CALIFORNIA STATE UNIVERSITY, NORTHRIDGE

EVALUATION OF NAVY AIRCREW EQUIPMENT

A project submitted in partial satisfaction of the requirements for the degree of Master of Science in

ENGINEERING

by

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The thesis of Bradley Clifford George is approved:

California State University, Northridge
May, 1976
PREFACE

As part of the Master of Science in Engineering degree from California State University, Northridge, two Test and Evaluation projects were completed for the Crew Systems Branch of the Pacific Missile Test Center, Point Mugu, CA.

The purpose of the first project was to evaluate an Integrated Body Armor/Flotation/Survival System for helicopter aircrewmen and the second was to compare two versions of the LRU-8/P All-Weather One-Man Life Raft for the fighter and attack aircrewmen. In addition to the two projects, data from a prior project was analyzed to explore the effects of small sample sizes and non-random sample selection on the conclusions regarding the equipment under test.

The report is separated into three Chapters and a number of Appendixes containing supporting material. The first chapter covers the method of evaluating aircrew equipment and the results of the statistical study. Chapter 2 is the final report of the evaluation of the Integrated Body Armor/Flotation/Survival System, and Chapter 3 is the final report of the comparison testing of the LRU-8/P All-Weather One-Man Life Raft.
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ABSTRACT

EVALUATION OF NAVY AIRCREW EQUIPMENT

by

Bradley Clifford George

Master of Science in Engineering

June, 1976

New or modified Navy aircrew equipment is evaluated for safety, compatibility, comfort and utility prior to production and Fleet use. To provide insight as to the effect of sample size and sample selection on the results of an evaluation, data from the evaluation of the HGU-27/P Sonarman's Helmet was analyzed. Also, two new items of aircrew equipment were evaluated, for possible Fleet use, for the Crew System Branch of the Pacific Missile Test Center, Point Mugu, California.

From the statistical analysis of the HGU-27/P data, it was concluded that:

1. The evaluation results and the squadron selected to perform the evaluation are not independent.

2. Randomly chosen samples with as few as five subjects will provide a reasonably correct evaluation of the equipment.

3. The evaluation results and the average experience level of the subjects are independent.
Two versions of the Integrated Body Armor/Flotation/Survival System designed and manufactured by the Naval Air Development Center (NAVAIRDEVCEN) were provided to Pacific Missile Test Center for developmental test and evaluation. The integrated survival system is designed for helicopter aircrewmen and consists of the basic helicopter survival vest, a heat sealed LPA-2 life preserver, a mini-raft, and front and/or rear armor plates. The integrated assemblies were evaluated by experienced aircrewmen in the swimming pool, in the open sea, during normal flight operations, and during combat Search and Rescue exercises. It was generally concluded that the integrated vest assembly offered improved configuration concepts over present survival equipment, but will require numerous modifications to be suitable for Fleet use.

A heat sealed version of the LRU-8/P one-man all-weather life raft was developed by the NAVAIRDEVCEN for the fighter and attack aircrewmen. The LRU-8/P is a one man raft consisting of an inflation assembly, a single compartment flotation tube, and an inflatable floor and weather-shield. Three heat sealed LRU-8/P rafts, manufactured by Switlik, were compared with three cemented seam LRU-8/P rafts, manufactured by Patten, Inc., during (1) packing tests in various Rigid Seat Survival Kits (RSSK) and soft kits, (2) mid-air and surface deployments from a cross section of seat kits and (3) an accelerated life cycle test. It was concluded that both versions of the LRU-8/P can be packed and deployed from a variety of seat kits and no major differences were noted during the life cycle tests. The heat sealed raft was easier to pack into the seat kits than the cemented-seam raft. Several changes are recommended for the heat sealed raft before possible Fleet use.
CHAPTER 1
DEVELOPMENTAL EVALUATION OF
AIRCREW EQUIPMENT

I. INTRODUCTION

Naval air operations rely almost totally on manned aircraft from helicopters and utility type aircraft to the high speed, computer controlled fighters. The successful completion of operational missions requires that the aircrews be provided with adequate life support and communications systems to perform their required functions as part of the man-aircraft system. In addition to this minimum equipment, an effort is made to provide for the survival of the aircrew by providing protective equipment, escape systems, flotation devices and survival equipment.

The clothing and equipment is under continuous review to ascertain its effectiveness and determine possible improvements. Information from Fleet users, the Naval Aviation Safety Center, and shore establishments is constantly monitored in an attempt to improve the equipment and eliminate problems as they occur.

The Naval Air Development Center at Warminster, PA, which is designated as the lead laboratory for development of aircrew equipment, designs new equipment or modifications to existing equipment and tasks the Pacific Missile Test Center, Point Mugu, CA or the Naval Air Test Center, Patuxent River, MD to evaluate it to determine its suitability for Fleet use.

The type of testing required is normally very user and operationally oriented with active duty Fleet personnel as subjects or evaluators. Typically the questions to be answered are:
- Are there compatibility problems with other equipment?
- Does it interfere with routine performance of the crewman's duties?
- Is it reliable and will it function under emergency conditions?
- Is it adequately comfortable?
- Can it be maintained by Fleet personnel?

A categorization and some examples of Navy aircrew equipment are shown in Table 1. As can be seen in the table some pieces of equipment fall into more than one category. A typical Navy aircrewman will have 30 to 40 pounds of equipment, not including his parachute or raft, on his person when he walks out to the airplane.

**TABLE 1**

**EXAMPLES OF NAVY AIRCREW EQUIPMENT**

**Life support systems**
- Oxygen equipment (regulators, LOX converters, masks, etc.)
- Pressure suits
- Temperature control

**Communications (man/aircraft interface)**
- Microphones
- Helmets (for sound attenuation and mounting for earphones)
- Earphones

**Protective equipment**
- Helmets
- Flight suits
- Anti-exposure suits
- Armor vests

**Escape systems**
- Ejection seats
- Parachutes
- Integrated harness
Survival equipment
- Flares
- Knife
- Handgun
- Tools
- Shark repellent
- Shroud cutter
- First aid kit
- Radio

Flotation equipment
- Life preservers
- Rafts (single and multiplace)

II. DATA COLLECTION AND ANALYSIS
A. The Questionnaire

The basic tool for obtaining subjective data is the questionnaire. The questionnaire provides a method of asking predetermined questions to obtain expressions of attitudes, preferences, and opinions. When properly formatted the questionnaire also aids in the tabulation of the data and analysis of the results. The questionnaire can be administered to a small group, as during developmental testing, or to a larger cross-section of Navy personnel. Behavior and performance are often determined by attitudes and perceptions and therefore a reliable estimate of individual or group attitudes is of value to the designer or decision maker.

Questionnaire design and administration are covered extensively in a number of references, some of which are listed in Appendix A. Although this paper is not concerned with the questionnaire design as a primary topic, an overview of the type of questionnaires used to evaluate aircrew equipment is presented for background information.
The method of designing a questionnaire can be loosely divided into five steps: (reference 1):

1. Preliminary planning - This includes acquiring knowledge of the equipment being evaluated and the type of people who will be using it. A list is made of the important attributes of the system which need investigation.

2. Selection of the question form - Generally there are three question forms, the free answer question, the "Yes" or "No" question and the multiple choice or rating scale question.

3. Writing the questions - This is one of the more difficult parts because care must be taken to avoid trick or confusing questions and wording which will bias the results.

4. Organizing the questionnaire - The questions should begin with preliminary information such as name, rate, squadron, etc., and then proceed in some logical order so the questionnaire flows from one question to the other.

5. Pretesting and administering the questionnaire - The questionnaire should be validated by administering it to a small sample of representative subjects prior to the main testing. Sometimes time restrictions and scheduling make this step difficult to accomplish, however to prevent confusing questions or oversights from biasing the results some method of checking the questionnaire is required.

The questionnaires which were used in the evaluation of the Integrated Body Armor/Flotation/Survival System and the evaluation of the HGU-27/P Sonarman's Helmet (the data from which the statistical analysis was performed) use a combination of all three question types.
(see Appendix B and Appendix C). The majority of questions are multiple choice with an invitation and space provided for the respondent to explain and elaborate on his answer. Also a few dichotomous "Yes" or "No" questions are asked. While the multiple choice and dichotomous questions are easy to analyze and tabulate, the most useful information is derived from the free responses of the subjects. Their descriptions of problems and recommendations for improvement of the equipment are what makes this type of testing so useful during the development process. For example, the evaluation of the Integrated System utilized so few subjects (because of time and funding problems and problems obtaining Fleet support) that statistical analysis of the data was impossible, however enough significant information and recommendations were obtained to improve the equipment. In many cases the new equipment is intended to replace or improve upon some existing equipment. In order to test the hypothesis, the same questions must be asked concerning the present equipment as were asked concerning the new equipment or a question asking the subject to compare the two equipments is required. The LRU-8/P life rafe evaluation used free answer questions almost exclusively, Appendix D.

B. Data Analysis

Tabulation and analysis of the responses to multiple choice and dichotomous questions can be handled by several methods. The most straightforward method and the one which requires the least number of assumptions is a tabulation of response frequencies, or relative frequencies, or a frequency histogram as was done with the HGU-27/P data in Appendixes E and F. A mode response may be chosen as the measure of central tendency and nonparametric tests such as the Chi-Square test,
Cochran Q test, and the McNemar test may be used to determine significance. The only requirements of the data are that it have a nominal (classification) scale. The next higher level of measurement is also applicable to the multiple choice ratings and is distinguished by an ordinal scale (ordered classifications such as Very Good, Good, etc.). In this case applicable descriptive statistics are medians and percentiles, and test statistics that are appropriate are nonparametric tests such as the Sign test, Krushal-Wallis oneway analysis of variance and Chi-Square test. The third way of treating the multiple choice scale is to assign numerical values to the response categories in ascending order and then apply the common descriptive statistics such as mean and standard deviation, and parametric tests such as the t-test and the F test. The use of these tests however, add an additional requirement to the data. The rating choices must have equal interval spacing, i.e. the distance from Poor to Very Poor should be the same as the distance from Good to Very Good. A number of standardized rating scales have been developed which supposedly achieve the equal interval spacing (references 2, 3 and 4) however, Siegel (reference 5) questions the validity of the methods used and concludes that interval scales are rarely achieved. In the case of the questionnaires used for the evaluation of aircrew equipment by the Crew Systems Branch, minimal attention was given to the development of equal interval scales other than the questionnaire designers intuitive feel what constitutes equal spacing. Parametric tests also require additional assumptions other than an interval measurement scale. The t-test for example requires the observations be drawn from normally distributed populations, and that the populations have the same variance or a known ratio of variances, reference 5.
For this reason parametric statistics should be used with some caution. Tables 2 and 3 from Siegel, reference 5, provide a summary of the appropriate statistics for each level of measurement.

If an interval scale (or assumed interval scale) is used, additional refinements in the data analysis can be made by drawing upon decision theory techniques. A Delphi method can be used to obtain a relative ranking of the importance of each of the equipment attributes being evaluated and then used to weight the mean ranking for each attribute prior to aggregation. The author intended to use this technique for the evaluation of the Integrated System, however previously described problems of funding, time and sample size prevented it. The short example below illustrates the method.

**EXAMPLE:**

<table>
<thead>
<tr>
<th>Attributes Being Evaluated</th>
<th>Expert Consensus of Ranking</th>
<th>Experts Opinion Of Importance (undefined units)</th>
<th>Normalize Relative Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of donning</td>
<td>3</td>
<td>10</td>
<td>0.125</td>
</tr>
<tr>
<td>Comfort during flight</td>
<td>2</td>
<td>30</td>
<td>0.375</td>
</tr>
<tr>
<td>Compatibility with other equip.</td>
<td>1</td>
<td>40</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>80</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**Typical Evaluation Questions:**

How would you rate equipment A for comfort during flight?

- **Very Poor**: 1
- **Poor**: 2
- **Adequate**: 3
- **Good**: 4
- **Very Good**: 5

How would you rate equipment B for comfort during flight?

- **Very Poor**: 1
- **Poor**: 2
- **Adequate**: 3
- **Good**: 4
- **Very Good**: 5
## TABLE 2

FOUR LEVELS OF MEASUREMENT AND THE STATISTICS* APPROPRIATE TO EACH LEVEL

<table>
<thead>
<tr>
<th>SCALE</th>
<th>DEFINING RELATIONS</th>
<th>EXAMPLES OF APPROPRIATE STATISTICS</th>
<th>APPROPRIATE STATISTICAL TEST</th>
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</thead>
<tbody>
<tr>
<td>Nominal</td>
<td>(1) Equivalence</td>
<td>Mode</td>
<td>Nonparametric statistical tests</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequency</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cotingency</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Coefficient</td>
<td></td>
</tr>
<tr>
<td>Ordinal</td>
<td>(1) Equivalence</td>
<td>Median</td>
<td>Nonparametric statistical test</td>
</tr>
<tr>
<td></td>
<td>(2) Greater than</td>
<td>Percentile</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spearman</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kendall</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Kendall W</td>
<td></td>
</tr>
<tr>
<td>Interval</td>
<td>(1) Equivalence</td>
<td>Mean</td>
<td>Nonparametric and parametric statistical tests</td>
</tr>
<tr>
<td></td>
<td>(2) Greater than</td>
<td>Standard deviation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3) Known ratio</td>
<td>Pearson product-moment correlation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>of any two intervals</td>
<td>Multitude product-moment correlation</td>
<td></td>
</tr>
<tr>
<td>Ratio</td>
<td>(1) Equivalence</td>
<td>Geometric mean</td>
<td>Nonparametric and parametric statistical test</td>
</tr>
<tr>
<td></td>
<td>(2) Greater than</td>
<td>Coefficient of variation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3) Known ratio</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>of any two intervals</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4) Known ratio</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>of any two scale values</td>
<td></td>
<td></td>
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*From reference 5
<table>
<thead>
<tr>
<th>LEVEL OF MEASUREMENT</th>
<th>NON PARAMETRIC STATISTICAL TEST*</th>
<th>TWO-SAMPLE CASE</th>
<th>K-SAMPLE CASE</th>
<th>NONPARAMETRIC MEASURE OF CORRELATION</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>RELATED SAMPLES</td>
<td>INDEPENDENT SAMPLES</td>
<td>RELATED SAMPLES</td>
</tr>
<tr>
<td>One-sample case</td>
<td>Nominal</td>
<td>Binomial test</td>
<td>McNemar test for the significance of changes</td>
<td>Fisher exact probability test</td>
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<tr>
<td></td>
<td></td>
<td>X² one-sample test</td>
<td>X² test for two independent samples</td>
<td>Contingency coefficient</td>
</tr>
<tr>
<td></td>
<td>Ordinal</td>
<td>Kolmogorov-Smirnov one-sample test</td>
<td>Sign test</td>
<td>Wilcoxon matched-pairs test</td>
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<tr>
<td></td>
<td></td>
<td>One-sample runs test</td>
<td>Mann-Whitney U test</td>
<td>Kolmogorov-Smirnov two-sample test</td>
</tr>
<tr>
<td></td>
<td>Interval</td>
<td>Walsh test</td>
<td>Randomization test for two independent samples</td>
<td>Randomization test for matched pairs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wald-Wolfowitz runs test</td>
<td>Moses test of extreme reactions</td>
<td></td>
</tr>
</tbody>
</table>

* Each column lists, cumulatively downward, the tests applicable to the given level of measurement. For example, in the case of k related samples, when ordinal measurement has been achieved both the Friedman two-way analysis of variance and the Cochran Q test are applicable.

The Wilcoxon test requires ordinal measurement not only within pairs, as is required for the sign test, but also of the differences between pairs.

Taken from reference 5.
Tabulate Results for Each Subject:

Subject #

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Donning</td>
<td>3</td>
<td>4</td>
<td>0.125</td>
<td>0.375</td>
<td>0.5</td>
</tr>
<tr>
<td>Comfort</td>
<td>4</td>
<td>3</td>
<td>0.375</td>
<td>1.5</td>
<td>1.125</td>
</tr>
<tr>
<td>Compat-ibility</td>
<td>2</td>
<td>3</td>
<td>0.5</td>
<td>1.0</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Overall Ratings Subject #__ 2.875 3.125

Compute Mean Difference and Standard Deviation of Differences:

Subject # Overall Rating Equip. A Overall Rating Equip. B A-B=

1 2.875 3.125 -0.25

Total ....

Use a Paired t-Test to Test Significance of Differences.

III. INVESTIGATION OF THE EFFECT OF SAMPLE SIZE AND SAMPLE SELECTION ON TEST CONCLUSIONS

A. Introduction

Most developmental tests are conducted utilizing small samples because limited numbers of prototype equipment are provided and funding and time constraints are always present. The evaluation of the Integrated System is a typical case. Only two units of equipment were provided, and they had small differences in configuration. As a result it was deemed appropriate to investigate the effect of sample size and sample selection on the test conclusions.

The HGU-27/P Sonarman's Helmet was developed specifically for helicopter sonar operators to provide a lighter weight helmet with
maximum sound attenuation. The SPH-3 is the current helicopter crewman's helmet. The helmet was evaluated in 1974-75 by sonar operators of Helicopter Anti-Submarine Squadrons (HS- )10, -4, -2 and -85 based on the West Coast. HS-2 also evaluated the helmets during an extended WEST PAC (South China Sea) cruise. A sample of 39 subjects was used for this evaluation and a questionnaire was used to collect the data. The data from this evaluation was used for the investigation of sample size and sample selection effects.

The following three questions were formulated:

1. Is the final conclusion regarding the helmet independent of the Squadron chosen?
2. Will randomly chosen sub-samples, of small size, provide the same conclusions as the complete sample?
3. Is the conclusion independent of the average experience level of the subjects.

B. Method of Investigation

1. General

The questionnaire, Appendix B, utilizes a multiple choice scale to rate a majority of the attributes being investigated, and two questions are asked concerning each attribute. First the subject is asked to rate the new helmet on a scale similar to the one below.

Very Poor Poor Adequate Good Very Good

The subject is then asked to rate the new helmet in comparison with his current helmet on a scale such as:

Much Worse Worse Same Better Much Better
The final question asks the subject to rate the helmet for "overall assessment" in comparison with his present helmet. The questionnaire also included several dichotomous, and free response questions but they were not used to answer the three questions posed in paragraph III.A. Responses on the questionnaire questions 9A, 10A, 11A, 12A, 13A and 14A were combined to provide an HGU-27/P Rating; responses for questions 9B, 10B, 11B, 12B, 13B, 14B and 15C combined to provide a Comparison Rating between the HGU-27/P and the SPH-3, and the responses from question 18 were tabulated separately to provide an Overall Assessment rating for the HGU-27/P.

The rating scales for each question are not uniformly worded and, therefore, the validity of combining the questions may be doubtful. The following rational was used:

a. Each scale has a somewhat neutral or middle ground category such as Moderate, No Difficulty, or Adequate and it appears reasonable to combine these categories under a category called Adequate.

b. Each scale has an extreme category at each end such as Very Heavy, Very Hot or Very Effective and these categories were combined respectively under the headings of Very Poor and Very Good.

c. In a similar manner the categories of Heavy, Hot, Cool, etc., were combined respectively into the intermediate categories of Poor and Good.

d. Some of the response scales did not readily fit the standardized scale but the combining appears adequate to obtain some insight into the questions posed in paragraph III.A.

e. Parametric statistics cannot be used with any degree of confidence because the assumptions of an equal interval measurement
scale and a normal distribution are impossible after combining the response categories. Nonparametric statistics, however, should still yield meaningful results. Although some parametric statistics were computed in addition to the nonparametric statistics, they were done so for comparison purposes and not as a primary method of testing a hypothesis.

The 39 questionnaires were numbered from 1 to 39 and a random digits table used to select five sub-samples for each N value of 5, 10, and 15. Appendix G shows questionnaire numbers selected for each sub-sample. The sub-samples were designated as 5-1 etc., to indicate sub-sample 1 with an N of 5. By this method 15 sub-samples were choosen. The questionnaires were also separated by squadron so 4 additional sub-samples were created.

The data was tabulated and the frequency histograms for the HGU-27/P Rating, the Comparison Rating HGU-27/P and SPH-3, and the Overall Assessment Rating were constructed for the complete sample as well as for each sub-sample. The histograms are included as Appendix E. The relative frequencies were also plotted, Appendix F, so that samples of different sizes could be readily compared.

2. Question - 1

The effect of squadron grouping on the evaluation results was investigated by:

a. A visual comparison of the relative frequency histograms.

b. Comparing the mode and median response for each squadron and the entire sample.
3. Question - 2

The effect of sub-sample size on the conclusions was investigated by:

a. A visual comparison of the relative frequency histograms.

b. Comparing the mode and median response for each squadron.

c. A Chi-Square test of the hypothesis "the sub-sample distribution is equal to the distribution of the complete sample."

d. A t-test to compare the means of the sub-sample with the mean of the complete sample. NOTE: The assumptions required for a t-test are not met.

4. Question - 3

a. The question of independence of evaluation results and experience level of the subjects was tested using the subjects pay grade as a measure of experience. The pay grades are based directly on the subjects rank and ranks are generally a measure of experience level. The average pay grade for each sub-sample was determined and two categories of pay grade created with each sub-sample falling into one of the categories. As a measure of "results" two methods were used. First the sub-samples were divided into two groups according to whether the
percent of responses in the category corresponding to the mode of the complete sample is less than or greater than the percent of responses at the mode for the complete sample. For the second method the sub-samples were divided into two groups depending on whether their mean rating was less than or more than the mean for the complete sample. This approach assumes that the mean rating is a valid statistic and may not be true.

A 2 x 2 Contingency Table was created for both methods and all the sub-samples placed into one of the four cells. A Fisher Exact Probability Test was used to test significance instead of a Chi-Square test because of the small value of N, reference 5 pg. 110.

b. As a final way of looking at the effect of subject experience and evaluation results, a plot of Average Pay Grade vs. Mean Rating was made and visually examined for possible correlations. This also assumes that the mean is a valid statistic which as discussed before, may not be true.

C. Results

A summary of the descriptive statistics for each of the three categories of questions are shown in Tables 4, 5, and 6. In each case the mode, the percent of responses at the mode, the median, the mean, and the standard deviation are tabulated for each sub-sample and for the complete sample.

1. Question - 1

Is the final conclusion regarding the helmet independent of the squadron chosen?

a. A visual comparison between the relative frequency plots for each squadron and the complete sample reveals they are very similar
<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>MODE</th>
<th>% RESPONSES AT THE MODE</th>
<th>MEDIAN</th>
<th>MEAN*</th>
<th>STANDARD*</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPLETE</td>
<td>GOOD</td>
<td>48%</td>
<td>GOOD</td>
<td>3.79</td>
<td>0.83</td>
</tr>
<tr>
<td>HS-10</td>
<td>GOOD</td>
<td>48%</td>
<td>GOOD</td>
<td>3.63</td>
<td>0.81</td>
</tr>
<tr>
<td>HS-4</td>
<td>GOOD</td>
<td>52%</td>
<td>GOOD</td>
<td>3.63</td>
<td>0.76</td>
</tr>
<tr>
<td>HS-2</td>
<td>VERY GOOD</td>
<td>47%</td>
<td>GOOD</td>
<td>4.31</td>
<td>0.79</td>
</tr>
<tr>
<td>HS-85</td>
<td>GOOD</td>
<td>54%</td>
<td>GOOD</td>
<td>3.92</td>
<td>0.78</td>
</tr>
<tr>
<td>5-1</td>
<td>GOOD</td>
<td>45%</td>
<td>GOOD</td>
<td>3.93</td>
<td>0.88</td>
</tr>
<tr>
<td>5-2</td>
<td>GOOD</td>
<td>40%</td>
<td>GOOD</td>
<td>3.97</td>
<td>0.85</td>
</tr>
<tr>
<td>5-3</td>
<td>GOOD</td>
<td>47%</td>
<td>GOOD</td>
<td>3.93</td>
<td>0.74</td>
</tr>
<tr>
<td>5-4</td>
<td>GOOD</td>
<td>50%</td>
<td>GOOD-ADEQ.</td>
<td>3.43</td>
<td>0.77</td>
</tr>
<tr>
<td>5-5</td>
<td>GOOD</td>
<td>47%</td>
<td>GOOD</td>
<td>3.90</td>
<td>0.80</td>
</tr>
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<td>10-1</td>
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<td>47%</td>
<td>GOOD</td>
<td>3.75</td>
<td>0.91</td>
</tr>
<tr>
<td>10-2</td>
<td>GOOD</td>
<td>35%</td>
<td>GOOD-ADEQ.</td>
<td>3.68</td>
<td>0.93</td>
</tr>
<tr>
<td>10-3</td>
<td>GOOD</td>
<td>45%</td>
<td>GOOD</td>
<td>3.68</td>
<td>0.87</td>
</tr>
<tr>
<td>10-4</td>
<td>GOOD</td>
<td>55%</td>
<td>GOOD</td>
<td>3.78</td>
<td>0.72</td>
</tr>
<tr>
<td>10-5</td>
<td>GOOD</td>
<td>52%</td>
<td>GOOD</td>
<td>3.90</td>
<td>0.80</td>
</tr>
<tr>
<td>15-1</td>
<td>GOOD</td>
<td>52%</td>
<td>GOOD</td>
<td>3.86</td>
<td>0.80</td>
</tr>
<tr>
<td>15-2</td>
<td>GOOD</td>
<td>47%</td>
<td>GOOD</td>
<td>3.80</td>
<td>0.86</td>
</tr>
<tr>
<td>15-3</td>
<td>GOOD</td>
<td>44%</td>
<td>GOOD</td>
<td>3.87</td>
<td>0.82</td>
</tr>
<tr>
<td>15-4</td>
<td>GOOD</td>
<td>51%</td>
<td>GOOD</td>
<td>3.82</td>
<td>0.77</td>
</tr>
<tr>
<td>15-5</td>
<td>GOOD</td>
<td>44%</td>
<td>GOOD</td>
<td>3.70</td>
<td>0.84</td>
</tr>
</tbody>
</table>

* Mean and standard deviation are questionable statistics because the intervals between rating categories may not be equally spaced.
<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>MODE</th>
<th>% RESPONSE AT MODE</th>
<th>MEDIAN</th>
<th>MEAN*</th>
<th>STANDARD*</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPLETE</td>
<td>BETTER</td>
<td>43%</td>
<td>BETTER</td>
<td>3.76</td>
<td>0.91</td>
</tr>
<tr>
<td>HS-10</td>
<td>BETTER</td>
<td>44%</td>
<td>BETTER</td>
<td>3.69</td>
<td>0.92</td>
</tr>
<tr>
<td>HS-4</td>
<td>BETTER</td>
<td>48%</td>
<td>BETTER-SAME</td>
<td>3.47</td>
<td>0.80</td>
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<tr>
<td>HS-2</td>
<td>MUCH BETTER</td>
<td>41%</td>
<td>BETTER</td>
<td>4.16</td>
<td>0.85</td>
</tr>
<tr>
<td>HS-85</td>
<td>BETTER</td>
<td>46%</td>
<td>BETTER</td>
<td>3.85</td>
<td>0.88</td>
</tr>
<tr>
<td>5-1</td>
<td>BETTER</td>
<td>50%</td>
<td>BETTER</td>
<td>3.66</td>
<td>0.87</td>
</tr>
<tr>
<td>5-2</td>
<td>BETTER</td>
<td>50%</td>
<td>BETTER</td>
<td>3.35</td>
<td>0.88</td>
</tr>
<tr>
<td>5-3</td>
<td>MUCH BETTER</td>
<td>43%</td>
<td>BETTER-MUCH BETTER</td>
<td>4.2</td>
<td>0.83</td>
</tr>
<tr>
<td>5-4</td>
<td>BETTER</td>
<td>46%</td>
<td>BETTER</td>
<td>3.57</td>
<td>0.85</td>
</tr>
<tr>
<td>5-5</td>
<td>SAME-BETTER</td>
<td>40+40 = 80</td>
<td>BETTER</td>
<td>3.80</td>
<td>0.76</td>
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<td>10-1</td>
<td>BETTER</td>
<td>43%</td>
<td>BETTER</td>
<td>3.68</td>
<td>0.93</td>
</tr>
<tr>
<td>10-2</td>
<td>BETTER</td>
<td>40%</td>
<td>BETTER</td>
<td>3.79</td>
<td>1.02</td>
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<td>BETTER</td>
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<td>0.88</td>
</tr>
<tr>
<td>10-4</td>
<td>BETTER</td>
<td>50%</td>
<td>BETTER</td>
<td>3.77</td>
<td>0.82</td>
</tr>
<tr>
<td>10-5</td>
<td>BETTER</td>
<td>50%</td>
<td>BETTER</td>
<td>3.83</td>
<td>0.83</td>
</tr>
<tr>
<td>15-1</td>
<td>BETTER</td>
<td>45%</td>
<td>BETTER</td>
<td>3.90</td>
<td>0.85</td>
</tr>
<tr>
<td>15-2</td>
<td>BETTER</td>
<td>42%</td>
<td>BETTER</td>
<td>3.57</td>
<td>0.94</td>
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<tr>
<td>15-3</td>
<td>BETTER</td>
<td>49%</td>
<td>BETTER</td>
<td>3.85</td>
<td>0.83</td>
</tr>
<tr>
<td>15-4</td>
<td>BETTER</td>
<td>50%</td>
<td>BETTER</td>
<td>3.79</td>
<td>0.83</td>
</tr>
<tr>
<td>15-5</td>
<td>BETTER</td>
<td>48%</td>
<td>BETTER</td>
<td>3.75</td>
<td>0.83</td>
</tr>
</tbody>
</table>

* Mean and standard deviation are questionable statistics because the intervals between rating categories may not be equally spaced.
<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>MODE</th>
<th>% RESPONSES AT THE MODE</th>
<th>MEDIUM</th>
<th>MEAN*</th>
<th>STANDARD* DEVIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPLETE</td>
<td>VERY GOOD</td>
<td>49%</td>
<td>VERY GOOD</td>
<td>3.7</td>
<td>0.89</td>
</tr>
<tr>
<td>HS-10</td>
<td>VERY GOOD</td>
<td>69%</td>
<td>VERY GOOD</td>
<td>3.81</td>
<td>0.54</td>
</tr>
<tr>
<td>HS-4</td>
<td>GOOD</td>
<td>50%</td>
<td>GOOD</td>
<td>3.0</td>
<td>0.70</td>
</tr>
<tr>
<td>HS-2</td>
<td>EXCELLENT</td>
<td>45%</td>
<td>VERY GOOD-GOOD</td>
<td>3.89</td>
<td>1.36</td>
</tr>
<tr>
<td>HS-85</td>
<td>VERY GOOD</td>
<td>75%</td>
<td>VERY GOOD</td>
<td>3.75</td>
<td>0.5</td>
</tr>
<tr>
<td>5-1</td>
<td>VERY GOOD</td>
<td>67%</td>
<td>VERY GOOD</td>
<td>4.33</td>
<td>0.58</td>
</tr>
<tr>
<td>5-2</td>
<td>VERY GOOD</td>
<td>60%</td>
<td>VERY GOOD</td>
<td>4.0</td>
<td>0.71</td>
</tr>
<tr>
<td>5-3</td>
<td>VERY GOOD</td>
<td>60%</td>
<td>VERY GOOD</td>
<td>4.0</td>
<td>0.71</td>
</tr>
<tr>
<td>5-4</td>
<td>GOOD</td>
<td>80%</td>
<td>GOOD</td>
<td>3.20</td>
<td>0.45</td>
</tr>
<tr>
<td>5-5</td>
<td>VERY GOOD</td>
<td>40%</td>
<td>VERY GOOD</td>
<td>3.6</td>
<td>1.14</td>
</tr>
<tr>
<td>10-1</td>
<td>VERY GOOD</td>
<td>56%</td>
<td>VERY GOOD</td>
<td>3.78</td>
<td>0.67</td>
</tr>
<tr>
<td>10-2</td>
<td>GOOD-VERY GOOD</td>
<td>37.5 + 37.5 = 75%</td>
<td>VERY GOOD</td>
<td>3.88</td>
<td>0.83</td>
</tr>
<tr>
<td>10-3</td>
<td>GOOD</td>
<td>50%</td>
<td>GOOD-VERY GOOD</td>
<td>3.30</td>
<td>1.06</td>
</tr>
<tr>
<td>10-4</td>
<td>VERY GOOD</td>
<td>77%</td>
<td>VERY GOOD</td>
<td>4.00</td>
<td>0.4</td>
</tr>
<tr>
<td>10-5</td>
<td>VERY GOOD</td>
<td>60%</td>
<td>VERY GOOD</td>
<td>3.80</td>
<td>1.14</td>
</tr>
<tr>
<td>15-1</td>
<td>VERY GOOD</td>
<td>58%</td>
<td>VERY GOOD</td>
<td>3.79</td>
<td>0.80</td>
</tr>
<tr>
<td>15-2</td>
<td>VERY GOOD</td>
<td>43%</td>
<td>VERY GOOD-GOOD</td>
<td>3.54</td>
<td>0.84</td>
</tr>
<tr>
<td>15-3</td>
<td>VERY GOOD</td>
<td>67%</td>
<td>VERY GOOD</td>
<td>3.8</td>
<td>0.56</td>
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<tr>
<td>15-4</td>
<td>VERY GOOD</td>
<td>64%</td>
<td>VERY GOOD</td>
<td>3.79</td>
<td>0.98</td>
</tr>
<tr>
<td>15-5</td>
<td>VERY GOOD</td>
<td>53%</td>
<td>VERY GOOD-GOOD</td>
<td>3.60</td>
<td>0.74</td>
</tr>
</tbody>
</table>

* Mean and standard deviation are questionable statistics because the intervals between rating categories may not be equally spaced.
with the exception of HS-2. The distributions for HS-2 are extremely skewed to the right. HS-2's reaction to the new helmet was more favorable than the other three squadrons. If HS-2 had been the only squadron chosen to evaluate the HGU-27/P the conclusions would have been more favorable than for one of the other squadrons, therefore, based on this test the answer to question No. 1 is "NO", the conclusions and squadron choice are not independent.

b. Examination of the mode and median responses, Tables 4, 5, and 6, for each squadron provides a similar conclusion. The mode response for each squadron was consistent except for HS-2. The median response for each squadron was consistent for HGU-27/P Rating and Comparison Rating, however the median response for Overall Assessment contained some variation by both HS-2 and HS-4. Again the conclusion is the evaluation results are not independent of the squadron chosen.

c. The results of Chi-Square tests of the distribution of each squadron in comparison with the distribution predicted by the complete sample are summarized in Tables 7, 8, and 9. Again the conclusion is that the results are not independent of the squadron. The Chi-Square test of the Comparison Rating, Table 8, indicated that both HS-2 and HS-4 were significantly different from the complete sample. Many Chi-Square tests for Overall Assessment are of questionable validity because the frequencies are too small. A Binomial test was used on sample 5-4 which was one of the more extreme cases, and the difference was not significant at the 0.05 level of significance, Appendix H. The extremely small values of N make hypothesis testing very inconclusive.
TABLE 7
RESULTS OF HYPOTHESIS TESTING FOR RATING OF HGU-27/P

For $X^2$ Test $H_0$: The distribution of the sub-sample is the same as the distribution of the complete sample.

For $t$-Test $H_0$: The mean score of the sub-sample is equal to the mean score of the complete sample.

Level of Significant $= 0.05$

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>RESULTS OF $X^2$ TESTS</th>
<th>RESULTS OF $t$-TEST*</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS-10</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>HS-4</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>HS-2</td>
<td>Reject</td>
<td>Reject</td>
</tr>
<tr>
<td>HS-85</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>5-1</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>5-2</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>5-3</td>
<td>Accept</td>
<td>Accept</td>
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<tr>
<td>5-4</td>
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<td>Reject</td>
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<tr>
<td>5-5</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>10-1</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>10-2</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>10-3</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>10-4</td>
<td>Accept</td>
<td>Accept</td>
</tr>
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<tr>
<td>15-5</td>
<td>Accept</td>
<td>Accept</td>
</tr>
</tbody>
</table>

* $t$-Test has questionable validity because intervals are not equally spaced.
TABLE 8
RESULTS OF HYPOTHESIS TESTING FOR COMPARISON OF HGU-27/P AND SPH-3

For $X^2$ Test $H_0$: The distribution of the sub-sample is the same as the distribution of the complete sample.

For t-Test $H_0$: The mean score of the sub-sample is equal to the mean score of the complete sample.

Level of Significant $= 0.05$

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>RESULTS OF $X^2$ TESTS</th>
<th>RESULTS OF t-TEST*</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS-10</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>HS-4</td>
<td>Reject</td>
<td>Reject</td>
</tr>
<tr>
<td>HS-2</td>
<td>Reject</td>
<td>Reject</td>
</tr>
<tr>
<td>HS-85</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>5-1</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>5-2</td>
<td>Accept</td>
<td>Reject</td>
</tr>
<tr>
<td>5-3</td>
<td>Reject</td>
<td>Reject</td>
</tr>
<tr>
<td>5-4</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>5-5</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>10-1</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>10-2</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>10-3</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>10-4</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>10-5</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>15-1</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>15-2</td>
<td>Accept</td>
<td>Reject</td>
</tr>
<tr>
<td>15-3</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>15-4</td>
<td>Accept</td>
<td>Accept</td>
</tr>
<tr>
<td>15-5</td>
<td>Accept</td>
<td>Accept</td>
</tr>
</tbody>
</table>

* t-Test has questionable validity because intervals are not equally spaced.
TABLE 9
RESULTS OF HYPOTHESIS TESTING FOR OVERALL ASSESSMENT OF HGU-27/P

For \( X^2 \) Test \( H_0 \): The distribution of the sub-sample is the same as the distribution of the complete sample.

For t-Test \( H_0 \): The mean score of the sub-sample is equal to the mean score of the complete sample.

Level of Significant \( = 0.05 \)

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>RESULTS OF ( X^2 ) TEST</th>
<th>RESULTS OF t-TEST*</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS-10</td>
<td>Accept</td>
<td>Accept</td>
<td>( X^2 ) assumptions not</td>
</tr>
<tr>
<td>HS-4</td>
<td>Reject</td>
<td>Reject</td>
<td>met more than 20%</td>
</tr>
<tr>
<td>HS-2</td>
<td>Accept</td>
<td>Accept</td>
<td>of categories have</td>
</tr>
<tr>
<td>HS-85</td>
<td>Accept</td>
<td>Accept</td>
<td>expected frequencies less than 5</td>
</tr>
<tr>
<td>5-1</td>
<td>Didn't Test</td>
<td>Didn't Test</td>
<td>( X^2 ) assumptions not</td>
</tr>
<tr>
<td>5-2</td>
<td>Accept</td>
<td>Accept</td>
<td>met more than 20%</td>
</tr>
<tr>
<td>5-3</td>
<td>Accept</td>
<td>Accept</td>
<td>of categories have</td>
</tr>
<tr>
<td>5-4</td>
<td>Accept</td>
<td>Accept</td>
<td>expected frequencies less than 5</td>
</tr>
<tr>
<td>5-5</td>
<td>Accept</td>
<td>Accept</td>
<td></td>
</tr>
<tr>
<td>10-1</td>
<td>Accept</td>
<td>Accept</td>
<td>( X^2 ) assumptions not</td>
</tr>
<tr>
<td>10-2</td>
<td>Accept</td>
<td>Accept</td>
<td>met more than 20%</td>
</tr>
<tr>
<td>10-3</td>
<td>Accept</td>
<td>Accept</td>
<td>of categories have</td>
</tr>
<tr>
<td>10-4</td>
<td>Accept</td>
<td>Accept</td>
<td>expected frequencies less than 5</td>
</tr>
<tr>
<td>10-5</td>
<td>Accept</td>
<td>Accept</td>
<td></td>
</tr>
<tr>
<td>15-1</td>
<td>Accept</td>
<td>Accept</td>
<td>( X^2 ) assumptions not</td>
</tr>
<tr>
<td>15-2</td>
<td>Accept</td>
<td>Accept</td>
<td>met more than 20%</td>
</tr>
<tr>
<td>15-3</td>
<td>Accept</td>
<td>Accept</td>
<td>of categories have</td>
</tr>
<tr>
<td>15-4</td>
<td>Accept</td>
<td>Accept</td>
<td>expected frequencies less than 5</td>
</tr>
<tr>
<td>15-5</td>
<td>Accept</td>
<td>Accept</td>
<td></td>
</tr>
</tbody>
</table>

* t-Test has questionable validity because intervals not equally spaced.
d. A Chi-Square test of independence (Contingency Table) resulted in rejection of the hypothesis that response distribution is independent of the squadron, Appendix H. HS-2 was removed from the Contingency Table, another test was performed, and the hypothesis of independence was not rejected.

e. T-tests comparing the mean rating of the squadron and the mean ratings of the complete sample, although of questionable validity, also indicated squadron differences. They are summarized in Tables 4, 5, and 6.

The final conclusion, based on the five tests above, is "the evaluation results and the squadron selected to do the evaluation are not independent." Several observations can be added which may explain this conclusion. HS-10, which provided 44% of the subjects, is a training squadron which never deploys from its home base at Imperial Beach, CA. HS-2 and HS-4 are regular Fleet squadrons and each accounted for 23% of the subjects. HS-85 is a reserve squadron which accounted for 10% of the subjects, and contains both active duty and reserve personnel. All the squadrons perform the same anti-submarine mission and are composed of personnel of similar experience levels (Appendix K), however, their overall situations are different. HS-2 was the only squadron that tested the helmets during an extended sea deployment and their evaluation departed the most from that of the complete sample. Looking only at the data, such as the frequency plots, a test conductor with incomplete background knowledge might be tempted to discard the data from HS-2 when in fact that data is probably the most realistic and valuable of all.
2. Question - 2

Will randomly chosen sub-samples, of small size, provide the same conclusions as the complete sample?

a. Visual comparison of the relative frequency diagrams for the HGU-27/P Rating suggested that sub-samples 5-3, 5-4, and 10-2 appeared different. Comparison of frequency diagrams for the Overall Assessment rating is difficult but a liberal evaluation still leaves sub-samples 5-1, 5-4, 10-1, 10-2, 10-3, and 15-3 as suspected of being different from the complete sample.

b. The mode response for the sub-samples was the same as the complete sample in all cases except sub-samples 5-3 and 5-5 for the comparison rating and sub-samples 5-4, 10-2 and 10-3 for the Overall Assessment Rating. The median responses for the Overall Assessment rating were the same except for sub-samples 5-4 and 10-3.

c. Results of the Chi-Square tests of the distributions of the sub-samples are summarized in Tables 6, 7, and 8. The only case in which the hypothesis was rejected was for the comparison rating from sub-sample 5-3.

d. The t-test rejected the equality of the complete sample mean ratings and the sub-sample mean ratings for the HGU-27/P Rating from sub-sample 5-4, and for the Comparison Rating from sub-samples 5-2, 5-3 and 15-2. NOTE: The t-test has questionable validity in this case.

In general, randomly chosen samples with as few as 5 subjects will provide the same conclusions regarding the new helmet. Some variations were apparent in the smaller samples, but they were variations in magnitude and not of a contradicting nature. Based on this analysis it would seem reasonable to expect that a sample with as few as 5 subjects
would provide conclusions with the correct order of magnitude, but in approximately 20% of the cases it would not provide entirely representative results. Extending this conclusion to other evaluations must be done with caution. The 39 subjects used for the HGU-27/P evaluation are a very homogenous group. They are all enlisted men who perform exactly the same job in exactly the same type of helicopter. In many evaluations the subjects are much more diverse.

3. Question - 3

Are the evaluation results independent of the subjects experience level?

a. The results of the Fisher Exact Probability Test conducted on the two Contingency Tables of Appendix L, indicated that the evaluation results and experience level were independent.

b. A plot of Mean Pay Grade of sub-sample vs. Mean HGU-27/P Rating did not reveal any correlations. The plot is shown in Appendix M.

In this case the evaluation results are independent of the average pay grade of the subjects. Caution must be used, however, if an attempt is made to extend this conclusion to other evaluations. A subject of almost any experience level may be capable of determining the comfort or the ease of donning a helmet, but the evaluation of an armor vest may be very difficult for a subject without combat or simulated combat experience.

4. Summary

Analysis of the data from the evaluation of the HGU-27/P helicopter sonarman's helmet resulted in the following conclusions:
a. The evaluation results and the squadron selected to perform the evaluation are not independent. (paragraph III.C.1)

b. Randomly chosen samples with as few as five subjects will provide a reasonably correct evaluation of the equipment. (paragraph III.C.2)

c. The evaluation results and the average experience level of the subjects are independent. (paragraph III.C.3)

These conclusions are probably restricted to evaluations which incorporate a fairly homogeneous group of aircrewm en and for which the equipment being evaluated does not require considerable experience to use or appreciate.

As a final observation, a conclusion regarding the HGU-27/P based solely on composite evaluation ratings would be seriously lacking. The open ended questions revealed that while the helmet offered many improvements over the SPH-3, it was unsuitable for Fleet use because of an extremely poor visor design. The helmet was rejected for Fleet use until the visor design is corrected and the helmet re-evaluated.
CHAPTER 2

FINAL REPORT OF THE EVALUATION OF THE INTEGRATED BODY ARMOR/FLOTATION/SURVIVAL SYSTEM
SUMMARY

Two versions of the Integrated Body Armor/Flotation/Survival System designed and manufactured by the Naval Air Development Center were provided to Pacific Missile Test Center for developmental test and evaluation. The integrated survival system is designed for helicopter aircrewmens and consists of the basic helicopter survival vest, a heat sealed LPA-2 life preserver, a mini-raft, and front and/or rear armor plates.

The integrated assemblies were evaluated by experienced crewmen in the swimming pool, in the open sea, during normal flight operations, and during combat Search and Rescue exercises. It was generally concluded that the integrated vest assembly offered improved configuration concepts over present survival equipment, but will require numerous modifications to be suitable for Fleet use.

As part of this test program, the Naval Air Development Center requested Pacific Missile Test Center to evaluate a vacuum packed version of the mini-raft which is designed to be carried in the lower leg pocket of the flight coveralls. It was concluded that the leg pocket stowage location for the mini-raft was not suitable for Fleet use.
I. INTRODUCTION

A. Background

The Naval Air Development Center (NAVAIRDEVCEN) was tasked by AIRTASK No. WFO0523401 to develop an integrated survival system for helicopter aircrewmen. The Integrated Body Armor/Flotation/Survival System was developed by NAVAIRDEVCEN as mission specific personal equipment for helicopter aircrewmen. The Pacific Missile Test Center (PACMISTESTCEN) as tasked by NAVAIRDEVCEN under Project Order N62269/76/PO/00511, dated July 1975, to conduct a test program to evaluate the integrated helicopter survival system.

NAVAIRDEVCEN also requested that PACMISTESTCEN conduct an evaluation of a vacuum packed mini-raft which was designed to be carried in the leg pocket of the flight coveralls. After inflation the mini-raft was packed into a soft pack configuration and used in the integrated vest assembly.

B. Purpose of Tests

The purpose of the Body Armor/Flotation/Survival System developmental tests was to determine the suitability of the system for Fleet use and assess the degree of improvement if any over current equipment. The following specific areas were investigated:

- Ease of donning/doffing.
- Fit and sizing.
- General comfort in aircraft.
- Ease of movement.
- Crew station compatibility.
- Overall performance during flight.
- Emergency egress from aircraft.
- Hoisting capability/comfort.
- Accessibility of inflation lanyards.
- Accessibility of survival items.
- Operation/performance of LPA-2 life preserver.
- Ease of boarding mini-raft.
- Stability of mini-raft.
The purpose of the leg pocket stowed mini-raft tests was to:

- Determine user acceptance.
- Aircraft compatibility.
- Accessibility.
- Functioning and performance.

II. SYSTEM DESCRIPTION

The integrated system is composed of the basic survival vest, a heat sealed LPA-2 life preserver, front and/or rear ballistic armor plates, and a new design heat sealed one-man life raft. The vest is configured with a snap link D-ring, located on the left shoulder, for use in connecting to rescue hoist devices. The vest is configured with adjustable side straps so the vest can be fitted snugly to the user but also accommodate a wide size range of users. The vest was configured with standard survival items as specified in NAVAIR, Crew Systems Manual 3-1-6.7, with the exception of the large survival knife and the SRU-31/P kit. Figures 1 and 2 show the integrated vest assembly. Figure 3 shows the survival items that were used in the vest assembly for this evaluation.

The heat sealed LPA-2 life preserver is the same design as the current LPA-2 with the exception that the seams are heat sealed vice cemented. The preserver attaches to the integrated vest assembly in the same manner as it does on the current SV-2B survival vest.

The heat sealed LPA-2 is being readied for operational evaluation and if successful may be provided to the Fleet for general use.

The mini-raft is a one man heat-sealed raft which was provided to PACMISTESTCEN in two vacuum packed configurations. One vacuum packed configuration is used in the vest assembly, Figure 4, and the other is designed to be carried in the leg pocket of the flight coveralls.
Figure 5. The raft is composed of multiple tube shaped air bladders which are stacked horizontally to form the sides of the raft, see Figure 6. The top three tubes are inflated by a CO₂ cylinder upon manual activation via a lanyard and the lower air tubes are inflated orally after the survivor boards the raft. The raft is stowed in a back pack and is held in place by straps which are secured by hook and pile tape, Figure 7. A covering flap held by hook and pile tape, protects the raft. Figure 7 shows the cover partially released to show the mini-raft. The raft inflation lanyard is routed over the right shoulder and when activated the raft will force the hook and pile tape to release as shown in Figure 8. After inflation either vacuum packed version can be repacked into a safe pack and reused in the integrated vest assembly.

The ballistic armor plates are made of a ceramic material and are designed to protect vital organs from small arms fire and shrapnel. The front and rear plates are individually attached to the vest assembly. The rear plate is secured under the back flap which is held in place by hook and pile tape, and is automatically jettisoned when the mini-raft is inflated. The front plate is attached by one of two different methods. On one vest assembly the plate is secured between the inner and outer layers of the vest with hook and pile tape, and in the other the plate is secured with zippers, Figures 1 and 9.

The vest can be used in six different configurations to meet the operational needs of helicopter crewmen. Table 1 shows the six configurations and the type of mission represented.
The following equipment was provided by NAVALVLVCEN:

One large long vest assembly with LPA-2 life preserver and front and rear armor plates. The front plate was secured by hook and pile tape.

One medium long vest with LPA-2 life preserver and front and rear armor plates. The front plate was secured by zippers.

One vacuum packed mini-raft configured for the back pack of the mini-raft.

One vacuum packed mini-raft configured for the leg pocket of the flight coveralls.

III. TEST DESCRIPTION

A. Scope of Tests

The tests conducted on the integrated vest assemblies consisted of: 1) user qualitative evaluation and aircraft compatibility
tests, 2) pool evaluations, 3) aircraft emergency egress drills, and 4) sea survival and rescue tests.

Evaluation of the leg pocket method of storing the mini-raft consisted of user qualitative assessment, aircraft compatibility evaluation, and swimming pool tests.

Aircraft compatibility and user evaluations were limited due to difficulty obtaining flight time with experienced aircrews. Sea tests were restricted because of helicopter non-availability and funding constraints.

Table 2 shows the extent of tests in each category.

<table>
<thead>
<tr>
<th>Tests Category</th>
<th>Extent of Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leg Pocket Stowed Mini-Raft</td>
<td></td>
</tr>
<tr>
<td>Qualitative evaluation and aircraft compatibility</td>
<td>7.0 flt hrs</td>
</tr>
<tr>
<td>Integrated Vest Assembly</td>
<td></td>
</tr>
<tr>
<td>Qualitative evaluation and aircraft compatibility</td>
<td>19.4 flt hrs</td>
</tr>
<tr>
<td>Pool Tests</td>
<td></td>
</tr>
<tr>
<td>Large long vest</td>
<td>2 subjects</td>
</tr>
<tr>
<td>Medium long vest</td>
<td>3 subjects</td>
</tr>
<tr>
<td>Aircraft Emergency Egress Tests</td>
<td></td>
</tr>
<tr>
<td>H-46</td>
<td>2 subjects</td>
</tr>
<tr>
<td>H-3</td>
<td>3 subjects</td>
</tr>
<tr>
<td>AH-1</td>
<td>2 subjects</td>
</tr>
<tr>
<td>CH-53</td>
<td>1 subject</td>
</tr>
<tr>
<td>UH-1N</td>
<td>1 subject</td>
</tr>
<tr>
<td>Sea Survival and Rescue Tests</td>
<td></td>
</tr>
<tr>
<td>Large long vest</td>
<td>2 subjects</td>
</tr>
<tr>
<td>Medium long vest</td>
<td>1 subject</td>
</tr>
</tbody>
</table>

B. Method of Tests

1. User Qualitative Evaluation and Aircraft Compatibility
The leg pocket stowed mini-raft and the integrated vest assemblies were provided to combat experienced helicopter aircrewmen and pilots for comments and evaluation during normal operations. The vest assembly was also evaluated during combat Search and Rescue (SAR) exercises. Data on the leg pocket stowed mini-raft were collected by personal interview with the crewmen. The crewmen who were evaluating the integrated assembly, however, were asked to complete an evaluation questionnaire after accumulating 5 to 10 hours of flight time. The questionnaire permitted the subjects to rate various attributes of both the new integrated vest assembly and their current equipment. The subjects' comments and recommendations were also solicited. A copy of the questionnaire is included in Appendix C. The small sample of experienced subjects precluded quantitative and statistical analysis of the data as was planned. The results of the evaluation are presented in a qualitative format.

2. Pool Tests

Both integrated vest assemblies were tested in the NAS Point Mugu swimming pool for functioning of flotation equipment, accessibility of lanyards and survival items, and hoisting capability. In addition the mini-raft was checked for ease of boarding and stability. Two of the five pool tests served as practice runs for the sea survival and rescue tests and provided the subjects with equipment familiarization.

The subjects were configured with the following equipment:

- Nomex flight coveralls.
- SPH-3 helmet.
- Flight boots.
- Integrated vest assembly.
The pool test of the leg pocket stowed mini-raft was conducted by configuring a subject in standard flight equipment and adding the mini-raft packed in the left lower leg pocket of the Nomex flight coveralls. Equipment worn includes:

- Nomex flight coveralls.
- Flight boots.
- SPH-3 helmet.
- SV-2P survival vest.
- LPA-2 life preserver.
- Leg pocket stowed mini-raft.

The subject inflated the LPA-2 life preserver, entered the pool, removed the mini-raft from the leg pocket, inflated the raft, boarded the raft, orally inflated the lower section, and attempted bailing with his helmet.

Data from the pool tests were collected by a test observer and from the subjects by personal interviews and questionnaires.

3. Aircraft Emergency Egress Tests

Aircraft emergency egress was simulated from H-3, H-46, CH-53, UH-1N, and AH-1 helicopters. Subjects donned the complete integrated vest assembly along with their other flight equipment and exited the aircraft from knock out windows as well as normal personnel and cargo exits. Debriefing was conducted by personal interview and questionnaire. Egress tests were not conducted with the leg pocket stowed mini-raft, due to time constraints and the relatively minor change in the total man/equipment external configuration.

4. Sea Survival and Rescue Tests

Sea tests were conducted with both versions of the integrated vest assembly. The complete assembly was used in each case. The first test utilized the large long vest which used hook and
pile to retain the front armor plate. The subject was configured as follows:

- Nomex flight coveralls.
- SPH-3 helmet.
- Complete integrated vest assembly.
- Survival items as shown in Figure 3.

The subject donned the integrated vest assembly and entered the Pacific Ocean from a Coast Guard boat. He deployed the flotation equipment, removed the armor plates and boarded the mini-raft. An H-46 rescue helicopter was directed to the area and the subject deployed a smoke flare to provide position and wind direction to the helicopter crew. A rescue swimmer was dropped from the helicopter and three separate hoisting operations were conducted. The first hoist was directly from the raft using the helicopter rescue hook and the snap link hoist ring on the vest assembly, Figure 10. The second hoist was from the water using the horse collar. The third hoist was a double hoist with the rescue swimmer attaching the snap link of his rescue harness to the subjects snap link and then attaching the second snap link of the rescue harness to the rescue hook, Figure 11.

The second test involved two subjects and both versions of the integrated vest assembly. The subjects entered the water from a PACMISTESTCEN aviation recovery vessel, inflated the LPA-2, inflated the mini-raft, removed armor plates and boarded the raft. The subjects attempted bailing, maneuvering, several boardings and checked the stability of the raft. The helicopter was unavailable for this test so no hoists were accomplished. Debriefing was conducted by personal interview and questionnaire.
C. Chronology

1. Two vest assemblies, eight 8 x 10 photographs, and a letter requesting a cost and schedule estimate to conduct a test and evaluation of the vest assemblies were received from NAVAIRDEVacen. Mar 1975

2. A cost and schedule estimate was completed and forwarded to NAVAIRDEVacen. May 1975

3. Two mini-rafts, to be used with the vest assembly, and associated packing instructions were received. 16 Jul 1975

4. Project Order N62269/76/PO/00511 was received. 31 Jul 1975

5. Leg pocket stowed mini-raft evaluation flights were completed. 1 Aug 1975

6. Leg pocket stowed mini-raft pool test was completed. 6 Aug 1975

7. Integrated vest assembly pool tests were completed. 26 Aug 1975

8. Integrated vest assembly sea survival and rescue tests completed. 22 Oct 1975

9. Integrated vest assembly aircraft emergency egress tests completed. 3 Dec 1975

10. Integrated vest assembly evaluation flight were completed. 4 Dec 1975
IV. RESULTS AND DISCUSSION

The following results summarize the responses received from air-crewmens who participated in the evaluation, and observations made by the test observers.

A. Integrated Vest Assembly

1. Pre-Issue Inspection

A pre-issue inspection of the integrated vest assembly revealed the following:

a. There is no provision for attaching a retention lanyard to the vacuum packed mini-raft as required by Aviation Crew Systems Manual NAVAR 13-1-6.1.

b. The vests were sized medium long and large long, however only medium regular size armor plates were provided. Armor plate size requirements are discussed in paragraph IV.A.4.

c. The armor plates intended for use in the medium long vest (zippered front attachment) were provided with a 1/4" anti-spalling pad whereas the other set was not. The anti-spalling pad traps fragmentation chips resulting from a projectile impact.

d. The location of the hoist ring was on the left shoulder whereas the usual position of a hoist ring is on the right. This left side position is also reversed from that shown in the photos which were provided with the vest assemblies.

e. No provision was made for carrying the large survival knife FSN 7340-00-098-4327, however the combination folding knife and shroud cutter, FSN 5110-00-526-8740, can be carried.

f. No provision was made for carrying a handgun within the vest.
g. Pockets are not large enough to carry the SRU-31/P kit as required for helicopter crewmen by Aviation Crew Systems Manual NAVAIR 13-1-6.7.

Table 3 provides weight comparison of the new vest assembly and current equipment.

Table 3

<table>
<thead>
<tr>
<th>Equipment Under Test</th>
<th>Weight, lbs.</th>
<th>Item</th>
<th>Weight, lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated Vest</td>
<td>5.7</td>
<td>SV-2B Vest and LPA-2</td>
<td>7.0</td>
</tr>
<tr>
<td>Medium long with heat sealed LPA-2 (without mini-raft or survival items)</td>
<td></td>
<td>(without survival items)</td>
<td></td>
</tr>
<tr>
<td>Armor Plates</td>
<td>16.7</td>
<td>Small Arms Protective Body Armor</td>
<td>23</td>
</tr>
<tr>
<td>Medium regular</td>
<td></td>
<td>Type II (from NAVAIR 13-1-6.7)</td>
<td></td>
</tr>
<tr>
<td>Mini Raft with CO₂ Cylinder and lanyard</td>
<td>3.1</td>
<td>LR-1 with CO₂ and packed for helicopter</td>
<td>9.2</td>
</tr>
</tbody>
</table>

2. Donning and Doffing

After donning and doffing several times, crewmen rated the ease of donning and doffing as Good to Very Good and comparable with the current SV-2B survival vest. Donning and doffing of armor plates was considered easier than with the current Small Arms Protective Body Armor.

Several crewmen had trouble connecting the leg strap snaps to the front securing rings because they were located under the LPA-2 life vest waist band. A modification to eliminate this problem would be to extend the rings approximately 3 inches on Type IV one inch nylon tape, Figure 12. Problems were also encountered when trying to
don the front armor plate which is secured by zippers. The zipper was sticky and the test subject sometimes required assistance from a second person.

3. General Comfort in Aircraft

Comfort was rated from Very Good to Poor. The Poor rating was received from a pilot who wore the zipped front armor plate. The front armor plate "rested on his hip bones" and "became very irritating." The zipped front plate cannot be adjusted for height and will possibly cause irritation for a significant number of pilots and copilots.

4. Fit and Sizing

The vest assembly was provided in two sizes; a medium long and a large long. The subjects who wore the vests ranged from the 2nd to the 98th percentile of Naval Aviators based on both height and weight. (Gifford et al. 1965). All subjects obtained a fit which was regarded as Good to Very Good and equal to or better than the current SV-2B. Although all subjects obtained an adequate fit from either sized vest, it was determined that subjects who fell above the 80th percentile by height, obtained a better fit from the large long vest assembly. The side adjustment straps provide a very good fit on a wide range of subjects.

Only medium regular sized armor plates were provided with the vest assemblies and it was determined that the single size was not adequate to properly fit all crewmen. Large subjects had substantial vital areas which were not protected. The plates were not long enough and left either the lower abdomen or the upper lung area exposed. Figure 2 shows the position of the back armor plate on a 5'10"
crewman. Comparison with the diagrams in Figure 13 reveals that considerable areas of the upper lungs are exposed as well as the major vessels from the heart. Several sizes of armor plates will be required to adequately protect the majority of crewmen. A better method of positioning the back plate could also be helpful. Hook and pile tapes attached to the armor plate casing as shown in Figures 14 and 15 would be a possible solution. The front armor plate which is attached by hook and pile tape provides adequate adjustment but is too short to cover the lower abdomen, Figure 1. The zipper attached front plate rides too low and does not protect the upper lung area, Figure 9.

5. Ease of Movement

The ease of movement was rated as Good to Very Good and comparable with the SV-2B. The following comment is quoted from a crewman who wore the vest during a combat SAR exercise at Naval Auxiliary Air Station, Fallon, Nevada:

"I performed all duties including going down the hoist with M-16, moving about on the ground, firing the weapon and assisting an injured survivor to the hoist and climbing back in the aircraft. During a GAU 2B/A mini-gun firing flight, I worked on and fired the weapon with no problems encountered."

Crewmen did note a problem when trying to run while wearing the vest assembly. The back armor plate is somewhat loose and bounces around. Crewmen need to run when manning the helicopters, assisting an injured survivor to the helicopter, or when their own helicopter is forced down under fire. The hook and pile tape tabs that
were added to the back armor plate casing to allow positioning of the plate, Figure 14, also helped reduce movement and bouncing of the plate while running.

6. Compatibility with Crew Station

Compatibility with crew stations was rated as Good to Very Good by both pilots and crewmen. No problems were noted and crewmen considered the vest assembly to be equal to their current equipment on this point. Pilots preferred the new vest because of the reduced bulk along the sides which provides for better comfort in the seats. Pilots and copilots of H-3, H-46, CH-53 and AH-1 helicopters checked functional reach to all extreme control positions and no restrictions or problems were encountered. Crewmen operating hoists and GAU2B/A mini-guns performed their duties without problems.

7. Overall Performance During Flights

No problems were encountered during short duration flights (1 to 2 hours). During long flights the vest assembly with armor plates installed became somewhat heavy, however, crewmen noticed and appreciated the weight reduction over the present Small Arms Protective Body Armor.

8. Emergency Aircraft Egress

Emergency egress was simulated from H-3, H-46, CH-53, AH-1 and UH-1N helicopters. No specific problems were encountered and crewmen considered the ease of exit as comparable with current equipment. All exits were of sufficient size to permit egress without entanglement. Egress from the AH-1 "COBRA" caused the most difficulty, however, entering and exiting the AH-1 is difficult even with no equipment on. The integrated vest assembly was not considered more
9. Hoisting Capability

The hoisting capability of the vest was rated as Very Good. However, two changes are recommended before the vest would be suitable for Fleet use. The webbing strap which secures the hoisting snap link ring to the vest is sewn into the Nomex material of the vest, but not to the reinforced waist band on the vest, Figure 16. As the vest material ages it may not provide the required strength for jerking a crewman out of the water. Several material failures, not related to hoisting, indicate the material may lack the required strength. No tests were performed to determine the strength of this configuration, but several subjects objected to its fragile appearance. It is recommended that the hoisting webbing be extended over and sewn into the reinforced waist band. The second change concerns reversing the hoisting rings so the opening gate is on the inside. Several crewmen felt that with the opening gate on the inside attaching to the hoist would be easier and a more natural movement.

10. Inflation Lanyard Accessibility

Accessibility of the LPA-2 and mini-raft lanyards was rated Very Good. The toggles can be reached with either hand and no problems were encountered locating them either in the pool or during open sea tests.

11. Survival Item Accessibility

Survival item accessibility was rated Good and slightly better than with the current SV-2B. The forward location of the pockets and the lack of zippers were the main improvements over the SV-2B. Several crewmen recommended hook and pile tape closures for the pockets.
vice snaps. The snaps become corroded and damaged and become difficult to open and close.

12. Functioning of LPA-2

The LPA-2 functioned correctly as integrated with the vest assembly. The LPA-2 provided adequate buoyancy for use with the armor plates.

13. Functioning of the Mini-raft

The mini-raft functioned correctly and deployed from the back pack of the vest as intended. No significant differences were noted during deployment between the vacuum packed and the soft packed versions. After boarding the raft, the subjects orally inflated the lower air tubes. The inflation tube was determined to be too short for easy access and some subjects experienced considerable difficulty getting to it, Figure 17. Extending the lower oral inflation tube 6 to 8 inches would eliminate this problem.

14. Ease of Boarding the Mini-Raft

Ease of boarding was rated as Very Good by all subjects and much easier than the LR-1 one-man raft.

Several methods of boarding the raft were tried in the pool. The easiest and most successful method was to push down one side of the raft and roll in as shown in Figure 18. The second best method was to push the narrow end of the raft under water and back into the raft while pulling it under the body as shown in Figure 19.

15. Stability of the Mini-Raft

Stability of the mini-raft was rated Very Good and in comparison, better than the LR-1. Due to the design of the raft the survivors center of gravity is below the water, thus making him very
The raft is difficult to bail dry, and due to the small amount of freeboard it takes on water in a sea state. The head end of the raft (end with CO₂ cylinder) has less freeboard than the rest of the raft and most water ships in at that location, Figure 20. The water within the raft increased the raft stability but would reduce the aircrewmans survival time because of increased heat loss.

Stability under rotor wash was good and hoisting of the survivor directly from the raft was demonstrated. Standard procedures require the survivor to swim away from the LR-1 raft or puncture and sink it prior to the helicopter pulling into a hover. This procedure is required to prevent the raft from being lifted up into the rotor blades. The mini-raft's low profile and the retained water, however, prevented the raft from lifting from the sea surface. Further tests involving hovers above the empty raft would be required before direct hoisting from the raft could be recommended for Fleet users.

16. Ease of Jettisoning Armor Plates

Ease of jettisoning armor plates was rated Very Good for normal water situations. The back plate usually fell away completely when the mini-raft was deployed, however, on two of eight tests the back plate did not fall away completely, Figure 21. The failure to release was not considered a major problem because the LPA-2 life preserver provides adequate flotation and both subjects were able to reach the plate and remove it with no difficulty. In addition, deployment of the raft was not impaired. Release of the back plate would be critical, however, if the LPA-2 life preserver was damaged or malfunctioned. All subjects preferred the front plate which was secured with hook and pile
tape vice zippers. The zippers were more difficult to release and may stick if damaged by projectiles or corrosion.

17. Reliability

The major reliability problem with the vest assembly was material failure at the upper corner of the seam which attaches the front armor plate cover to the vest material. The arrow in Figure 22 indicates the problem area. The material is not reinforced in this area and the weight of the front plate causes tears in the material. Figure 23 shows a major tear which occurred when a subject donned the vest and, with the armor plate attached to one side, jumped up and down to "settle it." Small tears and indications of strain have appeared on both vest assemblies at this location. Sufficient reinforcing should be incorporated in this area.

The leg strap adjusting hardware did not adequately secure the leg straps at their adjusted position. The leg straps worked loose during the crewmen's normal performance of duties within the helicopter as well as when he was in the water. Crewmen would have to adjust the straps just prior to being hoisted as the straps would work loose almost immediately. Loose leg straps caused considerable discomfort under the armpits during hoisting. More reliable adjusting hardware is required for the leg straps.

A possible reliability problem is the zipper attachment of the front armor plate which was used on the medium long vest assembly. The hook and pile tape attachment should be used to eliminate the possibility of a stuck zipper.

18. Maintainability

The vest assemblies were shown to four experienced
enlisted Aviation Survival Equipment Men (Navy enlisted rate - PR) to obtain comments concerning maintainability of the unit. No major problems were noted, however, two recommendations were received. To reduce labor and turnaround time during periodic inspections the vacuum packed raft is preferable to the soft packed version. Second, hook and pile closures for pockets are preferable to snaps because the snaps tend to tear out of the Nomex material and are difficult to repair.

B. Leg Stowed Mini-Raft

The vacuum packed mini-raft, which is intended to be carried in the leg pocket of the flight suit, Figure 24, was carried by two different crewmen and a pilot during normal flight operations.

A pre-issue inspection revealed there was no provision for attaching a retention lanyard. The addition of a retention lanyard is a requirement for Fleet use. For the purposes of the evaluation a lanyard was attached to the casing to provide the additional bulk, Figure 25. This method is unsuitable for Fleet use, as the lanyard must be attached securely to the raft and preferably around the CO₂ valve assembly.

Crewmen considered the raft too heavy and bulky to carry in the flight suit leg pocket. It became an annoyance to them while performing their duties. The raft was difficult to insert and remove, and the inflation handle seemed overly exposed and could be accidently inflated when removing the raft. Crewmen recommended that the inflation handle be protected with a fabric cover similar to the one provided by the temporary ordnance tape fix shown in Figure 25. The pilot also disliked the unbalanced feel on the rudder pedals caused by the raft.

All aircrewmen who used or saw the raft thought the small raft
pack was a good idea, but they considered it unsuitable for carrying in the flight suit. They indicated a preference to have the raft incorporated into their survival vest. Current vests are not configured for stowing the mini-raft.

Pool tests indicate the raft can be deployed from the leg pocket and inflated. Approximately 1 minute was required for the subject to deploy the raft. The raft functioned correctly, was easy to board and was very stable. Comments concerning "in water" evaluation of the mini-raft from Paragraphs IV.A-13, IV.A.14 and IV.A.15 also apply here.

V. CONCLUSION

A. It is concluded from the evaluation results that the Integrated Body Armor/Flotation/Survival System offers improved configuration concepts for helicopter crewmen over the current SV-2B/Small Arms Protective Body Armor/LR-1 Raft. However, numerous modifications are required before the equipment will be suitable for Fleet use. (Paragraphs IV.A.1 through IV.A.18)

B. The vest configuration which secures the front armor plate by hook and pile tape is preferable to the configuration which uses zippers. (Paragraphs IV.A.2, IV.A.4, IV.A.17)

C. Armor plates will be required in a range of sizes to adequately fit the size range of users. (Paragraph IV.A.4)

D. The vacuum packed version of the mini-raft, for use in the vest assembly, is preferable to the soft packed version of the raft. (Paragraph IV.A.18)

E. The leg pocket stowage location for the vacuum packed mini-raft is not suitable for Fleet users. (Paragraph IV.B)
VI. RECOMMENDATIONS

A. It is recommended that the Integrated Body Armor/Flotation/Survival System be modified as follows:

1. Vest Modifications
   a. Reinforce the vest material at the seam between the front armor plate securing flap and the vest to prevent material failures due to the weight of the armor plates. (Paragraph IV.A.17)
   b. Secure the hoisting strap into the base webbing of the vest to eliminate the possibility of separation if the vest material should fail. (Paragraph IV.A.9)
   c. Reverse the hoisting ring so that the opening gate is on the inside. (Paragraph IV.A.9)
   d. Extend the leg strap securing D rings approximately 3 inches to facilitate donning and doffing. (Paragraph IV.A.2)
   e. Replace the existing leg strap adjusting hardware with hardware which does not become loosened during normal use. (Paragraph IV.A.17)
   f. Replace the survival pocket snaps with hook and pile tape to facilitate opening and increase maintainability. (Paragraphs IV.A.11 and IV.A.18)

2. Mini-Raft Modifications
   a. A method of securing a seven foot raft retention lanyard through the casing and to the raft is required on the vacuum packed rafts. (Paragraph IV.A.1)
   b. The oral inflation tube for the lower air tubes should be lengthened approximately 6 to 8 inches. (Paragraph IV.A.13)
   c. Redesign the air bladders to provide greater buoyancy
at the CO₂ cylinder end of the raft. (Paragraph IV.A.15)

3. Armor Modification

A method of securing the back armor plate should be provided which allows vertical positioning and prevents excessive movement during physical activity. Hook and pile tape strips can be added to the edge of the armor plate casing and used for positioning and securing the plate. (Paragraphs IV.A.4 and IV.A.5)

B. The hook and pile tape method of securing the front armor plate should be used instead of zippers. (Paragraphs IV.A.2, IV.A.4 and IV.A.17)

C. Several sizes of armor plates should be provided to correctly fit the size range of users. (Paragraph IV.A.4)

D. The vacuum packed mini-raft of Figure 4, vice the soft pack mini-raft should be used in the vest assembly. (Paragraph IV.A.16)

E. Following implementation of the above modifications and recommendations, it is recommended that the integrated vest assembly be re-evaluated for Fleet use.
Figure 1

Integrated Body Armor/Flotation/Survival System
Figure 2
Integrated Body Armor/Flotation/Survival System
Figure 3

Survival Items Which Were Installed in The Vest Assembly During Evaluation
Figure 4

Vacuum Packed Mini-Raft Configured for the Vest Assembly
Figure 5
Vacuum Packed Mini-Raft Configured for the Leg Pocket of the Flight Coveralls
Figure 6
Inflated Mini-Raft
Figure 7
Mini-Raft Stowed in the Back Pack of the Vest Assembly
Figure 8

Mini-Raft Deploying from Back Pack of the Vest Assembly
Figure 9

Front Armor Plate Secured to the Vest Assembly with Zippers
Figure 10

Subject is Hoisted From the Mini-Raft via the Snap Link Hoist Ring Attached to the Vest
Figure 11

Hoisting of the Subject and the Rescue Swimmer via the Rescue Swimmer Harness and the Hoisting Ring of the Integrated Vest Assembly
Figure 12

Proposed Modifications of Leg Strap Securing Ring to Facilitate Donning and Doffing
Figure 13
Position of Lungs and Arteries
Figure 14

Hook and Pile Tape Strips Added to the Armor Plate Casing to Aid Positioning
Figure 15
Armor Plate Held in Position by Added Hook and Pile Tape Strips
Figure 16

Hoist Strap Sewn to the Vest Material but not to the Reinforced Waist Band
Figure 17

Subject Attempting to Reach Oral Inflation Tube to Inflate the Lower Air Tubes
Figure 18

Subject Boarding the Mini-Raft by Rolling Over the Side
Figure 19

Subject Boarding the Mini-Raft by Backing into it
Figure 20

The Small Amount of Freeboard at the Subjects Back Allows Water to Ship in
Figure 21
Back Armor Plate which did not Jettison Completely Following Raft Inflation
Figure 22
Area of Material Failure
Figure 23

Major Material Failure
Figure 24

Vacuum Packed Mini-Raft Installed in the Leg Pocket of the Flight Coverals
Figure 25

Leg pack Mini-Raft as Modified for Evaluation with the Addition of Retention Lanyard and a Protective Cover Over the Inflation Handle
CHAPTER 3

FINAL REPORT OF THE COMPARISON TEST OF THE LRU-8/P ALL WEATHER ONE MAN RAFT
LRU-8/P ONE MAN ALL-WEATHER
LIFE RAFT
TEST REPORT (U)

by
B. C. George

SUMMARY

The Naval Air Development Center (NAVAIRDEVCEN) developed a heat sealed version of the LRU-8/P one-man all-weather life raft for both the fighter and attack aircrewnen. The LRU-8/P is a one man raft consisting of an inflation assembly, a single compartment flotation tube, an inflatable floor and weathershield. The flotation tube is inflated by activation of the CO₂ cylinder valve. The floor and weathershield are inflated orally.

Three heat sealed LRU-8/P rafts, manufactured by Switlik, were compared with three cemented seam LRU-8/P rafts, manufactured by Patten, Inc., during (1) packing tests in various Rigid Seat Survival Kits (RSSK) and soft kits, (2) mid-air and surface deployments from a cross section of seat kits and (3) an accelerated life cycle test. It was concluded that both versions of the LRU-8/P can be packed and deployed from a variety of seat kits and no major differences were noted during the life cycle tests. The heat sealed raft was easier to pack into the seat kits than the cemented-seam raft. Several changes are recommended for the heat sealed raft before possible Fleet use.
I. INTRODUCTION

A. Background

The Naval Air Development Center (NAVAIRDEVSEN) developed a heat-sealed version of the LRU-8/P one-man all-weather life raft for both the fighter and attack aircrewmen. Pacific Missile Test Center (PACMISTESTCEN) was tasked under Project Order N62269/76/P0/00533, dated 2 September 1975, to conduct a test program to compare three heat sealed LRU-8/P life rafts, manufactured by Switlik, Inc., with three cemented seam LRU-8/P life rafts, manufactured by Patten, Inc. The Patten version of the LRU-8/P is currently authorized for use in the AV-8A aircraft utilizing the Martin Baker ejection seat.

B. Purpose of Tests

The purpose of the tests was to:

- Compare the two versions for packing in various Rigid Seat Survival Kits (RRSK's) and soft kits.
- Compare the two versions for inflation characteristics during both mid-air and surface deployments.
- Qualitatively compare the two versions for ease of boarding and ease of inflating weathershield and deck, and for stability and comfort.
- Compare the two versions during a simulated life cycle test which did not include aging.

II. SYSTEM DESCRIPTION

The LRU-8/P life raft consists of an inflation assembly (carbon dioxide cylinder and inflation valve), and a one-man life raft. The life raft consists of a single compartment flotation tube, an inflatable floor and an inflatable weathershield. The raft flotation tube is
inflated either manually by pulling the inflation assembly activating lanyard or automatically from RSSK's by gravity drop on kit activation. In addition the flotation tube is provided with a supplemental oral inflation valve. The raft floor and weathershield are orally inflated by separate inflation valves.

Two versions of the raft were provided for comparision testing. One version, manufactured by Patten, Inc., uses cemented seams and is black in color. The second version, designed by NAVAIRDEVCEN and manufactured by Switlik, Inc., is constructed with heat sealed seams, is bright yellow, and is approximately 6 inches longer than the Patten raft. Other small differences exist in size, shape, and configuration. Figures 1 and 2 show respectively the Patten and Switlik versions of the LRU-8/P.

III. TEST DESCRIPTION

A. Scope

The tests consisted of four parts:

1. Pre-issue inspection and functional testing of both versions in accordance with the Aviation-Crew Systems Manual (Reference 1).

2. Packing both versions in various RSSK's and soft kits.

3. Mid-air and surface inflation tests from various RSSK's and soft kits.

4. An accelerated life cycle test on both versions.

Table 1 shows the test conditions and the number of tests as planned and as subsequently conducted.

B. Method

1. Pre-issue Inspection and Functional Tests
<table>
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<tr>
<th>TEST</th>
<th>SEAT KIT</th>
<th>NUMBER OF TESTS PLANNED</th>
<th>NUMBER OF TEST CONDUCTED</th>
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**TABLE 1**

**TEST CONDITIONS**
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<td>APH-6 helmet</td>
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Three heat sealed LRU-8/P and three cemented seam LRU-8/P rafts were delivered to PACMISTESTCEN, Aviators Equipment Division of the Intermediate Maintenance Activity (IMA) for a pre-issue inspection and functional test in accordance with Reference 8. Test specifications, i.e., pressures and duration of tests, were provided by NAVAIRDEVcen.

2. Packing Tests

Packing tests were conducted by IMA and included three packings of each version of the raft in RSSK-8A, RSSK-1A, High Speed Soft Pack (HSSP) and Standard Soft Pack (SSP). Four packings of each version of the raft were conducted into the RSSK-7. The additional packing sequence was performed because of initial difficulties encountered with the RSSK-7. All seat kits were configured and the rafts packed in accordance with the Aviation-Crew Systems Manuals (References 8, 9 and 10). A summary of seat kit applications from Reference 8, is contained in Appendix 3.

3. Inflation Tests

Mid-air and surface deployments and inflations from seat kits were conducted during live subject parachute jumps at the Salton Sea test range of the National Parachute Test Range (NPTR), El Centro, CA. Data was gathered by a test observer from PACMISTESTCEN, and from jumper test reports. Photographic coverage consisted of 16 mm motion pictures and 35 mm slides. A copy of the NPTR Live Subject Test Report Form is included in Appendix D. Subject configuration for the jumps is provided in Table 1. Figure 3 shows a jumper configured with a RSSK kit, and Figure 4 shows a jumper configured with a HSSP.
4. Life Cycle Tests

One each heat sealed and cemented LRU-8/P rafts were provided to PACMISTESTCEN IMA for an accelerated life cycle test, which did not include aging. A life span is not specified for inflatable equipment, however discussions with Aviation Survival Equipmentmen (Navy enlisted rate - PR) indicated that seven years was a reasonable life span. Reference 8 requires inspection upon issue and every 30 weeks thereafter with a functional test performed on issue and every fourth inspection cycle thereafter. Over seven years this requirement results in 12 packings and inspections and three functional tests in addition to the pre-issue inspection and functional test. These requirements were followed for the life cycle tests conducted on the LRU-8/P rafts.

C. Chronology

1. Received NAVAIRDEVcen letter requesting PACMISTESTCEN to conduct an evaluation to compare three heat sealed LRU-8/P rafts with three cemented seam LRU-8/P rafts. 17 Apr 1975

2. Two Test Plans and associated cost and schedule estimates were completed and forwarded to NAVAIRDEVcen. 16 Jul 1975

3. Project Order N62269/76/PO/00533 for support of Test Plan II was received. 11 Sep 1975

4. Parachute jump tests completed. 14 Jan 1976

5. Seat kit packing tests completed. 10 Feb 1976

6. Life cycle tests completed. 24 Mar 1976
IV. RESULTS AND DISCUSSION

A. Pre- issue Inspection and Functional Tests

Inspection of the rafts revealed the following:

1. The valve assemblies on the deck and weathershield oral inflation tubes of the Switlik rafts are not the standard depress-to-inflate valves normally found on Navy inflatables. The valve has a small knurled nut which must be screwed open or closed. Figure 5 shows the standard valve on the left and the non-standard Switlik raft valve on the right.

This type of valve requires that the inflation tube be pinched closed to prevent air escape between inflation breaths or while closing the valve. Further, the non-standard valve may confuse a downed crewman who is familiar with the standard depress-to-inflate type of valve. No advantages were apparent with this valve and any possible cost savings seem greatly out weighed by the disadvantages to the user. It is recommended that the valves be replaced with the standard depress-to-inflate valves.

2. The Patten raft is provided with a securing line attached inside the raft at the stern, and a line stowage pocket located on the main flotation tube at the stern. Conversely the Switlik raft is not provided with either securing line or stowage pocket. A securing line is required for use with the soft pack, high speed soft pack and special configurations. Securing lines were added for deployment tests from the HSSP's.

3. The Patten rafts were configured with sea anchor pockets whereas the Switlik rafts were not. A sea anchor pocket is required and was added to one Switlik raft (Serial #03) in accordance with Reference
8. The remaining two Switlik rafts were unmodified.

4. Neither the Patten or the Switlik rafts were provided with a retaining line pocket for use with RSK's. The securing line, referred to in Paragraph IV.A.2 above, performs the same function as the retaining line, but they are used in different packing configurations, Reference 8, page 4-4.

5. The Patten rafts were configured with the Inspection Record Patch and the Directive Compliance Patch. The Switlik rafts did not contain these items and were added by IMA personnel. The inspection and directive patches should be installed by the manufacturer to reduce maintenance personnel labor.

B. Packing Tests

Both versions of the raft were packed into the seat kits, listed in Table 1, in accordance with the applicable manuals. It was determined that both the Patten and the Switlik rafts could be successfully packed into the seat kits, however some difficulties were encountered. The Patten rafts were difficult to pack in all the seat kits and normally required two people. Packing the Patten rafts into the RSK-1A and RSK-7 was especially difficult and required a great deal of effort to close the kits. Complete deflation and careful folding was required to successfully pack the rafts. The Switlik version was less bulky and was easier to pack than the Patten version, however, it sometimes required two people to close the kits when packing into the RSK-1A or RSK-7.

Problems were also encountered with both rafts when trying to completely deflate the decks and weathershields. The problem became evident when the rafts were folded and rolled prior to installation into
seat kits. Complete deflation is a requirement: (1) to allow the raft to fit in the kits, and (2) because the raft may be exposed to high ambient altitudes and trapped air would be subjected to as much as six times expansion. Several attempts at deflation according to standard procedures, i.e., use of a vacuum source, did not result in much improvement. The material in the vicinity of the oral inflator clings together during deflation and this action does not allow the weather-shield or deck area farthest from the valve to be completely deflated. An adequate solution to this problem was to deflate the canopy and/or deck by the standard method and then roll the raft as tightly as possible toward the oral inflation tube while maintaining the vacuum. In the case of the Switlik rafts, the vacuum must be maintained while the inflation tube is pinched off prior to closing the valve. This is required because of the non-standard valve (Paragraph IV.A.1) provided on the deck and weathershield oral inflation tubes of the Switlik rafts. After deflating in accordance with the above procedure, tightly rolled LRU-8/P (Switlik) and LR-1 rafts were placed in a low pressure chamber and taken to 50,000 feet pressure altitude. Expansion was evident in both rafts but was not considered significant.

C. Deployment

The live jumper tests generally demonstrated that both versions of the LRU-8/P could be deployed and correctly inflated from an assortment of RSSK's and from a HSSP both in mid-air and after water entry. The rafts did not cause abnormal mid-air oscillations of the jumper and water entries were normal.

Numerous problems, not associated with the rafts themselves, resulted in no test or partial test situations as summarized in Table
2. On four occasions the rafts only partially inflated; twice due to leaks between the carbon dioxide bottle valve and the raft and twice apparently due to undercharged bottles. The rafts were subsequently orally topped off after water entry. Two failures to actuate the valve following mid-air deployment were encountered. One failure was due to entanglement of the actuation line such that insufficient force was applied to actuate the valve. The cause of the second failure was undetermined. In both cases, however, the rafts were inflated after water entry by manual activation. Mid-air deployment of the Patten raft from the HSSP was not accomplished because the subject was unable to release one side of the kit and swing it for subsequent deployment. This was not caused by the particular raft but was due to subject inexperience.

The first two attempts at mid-air deployment of the RSSK-7 resulted in failure of the kit to open. Due to the difficulties encountered when packing the rafts in the RSSK-7's these failures were initially of some concern. The first kit was recovered from the water still intact and the seal unbroken. The subject had tried to deploy the kit with both the right and left hand handles. Both handles were extracted from their retained positions as can be seen in Figure 6. After inspection of the kit, a test observer squeezed the right handle and deployed the kit without undue effort. The subject could not account for his difficulty and it was concluded that the subject had pulled on the release handles without squeezing the release properly. The second RSSK-7 which failed to deploy opened on impact with the water and the cause of the failure to deploy was undetermined. Both kits were repacked and deployed numerous times in the equipment shop and no
<table>
<thead>
<tr>
<th>SEAT KIT/RAFT</th>
<th>RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mid-Air Deployments</strong></td>
<td></td>
</tr>
<tr>
<td>RSSK-7/Switlik</td>
<td>No mid-air deployment - kit opened on boat - conclude operator error.</td>
</tr>
<tr>
<td>RSSK-7/Patten</td>
<td>No mid-air deployment - kit opened on impact with water - cause unknown.</td>
</tr>
<tr>
<td>RSSK-7/Switlik</td>
<td>Kit deployed - raft did not inflate due to inflation lanyard entanglement.</td>
</tr>
<tr>
<td>RSSK-7/Patten</td>
<td>Kit deployed - partial inflation of raft - possible partially filled cylinder.</td>
</tr>
<tr>
<td>RSSK-7/Switlik</td>
<td>Kit deployed - partial inflation of raft - possible partially filled cylinder.</td>
</tr>
<tr>
<td>RSSK-8A/Switlik</td>
<td>Kit deployed - no inflation - inflated manually in water - partially inflated due to a leak at the valve - defective valve.</td>
</tr>
<tr>
<td>RSSK-8A/Patten</td>
<td>Kit deployed - raft inflated.</td>
</tr>
<tr>
<td>RSSK-1A/Switlik</td>
<td>Kit deployed - raft inflated.</td>
</tr>
<tr>
<td>RSSK-1A/Patten</td>
<td>Kit deployed - raft inflated.</td>
</tr>
<tr>
<td>HSSP/Switlik</td>
<td>Kit deployed - raft inflated.</td>
</tr>
<tr>
<td>HSSP/Patten</td>
<td>No test - subject unable to release rocket jet bitting and swing kit for subsequent deployment of raft.</td>
</tr>
<tr>
<td><strong>Surface Deployments</strong></td>
<td></td>
</tr>
<tr>
<td>RSSK-8A/Patten</td>
<td>Kit deployed - raft inflated.</td>
</tr>
<tr>
<td>RSSK-8A/Switlik</td>
<td>Kit deployed - raft inflated.</td>
</tr>
<tr>
<td>RSSK-1A/Switlik</td>
<td>Kit deployed - partial raft inflation - leak between raft and valve.</td>
</tr>
<tr>
<td>RSSK-1A/Patten</td>
<td>Kit deployed - raft inflated.</td>
</tr>
<tr>
<td>HSSP/Patten</td>
<td>Kit deployed - raft inflated.</td>
</tr>
<tr>
<td>HSSP/Switlik</td>
<td>Kit deployed - raft inflated.</td>
</tr>
</tbody>
</table>
problems were encountered. Both RSSK-7's had had considerable use and that may have also accounted for some of the problems encountered. Because of the initial problems, the jump tests of the RSSK-7 were repeated. During the second series of RSSK-7 jumps the kits deployed satisfactorily, however, problems of partial inflations were encountered as explained earlier.

D. Water Evaluations

1. Raft Boarding

Subjects rated the ease of boarding the LRU-8/P as normal and the same as the LR-1. No differences were noted between the Patten version and the Switlik version. The rafts were also boarded with the weathershields and decks inflated and no problems were encountered. Three subjects felt that additional boarding handles at the box end of the rafts would assist them when boarding. They indicated that they ran out of handles before getting completely into the raft. It was also determined that the rafts are almost impossible to board if the flotation tube is not fully inflated.

2. Weathershield and Deck Inflation

Inflation of the weathershield and deck was considered normal by all subjects. Two subjects experienced delays in locating the oral inflation tube for the weathershield on the Patten rafts. This was probably due to poor initial familiarization with the raft and/or because the black oral inflation tube blends with the black raft material. The Patten raft also required more time and greater effort by the subjects to get the hood portion of the weathershield up over the back of the collar lobe of the LPA-2 and over their heads. Both the delay in locating the inflation tube and the problem of getting the hood
up may be alleviated by suitable indoctrination and are not considered
major detriments.

3. Stability

The stability of both the Switlik and Patten rafts were
rated as normal in comparison with the LR-1. During the water tests
the sea state was very calm and no observations were made under sea
states that would normally be encountered in open ocean conditions.

4. Comfort

All subjects considered both versions of the raft very
comfortable. Subjects remained in the rafts following parachute de-
scents for varying periods of time ranging to 1.5 hours and were im­
pressed with the warmth and insulation provided by the inflatable deck
and weathershield. The wind was calm and the water temperature was
approximately 60°F. The Switlik raft, because of its extra length, was
more comfortable for the larger subjects, however even the largest
subject (74 inches - 200 pounds) considered the size of the Patten as
adequate.

E. Life Cycle Tests

One each Switlik and Patten rafts were packed, inspected and
functionally tested to simulate a seven year life span and no signifi­
cant differences were noted between the two versions with one exception.
The glued on pockets, weathershield securing straps and reinforcing
patches on the Switlik raft began pulling loose. It was determined
that all glued on fabric was easy to pull off. Figure 7 shows the
problem areas. Several items were reglued but pulled off as easily as
the originals. The glue does not adhere well to the slick side of the
fabric used on the heat sealed rafts. A piece of fabric from a pocket
which pulled loose was reglued with the rough side down and found to hold very well. The life cycle test did not include aging and therefore limits the conclusions which may be drawn regarding durability.

V. CONCLUSIONS

A. The Patten raft is suitable for Fleet use, however, it is extremely difficult to pack into most seat kits, also the addition of a retaining line pocket is required for use with RSSK's. (Paragraphs IV.A to IV.E)

B. The Switlik raft is suitable for Fleet use except for the following problems:

1. Non-standard oral inflation valves on the deck and weathershield. (Paragraph IV.A)

2. Glued on items were not adequately cemented. (Paragraph IV.E)

3. The rafts were not provided with sea anchor pockets, retaining line pockets and Directive Compliance and Inspection Record patches. (Paragraph IV.A)

C. Both the cemented and heat sealed rafts can be packed in a cross section of Navy seat kits (Paragraph IV.B)

D. Both versions can be deployed from a cross section of Navy seat kits. (Paragraph IV.C)

E. The heat-sealed, Switlik raft is considerably easier to pack into the seat kits because of less bulk. (Paragraph IV.B)

F. No significant differences were noted between the heat sealed and the cemented rafts with respect to boarding, weathershield and deck inflations, stability, and comfort. (Paragraph IV.D)
VI. RECOMMENDATIONS

The following change is recommended for the Patten raft:

A. Add a retaining line pocket for use with the RSSK's. (Paragraph IV.A)

The following changes are recommended for the Switlik rafts:

A. Replace the non-standard oral inflation valves with the standard depress-to-inflate valves. (Paragraph IV.A.1)

B. Attach pockets and other glued on items by a different method or use a fabric for the add on items that will adhere to the glue better. (Paragraph IV.E)

C. The rafts should be provided with sea anchor pockets, retaining line pockets, and Directive Compliance and Inspection Record patches in accordance with Reference (8). (Paragraphs IV.A.3, IV.A.4 and IV.A.5)
Figure 1
Cemented Seam LRU-8/P Manufactured by Patten, Inc.
Figure 2

Heat Sealed LRU-8/P Manufactured by Switlik, Inc.
Figure 3

Test Parachutist Configured for a Jump using a RSSK
Figure 4

Test Parachutist Configured for a Jump using a HSSP
Figure 5

Standard Oral Inflation Valve (left) and Non-standard Valve Provided on the Switlik Raft Weathershield and Deck (right)
Figure 6

RSSK-7 which Subject was Unable to Deploy
Figure 7

Switlik Raft Glued on Items which were not Adequately Attached
REFERENCES


APPENDIXES
APPENDIX A


APPENDIX B

The purpose of this evaluation is to collect Fleet data on the functional effectiveness of the HGU-27/P helmet, and to assess the degree to which its design objectives have been attained.

Design Objectives - The objectives in the design of the HGU-27/P helmet were to provide a lighter, cooler, better fitting protective helmet that provides optimum sound attenuation capability and; a simplified lightweight visor system permitting a high degree of unrestricted visibility in all directions within the limits of personal size differences.

Design Features - The HGU-27/P helmet is modular in construction so that each feature is independent and can be easily replaced by improved designs without replacing the total system. The cloth liner suspension system comes in sizes 6-3/4, 7, 7-1/4 and 7-1/2; proper size selection should provide a close and comfortable head fit. One size hard shell will integrate with all liner suspension sizes, and when properly removed for laundering or periodic replacement, will not disturb the communications system.

The cloth liner incorporates spacer fabrics in the sweat band to enable full air circulation. The cloth liner material was selected on the basis of its ability to absorb and evaporate perspiration.

Sound attenuation is effected by large volume car dome seals and spring suspensions. The car dome seals can normally be worn loose or may be adjusted to provide attenuation when required.
INSTRUCTIONS

Each aircrewman is requested to complete this questionnaire in its entirety after the HGU-27/P helmet has been worn during actual missions. Clear and specific comments in the space provided after each question are invited.

1. Name _____________________________ 2. Rank ________

3. Type of A/C flown during evaluation. ______________________

4. Total number of hours HGU-27/P helmet worn. ________________

5. Type of helmet presently worn. ______________________________

6. Hat Size _______ 7. Height _______ 8. Weight ______

9A. How was the weight of the HGU-27/P when worn during flight?

   Very Heavy   Heavy   Moderate   Light   Very Light
   [ ] [ ] [ ] [ ] [ ]

B. How did the weight of the HGU-27/P feel compared to your present helmet?

   Much Heavier   Slightly Heavier   Same   Lighter   Much Lighter
   [ ] [ ] [ ] [ ] [ ]

C. Amplifying Remarks:

   ____________________________________________________________

   ____________________________________________________________

10A. How effective was the cooling of the HGU-27/P helmet?

   Very Cool   Cool   Moderate   Hot   Very Hot
   [ ] [ ] [ ] [ ] [ ]

B. How effective was the cooling of the HGU-27/P helmet in comparison to your present helmet?

   Much Cooler   Slightly Cooler   Same   Hotter   Much Hotter
   [ ] [ ] [ ] [ ] [ ]
C. Amplifying Remarks: (please specify the temperature and humidity environment which prevailed during evaluation)

11A. How comfortable was the fit of the HGU-27/P helmet after you adjusted it to yourself?

<table>
<thead>
<tr>
<th>Very Comfortable</th>
<th>Fairly Comfortable</th>
<th>Adequately Comfortable</th>
<th>Uncomfortable</th>
<th>Very Uncomfortable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B. How comfortable was the HGU-27/P helmet in comparison to your present helmet?

<table>
<thead>
<tr>
<th>Much More Comfortable</th>
<th>More Comfortable</th>
<th>Same Comfortable</th>
<th>Less Comfortable</th>
<th>Much Less Comfortable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C. Amplifying Remarks: (please include hat size selected)

12A. How effective was the sound attenuation of the HGU-27/P after the spring suspension of the ear dome seals were adjusted to the desired level?

<table>
<thead>
<tr>
<th>Very Effective</th>
<th>Fairly Effective</th>
<th>Adequate</th>
<th>Ineffective</th>
<th>Very Ineffective</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B. How effective was the sound attenuation of the HGU-27/P in comparison to your present helmet?

<table>
<thead>
<tr>
<th>Much More Effective</th>
<th>More Effective</th>
<th>Same Effective</th>
<th>Less Effective</th>
<th>Much Less Effective</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
C. Amplifying Remarks: (please include approximate noise level in dB prevailing at time of evaluation)

13A. How was the visibility of the HGU-27/P visor design?

Excellent  Very Good  Good  Poor  Very Poor

Much Better  Better  Same  Worse  Much Worse

B. How was the visibility of the HGU-27/P visor in comparison to your present helmet?


C. Were problems encountered when wearing sunglasses?

Yes  No

D. Amplifying Remarks: (please include visual conditions prevailing at time of evaluation)

14A. How easy was it to don and doff the HGU-27/P helmet after you had worn it several times?

Very Easy  Easy  No Difficulty  Difficult  Very Difficult

B. How easy was it to don and doff the HGU-27/P helmet in comparison to your present helmet?

Very Easy  Easier  Same  More Difficult  Very Difficult
C. Amplifying Remarks:


15A. Is the HGU-27/P sufficiently stable on the head for mission performance?

Yes □ No □

B. If no, please explain. ____________________________

C. How is the stability of the HGU-27/P compared to your present helmet?

Much Better Better Same Worse Much Worse

□ □ □ □ □

16A. Did the HGU-27/P present any compatibility problems with other flight gear you currently use?

Yes □ No □

B. If yes, please explain. ____________________________

17. Recommendations for improvement of the HGU-27/P by changes of present features which presented problems to you or addition of other features.

______________________________________________

______________________________________________

18. Overall assessment of the HGU-27/P helmet compared to your present helmet.

Excellent Very Good Good Poor Unsatisfactory

□ □ □ □ □
APPENDIX C

Evaluation Questionnaire
for
Integrated Body Armor/Flotation/Survival System for Helicopter Aircrewnen

The integrated system is comprised of the basic helicopter vest, a heat sealed LPA-2 life preserver, a new design, heat sealed, mini-raft, and front and/or rear ballistic armor plates. The vest may be configured with standard survival items as specified in NAVAIR, Crew Systems Manual 13-1-6.7. The vest may be used in six different configurations to meet the operational needs of helicopter aircrew.

Please indicate the configuration of the unit you evaluated by circling the appropriate description. If your unit has a discrepancy or configuration not listed please note and explain. If you evaluate the system in more than one configuration, use a different questionnaire for each configuration. Ignore questions which do not apply to the configuration you use.
1. NAME ___________________________ 2. RANK ______________
3. SQUADRON ___________________________ 4. TYPE A/C __________
5. Task and/or crew station in A/C ___________________________
6. HEIGHT ___________________________ WEIGHT ______________
7. Vest configuration - circle one, use separate questionnaire for each configuration.
   a. Complete assembly including armor, flotation and survival equipment (mission - combat zone flying, over water).
   b. Complete assembly less armor plates (non-combat zone, over water).
   c. Complete assembly less flotation (combat zone, over land only).
   d. Complete assembly less back armor plate (pilots and co-pilots combat zone over water).
   e. Complete assembly less back armor plate and less flotation (pilots and co-pilots combat zone, over land only).
   f. Complete assembly less armor and less flotation (non-combat zone, over land).
   Describe any variations of the above configurations.

8. Total number of hours vest assembly was worn/aircraft
   Hrs. _______ A/C __________
   Hrs. _______ A/C __________
   Hrs. _______ A/C __________
9.A What type of survival vest/flotation do you currently use?
   SV-2/LPA-2
   MK-2
   Other ______________
   B Do you have past experience with ballistic body armor?
   Yes   No
   What type of armor and extent of experience?
Circle the response that best expresses your opinion. Explanations and recommendations will be appreciated.

10.A How easy was it to don and doff the vest assembly after you had worn it several times?

<table>
<thead>
<tr>
<th>Very Good</th>
<th>Good</th>
<th>Adequate</th>
<th>Poor</th>
<th>Very Poor</th>
</tr>
</thead>
</table>

B How easy is it to don and doff your present equipment?

<table>
<thead>
<tr>
<th>Very Good</th>
<th>Good</th>
<th>Adequate</th>
<th>Poor</th>
<th>Very Poor</th>
</tr>
</thead>
</table>

Explain: ____________________________________________________________

11.A What size vest did you wear:

| Medium | Large |

B How was the fit/sizing of the new vest?

<table>
<thead>
<tr>
<th>Very Good</th>
<th>Good</th>
<th>Adequate</th>
<th>Poor</th>
<th>Very Poor</th>
</tr>
</thead>
</table>

C How would you rate the fit/sizing of your present equipment?

<table>
<thead>
<tr>
<th>Very Good</th>
<th>Good</th>
<th>Adequate</th>
<th>Poor</th>
<th>Very Poor</th>
</tr>
</thead>
</table>

Explain: ____________________________________________________________

12.A How comfortable was the vest assembly in the aircraft?

<table>
<thead>
<tr>
<th>Very Good</th>
<th>Good</th>
<th>Adequate</th>
<th>Poor</th>
<th>Very Poor</th>
</tr>
</thead>
</table>

B How would you rate the comfort of your present equipment?

<table>
<thead>
<tr>
<th>Very Good</th>
<th>Good</th>
<th>Adequate</th>
<th>Poor</th>
<th>Very Poor</th>
</tr>
</thead>
</table>

Explain: ____________________________________________________________

13.A How was your ease of movement with the new vest?

<table>
<thead>
<tr>
<th>Very Good</th>
<th>Good</th>
<th>Adequate</th>
<th>Poor</th>
<th>Very Poor</th>
</tr>
</thead>
</table>

B How would you rate your ease of movement with your present equipment?

<table>
<thead>
<tr>
<th>Very Good</th>
<th>Good</th>
<th>Adequate</th>
<th>Poor</th>
<th>Very Poor</th>
</tr>
</thead>
</table>

Explain: ____________________________________________________________
14.A How compatible was the vest assembly with your crew station?

Very Good   Good   Adequate   Poor   Very Poor

B How compatible is your present equipment with your crew station?

Very Good   Good   Adequate   Poor   Very Poor

Explain: ________________________________________________

15.A How was the overall performance of the vest assembly during short flights? (1 to 2 hours)

Very Good   Good   Adequate   Poor   Very Poor

B How do you rate the overall performance of your current equipment during short flights?

Very Good   Good   Adequate   Poor   Very Poor

Explain: ________________________________________________

16.A How was the overall performance of the vest assembly during long flights?

Very Good   Good   Adequate   Poor   Very Poor

B How do you rate the overall performance of your current equipment during long flights?

Very Good   Good   Adequate   Poor   Very Poor

Explain: ________________________________________________

17.A How did the vest assembly perform during emergency egress drills?

Very Good   Good   Adequate   Poor   Very Poor

B How does your current equipment perform during emergency egress drills?

Very Good   Good   Adequate   Poor   Very Poor

Explain: ________________________________________________
18.A Were you hoisted by the vest D ring?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

B If so:

From land or water  
Simulated or Helo-lift

C How would you rate the hoisting capabilities of the vest assembly?

- Very Good
- Good
- Adequate
- Poor
- Very Poor

D How would you rate the hoisting capabilities of your current equipment?

- Very Good
- Good
- Adequate
- Poor
- Very Poor

Explain:

If you participated in water evaluations please answer the applicable questions below.

19.A Evaluation was done

a) at sea  
b) in pool

B If at sea, what was approximate sea state and weather conditions?


20.A How was the accessibility of the inflation lanyards?

- Very Good
- Good
- Adequate
- Poor
- Very Poor

B How is the inflation lanyard accessibility of your present equipment?

- Very Good
- Good
- Adequate
- Poor
- Very Poor

Explain:

21.A How was the accessibility of the survival items?

- Very Good
- Good
- Adequate
- Poor
- Very Poor

B How is the survival item accessibility of your present?

- Very Good
- Good
- Adequate
- Poor
- Very Poor

Explain:
22. Did the LPA-2 perform correctly/adequately?
   
   Yes   No

   Explain: ____________________________________________________________

23. Did the mini-raft perform correctly/adequately?
   
   Yes   No

   Explain: ____________________________________________________________

24. A How was the ease of boarding the mini raft?
   
   Very Good  Good  Adequate  Poor  Very Poor

   B How would you rate the ease of boarding the current one man raft?
   
   Very Good  Good  Adequate  Poor  Very Poor

   Explain: ____________________________________________________________

25. A How was the stability of the mini-raft?
   
   Very Good  Good  Adequate  Poor  Very Poor

   B How would you rate the stability of the current one man raft?
   
   Very Good  Good  Adequate  Poor  Very Poor

   Explain: ____________________________________________________________

26. A How easy was it to jetison the armor plates from the vest assembly?
   
   Very Good  Good  Adequate  Poor  Very Poor

   B How would you rate the ease of jetisoning current armor plate assemblies?
   
   Very Good  Good  Adequate  Poor  Very Poor

   Explain: ____________________________________________________________
### APPENDIX D

**LIVE SUBJECT TEST REPORT**

<p>| | | | | | | | |</p>
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<tbody>
<tr>
<td>1.</td>
<td>Test program No.</td>
<td>2.</td>
<td>Test No.</td>
<td>3.</td>
<td>Date</td>
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<td>4.</td>
<td>Jumper's name</td>
<td>5.</td>
<td>Previous No. Jumps</td>
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<td>6.</td>
<td>Age</td>
<td>7.</td>
<td>Nude Weight</td>
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<tr>
<td>8.</td>
<td>Suspended weight</td>
<td>9.</td>
<td>Height</td>
<td></td>
<td></td>
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<tr>
<td>10.</td>
<td>Type of equipment:</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>a.</td>
<td>Parachute</td>
<td>f.</td>
<td>Seat Pan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Parachute container</td>
<td>g.</td>
<td>Life raft</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>Clothing</td>
<td>h.</td>
<td>Reserve parachute</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>Harness</td>
<td>i.</td>
<td>Other</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>e.</td>
<td>Life vest</td>
<td>b.</td>
<td>Weight of test item</td>
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<td></td>
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<tr>
<td>11.</td>
<td>a.</td>
<td>Test item</td>
<td></td>
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<tr>
<td>12.</td>
<td>Weight of all equipment and clothing less test item</td>
<td></td>
<td></td>
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<tr>
<td>13.</td>
<td>Jumper's Evaluation and comments (if none write &quot;none&quot;): (Use separate</td>
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<td></td>
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<tr>
<td>a.</td>
<td>Pre-egress and egress:</td>
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<tr>
<td>b.</td>
<td>Free-fall:</td>
<td>Time:</td>
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<tr>
<td>c.</td>
<td>Parachute actuation and deployment; check appropriate block(s):</td>
<td>Manual</td>
<td>Automatic Timer</td>
<td>Other</td>
<td></td>
<td></td>
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<tr>
<td>d.</td>
<td>Rate opening shock on scale 1-5: (1 = very mild, 2 = mild, 3 = average, 4 = severe, 5 = very severe)</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>e.</td>
<td>Descent under canopy, oscillation, drift, steering, four-line, release etc.</td>
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<tr>
<td>f.</td>
<td>Impact:</td>
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<tr>
<td>g.</td>
<td>Suspected injury: Yes</td>
<td>No</td>
<td>If yes, complete Live Subject Injury Report NAVAERO RECOVFAC FORM 5100/2</td>
<td></td>
<td></td>
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<tr>
<td>h.</td>
<td>Equipment malfunction: Yes</td>
<td>No</td>
<td>If yes, explain suspected cause of failure below.</td>
<td></td>
<td></td>
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<tr>
<td>i.</td>
<td>Did the test item hamper or compromise the subject's ability to perform a safe test? Yes</td>
<td>No</td>
<td>If yes, explain below.</td>
<td></td>
<td></td>
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<tr>
<td>j.</td>
<td>Other comments: (Deployment and inflation of raft, action in air, water entry, boarding, and hood and deck inflation - use back.)</td>
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</table>

Jumper's signature:

NAVAERO RECOVFAC FORM 3960/9 (May 1973)
APPENDIX E
HGU-27/P RATING

SAMPLE COMPLETE
N = 39
n = 233
X^2 = 3.79
S_x = 0.83
t = 
df =
c = 

V.P. P. A. G. V.G.
RATING CATEGORY
1 2 3 4 5

V.P. P. A. G. V.G.
EXPECTED VALUES

\chi^2 =
df =
c =
### HGU-27/P Rating

#### Sample: M5-2

<table>
<thead>
<tr>
<th>N</th>
<th>n</th>
<th>( \bar{X} )</th>
<th>( S_X )</th>
<th>t</th>
<th>df</th>
<th>c</th>
<th>( \alpha )</th>
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<td>9</td>
<td>51</td>
<td>4.31</td>
<td>0.79</td>
<td>-9.09</td>
<td>282</td>
<td>-1.65</td>
<td>0.05</td>
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#### Frequency

<table>
<thead>
<tr>
<th>V.P.</th>
<th>P.</th>
<th>A.</th>
<th>G.</th>
<th>V.G.</th>
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<td>5</td>
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<td>25</td>
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#### Observed and Expected Values

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<th>P.</th>
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<th>G.</th>
<th>V.G.</th>
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<td>21</td>
<td>24</td>
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</tbody>
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<table>
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<th>3.52</th>
<th>24.28</th>
<th>24.28</th>
<th>9.84</th>
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<td>0</td>
<td>13.36</td>
<td>9.84</td>
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</tbody>
</table>
HGU-27/P RATING

SAMPLE 115-85

N = 4
n = 24

X̄ = 3.92
S_x̄ = 0.78

t = -0.73
df = 255

V.P. P. A. G. V.G.
RATING CATEGORY

V.P. P. A. G. V.G.
EXPECTED VALUES

X² = 0.78
df = 3

e = 7.81
x = 0.05
HGU-27/P RATING

SAMPLE: 5 - 2

N = 5
n = 30

\( \bar{x} = 3.92 \)

\( s_x = 0.85 \)

t = -1.12

df = 261

c = -1.65

\( \chi^2 = 0.05 \)

V.P. P. A. G. V.G.

RATING CATEGORY

V.P. P. A. G. V.G.

EXPECTED VALUES

\( \chi^2 = 2.7 \)

df = 3

c = 7.81

\( \chi^2 = 0.05 \)
HGU-27/P RATING

SAMPLE
N = 5
n = 30
\( \bar{X} = 3.93 \)
\( S_x = 0.79 \)
\( t = -0.88 \)
df = 26.1
\( c = -1.65 \)
\( \chi^2 = 0.05 \)

FREQUENCY
16
14
12
10
8
6
4
2

RATING CATEGORY
V.P. P. A. G. V.G.

9 14 7

\( \chi^2 = 2.49 \)
df = 3
\( c = 7.81 \)
\( \chi = 0.05 \)

EXPECTED VALUES
V.P. P. A. G. V.G.
0 2.07 14.28 5.79 2.66 5.79
HGUN 27/P RATING

**Sample 5-5**

- \( N = 5 \)
- \( n = 30 \)
- \( \bar{x} = 3.90 \)
- \( S_x = 0.80 \)
- \( t = -0.67 \)
- \( df = 25.1 \)
- \( c = 1.65 \)
- \( \alpha = 0.05 \)

**Frequency Distribution**

- 2: 1
- 4: 8
- 6: 14
- 8: 7

**Rating Categories**

- V.P.
- P.
- A.
- G.
- V.G.

**Expected Values**

- \( \chi^2 = 0.81 \)
- \( df = 3 \)
- \( c = 7.81 \)
- \( \alpha = 0.05 \)
HGU-27/P RATING

SAMPLE 10-4
N= 10
n= 60

}\bar{x}= 3.78 
S_x= 0.72

t= 0.09
df= 29.1

\chi^2= 3.01

V, P, P, A, G, V, G.
RATING CATEGORY

V, P, P, A, G, V, G.
EXPECTED VALUES

\chi^2= 3.01

df= 3

c= 7.81
\chi = 0.05
HGU-27/P RATING

SAMPLE: 15-1

\[ \begin{align*}
N &= 15 \\
n &= 90 \\
\bar{x} &= 3.86 \\
S_x &= 0.80 \\
t &= -0.69 \\
df &= 3.21 \\
c &= -1.65 \\
\alpha &= 0.05
\end{align*} \]

FREQUENCY

V.P., P., A., G., V.G.

RATING CATEGORY

\[ \begin{align*}
&5^* \\
&21 \\
&46 \\
&18
\end{align*} \]

\[ \chi^2 = 0.72 \]

\[ \text{df} = 5 \]

\[ c = 7.81 \]

\[ \alpha = 0.05 \]

V.P., P., A., G., V.G.

EXPECTED VALUES
HGU-27/P RATING

SAMPLE: 15 - 2
N = 15
n = 88

χ² = 3.80
Sχ = 0.86
t = -0.10
df = 319
c = -1.65
λ = 0.05

FREQUENCY

V.P. P. A. G. V.G.
RATING CATEGORY

EXPECTED VALUES

χ² = 0.27
df = 3
c = 7.81
λ = 0.05

6.07 41.89 16.98
Simple linear regression analysis:

**SAMPLE:** 15-3

- **N:** 15
- **n:** 90
- **X:** 3.87
- **S_x:** 0.82
- **t:** -0.78
- **df:** 321
- **c:** -1.65
- **α:** 0.05

**FREQUENCY**

- 40
- 36
- 32
- 28
- 24
- 20
- 16
- 12
- 8
- 4

**RATING CATEGORY**

- V.P.
- P.
- A.
- G.
- V.G.

**EXPECTED VALUES**

- 0
- 23.58
- 17.37

**EXPECTED VALUES**

- 6.21
- 42.84
HGU-27/P RATING

SAMPLE
N = 15
n = 90

X̄ = 3.70
S_x = 0.84

t = 0.87
df = 321

V.P. P. A. G. V.G.
RATING CATEGORY

χ^2 = 1.49
df = 3

c = 0.81
x = 0.05

V.P. P. A. G. V.G.
EXPECTED VALUES

0 6.21 23.58 17.37 42.84
COMPARISON RATING: HGU-27/P & SPH-3

SAMPLE COMPLETE

N = 39
n = 271
X̄ = 3.26
Sx = 0.91
t = 

COMPARISON CATEGORY

M.W. W. S. B. M.B.

110
100
90
80
70
60
50
40
30
20
10

28 68 117 58

EXPECTED VALUES

M.W. W. S. B. M.B.

χ² = 
df = 
ce = 

### Comparison Rating: HGU-27/P & SPH-3

**Sample: HS-10**

<table>
<thead>
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<th>Frequency</th>
<th>Count</th>
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<td>45</td>
<td>29</td>
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<td>53</td>
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<td>3</td>
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<td>25</td>
<td>22</td>
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<td>15</td>
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<tr>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

- **N**: 17
- **n**: 119
- **X**: 3.69
- **S_x**: 0.92
- **t**: 0.70
- **df**: 388
- **c**: 1.65
- **α**: 0.05

**Comparison Category**

- **X^2**: 1.16
- **df**: 3
- **c**: 7.81
- **α**: 0.05

**Expected Values**

<table>
<thead>
<tr>
<th>M.W. W.</th>
<th>S. B.</th>
<th>M.B.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>11.26</td>
<td>29.87</td>
</tr>
<tr>
<td>25.47</td>
<td>1.91</td>
<td>2.47</td>
</tr>
<tr>
<td>15.26</td>
<td>11.26</td>
<td>29.87</td>
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</tbody>
</table>

**Histogram**
COMPARISON RATING - HGU-27/P & SPH-3

SAMPLE NS-4

<table>
<thead>
<tr>
<th>N</th>
<th>n</th>
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</thead>
<tbody>
<tr>
<td>9</td>
<td>6.3</td>
</tr>
</tbody>
</table>

χ² = 3.47

Sχ = 0.80

t = 2.33

df = 3.32

c = 1.65

α = 0.05

FREQUENCY

M.W. W. S. B. M.B.

COMPARISON CATEGORY

χ² = 9.0

df = 3

c = 1.81

6.99 15.81 13.48

M.W. W. S. B. M.B.

EXPECTED VALUES
COMPARISON RATING-HGU-27/P & SPH-3

SAMPLE: HS-2

N = 9
n = 63
X = 4.16
S_x = 0.85

t = -3.18
df = 33.2
c = -1.65
\alpha = 0.05

M.W. W. S. B. M.B.

COMPARISON CATEGORY

\chi^2 = 16.31

df = 3

c = 7.81

M.W. W. S. B. M.B.

EXPECTED VALUES

0  6.49  15.8  22.22  33.48

0  15.8  22.22  33.48
COMPARISON RATING-HGU-27/P & SPH-3

SAMPLE 15-85

\[ N = 4 \]
\[ n = 26 \]
\[ X = 3.85 \]
\[ S_x = 0.88 \]
\[ t = -0.48 \]
\[ df = 3.95 \]
\[ c = -1.65 \]
\[ \alpha = 0.05 \]

FREQUENCY

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M.W. W. S. B. M.B.
COMPARISON CATEGORY

\[ X^2 = 0.30 \]
\[ df = 3 \]
\[ c = 2.81 \]
\[ \alpha = 0.05 \]

M.W. W. S. B. M.B.
EXPECTED VALUES
### COMPARISON RATING-HGU-27/P & SPH-3

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<tr>
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<tr>
<td>$\chi^2$</td>
<td>3.66</td>
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<td>$S_x$</td>
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<td>df=</td>
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#### FREQUENCY

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#### EXPECTED VALUES

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</table>
COMPARISON RATING-HGU-27/P & SPH-3

SAMPLE 5-2

N = 5
n = 34

\( \bar{X} = 3.35 \)

\( s_x = 0.88 \)

t = 2.49

df = 30.3

c = 1.65

\( \chi^2 = 0.05 \)

M.W. W. S. B. M.B.

COMPARISON CATEGORY

\( \chi^2 = 7.81 \)

df = 3

c = 7.81

\( \nu = 0.05 \)

M.W. W. S. B. M.B.

EXPECTED VALUES
COMPARISON RATING - HGU-27/P & SPH-3

SAMPLE 5-3

N = 5
n = 35

\[ \bar{x} = 9.2 \]
\[ s_x = 0.83 \]

\[ t = -2.72 \]
\[ df = 30.9 \]
\[ c = -1.65 \]
\[ \alpha = 0.05 \]

FREQUENCY

M.W.W. S. B. M.B.

COMPARISON CATEGORY

\[ \chi^2 = 10.60 \]
\[ df = 3 \]
\[ c = 7.81 \]
\[ \chi = 0.05 \]

M.W.W. S. B. M.B.

EXPECTED VALUES

3.61 15.12
0 8.79 7.99
COMPARISON RATING-HGU-27/P. & SPH-3

SAMPLE

<table>
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<tr>
<td>df=</td>
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</table>

FREQUENCY

18
16
14
12
10
8
6
4
2

M.W. W. S. B. M.B.

COMPARISON CATEGORY

M.W. W. S. B. M.B.

EXPECTED VALUES

\[ \chi^2 = 2.28 \]
\[ df= 3 \]
\[ c= 7.81 \]
\[ 2 = 0.05 \]
COMPARISON RATING-HGU-27/P & SPH-3

SAMPLE 5-5

N = 5
n = 35
X = 3.80
S = 0.76

t = -0.25
df = 304
C = -1.65

M.W. W. S. B. M.B.
COMPARISON CATEGORY

X^2 = 6.61
df = 3

t = 7.81

M.W. W. S. B. M.B.
EXPECTED VALUES

0 0.79 2.49
COMPARISON RATING - HGU-27/P & SPH-3

SAMPLE 10-1

\[ N = 10 \]
\[ n = 6.9 \]
\[ X = 3.68 \]
\[ S_x = 0.93 \]
\[ t = 0.65 \]
\[ df = 3.38 \]
\[ c = 1.65 \]
\[ \alpha = 0.05 \]

FREQUENCY

M.W.  W.  S.  B.  M.B.
COMPARISON CATEGORY

\[ X^2 = 0.72 \]
\[ df = 3 \]
\[ c = 7.81 \]
\[ \alpha = 0.05 \]

M.W.  W.  S.  B.  M.B.
EXPECTED VALUES

\[ 7.11 \quad 29.81 \quad 29.81 \]
\[ 0 \quad 17.32 \quad 14.77 \]
COMPARISON RATING-HGU-27/P & SPH-3

SAMPLE 10-2

N = 10
n = 70

\( \chi^2 = 3.79 \)
\( S_x = 1.02 \)

\( t = -0.29 \)
\( df = 3.39 \)
\( c = -1.65 \)

\( \lambda = 0.05 \)

M.W. W. S. B. M.B.

COMPARISON CATEGORY

\( \chi^2 = 5.0 \)
\( df = 3 \)
\( c = 7.01 \)

\( \lambda = 0.05 \)

M.W. W. S. B. M.B.

EXPECTED VALUES
COMPARISON RATING-HGU-27/P & SPH-3

SAMPLE 10 - 3

\[ N = 10 \]
\[ n = 6.9 \]
\[ \bar{x} = 3.68 \]
\[ s_x = 0.88 \]
\[ t = 0.66 \]
\[ df = 3.38 \]
\[ c = 1.65 \]
\[ \alpha = 0.05 \]

FREQUENCY

| 32 | 28 |
| 24 | 20 |
| 16 | 12 |
| 8  | 4  |

M.W., W., S., B., M.B.

COMPARISON CATEGORY

\[ x^2 = 1.42 \]
\[ df = 3 \]
\[ c = 7.81 \]
\[ \lambda = 0.05 \]

M.W., W., S., B., M.B.

EXPECTED VALUES

0, 12.32, 14.27
COMPARISON RATING: HGU-27/P & SPH-3

SAMPLE: 10 - 4

N = 10
n = 70

χ = 3.22

S^2 = 0.82

\( t = -0.88 \)

df = 239

c = -1.65

\( \alpha = 0.05 \)

M.W.W. S. B. M.B.

COMPARISON CATEGORY

\( \chi^2 = 2.03 \)

df = 3

c = 7.81

\( \alpha = 0.05 \)

M.W.W. S. B. M.B.

EXPECTED VALUES
COMPARISON RATING-HGU-27/P & SPH-3:

SAMPLE 10-5

N = 10
n = 70

X = 3.83
S_x = 0.83

t = -0.58
df = 3.39
c = -1.65
x = 0.05

FREQUENCY

36 32 28 24 20 16 12 8 4

M.W. W. S. B. M.B.

COMPARISON CATEGORY

x^2 = 1.63
df = 3
c = 7.81

M.W. W. S. B. M.B.

EXPECTED VALUES

0 7.21 17.57 36.24 14.98
COMPARISON RATING-HGU-27/P & SPH-3

SAMPLE 15-1

N = 15
n = 10.5

X = 3.90
S_x = 0.85

t = -1.36
df = 3.74
C = -1.65
P = 0.05

FREQUENCY

M.W. W. S. B. M.B.
COMPARISON CATEGORY

10, 8, 4, 7, 2, 2

M.W. W. S. B. M.B.
EXPECTED VALUES

X^2 = 3.19
df = 3
C = 7.81
P = 0.05
COMPARISON RATING-HGU-27/P & SPH-3

SAMPLE 15 + 2
N = 15
n = 16

\( \bar{x} = 3.57 \)
\( S_x = 0.99 \)

\( t = 1.79 \)
\( df = 373 \)
\( c = 1.65 \)
\( \alpha = 0.05 \)

FREQUENCY

M.W. W.S. B. M.B.
COMPARISON CATEGORY

\( \chi^2 = 5.5 \)
\( df = 3 \)
\( c = 7.81 \)
\( \alpha = 0.05 \)

0 10.71 26.10 44.93 22.26
M.W. W. S. B. M.B.
EXPECTED VALUES
COMPARISON RATING-HGU-27/P & SPH-3

**SAMPLE 15-3**

N = 15

n = 104

χ² = 3.85

S₂ = 0.83

t = -0.88

df = 373

c = -1.65

α = 0.05

**FREQUENCY**

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<th>Frequency</th>
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<td>10</td>
<td>24</td>
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<td>15</td>
<td>51</td>
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<td>20</td>
<td>22</td>
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**EXPECTED VALUES**

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<thead>
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<th>Value</th>
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<td>0</td>
<td>10.71</td>
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<td>5</td>
<td>19.40</td>
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<tr>
<td>10</td>
<td>24.93</td>
</tr>
<tr>
<td>15</td>
<td>22.26</td>
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</tbody>
</table>

**COMPARISON CATEGORY**

M.W. W., S., B., M.B.
Sample: 15 - S
N = 15
n = 10.4
X = 3.75
S_x = 0.83
t = 0.10
df = 3.73
c = 1.65
x = 0.05

M.W. W. S. B. M.B
Comparison Category

0 26.10 44.93 22.26
M.W. W. S. B. M.B
Expected Values
OVERALL ASSESSMENT

SAMPLE H5-10

N = 12
n = 16

X̄ = 3.81
S_x = 0.54

t = -0.46
df = 51

c = -1.68
\( \chi^2 = 0.05 \)

FREQUENCY

1
10
9
8
7
6
5
4
3
2
1

UNS, P, G, V.G, EX,

RATING

X^2 = 2.64
df = 2

c = 5.99
\( \chi^2 = 0.05 \)

0.43 0.86 4.75 7.78 2.16

UNS, P, G, V.G, EX,

EXPECTED VALUES
OVERALL ASSESSMENT

SAMPLE

\[ \mu = 4 \]

\[ N = 9 \]

\[ n = 8 \]

\[ \bar{X} = 3.0 \]

\[ S_x = 0.76 \]

\[ t = 2.06 \]

\[ df = 43 \]

\[ c = 1.68 \]

\[ \alpha = 0.05 \]

\[ \chi^2 = 4.69 \]

\[ df = 1 \]

\[ 3.0^2 \]

\[ 4.97 \]

\[ 0.43 \]

\[ 1.89 \]

\[ 0.22 \], \[ 2.38 \], \[ 1.08 \]

UNS: P. G. V.G. EX.

RATING

EXPECTED VALUES
## Overall Assessment

**Sample**: H5-2

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<tr>
<th>N</th>
<th>9</th>
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<tbody>
<tr>
<td>n</td>
<td>9</td>
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</tbody>
</table>

\[
\bar{x} = 3.89
\]

\[
S_x = 1.36
\]

\[
t = -0.52
\]

\[
df = 44
\]

\[
c = -1.68
\]

### Frequency Distribution

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<tr>
<td>P. G.</td>
<td>2</td>
</tr>
<tr>
<td>V.G. EX.</td>
<td>2</td>
</tr>
<tr>
<td>EX.</td>
<td>4</td>
</tr>
</tbody>
</table>

\[
\chi^2 = 0.07
\]

\[
df = 1
\]

\[
3.88 5.59
\]

\[
0.47 4.37
\]

\[
0.74 2.67 1.22
\]

### Expected Values

\[
\chi^2 = 0.05
\]
OVERALL ASSESSMENT

SAMPLE    H5-85

N = 4
n = 4

X = 3.75

Sx = 0.5

t = 0.11

df = 3.9

c = -1.68

χ² = 0.05

FREQUENCY

3
2
1

UNS. P. G. V.G. EX.

RATING

CELLS TOO SMALL

χ² = 0.27

df = 1

c = 3.84

UNS. P. G. V.G. EX.

EXPECTED VALUES

1.52  2.98  1.22  1.99  0.94  0.54
<table>
<thead>
<tr>
<th>Rating</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
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<td>1</td>
</tr>
</tbody>
</table>

**Expected Values**

<table>
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<tr>
<th>Sample</th>
<th>V, G, Y, G, EX, P, G, I, S, Y</th>
<th>0.58</th>
<th>4.33</th>
<th>3</th>
<th>5</th>
<th>Overall Assessment</th>
</tr>
</thead>
</table>

Note: The table and diagram contain data related to expected values and frequency, but the specific details are not fully legible due to the image quality.
OVERALL ASSESSMENT

SAMPLE
N = 5
n = 5

\[ \bar{x} = 4.0 \]
\[ s_x = 0.71 \]
\[ t = -0.72 \]
\[ df = 3.7 \]
\[ c = 1.68 \]
\[ \alpha = 0.05 \]

FREQUENCY
1
2
3

RATING
UNS. P. G. V. G. EX.

\[ x^2 = 0.68 \]
\[ c = 3.84 \]
\[ \alpha = 0.05 \]

UN. P. G. V. G. EX.

EXPECTED VALUES

Cells too small
\[ df = 1 \]
\[ 1.7 \]
\[ 3.11 \]
\[ 0.27 \]
\[ 0.93 \]
\[ 0.19 \]
\[ 1.99 \]
OVERALL ASSESSMENT

SAMPLE 5-3

N= 5
n= 5
X= 4.0
s_x= 0.71

t= -0.72
df= 3.7
c= 1.68
\alpha = 0.05

FREQUENCY

<table>
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<tr>
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<th>3</th>
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<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

RATING

UNS, P, G, V.G, EX.

\chi^2 = 0.06

CELLS TOO SMALL df = 1

\chi^2 = 3.84
c = 3.84
\alpha = 0.05

UNS, P, G, V.G, EX.

EXPECTED VALUES
OVERALL ASSESSMENT

SAMPLE 5-9

N= 5
n= 5

\[ \bar{X} = 3.2 \]

\[ S_x = 0.95 \]

\[ t = 1.23 \]

\[ dF = 3.7 \]

\[ c = 1.68 \]

\[ \alpha = 0.05 \]

FREQUENCY

4
3
2
1

UNS. P. G. V.G. EX.

RATING

\[ \chi^2 = 3.75 \]

\[ dF = 1 \]

CELLS TOO SMALL

1.9
3.11

\[ c = 3.89 \]

\[ \alpha = 0.05 \]

UNS. P. G. V.G. EX.

EXPECTED VALUES
### Expected Values

<table>
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<th>0.2</th>
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<tr>
<td>B</td>
<td>0.6</td>
<td>0.4</td>
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</table>

\[ \chi^2 = 0.01 \]

### Table

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<th>RAINFOREST</th>
<th>UNS</th>
<th>P</th>
<th>G</th>
<th>A</th>
<th>B</th>
<th>G.E.</th>
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</table>

### Frequency

\[ \chi^2 = 0.01 \]

- \( \chi^2 = 0.05 \)
- \( \chi^2 = 0.16 \)
- \( \chi^2 = 0.37 \)
- \( \chi^2 = 0.23 \)

- \( s = 0.19 \)
- \( 3.60 \)
- \( 5 \)
- \( 5 \)
- \( 5 \)
- \( 5 \)
- \( 5 \)

### Overall Assessment

- \( s = 0.05 \)
- \( c = 0.05 \)
- \( d = 0.05 \)
- \( e = 0.05 \)
- \( f = 0.05 \)
- \( g = 0.05 \)
- \( h = 0.05 \)
- \( i = 0.05 \)
- \( j = 0.05 \)
- \( k = 0.05 \)
- \( l = 0.05 \)
- \( m = 0.05 \)
- \( n = 0.05 \)
- \( o = 0.05 \)
- \( p = 0.05 \)
- \( q = 0.05 \)
- \( r = 0.05 \)
- \( s = 0.05 \)
- \( t = 0.05 \)
- \( u = 0.05 \)
- \( v = 0.05 \)
- \( w = 0.05 \)
- \( x = 0.05 \)
- \( y = 0.05 \)
- \( z = 0.05 \)
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</tbody>
</table>

SAMPLE: 10-1
OVERALL ASSESSMENT

SAMPLE  

\( n = 10 \) 
\( n = 8 \) 
\( \bar{x} = 3.68 \) 
\( s_x = 0.83 \) 
\( t = -0.52 \) 
\( d_f = 93 \) 
\( c = -1.68 \) 
\( \alpha = 0.05 \)

FREQUENCY

- 3
- 2
- 1

UNS. P. G. V.G. EX.
RATING

\( \chi^2 = 0.99 \)
\( d_f = 2 \)
\( c = 0.99 \)
\( \alpha = 0.05 \)

UNS. P. G. V.G. EX.
EXPECTED VALUES
OVERALL ASSESSMENT

SAMPLE 10-9

N = 10
n = 9
\( \bar{x} = 4.0 \)
\( s_x = 0.4 \)

\( t = -0.96 \)
\( df = 9.4 \)
\( c = -1.68 \)
\( \alpha = 0.05 \)

FREQUENCY

UNS. P. G. V. G. EX.

RATING

4
3
2
1

\( \chi^2 = 3.29 \)
\( df = 2 \)
\( c = 5.99 \)
\( \alpha = 0.05 \)

EXPECTED VALUES
OVERALL ASSESSMENT

SAMPLE 10 - 5

N = 10
n = 10

\( \bar{x} = 3.80 \)
\( s_x = 1.14 \)

\( t = -0.30 \)
\( df = 4.5 \)
\( c = -1.66 \)
\( \alpha = 0.05 \)

FREQUENCY

2
6
5
4
3
2
1

1 1 6 1

UNS. P. G. V.G. EX.

RATING

\( \chi^2 = 1.42 \)
\( df = 2 \)
\( c = 5.99 \)
\( \alpha = 0.05 \)

EXPECTED VALUES
### Overall Assessment

**Sample**: 15-2

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<th>n</th>
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<th>S_x</th>
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<td>0.84</td>
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<table>
<thead>
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<th>t</th>
<th>df</th>
<th>c</th>
<th>x^2</th>
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<tbody>
<tr>
<td>0.58</td>
<td>49</td>
<td>1.68</td>
<td>0.19</td>
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</table>

### Frequency

**Ratings**: Uns, P, G, V.G, Ex.

<table>
<thead>
<tr>
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<th>Uns</th>
<th>P</th>
<th>G</th>
<th>V.G</th>
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### Expected Values

<table>
<thead>
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<th>G</th>
<th>V.G</th>
<th>Ex</th>
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<td>6.80</td>
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<tr>
<td>1.89</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Chi-Squared**: 5.3

<table>
<thead>
<tr>
<th>x^2</th>
<th>df</th>
<th>c</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.19</td>
<td>2</td>
<td>5.99</td>
<td>0.05</td>
</tr>
</tbody>
</table>
OVERALL ASSESSMENT

SAMPLE: 15 - 3
N = 15
n = 15

X = 3.8
S_X = 0.56

t = -0.40
df = 50
c = -1.68
a = 0.05

FREQUENCY

UNS. P. G. V.G. EX.
RATING

UNS. P. G. V.G. EX.
EXPECTED VALUES

X^2 = 2.03
df = 2
c = 5.99
a = 0.05

2.29
2.03
5.68
OVERALL ASSESSMENT

SAMPLE: 15-4

N = 15
n = 14

\( \bar{x} = 3.79 \)

\( s_x = 0.98 \)

\( t = -0.31 \)

\( df = 4.9 \)

\( c = 1.18 \)

\( \alpha = 0.05 \)

FREQUENCY

UNS. P. G. V.G. EX.

RATING

\( \chi^2 = 1.72 \)

\( df = 2 \)

\( c = 5.99 \)

\( \alpha = 0.05 \)

EXPECTED VALUES

UNS. P. G. V.G. EX.

6.8

5.3

1.89
SAMPLE COMPLETE RELATIVE FREQUENCIES
APPENDIX F
HGU-27/P RATING

\[ N = 39 \]
\[ n = 233 \]

V.P. P. A. G. V.G.
RATING CATEGORY

COMPARISON RATING-HGU-27/P & SPH-3

\[ n = 271 \]

M.W. W. S. B. N.B.
COMPARISON CATEGORY

OVERALL ASSESSMENT

\[ n = 27 \]

UNS. P. G. V.G. EX.
RATING
SAMPLE HS-4 RELATIVE FREQUENCIES

HGU-27/P RATING

\[ N = 9 \]
\[ n = 54 \]

V.P. P. A. G. V.G.
RATING CATEGORY

COMPARISON RATING-HGU-27/P & SPH-3

\[ n = 63 \]

M.W. W. S. B. M.B.
COMPARISON CATEGORY

OVERALL ASSESMENT

\[ n = 8 \]

UNS. P. G. V.G. EX.
RATING
SAMPLE HS-85 RELATIVE FREQUENCIES

HGU-27/P RATING

V.P. P. A. G. V.G.
RATING CATEGORY

N = 4
n = 21

COMPARISON RATING-HGU-27/P & SPH-3

M.W. N. S. B. M.R.
COMPARISON CATEGORY

n = 26

OVERALL ASSESSMENT

n = 4

UNS. P. G. V.G. EX.
RATING
SAMPLE 15-1 RELATIVE FREQUENCIES

HGU-27/P RATING

V.P. P. A. G. V.G.
RATING CATEGORY

n = 90

COMPARISON RATING-HGU-27/P & SPH-3

M.W. W. S. B. M.B.
COMPARISON CATEGORY

n = 105

OVERALL ASSESSMENT

n = 14

UNS. P. G. V.G. EX.
RATING
SAMPLE 15-2 RELATIVE FREQUENCIES

HGU-27/P RATING

V.P., P., A., G., V.G.
RATING CATEGORY

COMPARISON RATING HGU-27/P & SPH-3

M.W., W., S., B., M.B.
COMPARISON CATEGORY

OVERALL ASSESSMENT

UNS. P. G. V.G. EX.
RATING

n = 88

n = 104

n = 14
APPENDIX G
RANDOM SAMPLE SELECTION

Random numbers selected from "Table 5. Random Digits" page 449 of reference 6.

For N=5

<table>
<thead>
<tr>
<th>Sample 5-1</th>
<th>Sample 5-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>27,14,24,09,07</td>
<td>10,20,35,29,12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample 5-2</th>
<th>Sample 5-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>04,09,07,13,18</td>
<td>23,33,37,07,28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample 5-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>32,03,28,10,22</td>
</tr>
</tbody>
</table>

For N=10

<table>
<thead>
<tr>
<th>Sample 10-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>11,28,26,27,37,30,06,16,38,23</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample 10-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>37,13,25,15,39,11,03,06,14,34</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample 10-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>37,10,02,05,31,11,29,32,20,17</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample 10-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>23,25,24,08,16,27,32,28,19,17</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample 10-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>04,16,05,18,02,13,19,38,17,24</td>
</tr>
</tbody>
</table>

For N=15

<table>
<thead>
<tr>
<th>Sample 15-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>09,07,31,26,33,37,27,03,17,38,04,10,08,13,30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample 15-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>12,18,14,02,39,38,06,30,11,21,29,33,28,16,04</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample 15-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>08,32,25,38,01,23,10,18,16,36,09,15,24,06,20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample 15-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>38,19,13,02,18,05,16,04,08,17,28,32,27,25,24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample 15-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>04,09,11,10,12,20,23,37,18,07,22,17,31,33,32</td>
</tr>
</tbody>
</table>
APPENDIX H

Test significance of difference between the distribution of the overall assessment rating for sub-sample 5-4 and the complete sample. Divide frequencies into two categories and use Binomial Probability (sample too small for other tests) to find probability of F(x) or worse given the probabilities predicted by the complete sample.

\[ P = \sum_{i=0}^{x} \binom{N}{i} p^i q^{N-i} \]

\[ Q = 1 - p \]
\[ P = 0.62 \]
\[ N = 5 \]
\[ x = 1 \]

\[ P = \sum_{i=0}^{1} \binom{5}{i} 0.62^i 0.38^{N-i} \]

\[ P = 0.07 \] of obtaining a 0 or 1 in category V.G.

NOT SIGNIFICANT AT 0.05 level, however is close
APPENDIX I

Test $H_0$: Frequency distribution is independent of the squadron chosen.

Chi-Square Contingency Table For HGU-27/P Rating

<table>
<thead>
<tr>
<th>Squadron</th>
<th>V.P.</th>
<th>P.</th>
<th>A.</th>
<th>G.</th>
<th>V.G.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EXPECTED</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HS-10</td>
<td>7.06</td>
<td>25.61</td>
<td>49.01</td>
<td>20.3</td>
<td></td>
<td>102</td>
</tr>
<tr>
<td>HS-4</td>
<td>3.74</td>
<td>13.56</td>
<td>25.95</td>
<td>10.75</td>
<td></td>
<td>54</td>
</tr>
<tr>
<td>HS-2</td>
<td>3.53</td>
<td>12.81</td>
<td>24.51</td>
<td>10.16</td>
<td></td>
<td>51</td>
</tr>
<tr>
<td>HS-85</td>
<td>1.66</td>
<td>6.03</td>
<td>11.53</td>
<td>4.78</td>
<td></td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
<td>58</td>
<td>111</td>
<td>46</td>
<td></td>
<td>231</td>
</tr>
</tbody>
</table>

$X^2 = 36.4$  $df = 9$  level of significance $= 0.05$

$H_0$ IS REJECTED

Chi-Square Contingency Table For Comparison Rating-HGU-27/P & SPH-3

<table>
<thead>
<tr>
<th>Squadron</th>
<th>M.W.</th>
<th>W.</th>
<th>S.</th>
<th>B.</th>
<th>M.R.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EXPECTED</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HS-10</td>
<td>11.86</td>
<td>29.86</td>
<td>51.82</td>
<td>25.47</td>
<td></td>
<td>119</td>
</tr>
<tr>
<td>HS-4</td>
<td>6.28</td>
<td>15.81</td>
<td>27.43</td>
<td>13.48</td>
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<td>63</td>
</tr>
<tr>
<td>HS-2</td>
<td>6.28</td>
<td>15.81</td>
<td>27.43</td>
<td>13.48</td>
<td></td>
<td>63</td>
</tr>
<tr>
<td>HS-85</td>
<td>2.59</td>
<td>6.52</td>
<td>11.32</td>
<td>5.56</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>68</td>
<td>118</td>
<td>58</td>
<td></td>
<td>271</td>
</tr>
</tbody>
</table>

$X^2 = 26.9$  $df = 9$  level of signif. $= 0.05$

$H_0$ IS REJECTED
APPENDIX J

Test $H_0$: Frequency distribution is independent of squadron. (HS-2 not included)

Chi-Square Contingency Table For HGU-27/P Rating

<table>
<thead>
<tr>
<th>Squadron</th>
<th>V.P.</th>
<th>P.</th>
<th>A.</th>
<th>G.</th>
<th>V.G.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EXPECTED</td>
<td>7.93</td>
<td>30.6</td>
<td>51</td>
<td>12.47</td>
<td></td>
</tr>
<tr>
<td>HS-10 OBSERVED</td>
<td>9</td>
<td>32</td>
<td>49</td>
<td>12</td>
<td>102</td>
<td></td>
</tr>
<tr>
<td>HS-4</td>
<td>4.2</td>
<td>16.2</td>
<td>27</td>
<td>6.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HS-85</td>
<td>4</td>
<td>17</td>
<td>28</td>
<td>5</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.87</td>
<td>7.2</td>
<td>12</td>
<td>2.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>5</td>
<td>13</td>
<td>5</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
<td>54</td>
<td>90</td>
<td>22</td>
<td>180</td>
<td></td>
</tr>
</tbody>
</table>

$x^2 = 3.4$  \(\text{df} = 6\)  level of signif. = 0.05

$H_0$ IS NOT REJECTED

Chi-Square Contingency Table For Comparison Rating-HGU-27/P & SPH-3

<table>
<thead>
<tr>
<th>Squadron</th>
<th>M.W.</th>
<th>W.</th>
<th>S.</th>
<th>B.</th>
<th>M.B.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EXPECTED</td>
<td>14.3</td>
<td>32.04</td>
<td>54.35</td>
<td>18.31</td>
<td></td>
</tr>
<tr>
<td>HS-10 OBSERVED</td>
<td>15</td>
<td>29</td>
<td>53</td>
<td>22</td>
<td>119</td>
<td></td>
</tr>
<tr>
<td>HS-4</td>
<td>7.57</td>
<td>16.96</td>
<td>28.77</td>
<td>9.69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HS-85</td>
<td>8</td>
<td>21</td>
<td>30</td>
<td>4</td>
<td>63</td>
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</tr>
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<td>7.0</td>
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<td>4.0</td>
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<tr>
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<td>6</td>
<td>12</td>
<td>6</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>56</td>
<td>95</td>
<td>32</td>
<td>208</td>
<td></td>
</tr>
</tbody>
</table>

$x^2 = 7.03$  \(\text{df} = 6\)  level of signif. = 0.05

$H_0$ IS NOT REJECTED
<table>
<thead>
<tr>
<th>SUBJECT #</th>
<th>RATE</th>
<th>PAY GRADE</th>
<th>SQUADRON</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AW2</td>
<td>5</td>
<td>HS-2</td>
</tr>
<tr>
<td>2</td>
<td>AW2</td>
<td>5</td>
<td>HS-2</td>
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<td>3</td>
<td>AW2</td>
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<td>HS-2</td>
</tr>
<tr>
<td>4</td>
<td>AW2</td>
<td>5</td>
<td>HS-2</td>
</tr>
<tr>
<td>5</td>
<td>AWC</td>
<td>7</td>
<td>HS-2</td>
</tr>
<tr>
<td>6</td>
<td>AW2</td>
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<td>7</td>
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<td>8</td>
<td>HS-10</td>
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<td>AWC</td>
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<td>AWC</td>
<td>7</td>
<td>HS-10</td>
</tr>
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<td>AW3</td>
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<td>HS-10</td>
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<td>AWH3</td>
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<td>HS-4</td>
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<td>AW1</td>
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<td>HS-5</td>
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<td>HS-85</td>
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<tr>
<td>37</td>
<td>AW1</td>
<td>6</td>
<td>HS-85</td>
</tr>
<tr>
<td>38</td>
<td>AW3</td>
<td>4</td>
<td>HS-85</td>
</tr>
<tr>
<td>39</td>
<td>AW2</td>
<td>5</td>
<td>HS-85</td>
</tr>
</tbody>
</table>
APPENDIX L

Test $H_0$: Results are independent of experience level.

- Use Pay Rate as measure of experience level and divide into two categories at the mean pay rate of the complete sample.

- Use Two methods to measure results.
  
  (1) Divide sub-samples into two groups - those which have higher percentage of responses at the complete sample mode and those with less.

  (2) Use the calculated mean rating (which may not be a valid statistic) and divide sub-samples into two groups - one with means higher than the mean of the complete sample and the other with means lower.

- Use a $2 \times 2$ Contingency Table.

- Conduct a Fisher Exact Probability Test of independence ($X^2$ can't be used because $N<20$.

### TEST HGU-27/P RATING INDEPENDENCE

#### Method (1)

<table>
<thead>
<tr>
<th>Pay Cat. #1</th>
<th>&lt;48%</th>
<th>48%+</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.7 to 5.62</td>
<td>5</td>
<td>3</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pay Cat. #2</th>
<th>&lt;48%</th>
<th>48%+</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.62 to 6.3</td>
<td>6</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>

TOTAL 11 9 20

NOT SIGNIFICANT AT 0.05% LEVEL  
(From Ref. 5, pg. 262)
APPENDIX L (cont'd)

TEST HGU-27/P RATING INDEPENDENCE
Method 2

<table>
<thead>
<tr>
<th></th>
<th>GREATER THAN 3.79</th>
<th>LESS THAN 3.79</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pay Cat.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.7 to 5.62</td>
<td>5</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
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NOT SIGNIFICANT AT 0.05 LEVEL OF SIGNIFICANCE
(From Ref. 5, pg. 262)

AVERAGE PAY RATES

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<tr>
<th>SUB-SAMPLE</th>
<th>AVERAGE PAY RATE</th>
<th>SUB-SAMPLE</th>
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<td>5.7</td>
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</tr>
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<td>5.2</td>
<td>15-1</td>
<td>5.5</td>
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<td>6.2</td>
<td>15-2</td>
<td>5.1</td>
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<td>15-3</td>
<td>5.9</td>
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<td>5.6</td>
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<td>6.3</td>
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MEAN PAY RATE OF COMPLETE SAMPLE 5.62
APPENDIX M

MEAN PAY GRADE OF SUB-SAMPLE

vs.

MEAN HGU-27/P RATING

MEAN PAY GRADE (E-)

@ mean of complete sample

E-7 Chief approx. 14-20 years
E-6 1st. class 8-10 years
E-5 2nd. class 3-5 years
E-4 3rd. class 1.5-2 years
## APPENDIX N

### SEAT KIT APPLICATION (1)

<table>
<thead>
<tr>
<th>SEAT KIT</th>
<th>AIRCRAFT</th>
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<tr>
<td><strong>Standard Soft Pack Assembly</strong></td>
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</tr>
<tr>
<td>A-1E</td>
<td>S-2A</td>
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<tr>
<td>EA-1E</td>
<td>TS-2A</td>
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<tr>
<td>EA-1F</td>
<td>T-28A</td>
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<tr>
<td>A-1G</td>
<td>OT-28B</td>
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<tr>
<td>A-1H</td>
<td>T-28C</td>
</tr>
<tr>
<td>A-1J</td>
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<td>EA-3B</td>
<td>S-2D</td>
</tr>
<tr>
<td>RA-3B</td>
<td>S-2E</td>
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<tr>
<td>TA-3B</td>
<td>U-1B</td>
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<tr>
<td><strong>High Speed Soft Pack Assembly</strong></td>
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</tr>
<tr>
<td>A-3A</td>
<td>AF-9J*</td>
</tr>
<tr>
<td>A-3B</td>
<td>F-1E</td>
</tr>
<tr>
<td>A-4C</td>
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</tr>
<tr>
<td>A-4E</td>
<td>F-4K</td>
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<tr>
<td>AF-1E</td>
<td>F-4M</td>
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<td>KC-130F</td>
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<td>A-4B</td>
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<td><strong>High Speed Soft Pack (Modified) Assembly</strong></td>
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<td><strong>Rigid Seat Survival Kit 1</strong></td>
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<td>F-4B</td>
<td>F-4J</td>
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<td>R-4K</td>
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<td>T-2A</td>
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<td><strong>Rigid Seat Survival Kit 8A</strong></td>
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<td><strong>Rigid Seat Survival Kit 9</strong></td>
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<td><strong>Helicopter Back Pack Assembly</strong></td>
<td>All Helicopters (Except those Authorized</td>
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<td><strong>Special Assembly</strong></td>
<td>Multiplace Life Rafts)</td>
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(1) Reference 1, Table 4-4, pg. 4-8, Change 2.
Reference 2, pg. 15-3, Change 4.