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BOOM OPERATOR PART-TASK TRAINER: TEST AND EVALUATION OF THE TRANSFER OF TRAINING

By

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Final Report

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AIR FORCE SYSTEMS COMMAND
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The report presents the rationale, methodology and results of a study of the training capabilities of the Boom Operator Part-Task Trainer (BOPPT), an air refueling simulator. The study was performed as part of an Air Force Initial Operational Test and Evaluation (IOT&E) of the device. Actually, three transfer of training sub-studies were conducted simultaneously: the first with undergraduate boom operators in the Combat Crew Training Squadron (CCTS) phase of instruction; the second with instructor boom operators in the Central Flight Instructor Course (CFIC); and the third with highly experienced boom operators who were maintaining essential skills.

In the CCTS application, it was found that all student groups trained in the BOPTT required significantly fewer air refueling attempts (50 versus 71) to reach proficiency in KC-135A air refueling skills than did

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conventionally trained students. In boom operations, procedures, and communications, the BOPTT trained students were equal or superior to the students in the standard syllabus. Also, proper utilization of the BOPTT could avoid over one million dollars in training costs per year.

For the CFIC application, the data show that trainees who received all training sessions in the BOPTT demonstrated proficiency equal to that of instructor trainees who received all training in the KC-135A aircraft. The 1:1 training transfer ratio afforded by the direct substitution of BOPTT training for aircraft training is striking confirmation of device effectiveness.

Finally, the skill maintenance data revealed that no measurable degradation of boom operator skills occurred for the duration of the two test periods (60 and 120 days). Consequently, no conclusions could be drawn concerning the effectiveness of the BOPTT in maintaining the proficiency of highly skilled boom operators.

PREFACE

This research was completed under project 1123, United States Air Force Flying Training Development; Task 112311, Operational Command Training Program Support; and Work Unit 11231108, Boom Operator Part-Task Trainer Initial Operational Test and Evaluation. Mr. James F. Smith was the project scientist and Dr. Thomas H. Gray was the task scientist. The report covers research performed between June 1978 and April 1979 by the Flying Training Division of the Air Force Human Resources Laboratory (AFSC).

The author wishes to express special appreciation to CMSgt Dale E. Lord, Detachment 1, 4200 Test and Evaluation Squadron, Castle AFB, California. Without CMSgt Lord's interest, dedication, and support, the research could not have been accomplished.

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BOOM OPERATOR PART-TASK TRAINER: TEST AND EVALUATION OF THE TRANSFER OF TRAINING

I. INTRODUCTION

This technical report presents the rationale, methodology, and results of a study of the training capabilities of a part-task trainer. The research was performed as part of an Air Force Initial Operational Test and Evaluation (IOT&E) of the device. The philosophy reflected in the research is well defined by three words: empirical, realistic, and, evaluative. It was empirical in that quantitative data were collected through observation and experiment. It was realistic because these data were generated under real-world operating conditions and within the environment where the trainer would be employed. Finally, it was evaluative because these data were used to determine the worth of the device for its designated training applications.

Background

As with most Air Force projects, a considerable "history" exists behind the final product. To detail the activities, decisions, and contributions of all the organizations and personnel involved would be far beyond the scope of this report. Therefore, only the key events in the program will be briefly summarized.

The Air Force Requirement. The final report of the Air Force Master Plan, Simulators for Aircrew Training, June 1974, identified the need for modern simulators to meet the Office of Management and Budget and Office of Secretary of Defense goal of reduced flying time, thereby cutting training costs. In addition, the energy crisis, escalating costs of aircraft operation, and the need to extend the life of operational aircraft necessitated capital investment in modern simulator capabilities and subsequent expanded simulator use.

The Strategic Air Command (SAC) believed that boom operator air refueling training was one area where simulation could be effectively applied. The heavy commitment of the KC-135A to support Air Force-wide operational and training sorties sharply reduced its availability for boom operator training. Thus, SAC KC-135A student boom operators were hampered in developing hands-on air refueling skills because of limited flying time. Training aids (films, slides, and mock-ups) provided a means for the student to conceptualize some operator skills, but they did not allow the instructor to present and explain basic refueling cues or give the student hands-on experience. As a result, a need existed to provide the student a means for safe and effective practice of air refueling tasks on the ground.

Consequently, in January 1974, SAC submitted a Required Operational Capability (ROC 2-74) which identified the need for a state-of-the-art air refueling simulator with proven reliability and training capacity. From this ROC, an Air Force program was begun to design, fabricate and test one proof-of-concept prototype KC-135A Boom Operator Part-Task Trainer (BOPTT). The first two steps of this in-house program were completed early in 1978; the subsequent operational testing of device training capability is the subject of this report.

BOPTT System Description. The KC-135A BOPTT (see Figure 1) is a fixed-base, ground trainer designed to duplicate essential air refueling cues. Major components of the BOPTT are a student station complete with boom operator pallet, "window," operator controls and indicators; a 1/100 scale model of the B-52 aircraft; and a 20-inch-long model of an aerial refueling boom. The instruments and controls operate as they would in actual flight. The boom operator's "window" is actually an optical system which makes the boom and receiver aircraft appear as they do in the real world.

The B-52 model is mounted on a three-axis gimbal that simulates aircraft pitch, roll, and yaw. A video image of the model is captured by a closed circuit TV camera and displayed on a CRT screen placed about 20 inches outside the boom operator's window.

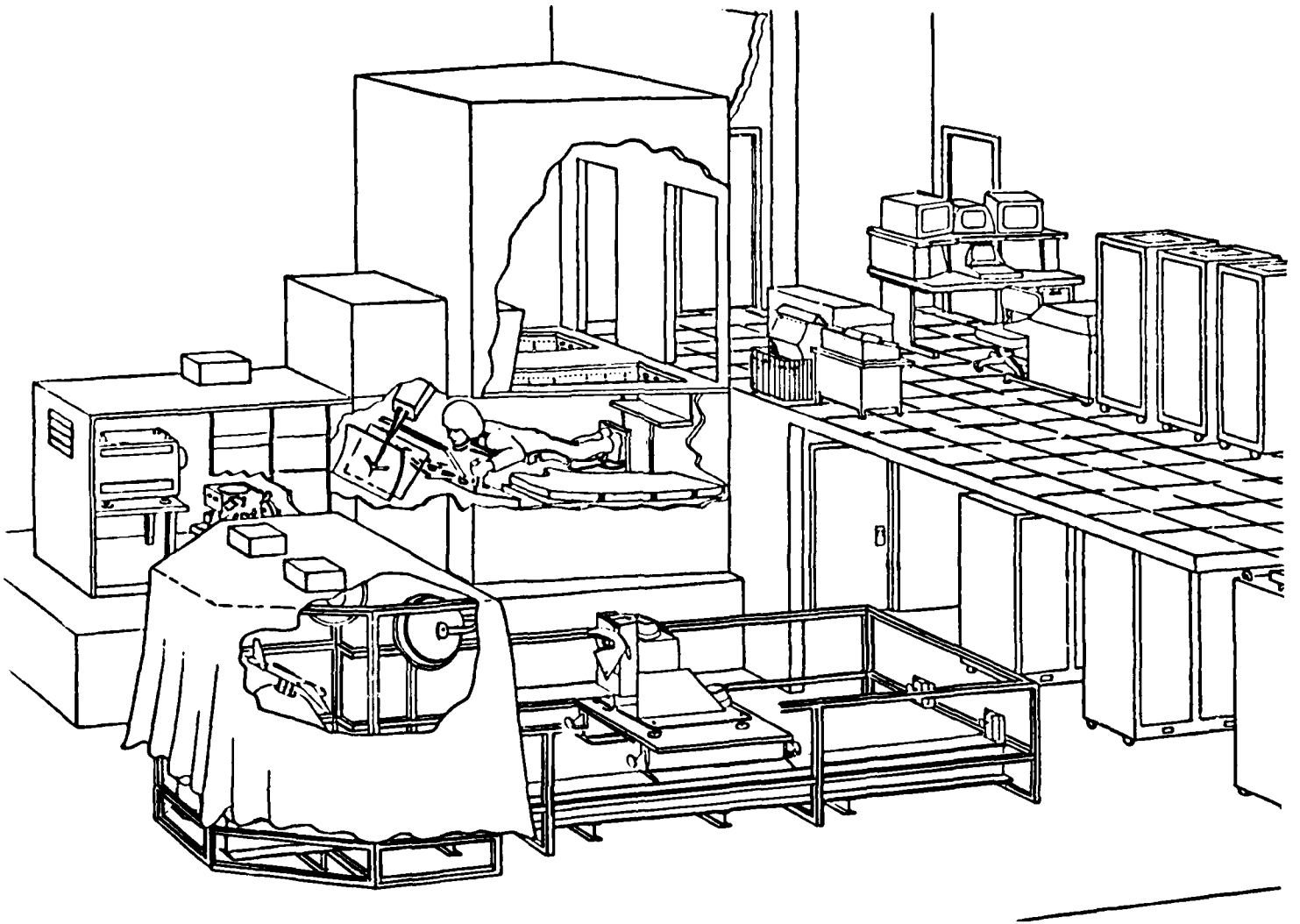

Figure 1. **Boom Operator Part-Task Trainer.**

The model boom is located between that screen and the window, and is designed so that the trainee operator can position and extend the boom and can simulate connecting it to the B-52. Clouds and ground terrain are displayed on the sc: en as they would be seen from the rear of a KC-135A. Engine noise and boom noise are produced electronically and played through speakers into the boom operator's station.

The BOPTT portrays the B-52 aircraft as it approaches the tanker from 1.25 miles through hook-up for refueling; the boom reacts to control inputs and aerodynamic forces. The simulation equations permit variations in refueling speed and altitude, amount of air turbulence, and the approach trajectory of the receiver aircraft. It is also possible to simulate five levels of B-52 piloting "skill" which range from novice to expert.

BOPTT Fabrication Site Testing. A preliminary evaluation of the training capabilities of the BOPTT was performed at Wright-Patterson AFB in February 1978. The purposes of this Qualification Operational Test and Evaluation (QOT&E) were to provide an economical and early look at the training potential of the BOPTT and to permit identification of correctable deficiencies in this regard. To accomplish these objectives, an investigation was made of the BOPTT's (a) capability for training boom operator tasks, (b) fidelity for training boom operator tasks, and (c) advanced instructional features.

Eight highly experienced SAC instructor boom operators were used as subjects for the QOT&E. Each subject flew three missions in the trainer and subjectively evaluated the device in three areas: training capability, fidelity, and instructional features utilization. Analyses of the responses showed the following:

1. The simulator would provide fully acceptable training in nearly all tasks performed by the boom operator. Training on many tasks was estimated to be approximately equal to that received in the aircraft.

2. The fidelity of the simulator was adequate for training applications. Although differences could be perceived between aircraft and simulator cues, there was sufficient fidelity for the majority of required boom operator tasks to be performed.

3. The instructional features were useful for training purposes and were necessary adjuncts for training certain tasks.

The evaluation was quite limited, and it was emphasized that the findings were not definitive and could be used only as estimates of the true training effectiveness of the BOPTT. Further investigations, conducted with scientific rigor and utilizing quantitative dependent measures, were planned to occur during the IOT&E.

Study Objectives

To satisfy test and evaluation objectives, SAC wrote a Request for Personnel Research (RPR 76-33) that addressed four primary issues and two secondary issues in boom operator simulator training. The overall goal of the study was to make long-range determinations of the cost-effectiveness of simulator training of boom operator skills in a limited flying environment. These determinations were to include consideration of undergraduate training in the Combat Crew Training Squadron (CCTS), training of instructor boom operator personnel, and device usage to maintain the proficiency of experienced personnel. Specifically, the four primary objectives of the study were as follows:

1. Determine the transfer of training from the BOPTT to the KC-135A aircraft for the CCTS boom operator student.

2. Evaluate the BOPTT training effectiveness for the instructor boom operator in the Central Flight Instructor Course (CFIC) when the BOPTT serves as the sole training device.

3. Investigate, to a limited extent, boom operator skill degradation and reacquisition for experienced personnel by substituting the BOPTT for the KC-135A aircraft as the practice medium.

4. Evaluate the cost effectiveness of the BOPTT in the CCTS program.

The following were secondary objectives:

1. Collect and analyze task frequency data on initial training for KC-135A boom operator tasks.
2. Determine the operator training required to support BOPTT system operations.

Study Rationale

The rationale that shaped the study had two components. The first of these dealt with the impact of system maturity on the evaluation of device training effectiveness; the second concerned the methods used in evaluating a system at the given stage of development.

System Maturity. The point of departure for this study was based on a "developmental" viewpoint. A simulator training system does not "spring full-blown from the procurement office." On the contrary, the system undergoes a period of development and maturation which in some cases may be very lengthy indeed. Furthermore, the simulator itself is only a device; it is but one element in the training system. A few of the factors that influence its "effectiveness" are user acceptance, the training syllabus, the tasks it is used to train, the caliber of students, and the imagination of training managers. Because a simulator training system passes through different phases of development, the results of an evaluation are a function of the point in time at which the evaluation was performed. Depending on when they are accomplished, two evaluations (of the same device) will (a) have different objectives (therefore, results), (b) use different techniques, and (c) be supported by different agencies and funds.

As pertains to most Air Force training devices, the evaluation process may be separated into three phases which occur at different stages of system maturity. While this arbitrary delineation of the evaluation cycle into three phases may be more ideal than real, the testing processes as described below are not. The objective of the first phase (typified by "qualification" testing) is to discover major problems, if any exist, that prevent the embryonic device from providing effective training. There are two important considerations incorporated in this objective. First, it is assumed that device modification (i.e., corrective action) is possible. Second, an estimate is made of the training *potential* of the device.

From the training research standpoint, the techniques associated with this first evaluation are far from robust. The subjects are usually "experts" and few in number. The device may not be completely functional in all areas and may have only limited availability (other testing is ongoing). Finally, the dependent measures are usually subjective ratings. The effort is normally funded by the Air Force Systems Command, with minor support from other organizations.

The objectives of properly conducted second phase training evaluations are more germane to the device's ultimate utilization. As above, it is necessary to identify (and correct, if possible) major system training deficiencies. But the main intent of the evaluation is to obtain a resonably accurate prediction of the training value of the system. This prediction should have sufficient validity to permit a reasonable approximation of device cost effectiveness and training transfer. It is not sufficient to determine that the device *can* train a designated task (first phase finding): some quantitative estimate of device *efficiency* must be derived.

Second phase evaluations depend upon techniques that provide "hard" data. The subjects should be a sample from the projected trainee population. The device should be free of correctable deficiencies and should be an approximation of its final stage of development. It should be operated in the training environment for which it was designed, and a prototype syllabus should be used for training the subjects. Objective measures of task performance should be available for scoring. This effort, usually termed an IOT&E, is generally funded by the Air Force Test and Evaluation Center or the using command.

Third phase evaluations deal with the mature training system *in situ*. In the ideal case, these evaluations have two purposes. The first is to determine the optimum utlization of the device within the training program. The second is to certify the device as a criterion training medium. Although it is easy to obtain Air Force agreement that it is essential to determine how, where, and when the device is most effective and efficient in a training program, certification that performance of a task in a simulator satisfies operational requirements is an idea that has yet to gain wide acceptance (as expressed in Air Force Regulation 50-11).

The evaluation techniques *per se* are extensions of those employed in second phase evaluations. Subjects are actual trainees, the device is fully operational, and positive transfer of training in some form provides the assessment criteria. The dependent variables used to measure transfer may be trials to proficiency, aircraft hours saved, degree of skill attained, or some other relevant gauge of performance.

The critical dimension by which third phase evaluations differ from second phase evaluations is the manipulation of independent variables. Assuming that a second phase evaluation established that the device provided a given degree of positive transfer under certain conditions, what elements in the training mix should be used or modified, to enhance the effectiveness of device utilization? The major variables amenable to manipulation (i.e., study) concern: training syllabus variation (i.e., sequence of presenting tasks, massed or distributed practice on these tasks, whole versus part-task training, etc); trainee characteristics (i.e., fast versus slow learners, experienced or inexperienced subjects, etc); use of adjunct training media (i.e., cognitive pretraining, utilization of simpler and cheaper training devices, etc); and, use of device special training capabilities (i.e., freeze and demonstration for better training, playback for self-confrontation, inserting special cues, etc.). Third phase evaluations are illustrated by Follow-On Operational Tests and Evaluations (FOT&E). They are usually funded by the using command.

Methodological Model. The evaluative method used in this study emphasized five points:

1. Conceptualizing the problem.
2. Developing a research strategy and design.
3. Selecting the target population.
4. Defining the dependent variables.
5. Determining data collection standards.

The problem was formulated as a straightforward evaluation of a training system in the second phase of development. The requirements for this type of evaluation (as defined in the preceding section) were *met: a successful QOT&E had been accomplished; the* BOPTT was in-place and operating; and a trainee subject pool was available. All that was needed were a syllabus and objective performance measures. The syllabus was rather easily produced because a comprehensive task analysis existed, and the QOT&E had yielded information that could be directly applied to this requirement. It was somewhat more difficult to develop objective performance measures, but this was accomplished in time to begin the IOT&E on schedule.

In an Air Force IOT&E, the study of transfer of training is limited to the investigation of what has been learned as a result of specific training experiences. In the selection of a research design to evaluate this process, the Instructional System Development (ISD) policy of training to criterion-referenced behavioral objectives is most beneficial. This "teaching the test" has the effect of producing parallel test forms which provide pretest and posttest benchmarks for measuring transfer. A true experimental design, labeled a "Pretest-Posttest Control Group Design" by Campbell and Stanley (1963), becomes a feasible approach. Such a design has sufficient validity to permit strong statistical inferences and was the one used in the study.

In the selection of samples for test and evaluation, the determination that a given sample is truly representative of the target population is an issue of major importance. The failure to achieve "representativeness" is usually due to two factors: calendar-linked errors and stratification errors. Most formal Air Force training programs are of rather short duration (i.e., 6 to 48 weeks) and in those courses teaching entry-level skills (e.g., CCTS programs) the ability level of the trainees is frequently tied to the calendar year. Although the all-volunteer force has had a leveling effect upon this phenomenon, classes at certain periods of the year are often greatly superior in ability to those at other periods. In some cases, this variation may be so extreme that there is no overlap in the distribution of test scores. In programs involving flying training, weather conditions will compound this inequality. Consequently, it is necessary to collect the sample over several classes throughout the year.

Stratification errors may be viewed as a subset of time-phase errors but are significant enough in their own right to warrant discussion. Because of the small N's (number of Subjects) normally encountered, if

the only "control" on sampling is randomization, the test and evaluation results depend heavily on chance. This potential problem may be circumvented through the use of matching. Measures of student ability relevant to training course tasks are often available and can be used for pretest matching of subjects. The subjects may then be assigned in a manner that will balance ability in the experimental and control groups.

In a training effectiveness test and evaluation, "scores" made by students in attaining course objectives form the basis for the dependent variables. These variables may be in the form of percent of correct responses, number of errors or trials, or some other quantitative index of performance. Aside from the necessary validity, the critical requirement that these measures must meet is that they be usable for estimating transfer (Diehl & Ryan, 1977).

Setting and maintaining data collection standards may seen a trivial and mundane undertaking, but an evaluation can founder unless this is properly done. A transfer of training study is intimately enmeshed in Air Force operations. To insure full cooperation, the operational people must be fully briefed as to the intent of the study and the means for carrying it out. The importance of their role in the data collection aspects of the project should be stressed. If data collection standards cannot be defined, and compliance with these standards achieved, there is no point in performing the study.

Organization of the Report

There were four primary and two secondary study objectives. To satisfy these objectives, it was necessary to perform three sub-studies: one dedicated to the CCTS area; one to the CFIC area; and, one to the skill retention area. All the research used transfer of training methodology, but the specific application of this technique differed for each sub-study. The bulk of the work was concentrated in the CCTS area because this would overwhelmingly constitute the major utilization of the BOPTT. For clarity, the methods, procedures and results of each sub-study will be presented in a separate section of the report.

II. PROCEDURES AND RESULTS: CCTS RESEARCH

The objectives of the CCTS sub-study were (a) to determine the transfer of training from the BOPTT to the KC-135A aircraft for the CCTS boom operator student and (b) to evaluate the cost effectiveness of the BOPTT in the CCTS program.

Background Information

For a more complete picture of the CCTS research, two items of background material are noteworthy:

CCTS Course Description. At the time of the study, the CCTS boom operator training program consisted of two phases. The first phase was composed of academic instruction and lasted 7 weeks. The phase concluded with a block of instruction devoted to air refueling operations and two KC-135A flights. These two flights were purely for orientation purposes, and no formal student training was given. Course grades were available for all academic material taught, including the last block.

The second phase of the CCTS program was flight training. This phase lasted 9 weeks, with the core of training being built around 15 KC-135A sorties of approximately 6.7 hours each. The flight training phase was partitioned into a 2-week pretraining (P) period with four sorties and a 7-week flightline (S) period with ten sorties. In sorties P-3 through P-6, the student received hands-on training in air refueling and performed an average of three contact attempts per flight. This training was intensified in sorties S-1 through S-10. The final aircraft sortie was an end-of-course evaluation checkride (60-4).

The division of flight training into pretraining and flightline periods had an unfortunate consequence. It produced a delay of approximately 10 days between the time when the students completed pretraining and the onset of flightline instruction. As will be apparent in the results, this delay had a detrimental effect upon student performance.

Baseline Data. Before the start of the controlled IOT&E study, baseline data were collected on four CCTS classes in undergraduate boom operator training at Castle AFB. There was a total of 46 students in these classes. Each of these classes was trained following the standard CCTS syllabus. Thus, the data from these classes provided a baseline against which to evaluate research controls and the BOPTT's impact on the training program.

Procedures

In order to obtain a valid assessment of device training effectiveness, the emphasis in the approach was to perform the study within the context of normal boom operator CCTS operations. The avoidance of "halo effects" was a basic guideline followed throughout the study.

Subjects. The subjects were 59 students enrolled in the boom operator CCTS program at Castle AFB. To generate a representative sample, all students in five consecutive classes participated in the study. The first class started training in April 1978, and the last class completed training in December 1978.

Group Equating. Four groups, one control and three experimental, were used in the study. To match these groups for greater reliability and generalization, grades on all academics and the air refueling block were equally weighted (50/50) and a rank order of "merit" assigned to each student in each of the five classes that provided subjects. The ranking was then used to place the students in one of the four study conditions. For example, in the first class, the subject ranked first was placed in the control group, the subject ranked second was placed in the first experimental group, etc., until all subjects were assigned. For the second class, the first-ranked student was placed in the first experimental group, the second-ranked student in the second experimental group, and so on. It was originally planned to use four classes, each with 16 students. If this plan could have been followed, the ranking procedure would have allowed all groups to be perfectly matched on the basis of demonstrated academic ability. However, due to attrition and uneven distribution of incoming students, student numbers in the classes varied from 5 to 16.

But even with these perturbations in class size, the matching technique worked very well. Table 1 lists the number of students in each group who were above or below the median ability level in academics. (The N is 56 because the rank order of three students *was* the median.) A chi-square analysis of these data did not show any significant difference in ability level among the four groups.

Table 1. **Academic Ability Level of Groups**

Groups	Number of Students Above Median Ability	Number of Students Below Median Ability
Control	7	8
Experimental 1	7	6
Experimental 2	8	7
Experimental 3	6	7

Proficiency Advancement. One of the most critical methodological aspects of this study was the use of proficiency advancement for all students in the Flightline Period. The use of proficiency advancement permitted a valid assessment of the BOPTT's training value and allowed a direct derivation of aircraft flight training savings attributable to the device.

Independent Variable. The independent variable for the CCTS sub-study was the amount of BOPTT utilization in the Flight Training Phase of instruction. Four levels of this variable were established:

1. The first level, a control condition (C), consisted of 16 subjects who received no BOPTT instruction. This group provided a direct check against the established baseline and was trained using the standard syllabus. All subjects received three refueling contact attempts in each pretraining KC-135A sortie.

This procedure was consistent with the aircraft training process as observed during the Baseline Data collection and was necessary in order to equalize learning trials among the four levels.

2. The second level, a minimal intensity experimental group (E_1), received four one-hour sorties in the BOPTT and no KC-135A training flights until the Flightline Period was reached. There were 13 subjects in this group.

3. The third level, a moderate intensity experimental group (E_2) received eight one-hour sorties in the BOPTT and also had no aircraft training until the Flightline Period. There were 15 subjects in this group.

4. The fourth level, a maximal intensity experimental group (E_3), was treated as the E_2 group but had additional individualized BOPTT training (eight sorties) during the Flightline Period. There were 15 subjects in this group. Table 2 presents a schematic of the study.

Table 2. **Study Design: CCTS Research Flight Training**

	2-Week Pretraining Period				7-Week Flightline Period			60-4 Checkride
Groups	Test			Test	Test			Test
Control N=16	P-3	P-4	P-5	P-6	S-1		S-10	Stan Eval
E_1 N=13	BOPTT	4 hrs BOPTT		BOPTT	S-1		S-10	Stan Eval
E_2 N=15	BOPTT	8 hrs BOPTT		BOPTT	S-1		S-10	Stan Eval
E_3 N=15	BOPTT	8 hrs BOPTT		BOPTT	S-1	8 hrs BOPTT	S-10	Stan Eval

Prototype Training Program. The results of the QOT&E indicated that most boom operator tasks could be trained in the BOPTT. A task analysis of the boom operator duties existed, and this was used to develop a prototype course of instruction. Expert boom operator instructors wrote a special syllabus to be used with the device. The syllabus consisted of two parts: a Student Guide and an Instructor Guide. The entire syllabus was built around eight refueling mission scenarios (i.e., sorties) that encompassed the boom operator's tasks. Accompanying each scenario was a student lesson guide that contained three areas of concentration for student training: mission conditions (i.e., day, VFR, degree of turbulence, etc.); tasks to be accomplished (i.e., checklist items, communications, etc.); and, written materials recommended for student study prior to practice in the simulator. Each scenario was one hour in length. These scenarios possessed one restriction which must be emphasized–*each contained three, and only three, refueling attempts.* This was done in order to equate air refueling contact opportunities between the experimental and control groups. A facsimile of the Student and Instructor Guides is given in Appendix A.

The prototype BOPTT training program was incorporated into the course of instruction for the three experimental groups. For the E_1 and E_2 groups, all BOPTT training was accomplished in the Pretraining Period. As stated, this training consisted of four sorties for the E_1 Group and eight sorties for the E_2 Group. The E_3 Group had eight BOPTT sorties in the Pretraining Period and eight during the Flightline Period.

Dependent Variables. Two sets of measures served as dependent variables in this sub-study. The first of these was a simple count of the number of air refueling contacts needed to reach proficiency. These measures are identical to a "trial" in most psychological studies of learning and constitute the lowest common denominator of skill acquisition in boom operator training.

A specially constructed objective performance test comprised the second set of measures. This test, named the Boom Operator Progress Evaluation, was used as the criterion of student ability in boom operator tasks. The items in this scale were taken from the three skill areas (procedures, communications, and boom control and operation) critical to this job as defined by ISD task analysis. At the four evaluation points where the test was administered, each item attempted was graded by the Instructor (in training flights) or the Stan Eval Boom Operator (in the 60-4 checkride). These evaluations were then used to compute the student's percent-correct score, which could range in value from zero to one hundred. A facsimile of the Boom Operator Progress Evaluation is presented in Appendix B.

Evaluation Points. In order to obtain a better understanding of how BOPTT utilization affected training and a more accurate assessment of its value to the CCTS program, measures of its training effectiveness were taken at four points in the Flight Training Phase: at P-3, P-6, S-1, and 60-4. This procedure allowed an initial, two intermediate, and a final look at the utility of the device.

Study Design. Table 2 is a schematic of the CCTS study design.

Data Analysis. The air refueling contact data were analyzed using a simple randomized group analysis of variance. The data from the Boom Operator Progress Evaluation formed a matrix in which there were repeated measures on four groups of subjects. These data were analyzed using Winer's analysis of variance model for a two-factor experiment with repeated measures on one factor (Winer, 1962, pp. 298–318).

Interviews. As an adjunct to the quantitative data collected, 10 senior flightline Instructor Boom Operator and Stan Eval personnel were interviewed to ascertain their attitudes and opinions on the BOPTT program. Data of this nature are highly subjective, but they provide insights that can be obtained in no other manner.

Results

The first research objective may be posed as a simple question: In CCTS, how well does BOPTT training transfer to the aircraft? The answer is: quite well. Both the quantitative (air refueling contact attempts and performance measures) and qualitative (interviews) data substantiate this response.

Quantitative Data Results. Table 3 summarizes the refueling contact attempts (i.e., trials to proficiency) data. Four (one for each event category) randomized-groups analyses of variance were performed on the raw data.

Table 3. **Aircraft Refueling Contact Attempts to Achieve Proficiency: All Groups**

Group	n	Total Range	Total Mean	Day Mean	Night Mean	Tanker Manual Operations[a] Mean
Baseline	46	42–106	72.83	51.30	21.54	19.63
Control	16	49–126	71.06	50.31	20.75	19.06
E_1	13	41–73	53.38	36.15	17.23	17.08
E_2	15	41–83	53.60	37.47	16.20	21.73
E_3	15	25–88	50.00	33.13	16.87	15.87

[a]Event is dual-logged in conjunction with day and night contact attempts.

In all four analyses, Scheffe's criterion was used in testing for significant group mean differences. This test is extremely conservative (the critical ratio is determined at the maximum value for all possible mean pair comparisons), so the number of significant differences reported are minimized (Winer, 1962). Even with this "understated" statistical approach, however, the findings indicated that the BOPTT did an excellent job. All tests were run at the 5 percent level of significance.

Analysis of the total attempts showed no reliable differences between the Baseline and Control Groups. There were reliable differences between these two groups and all experimental groups. The experimental groups did not differ among themselves in a reliable manner. Exactly the same result and pattern were found when the Day attempts were analyzed. There were no reliable differences of any kind for Night and Tanker Manual Operations comparisons.

Five two-way analyses of variance were run on the performance measurement data for the four study groups. All five analyses uncovered significant main effects for groups and repeated measures: however, there was always a significant interaction between these two factors. The presence of this interaction effect required that the analysis for simple effects (group means within measurement conditions) be performed using t-tests.

Figure 2 is based on total score data and clearly illustrates the pattern of results found for all performance measures data.

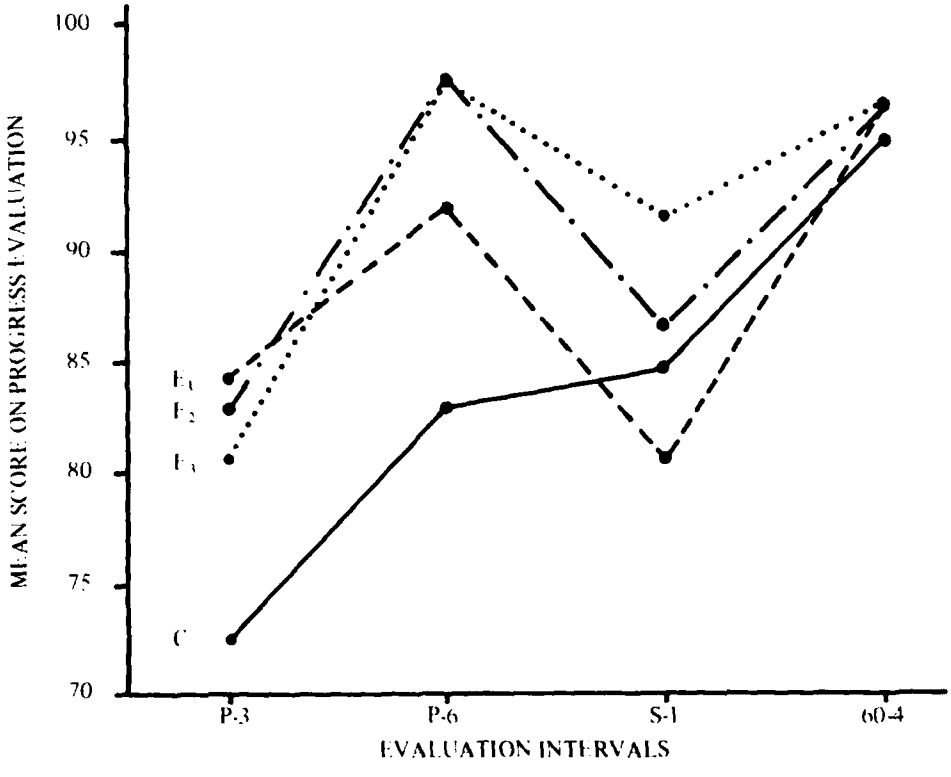

Figure 2. **Pattern of performance measures data.**

Table 4 gives the mean total score on the Boom Operator Progress Evaluation achieved by the four study groups at the four evaluation points. At the P-3 point, all Experimental groups demonstrate reliably better performance than the Control Group, but do not differ reliably among themselves. This finding is repeated at the P-6 point. At the S-1 point, the E_3 Group is significantly above the E_1 Group, with no significant differences in the C, E_1, and E_2 Groups. At the 60-4 point, there are no significant differences among the groups.

Table 4. **Mean Score on Boom Operator Progress Evaluation: Total Score**

Group	P-3 Eval Point	P-6 Eval Point	S-1 Eval Point	60-4 Eval Point
Control	72.36	82.83	84.45	94.84
E_1	84.05	91.75	80.37	96.40
E_2	83.11	97.54	86.57	96.11
E_3	80.57	97.56	91.44	96.01

Table 5 presents the mean percentage of items perfectly accomplished by each group at the selected evaluation points. (Perfectly accomplished items provide a highly sensitive index of performance.) There are no reliable differences at the P-3 point, but at P-6, all Experimental groups are significantly superior to the Control Group. The Experimental Groups did not differ significantly among themselves. The E_3 Group is superior to the C and E_1 Groups at the S-1 point, but not to the E_2 Group, with no significant differences observed among the C, E_1 and E_2 Groups. By the 60-4 point, all significant differences among groups have vanished.

Table 5. **Mean Percent of Perfectly Accomplished Items: Boom Operator Progress Evaluation**

Group	P-3 Eval Point	P-6 Eval Point	S-1 Eval Point	60-4 Eval Point
Control	15.27	45.32	44.49	87.53
E_1	38.53	72.52	38.63	89.33
E_2	35.13	93.27	56.55	86.73
E_3	35.65	90.51	70.35	89.95

Tables 6, 7, and 8 document the average performance of the groups studied with respect to the three principal components of the boom operator's job. Table 6 presents the data on boom control and operation. At the P-3 point, the E_2 and E_3 Groups are superior to the C group with no significant difference between the C and E_1 Groups. At P-6, the E_2 and E_3 experiment groups are superior to the C Group with no significant differences between themselves. They are not reliably superior to the E_1 Group which does not differ reliably from the C Group. By S-1, all significant differences disappear and remain absent at the 60-4 evaluation point.

Table 6. **Mean Score on Boom Operator Progress Evaluation: Boom Control and Operation Only**

Group	P-3 Eval Point	P-6 Eval Point	S-1 Eval Point	60-4 Eval Point
Control	66.89	77.73	74.16	88.11
E_1	78.33	87.72	71.99	92.62
E_2	82.00	96.07	76.35	91.12
E_3	80.67	94.09	84.41	91.15

Table 7. **Mean Score on Boom Operator Progress Evaluation: Procedures Only**

Group	P-3 Eval Point	P-6 Eval Point	S-1 Eval Point	60-4 Eval Point
Control	70.39	82.69	86.41	99.24
E_1	85.73	99.37	83.57	96.96
E_2	83.75	99.04	90.36	97.79
E_3	81.58	98.57	94.30	98.34

Table 8. **Mean Score on Boom Operator Progress Evaluation: Communications Only**

Group	P-3 Eval Point	P-6 Eval Point	S-1 Eval Point	60-4 Eval Point
Control	66.23	80.83	83.69	93.73
E_1	78.73	86.65	71.77	98.27
E_2	79.97	96.37	81.64	95.77
E_3	74.98	98.55	87.91	95.83

Table 7 lists the data on procedures and tells much the same story as Table 6. At the P-3 point, all Experimental Groups are significantly better than the Control Group, but do not differ significantly among themselves. This finding is repeated at the P-6 point. At the S-1 point, the E_3 Group is reliably better than the E_1 Group, with no reliable differences among the C, E_1, and E_2 groups. As in Table 5, no significant differences exist at the 60-4 point.

The information depicted by Table 8 tells much the same story. At the P-3 point, the E_1 and E_2 groups are better in communications than the C group, but not the E_3 Group, with no significant differences between the C Group and the E_3 Group. At the P-6 point, the E_2 and E_3 are reliably above the C Group, but not the E_1 Group. There are no reliable differences between the C and E_1 Groups. The E_1 Group is significantly inferior to the E_3 Group at S-1 with no other significant differences among the groups at this point. At the 60-4 point, there are no reliable differences among the groups.

Qualitative Data Results. The open-ended interviews could not be quantitatively analyzed but did provide a valuable source for a greater understanding of the BOPTT program. Although the feelings expressed by the interviewed personnel were not always in complete accord, there was considerable agreement as to the program components on which the comments were made. This result was interpreted as the significant finding revealed by the interviews. The statements listed below comprise the essence of the points reported by the majority of those interviewed.

1. The BOPTT Training Effects. Nearly all interviewees believed that BOPTT improved the skills of the students who had received training in the device. Specific items mentioned were:

a. Communications. The opinion was unanimous that BOPTT students were more familiar with radio calls and performed all communication functions better than non-BOPTT trained students.

b. Procedures. Students trained in BOPTT started their aircraft training flights with a proficiency normally not equalled until the fifth flight.

c. Boom Control and Operations. Minor deficiencies in the fidelity of simulation in the BOPTT (i.e., slipway non-existence and target depth perception cues) produced some training problems for the students in early aircraft flights, but these problems were rather quickly overcome and overall the effects of

BOPTT training were quite positive. The confidence instilled by the device was viewed as "a big plus." The maority of interviewees believed that the BOPTT trained students were better than previous students, particularly by showing more familiarity with the boom pod and controls. One interesting observation was that because the BOPTT does not have a slipway capability, the students tended to make "precision" contacts. This will help the boom operator with the fighter refueling task later in his career. The areas where training improvement in BOPTT was suggested dealt with breakaway and malfunctions.

2. The BOPTT Syllabus. The BOPTT was not optimally integrated into the CCTS program. Although this integration will eventually occur, at the time of the study, scheduling problems occurred between the aircraft training missions and the simulator training missions for the E_3 Group.

3. Optimum BOPTT Utilization. The interviewees felt that the 8-sortie group was clearly superior to the 4-sortie group, but that the 16-sortie group showed only a small advantage over the 8-sortie group. It appears that simulator training reaches asymptote at about the tenth BOPTT sortie, and additional training does not produce easily observable benefits in the aircraft.

4. Critical Point. One important fact uncovered was the existence of flightline operation procedures which penalize the flightline Instructor Boom Operator for "proficiency advancing" a student. If the student finished early, the instructor would usually be assigned other duties not associated with instruction. An instructor with no student load was "in limbo" and was subject to assignment to fill-in flights and other duties. This procedure undoubtedly affected the proficiency advancement of students in the flight training phase of CCTS.

BOPTT Cost Effectiveness in CCTS

The fourth primary objective was to evaluate BOPTT cost effectiveness in the CCTS program. There were two difficulties encountered in meeting this objective. First, accurate fixed costs information on SAC boom operator training, sufficiently detailed to satisfy precise accounting procedures, was not available. Second, an Air Force cost effectiveness model sensitive to critical training parameters does not presently exist.

Fortunately, SAC did have cost data on the overall expense of training a CCTS boom operator. These cost data were broken down by training phase and identified the direct costs in the flight phase. Although this information was not as "fine-grained" as desired, it was complete enough to be usable for IOT&E purposes. The second difficulty was overcome by using a very simple "substitution" model. In this model, the costs associated with BOPTT operation, weighted by the device's demonstrated transfer of training ratio was compared to official SAC program cost figures.

Using this simple model, the analysis of the potential savings that could be realized through proper BOPTT utilization in CCTS presents an extremely favorable outlook. According to SAC accounts, current costs to graduate a CCTS student are $77,007. Of this figure, $65,043 is incurred in the flight training phase, with $31,419 being a direct expense. When Control Group data are considered, the mean number of aircraft refueling contact attempts required by CCTS students to reach proficiency was approximately 71. This translates to an average cost of $442.52 per contact attempt. The equivalent cost in the BOPTT is $24.00 per contact attempt.

The data from the Experimental Groups may be interpreted to show that a reduction of 20 aircraft contact attempts may be made by directly substituting BOPTT for the KC-135A without suffering a loss in student proficiency. Since performing a contact attempt in the BOPTT is $418.52 less expensive than doing its counterpart in the aircraft, the total savings per CCTS student would be $8,370.40. Based on an estimated CCTS output of 170 students per year, the resultant savings would be $1,422,968.

III. PROCEDURES AND RESULTS: CFIC RESEARCH

The objective of the CFIC research was to evaluate the effectiveness of the BOPTT when used as a surrogate for the KC-135A aircraft.

Background Information

The purpose of the CFIC is to upgrade a qualified boom operator to instructor status. The course is 5 weeks long and consists of academic training, mission planning, and equipment operation (flying). Although the job duties require that a graduate of this course be qualified to instruct in three areas (i.e., ground training, cockpit procedures training, and flight training), the actual criterion for course completion is demonstration of proficiency in boom operation. In preparation for this checkride, the instructor boom operator trainee is given five missions in the KC-135 to polish the boom operations technique.

The academic training portion of CFIC precedes the mission planning and flying portions. Grades are available from this initial part of the course.

Procedures

The simplicity and directness of the objective permitted an extremely straightforward study approach. The sample population, variables and study design, and analysis are reflections of this fact.

Subjects. The subjects were 21 trainees in the CFIC for Boom Operators. These subjects were the entire student population of four classes during the period June through October 1978. It was originally planned to use 30 subjects in the evaluation, 15 in a control group and 15 in an experimental group. These subjects were to have been selected from each class and systematically assigned to one group or the other. But again, due to fluctuations in the number of incoming students and course attrition, the desired N could not be reached. Instead, the final sample consisted of 9 trainees in the control group and 12 in the experimental group.

As in the CCTS research, the groups to which these trainees were assigned were balanced using the trainee's demonstrated academic ability. Subjects from each class were ranked on the basis of their academic test scores. In the first class, the top-ranked subject was placed in the Control Group, the second-ranked in the Experimental Group, etc., until all class members were assigned. This procedure was reversed for the second class. The members of the third class were assigned as those of the first, and the fourth as those of the second.

Independent Variable and Study Design. The point of this sub-study was, of course, the utilization of the BOPTT in lieu of the four KC-135A flight missions. This substitution was done on a one-for-one basis in which the Control Group was trained using the standard syllabus while the Experimental Group was trained with the same syllabus but the simulator served as the sole practice medium (see Appendix C). In point of fact, the use of the term "one for one" may be misleading: one hour in the BOPTT was substituted for approximately 6 hours in the KC-135A.

Thus, for the Experimental Group, the only aircraft flight was the evaluation checkride. Table 9 gives a schematic of the study design.

Table 9. **Study Design: CFIC Research**

Groups	Training Period	Evaluation
Control (9 subjects)	CFIC Syllabus Four 6-hour flights in the KC-135A	KC-135A Flight
Experimental (12 subjects)	CFIC Syllabus Four 1-hour BOPTT missions	KC-135A Flight

Dependent Variable. The evaluative procedure routinely followed for the end-of-course checkride in the CFIC syllabus was not sufficiently quantitative for use in this study. However, the content of Boom Operator Progress Evaluation was perfectly suited for this purpose and was used as the criterion.

Data Analysis. Since the research design was based on a comparison of the performance of two groups, a t-test was used for the analysis. In accordance with Cohen (1977), a post hoc power analysis was run on the result of this test.

Results

The data presented in Table 10 give a succinct summary of the results of the CFIC sub-study. A t-test was performed to determine if reliable differences existed between the means of the Control and Experimental Group. The resulting value of .11 did not reach the 5 percent level of significance. Such an outcome would be expected with even a casual glance at Table 10, but the importance of this finding requires some exposition.

Table 10. **Instructor Boom Operator Evaluation Check Ride Results**

Group	N	Range	Mean	SD
Control	9	74.4 to 100	96.04	8.63
Experimental	12	88.0 to 100	96.37	3.98

A power analysis (Cohen, 1977) of the magnitude of the observed effect showed that the mean differences between the two groups did not significantly differ from zero. There was a nearly total overlap of the distribution of scores. Considering the size of the mean differences, several thousand cases would be needed to prove any reliable treatment effect. With the currently projected class sizes in the CFIC, it would take decades to demonstrate that one training condition was superior to the other. This time period exceeds the planned in-service life-span of the KC-135A.

IV. PROCEDURES AND RESULTS: SKILL MAINTENANCE RESEARCH

The objective of this sub-study was to perform a limited investigation of the BOPTT's capability for maintaining the skill of experienced boom operators.

Procedures

Eighteen experienced boom operators stationed at Castle AFB were used as subjects. These individuals were academic instructors and staff personnel who maintain proficiency as instructors.

The subjects were randomly assigned to a control group and two experimental groups (E_1 and E_2). The control group simply continued their normal flying duties. After being excused from flying requirements, the E_1 group did not fly or perform boom operator duties for a 60-day period. Flying requirements were also waived for the E_2 group, but in this case, the non-flying or boom operating period was extended to 120 days.

At the onset of the research, the subjects in all three groups were administered a special in-flight test, the Boom Operator Progress Evaluation. Sixty days later this test was given again, with a third testing administered 120 days after the first. The final retest was to occur 180 days after the start of the study. The E_1 group was to receive 4 hours of training in the BOPTT between the second and third test and the E_2 group was scheduled for such training after the third test. A schematic of this sub-study is presented in Table 11.

A randomized group analysis of variance was intended to be used to analyze the data. For reasons that will be explained later, this step was never taken and the sub-study was terminated before its planned conclusion.

Table 11. **Study Design: Skill Maintenance Research**

Groups	Special Test	Sixty Days	Retest #1	Sixty Days	Retest #2	Sixty Days	Retest #3
Control (6 Subjects)	All	Normal Flying	All	Normal Flying	All	Normal Flying	All
E_1 (5 Subjects)	All	No Flying	All	BOPTT Training	All	Normal Flying	All
E_2 (7 Subjects)	All	No Flying	All	No Flying	All	BOPTT Training	All

Results

All 18 subjects scored 100 percent on the first administration of the performance test. The same occurrence was observed for the first retest. It was repeated (with one minor exception for one subject in the E_2 Group) in the second retest. Since there was no measurable degradation of boom operator skills for the duration of the two test periods, no conclusions can be drawn as to the effectiveness of the BOPTT in this application. This lack of measurable skill deterioration during the no-flying periods is assumed to be a consequence of the extremely high competence and experience level of the personnel used as test subjects.

V. SECONDARY OBJECTIVES

As previously stated, the two secondary objectives were to (a) collect and analyze task frequency data on initial training for KC-135A boom operator tasks and (b) determine the operator training required to support BOPTT system operations. The secondary objectives were achieved by careful observation and a simple "cut and try" approach. Such pragmatic and direct methods are unrefined but proved highly effective in this case.

Task Frequency Data

The principal interest was in the number of air refueling contact attempts required to obtain an adequate proficiency level for boom operation tasks. These data were compiled from all undergraduate boom operator students in Classes 78-09, 78-10, 78-11, and 78-12 (total N equals 46). Instructor personnel collected these data and forwarded them to the IOT&E test director who then documented and tabulated them. The results of this effort are shown in Tables 12, 13, 14, and 15. These data will provide a statistical base to be used in updating the CCTS training syllabus.

Table 12. **Total Aircraft Refueling Contact Attempts Required to Reach Proficiency**

Group	N	Range	Mean	SD
Baseline	46	42–106	72.83	16.43
Control	16	49–126	71.06	19.76
E_1	13	42– 73	53.38	10.15
E_2	15	41– 83	53.60	12.98
E_3	15	25– 88	50.00	16.18

Table 13. **Day Aircraft Refueling Contact Attempts Required to Reach Proficiency**

Group	N	Range	Mean	SD
Baseline	46	24– 83	51.30	10.87
Control	16	29– 98	50.31	16.14
E_1	13	25– 53	36.15	7.91
E_2	15	23– 48	37.47	7.98
E_3	15	15– 63	33.13	12.99

Table 14. **Night Aircraft Refueling Contact Attempts Required to Reach Proficiency**

Group	N	Range	Mean	SD
Baseline	46	8– 40	21.54	6.83
Control	16	8– 33	20.75	7.78
E_1	13	8– 28	17.23	6.34
E_2	15	4– 35	16.20	8.62
E_3	15	8– 25	16.87	6.94

Table 15. **Tanker Manual Operations Aircraft Refueling Contact Attempts Required to Reach Proficiency[a]**

Group	N	Range	Mean	SD
Baseline	46	7– 39	19.63	8.90
Control	16	8– 40	19.06	10.43
E_1	13	10– 28	17.08	5.45
E_2	15	11– 25	21.73	11.42
E_3	15	5– 43	15.87	8.92

[a]Event is dual logged in conjunction with day and night contact attempts.

Operator Training

The BOPTT operator crew was composed of five persons, all classified as Bomb Navigator Tactics Specialist (AFSC 34136), skill level three. Two persons of this group had previous electronics experience that gave them some understanding of the capabilities of the keyboard used to operate the BOPTT. Three of the operators were cross-trainees and two were direct from basic training to technical school and then to Castle AFB. All attended the AFSC 34136 specialty school.

The actual training for BOPTT operation received by these personnel consisted of the following:

1. Individual study of the BOPTT prime item development specification.

2. Observation of tapes of the aerial refueling task.

3. Participation in aerial refueling activities during a KC-135A mission.

4. Briefings from qualified Instructor Boom Operators on boom operator training and the syllabus of instruction.

5. One week of hands-on training at the operator's console under the tutelage of senior technical personnel. At the end of this period, all operator personnel were able to provide basic control inputs and

standard responses for training operations. The two operators with previous electronics experience were capable of controlling deviations from standard routines. All operator personnel were able to handle such problems within 3 weeks.

The major training problem encountered was in developing an understanding of the B-52 and KC-135A aircraft crew positions in order to control non-routine training operations and to provide communications. There was some difficulty with learning to play the role of the B-52 receiver aircraft.

VI. DISCUSSION AND RECOMMENDATIONS

An often ignored but fundamental truism is that the proper understanding of "training" requires a systems approach. Unless the training system is considered in toto, it is likely that an erroneous picture will be drawn when any one piece of the system is viewed in isolation. The training system of which the BOPTT will become a part is no exception to this rule. The BOPTT is only a device. Of the six major elements in a training system (i.e., equipment, syllabus, instructors and evaluators, maintainers, managers, and students) the BOPTT is merely one of the media used. It must also be realized that a training system is interactive with itself. As the BOPTT becomes integrated into the total training system, all six elements will be affected to some degree. It is probable that the BOPTT's capability within the system will increase, with the most substantial gains being realized in the initial program stages. Thus, it is premature to attempt a definitive evaluation of the BOPTT's contributions at this time. Nevertheless, using the findings of the IOT&E, substantial recommendations concerning BOPTT utilization can be made with confidence.

The BOPTT in CCTS

The main research emphasis was BOPTT usage in CCTS. In discussing the IOT&E results from this BOPTT application, there are six salient points:

1. The validity of the study. One result that argues well for high study validity is the very close correspondence in the performance of the Baseline and Control Groups. The nearly identical air refueling contact attempt data (see Tables 12 through 15) for these two groups are evidence that the IOT&E was conducted under normal circumstances and that the Control Group was trained using the standard CCTS syllabus.

Opposed to this finding is the P-3 Progress Evaluation test data which reveals that the Experimental Groups were generally superior in performance to the Control Group. (The same finding at the P-6 point is not relevant; it could easily be the result of better training in a better device.) If the groups were balanced in ability (they were) and had received equal training (they had), then why the disparity? Were the subjects in the Experimental Groups of higher ability than those in the Control Group? It is most unlikely that this was the case. In fact, the raw data might be interpreted to show that the Control Group had a small (definitely not statistically reliable) edge in ability over the Experimental Groups. It is believed that the explanation for the P-3 "anomaly" is found in the two devices where the testing occurred: the BOPTT and the KC-135 aircraft. The test was more difficult to administer, perform, and score in the aircraft. The "dip" in performance observed for all Experimental Groups at the S-1 evaluation point supports this position.

2. Transfer of Training. To be successful, a transfer of training study involving simulation must prove two things: (a) training occurs in the simulator, and (b) this training transfers positively to the real device. The first point is demonstrated by the gains between the P-3 and P-6 evaluation points for the Experimental Groups. Not only is there significant improvement in performance, but also, this improvement is precisely in the direction and to the degree that would be predicted.

The second point is also confirmed by the data. All Experimental Groups were slightly superior (although not statistically reliably so) to the Control Group on the 60-4 checkride. The important element to remember here is that this performance was achieved in roughly 40 percent fewer trials (an average of 52.33 trials versus 71.06) in the aircraft.

3. Efficiency of BOPTT. By using the trials to proficiency data, the BOPTT's true transfer efficiency can be calculated. The mean number of aircraft trials saved by the Experimental Groups was 18.73. The mean number of simulator trials for these groups was 28. The resulting ratio yields a value of .67 which is estimated as the BOPTT's transfer of training efficiency.

A caveat must be filed with this statement. The BOPTT's effectiveness is a function of the trainee's proficiency: the device is nearly 100 percent efficient in the initial stages of boom operator training, but declines below this level in the final stages.

4. The consequences of proficiency advancement for the instructor boom operator. The "other duties" penalty inflicted upon the instructor who proficiency advanced a student very likely inflated the contact attempts count. It is suspected that the impact of this "lockstep" training was most severe for the E_3 group.

5. Artificial restriction of contact attempts in the BOPTT. In the effort to generate comparable data for deriving a transfer effectiveness ratio, the students in the experimental groups were limited to three contact attempts per BOPTT training sortie. This procedure did succeed in producing the desired data, but unquestionably it reduced the effectiveness of the training that could have been provided by a one-hour BOPTT sortie.

6. Costs Avoidance Capabilities. The BOPTT has enormous potential to reduce costs in the CCTS boom operator program. It is believed that efficient use of several copies of this device at various bases could save SAC several million dollars per year.

The training value of the BOPTT is well enough established to warrant the following recommendations:

1. The number of attempted contacts per BOPTT sortie should be increased to four or more.

2. The BOPTT should be used for training students in refueling other than B-52 aircraft (e.g., the C-5A, F-4, and FB-111).

3. The entire CCTS program of instruction should be modified to take maximum advantage of the BOPTT's training capability. The CCTS program should be changed so that: (a) Two BOPTT sorties are included in the academic phase of instruction. (b) The Pretraining Period of flight training is eliminated; six BOPTT sorties should replace this phase of instruction. (c) The Flightline Period include four BOPTT sorties for individualized student training and two sorties dedicated to refueling training for other than B-52 receivers. (d) The number of aircraft missions in the Flightline Period be reduced to six; the 60-4 Evaluation Checkride should remain as a separate mission.

The BOPTT in CFIC

Within the framework of the current CFIC syllabus, it would appear that the BOPTT is a perfectly adequate replacement for the KC-135A training flights. In this study, the BOPTT was equal to the aircraft as a training and practice medium. In light of this fact, the following recommendations are made for the CFIC program:

1. Four KC-135A training flights should be removed from the curriculum. Four 1-hour training missions in the BOPTT should be placed in their stead.

2. One KC-135A training flight should remain and be used for instruction that cannot presently be accomplished in the BOPTT (e.g., emergency gear and flap landings).

3. The BOPTT should be employed as a "classroom" wherein the candidate instructor can perform "practice teaching." Such BOPTT utilization would allow the candidate instructor to receive on-the-job training working with real students under the tutelage of qualified professionals. The capability of simulation to provide and control all aspects of the boom operation environment offers opportunities for course improvement in CFIC.

The BOPTT in Skill Maintenance

Although the sub-study on skill maintenance was not completed, the evidence from the CCTS and CFIC BOPTT sub-studies indicates that the device should be effective in this application. Considering the CCTS and CFIC results, it seems safe to make this extrapolation.

VII. CONCLUSIONS

The results of the BOPTT IOT&E support the following statements:

1. CCTS students trained in the BOPTT required significantly fewer air refueling attempts to reach proficiency in KC-135A air refueling skills than CCTS students trained by the standard syllabus. In boom operations, procedures, and communications, BOPTT trained students were equal or superior to students trained using the standard syllabus. The BOPTT training transfer ratio is 1:1 in the early phases of flight training but declines in the later phases with an average of approximately 3:2 for the total flight program.

2. The utilization of the BPTT as a surrogate for the KC-135A in the CFIC produced results as positive as those observed in the CCTS application. Instructor trainees who received all training sessions in the BOPTT demonstrated proficiency equal to that of instructor trainees who received all training in the KC-135A aircraft. The 100 percent transfer afforded by the direct substitution of BOPTT training for aircraft training is a striking confirmation of device effectiveness.

3. Probably due to the extremely high proficiency of the personnel used as subjects, the BOPTT had neither a positive nor negative effect on the maintenance of boom operator skills. In this study, there was no measurable degradation of boom operator skills for the duration of the two test periods (60 and 120 days). Consequently, no conclusions can be drawn as to BOPTT effectiveness for this application, and until periods without flying are extended beyond 120 days, the effectiveness of the BOPTT in maintaining the proficiency of highly skilled boom operators will be unknown.

4. The cost savings potential of the BOPTT is most impressive. Using SAC figures as a basis for calculation, it is estimated that proper utilization of the device could save more than 1 million dollars per year. This estimate does not include the savings in personnel costs (student time and instructors) that would also accrue.

5. Task frequency data were successfully collected and will furnish valuable inputs to the BOPTT operational syllabus.

6. If conducted by competent experienced personnel, operator training for the BOPTT can be successfully accomplished through on-the-job training procedures.

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APPENDIX A: CCTS STUDENT AND INSTRUCTOR GUIDES

INTRODUCTION

This student guide has been developed specifically for your use in the Boom Operators Part Task Trainer (BOPTT).

Your class has been divided into four test groups to evaluate the effectiveness of the BOPTT. Depending on which group you are assigned, you may receive from four to sixteen missions in the BOPTT.

Scenarios

This guide has eight mission scenarios for your use. Each scenario is broken into three areas. Lets take a brief look at each area.

(1) Conditions

Day, Night, VFR, IFR, Turbulence, and receiver pilot number. IFR and VFR tell us the amount of clouds that we may encounter during air refueling. VFR is clear and IFR is heavy clouds sometimes blocking our view of the receiver. Receiver pilot number tells us the experience level of the receiver pilot. Number 1 is an instructor and number 5 is a student on his first air refueling.

(2) Student Accomplishments

You will find each of these tasks, except three contacts with the receiver, were in the Objectives of your KBAR Course. During the mission you are required to accomplish each of these Objectives listed. (A listing of the KBAR Objectives is included at the end of this text.)

(3) Recommended Study

Reviewing these materials will help you prepare yourself for the mission. A word of CAUTION, your T.O.s and Checklists have not been listed, however they are always the primary study materials for any mission in the simulator or the aircraft. You should review any additional material that you feel is necessary, or practice procedures on the CFT prior to your mission. You must complete the recommended study prior to your scheduled simulator period. Remember, your mission will only be as good as your preparation..

The Mission

You will be scheduled for a two hour period for each mission in the simulator. The first thirty minutes will consist of a prebriefing conducted by the simulator instructor. He will discuss with you the mission and answer any questions that you may have. If you have not prepared for the mission, he will not have time to accomplish his requirements. After the prebrief is completed you will start your mission. You will be alloted one hour for the scenario, more than enough time. After the mission is completed, the final thirty minutes will consist of a critique given by the simulator instructor. He will review the mission with you and discuss any problem areas you may have had. He will also recommend study materials that may help you.

Test Groups

Control Group - The control group will not perform air refueling tasks in the BOPTT. They will accomplish four "P" Missions at the flight line.

Group E-1 - These students will accomplish Mission Scenarios #1 through #4 in the BOPTT.

Group E-2 - These students will accomplish Mission Scenarios #1 through #8 in the BOPTT.

Group E-3 - These students will accomplish Mission Scenarios #1 through #8 in the BOPTT. They will accomplish 8 additional BOPTT missions during their flight line training. The training requirements for these missions will be as requested by their flight line instructor.

KBAR Objectives

RECALL AIR REFUELING TERMS AND DEFINITIONS

KBAR 9

OBJECTIVE

Given a list of air refueling terms and their definitions, recall the correct term by matching it with its definition. No more than five errors are permitted.

LOCATE, IDENTIFY AND STATE POSITIONS OF THE AIR REFUELING SYSTEM CONTROLS AND INDICATORS

KBAR 8

OBJECTIVE

In the boom compartment cockpit familiarization trainer, locate, identify, and state the positions of the air refueling system controls and indicators.

Locate and identify all items without error. State the positions with no more than 2 errors.

RECALL THE OPERATIONAL CHARACTERISTICS OF THE AIR REFUELING SYSTEM

KBAR 7

OBJECTIVE

Given a series of incomplete statements and without reference, recall the operational characteristics of the air refueling system. No more than 5 errors are permitted.

RECOGNIZE AIR REFUELING SYSTEM MALFUNCTIONS AND STATE THE CORRECTIVE ACTION

KBAR 6

OBJECTIVE

Given a list of air refueling system malfunctions, recognize the malfunction and state the corrective action by filling in the blanks. No more than two errors are permitted.

OPERATE THE AIR REFUELING SYSTEM AND RECALL CHECKLIST AMPLIFICATIONS AND RESTRICTIONS

KBAR 5

OBJECTIVE #1

Provided a list of incomplete statements pertaining to air refueling system operation, recall checklist amplifications and restrictions by filling in the blanks. No errors are permitted.

OBJECTIVE #2

In the boom pod CFT, using T.O.'s 1C-135(K)A-1CL-3 and 1-1C-13CL-3, operate the air refueling system by accomplishing the following checklists;

a. Boom Compartment Preflight.
b. Preparation for Contact.
c. Tanker Manual Operation.
d. Post Air Refueling.

All checklist steps must be accomplished in sequence without omission. For items which cannot be accomplished on the CFT, the student will state his actions for the applicable checklist step.

PERFORM AIR REFUELING COMMUNICATIONS PROCEDURES

OBJECTIVE #1

KBAR 4

Provided a list of incomplete statements pertaining to air refueling communications, recall communications procedures by filling in the blanks. No more than three errors are allowed.

OBJECTIVE #2

On the boom compartment CFT, using your headset and T.O. 1-1C-1-3CL-3, perform the following communications procedure for the applicable situation:

1. ½ mile radio check.
2. Receiver clearance from precontact.
3. Tanker Manual Operation (TMO) without disconnect capability.
4. Manual/Emergency boom latching (MBL/EBL).

No omissions or errors are permitted.

RECALL AIR REFUELING PROCEDURES AND RESTRICTIONS FOR B-52 - 135 AND C-130 RECEIVERS

KBAR 3

OBJECTIVE

Given a list of incomplete statements pertaining to the following air refueling situations with B-52, EC/RC/KC/WC-135 or C-130 receiver aircraft;

1. Rendezvous
2. Pre-contact
3. Contact
4. Disconnect
5. Breakaway

Recall the air refueling procedures and restrictions for the applicable situation by selecting the correct answer. No more than 3 errors are permitted.

RECALL AIR REFUELING PROCEDURES AND RESTRICTIONS FOR C-5/E-3/E-4 AND FIGHTER AIRCRAFT

KBAR 2

OBJECTIVE

Given a list of incomplete statements pertaining to the following air refueling situations with C-5/E-3/E-4 FB-111/A-10 F/RF-4 and other fighter aircraft, (to include boom or drogue air refueling);

1. Rendezvous
2. Precontact
3. Contact
4. Disconnect
5. Breakaway

Recall the air refueling procedures and restrictions for the applicable situation by selecting the correct answer. No more than 4 errors are permitted.

ACCOMPLISH AIR REFUELING DUTIES

KBAR 1

OBJECTIVE

On an air refueling mission with a B-52, using T.O. 1-1C-1-3CL-3, accomplish boom operator air refueling duties, to include;

a. Air refueling checklists.

b. Effect contacts with the receiver using normal and override functions of the air refueling system.

c. Effect disconnects using automatic and manual retraction of the boom.

d. Breakaway procedures.

e. All oral communications to include operation of the pilot director lights.

All checklist steps must be accomplished without deviation or omission of items. All tasks must be accomplished without violation of technical data contained in T.O. 1C-135(K)A-1, T.O. 1-1C-1, and T.O. 1-1C-1-3 or restrictions in SACM 51-135 Vol VI.

Mission Scenario #1

1. Mission will be a day, VFR air refueling with receiver pilot #1.

2. The student will accomplish the following:

   a. All boom compartment checklist tasks.

   b. Three contacts with the receiver.

   c. All required communications.

   d. Recognize and analyze the following malfunction:

      (1) A/R master switch failure.

   e. Execute a planned breakaway at end A/R.

3. Recommended Study

   ☐ KBAR 3, A/R procedures for B-52 receivers.

   ☐ KBAR 4, Communications procedures.

   ☐ KBAR 5, Checklist amplifications and restrictions.

   ☐ KBAR 6, System malfunctions and corrective action.

   ☐ KBAR 7, Operational characteristics of the A/R System.

   ☐ KBAR 8, Location, identification, and positions of A/R system controls and indicators.

   ☐ KBAR 9, A/R Terms and definitions.

   ☐ Read Lesson Text

LESSON TEXT

Tanker Call Sign BREAKAWAY

BREAKAWAY

BREAKAWAY

The descision to call a BREAKAWAY will always be yours because it is a judgement based on the situation as you see it.

Our BREAKAWAY procedure as specified in T.O. 1-1C-1-3 states;

> Boom Operator - Actuate the disconnect switch. Flash the pilot director lights for boom air refueling. Move the boom away from the receiver. Notify the tanker pilot when clear to climb.

This procedure is used for all Breakaway situations regardless of the receiver aircraft position. Since it is a critical skill, here in the training situation, you will practice it on every mission. You will see, in some of the scenarios it is planned, and in others it will be your judgement to call it. If planned, the Breakaway will be called at the end of air refueling.

SACM 51-135 Vol VI imposes restrictions on us for the planned situations only. Here for your use is an extract of that manual.

SACM 51-135, VOL VI 6 June 1977

(2) Student Receiver/Boom Operator Training. To increase the safety aspects of student breakaway training, the following procedures are mandatory prior to accomplishing the actual breakaway maneuver:

(a) Insure inflight coordination between the tanker pilot, boom operator, and receiver pilot. Coordination must include when the event will occur and who will give the command of execution.

(b) If initiated while in contact, the tanker and receiver's air refueling system must be in normal. Tanker disconnect capability must have been determined with the applicable receiver by either a boom operator initiated or a boom limit switch disconnect.

Item (2)(a) pertains to coordination. This step will be accomplished by you. If you have any questions, discuss them with your instructor during the mission prebrief.

Mission Scenario #2

1. Mission will be a day, VFR air refueling with receiver pilot #2.

2. The student will accomplish the following:

   a. All boom compartment checklist tasks.

   b. Three contacts with the receiver.

   c. All required communications.

   d. Recognize and analyze the following malfunctions:

      (1) Locked ruddevators.

      (2) Receiver signal amplifier failure.

      (3) Bypass valve failure.

      (4) Fuel leak.

      (5) Signal system "Ready" indicator failure.

   e. Execute a planned Breakaway at end A/R.

3. Recommended Study

   ☐ KBAR 6, System malfunctions and corrective actions, with emphasis on those malfunctions in this mission scenario.

   ☐ Review any KBAR lessons that you may need more study of, and materials as directed by your instructor from your last mission.

Mission Scenario #3

1. Mission will be a day, VFR air refueling with any receiver pilot #1 through #5.

2. The student will accomplish the following:

   a. All boom compartment checklist tasks.

   b. Three contacts with the receiver.

   c. All required communications, to include those required for an autopilot OFF air refueling by the tanker.

   d. Use the pilot director light coaching switches to direct the receiver to the Contact position.

   e. Recognize and analyze the following malfunctions:

      (1) Elevation indicator failure.

      (2) Signal system "Contact Made" indicator failure.

      (3) Signal system "Disconnect" indicator failure.

   f. Execute a planned Breakaway at end A/R.

3. Recommended Study

   ☐ Read lesson text.

   ☐ KBAR 6, System malfunctions and corrective actions, with emphasis on those malfunctions in this mission scenario.

   ☐ Review any KBAR lesson you feel that you may need more study of, and materials as directed by your instructor from your last mission.

LESSON TEXT

Autopilot OFF Air Refueling

The tanker autopilot will normally be ON for air refueling. There will be situations, for pilot training or when the autopilot malfunctions, that require the autopilot to be turned OFF.

The autopilot keeps the tanker straight and level during air refueling. It compensates for the bow wave of the receiver by trimming the horizontal stabilizer. With the autopilot turned OFF, our pilot now has this job. He is at a disadvantage since he cannot feel the bow wave effect soon enough, which may cause the aircraft to vary in altitude.

We can eliminate this disadvantage by keeping him informed of the receiver's position during closure. If we are "talking" the receiver into position, Fwd 50, Fwd 40, Fwd 30, Fwd 20, etc., our pilot knows the receiver's position and will trim the stabilizer accordingly. However, if we are only using the pilot director light coaching switches, our pilot does not know what's happening. We can solve this very easily by stating the receiver's position over interphone as he closes from precontact to contact. An example is 50, 40, 30, 20, 10, etc., Contact. As we call these distances, our pilot trims the stabilizer at approximately 30, 20, and 10 feet. This will compensate for the bow wave effect and keep the tanker straight and level. When the receiver disconnects and drops back, our pilot must retrim the aircraft for straight and level flight without the bow wave. We must inform him of the receiver's position as the receiver moves aft; i.e., 10, 20, 30, 40, precontact. This is a simple procedure that keeps our pilot informed of the receiver's position at all times.

Mission Scenario #4

1. Mission will be a day, IFR air refueling with turbulence of varing intensity and receiver pilot #1.

2. The student will accomplish the following:

   a. All boom compartment checklist tasks.

   b. Three contacts with the receiver.

   c. All required communications.

   d. Use the pilot director light coaching switches to direct the receiver to the Contact position.

   e. Recognize and analyze the following malfunctions:

      (1) Boom instability.

      (2) Azimuth movement restriction.

      (3) Elevation movement restriction.

      (4) Telescoping indicator failure.

   f. Recognize and execute a Breakaway during a closure overrun by the receiver.

3. Recommended Study

   ☐ KBAR 6, System malfunctions and corrective actions, with emphasis on those malfunctions in this mission scenario.

   ☐ Review any KBAR lesson you feel that you may need more study of, and materials as directed by your instructor from your last mission.

Mission Scenario #5

1. Mission will be during twilight with VFR conditions, air refueling with any receiver pilot #1 through #4.

2. The student will accomplish the following:

   a. All boom compartment checklist tasks.

   b. Three contacts with the receiver.

   c. All required communications.

   d. Use the pilot director light coaching switches in conjunction with oral procedures to direct the receiver to the contact position.

   e. Recognize and analyze the following malfunctions:

      (1) Boom extension motor failure.

      (2) AC Power failure.

      (3) Boom nozzle light inoperative.

   f. Execute a planned Breakaway at end A/R.

3. Recommended Study

   ☐ KBAR 6, System malfunctions and corrective actions, with emphasis on those malfunctions in this mission scenario.

   ☐ Review any KBAR lesson you feel that you may need more study of, and materials as directed by your instructor from your last mission.

Mission Scenario #6

1. Mission will be night, VFR air refueling with receiver pilot #3.

2. The student will accomplish the following:

   a. All boom compartment checklist tasks.

   b. Three contacts with receiver.

   c. All required communications.

   d. Use pilot director light coaching switches to direct the receiver to the contact position.

   e. Recognize and analyze the following malfunctions:

      (1) Locked ruddevators.

      (2) Boom nozzle light inoperative.

      (3) Receiver receptacle light inoperative.

      (4) Azimuth indicator failure.

      (5) DC power failure.

   f. Execute a planned Breakaway at the end of A/R.

3. Recommended Study

   ☐ KBAR 6, System malfunctions and corrective actions, with emphasis on those malfunctions in this mission scenario.

   ☐ Review any KBAR lesson you feel that you may need more study of, and materials as directed by your instructor from your last mission.

Mission Scenario #7

1. Mission will be a day VFR-IFR air refueling with light turbulence and receiver pilot #3.

2. The student will accomplish the following:

   a. All boom compartment checklist tasks.

   b. Three contacts with the receiver, at least one of which will be in TMO.

   c. All required communications.

   d. Use the pilot director light coaching switches to direct the receiver to the contact position.

   e. Recognize and analyze the following malfunctions:

      (1) Signal coil failure.

      (2) Tanker signal amplifier failure.

      (3) Binding boom latch lever.

   f. Recognize and execute a Breakaway during an inner limit closure of the receiver.

3. Recommended Study

   ☐ KBAR 6, System malfunctions and corrective actions, with emphasis on those malfunctions in this mission scenario.

   ☐ Review any KBAR lesson you feel that you may need more study of, and materials as directed by your instructor from your last mission.

Mission Scenario #8

1. Mission will be a day, VFR air refueling with receiver pilot #3.

2. The student will accomplish the following:

   a. All boom compartment checklist tasks.

   b. Three contacts with the receiver.

   c. All required communications.

   d. Use the pilot director light coaching switches to direct the receiver to the contact position.

   e. Recognize and analyze the following malfunctions:

      (1) Boom hoist motor failure.

      (2) Receiver signal amplifier and toggle failure.

      (3) Interplane communications failure.

   f. Execute a planned Breakaway at end A/R.

3. Recommended Study

   ☐ KBAR 6, System malfunctions and corrective actions, with emphasis on those malfunctions in this mission scenario.

   ☐ Review any KBAR lesson you feel that you may need more study of, and materials as directed by your instructor from your last mission.

MISSION #1

1. Mission will be a day, VFR air refueling with receiver pilot #1.

2. The student will accomplish the following:

   A. All required checklist task.

   B. Three contacts with receiver model.

   C. All required communications.

   D. Recognize A/R master switch failure.

   E. Execute a planned breakaway at end A/R.

3. The instructor will do the following:

   A. Assist as required to insure correct procedures are utilized by student in the accomplishment of:

      1. Checklist.

      2. Contacts.

      3. Communications/crew coordination.

      4. Malfunction Analysis.

      5. Breakaway maneuver.

   B. Advise operator when malfunction is desired.

   C. Document all training of student.

   D. Perform student critique.

MISSION #2

1. Mission will be a day, VFR air refueling with receiver pilot #2.

2. The student will accomplish the following:

   A. All required checklist task.

   B. Three contacts with receiver model.

   C. All required communications.

   D. Recognize and analyze the following malfunctions:

      1. Locked ruddevators.

      2. Receiver signal amplifier failure.

      3. Bypass valve failure.

      4. Fuel leak.

      5. Signal system "ready" indicator failure.

   E. Execute planned breakaway at end A/R.

3. The instructor will do the following:

   A. Assist as required to insure correct procedures are utilized by student in the accomplishment of:

      1. Checklist.

      2. Contacts.

      3. Communications/crew coordination.

      4. Malfunction Analysis.

      5. Breakaway maneuver.

   B. Advise operator when malfunctions are desired.

   C. Document all training of student.

   D. Perform student critique.

MISSION #3

1. Mission will be a day, VFR air refueling with receiver pilots #1-5.

2. The student will accomplish the following:

   A. All required checklist task.

   B. Three contacts with receiver model.

   C. All required communications to include those required for an autopilot off air refueling by tanker.

   D. Use Pilot director light coaching switches for directing receiver to contact position.

   E. Recognize and analyze the following malfunctions.

      1. Elevation indicator failure.

      2. Signal system "contact made" indicator failure.

      3. Signal system "disconnect" indicator failure.

   F. Execute planned breakaway at end A/R.

3. The instructor will do the following:

   A. Assist as required to insure correct procedures are utilized by student in the accomplishment of:

      1. Checklist.

      2. Contacts.

      3. Communications/crew coordination.

      4. Malfunction Analysis.

      5. Breakaway maneuver.

   B. Advise operator when malfunctions are desired.

   C. Document all training of student.

   D. Perform student critique.

MISSION #4

1. Mission will be day, IFR air refueling, with turbulence of varying intensity, with receiver pilot #1.

2. The student will accomplish the following:

   A. All required checklist task.

   B. Three contacts with receiver model.

   C. All required communications.

   D. Use pilot director light coaching switches to direct receiver to contact position.

   E. Recognize and analyze the following malfunctions:

      1. Boom instability

      2. Azimuth movement restriction

      3. Elevation movement restriction

      4. Telescoping indicator failure

   F. Recognize and execute a breakaway during a closure overrun by receiver.

3. The instructor will do the following:

   A. Assist as required to insure correct procedures are utilized by student in the accomplishment of:

      1. Checklist

      2. Contacts

      3. Communications/crew coordination

      4. Malfunction analysis

      5. Breakaway maneuver

   B. Advise operator when malfunctions are desired.

   C. Advise operator when receiver closure overrun is desired.

   D. Document all training of student.

   E. Perform student critique.

MISSION #5

1. Mission will be during twilight with VFR conditions, air refueling with receiver pilots #1-4.

2. The student will accomplish the following:

   A. All required checklist task.

   B. Three contacts with receiver model.

   C. All required communications.

   D. Use pilot director light coaching switches in conjunction with oral procedures to direct receiver to contact position.

   E. Recognize and analyze the following malfunctions:

      1. Boom extension motor failure

      2. AC Power failure

      3. Boom nozzle light inoperative

   F. Execute a planned breakaway at end A/R.

3. The instructor will do the following:

   A. Assist as required to insure correct procedures are utilized by student in the accomplishment of:

      1. Checklist

      2. Contacts

      3. Communications/crew coordination

      4. Malfunction analysis

      5. Breakaway maneuver

   B. Advise operator when malfunctions are desired.

   C. Document all training of student.

   D. Perform student critique.

MISSION #6

1. The student will accomplish the following:

   A. All required checklist task

   B. Three contacts with receiver model

   C. All required communications

   D. Use pilot director light coaching switches to direct receiver to contact position.

   E. Recognize and analyze the following malfunctions:

      1. Locked ruddevators.

      2. Boom nozzle light inoperative

      3. Receiver receptacle light inoperative

      4. Azimuth indicator failure

      5. DC power failure

   F. Execute a planned breakaway at end A/R

2. The instructor will do the following:

   A. Give student only minimum assistance as required to insure correct procedures are utilized by student in the accomplishment of:

      1. Checklist

      2. Contacts

      3. Communications/crew coordination

      4. Malfunction analysis

      5. Breakaway maneuver

   B. Advise operator when malfunctions are desired.

   C. Document all training of student.

   D. Perform student critique.

3. Mission will be night, VFR air refueling with receiver pilot #3.

MISSION #7

1. The student will accomplish the following:

   A. All required checklist task

   B. Three contacts with receiver model of which at least one will be in TMO.

   C. All required communications

   D. Use pilot director light coaching switches to direct receiver to contact position.

   E. Recognize and analyze the following malfunctions:

      1. Signal coil failure

      2. Tanker signal amplifier failure

      3. Binding Boom latch lever

   F. Recognize and execute a breakaway during an inner limit closure of receiver.

2. The instructor will do the following:

   A. Assist the student only as required to insure safe accomplishment of:

      1. Checklist

      2. Contacts

      3. Communications/crew coordination

      4. Malfunction analysis

      5. Breakaway maneuver

   B. Advise operator when malfunctions are desired.

   C. Document all training of student

   D. Perform student critique

3. Mission will be a day VFR-IFR air refueling with light turbulence and receiver pilot #3.

MISSION #8

1. The student will accomplish the following:

   A. All required checklist task

   B. Three contacts with receiver model

   C. All required communications

   D. Use pilot director light coaching switches to direct receiver to contact position.

   E. Recognize and analyze the following malfunctions:

      1. Boom Hoist motor failure

      2. Receiver signal amplifier and toggle failure

      3. Interplane communications failure.

   F. Execute a planned breakaway at end A/R.

2. The instructor will do the following:

   A. Give only that assistance required for safe accomplishment of:

      1. Checklist

      2. Contacts

      3. Communications/crew coordination

      4. Malfunction analysis

      5. Breakaway maneuver

   B. Advise operator when malfunctions are desired.

   C. Document all training of student.

   D. Perform student critique.

3. Mission will be a day, VFR air refueling with receiver pilot #3.

APPENDIX B: BOOM OPERATOR PROGRESS EVALUATION

KC-135 PROGRESS REPORT - BOOM OPERATOR PART TASK TRAINER

NAME	RANK	GROUP	MISSION #	DATE

GRADING:

1 – Major deviations or omissions. Demonstration required.
2 – Significant deviations or omissions. Instructor assistance required.
3 – Slight deviation. Only occasional verbal assistance required.
4 – No errors or omissions. No assistance required.

ACCOMPLISHMENTS	ITEM	ACCOM	GRADE	PROF	REMARKS
1. GROUND OPERATIONS					
a. Interior Inspections					
2. NORMAL PROCEDURES					
a. Checklist Proc/Use	P05				
b. Crew Coordination	P06				
3. AIR REFUELING					
a. Rad Silent Vis Signals	R21				
b. Rendezvous Procedures	R23				
c. Contacts (total)	R25				
d. Contacts Night	R26				
e. Tanker Manual Contacts	R27				
f. Contacts Fighter	R29				
g. Tanker Air Refueling	.41				
h. Tanker AR Breakaway					
4. PROFICIENCY					
a. Precrew Flt Trng	P50				
b. Cat B Receivers					
c. Cat C Receivers (Day)					
d. Cat C Receivers (Night)					
e. Cat E Receivers (Day)					
f. Cat E Receivers (Night)					
g. Cat F Receivers					
5. QUAL CERTIFICATION					
a. Cat B Receiver	Q21				
b. Cat C Receiver (Day)	Q22				
c. Cat C Receiver (Night)	Q23				
d. Cat E Receiver (Day)	Q24				
e. Cat E Receiver (Night)	Q25				
f. Cat F Receiver	Q26				

ACCOMPLISHMENTS	ITEM	ACCOM	GRADE	PROF	REMARKS
6. MALFUNCTIONS	P44				
a. Hoist Motor					
b. Extension Motor					
c. Bypass Valve					
d. AC Power					
e. DC Power					
f. AR Master Switch					
g. Locked Ruddevators					
h. Signal Coil Failure					
i. Tanker Signal Amplifier					
j. Rcvr Signal System (Elec)					
k. Rcvr Signal System (Tgl)					
l. Nozzle Light					
m. Receptacle Lights					
n. Fuel Leak					
o. Azimuth Indicator					
p. Telescoping Indicator					
q. Elevation Indicator					
r. Latching Lever Binding					
s. Ready Light					
t. Contact Mode Light					
u. Disconnect Light					
v. Boom Control Log					
w. Boom Control Azimuth					
x. Boom Control Elevation					
7. POSTFLIGHT					
a. Training Sorties	P02				
b. Simulator Time					
8. INSTRUCTOR DUTIES	P17				
a. Student Briefing					
b. Student Critique					
c. Prof./Inst. Abilities					
9. OVERALL GRADE (E–Excel, S–Sat,					
M–Min Sat, U–Unsat)					
SIGNATURE (Instructor)					SIGNATURE (Student)

KC-135 BOOM OPERATOR PROGRESS EVALUATION

NAME	RANK	GROUP	FLIGHT #	DATE

GRADING:

1 – Major deviations or omissions. Demonstration required

2 – Significant deviations or omissions. Instructor assistance required.

3 – Slight deviation. Only occasional verbal assistance required.

4 – No errors or omissions. No assistance required.

ITEM	GRADE	REMARKS
1. CHECKLIST PROC/USE (Boom Compt. Items Only)		
a. Boom Compartment Check		
1) Checklist Completion		
2) Crew Coordination		
3) Timing		
b. Starting Engines		
1) Checklist Completion		
2) Crew Coordination		
3) Timing		
c. Before Takeoff		
1) Checklist Completion		
2) Crew Coordination		
3) Timing		
d. After Takeoff–Climb		
1) Checklist Completion		
2) Crew Coordination		
3) Timing		
e. Descent and Before Landing		
1) Checklist Completion		
2) Crew Coordination		
3) Timing		
f. Postflight		
1) Checklist Completion		
2) Crew Coordination		
3) Timing		

ITEM	GRADE	REMARKS
2. AIR REFUELING		
CHECKLISTS		
a. Preparation for Contact		
1) Checklist Completion		
2) Crew Coordination		
3) Timing		
4) Communications		
b. Tanker Manual Operation		
1) Checklist Completion		
2) Crew Coordination		
3) Timing		
4) Communications		
c. Post Air Refueling		
1) Checklist Completion		
2) Crew Coordination		
3) Timing		
4) Communications		
OPERATION		
d. Locating Receiver		
e. Normal Operation		
1) Boom Control		
2) Extension/Retraction (Auto)		
3) Extension /Retraction (Man)		
4) Contact		
5) Boom Alignment		
6) Disconnect		
7) Communications		
8) Crew Coordination		
f. Tanker Manual Operation		
1) Boom Control		
2) Extension/Retraction (Auto)		
3) Extension/Retraction (Man)		
4) Contact		
5) Boom Alignment		
6) Disconnect		
7) Communications		
8) Crew Coordination		

ITEM	GRADE	REMARKS
g. Breakway		
1) Procedures		
2) Communications		
h. A/R System Malfunction		
(If Applicable)		
1) Recognition		
2) Procedural Knowledge		
3) Corrective Action		
FACTORS: YES/NO		
(Indicate if any of the factors listed influenced		
the student's performance)		
a. Receiver		
b. Weather		
c. Equipment		

INSTRUCTOR NAME, RANK	SIGNATURE

APPENDIX C: CFIC BOPTT SYLLABUS

The following guidelines will be used for all training activities in the PTT.

- ☐ Schedule: Determine student and scenario required. Changes in the schedule will be at the discretion of the OT&E Test Director.

- ☐ PTT: Determine Status
  Review 781 and check with the operator for the applicable mission scenario.

- ☐ Student Folder: Review student progress reports. For Test Group E-3, review simulator training request.

- ☐ Prebrief: Determine students status for the mission by asking questions pertaining to the scenario. If the student is not up to the required level, the instructor will try to get him to that level during the prebrief. If time does not permit, the student will be rescheduled for the first available period, later that day if possible.

- ☐ Mission Scenario: All scenarios will be followed verbatum unless approved otherwise by the OT&E Test Director.

- ☐ Post Mission Review: Accomplish Mission Critique form for all missions.
  Accomplish the student progress reports to reflect all activities accomplished with appropriate grades.

Mission Scenario #1

1. Mission will be a day, VFR air refueling with receiver pilot #1.

2. The student will accomplish the following:

   a. All boom compartment checklist tasks.

   b. Three contacts with the receiver.

   c. All required communications.

   d. Recognize and analyze the following malfunction:

      (1) A/R master switch failure.

   e. Execute a planned Breakaway at end A/R.

3. Instructor Procedures

   a. Give the student only the minimum assistance as required to insure correct procedures are utilized by the student in the accomplishment of:

      (1) Checklist tasks.

      (2) Contacts.

      (3) Communications and crew coordination

      (4) Malfunction Analysis.

      (5) Breakaway maneuver.

   b. Advise operator when malfunctions are desired.

   c. Document all student training.

   d. Perform student critique. Recommend additional study areas for the student if applicable.

Mission Scenario #2

1. Mission will be a day, VFR air refueling with receiver pilot #2.

2. The student will accomplish the following:

   a. All boom compartment checklist tasks.

   b. Three contacts with the receiver.

   c. All required communications.

   d. Recognize and analyze the following malfunctions:

      (1) Locked ruddevators.

      (2) Receiver signal amplifier failure.

      (3) Bypass valve failure.

      (4) Fuel leak.

      (5) Signal system "Ready" indicator failure.

   e. Execute a planned Breakaway at end A/R.

3. Instructor Procedures

   a. Give the student only the minimum assistance as required to insure correct procedures are utilized by the student in the accomplishment of:

      (1) Checklist tasks.

      (2) Contacts.

      (3) Communications and crew coordination.

      (4) Malfunction analysis.

      (5) Breakaway maneuver.

   b. Advise operator when malfunctions are desired.

   c. Document all student training.

   d. Perform student critique. Recommend additional study areas for the student if applicable.

Mission Scenario #3

1. Mission will be a day, VFR air refueling with any receiver pilot #1 through #5.

2. The student will accomplish the following:

   a. All boom compartment checklist tasks.

   b. Three contacts with the receiver.

   c. All required communications, to include those required for an autopilot OFF air refueling by the tanker.

   d. Use the pilot director light coaching switches to direct the receiver to the Contact position.

   e. Recognize and analyze the following malfunctions:

      (1) Elevation indicator failure.

      (2) Signal system "Contact Made" indicator failure.

      (3) Signal system "Disconnect" indicator failure.

   f. Execute a planned Breakaway at end A/R.

3. Instructor Procedures

   a. Give the student only the minimum assistance as required to insure correct procedures are utilized by the student in the accomplishment of:

      (1) Checklist tasks.

      (2) Contacts.

      (3) Communications and crew coordination.

      (4) Malfunction analysis.

      (5) Breakaway maneuver.

   b. Advise operator when malfunctions are desired.

   c. Document all student training.

   d. Perform student critique. Recommend additional study areas for the student if applicable.

Mission Scenario #4

1. Mission will be a day, IFR air refueling with turbulence of varing intensity and receiver pilot #1.

2. The student will accomplish the following:

   a. All boom compartment checklist tasks.

   b. Three contacts with the receiver.

   c. All required communications.

   d. Use the pilot director light coaching switches to direct the receiver to the Contact position.

   e. Recognize and analyze the following malfunctions:

      (1) Boom instability.

      (2) Azimuth movement restriction.

      (3) Elevation movement restriction.

      (4) Telescoping indicator failure.

   f. Recognize and execute a Breakaway during a closure overrun by the receiver.

3. Instructor Procedures

   a. Give the student only the minimum assistance as required to insure correct procedures are utilized by the student in the accomplishment of:

      (1) Checklist tasks.

      (2) Contacts.

      (3) Communications and crew coordination.

      (4) Malfunction analysis.

      (5) Breakaway maneuver.

   b. Advise operator when malfunctions are desired.

   c. Document all student training.

   d. Perform student critique. Recommend additional study areas for the student if applicable.

Mission Scenario #5

1. Mission will be during twilight with VFR conditions, air refueling with any receiver pilot #1 through #4.

2. The student will accomplish the following:

   a. All boom compartment checklist tasks.

   b. Three contacts with the receiver.

   c. All required communications.

   d. Use the pilot director light coaching switches in conjunction with oral procedures to direct the receiver to the contact position.

   e. Recognize and analyze the following malfunctions:

      (1) Boom extension motor failure.

      (2) AC Power failure.

      (3) boom nozzle light inoperative.

   f. Execute a planned Breakaway at end A/R.

3. Instructor Procedures

   a. Give the student only the minimum assistance as required to insure correct procedures are utilized by the student in the accomplishment of:

      (1) Checklist tasks.

      (2) Contacts.

      (3) Communications and crew coordination.

      (4) Malfunction analysis.

      (5) Breakaway maneuver.

   b. Advise operator when malfunctions are desired.

   c. Document all student training.

   d. Perform student critique. Recommend additional study areas for the student if applicable.

Mission Scenario #6

1. Mission will be night, VFR air refueling with receiver pilot #3.

2. The student will accomplish the following:

   a. All boom compartment checklist tasks.

   b. Three contacts with receiver.

   c. All required communications.

   d. Use pilot director light coaching switches to direct the receiver to the contact position.

   e. Recognize and analyze the following malfunctions:

      (1) Locked ruddevators.

      (2) Boom nozzle light inoperative.

      (3) Receiver receptacle light inoperative.

      (4) Azimuth indicator failure.

      (5) DC power failure.

   f. Execute a planned Breakaway at the end of A/R.

3. Instructor Procedures

   a. Give the student only the minimum assistance as required to insure correct procedures are utilized by the student in the accomplishment of:

      (1) Checklist tasks.

      (2) Contacts.

      (3) Communications and crew coordination.

      (4) Malfunction analysis.

      (5) Breakaway maneuver.

   b. Advise operator when malfunctions are desired.

   c. Document all student training.

   d. Perform student critique. Recommend additional study areas for the student if applicable.

Mission Scenario #7

1. Mission will be a day VFR-IFR air refueling with light turbulence and receiver pilot #3.

2. The student will accomplish the following:

   a. All boom compartment checklist tasks.

   b. Three contacts with the receiver, at least one of which will be in TMO.

   c. All required communications.

   d. Use the pilot director light coaching switches to direct the receiver to the contact position.

   e. Recognize and analyze the following malfunctions:

      (1) Signal coil failure.

      (2) Tanker signal amplifier failure.

      (3) Binding boom latch lever.

   f. Recognize and execute a Breakaway during an inner limit closure of the receiver.

3. Instructor Procedures

   a. Give the student only the minimum assistance as required to insure correct procedures are utilized by the student in the accomplishment of:

      (1) Checklist tasks.

      (2) Contacts.

      (3) Communications and crew coordination.

      (4) Malfunction analysis.

      (5) Breakaway maneuver.

   b. Advise operator when malfunctions are desired.

   c. Document all student training.

   d. Perform student critique. Recommend additional study areas for the student if applicable.

Mission Scenario #8

1. Mission will be a day, VFR air refueling with receiver pilot #3.

2. The student will accomplish the following:

   a. All boom compartment checklist tasks.

   b. Three contacts with the receiver.

   c. All required communications.

   d. Use the pilot director light coaching switches to direct the receiver to the contact position.

   e. Recognize and analyze the following malfunctions:

      (1) Boom hoist motor failure.

      (2) Receiver signal amplifier and toggle failure.

      (3) Interplane communications failure.

   f. Execute a planned Breakaway at end A/R.

3. Instructor Procedures

   a. Give the student only the minimum assistance as required to insure correct procedures are utilized by the student in the accomplishment of:

      (1) Checklist tasks.

      (2) Contacts.

      (3) Communications and crew coordination.

      (4) Malfunction analysis.

      (5) Breakaway maneuver.

   b. Advise operator when malfunctions are desired.

   c. Document all student training.

   d. Perform student critique. Recommend additional study areas for the student if applicable.

Mission #1

1. Mission will be a day, VFR air refueling with a B-52 and light turbulence.

2.. The CFIC instructor candidate will accomplish the following:

a. All boom pod checklist task.
b. All required communications (oral and/or visual).
c. Contacts with receiver model to include TMO.
d. Recognize the following malfunctions:

1. Locked ruddevators
2. Receiver toggles fail to engage.
3. Elevation gage failure.
4. Extension motor failure.
5. Boom elevation control failure.
6. Boom latching lever binding.

e. Recognize a breakaway situation and execute required procedures.

3. The instructor will evaluate the instructor candidates proficiency and capability in the accomplishment of the following:

a. Checklist procedures.
b. Communications.
c. Boom control.
d. Air refueling techniques (normal and TMO).
e. Malfunction recognition.
f. Judgement.

4. This will be a one hour mission.

5. A 30 minute period is required for pre-briefing and 30 minutes for post briefing.

Mission #2

1. Mission will be a day, VFR air refueling with a B-52 and no turbulence.

2. The CFIC instructor candidate will accomplish the following:

a. Preparation for contact checklist.
b. All required communications (oral and/or visual).
c. Contacts with receiver model.
d. Describe all actions as they are accomplished to the CFIC instructor.
e. Demonstrate knowledge of normal procedures, air refueling motor skills and techniques.

3. The instructor will evaluate the instructor candidate in the following areas:

a. Description of each maneuver, procedure or exercise.
b. Purpose of each exercise.
c. Explanation of procedures.
d. Use of standard terminology.

4. This will be a one hour mission

5. A 30 minute period is required for pre-briefing and 30 minutes for post briefing.

Mission #3

1. Mission will be a scheduled CCTS student mission. Mission will not be CCTS mission 1 or 2, but could be any one of the other missions.

2. The instructor candidate will report to the simulator section one hour prior to scheduled mission. A 30 minute period will be provided for the instructor candidate to review the scheduled mission scenario and prepare student briefing.

3. The instructor candidate will conduct a pre-briefing prior to scheduled mission with the CCTS student. Pre-briefing will cover the mission in its entirety.

4. Following the mission a post briefing and critique will be conducted with the student by the instructor candidate.

5. The simulator instructor will be present during all phases of the mission including the pre-briefing, post briefing and critique. The simulator instructor will evaluate the instructor candidate in the following areas:

a. Knowledge of each manuever, procedure or exercise.
b. Purpose of maneuver or exercise.
c. Explanation of procedures.
d. Use of standard terminology.
e. Effective communication techniques with student during all phases of training.

Mission #4

1. Mission will be a scheduled CCTS student mission. Mission will not be CCTS mission 1 or 2, but could be any one of the other missions.

2. The instructor candidate will report to the simulator section one hour prior to scheduled mission. A 30 minute period will be provided for the instructor candidate to review the scheduled mission scenario and prepare student briefing.

3. The instructor candidate will conduct a pre-briefing prior to scheduled mission with the CCTS student. Pre-briefing will cover the mission in its entirety.

4. Following the mission a post briefing and critique will be conducted with the student by the instructor candidate.

5. The simulator instructor will be present during all phases of the mission including the pre-briefing, post briefing and critique. The simulator instructor will evaluate the instructor candidate in the following areas:

a. Knowledge of each manuever, procedure or exercise.
b. Purpose of maneuver or exercise.
c. Explanation of procedures.
d. Use of standard terminology.
e. Effective communication techniques with student during all phases of training. During the evaluation of the above five (5) areas the instructor candidate will be expected to be at a proficiency level higher than the previous mission and should be competent in his air refueling duties as an instructor.