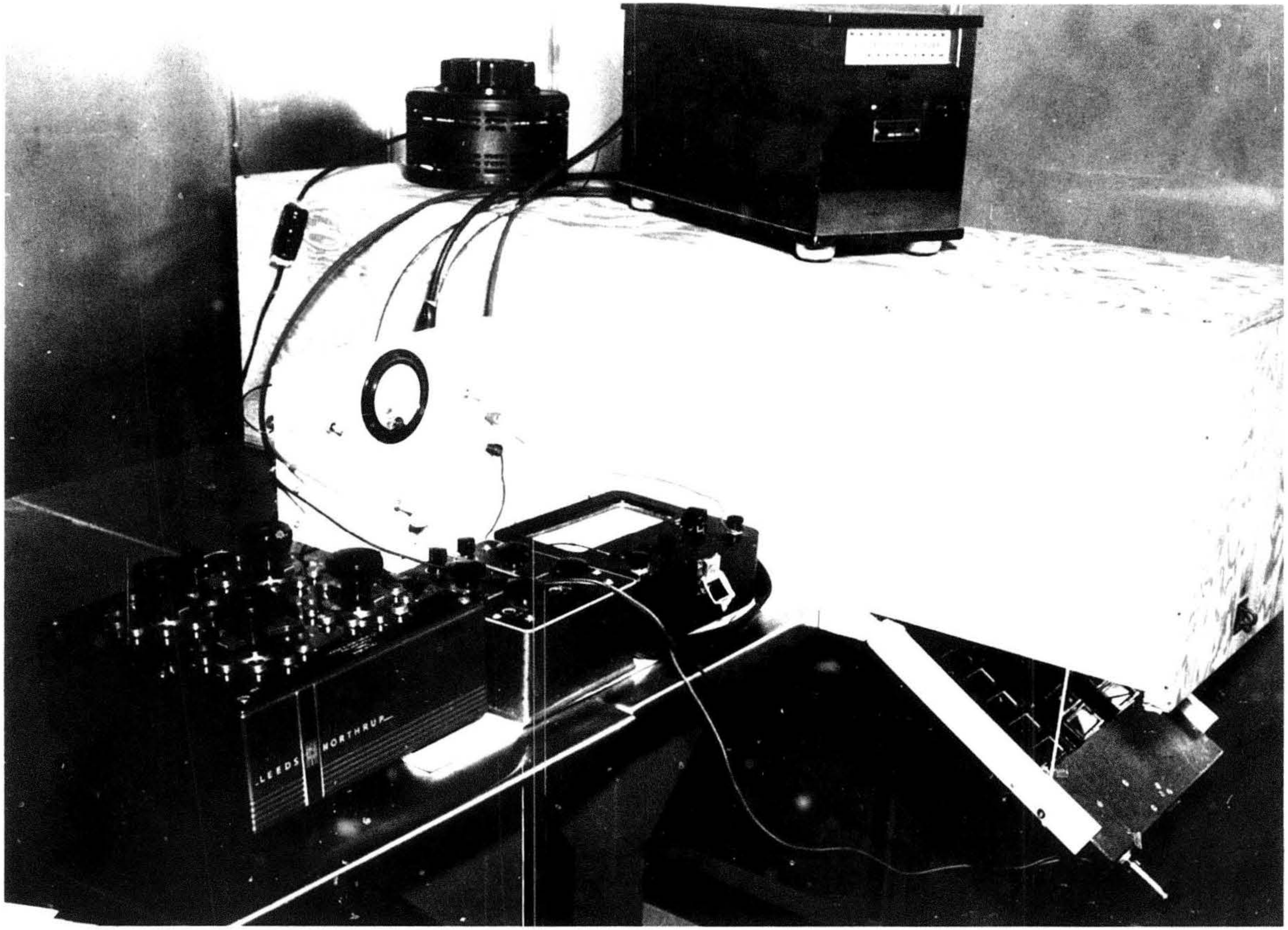

FIG. 2.12 Apparatus Used to Measure Autoradiograph Film Density

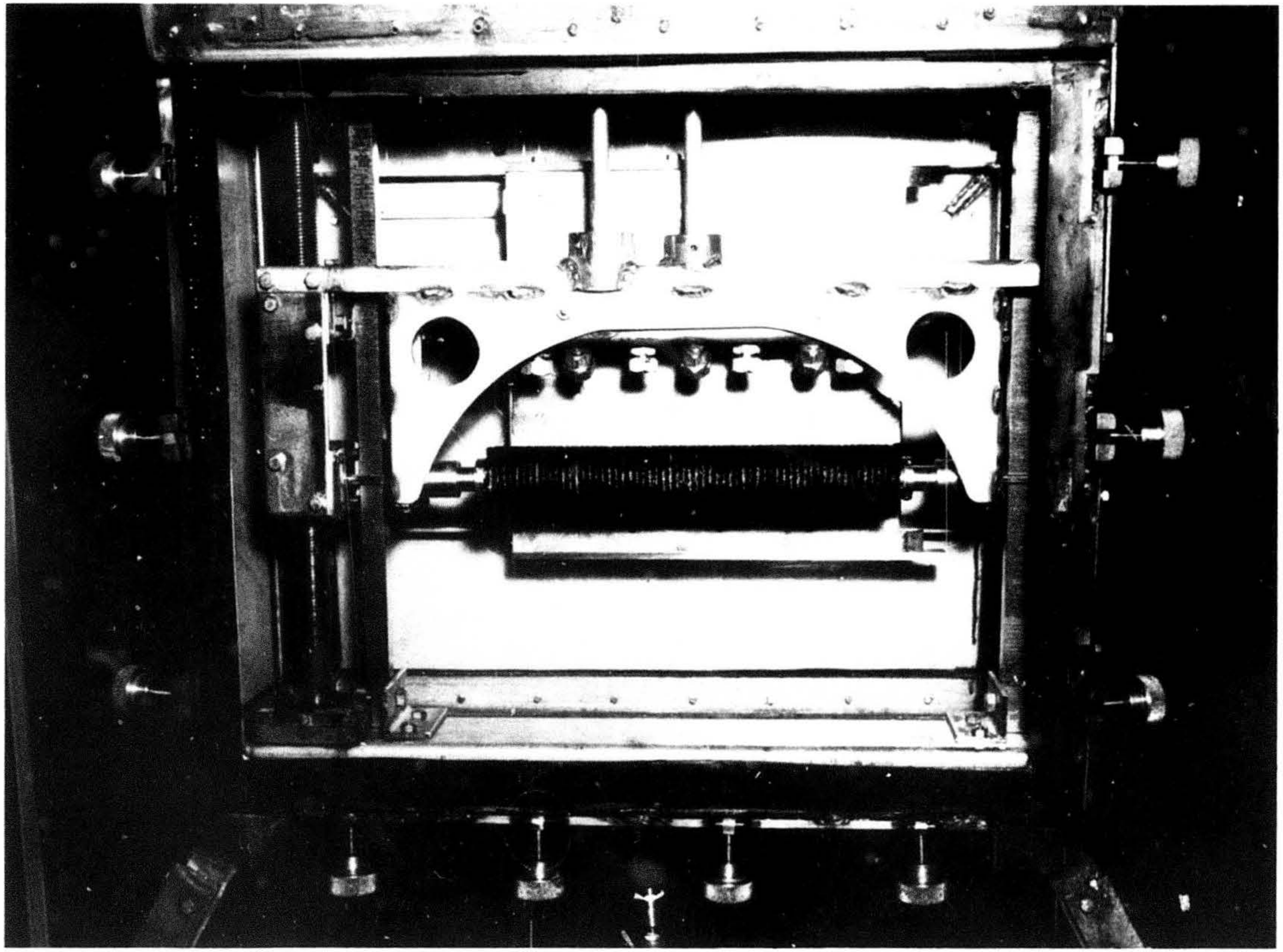

FIG. 2.13 Brushing Decontamination Apparatus

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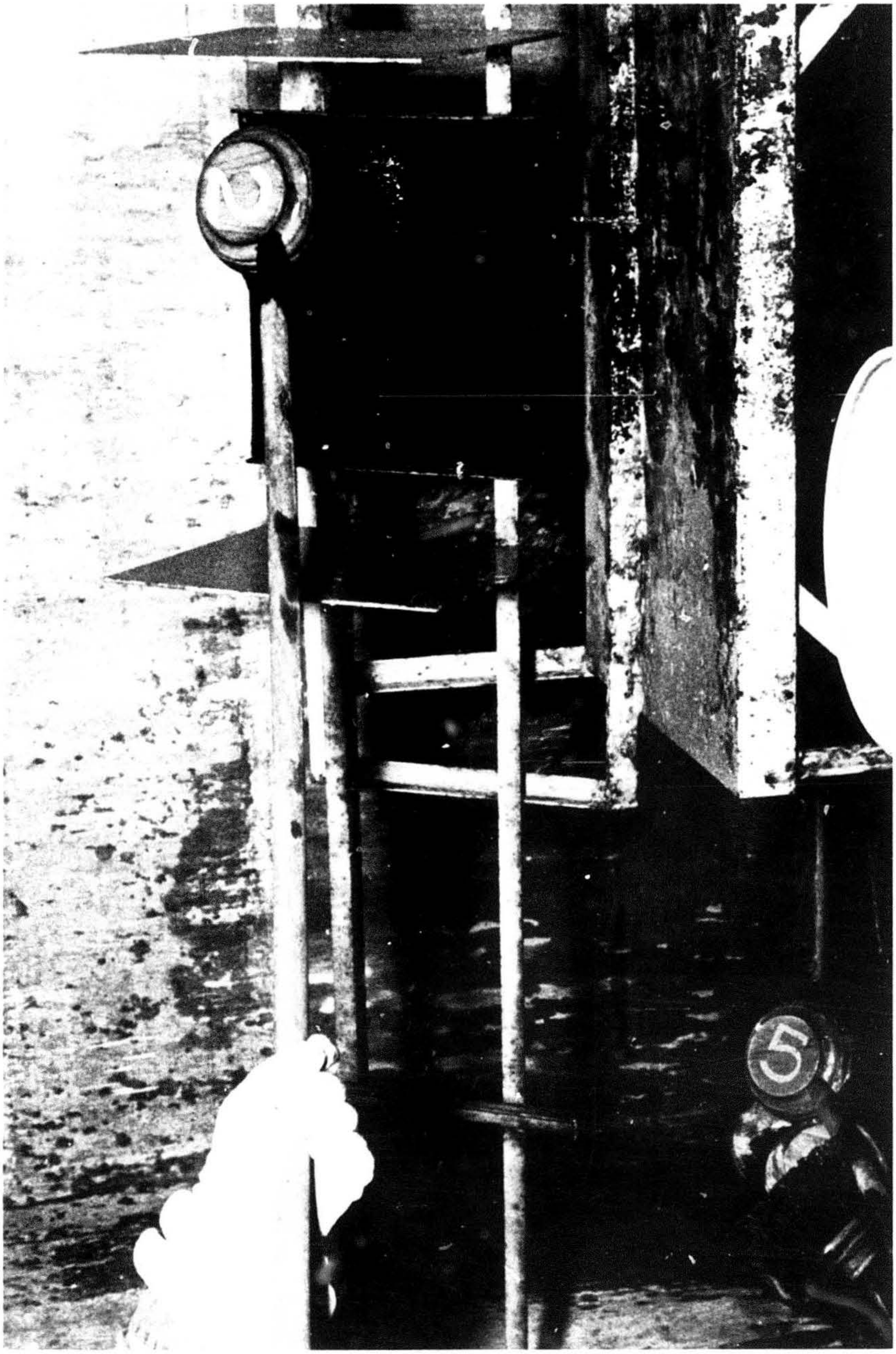

FIG. 2.14 Brushing Technique Used in Investigation of Industrial Decontamination Procedures

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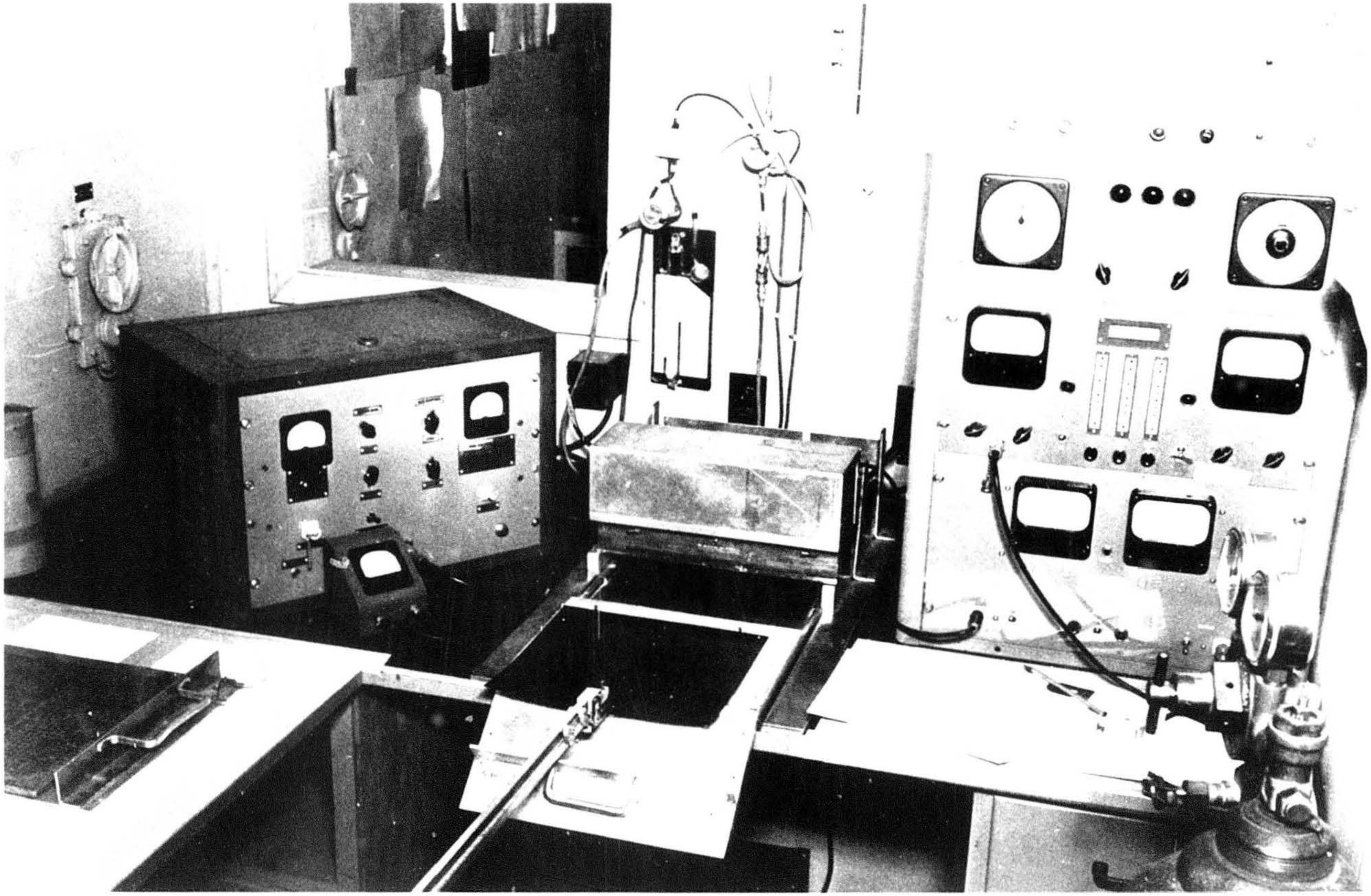

FIG. 2.15 Large Probe and Auxiliary Counting Equipment Used in Studies of Industrial Decontamination Procedures

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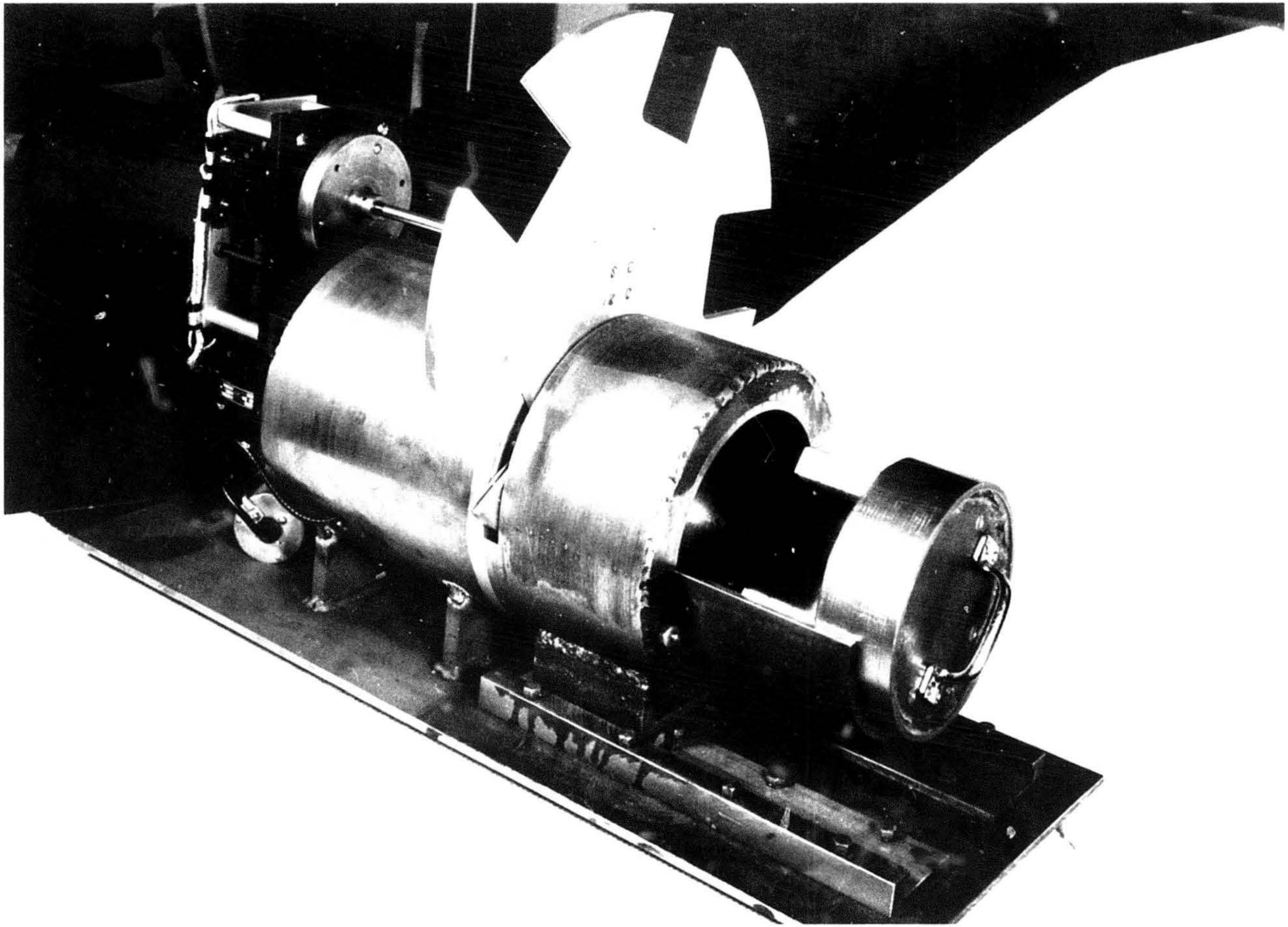

Fig. 2.16 Automatic Absorber Changer

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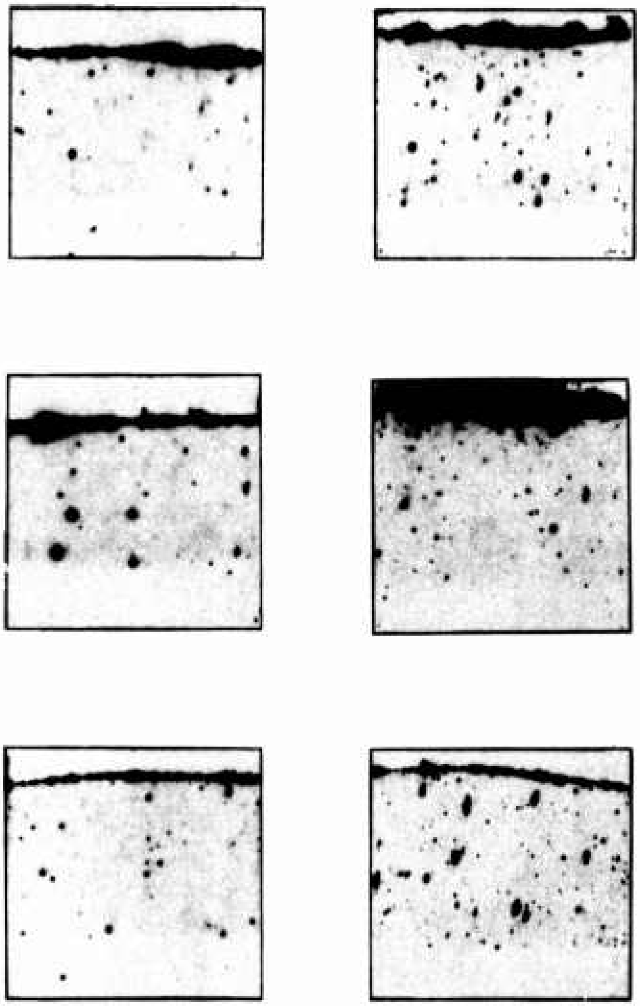

FIG. 3.1 Reproductions of Autoradiographs of Small Plates Prior to Decontamination

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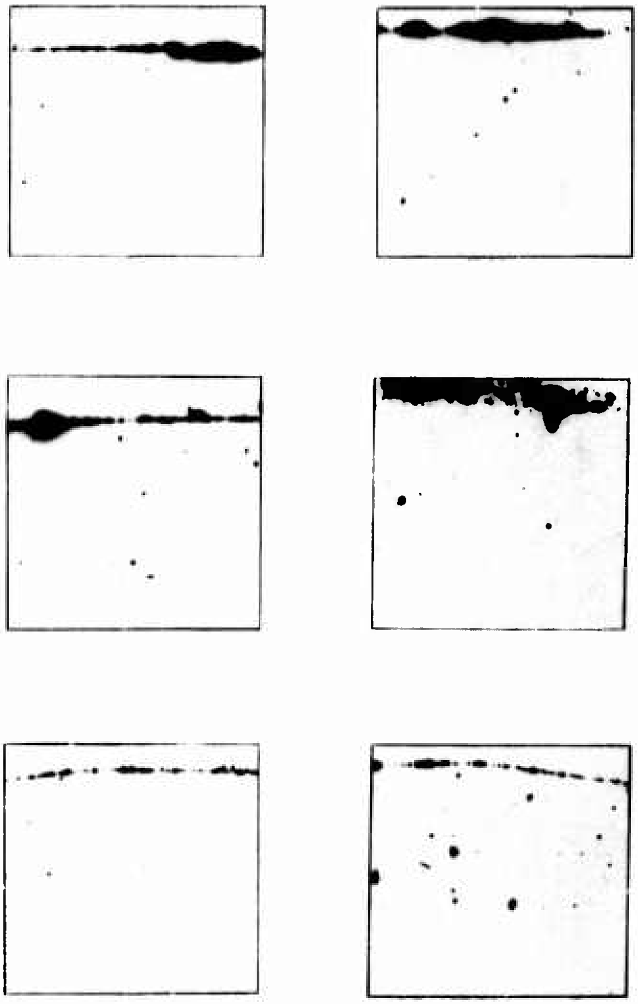

FIG. 3.2 Reproductions of Autoradiographs of Small Plates after Decontamination

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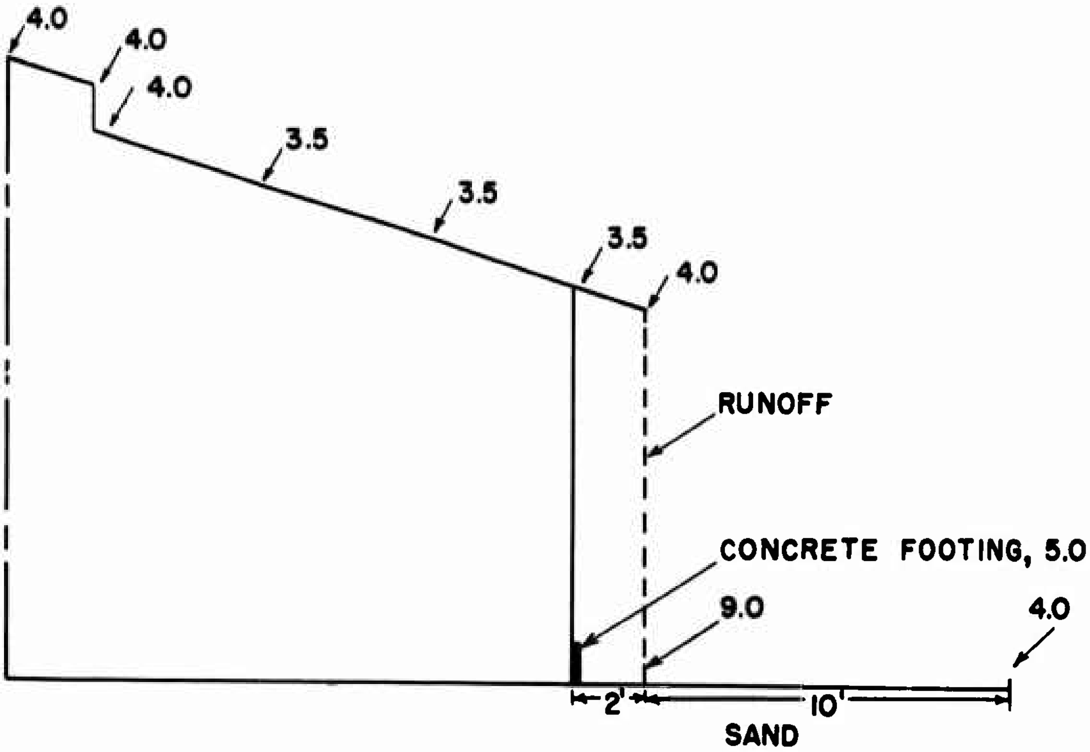

Fig. 3.3 Contaminant Distribution on and about Aluminum Building

[redacted]

[redacted]

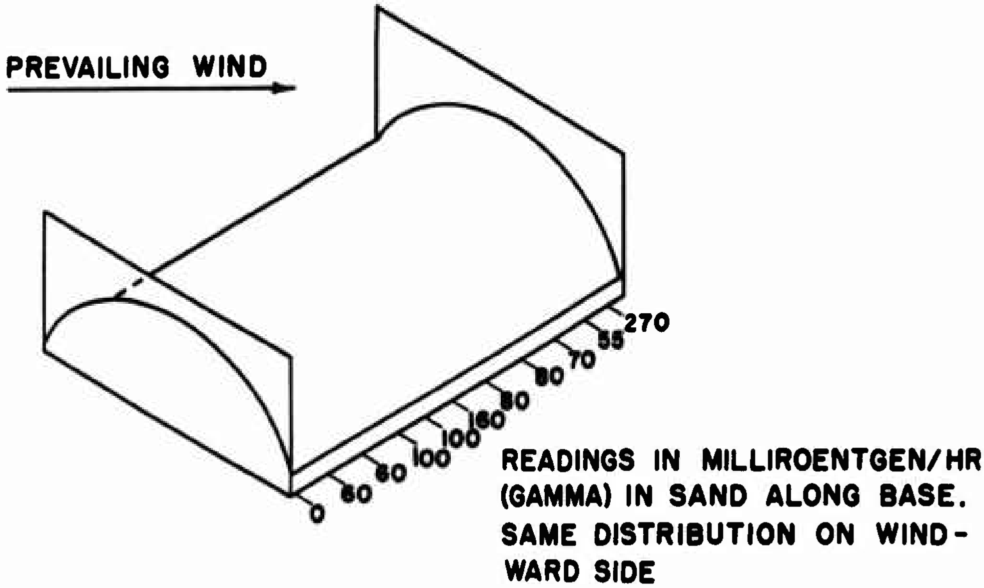

Fig. 3.4 Contaminant Distribution at Base of B-50 Hangar

[redacted]

[redacted]

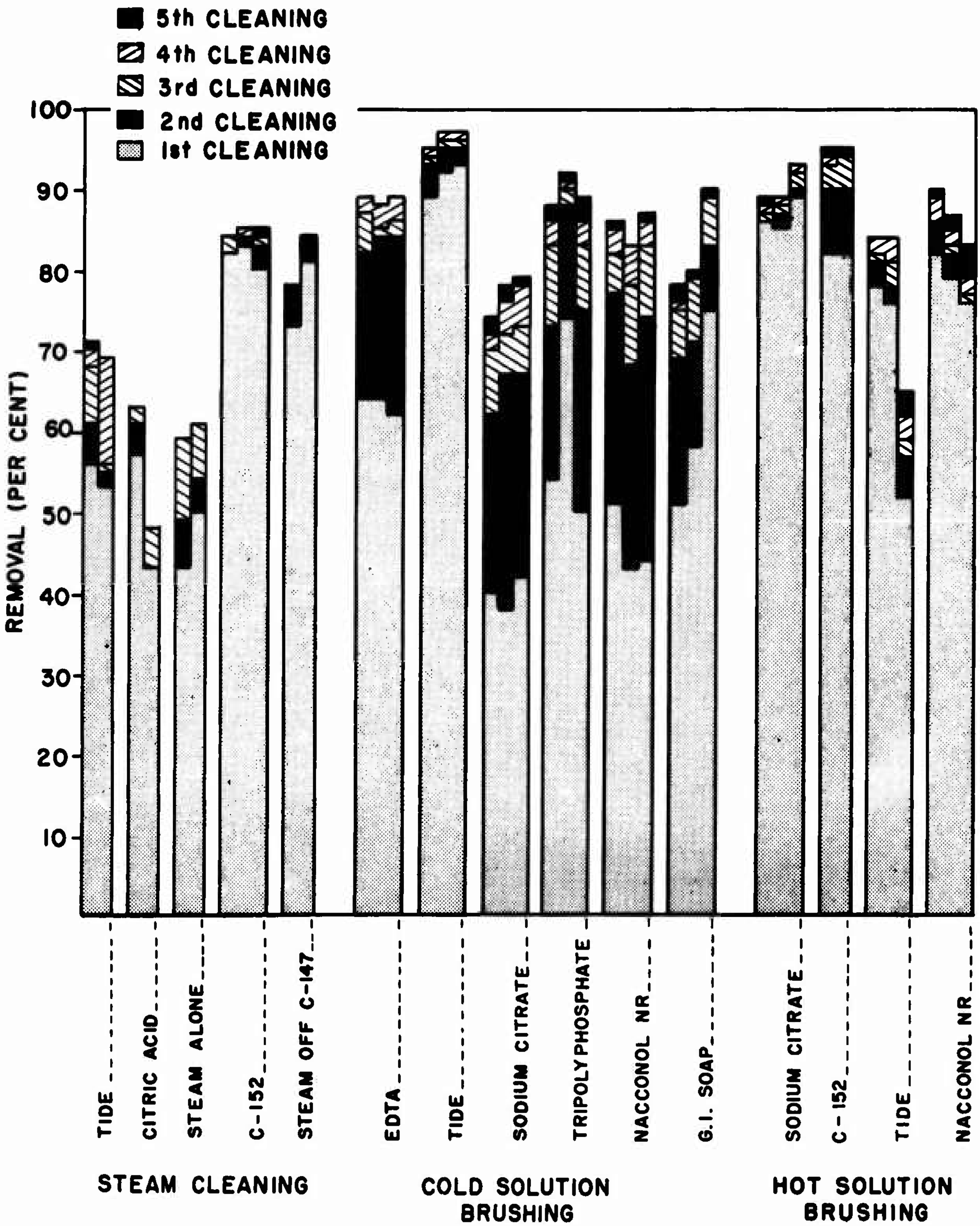

FIG. 3.5 Decontamination of Sea-blue Paint by Industrial Procedures

[redacted]

[redacted]

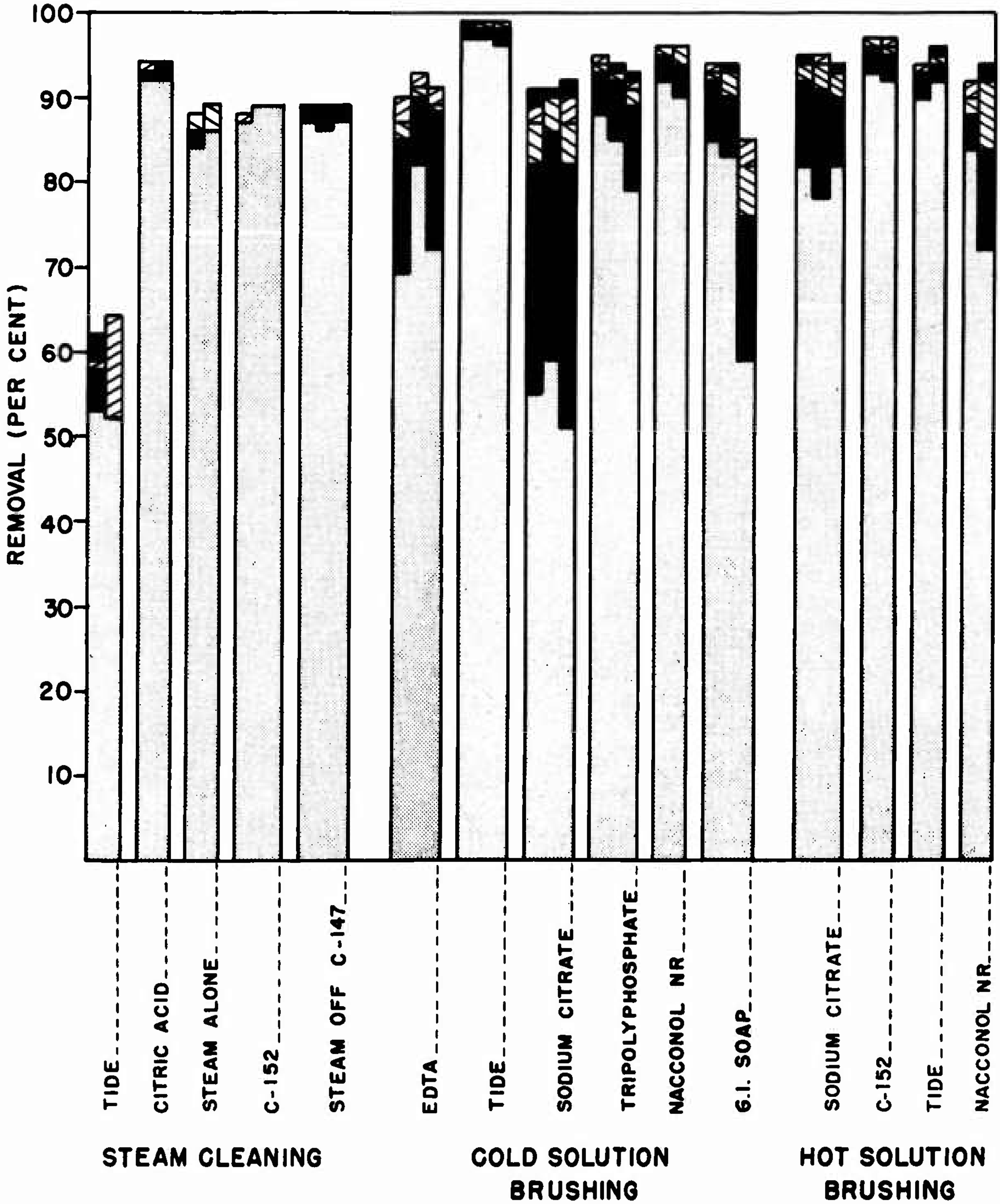

FIG. 3.6 Decontamination of Aluminized Paint by Industrial Procedures

[redacted]

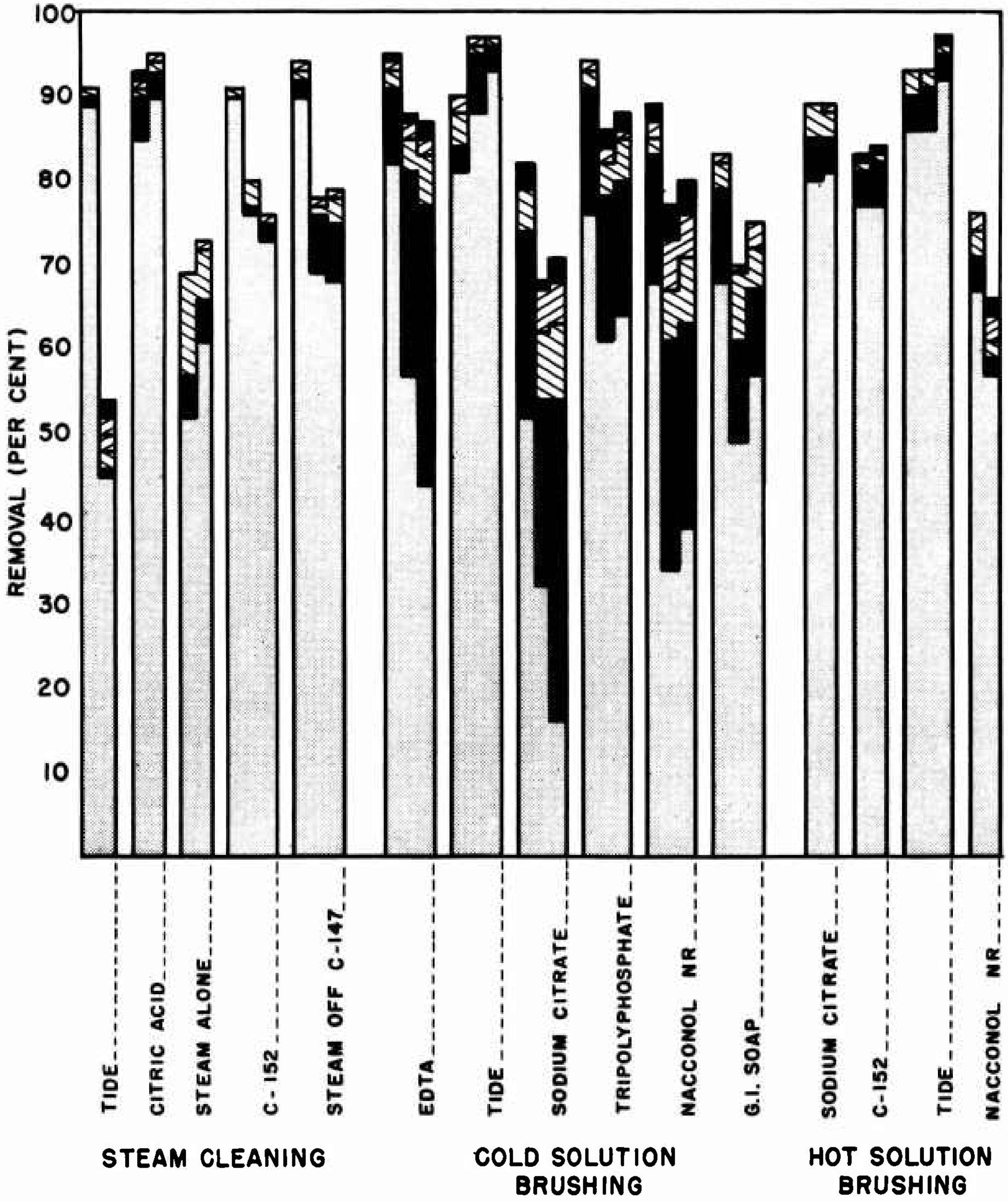

FIG. 3.7 Decontamination of Alclad Aluminum by Industrial Procedures

[redacted]

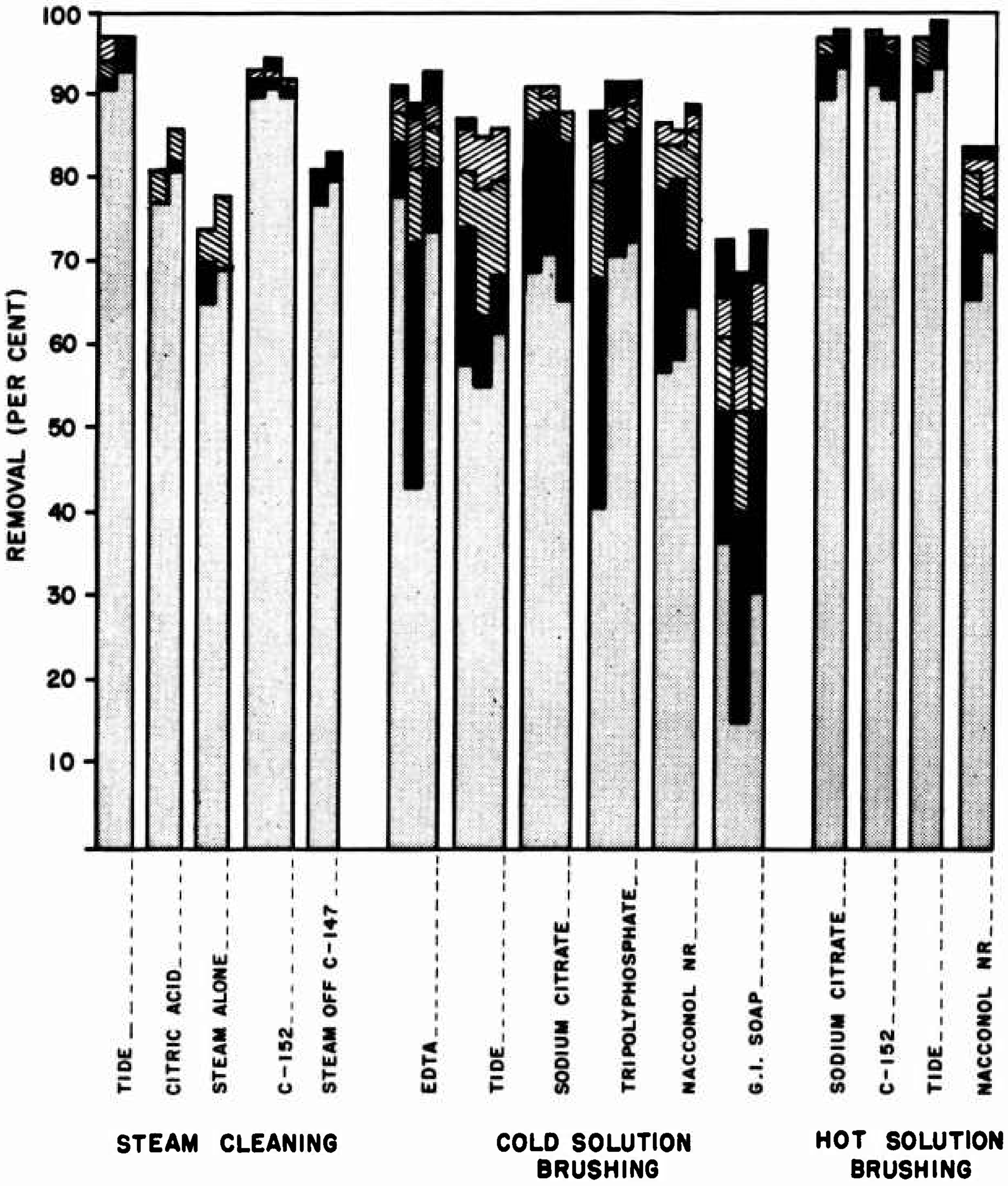

FIG. 3.8 Decontamination of OD Paint by Industrial Procedures

[redacted]

[redacted]

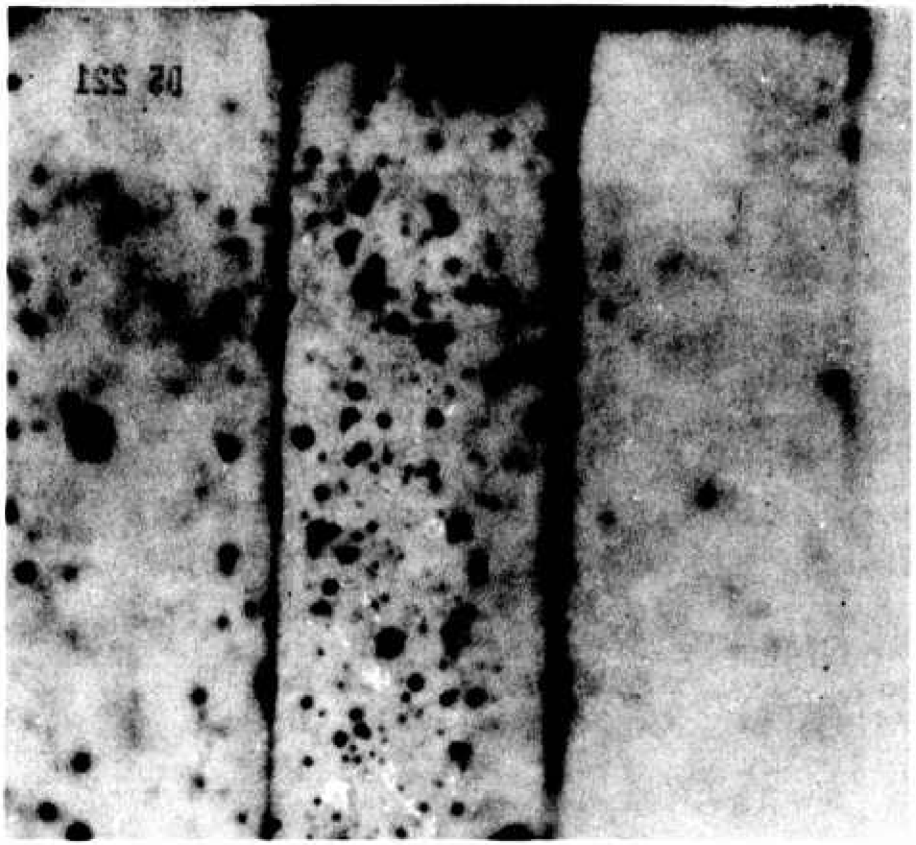

Fig. 3.9 Reproduction of Autoradiograph of Panel before Decontamination—Position 22, Dog Shot, 24,000 ft (Plane 5)

[redacted]

[redacted]

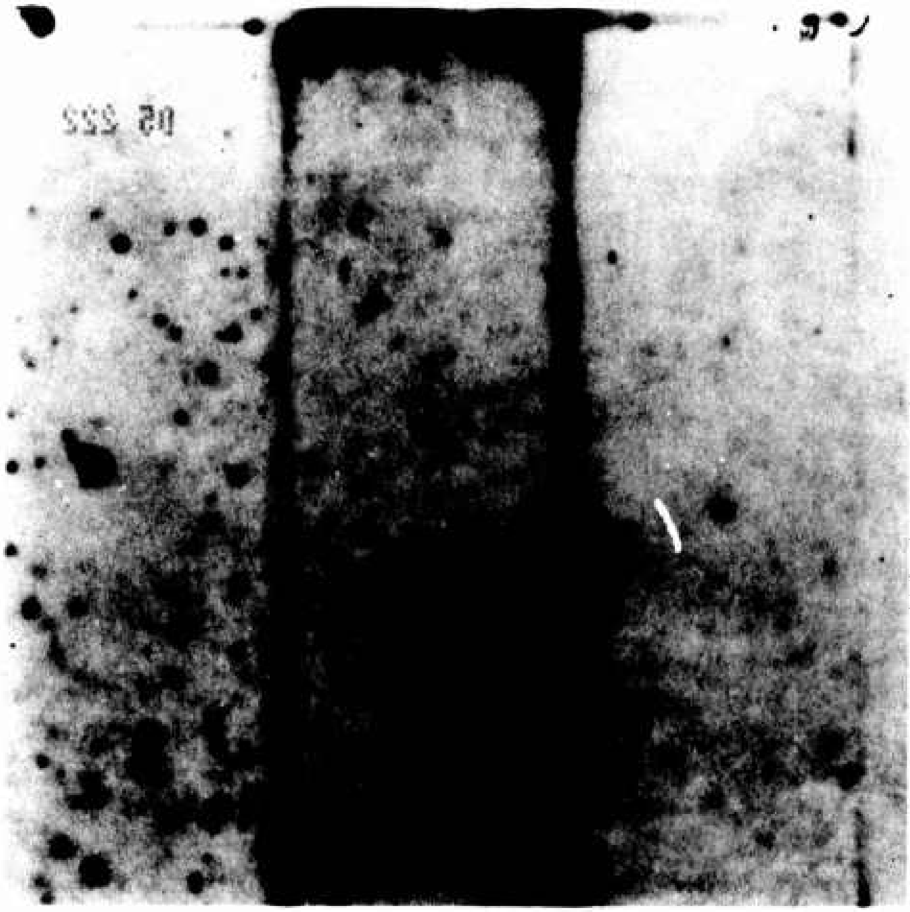

FIG. 3.10 Reproduction of Autoradiograph of Panel after Decontamination—Position 22, Dog Shot, 24,000 ft (Plane 5)

[redacted]

FIG. 3.11 Reproduction of Autoradiograph of Panel before Decontamination—Position 18, Dog Shot, 20,000 ft (Plane 3)

[redacted]

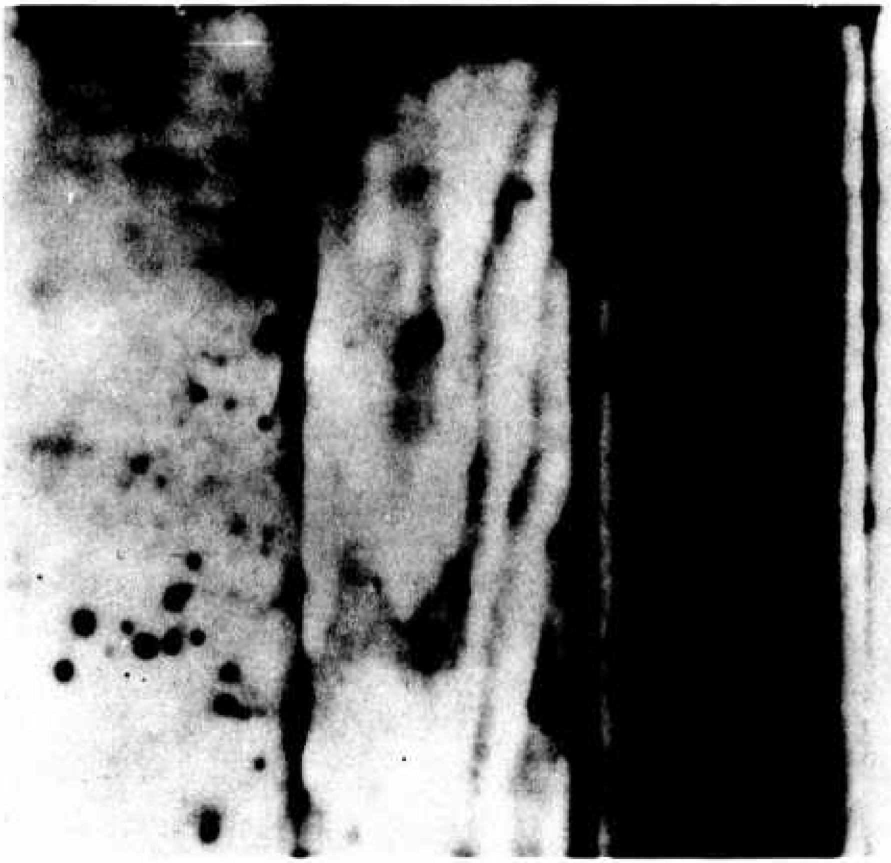

Fig. 3.12 Reproduction of Autoradiograph of Panel after Decontamination—Position 18, Dog Shot, 20,000 ft (Plane 3)

[redacted]

[redacted]

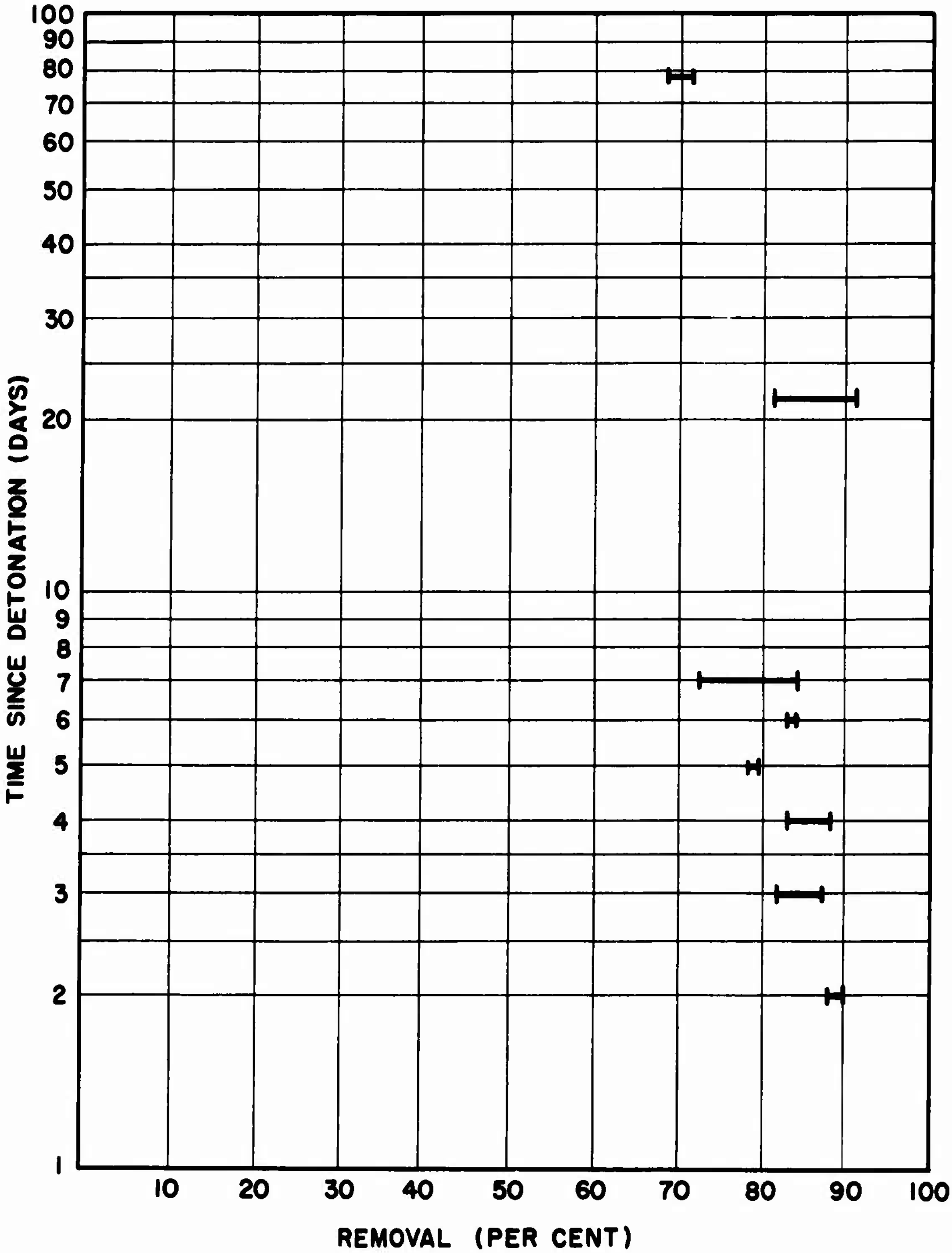

FIG. 3.13 Decontamination as a Function of Time—OD Paint, Dog Shot, Contaminated at 16,000 ft

[redacted]

[redacted]

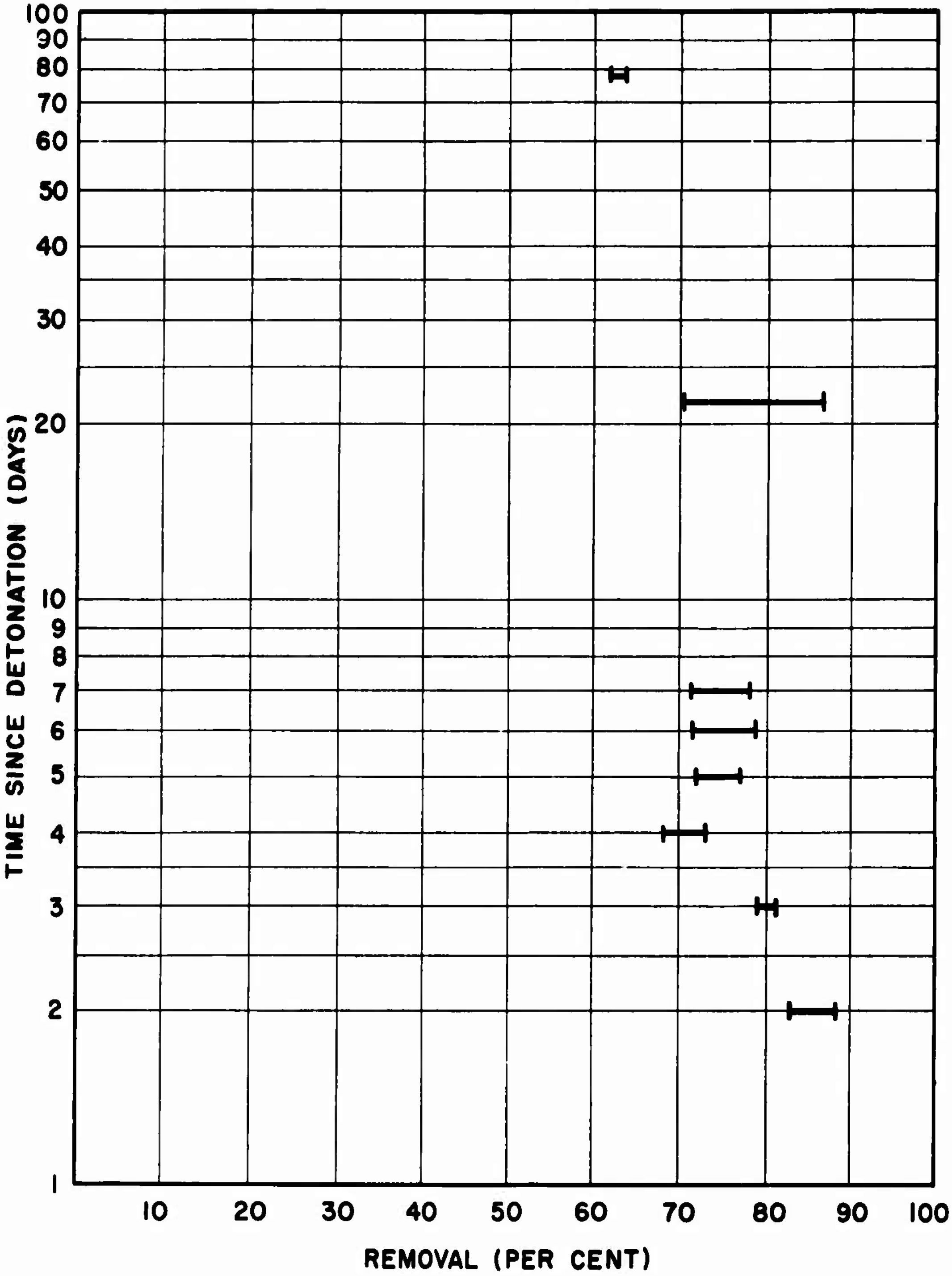

FIG. 3.14 Decontamination as a Function of Time—Aluminum Surface, Dog Shot, Contaminated at 20,000 ft

[redacted]

[redacted]

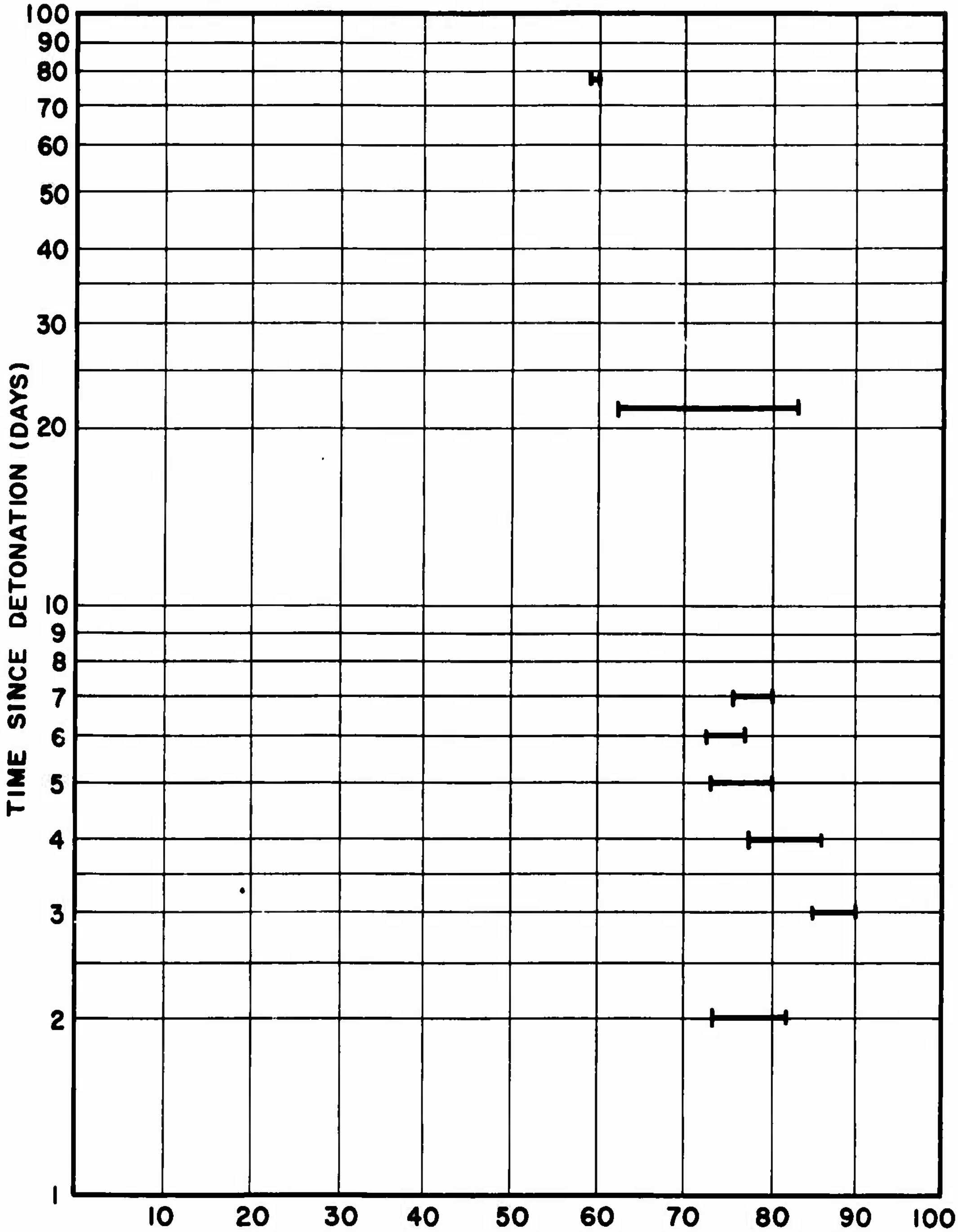

FIG. 3.15 Decontamination as a Function of Time—Aluminum Surface, Dog Shot, Contaminated at 28,000 ft

[redacted]

[redacted]

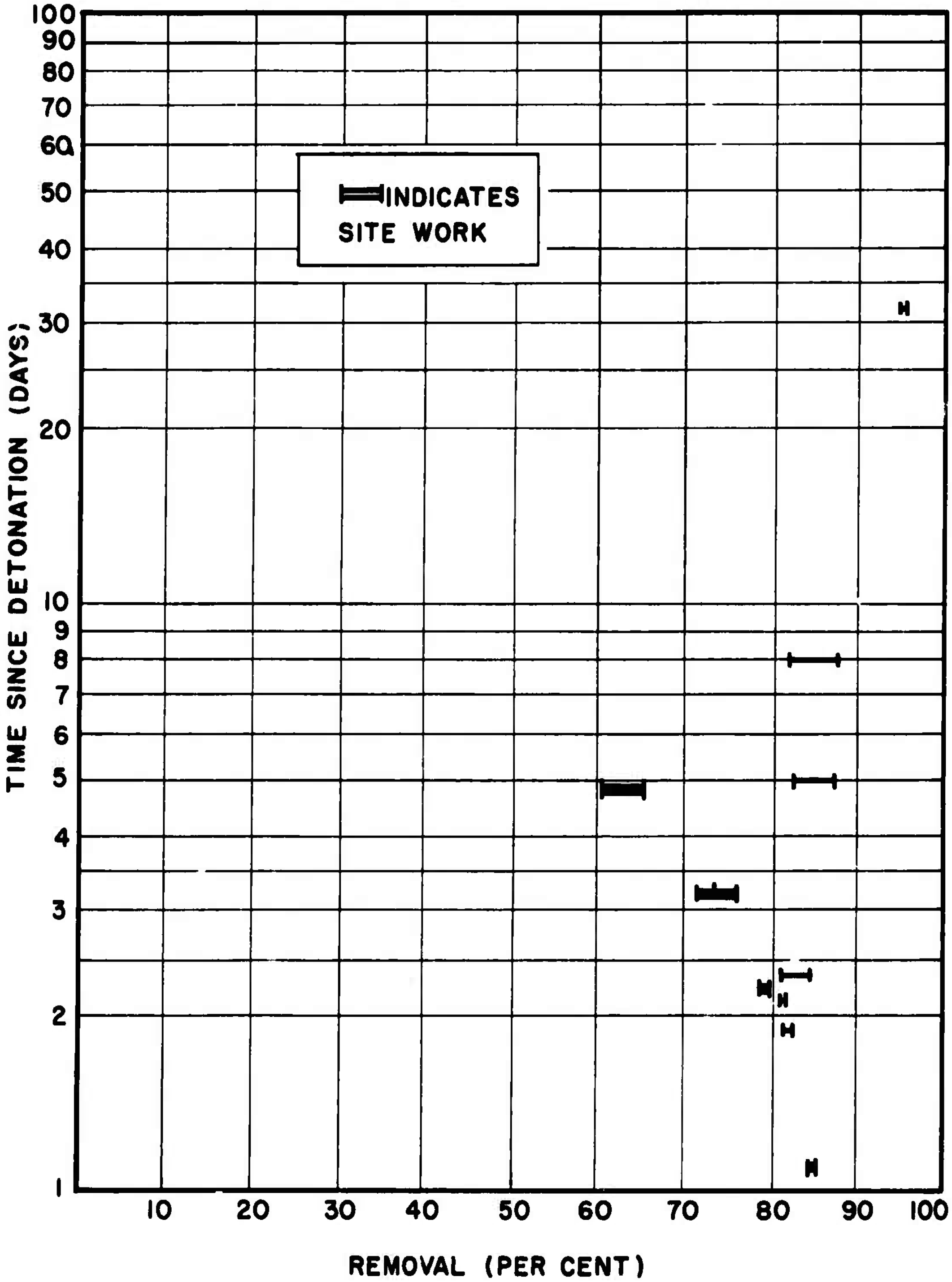

FIG. 3.16 Decontamination as a Function of Time—Aluminum Surface, Easy Shot, Contaminated at 20,000 ft

[redacted]

[redacted]

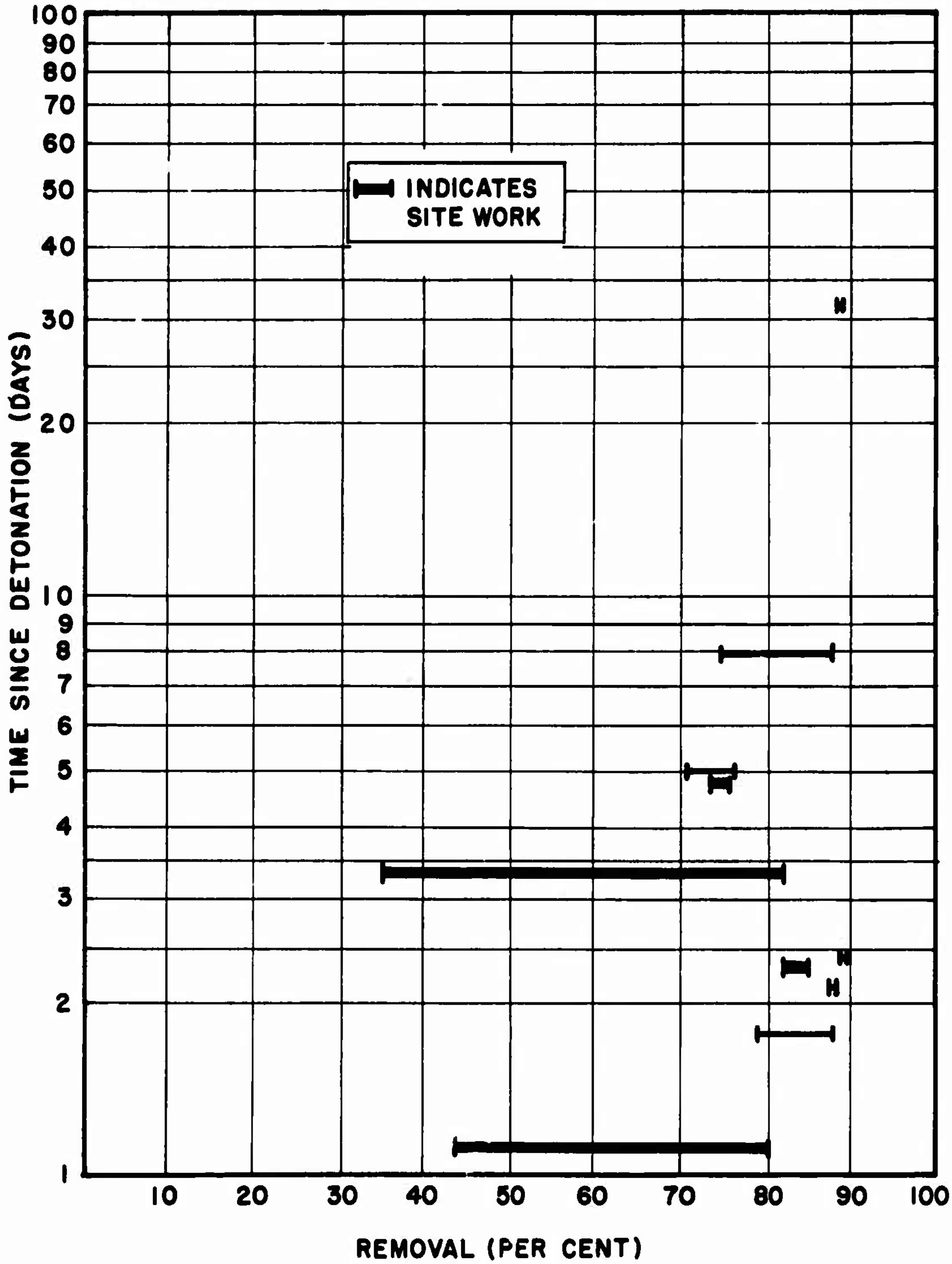

FIG. 3.17 Decontamination as a Function of Time—OD Paint, Easy Shot, Contaminated at 24,000 ft

[redacted]

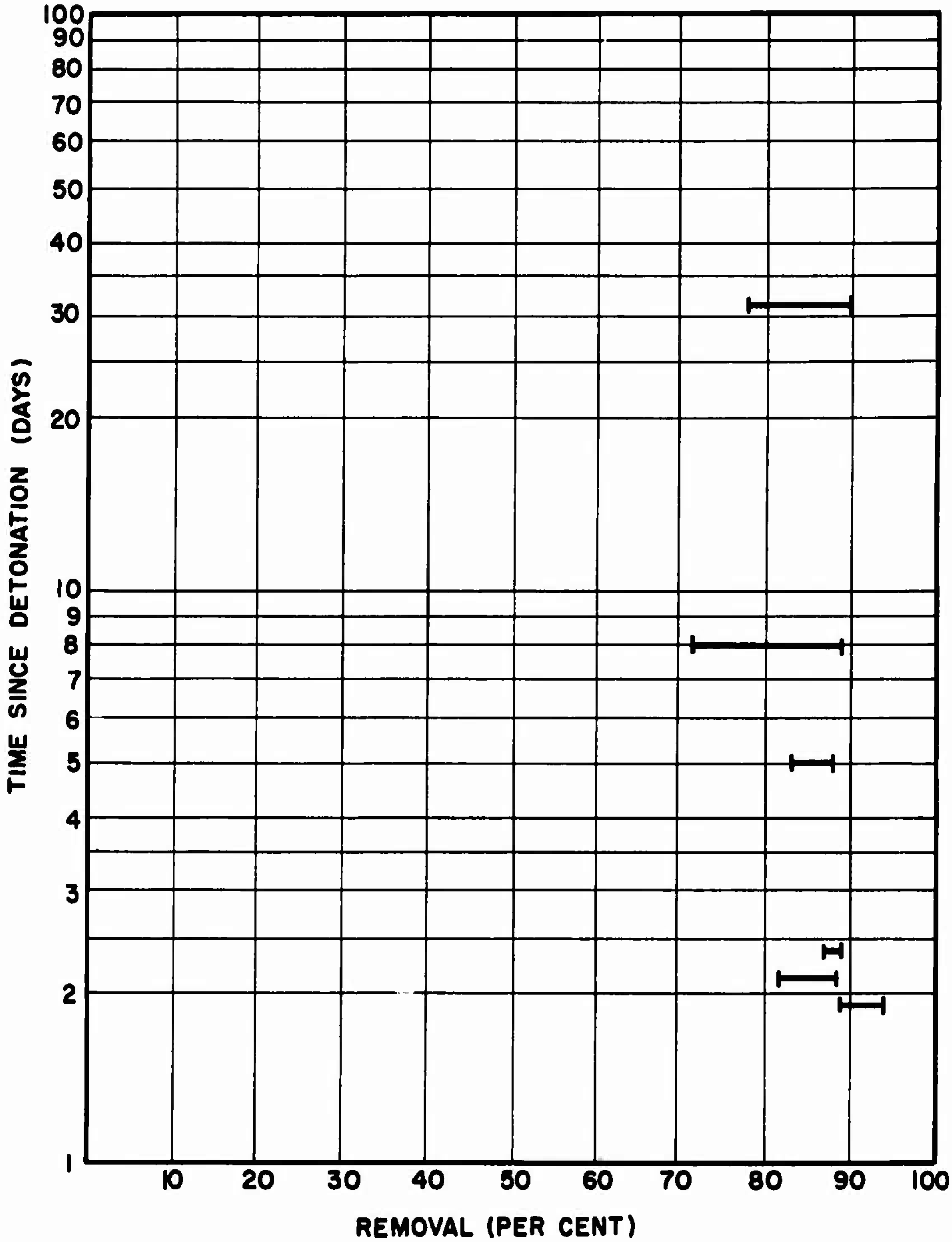

FIG. 3.18 Decontamination as a Function of Time—Aluminum Surface, Easy Shot, Contaminated at 30,000 ft

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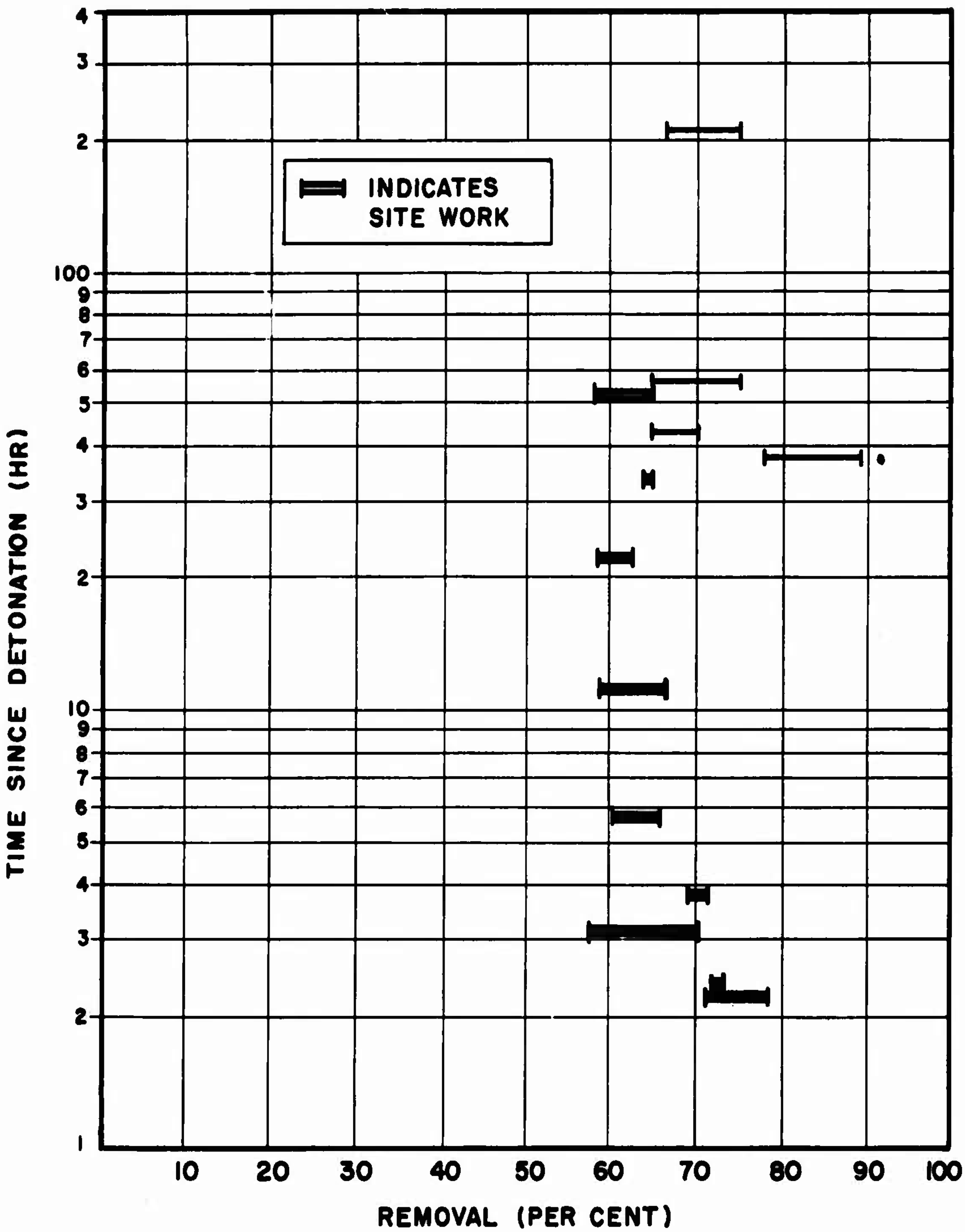

FIG. 3.19 Decontamination as a Function of Time—Aluminum Surface, George Shot, Contaminated at 28,000 ft

[redacted]

[redacted]

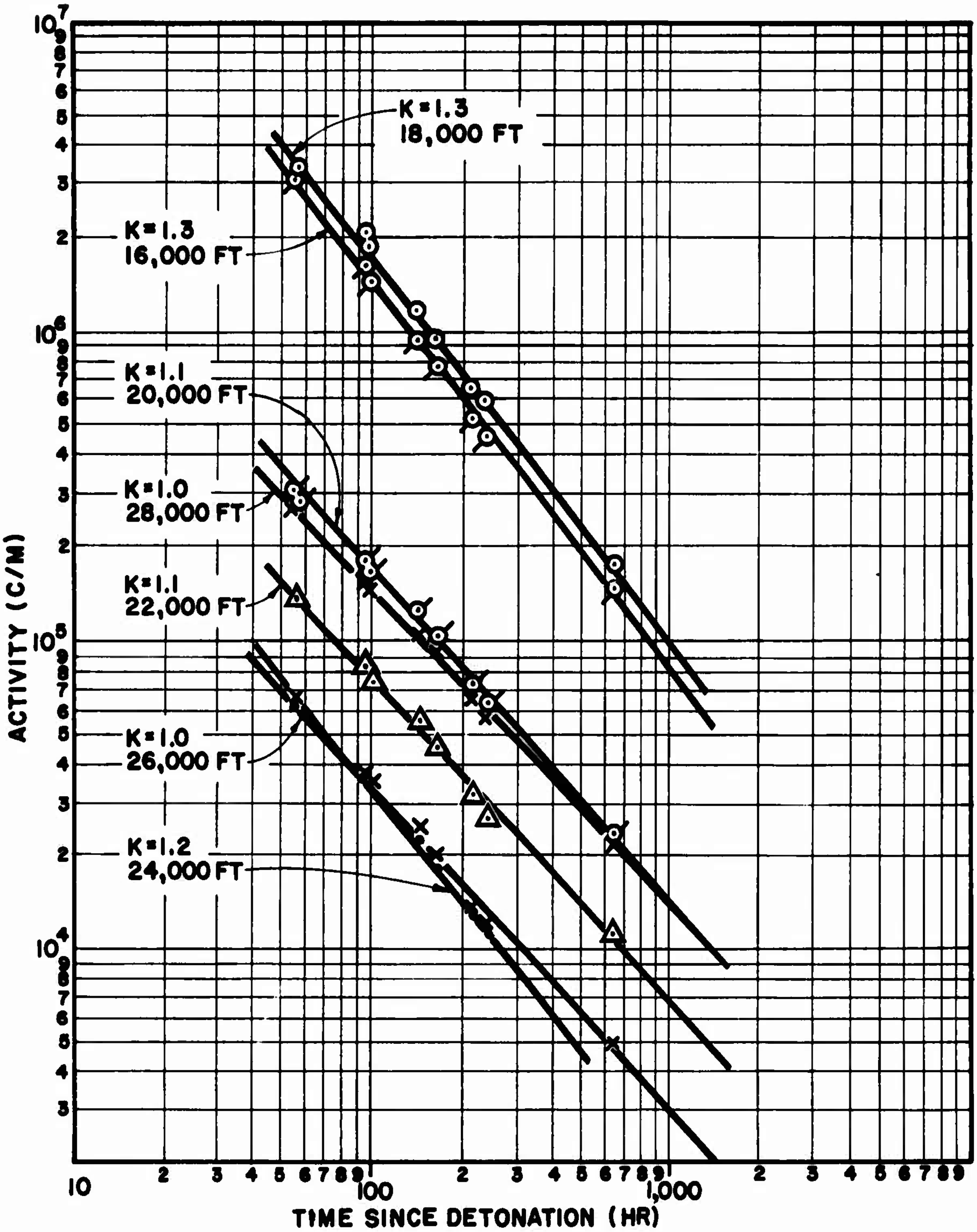

Fig. 3.20 Decay of Radioactive Material Deposited on Aircraft—Dog Shot

[redacted]

[redacted]

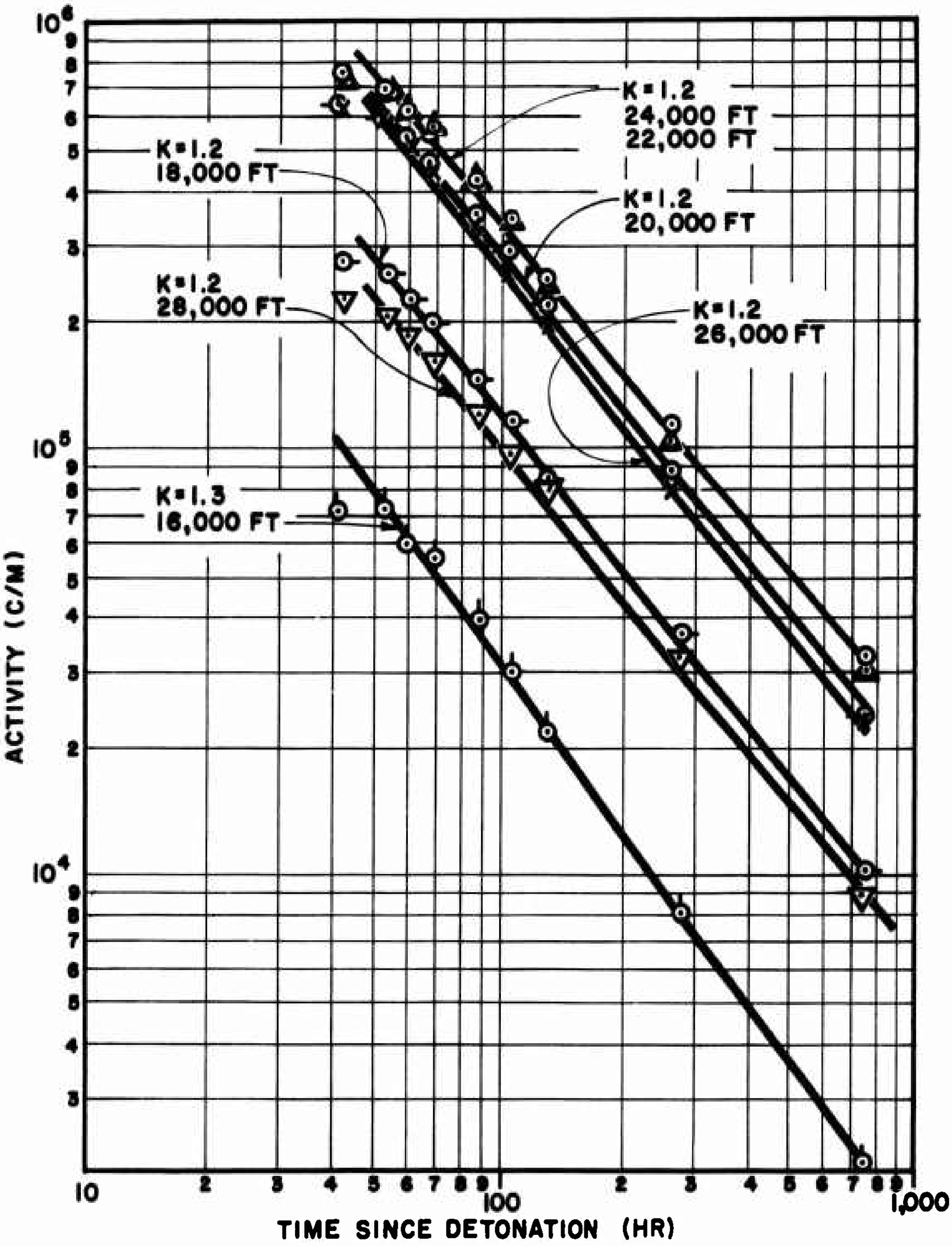

Fig. 3.21 Decay of Radioactive Material Deposited on Aircraft—Easy Shot

[redacted]

[redacted]

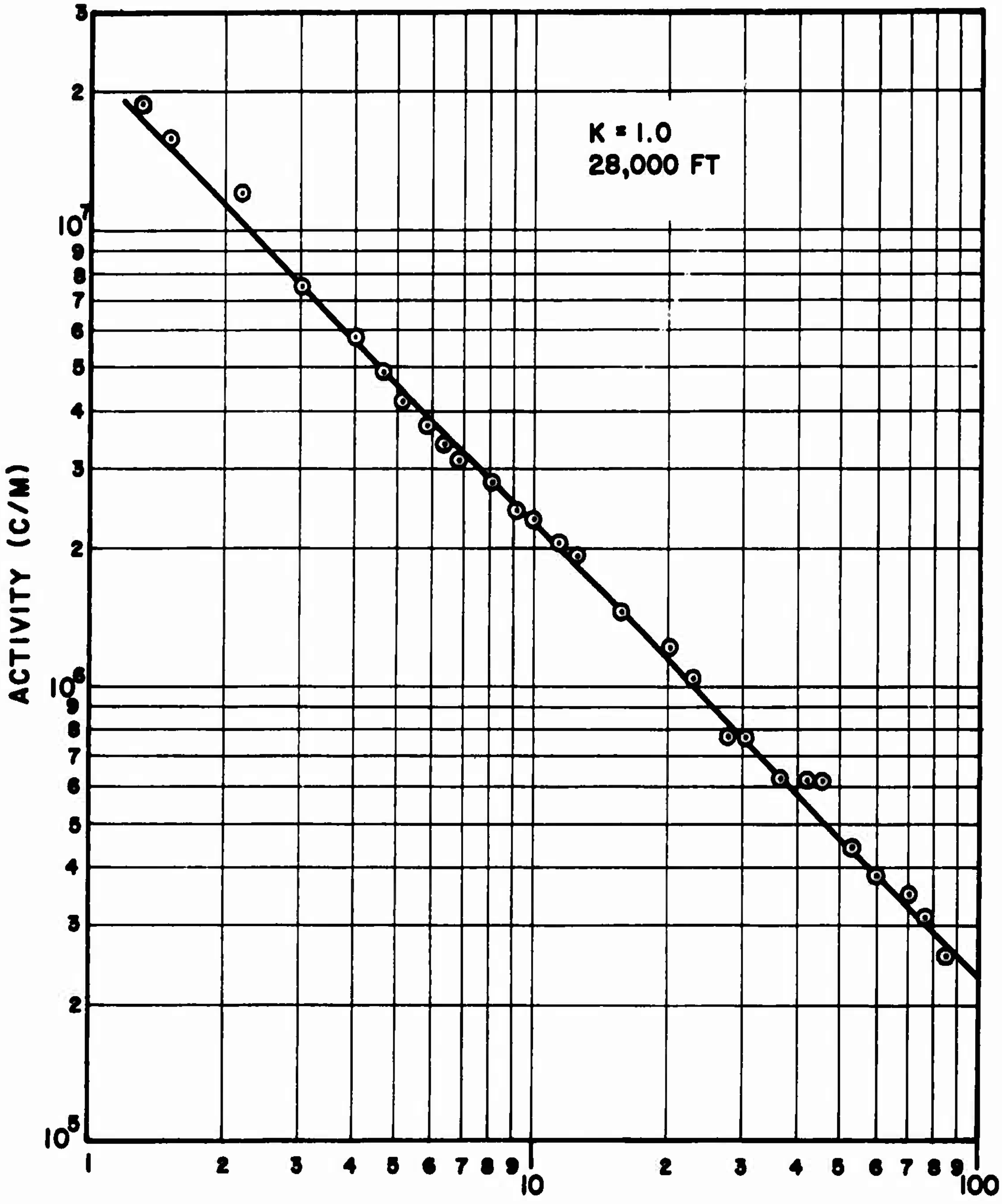

Fig. 3.22 Decay of Radioactive Material Deposited on Aircraft—George Shot

[redacted]

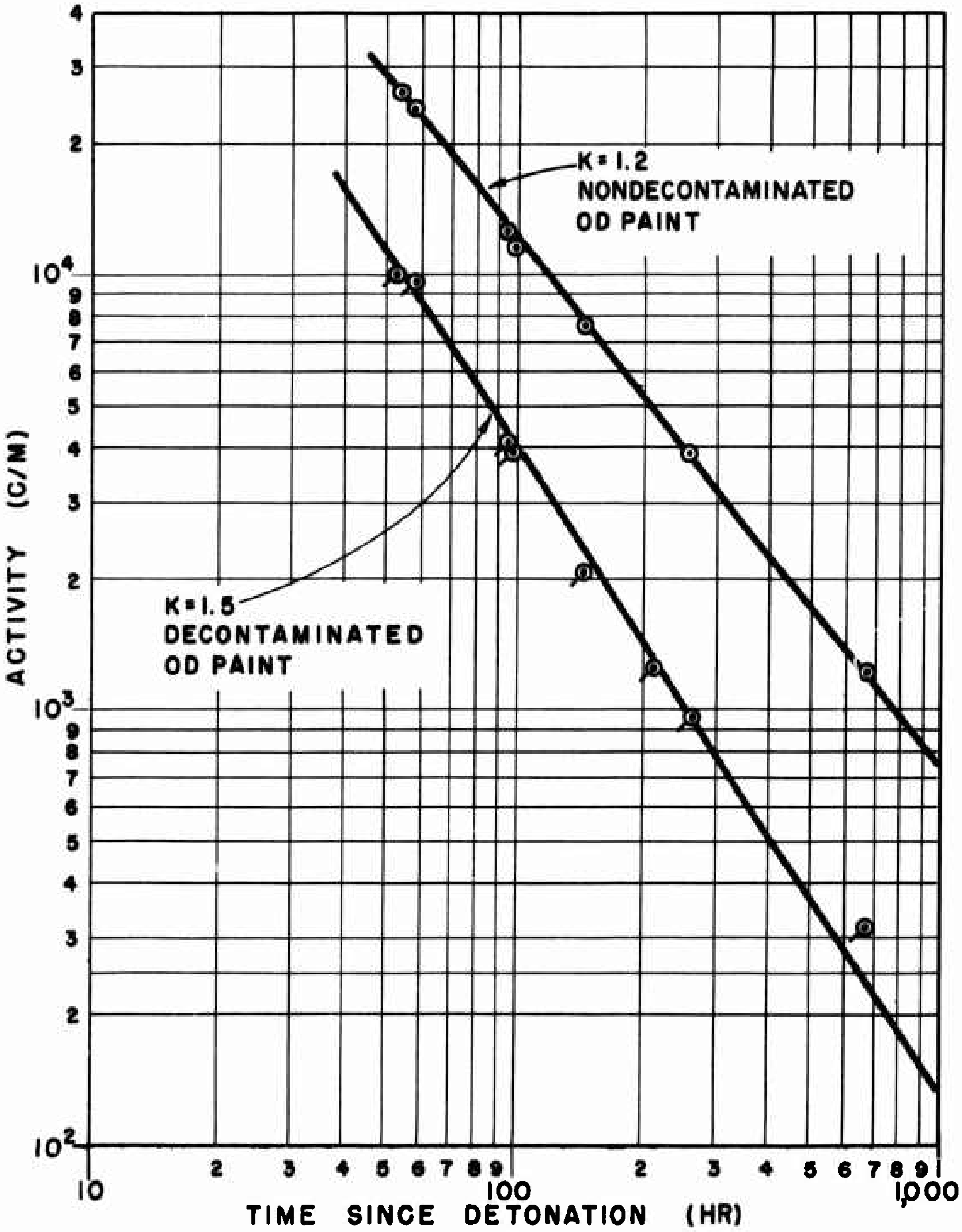

FIG. J.1 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Dog Shot, Counted through 55.7-mg/sq cm Aluminum Absorber

[redacted]

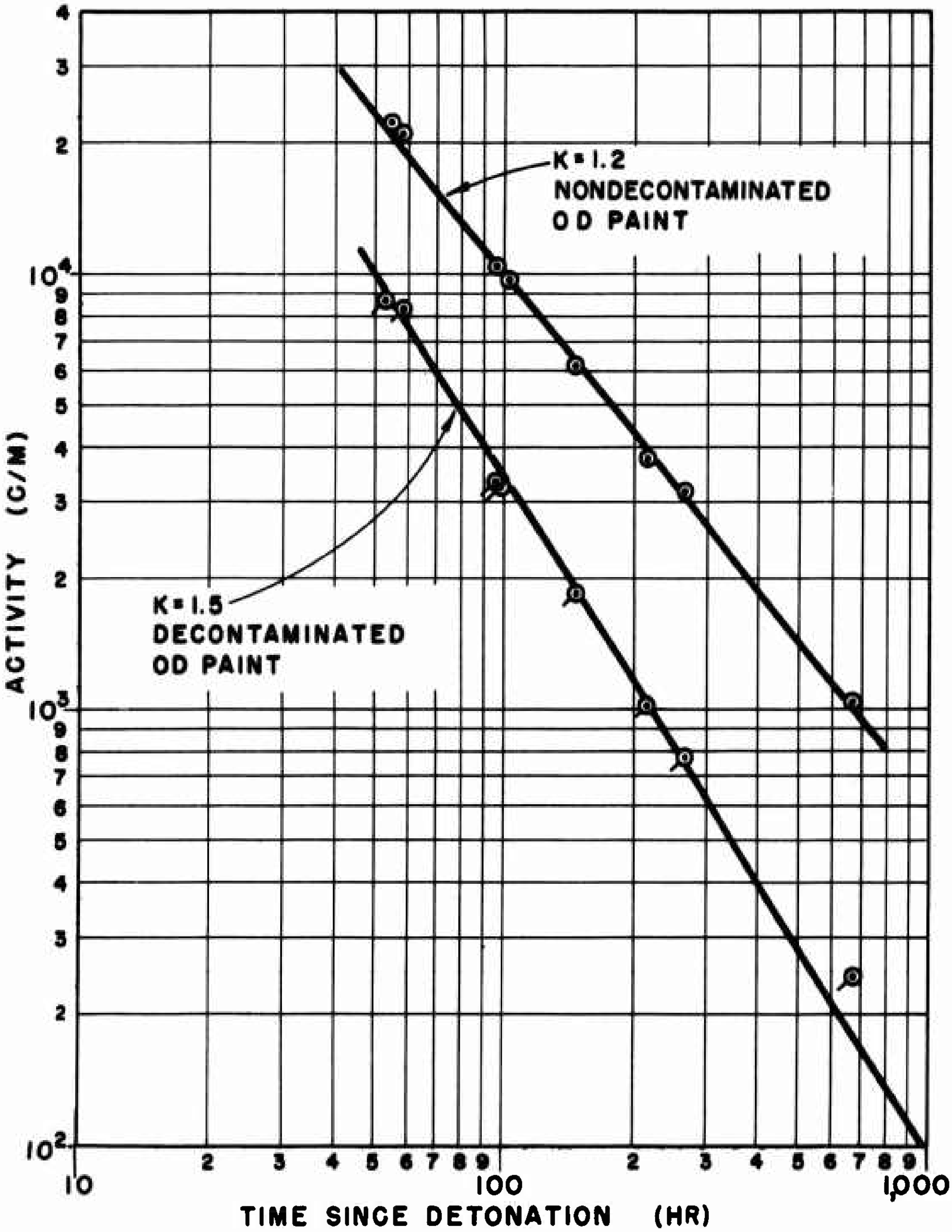

FIG. J.2 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Dog Shot, Counted through 70.3-mg/sq cm Aluminum Absorber

[redacted]

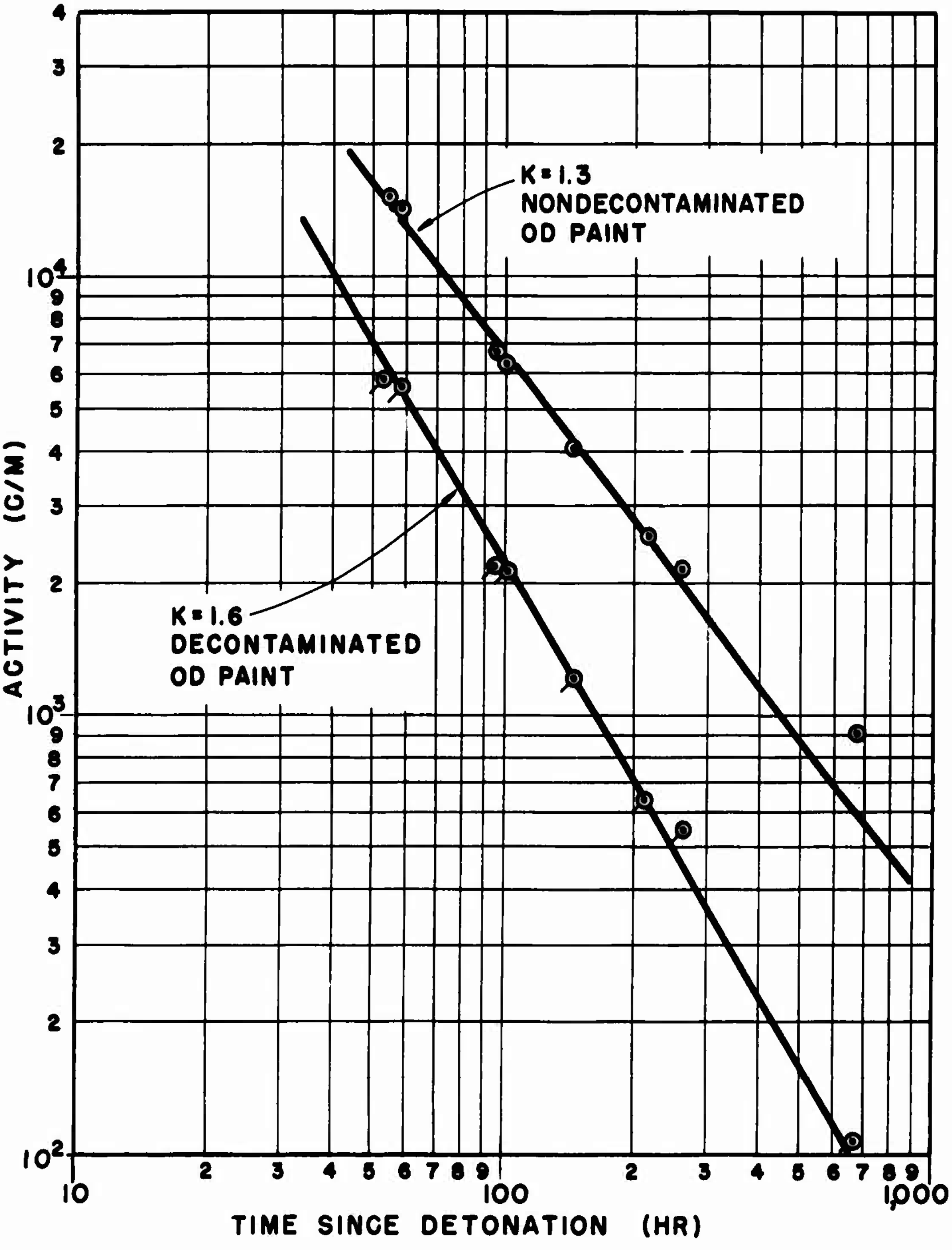

FIG. J.3. Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Dog Shot, Counted through 109-mg/sq cm Aluminum Absorber

[redacted]

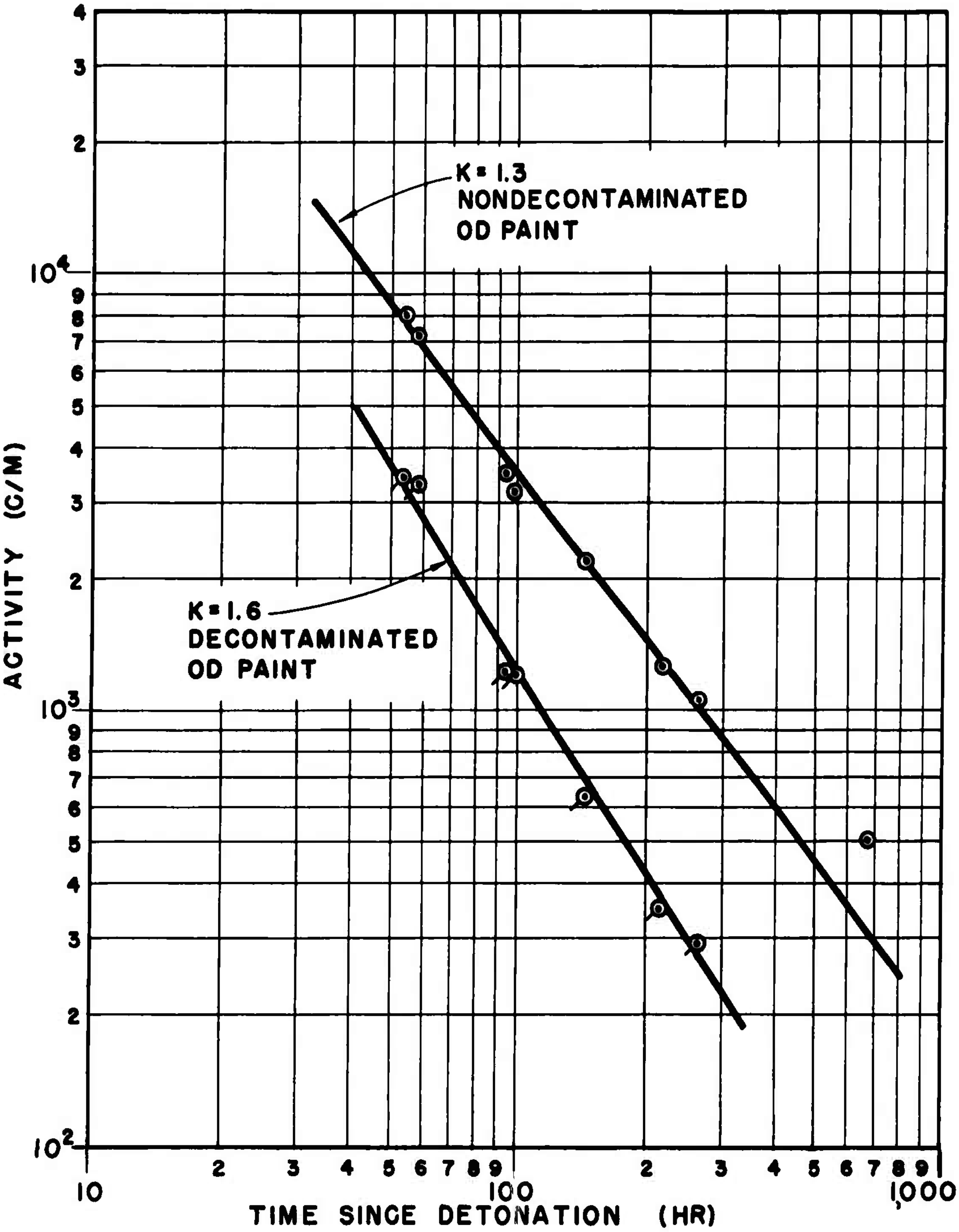

FIG. J.4 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Dog Shot, Counted through 176-mg/sq cm Aluminum Absorber

[redacted]

[redacted]

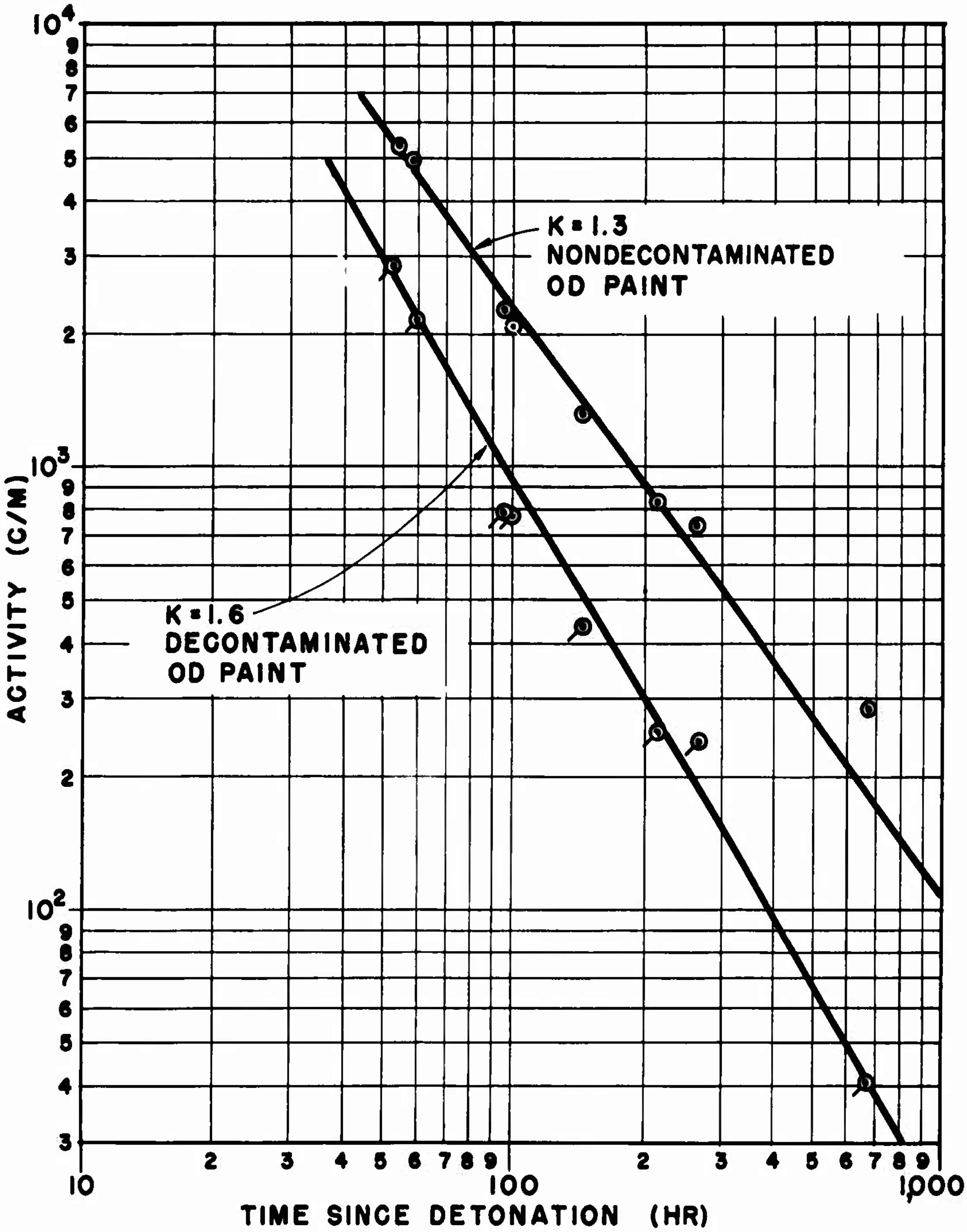

FIG. J.5 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Dog Shot, Counted through 217-mg/sq cm Aluminum Absorber

[redacted]

[redacted]

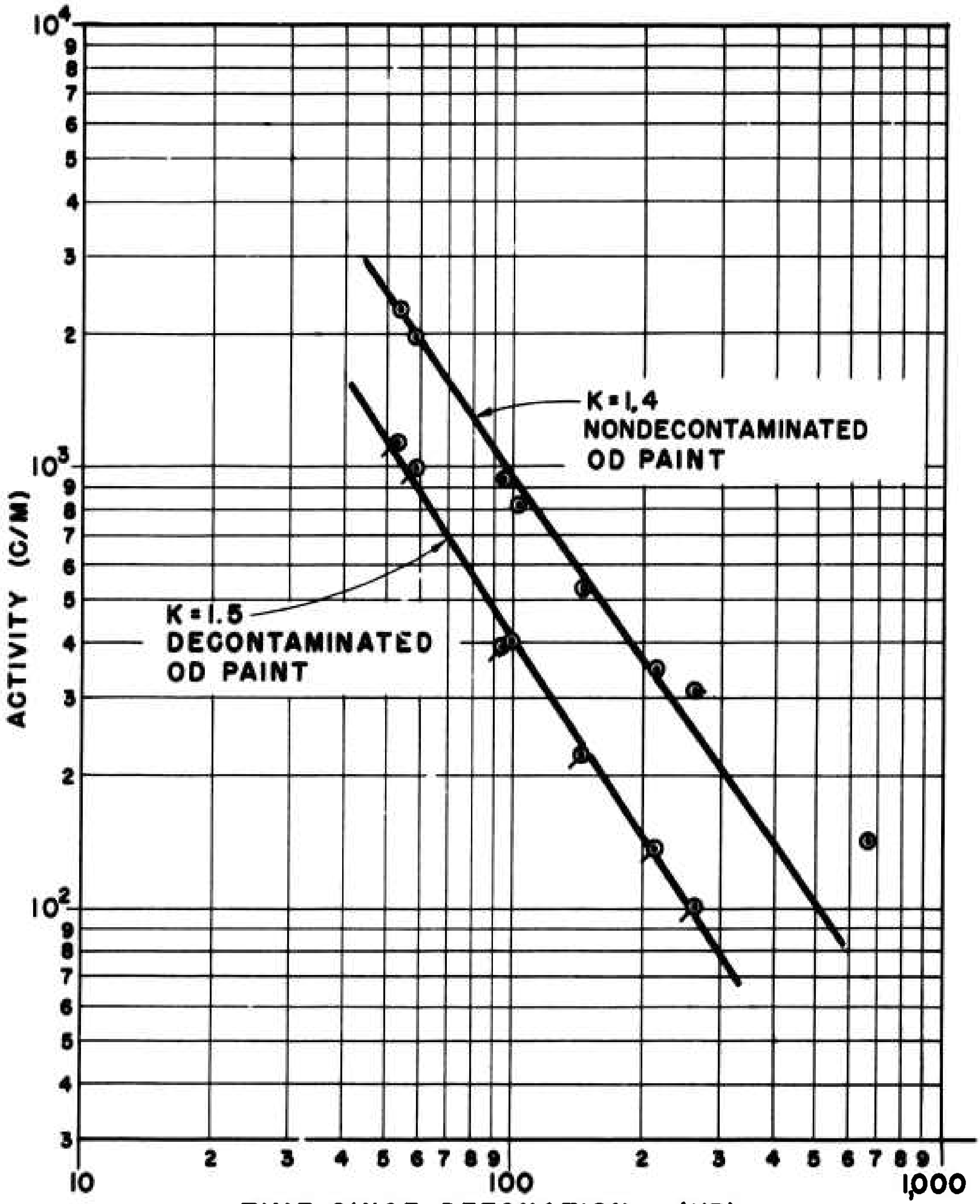

FIG. J.6 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Dog Shot, Counted through 348-mg/sq cm Aluminum Absorber

[redacted]

[redacted]

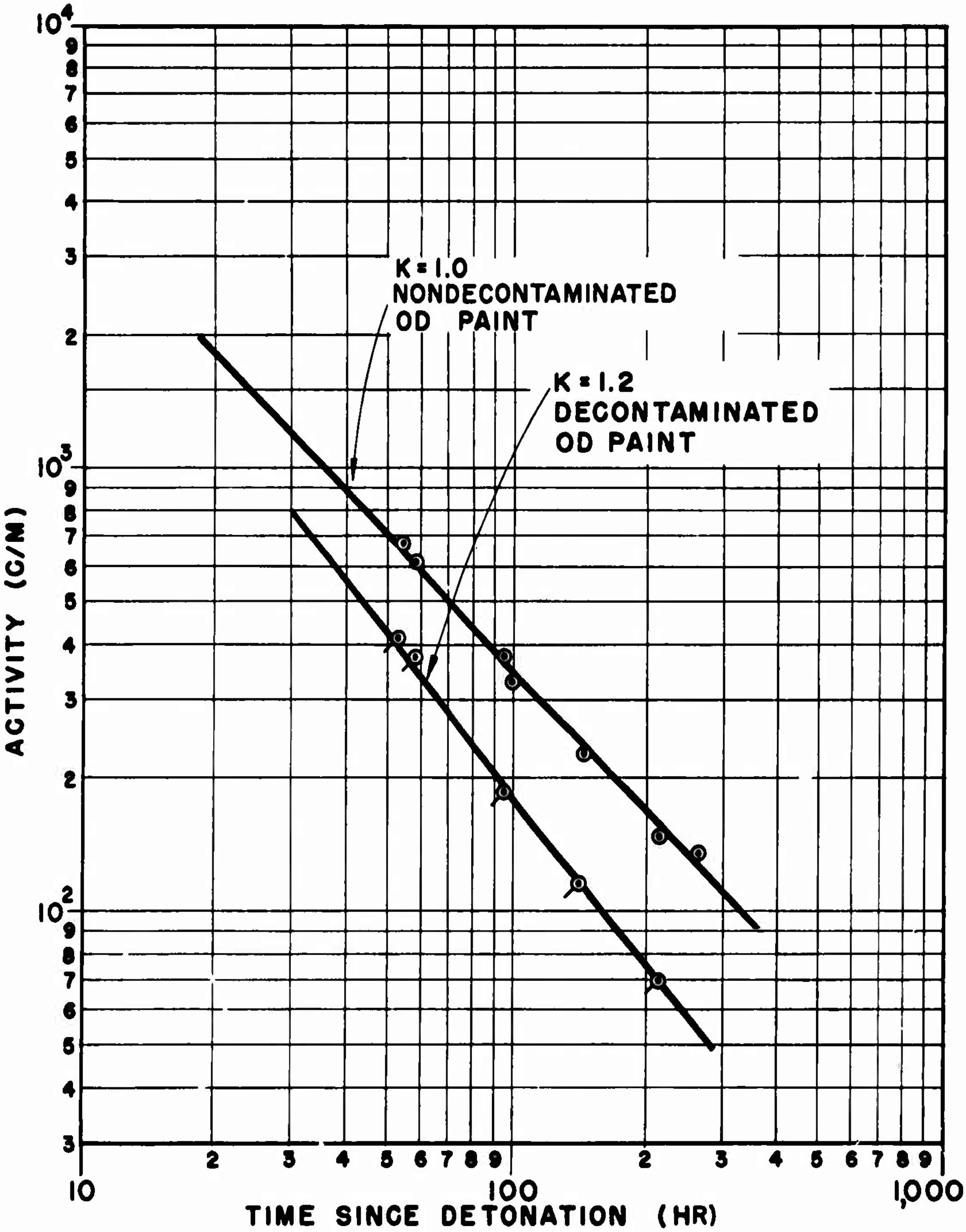

FIG. J.7 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Dog Shot, Counted through 692-mg/sq cm Aluminum Absorber

[redacted]

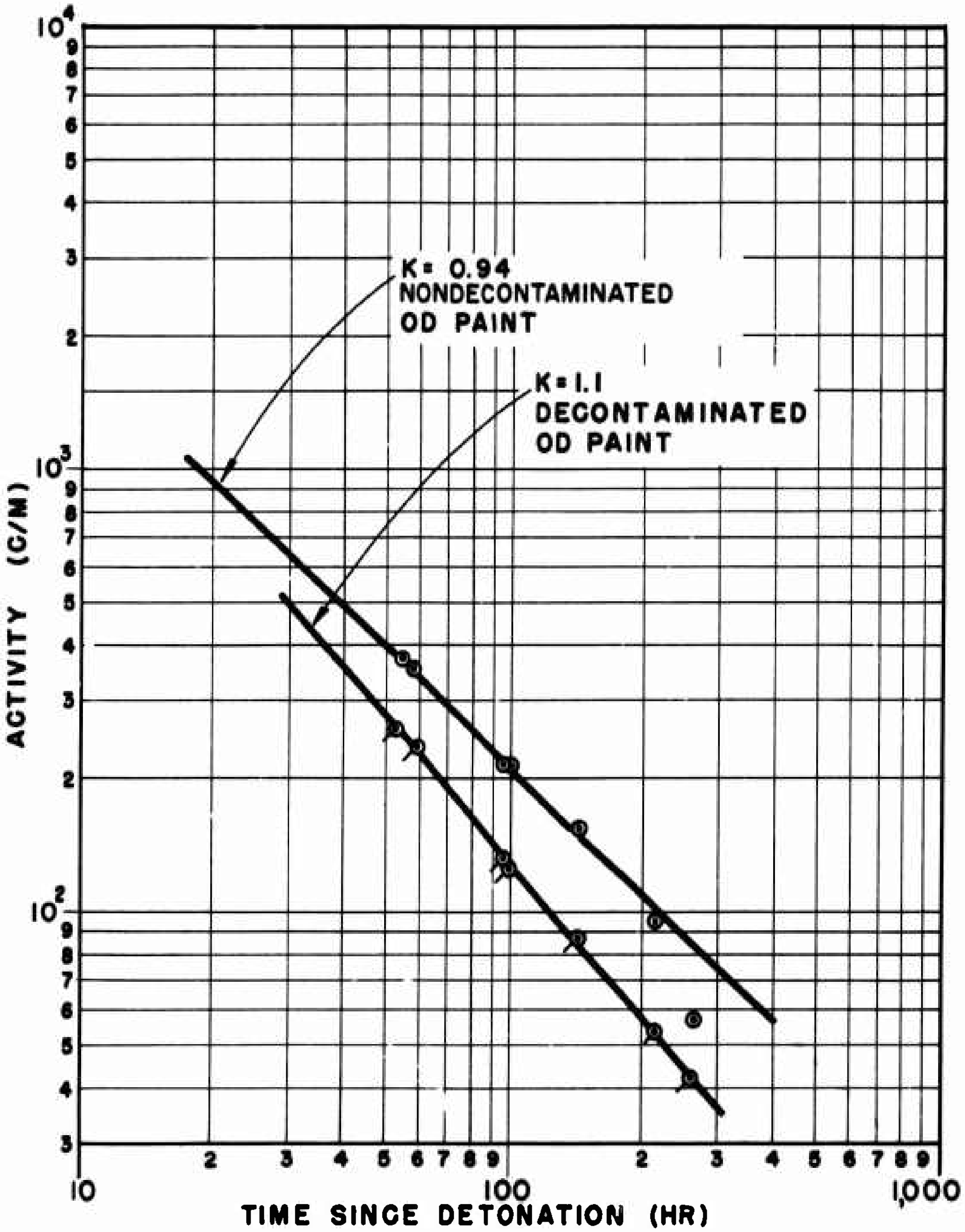

FIG. J.8 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Dog Shot, Counted through 2,059-mg/sq cm Aluminum Absorber

[redacted]

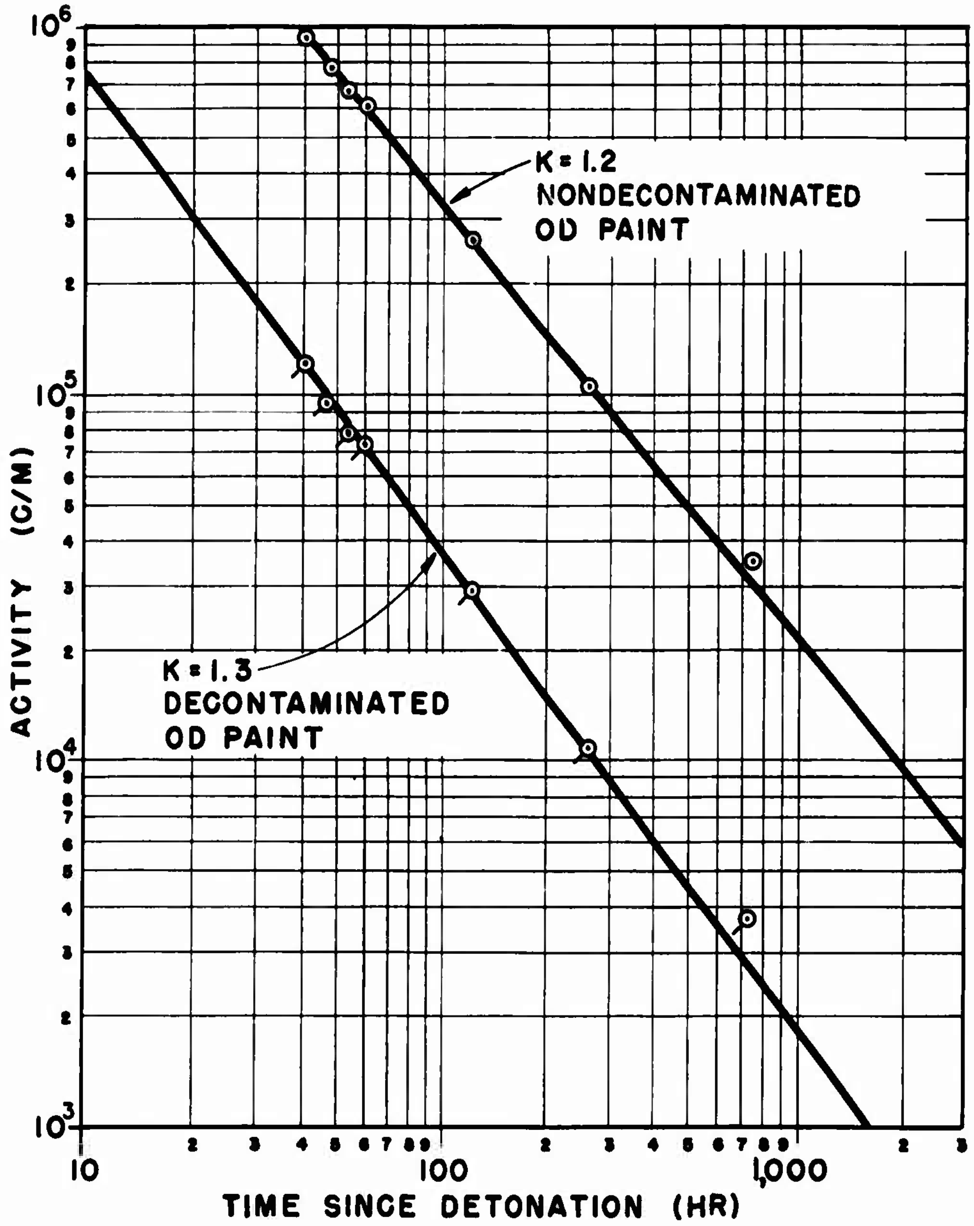

FIG. J.9 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 2.6-mg/sq cm Aluminum Absorber

[redacted]

[redacted]

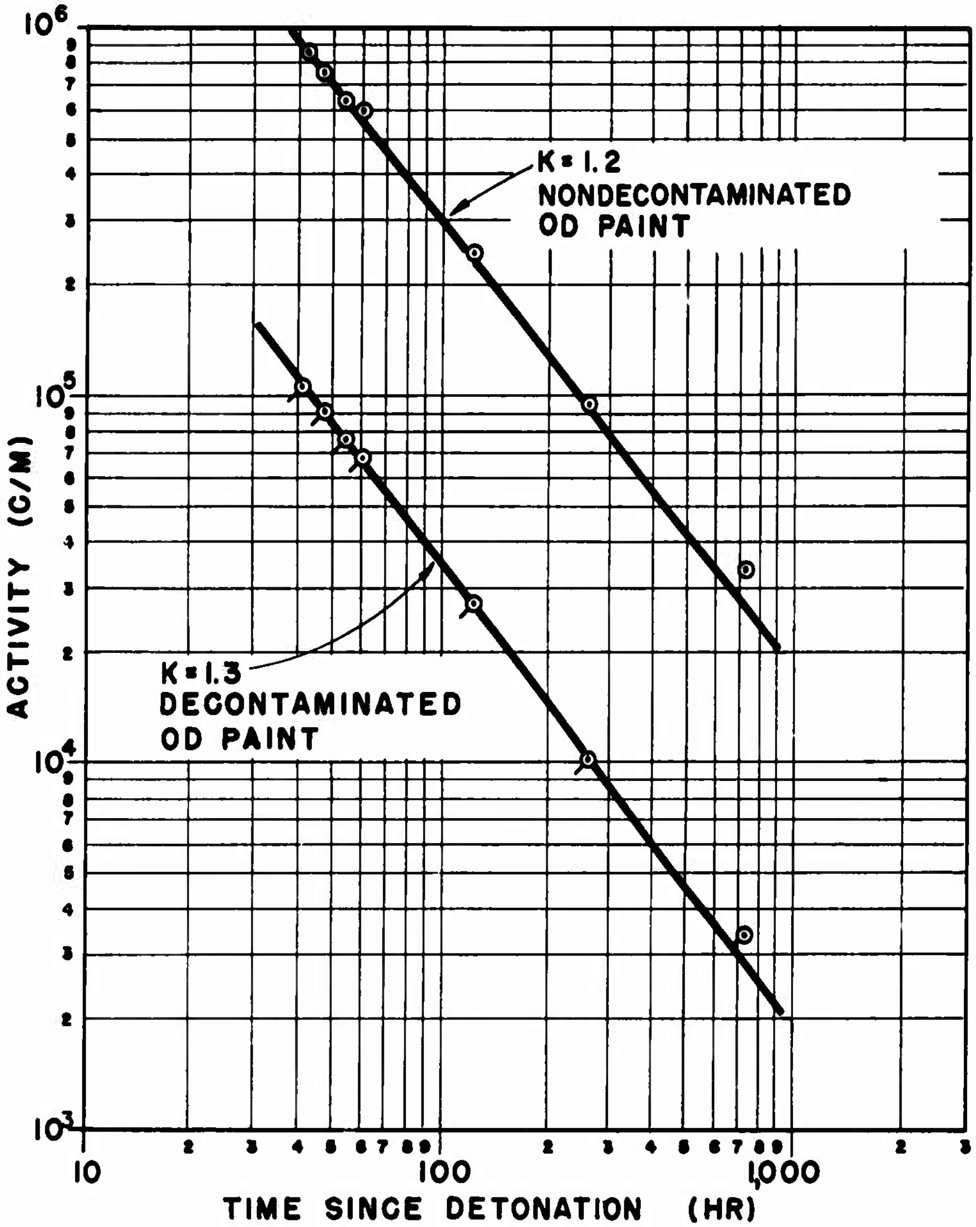

FIG. J.10 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 3.7-mg/sq cm Aluminum Absorber

[redacted]

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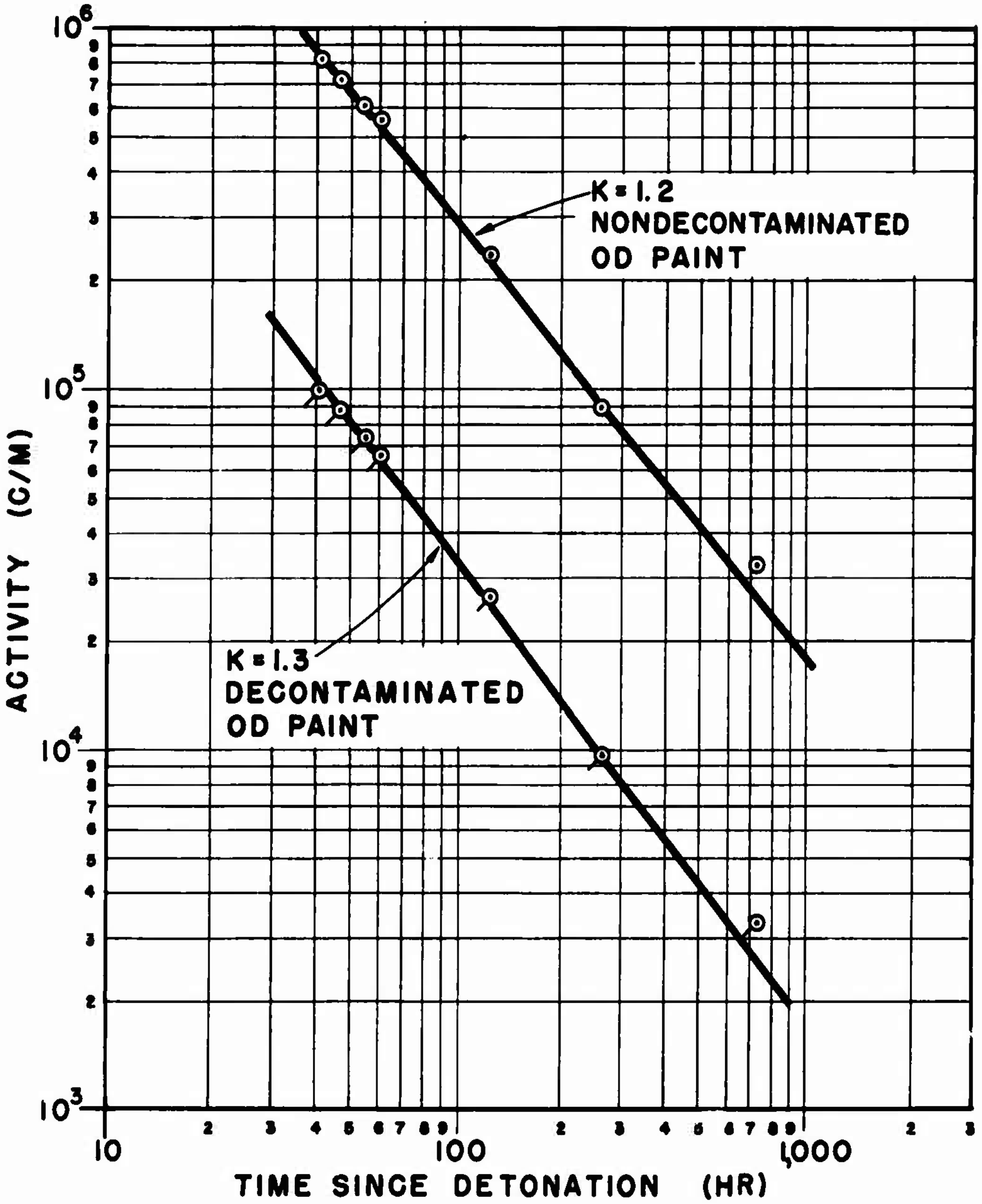

FIG. J.11 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 4.6-mg/sq cm Aluminum Absorber

[redacted]

[redacted]

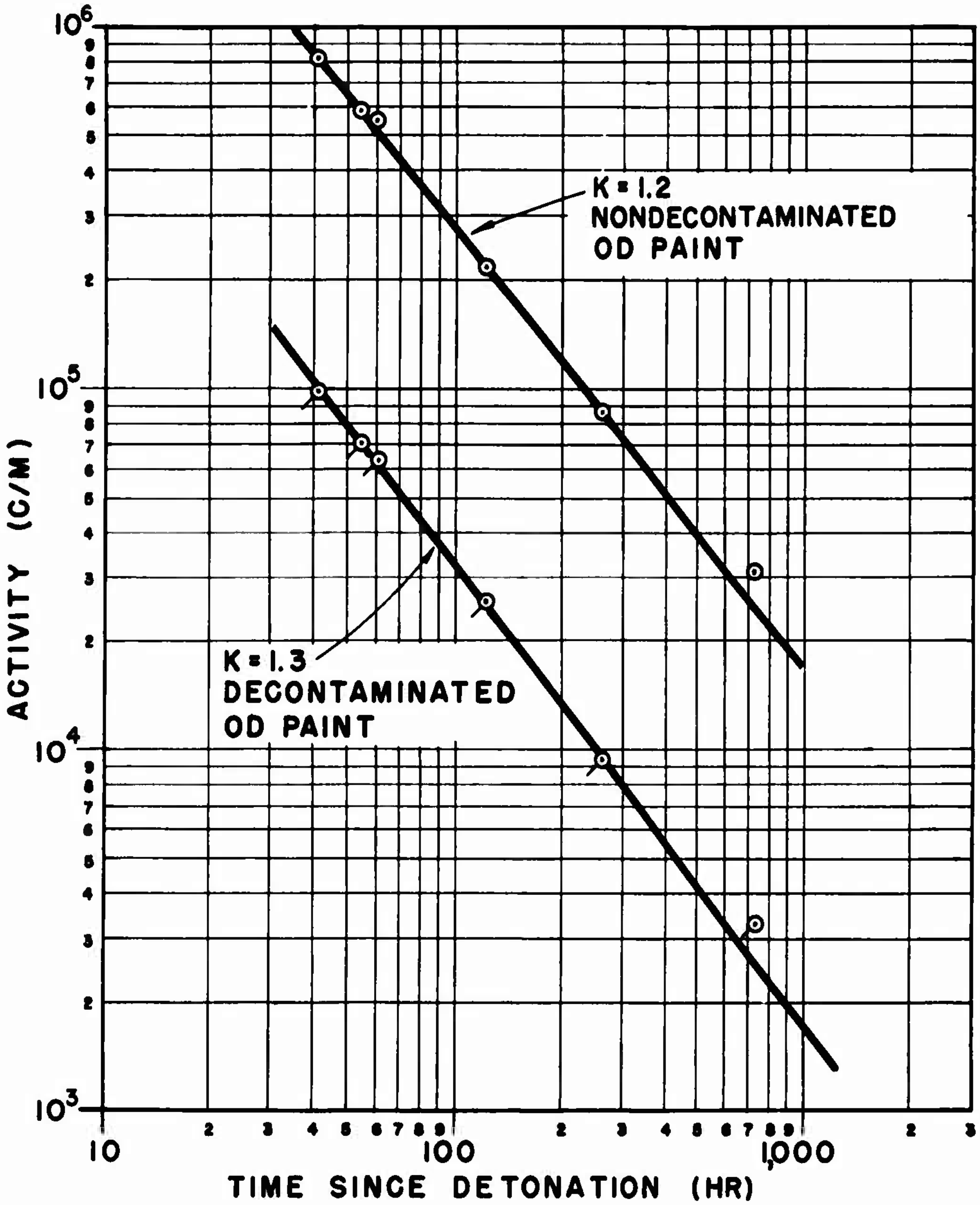

FIG. J.12 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 5.2-mg/sq cm Aluminum Absorber

[redacted]

[redacted]

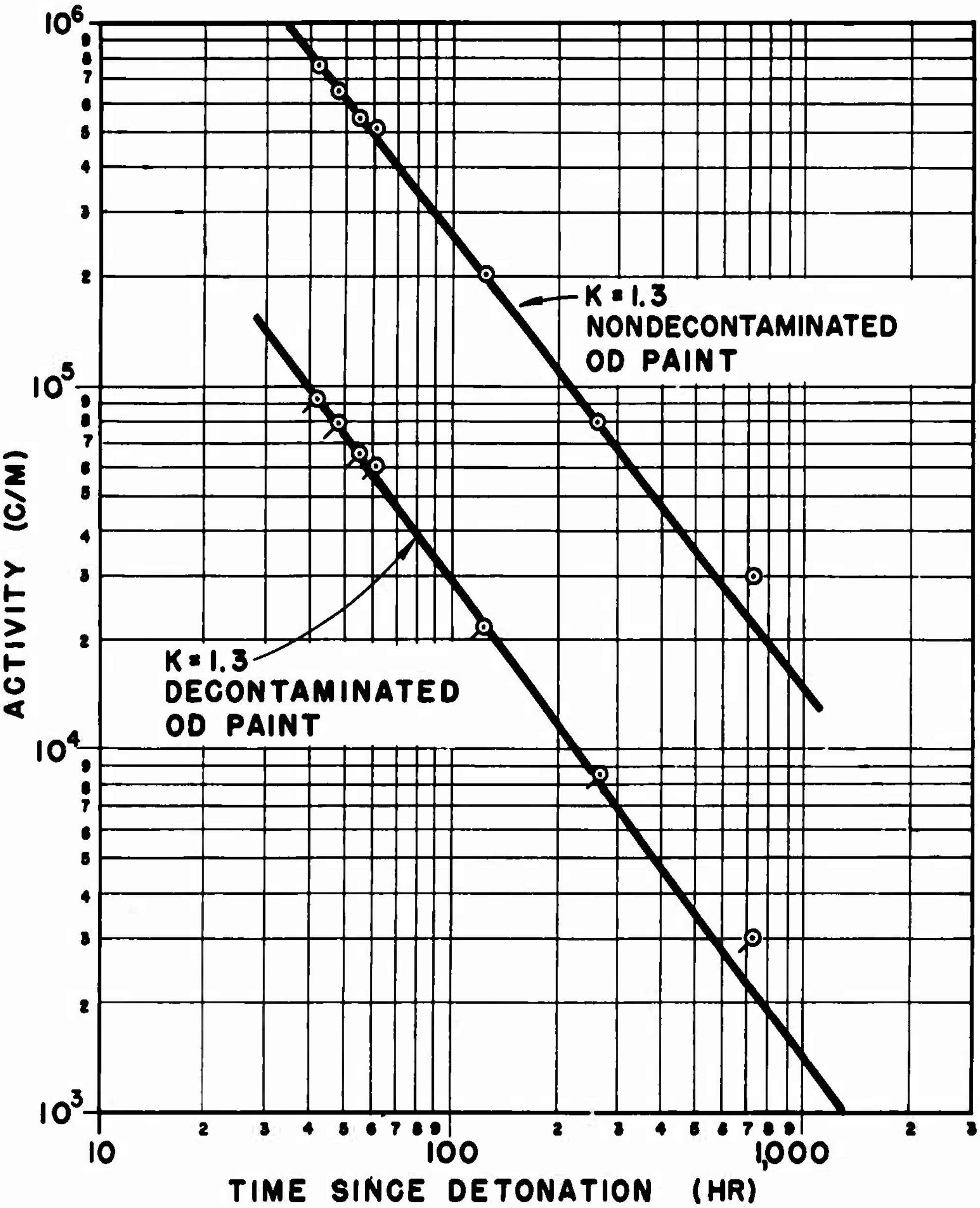

FIG. J.13 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 7.9-mg/sq cm Aluminum Absorber

[redacted]

[redacted]

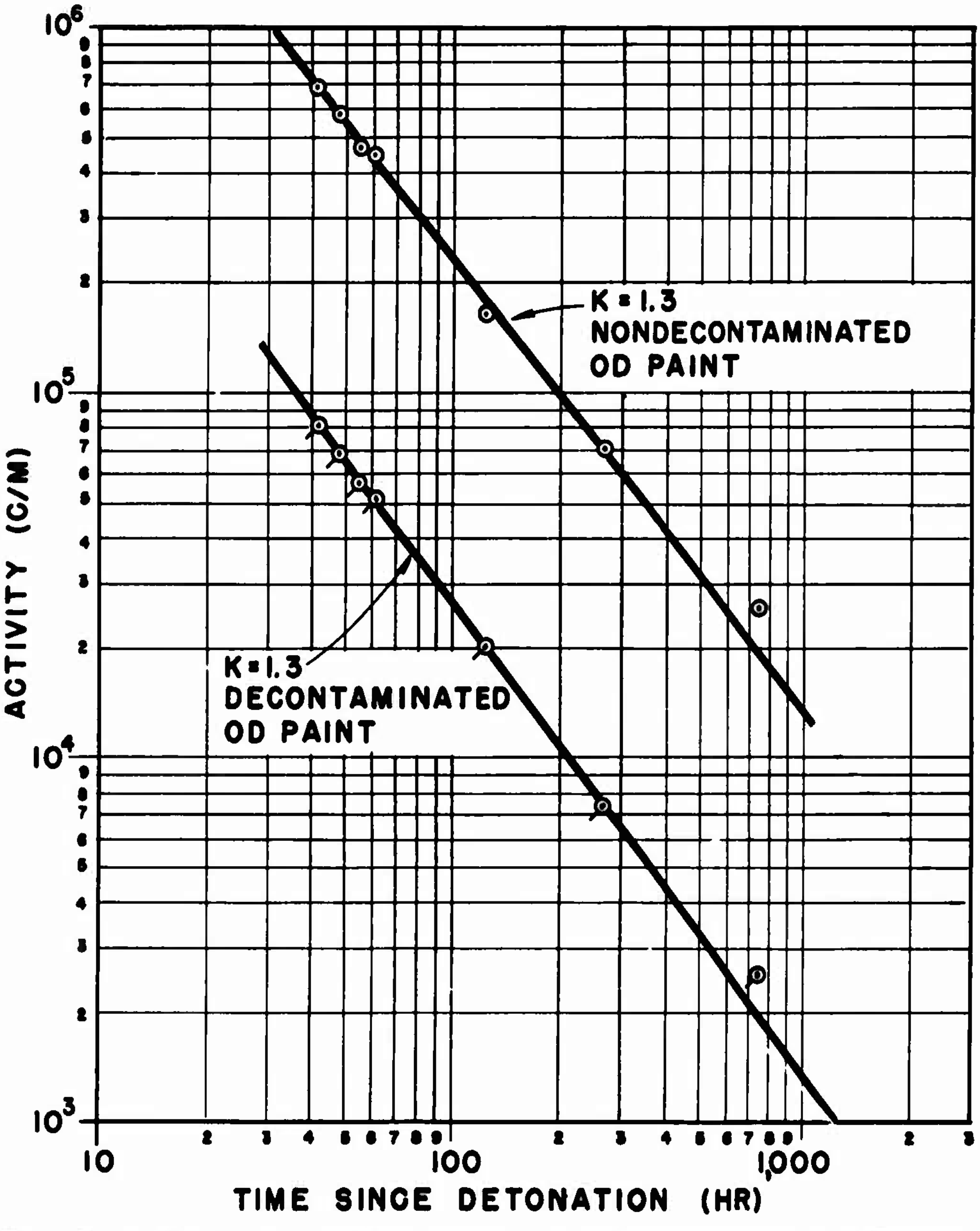

FIG. J.14 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 11.7-mg/sq cm Aluminum Absorber

[redacted]

[redacted]

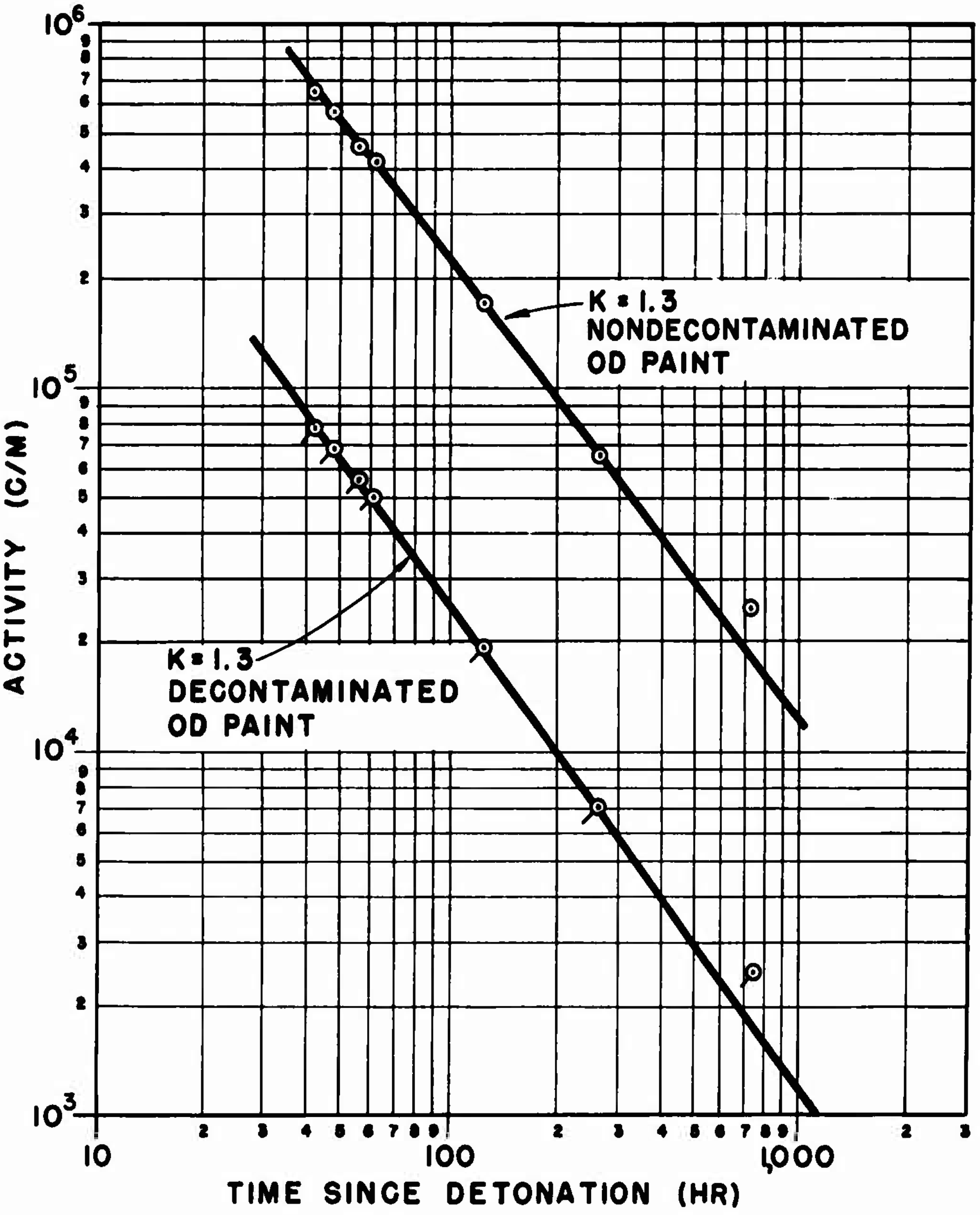

FIG. J.15 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 13.0-mg/sq cm Aluminum Absorber

[redacted]

[redacted]

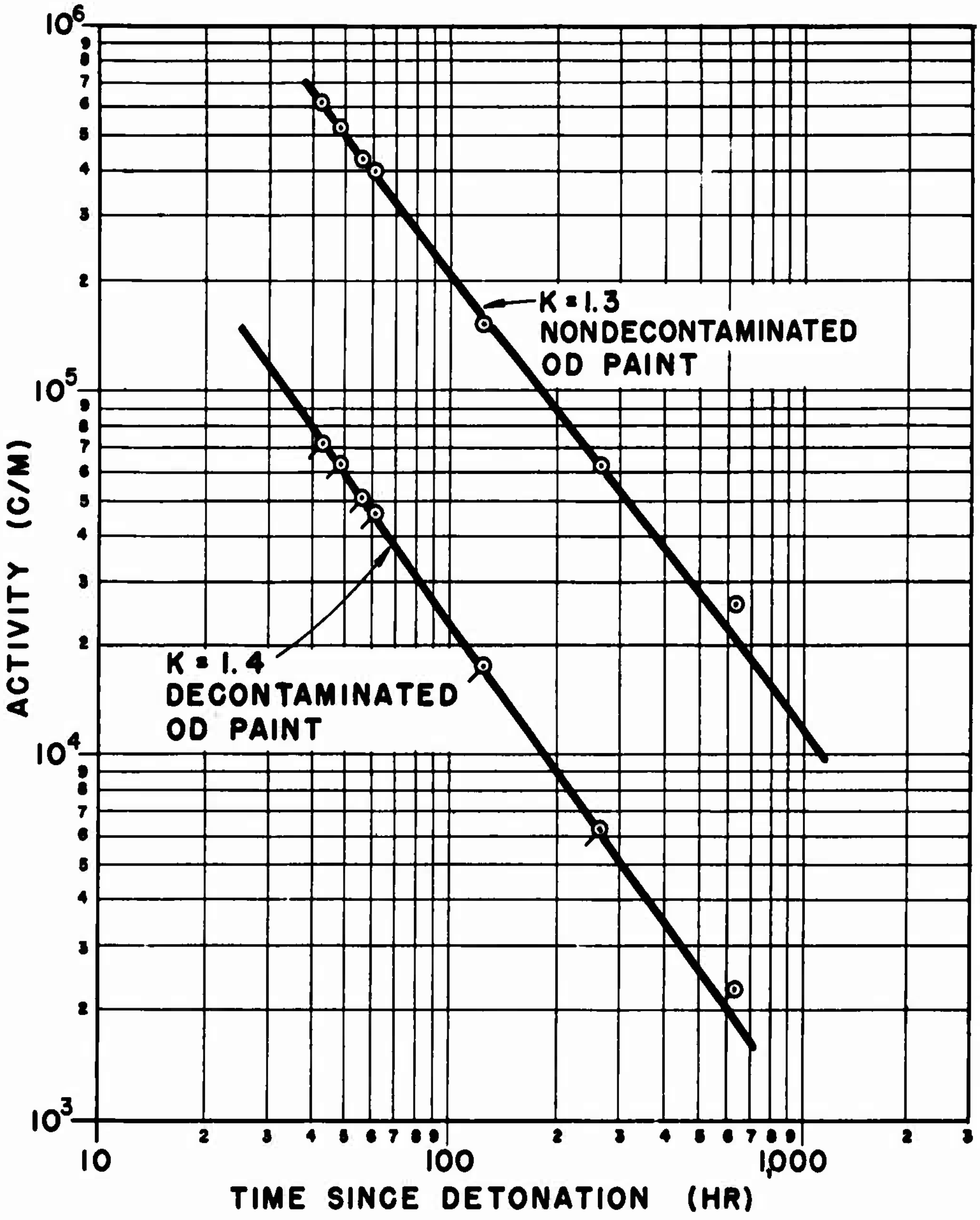

FIG. J.16 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 16.3-mg/sq cm Aluminum Absorber

[redacted]

[redacted]

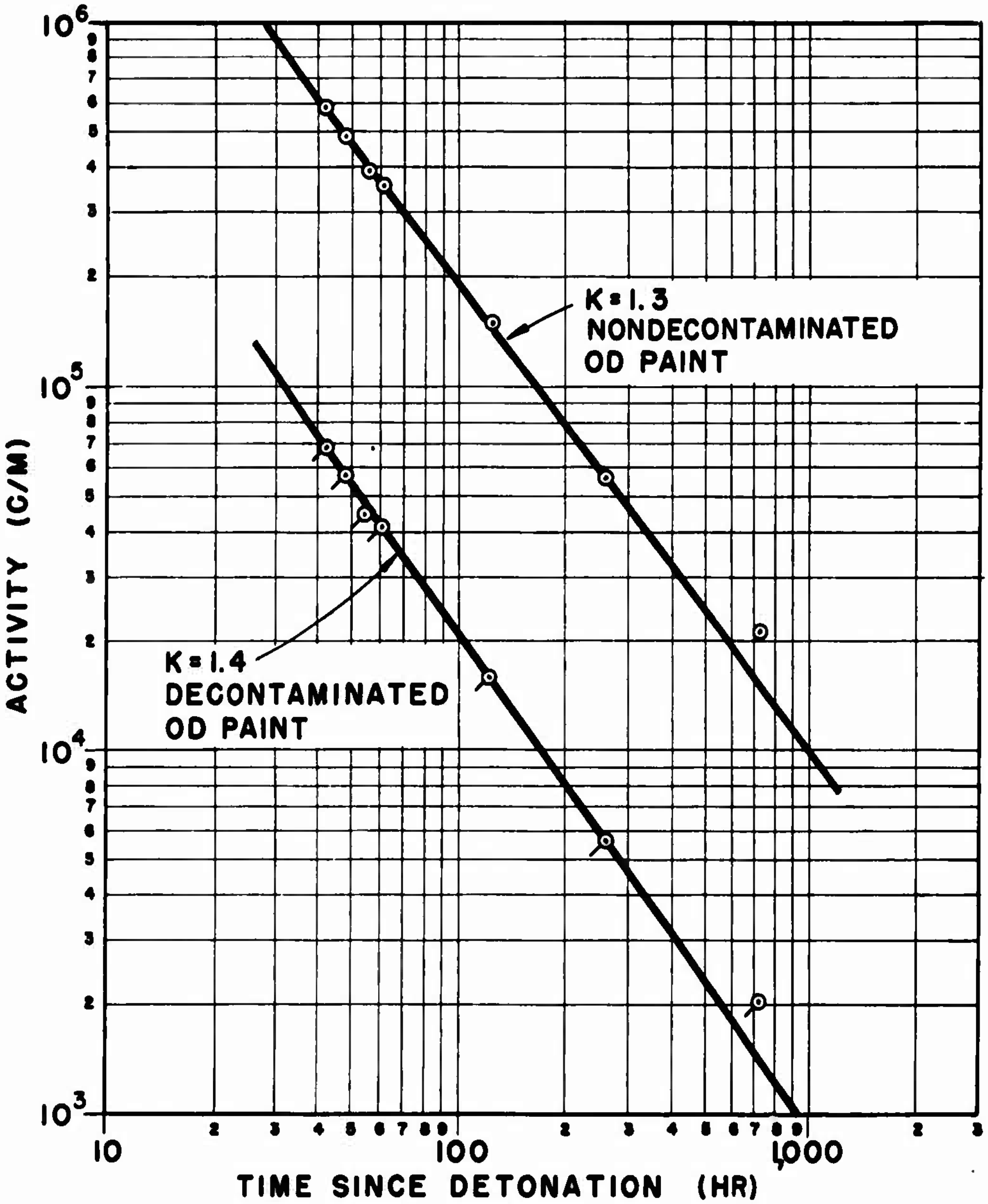

FIG. J.17 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 20.5-mg/sq cm Aluminum Absorber

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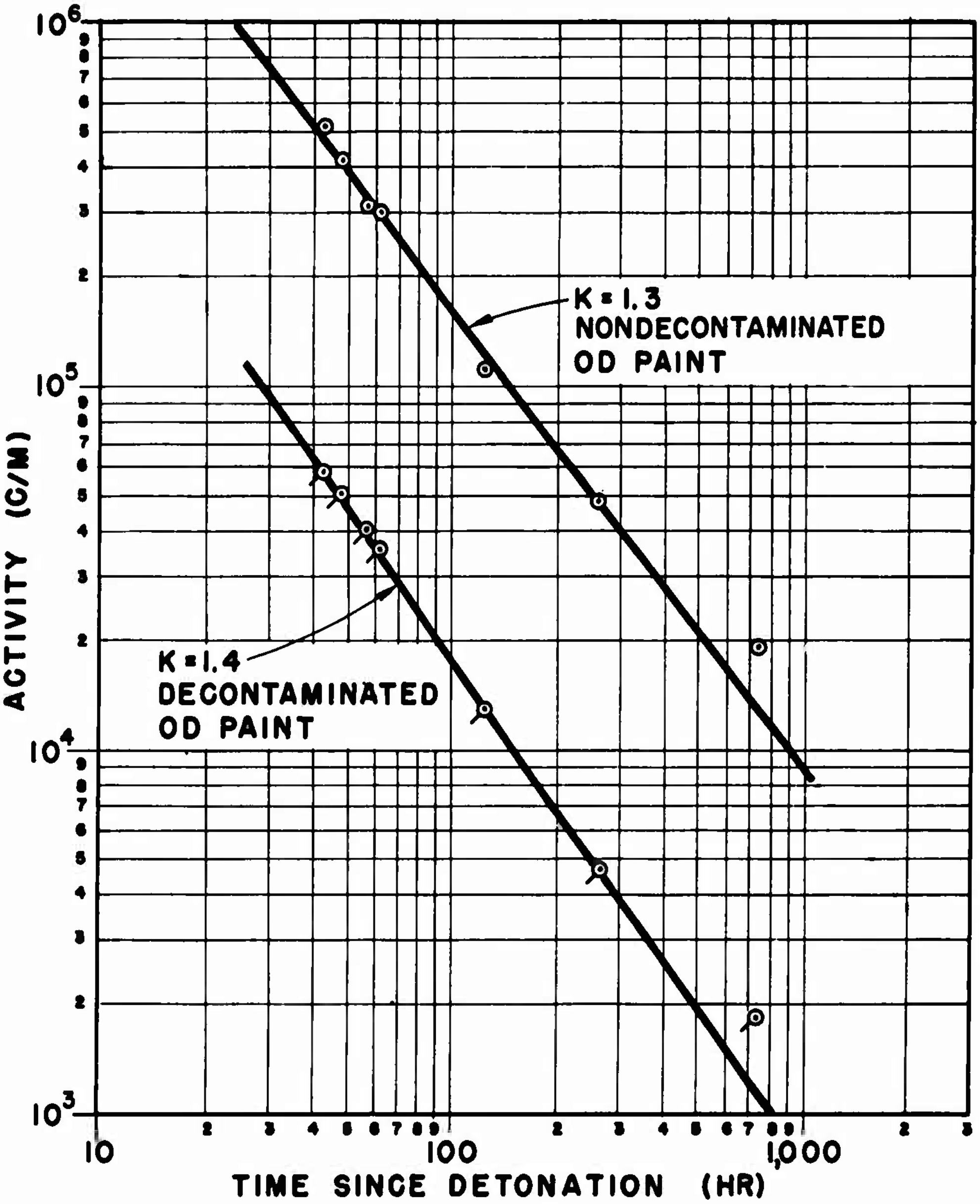

Fig. J.18 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 28.5-mg/sq cm Aluminum Absorber

[redacted]

[redacted]

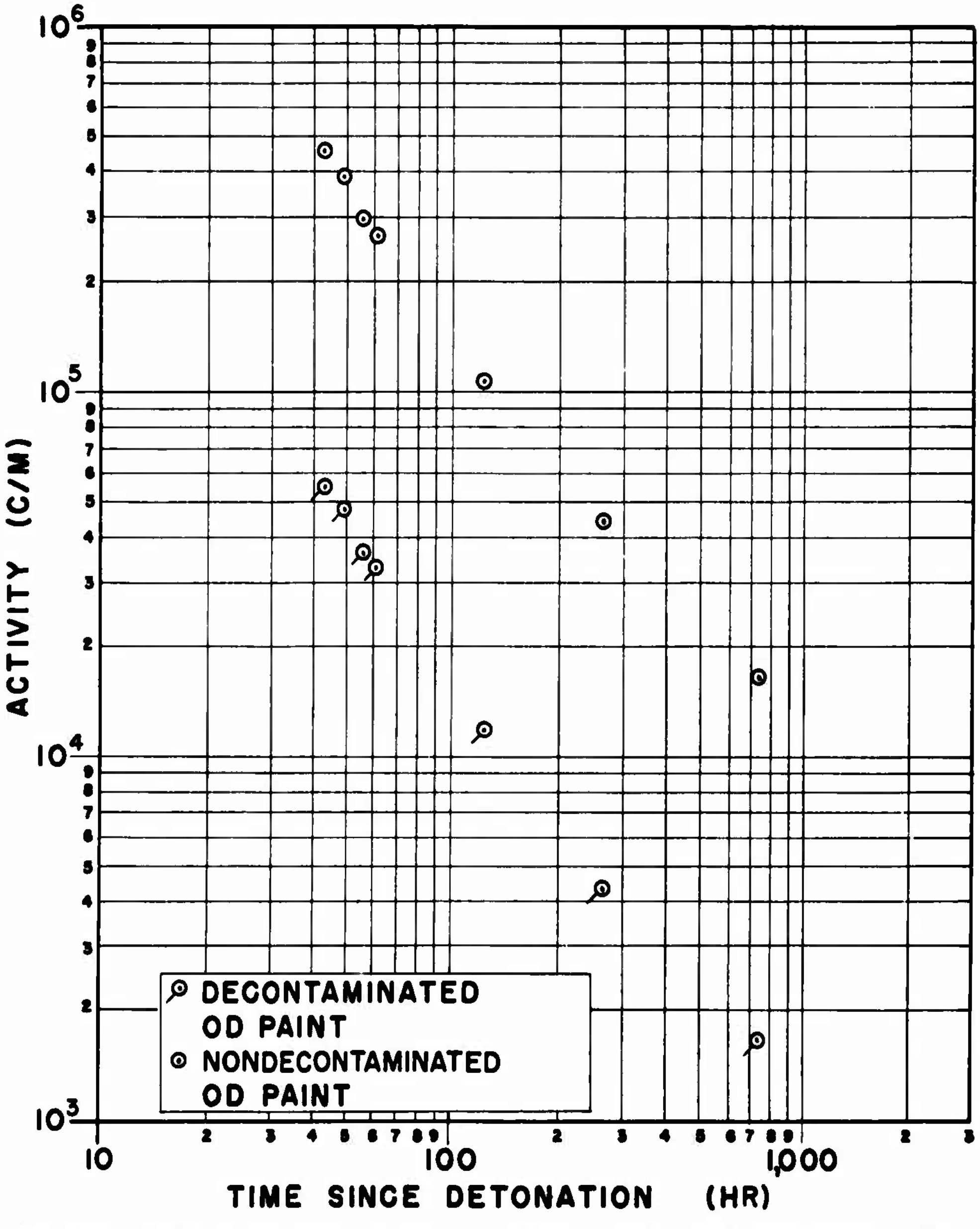

FIG. J.19 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 32.4-mg/sq cm Aluminum Absorber

[redacted]

[redacted]

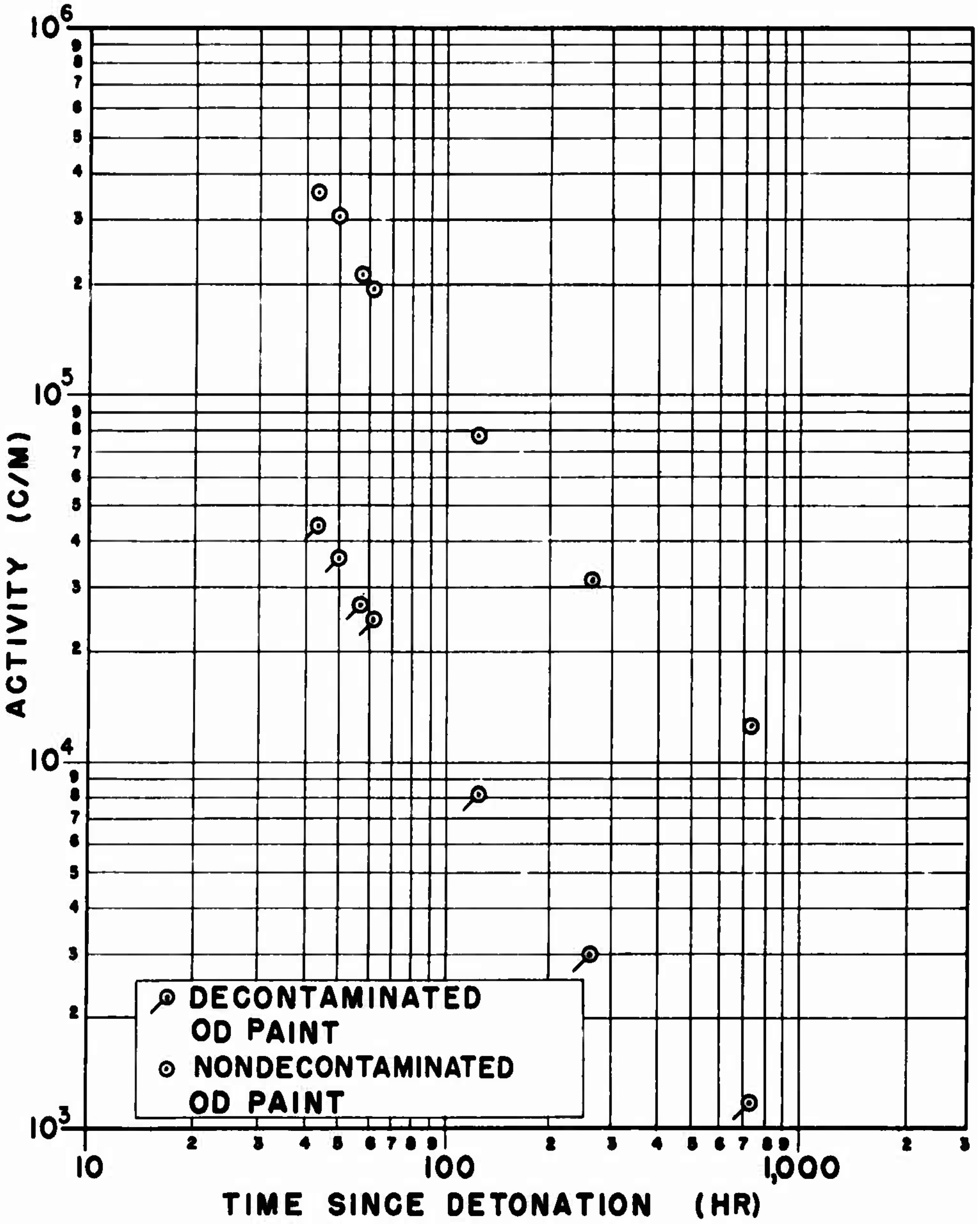

FIG. J.20 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 55.7-mg/sq cm Aluminum Absorber

[redacted]

[redacted]

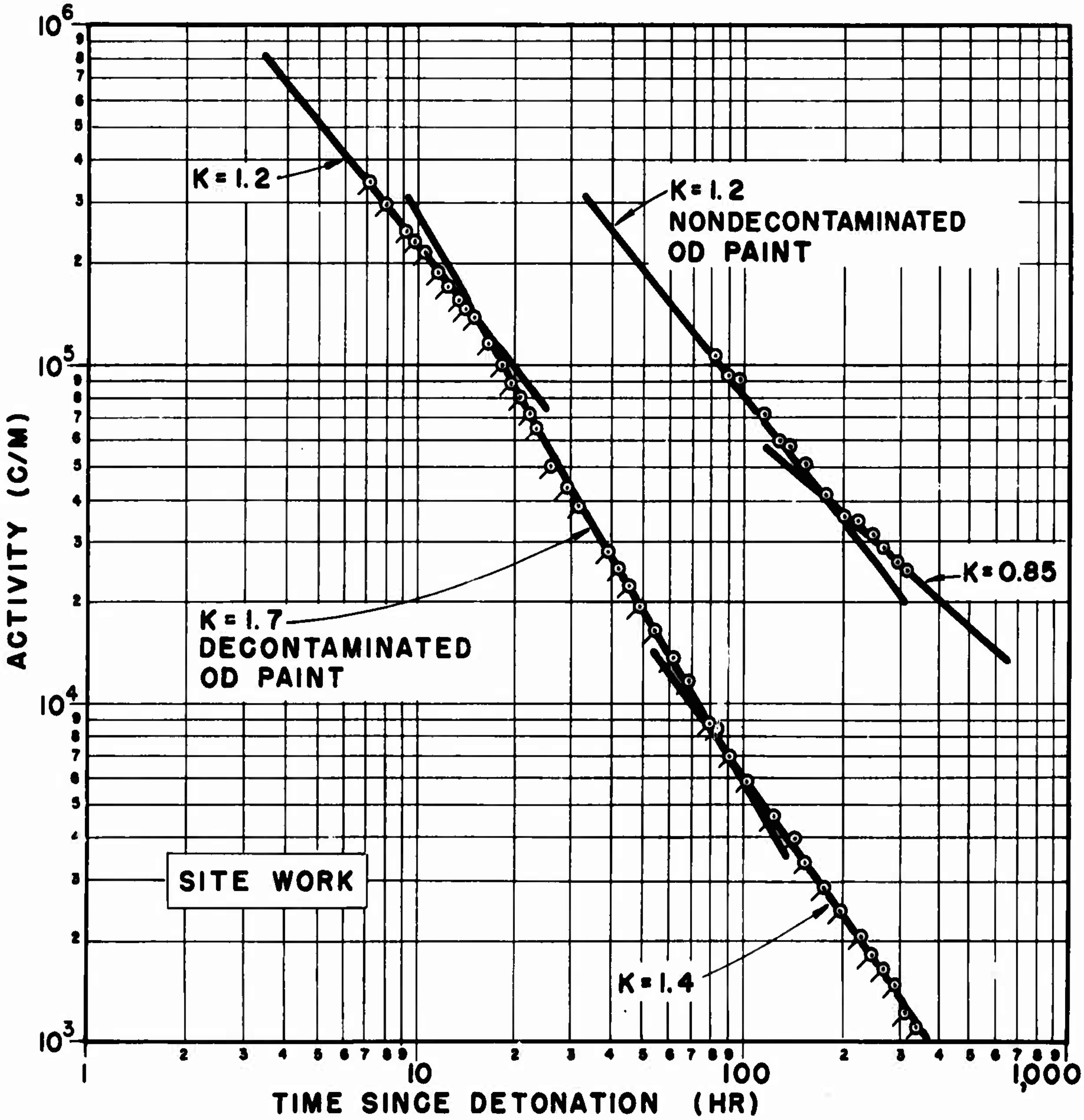

FIG. J.21 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 55.7-mg/sq cm Aluminum Absorber. (Site Work)

[redacted]

[redacted]

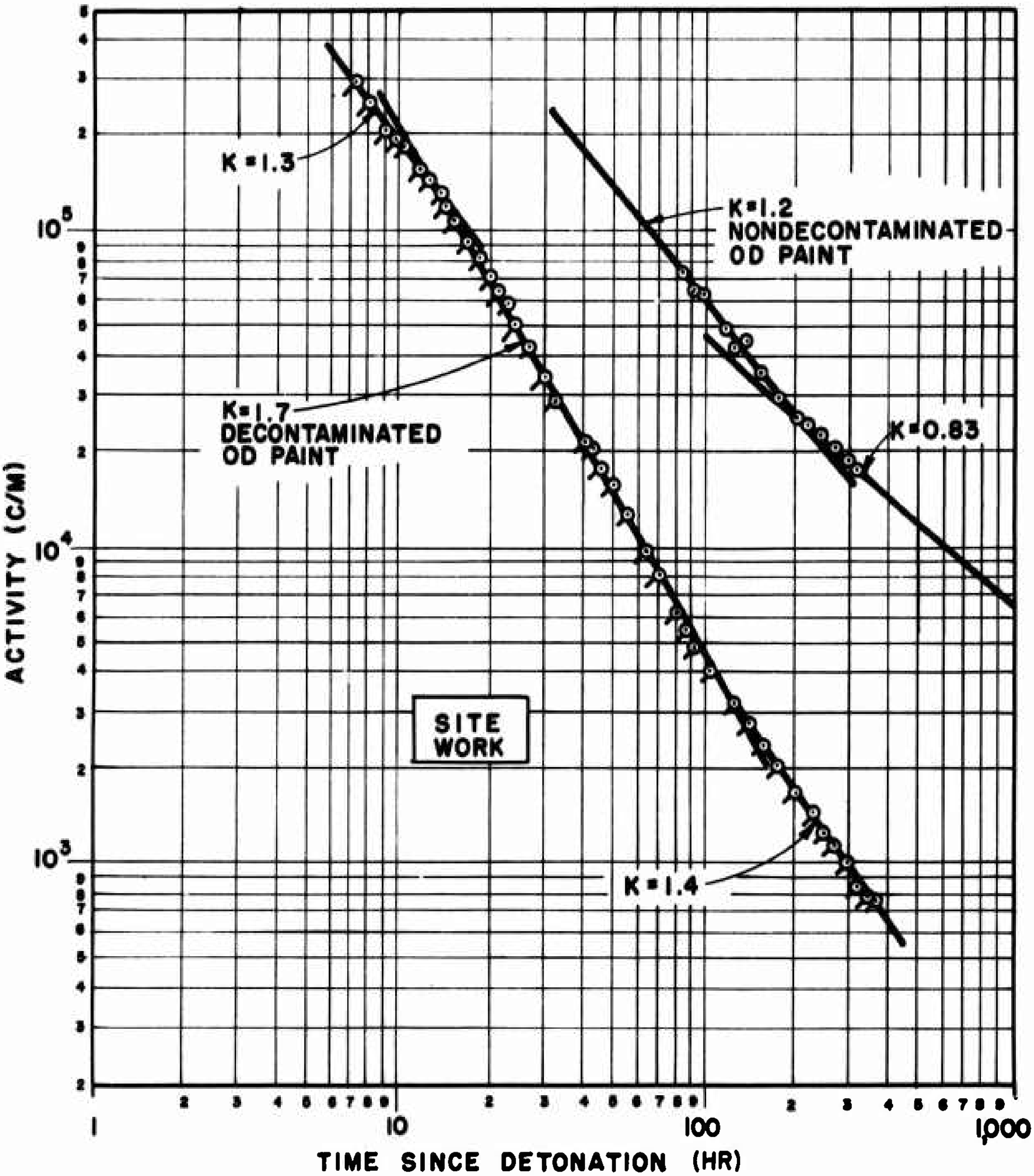

Fig. J.22 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 83.2-mg/sq cm Aluminum Absorber (Site Work)

[redacted]

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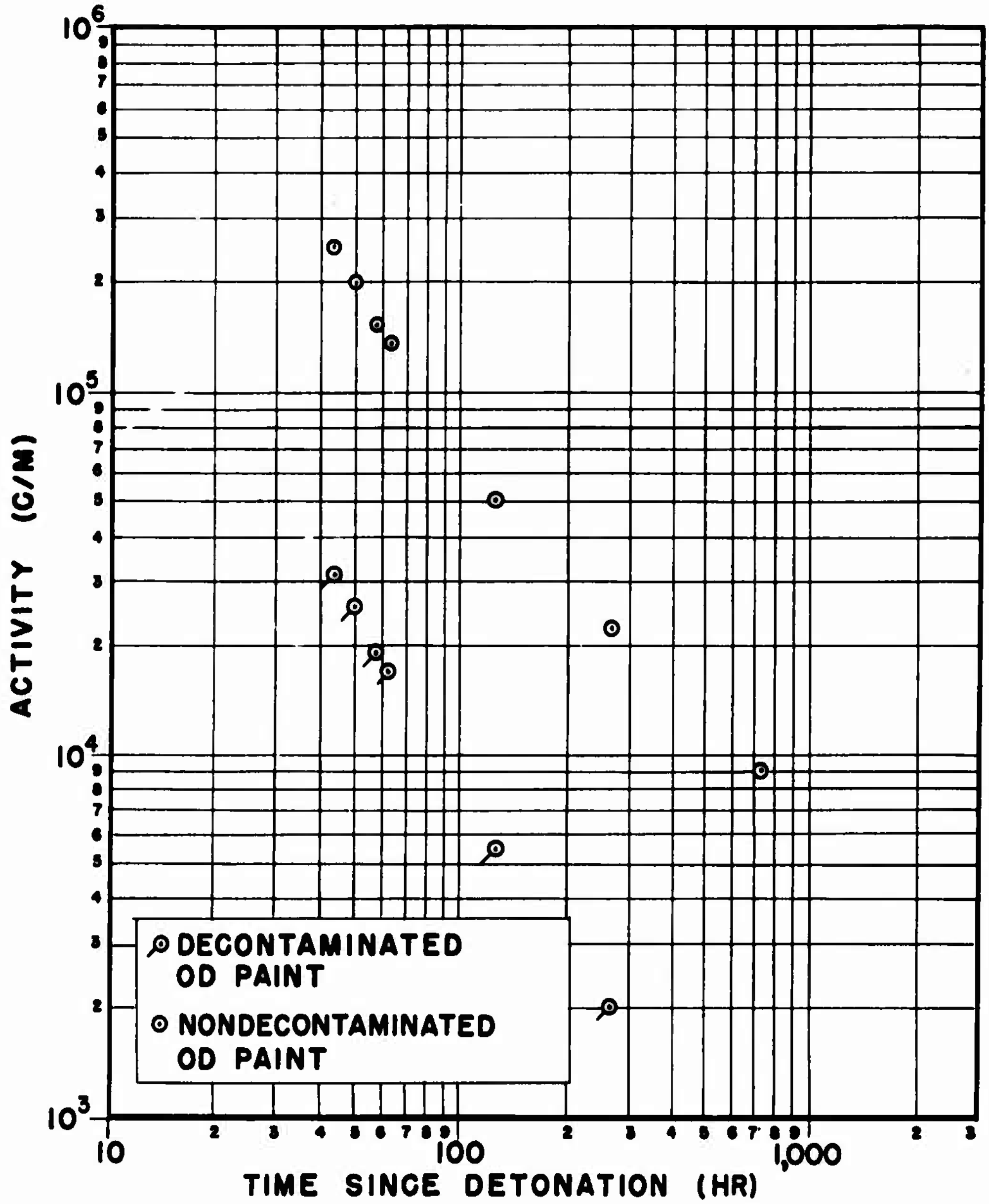

FIG. J.23 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 85.4-mg/sq cm Aluminum Absorber

[redacted]

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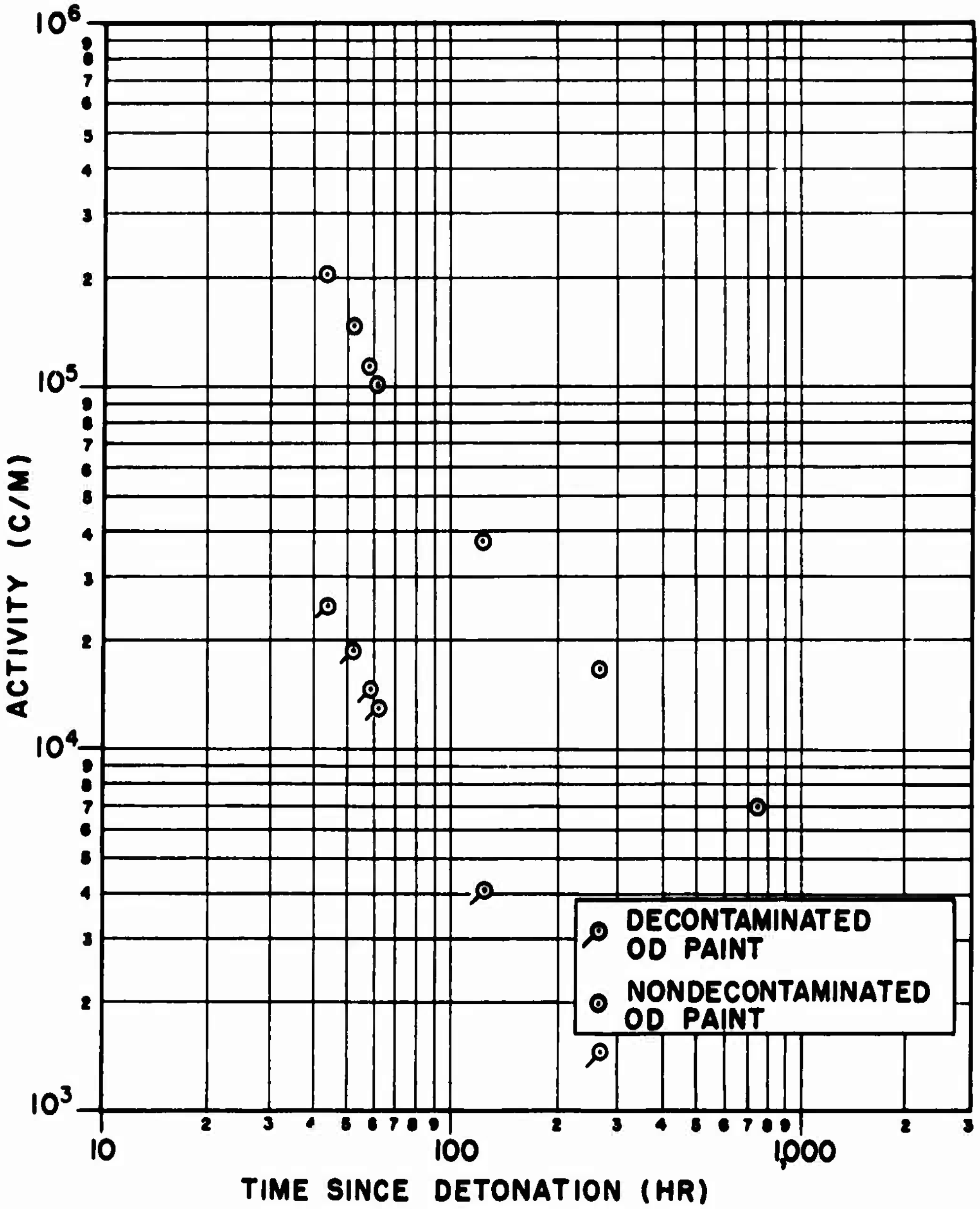

FIG. J.24 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 112-mg/sq cm Aluminum Absorber

[redacted]

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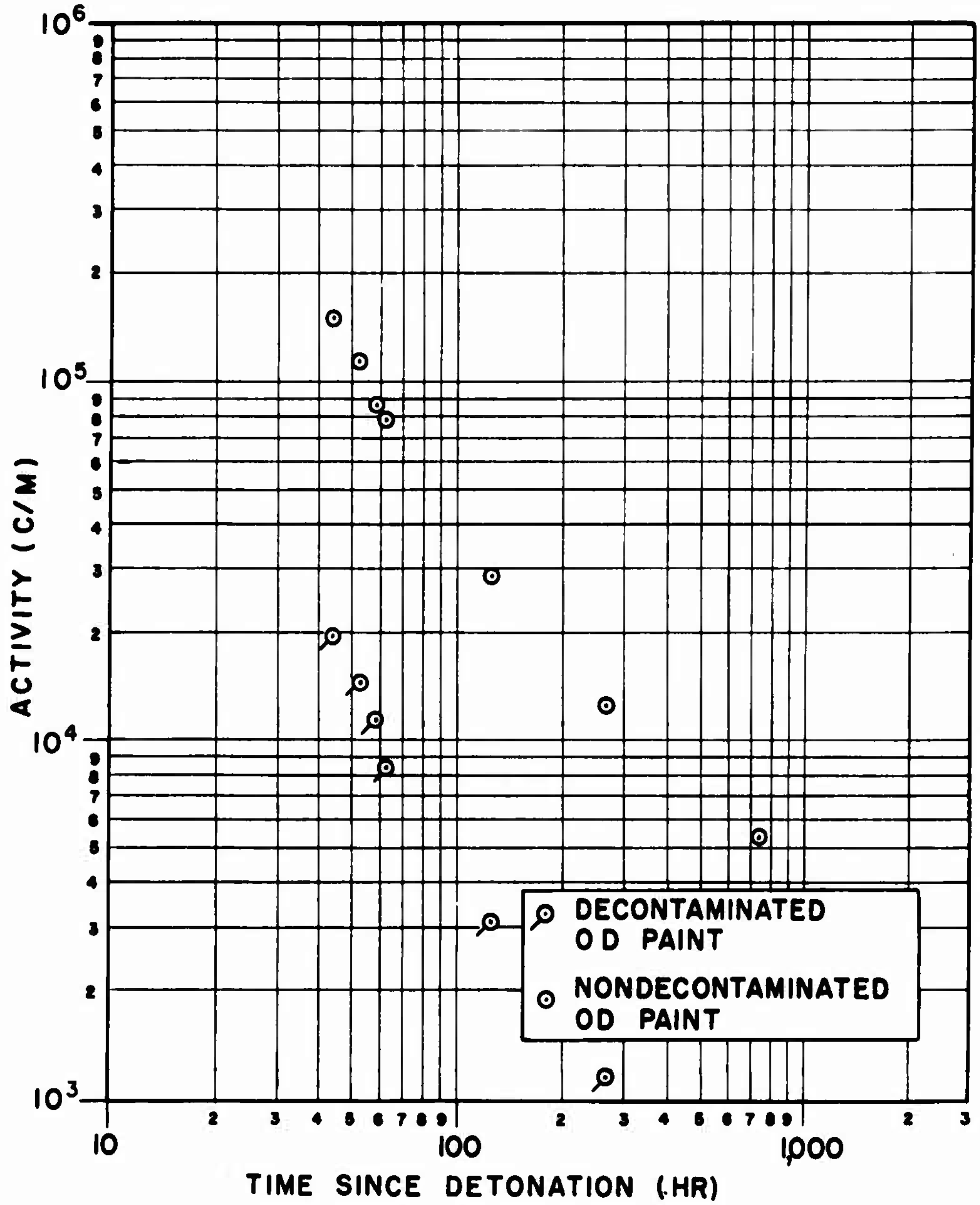

Fig. J.25 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 138-mg/sq cm Aluminum Absorber

[redacted]

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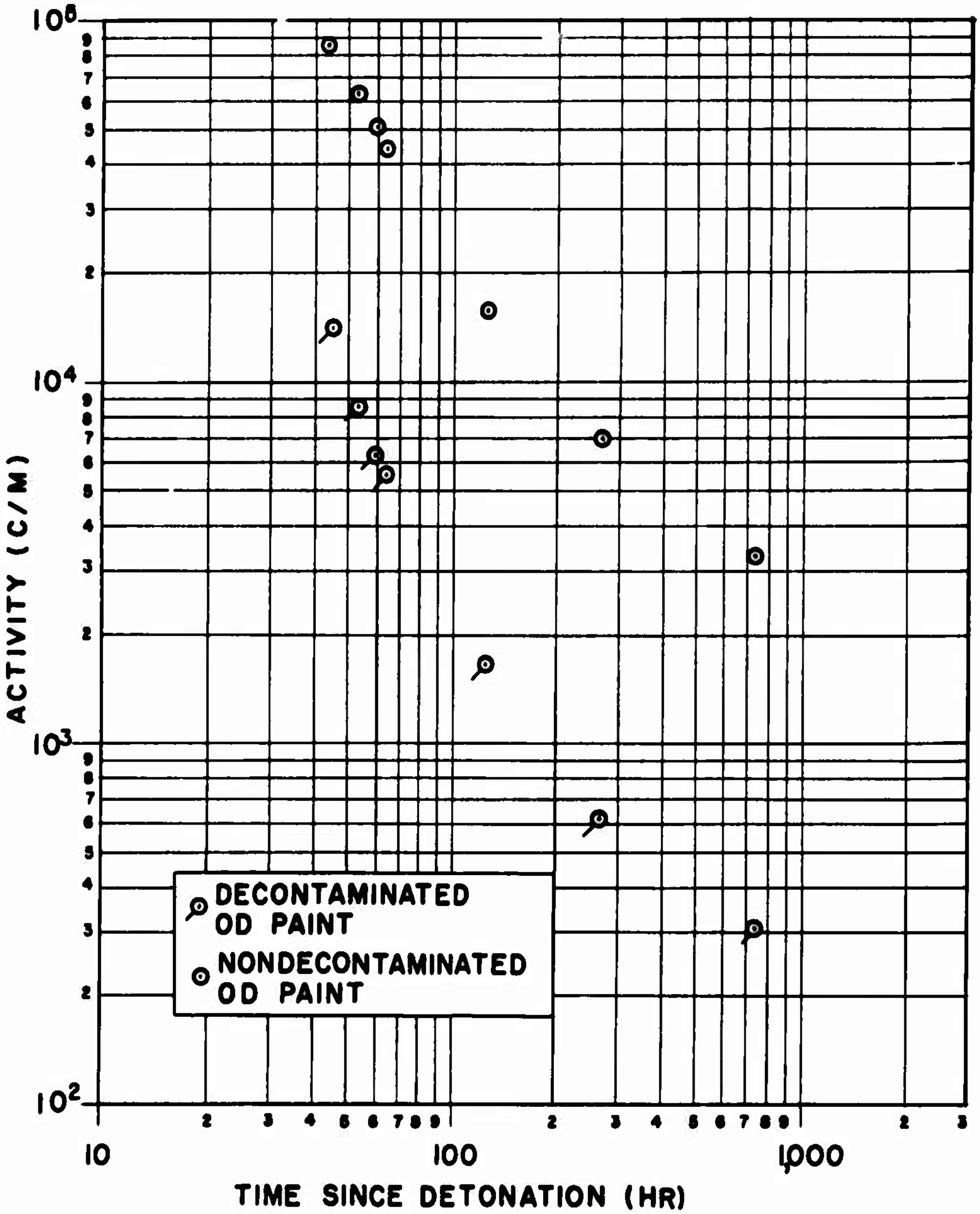

FIG. J.26 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 208-mg/sq cm Aluminum Absorber

[redacted]

[redacted]

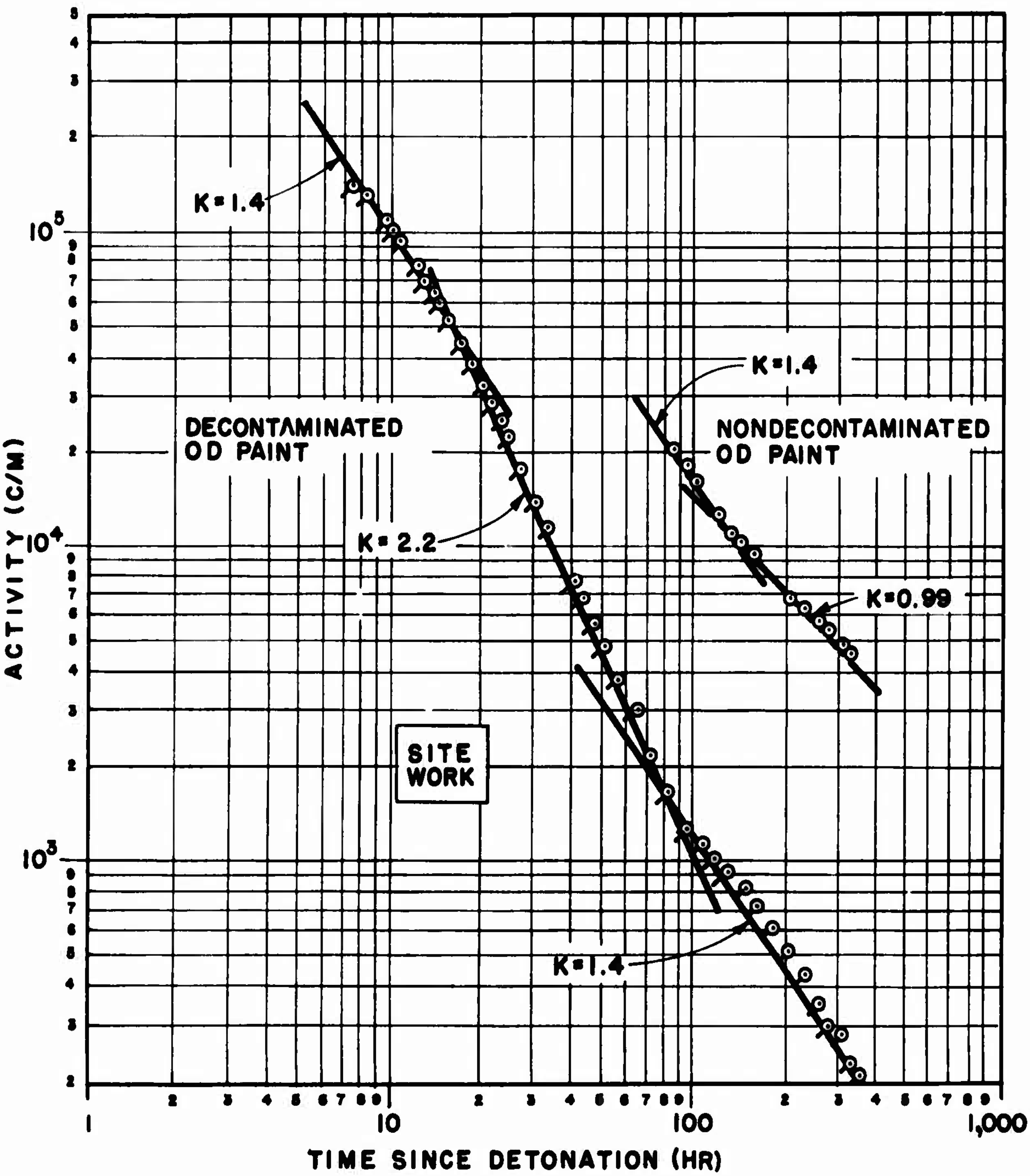

FIG. J.27 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 219-mg/sq cm Aluminum Absorber (Site Work)

[redacted]

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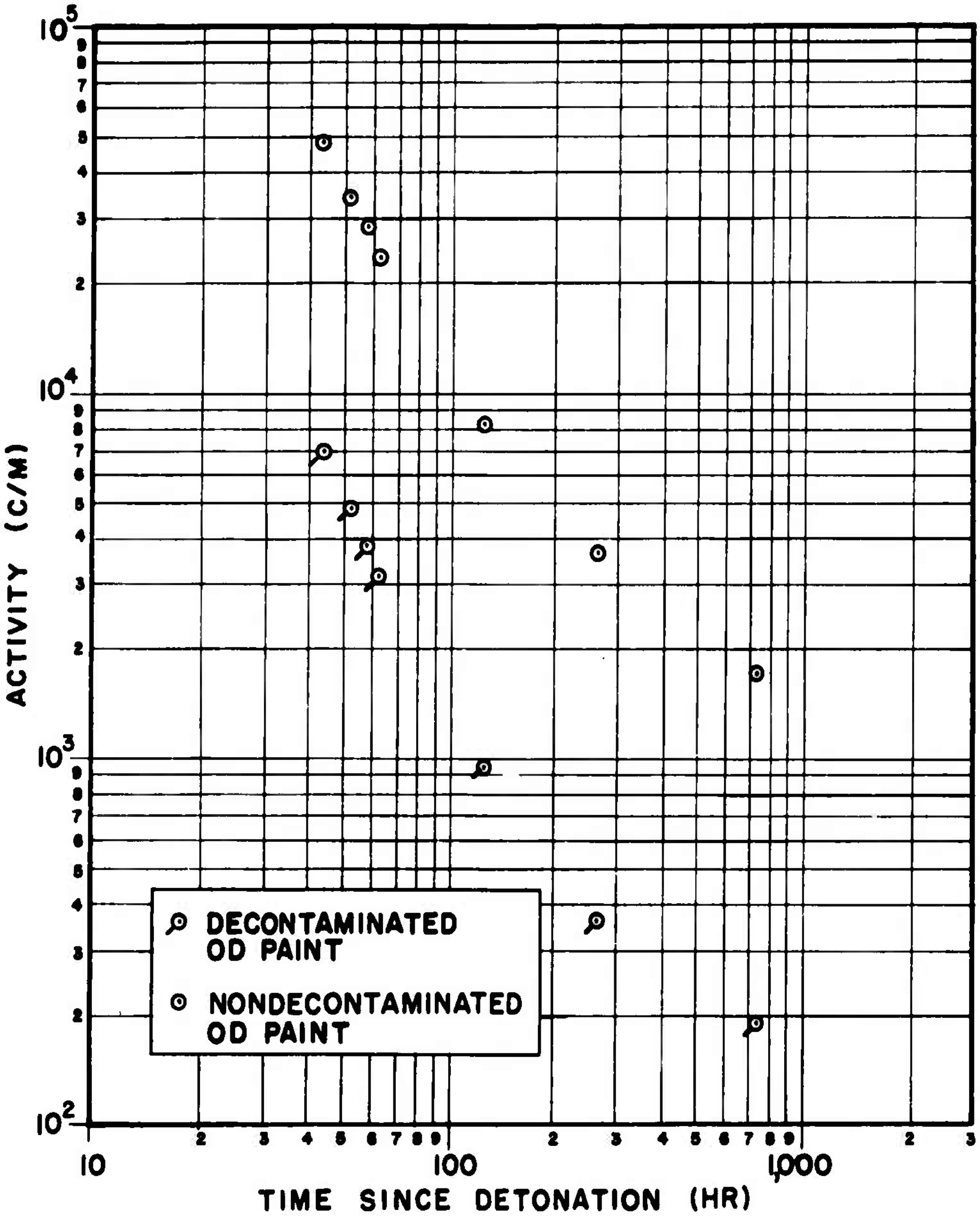

FIG. J.28 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 287-mg/sq cm Aluminum Absorber

[redacted]

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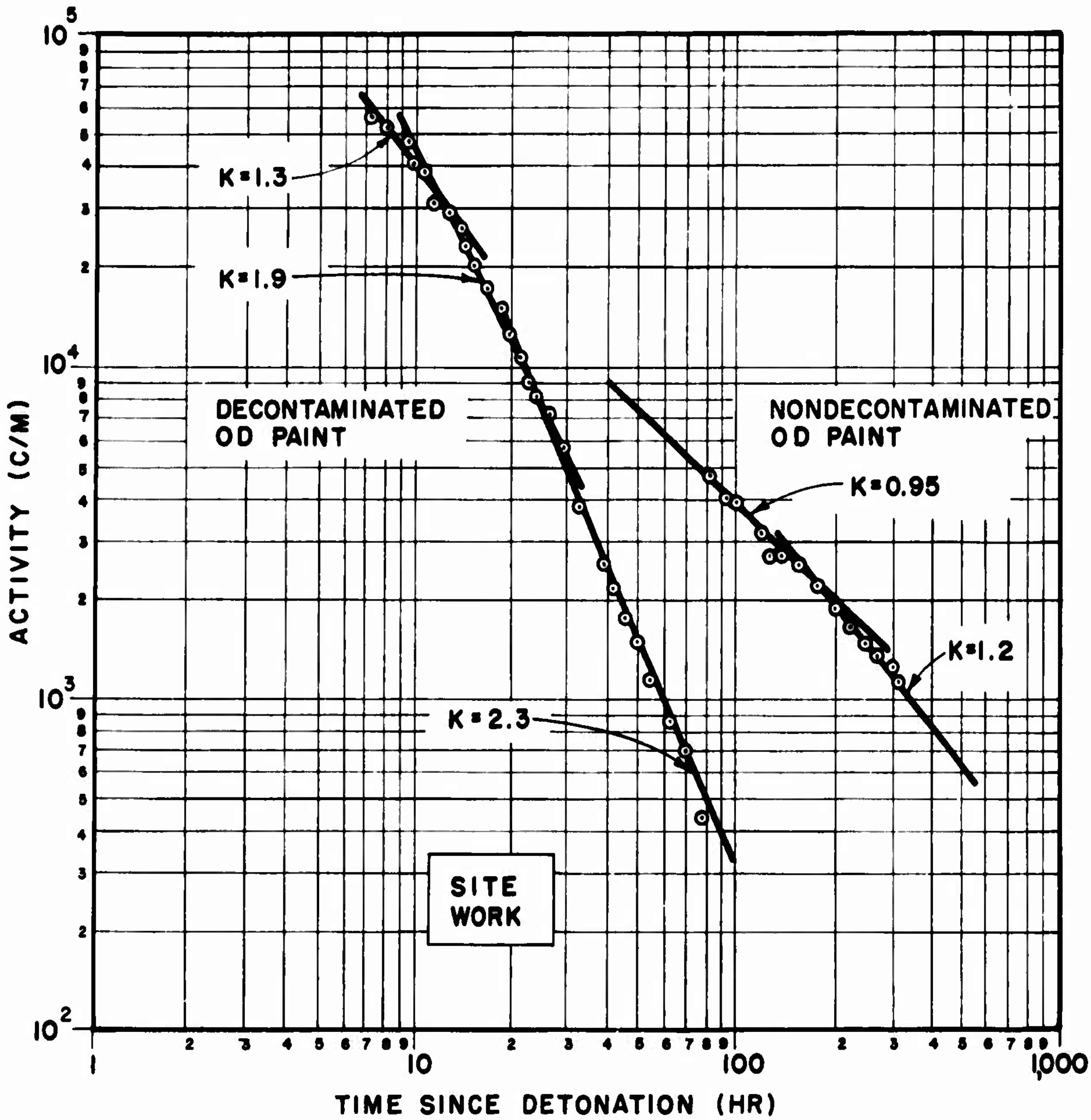

FIG. J.29 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 433-mg/sq cm Aluminum Absorber (Site Work)

[redacted]

[redacted]

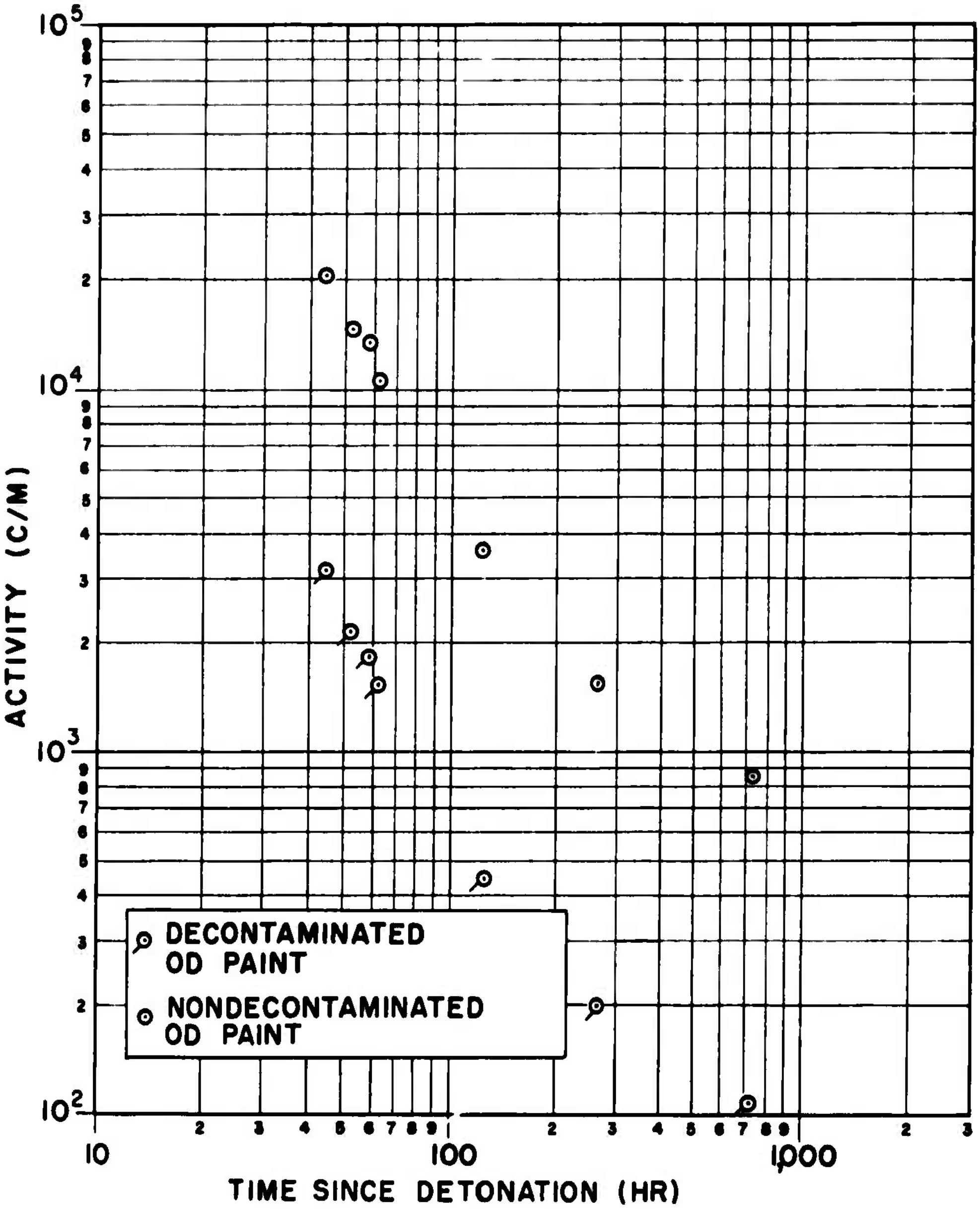

FIG. J.30 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 446-mg/sq cm Aluminum Absorber

[redacted]

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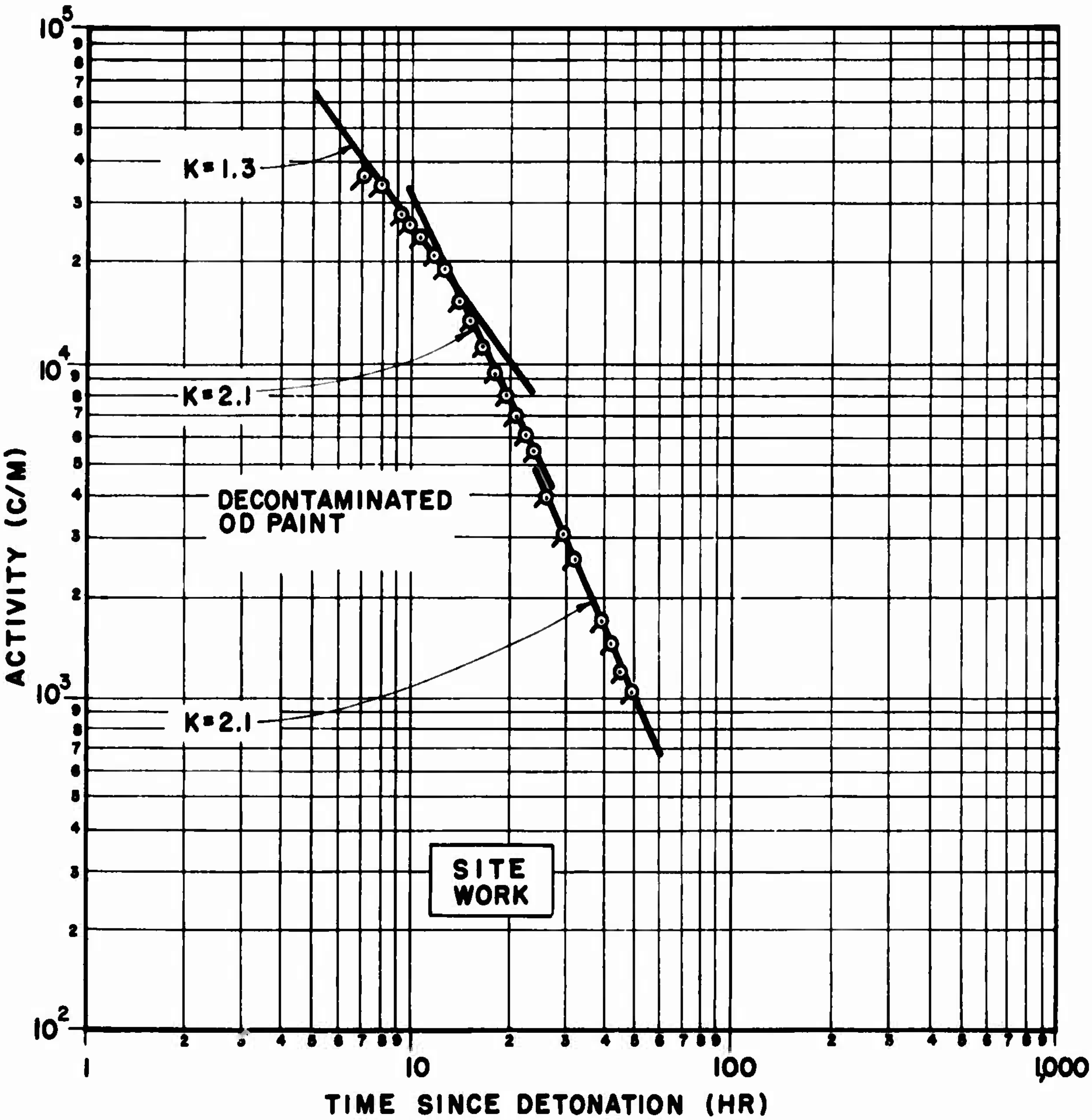

FIG. J.31 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 545-mg/sq cm Aluminum Absorber (Site Work)

[redacted]

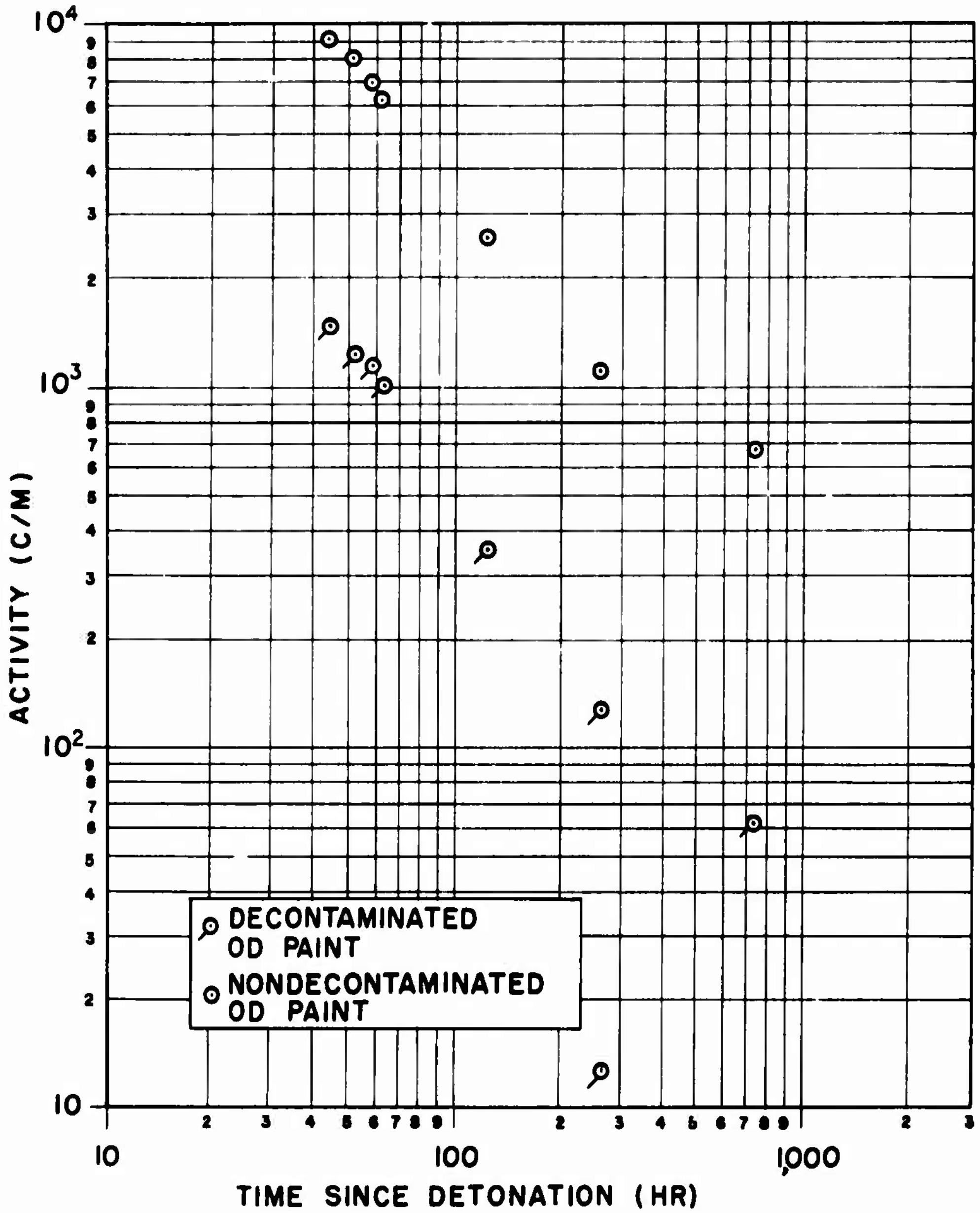

FIG. J.32 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 692-mg/sq cm Aluminum Absorber

[redacted]

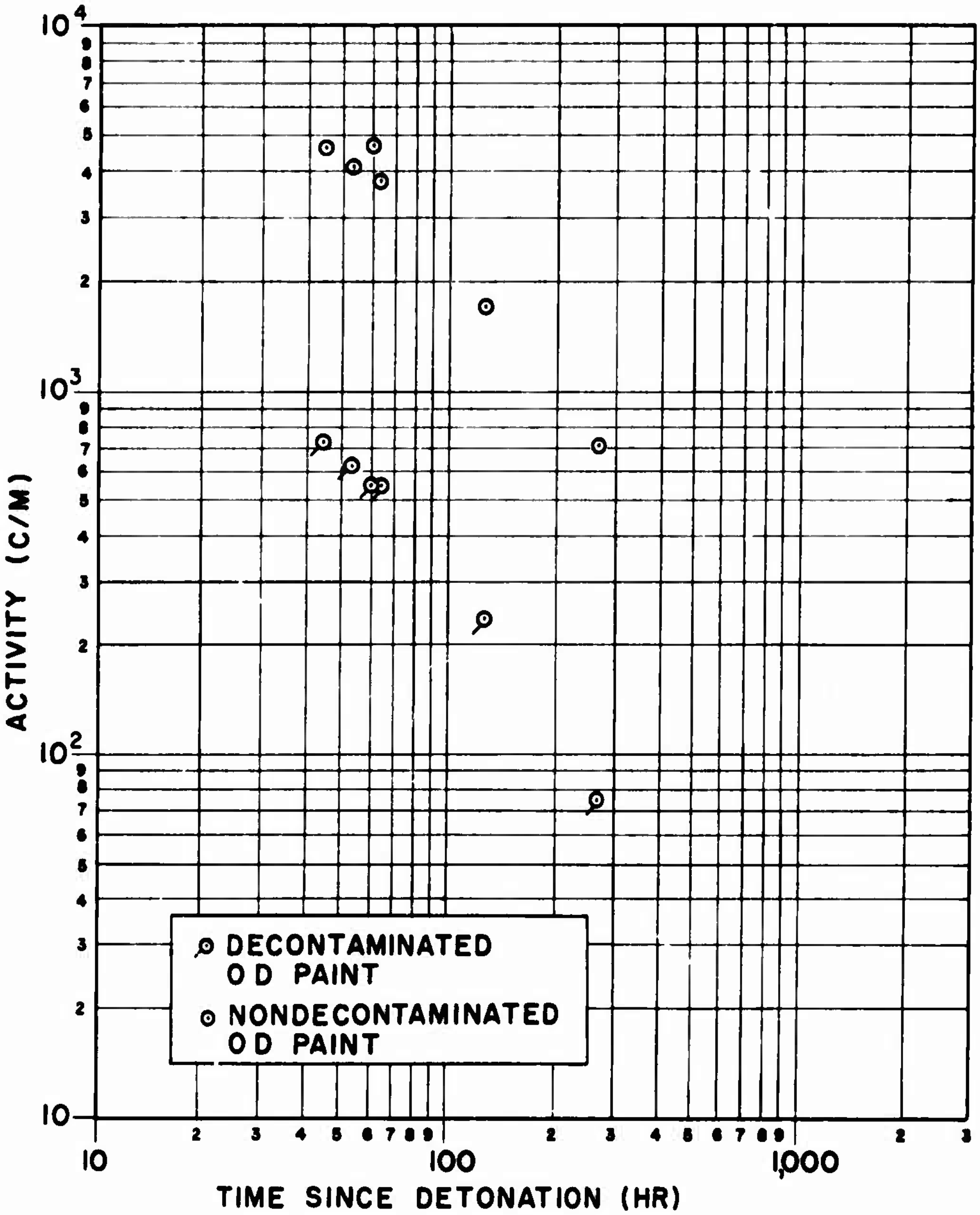

Fig. J.33 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, Easy Shot, Counted through 2,059-mg/sq cm Aluminum Absorber

[redacted]

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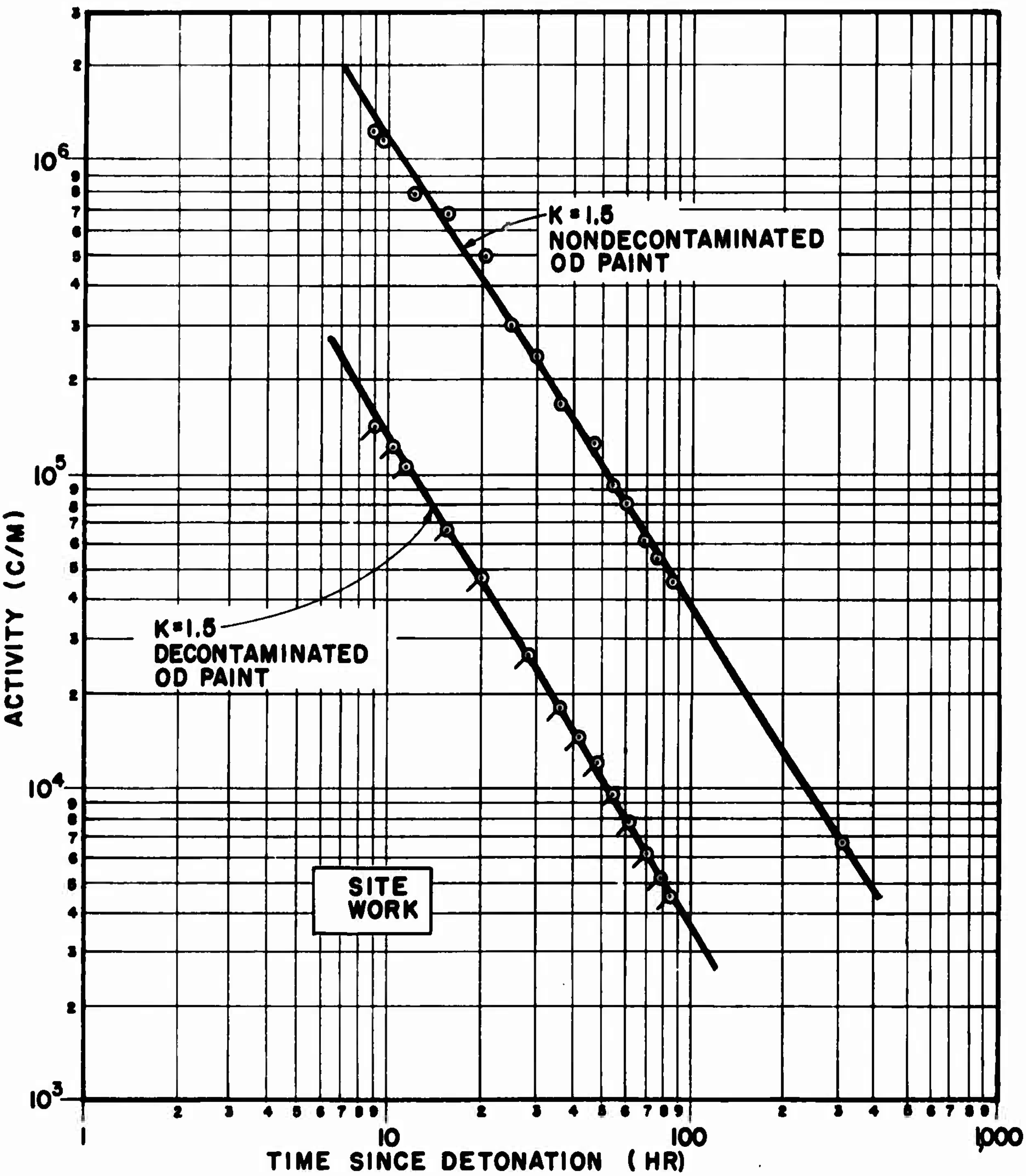

Fig. J.34 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, George Shot, Counted through 83.2-mg/sq cm Aluminum Absorber (Site Work)

[redacted]

[redacted]

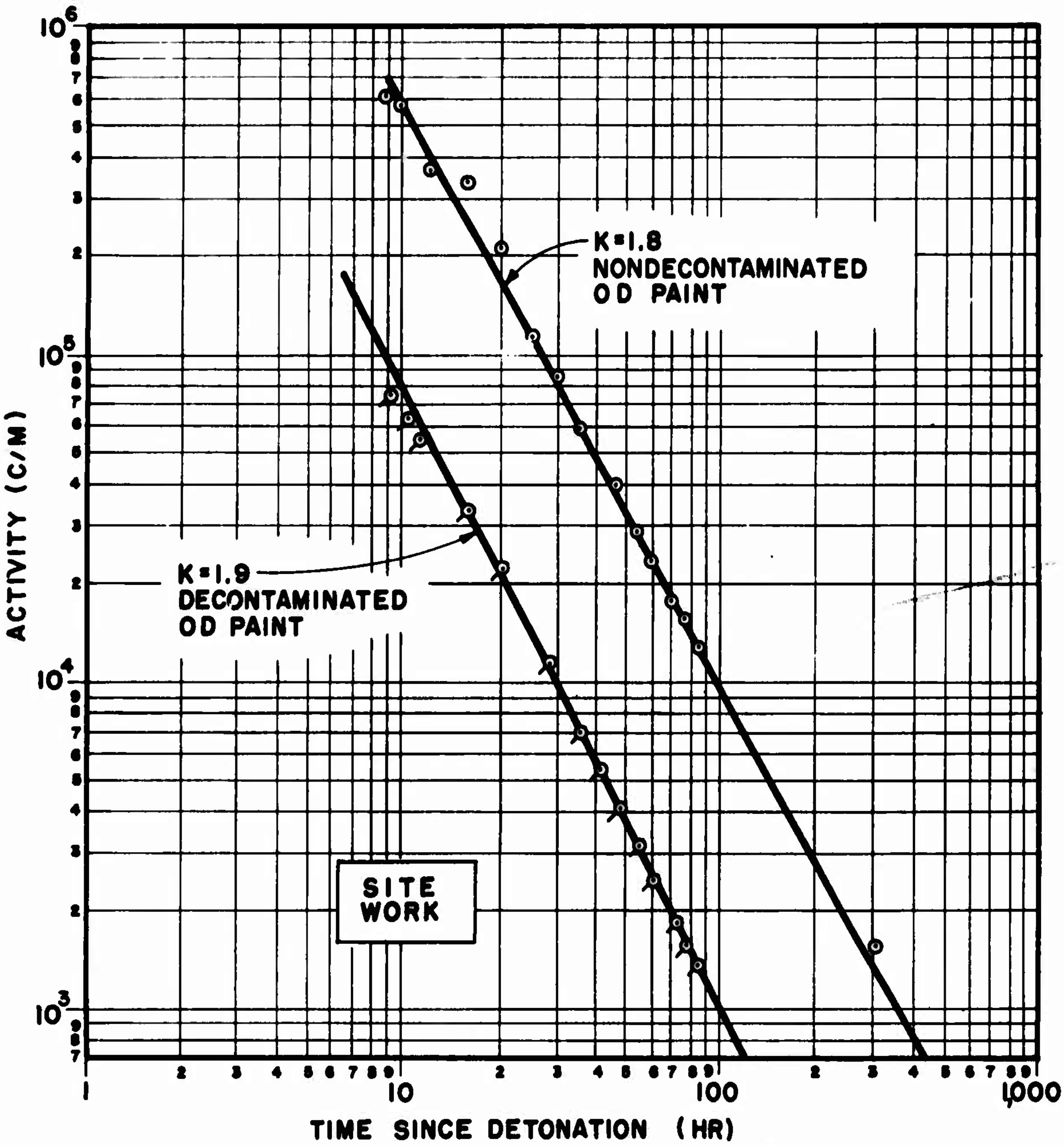

FIG. J.35 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, George Shot, Counted through 219-mg/sq cm Aluminum Absorber (Site Work)

[redacted]

[redacted]

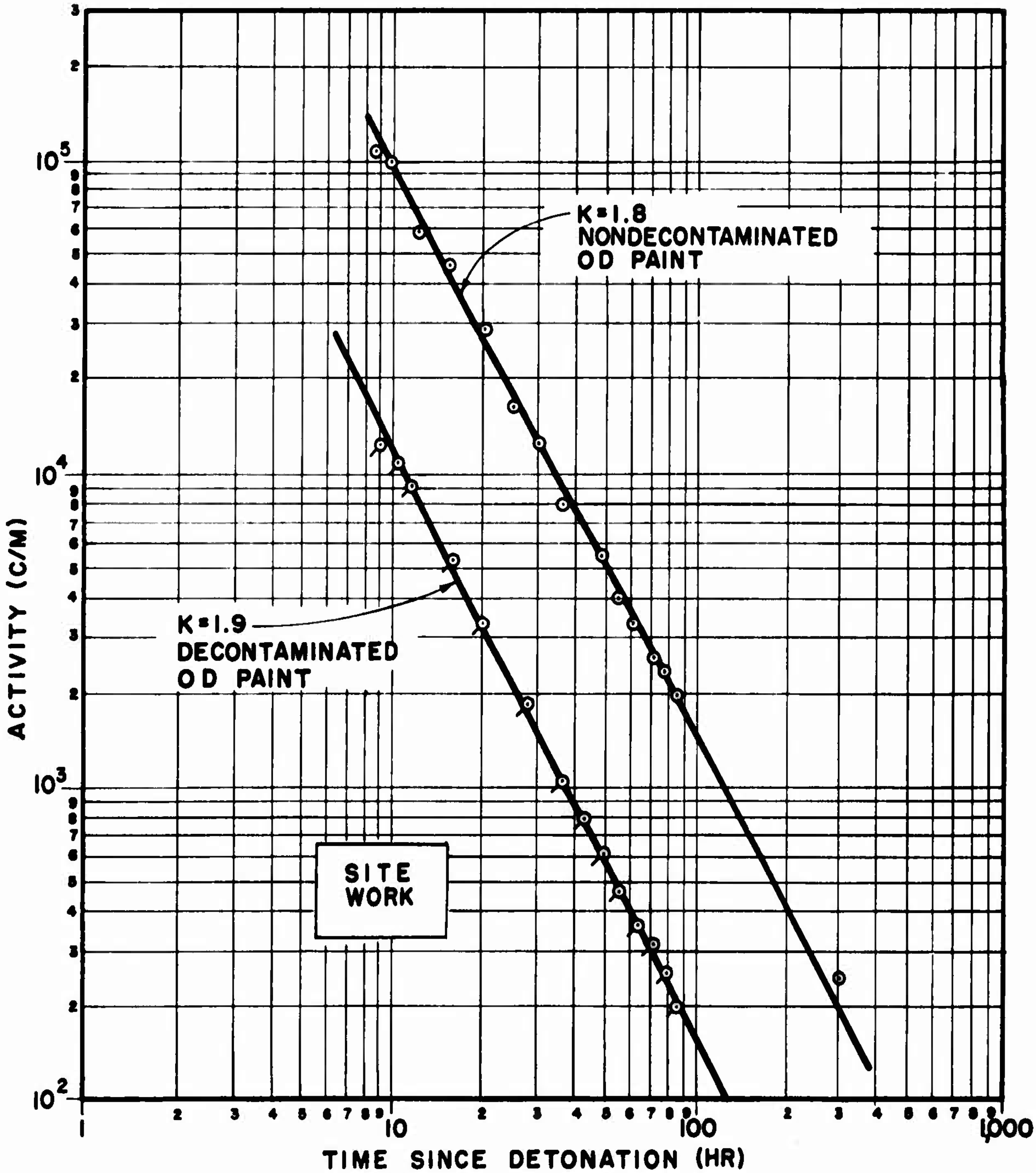

FIG. J.36 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, George Shot, Counted through 679-mg/sq cm Aluminum Absorber (Site Work)

[redacted]

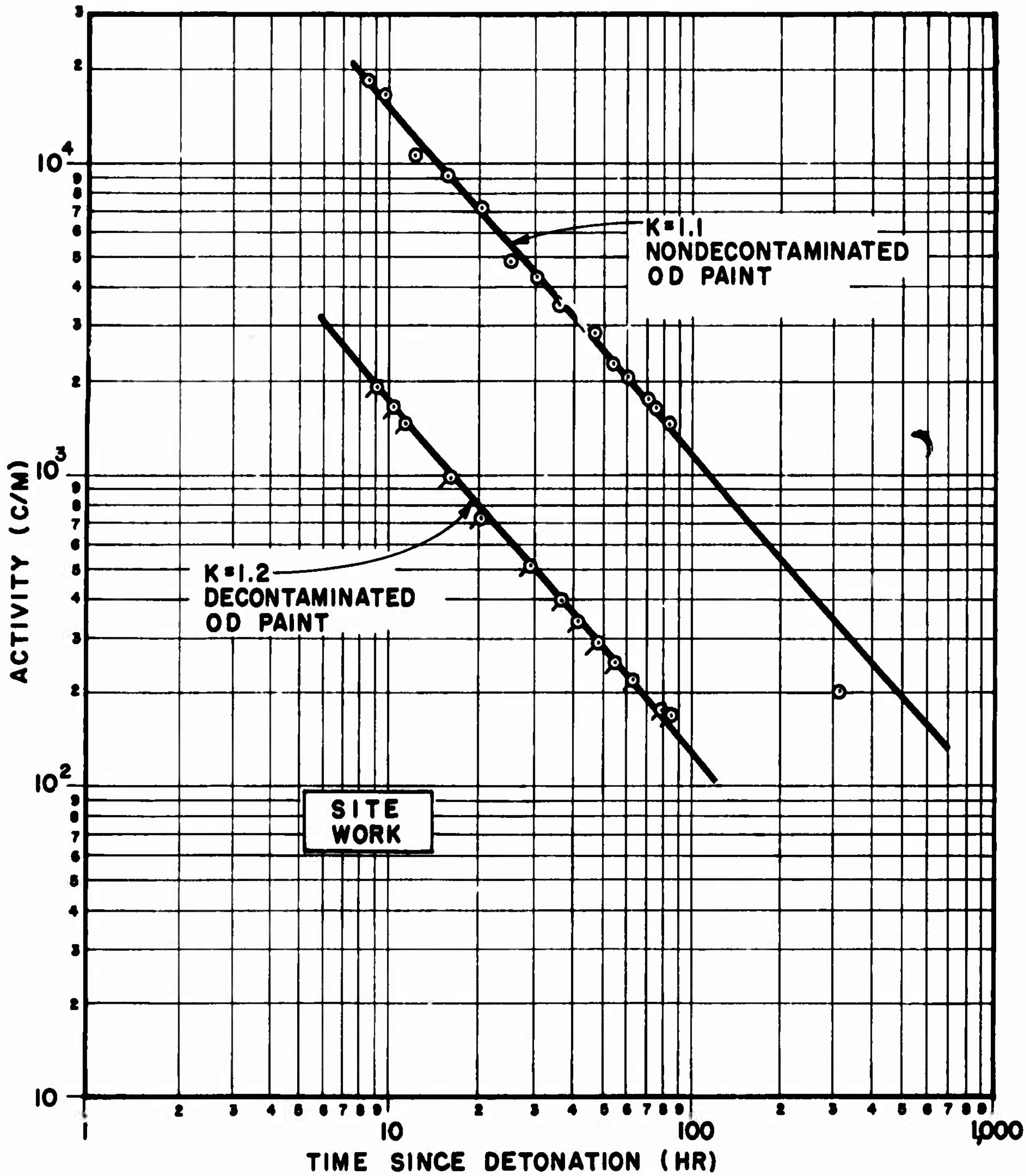

FIG. J.37 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, George Shot, Counted through 1,610-mg/sq cm Aluminum Absorber (Site Work)

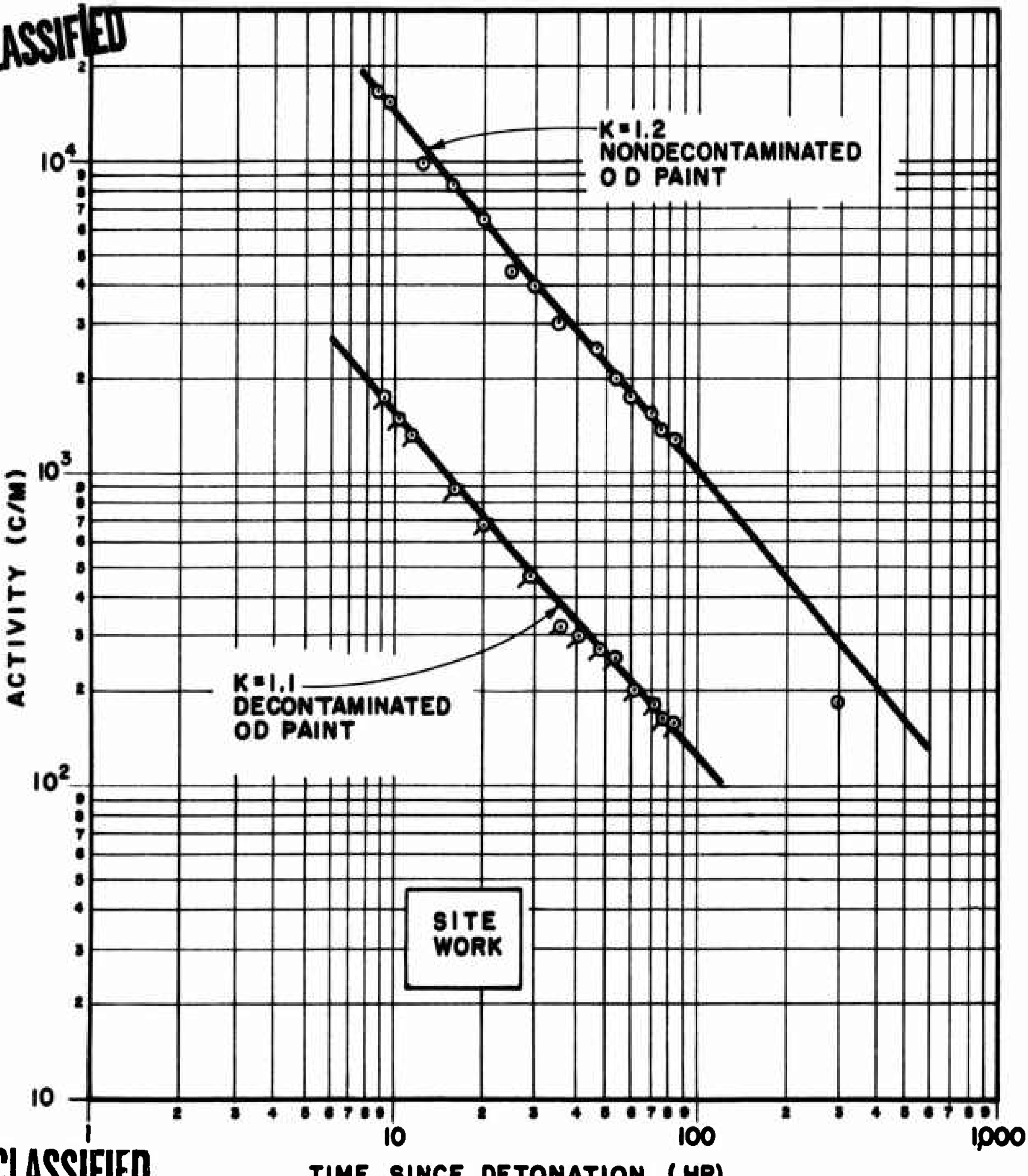

Fig. J.38 Radioactive Decay of Decontaminated and Nondecontaminated Surfaces, George Shot, [illegible] 380-mg/sq cm Aluminum Absorber (Site Work)