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ENGINEERING EVALUATION OF AGE LIFE EXTENSION, T-10 HARNESSES, RISERS AND T-10 TROOP CHEST RESERVE PARACHUTE CANOPIES. SUPPLEMENT I-1964-65 YEAR CLASSES

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TECHNICAL REPORT

74—9—CE

ENGINEERING EVALUATION

of

AGE LIFE EXTENSION, T-10 HARNESSES, RISERS AND T-10 TROOP CHEST RESERVE PARACHUTE CANOPIES

SUPPLEMENT I — 1964-65 YEAR CLASSES
(Reference Technical Report 72—59—CE)

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U. S. ARMY NATICK LABORATORIES
Natick, Massachusetts

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FOREWORD

The determination of the most prudent and economical service or age life limit for nylon parachute equipment is a problem with no wholly satisfactory solution. For lack of definitive inspection criteria or non-destructive test methods, the problem has been managed by prescribed overall elapsed time limits, and by repair cost and formerly by jump limits applicable to individual cases. Engineering data as a basis for such limits have been fragmentary and quickly outdated. Until recently, the major reliance has been on experience and conservative judgment.

A major effort to establish a substantial body of current data on T-10 Troop Chest Reserve Parachutes was funded by the Army Aviation Systems Command in 1971. This evaluation was conducted at Natick Laboratories by collaboration of the Airdrop Engineering Laboratory and the Clothing and Personal Life Support Equipment Laboratory. The basic report referenced herein covers that effort and the conclusions which have led to a substantial increase in the prescribed age life limits for the year classes surveyed. The present report covers the follow-on effort to up-date information on the up-coming 1964-65 year classes, and is a supplement to Technical Report 72-59-CE (AD 742-668) which should be referred to for more complete background and discussion.

The guidance and contribution of Mssrs. William Lewis and Herman Weber of the Parachute Equipment Division, Airdrop Engineering Laboratory, are acknowledged. Also to be noted is the contribution of Mr. Don Ferrell, Intern Training Center, Red River Army Depot, in statistical analysis by computer technology to determine possible trends or correlations which are not obvious by examination.

LIST OF CHARTS

Chart 1 — Breaking Strength Frequency Distribution by age class of Riser Legs manufactured in 1964-65.

Chart 2 — Breaking Strength Frequency Distribution by age class of Horizontal Backstraps from T-10 Harnesses manufactured in 1964-65.

Chart 3 — Breaking Strength Frequency Distribution by age class of Diagonal Backstraps from T-10 Harnesses manufactured in 1964-65.

Chart 4 — Breaking Strength Frequency Distribution by age class of Leg Straps from T-10 Harnesses manufactured in 1964-65.

Chart 5 — Breaking Strength Frequency Distribution by age class of Canopy Fabric Sections from T-10 Chest Reserve Parachutes manufactured in 1964-65.

Chart 6 — Elongation Frequency Distribution by age class of Canopy Fabric Sections from T-10 Chest Reserve Parachutes manufactured in 1964-65.

Chart 7 — Tearing Strength Frequency Distribution by age class of Canopy Fabric Sections from T-10 Chest Reserve Parachutes manufactured in 1964-65.

Chart 8 — Air Permeability Frequency Distribution by age class of Canopy Fabric Sections from T-10 Chest Reserve Parachutes manufactured in 1964-65.

Chart 9 — Breaking Strength Distribution by age class of Suspension Lines from T-10 Chest Reserve Parachutes manufactured in 1964-65.

ABSTRACT

An engineering evaluation of T-10 troop-type Harnesses, Risers, and Chest Reserve Parachute Assemblies of year classes (dates of manufacture) 1964 and 1965 was conducted by laboratory testing of component materials. The data obtained from limited samplings from Fort Bragg, No. Carolina, Alaska and the Panama Canal Zone indicated a generally serviceable condition for this equipment at 9 and 8 years of total age. Taken with more extensive data and with the technical background and criteria developed in the earlier basic report 72-59-CE, (DDC AD 742-668) of the same title, dated March 1972, it was concluded that the recently extended 13 year (risers and harnesses) and 12 year (canopy assemblies) limits are fully substantiated for these 1964-65 classes. Subject to later check testing, further extension of the age life limit may be found appropriate.

ENGINEERING EVALUATION OF

AGE LIFE EXTENSION, T-10 HARNESSES, RISERS

AND T-10 TROOP CHEST RESERVE PARACHUTE CANOPIES

SUPPLEMENT I

1. PROJECT BACKGROUND AND REFERENCES.

1. Project Background — As described in the basic report of the same title, (see 2a), Natick Laboratories were tasked by the Army Aviation Systems Command to conduct a test survey and analysis of T-10 Troop Back Personnel Harnesses and Risers, and Chest Reserve Parachute Canopies, to determine the feasibility of extending the age life, then held at 10 years, for a significant additional number of years. Samples were furnished from several user agencies representing differing climatic and usage environments. The sample plan was initially directed to 1961 - 1963 year classes (years of manufacture) as being the most relevant to immediate decision and potential benefit in extended utilization of current assets. However, some samples of later years were also included so as to reveal any consistent trends or critical age period within the 10-year span.

The findings of the survey were the basis for the subsequent decision to extend the maximum serviceable age-life of classes 1961-63 reserve canopies to 12 years total, and of 1961-63 back harnesses and risers to 13 years total. However, the findings of that survey and previous limited spot tests had indicated a high degree of specificity in the data due to varying manufacturing, use and environmental factors. Accordingly, the investigators urged that conclusions should not be made by extrapolation without further survey or check tests, with particular respect to the following:

a. Equipment of the same type, of subsequent year classes (e.g. 1964-65).

b. Equipment of the same type and year classes, at attained greater age (e.g. 12-13 years).

c. Equipment of other types (e.g. T-10 troop main parachutes).

This supplemental report covers the recommended check of up-coming year classes, related to (a) above. Concurrently, a limited check test program is being initiated to cover earlier reserve parachute equipment approaching its now extended 12 and 13 year total age life, as referenced in (b) above, in continuation of the basic survey. Also, as related to (c) above, a new program for T-10 troop main parachute equipment, requested at the Air Items Life Extension Conference at AAVSCOM HQ, St. Louis, MO, on 28 February 1973, is now underway with completion expected by October-November 1973.

2. References — The authorization and reference documents noted in the basic report are applicable to this supplement; and also the following:

a. Engineering Evaluation of Age Life Extension, T-10 Harnesses, Risers, and T-10 Troop Chest Reserve Parachute Canopies, U. S. Army Natick Laboratories Technical Report 72-59-CE, March 1972.

b. Letter, USANLABS, AMXRE-APE, dated 23 May 1972 to CG, USAAVSCOM, ATTN: AMSAV-D-L, Subject: Age Life Extension of T-10 Troop Type Harness, Risers and Chest Reserve Parachute Canopies.

c. Letter, USAAVSCOM, AMSAV-SI(L) dated 5 July 1972 to CG, USANLABS, AMXRE-APE, Subject: as above.

d. Letter, USANLABS, AMXRE-APE dated 7 August 1972 to CG, USAAVSCOM, ATTN: AMSAV-SI(L), Subject: as above.

e. Letters, USAAVSCOM, AMSAV-SI(L) dated 14 November 1972 to U.S. Army Alaska; XVIII Airborne Corps, Fort Bragg, N.C.; and 8th Special Forces Group, APO New York 09837; Subject: Age Life Extension Test Items.

II. TECHNICAL BACKGROUND

The technical background as discussed in the basic report with particular respect to the nature of the problem (causes, patterns, reliability control system) is still appropriate and has been generally accepted in discussions with investigators from the other Services following presentation of the data and basic report.

III. EVALUATION PLAN AND SAMPLING RESPONSE

Since in the basic survey no marked differences were found between equipment samples from the several locations, it was decided to limit sampling to Fort Bragg as representing the temperate zone environment worldwide, and to Alaska and the Panama Canal Zone. Call out of samples was by USAAVSCOM letter, reference 2e above. The sampling plan quantity for each item was three each from 1964 and 1965 classes, from the three locations, totalling 18 of each item. This was not strictly followed, but quantities believed to be adequate were obtained. Final samples were received and acknowledged by USANLABS, 8 February 1973, following rigger inspection which determined all samples to meet normal visual criteria.

IV. SHOCK LOAD TESTS ON RISERS AND HARNESSES

It was decided to defer boom-drop shock load testing of risers and harness assemblies until initial laboratory data might indicate a need for such testing for further assurance. A few assemblies were pre-conditioned with drops at the 3000 pound impact range, to see if this degree of overloading might affect laboratory test results. No such effect was found, and no visible damage was apparent. Since the laboratory data showed the condition of the material and stitching in the 1964-65 samples to be at least as good as those in the basic survey, no higher shock load proof testing of the 1964-65 samples was conducted.

V. LABORATORY TEST METHODS

The preparation of specimens, systems for mounting and laboratory test methods were as followed in the basic survey and described in that report.

The data obtained from the laboratory tests of the 1964-65 classes of reserve equipment are presented in Charts 1 - 9 in frequency distribution form, as in the basic report, so as to be most evident and comparable by quick examination. The major immediate purpose of examination was to determine the apparent soundness of projecting the now extended service life limits (canopy 12 years, harnesses and risers 13 years) to the upcoming 1964-65 classes. A second purpose was to see if there are indications of significant improvement of the aged condition of 1964-65 classes, compared to that of prior year classes at the same attained ages, which might result from the use of the "light and heat resistant" nylon which commenced with 1964 production. Since it was also an objective to show either progression (or its absence) for the same 1964-65 year classes from the earlier 7-8 year ago survey period to the present 8-9 years of age, the former data are shown at the top section of each chart.

It is urged that data and conclusions in the report be considered primarily in conjunction with those of the basic survey report. The supplemental sampling and testing reported herein are not adequate by themselves to characterize the equipment populations represented, independently of the context previously developed.

The immediate practical conclusions drawn from the data in this report are based on the most apparent levels and patterns shown. Further statistical analysis for minor distinctions and trends will be done to develop additional background information and context for future surveillance studies.

VI. LABORATORY TESTS ON RISERS AND HARNESSES

A. Risers — Strength test values for the 1964-65 risers are shown in Chart 1. Since no meaningful distinctions were apparent between sources, years or top and bottom sections, the data are consolidated for presentation here. Most of the test values are somewhat below the 6500 pound specification minimum, but generally are higher than those found for earlier year classes at corresponding ages. Also noted is that the proportion of breaks by seam failure, rather than of the webbing itself, was lower among these 1964-65 samples. Under the "worst case" conditions discussed in the basic report, the samples indicated a fully serviceable status for these items. No progressive trend was indicated by the data for these classes at the two age intervals tested.

B. Harnesses — Strength test values for the three sections of the harness assembly are shown in Charts 2, 3 and 4. Most values for the horizontal backstrap sections are below the 6500 pound specification minimum. However, the general level corresponds, and the lowest individual value of 5710 pounds is only slightly below that in the same year classes when tested previously, so that no change is indicated from the data available. No practical differences were apparent between the three source locations or the two class years. It is taken from the general condition of the webbing positioned in the relatively protected horizontal backstrap sections that age per se, depot and user storage conditions, and normal exposure in use have not caused marked progressive loss in tensile test strength.

The test values for the diagonal backstrap sections show a number of specimens with test strengths somewhat further below the specification minimum, and a broader range of distribution compared to the horizontal backstrap sections. As was found in the basic survey, somewhat greater losses of effective strength have occurred in these diagonal sections, due variously to exposure, mechanical wear, and/or contamination. However, the lowest individual value (4550 pounds) was still 1000 pounds higher than the lowest value found in the basic survey of earlier equipment classes at the same attained age. Also, all values are well above the estimated "worst case" loading (600 pounds) as projected in the basic study.

The test values in the leg straps were again in all cases limited by the rupture at the base of the rolled end of the strap when pulled through and jammed or pinched against the adjustment hardware. (This condition is eliminated in the configuration of the new troop type personnel harness expected to be adopted soon.) Again, for the present equipment, this jammed condition is considered valid on a "worst case" basis, and the values obtained are accordingly taken as the effective strength of the harness section. However, in comparison with the combination worst load case, as discussed in the basic report, the lowest value (2700) obtained in the 1964-65 specimen still provides a 2.3/1 safety factor. While there may have been actual strength deterioration due to exposure, wear and/or contamination, such effects are obscured

by the major strength efficiency loss of the rolled end configuration when jammed against the hardware.

It appears that the age life extension to 13 years as now applied to 1961-63 T-10 harnesses is at least equally justified for 1964-65 year classes. There is also some indication, subject to subsequent confirmation testing as these populations approach the now extended limits, that the 1964-65 and subsequent year classes may be further extended beyond the 13-year level.

VII. LABORATORY TESTS ON CANOPY ASSEMBLIES.

A. Canopy Fabric — The strength and elongation values for the fabric in the canopies are shown in Charts 5, 6 and 7. All values are significantly above the specification minima, and appear to correspond quite well to typical levels and distributions for new fabric of the time. As also shown on the strength charts, the samples in this survey appeared at least as good as those from the same 1964-65 year classes tested at 7 and 8 years of age in the basic survey. Though the 196465 sampling (at 8 and 9 years) in this supplemental survey is more limited than in the basic study, it is notable that there is no indication of the wide scatter and presence of low values which had been observed in the data for previous year classes. There were no apparent differences by year or location from which the samples were obtained. As regards the indicated conditions of the canopy fabric itself, there is thought to be strong support here for the expectation (subject to later confirmation testing) that these later year classes may be kept in service status beyond the 12 year limit now in effect for 1961-63 equipment, without sacrifice of reliability.

The air permeability values shown in Chart 8 were of an entirely normal level and distribution.

B. Suspension Lines — The strength values for the suspension lines are shown in Chart 9. Two values were below the specification 550 pound minimum by relatively small amounts, but most of the others were well above and in a range typical of original values for those years. The picture is in notable contrast to that shown for prior (particularly 1961) year classes in the basic survey. Because of these normal high strength values at the conventional laboratory test speeds required in the specification, no secondary evaluations were made with the impact test equipment on these particular samples.

There appears to be good support for the conclusion that the 1964-65 suspension lines as well as the canopies can be kept in service status for at least 12 years, with expectation of further extension, subject to subsequent confirmation testing as these populations approach the present 12 year limit.

No separate evaluation of thread or seams was made since these have not appeared to be limiting factors in prior parachute evaluations.

VIII. SUMMARY CONCLUSIONS AND RECOMMENDATIONS.

(1) Risers and Harnesses — It is concluded that T-10 Troop Parachute Riser and Harness Assemblies of 1964-65 years of manufacture, world-wide, are suitable for continued service through 13 years from date of manufacture indicated thereon. It is further expected that these and subsequent year classes will be found on subsequent testing to be extendable for a significant additional number of years, barring marked change in circumstances such as atmospheric contamination, usage, maintenance practices and discipline.

(2) Canopy Assemblies — It is concluded that T-10 Troop Chest Reserve Canopy Assemblies of 1964-65 years of manufacture, world-wide, are suitable for continued service through 12 years as now authorized for the prior year classes. There is a high degree of expectation that subsequent check testing will show a basis for extension to at least the 13 years as now authorized for the risers and harnesses.

(3) Surveillance — It is recommended that the surveillance program for personnel parachute equipment be continued on a sustained basis with sufficient sampling and testing for engineering consideration with respect to:

a. Further extension of age limits for maturing and up-coming classes.

b. Distinction between the original storage phase and the subsequent "service" phase, as to time limitations to be established.

c. Changes in management programs which might be indicated as result of significant changes in initial materials, usage, environment (including atmospheric pollution), maintenance and discipline.

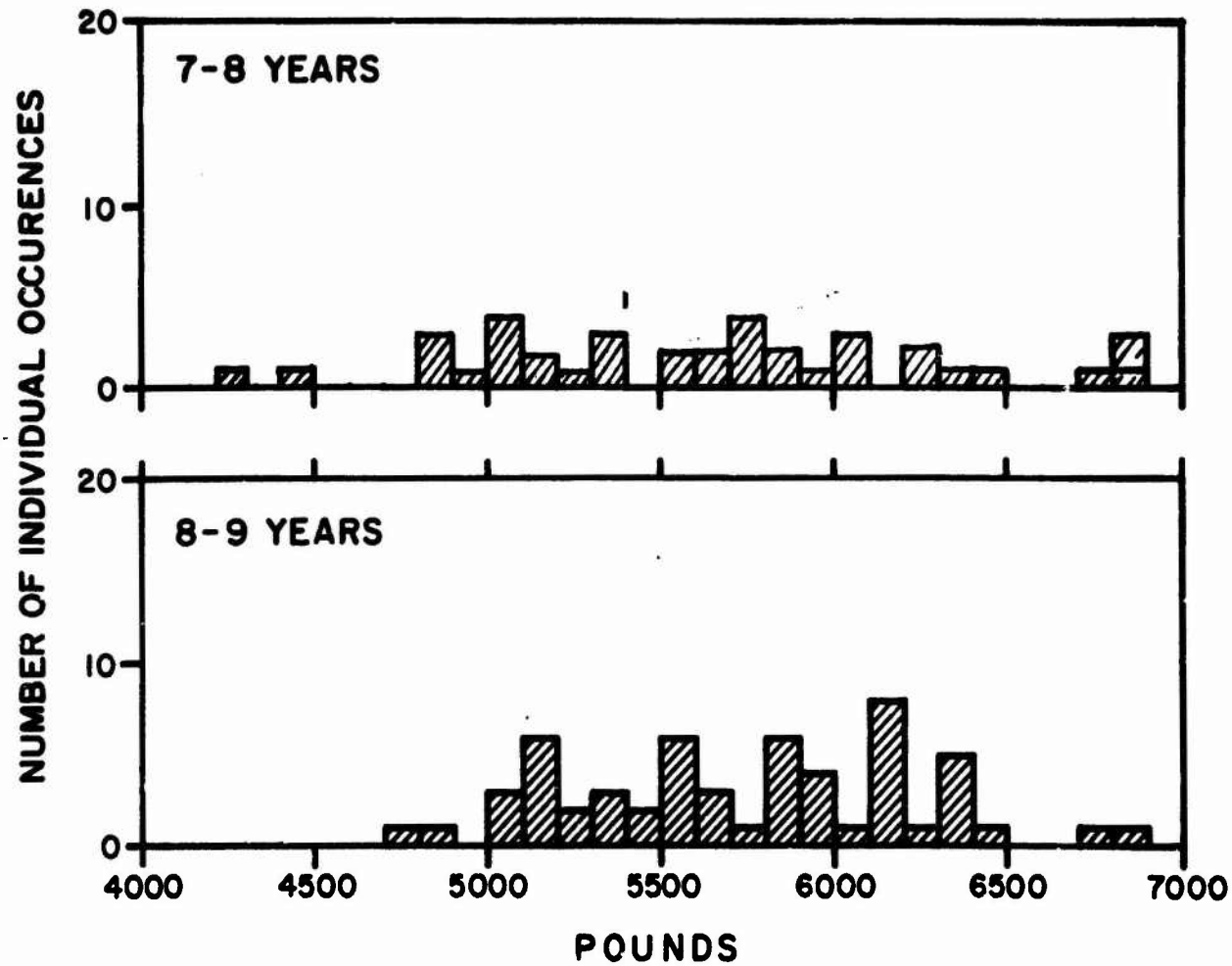

CHART I BREAKING STRENGTH FREQUENCY DISTRIBUTION BY AGE CLASS OF RISER LEGS MANUFACTURED IN 1964-1965

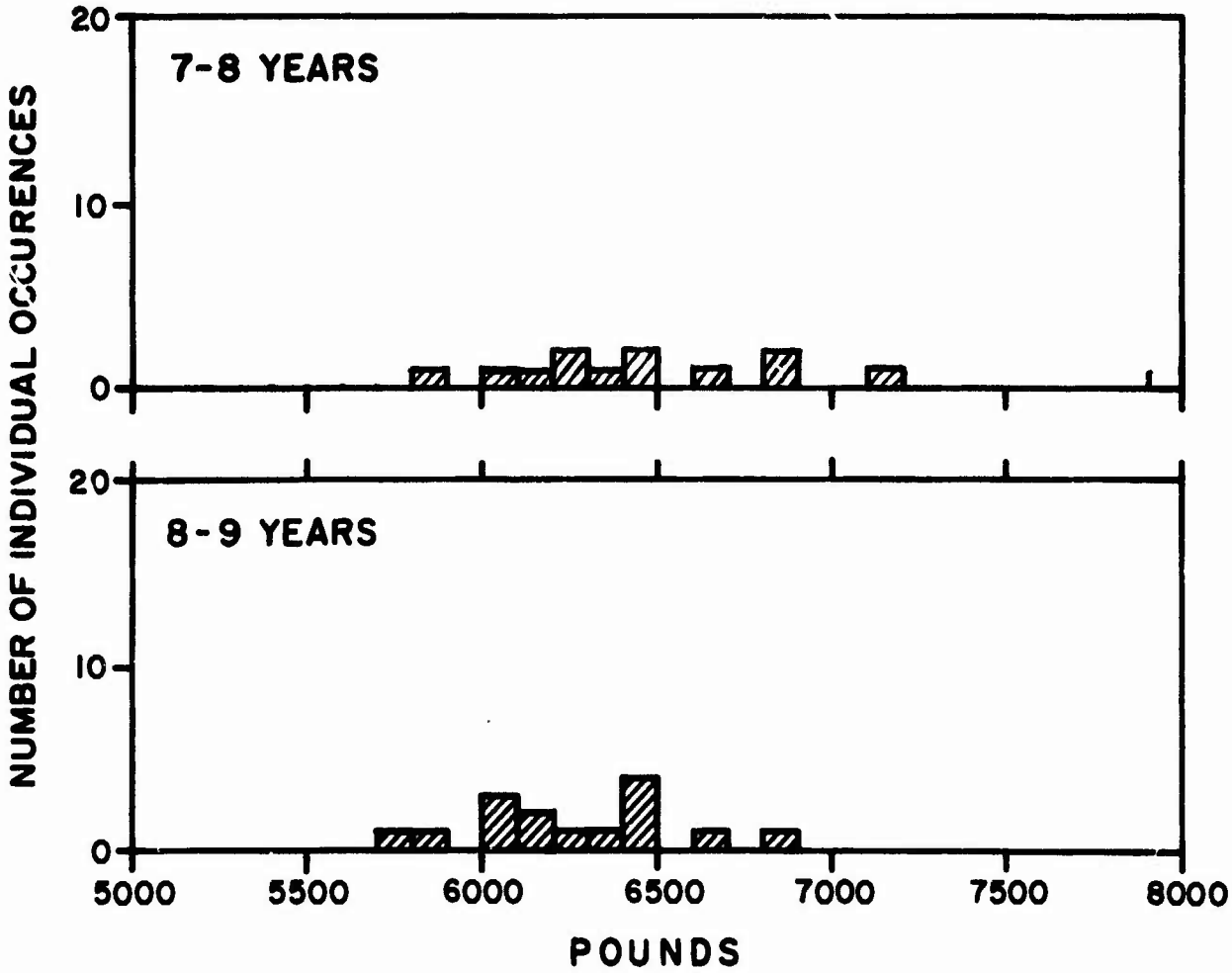

CHART 2 BREAKING STRENGTH FREQUENCY DISTRIBUTION BY AGE CLASS OF HORIZONTAL BACKSTRAPS FROM T-10 HARNESSES MANUFACTURED IN 1964-1965

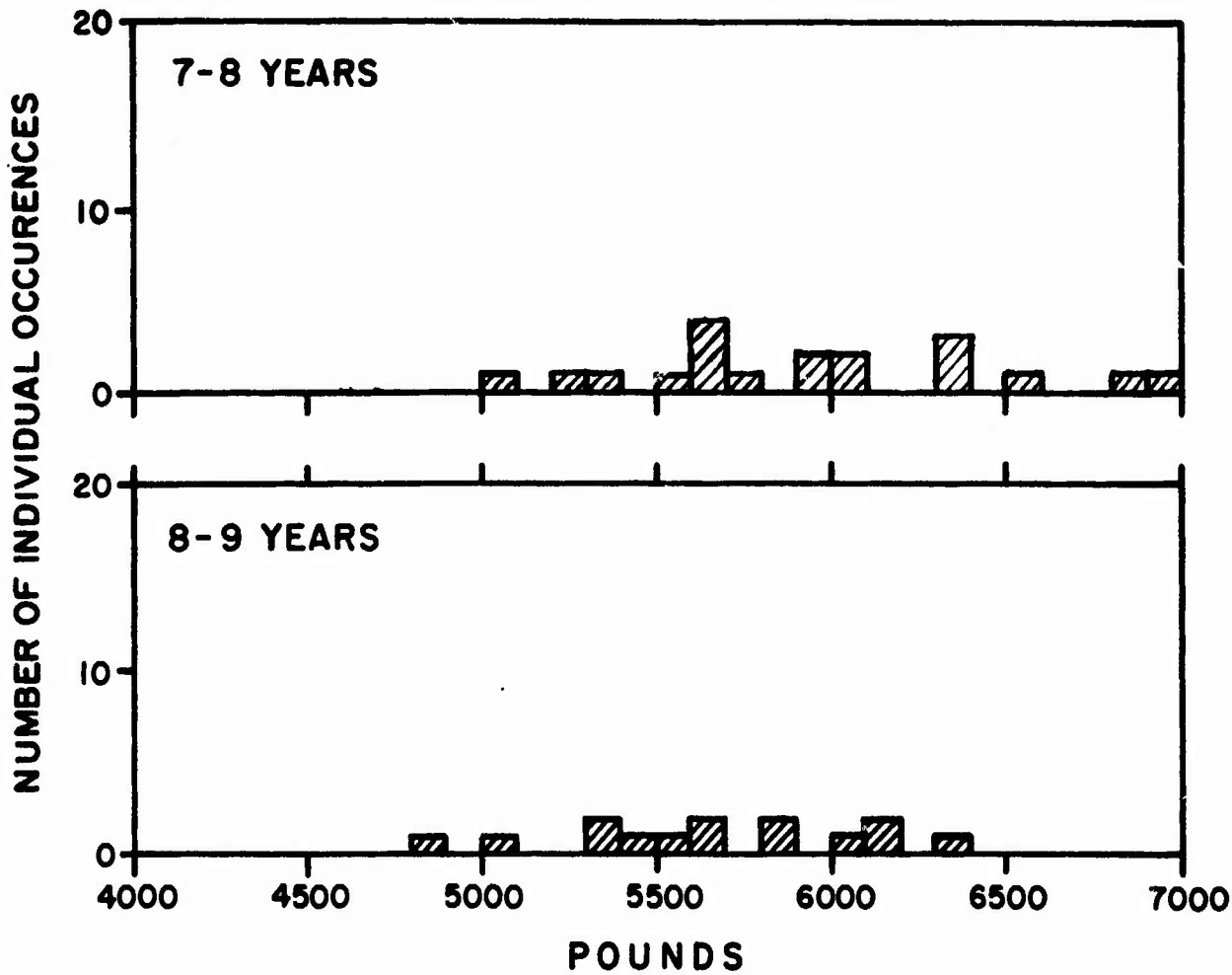

CHART 3 BREAKING STRENGTH FREQUENCY DISTRIBUTION BY AGE CLASS OF DIAGONAL BACKSTRAPS FROM T-10 HARNESSES MANUFACTURED IN 1964-1965

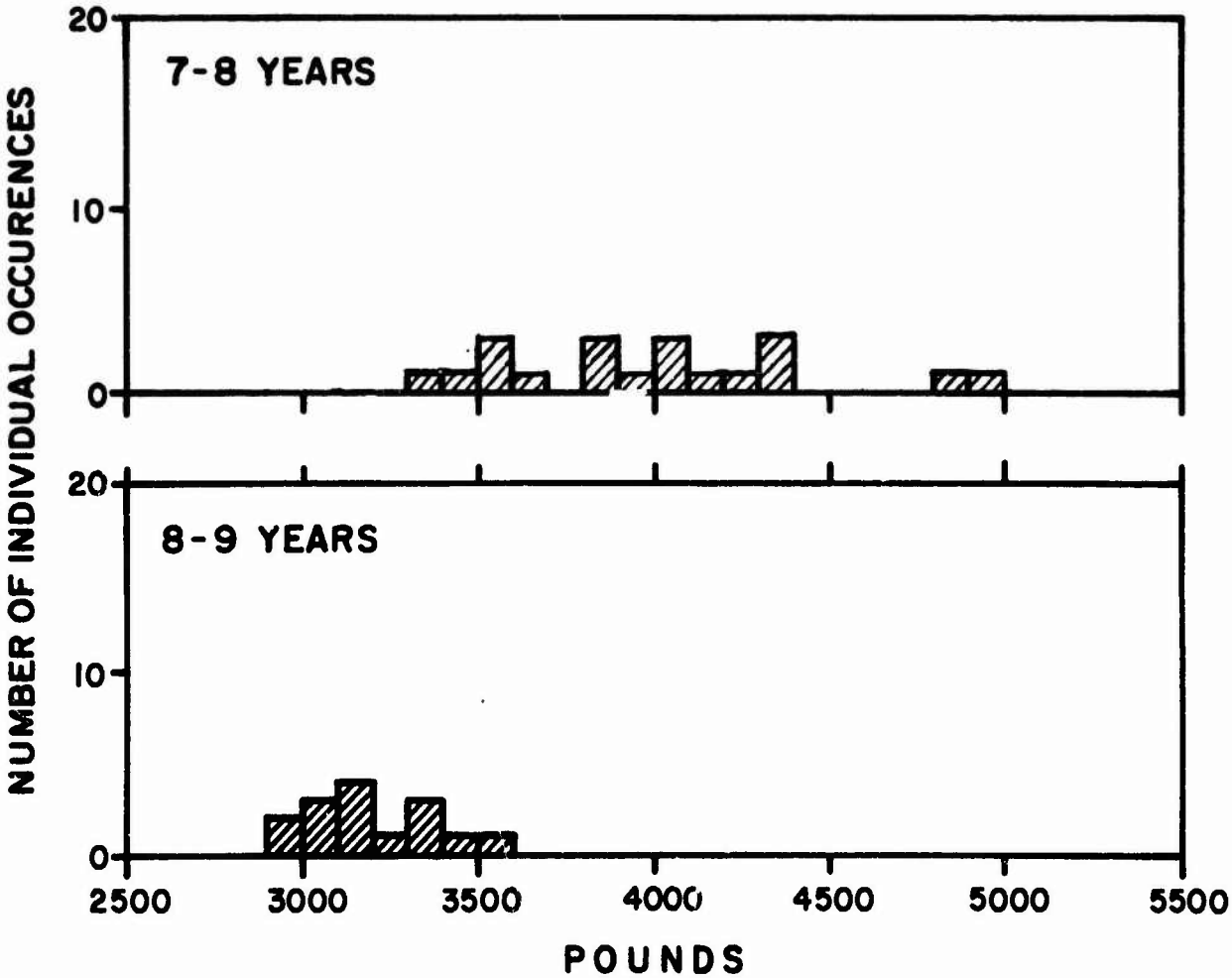

CHART 4 BREAKING STRENGTH FREQUENCY DISTRIBUTION BY AGE CLASS OF LEG STRAPS FROM T-10 HARNESSES MANUFACTURED IN 1964-1965

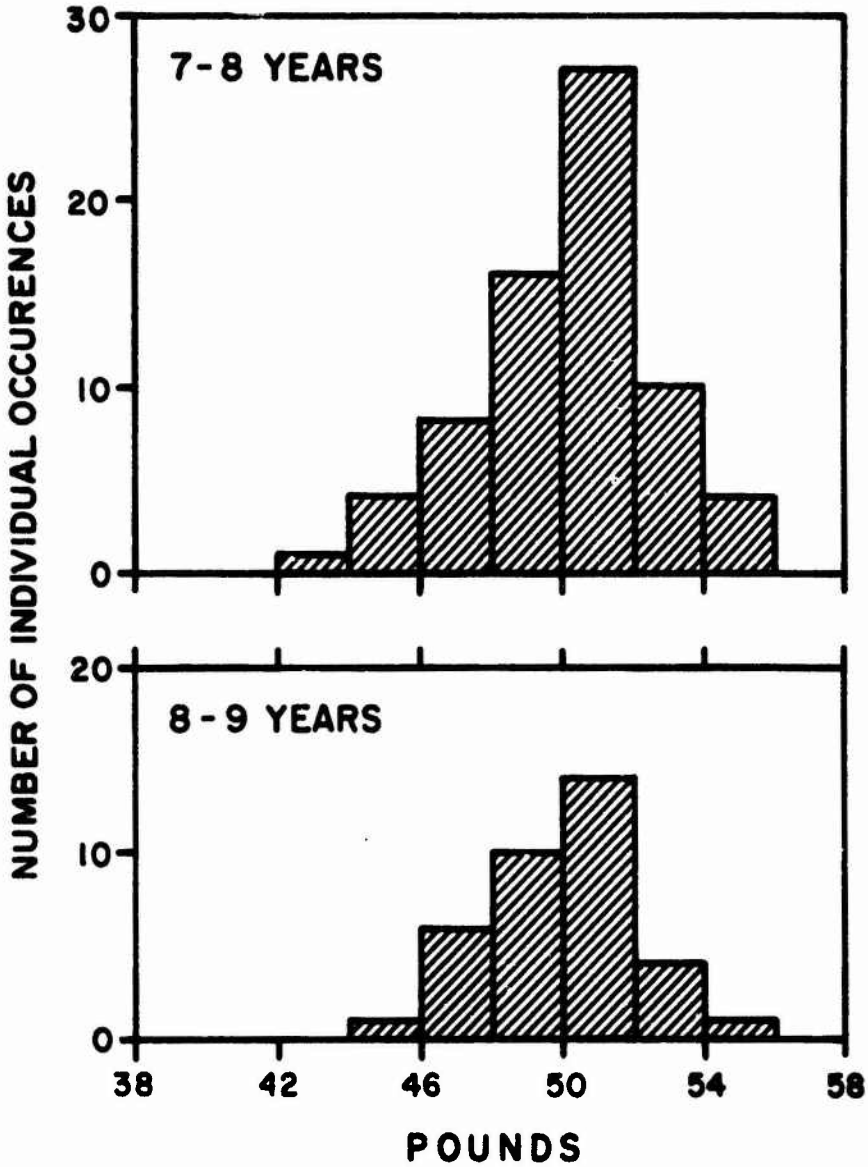

CHART 5 BREAKING STRENGTH FREQUENCY DISTRIBUTION BY AGE CLASS OF CANOPY FABRIC SECTIONS FROM T-10 CHEST RESERVE PARACHUTES MANUFACTURED IN 1964-1965

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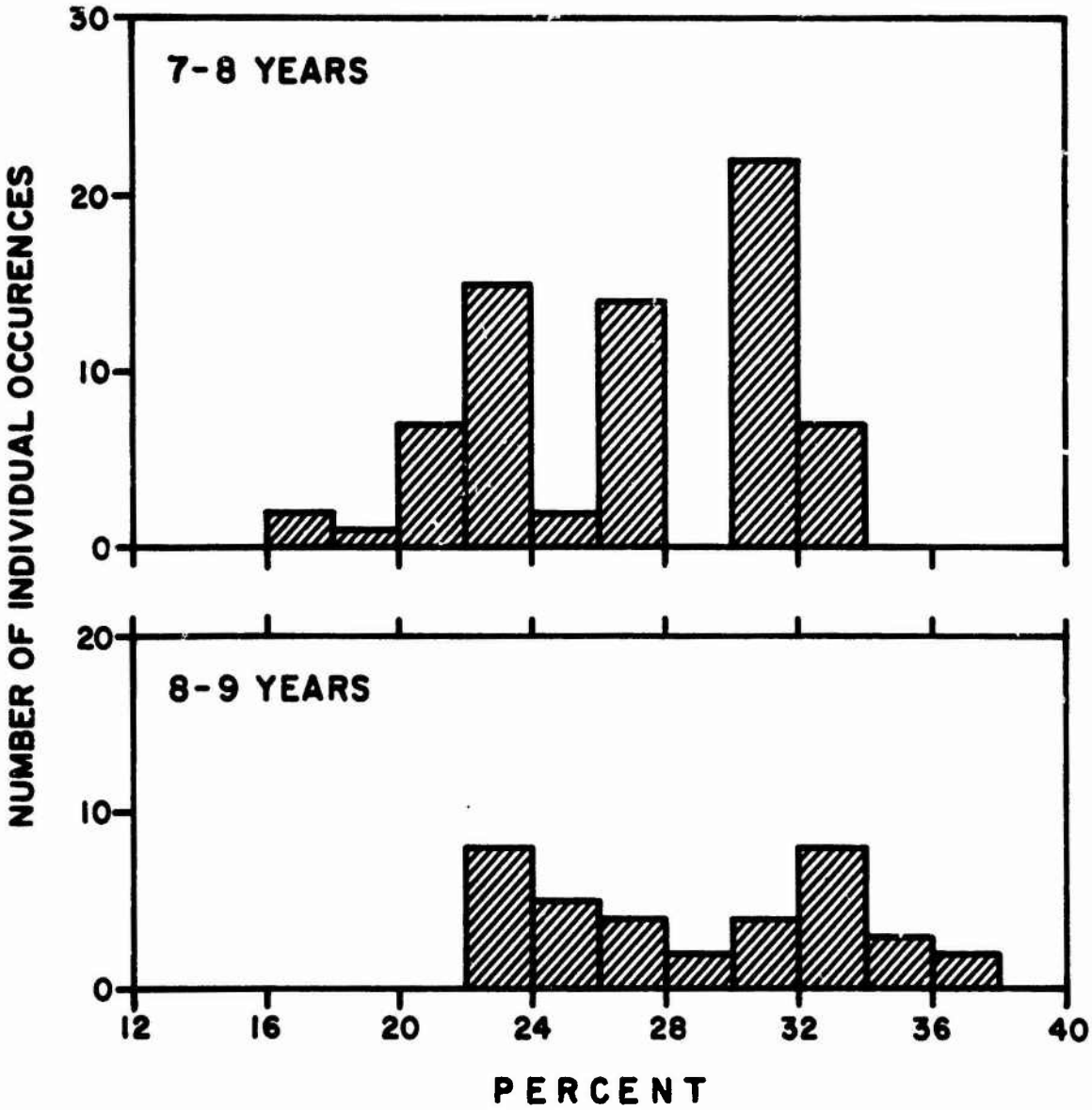

CHART 6 ELONGATION FREQUENCY DISTRIBUTION BY AGE CLASS OF CANOPY FABRIC SECTIONS FROM T-10 CHEST RESERVE PARACHUTES MANUFACTURED IN 1964-1965

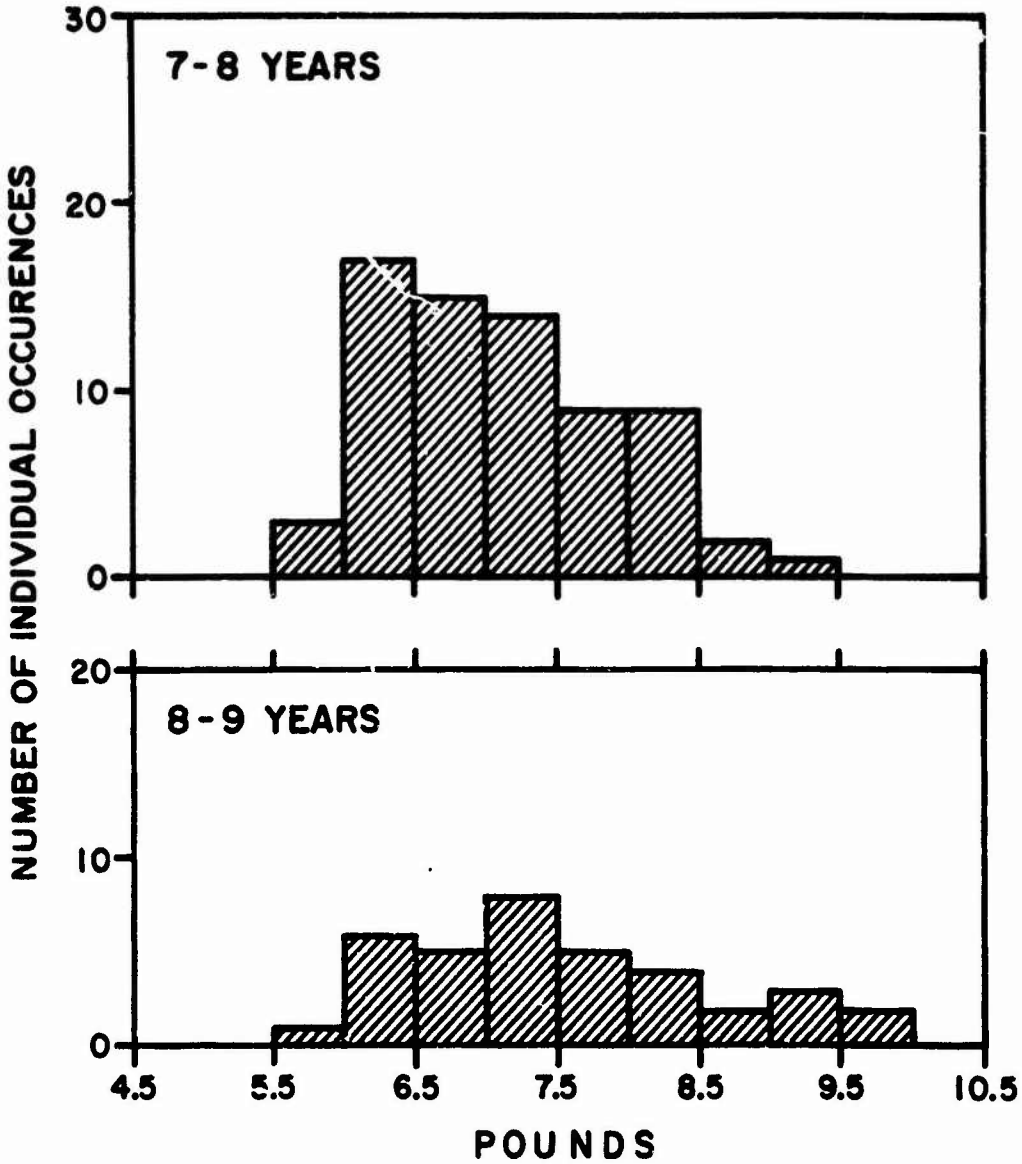

CHART 7 TEARING STRENGTH FREQUENCY DISTRIBUTION BY AGE CLASS OF CANOPY FABRIC SECTIONS FROM T-10 CHEST RESERVE PARACHUTES MANUFACTURED IN 1964-1965

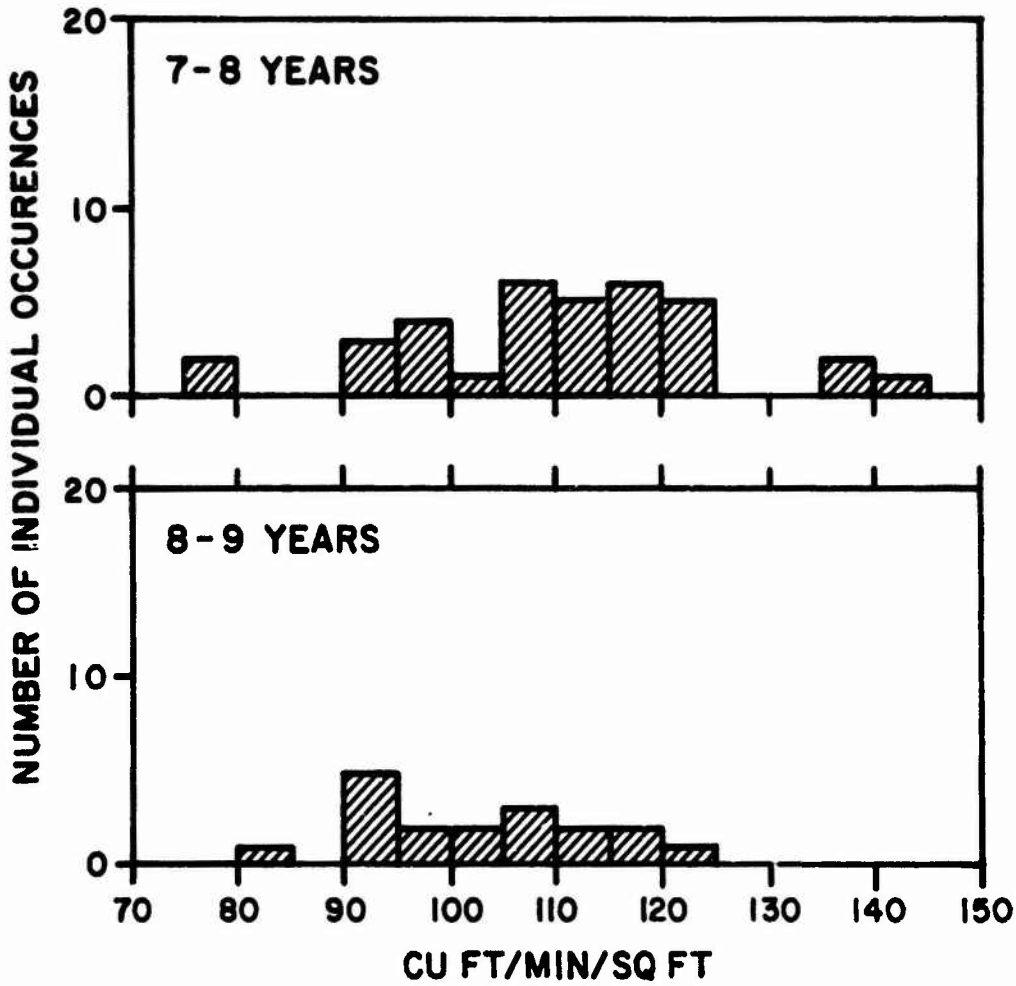

CHART 8 AIR PERMEABILITY FREQUENCY DISTRIBUTION BY AGE CLASS OF CANOPY FABRIC SECTIONS FROM T-10 CHEST RESERVE PARACHUTES MANUFACTURED IN 1964-1965

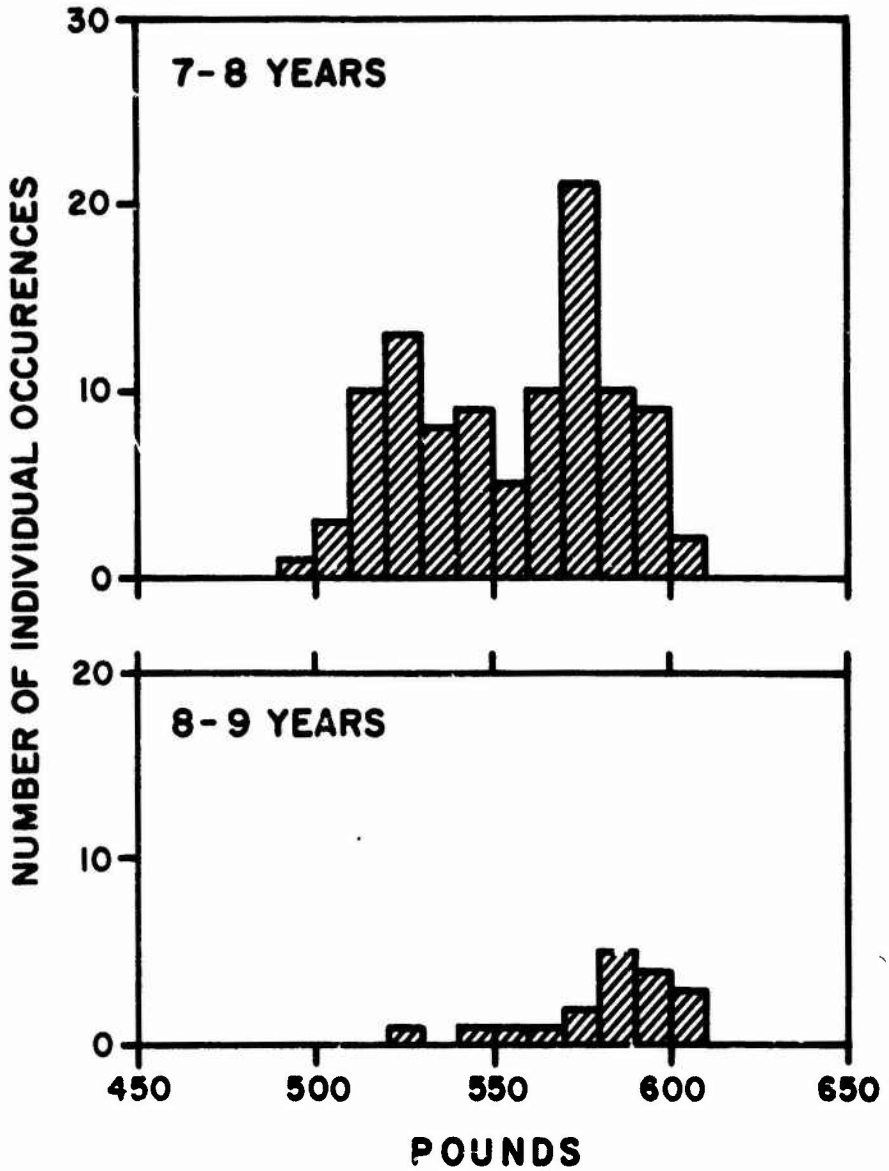

CHART 9 BREAKING STRENGTH DISTRIBUTION BY AGE CLASS OF SUSPENSION LINES FROM T-10 CHEST RESERVE PARACHUTES MANUFACTURED IN 1964-1965