Defense Nuclear Agency
Alexandria, VA 22310-3398

DNA-TR-92-54-V1

Predicting Radiation Induced Performance Decrements of AH-1 Helicopter Crews

Volume 1—Predicted Versus Actual Performance of AH-1 Crews Induced with Symptoms Simulating Radiation Sickness

Vaughn W. Inman, et al.
Science Applications Intl. Corp.
P.O. Box 1303
McLean, VA 22102

July 1993

Technical Report

CONTRACT No. DNA 001-86-C-0308

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	930701	Technical 860925 – 911130

4. TITLE AND SUBTITLE
Predicting Radiation Induced Performance Decrements of AH-1 Helicopter Crews, Volume 1—Predicted Versus Actual Performance of AH-1 Crews Induced with Symptoms Simulating Radiation Sickness

5. FUNDING NUMBERS
C - DNA 001-86-C-0308
PE - 62715H
PR - RM
TA - RH
WU - DH860308

6. AUTHOR(S)
Vaughn W. Inman, William A. Perez, Joseph I. Peters, and Robert R. Sanchez (SAIC); and Robert W. Young (DNA)

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Science Applications Intl. Corp.
P.O. Box 1303
McLean, VA 22102

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Defense Nuclear Agency
6801 Telegraph Road
Alexandria, VA 22310-3398
RARP/Kehlet

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
DNA-TR-92-54-V1

11. SUPPLEMENTARY NOTES
This work was sponsored by the Defense Nuclear Agency under RDT&E RMC Code B4662D RM RH 00121 RARP 3500A 25904D.

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The purpose of this study was to assess the utility of the Performance Decrement Questionnaire (PDQ) technique for prediction of radiation induced performance decrements in Army personnel. Twenty AH-1 pilots participated in an experiment in which they (1) predicted the effects of various symptom complexes on their performance, (2) went through a 36-hour protocol to induce symptoms similar to those that are followed by intermediate doses of radiation exposure, and (3) performed a simulated AH-1 mission before and after symptom induction. The participants' performance time predictions were compared to actual performance times. The comparisons between predicted and actual performance were conducted with correlational and modeling (MicroSAINT) techniques. The modeling analysis suggested greater concordance between predicted and actual performance than did the correlational analysis.

14. SUBJECT TERMS

Performance Time Estimation	Flight Simulation	Modeling	AH-1
Intermediate Dose Program	Sickness	MicroSAINT	
Symptom Simulation	Radiation Sickness	Helicopter	

15. NUMBER OF PAGES 212

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAR

NSN 7540-280-5500

Standard Form 298 (Rev.2-89)
Prescribed by ANSI Sta. 239-18
298-102

CLASSIFIED BY:

N/A since Unclassified.

DECLASSIFY ON:

N/A since Unclassified.

EXECUTIVE SUMMARY

The primary purpose of this study was to evaluate the Defense Nuclear Agency's performance decrement questionnaire (PDQ) methodology. The methodology is used to estimate the effects of intermediate doses of radiation on the performance of soldiers. The PDQ uses the estimates of subject matter experts (SMEs) to gauge the effects of radiation on performance. The SMEs are familiar with the tasks relevant to performance and are informed of the physical symptoms that will be induced by the radiation.

The method of the study was similar to that used in previous studies in that it focused on estimates of task time duration as the indicators of the effects of the radiation. The SMEs were 20 AH-1 helicopter crew members. However, unlike previous PDQ studies, the SMEs' performance estimates were compared to their actual performance. Their actual performance was measured in a high fidelity AH-1 simulator. SMEs' performance was initially measured early in the study while they were feeling fine and had just completed a practice session of the AH-1 tasks for which they would be asked to estimate the effects of the radiation symptoms. As in previous studies, the SMEs were told of the physical effects of the radiation (the symptoms they would feel). Following that, they estimated the performance decrements they believed such symptoms would have for them.

Then the SMEs underwent a protocol of sleep and food deprivation, strenuous physical exercise, and rotation in a Barany chair (producing motion sickness) to Induce the symptoms associated with intermediate doses of radiation. The protocol appeared to be successful in inducing symptoms in three categories: upper gastrointestinal distress; fatigability/weakness; and hypotension (e.g., lightheaded, unsteady). SMEs' performance was again measured after the symptoms were induced.

The performance decrements obtained in the simulation were compared to those predicted by the PDQ. The comparison was accomplished with the use of correlational and modeling techniques. The correlational analyses did not show a high degree of concordance between predicted and resulting performance decrements observed in the AH-I simulations. The lack of statistical concordance appears to have been due, in part, to the small number of subjects employed.

The modeling (MicroSAINT) analysis showed that PDQ based and performance based estimates of performance degradation were related. The modeling analysis focused on the evaluation of total crew performance rather than task (tasks associated with tank engagements using TOWs or Rockets) or position (gunner or pilot) level performance. The modeling approach allowed the estimation of AH- 1 crew/system performance when both crew members were affected by the symptoms. The MicroSAINT models were executed multiple times to model a large number of tank engagements. Therefore, comparisons between PDQ and simulation based estimates of performance degradation were conducted with distributions of results rather than with single point estimates as with the correlational techniques.

CONVERSION TABLE

Conversion factors for U.S. Customary to metric (SI) units of measurement.

MULTIPLY → / ← TO GET	BY → / ← BY	TO GET → / ← DIVIDE
angstrom	1.000 000 X E -10	meters (m)
atmosphere (normal)	1.013 25 X E +2	kilo pascal (kPa)
bar	1.000 000 X E +2	kilo pascal (kPa)
barn	1.000 000 X E -28	meter^2 (m^2)
British thermal unit (thermochemical)	1.054 350 X E +3	joule (J)
calorie (thermochemical)	4.184 000	joule (J)
cal (thermochemical/cm^2)	4.184 000 X E -2	mega joule/m^2 (MJ/m^2)
curie	3.700 000 X E +1	*giga becquerel (GBq)
degree (angle)	1.745 329 X E -2	radian (rad)
degree Fahrenheit	$t_k = (t^\circ f + 459.67)/1.8$	degree kelvin (K)
electron volt	1.602 19 X E -19	joule (J)
erg	1.000 000 X E -7	joule (J)
erg/second	1.000 000 X E -7	watt (W)
foot	3.048 000 X E -1	meter (m)
foot-pound-force	1.355 818	joule (J)
gallon (U.S. liquid)	3.785 412 X E -3	meter^3 (m^3)
inch	2.540 000 X E -2	meter (m)
jerk	1.000 000 X E +9	joule (J)
joule/kilogram (J/kg) radiation dose absorbed	1.000 000	Gray (Gy)
kilotons	4.183	terajoules
kip (1000 lbf)	4.448 222 X E +3	newton (N)
kip/inch^2 (ksi)	6.894 757 X E +3	kilo pascal (kPa)
ktap	1.000 000 X E +2	newton-second/m^2 (N-s/m^2)
micron	1.000 000 X E -6	meter (m)
mil	2.540 000 X E -5	meter (m)
mile (international)	1.609 344 X E +3	meter (m)
ounce	2.834 952 X E -2	kilogram (kg)
pound-force (lbs avoirdupois)	4.448 222	newton (N)
pound-force inch	1.129 848 X E -1	newton-meter (N·m)
pound-force/inch	1.751 268 X E +2	newton/meter (N/m)
pound-force/foot^2	4.788 026 X E -2	kilo pascal (kPa)
pound-force/inch^2 (psi)	6.894 757	kilo pascal (kPa)
pound-mass (lbm avoirdupois)	4.535 924 X E -1	kilogram (kg)
pound-mass-foot^2 (moment of inertia)	4.214 011 X E -2	kilogram-meter^2 (kg·m^2)
pound-mass/foot^3	1.601 846 X E +1	kilogram/meter^3 (kg/m^3)
rad (radiation dose absorbed)	1.000 000 X E -2	**Gray (Gy)
roentgen	2.579 760 X E -4	coulomb/kilogram (C/kg)
shake	1.000 000 X E -8	second (s)
slug	1.459 390 X E +1	kilogram (kg)
torr (mm Hg, 0° C)	1.333 22 X E -1	kilo pascal (kPa)

*The becquerel (Bq) is the SI unit of radioactivity; 1 Bq = 1 event/s.
**The Gray (GY) is the SI unit of absorbed radiation.

PREFACE

The authors wish to express thanks to the many individuals who contributed to this effort. Major Bruce West, and Major Robert Kehlet of DNA provided coordination with the Army. Members of the Intermediate Dose and Human Response Programs aided significantly in research program definition. Dr. Charles N. Davidson and LTC Douglas L. Watson, of the U.S. Army Nuclear and Chemical Agency provided invaluable inputs to the approach and aided in securing troop support through FORSCOM.

Personnel of the 101st Airborne Division, Fort Campbell, Kentucky provided extensive support during the data collection process. Division personnel ensured that the AH-I simulator was dedicated to this study throughout the 2 week data collection schedule. Special thanks go to the pilots at Fort Campbell who dedicated hundreds of hours under difficult conditions to support this study.

Special thanks go to J. Moyer of SAIC who is responsible for the task timeline analysis supporting this experiment. Thanks also to Steve Eschholz and Stephen Masterson, of SAIC, who were essential to the data collection effort. Dr. Roy DeHart, from the University of Oklahoma, was critical to the approval and implementation of the human use protocol. Mr. C. J. Percle served as second crew member for all simulator sessions and provided outstanding liaison with the Fort Campbell community. Ms. Merchant-Last and Ms. Krugman of SAIC performed pilot background data summarization, video tape transcription and content analysis. We are also indebted to Dr. Michael L. Fineberg, now at the Institute for Defense Analysis, for his assistance in formulation of the conceptual approach to the study.

This report was prepared by the Human Performance Technology Division of Science Applications International Corporation (SAIC) for the Radiation Sciences Directorate of the Defense Nuclear Agency (DNA) under contract number DNA 001-86-C-0308. The report describes a study conducted to assess the utility of methods for predicting effects of intermediate dose levels of ionizing radiation on AH-1 crew performance. The principal method under study was the Performance Decrement Questionnaire, developed as part of DNA's Intermediate Dose Program. A secondary aspect of the study was to investigate performance based predictions using the Walter Reed Performance Assessment Battery (WRPAB).

The objectives of this study were to:

(1) Induce symptoms similar to those of low level radiation exposure,
(2) Assess the PDQ methodology in the context of a helicopter simulation,
(3) Develop MicroSAINT models of AH-1 crew performance based on simulation data and PDQ estimates, and
(4) Evaluate the relationship between Walter Reed Performance Assessment Battery (WRPAB) performance, PDQ performance estimates, and helicopter simulator task performance using MicroSaint models of AH-1 .

This volume addresses the first three objectives. The PAB portion of the study is addressed in Volume II.

The data reported here are the result of research conducted at Fort Campbell, Kentucky, between 20 June 1988 and 7 July 1988. To achieve the study objectives, the research team obtained 20 volunteers, 10 AH-1 pilots and 10 AH-1 gunners who were: (a) deprived of sleep for 36 hours; (b) exercised rigorously; and (c) rotated in a Barany chair to induce upper gastrointestinal distress. Each volunteer's symptoms, AH-1 helicopter task performance, and PAB performance were assessed periodically. Prior to induction of symptoms, each volunteer provided PDQ time estimates for the simulator performance of a crew person subjected to each of 43 symptom complexes. PDQ performance time estimates were obtained for each of 12 AH-1 tasks.

This report describes:

- subjects' self report symptoms,
- AH-1 task performance at the beginning and end of the experimental session,
- PDQ predictions of the duration of 12 AH-1 tasks under each of 43 symptom complexes (including "healthy, feeling fine"),
- the relationship between reported symptoms and AH-1 task performance,
- the relationship between PDQ estimates and actual performance under induced symptomatology, and
- the results of MicroSAINT models of tank engagements.

The views expressed within this report are solely the responsibility of the authors and are not necessarily those of the Defense Nuclear Agency, The U.S. Army, or any other U. S. government agency.

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SECTION 1

INTRODUCTION

The primary purpose of this study was to evaluate the Defense Nuclear. Agency's Performance Decrement Questionnaire (DNA) methodology that relates soldier performance on a nuclear battlefield to radiation exposure dosage and time since exposure. A secondary purpose of the study was to investigate the relative utility of a performance based prediction methodology. The PDQ methodology was developed under the DNA's Intermediate Dose Program (IDP) and is currently employed in the DNA's Human Response Program (HRP).

The objective of the Intermediate Dose Program was to estimate the effect of prompt radiation on the performance of combat crews and units. Human performance data under actual nuclear battlefield conditions do not exist. The IDP has produced an ethical method for predicting crew effectiveness with exposure to intermediate doses of gamma and neutron radiation. Whereas models of battlefield survival and effectiveness prior to the IDP effort were successful in describing the effects of nuclear weapons on equipment, those models insufficiently characterized the effects of those weapons on personnel. Earlier models classified exposed personnel as zeroes (Os) or ones (1 s), where zeroes were assumed to be not effective and ones were assumed to be fully capable. With intermediate dose exposure, however, it is known that personnel will have a range of symptoms from mild to incapacitating. The goal of the IDP was to better characterize the effects of intermediate doses of radiation on personnel, in particular to predict personnel performance. The method the IDP used to achieve this goal was based on:

(1) a comprehensive assessment of acute- radiation effects and symptoms in humans,
(2) quantified descriptions of radiation sickness symptoms,
(3) identification of dose and time after dose relations to symptoms,
(4) subjective estimates of combat crew performance under selected symptoms, and
(5) use of subjective performance estimates in models of combat crew performance as a function of dose and time after dose.

The above outline of the IDP methodology is further described in the paragraphs that follow.

Baum, Anno, Young, and Withers (1984) compiled descriptions of human symptoms that result from free-in-air doses of 75 to 4500 rads (cGy) prompt ionizing radiation. The reactions were characterized for post-exposure times up to six weeks. Sources of data included case studies of nuclear accident victims, radiation therapy patient records, and experiences of Japanese atomic bomb survivors.

Anno, Wilson, and Baum (1985) developed a structure for characterizing and quantifying radiation sickness symptoms described by Baum et al. This structure describes the sequelae to radiation exposure in the form of symptom complexes, where a complex consists of severity rankings in each of six symptom categories. Severity levels range from 1 (no apparent effect) to 5 (maximum severity) in each of the symptom categories. The categories are:

(a) Upper Gastrointestinal Distress (UG),
(b) Lower Gastrointestinal Distress (LG),
(c) Fatigability and Weakness (FW),
(d) Hypotension (HY),
(e) Infection, Bleeding and Fever (IB), and
(f) Fluid Loss and Electrolyte Imbalance (FL).

A symptom complex is defined by a severity rank in each category. Table 1-1 summarizes the severity ranks defined for each category. A symptom complex is described by a set of six digits where each digit represents the severity of UG, LG, FW, HY, IB, and FL, respectively. For example, a symptom complex coded 311111 is Interpreted as upper gastrointestinal distress at the third level (i.e., nauseated; considerable sweating; swallowing frequently to avoid vomiting) with no other symptoms.

Baum et al. (1984) compiled data on symptom sequelae of exposure to prompt radiation in terms of dose and time after dose, and Anno et al. (1985) developed a scheme for quantifying the symptoms. Anno et al. summarized the relationship between dose, time after dose and symptoms in a map shown in Figure 1-1.

Table 1-1. Syndromes of Radiation Sickness (Adapted from Glickman, et al., 1984).

UPPER GASTROINTESTINAL DISTRESS
1. No effect.
2. Upset stomach; clammy and sweaty, mouth waters and swallows frequently.
3. Nauseated; considerable sweating; swallows frequently to avoid vomiting.
4 Vomited once or twice; nauseated and may vomit again.
5. Vomited several times including the dry heaves; severely nauseated and will soon vomit again.

LOWER GASTROINTESTINAL DISTRESS
1. No effect .
2. Feels uncomfortable urge to defecate.
3 Occasional diarrhea; recently defecated and may again.
4 Frequent diarrhea and cramps; defecated several times and will again soon.
5. Uncontrollable diarrhea and painful cramps.

FATIGABILITY/WEAKNESS

1. No effect.
2 Somewhat tired with mild weakness.
3 Tired, with moderate weakness.
4 Very tired and weak.
5 Exhausted with almost no strength.

HYPOTENSION
1. No effect.
2 Slightly light-headed.
3. Unsteady upon standing quickly.
4 Faints upon standing quickly.
5 In shock; breathes rapidly and shallowly, motionless, skin cold, clammy, and very very pale

INFECTION AND BLEEDING
1. No effect.
2 Mild fever and headache - like starting to come down with flu.
3. Joints ache, considerable sweating; moderate fever; does not want to eat; sores in mouth/throat.
4. Shakes and chills and aches all over; difficult in stopping any bleeding.
5. Delirious, overwhelming infections; cannot stop any bleeding.

FLUID LOSS AND ELECTROLYTE IMBALANCE
1. No effect.
2. Thirsty and has dry mouth; weak and faint.
3 Very dry mouth and throat, headache, rapid heartbeat and may faint with moderate exertion.
4. Extremely dry mouth, throat, skin and very painful headache; has difficult moving; short of breath, burning skin and eyes.
5. Prostrate.

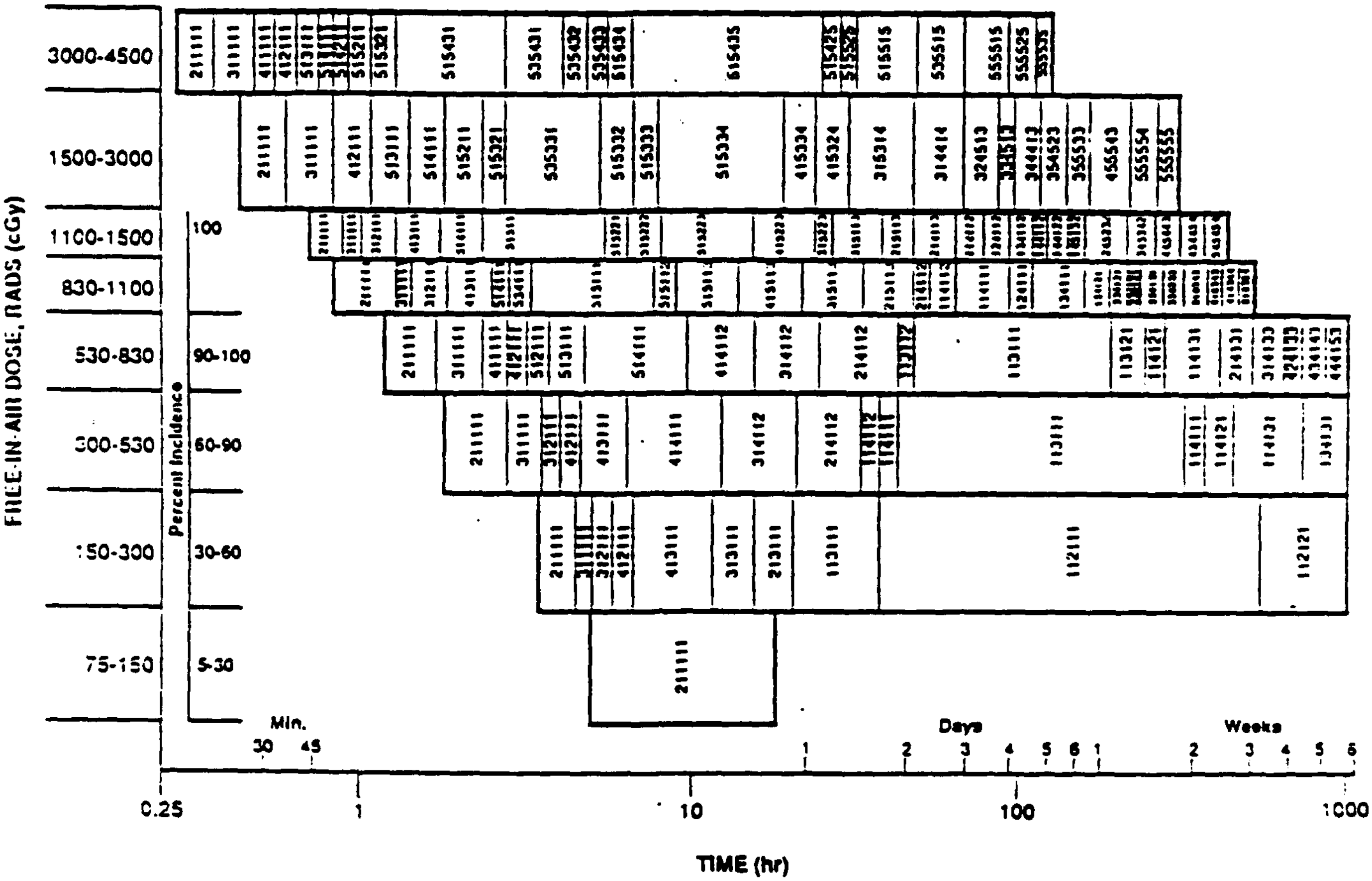

Figure 1-1. Symptom complexes mapped as a function of dose and time after dose (Anno et al., 1985).

Glickman, Winne, Morgan, and Moe (1984) used a performance decrement questionnaire (PDQ) to elicit estimates of the performance time decrements that would be expected when a crew member is subjected to a particular symptom complex. The method of obtaining estimates was to solicit questionnaire data from instructors who were highly experienced in the tasks of interest. The questionnaire provided descriptions of tasks and specifications of how long those tasks should take based on system technical order documentation. The instructors were then asked to estimate how long the tasks would take if the crew member performing them was subject to a particular complex of symptoms. Estimates were obtained for 40 symptom complexes.

Performance time estimates were obtained for artillery, armor and anti-armor duties across a number of crew positions.

Anno et al. used the Glickman et al. PDQ data to predict performance time decrements that would result from symptom complexes not sampled by Glickman et al. Anno et al. used a linear multiple regression model to predict the decrements. Figure 1-2 shows the plot of a response surface Anno et al. extrapolated from the regression model. The figure is for one crew position in one weapon system. A separate plot is generated for each unique crew duty. The response surface plots show predicted performance decrement as a function of both free-in-air dose and time since exposure.

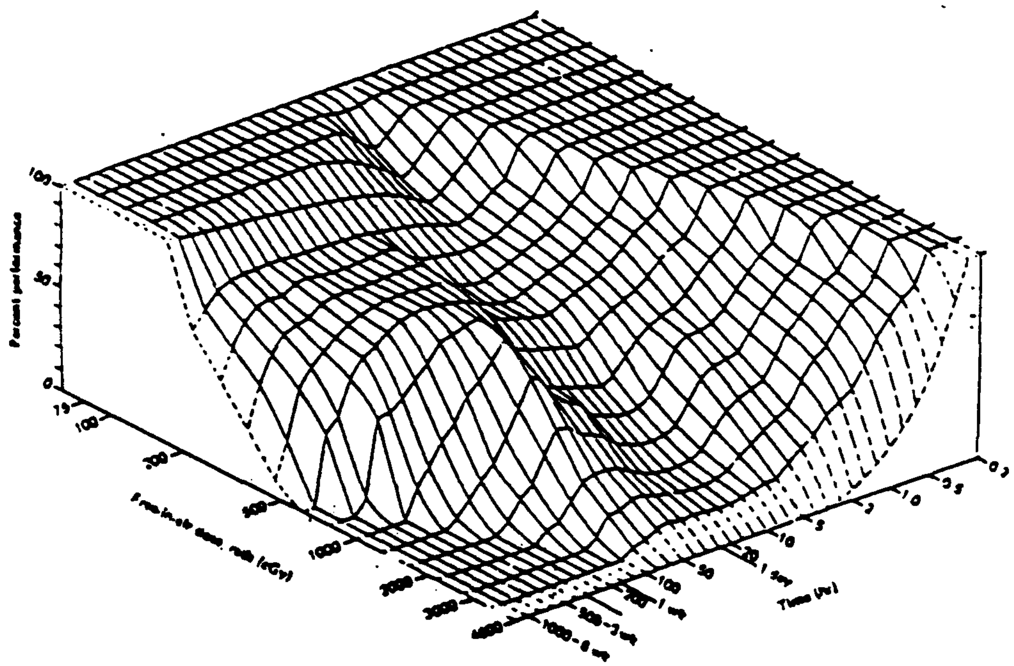

Figure 1-2. Percent predicted performance for gun crew gunner plotted as a function of dose and time after dose (Anno et al., 1985).

The performance decrement is scaled on the vertical axis from 0 to 100 where 100 represents performance equal to that expected from a healthy crew person and 0 represents (non)performance expected from a completely incapacitated crew person. Free in air dose and elapsed time since receiving the dose are represented on separate horizontal dimensions.

The United States Army Nuclear and Chemical Agency has based, in part, its update of the Staff Officers Field Manual that deals with nuclear weapons employment doctrine and procedures (FM 101-31-1,1986) on the Anno et al. report. Figure 1-3 is an example of how the Anno data are presented in the field manual. The manual represents human performance decrements in four categories: combat effective (up to 25% performance time decrements); performance degraded (task time decrements between 25 and 50%); combat ineffective (75 to 100% task time degradation); and death.

Whereas human performance decrements have been measured following onset of symptoms similar to those defined by the complexes of Anno and Glickman (e.g., McClellan and Wiker, 1985), no data exist that determine the accuracy of subject matter expert (SME) estimates of performance decrements in the modelling of performance decrements. It is reasonable to expect performance decrements with sufficient levels of symptom severity. However, the accuracy of SMEs, such as Army instructors, in projecting those decrements has not been shown. The primary purpose of this study was to evaluate the accuracy of SME estimates of performance decrements associated with various radiation symptom complexes.

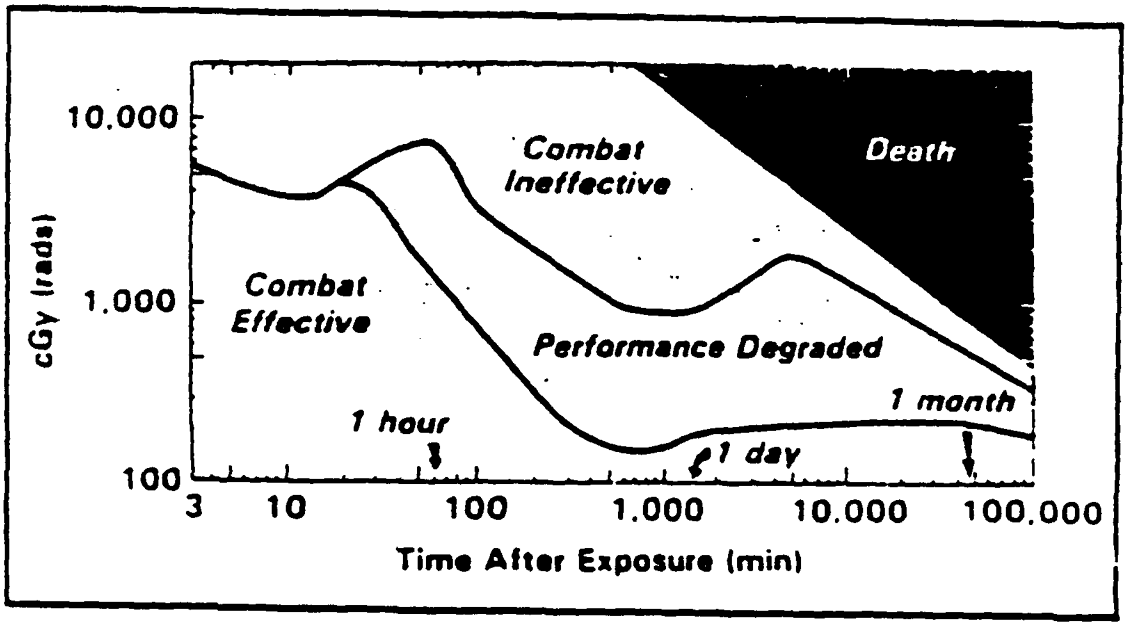

Figure 1-3. Expected response to radiation for physically demanding tasks. Adapted from FM 101-31-1, 1986.

SECTION 2

APPROACH

2.1 EXPERIMENTAL PLAN.

A method similar to that used in previous IDP studies (i.e., Anno et al., 1985; Peters et al., 1985) was used to obtain subject matter expert (SME) estimates of task time durations. The SMEs were AH-1 helicopter crewmembers (pilots and gunners). As in previous studies. the SMEs were asked to estimate how various symptom complexes would affect the speed of specific tasks, e.g., tasks required to fire rockets and tube launched, optically tracked, wire guided (TOW) missiles. Unlike previous studies, the SMEs then underwent a protocol to induce symptoms resembling the average response to an intermediate dose of radiation. Performance under experimentally induced symptoms was compared to their performance when healthy and to PDQ performance predictions.

Of the six symptom categories defined to describe radiation sickness, upper gastrointestinal distress (UG), and fatigability and weakness (FW) show the most deviation from normal (healthy) during the first three days following exposure to intermediate doses of 1000 rads or less (see Figure 1-3). In the Anno et al. (1985) regression model, most of the predicted performance degradation was accounted for by UG and FW. Because this time and dosage domain will have great impact on decision making in the military operational environment, it was the focus of the present research effort. Emphasis in this study was placed on simulating the UG and FW symptoms of prompt intermediate doses of radiation.

2.2 INDEPENDENT VARIABLES.

The independent variables, or treatments, consisted of a number of manipulations to induce UG and FW symptoms. These manipulations were:

- sleep deprivation of approximately 36 hours,
- food deprivation for approximately 20 hours,

- one session of strenuous exercise, and
- inducement of motion sickness.

Other methods of inducing UG and FW symptoms were considered but not used. Other means of symptom induction that were considered included:

- apomorphine,
- ipecac, and
- alcohol hangover.

The latter manipulations were rejected for one or more of the following reasons: (l) lack of FDA approval for the intended purpose, (2) prominent side-effects which do not mimic radiation induced symptoms, and (3) failure to mimic radiation induced symptoms adequately

Contra-indications for the use of sleep deprivation and motion sickness induction were addressed during the approval process of the research protocol. Risks that were considered included:

- risk of seizure with motion sickness induction,
- possible nystagmic responses to motion sickness induction, and
- risk of cardiovascular incidents with sleep deprivation and exercise.

The seizure and cardiovascular risks were deemed negligible in the subject population. Volunteers were informed of the risk, and provisions for prompt on site medical attention were made. The nystagmic response was determined to be of too short a duration to affect the study results.

2.3 EXPERIMENTAL TASKS.

There were four tasks which generated the dependent measures in this study. These tasks, and the environment in which they were conducted, are described in detail in the Methods section (Section 3). Briefly, the tasks were to:

(1) use the PDQ format to provide estimates of the time required to perform each of 12 AH-I tasks under each of 43 symptom complexes,

(2) use a symptom checklist to describe physical condition in terms of the IDP symptom complex scheme,

(3) fly the AH-I simulator in a scripted scenario in which rockets and TOWs were fired and

(4) complete the Walter Reed Performance Assessment Battery.

In addition to the above tasks, subjects completed a biographical data form which provided such information as age, rank, flight experience (hours logged by aircraft class and type), and the amount of sleep they had experienced the previous evening. The attending physician, Dr. DeHart, examined participants at regular Intervals throughout the study.

SECTION 3

METHOD

3.1 SUBJECTS.

Twenty AH-1, "Cobra," helicopter crew members volunteered for this experiment. The volunteers were males between 23 and 31 years old. All were members of the 101st Airborne Division (Air Assault) at Fort Campbell, Kentucky. They averaged 474 flight hours in the AH-1, and 84 AH-1 combat weapon system trainer hours.

Volunteers were medically screened and monitored throughout the course of the 36 hour protocol. Lunch and dinner were served on the first day of the experiment and no food was served prior to completion of the test session on day two. Water was available throughout the experiment.

Half of the crew members flew in the pilot's seat, and the other half flew in the gunner's seat, all were tested in the crew position at which they normally work.

3.2 TEST FACILITIES AND MATERIALS.

The experiment was conducted at Building 6555, Fort Campbell, Kentucky. The parking lot, outside the building, was used for a shuttle run exercise. The inside of the building consisted of several rooms used for the study: the AH-1 simulator room, a room used as a doctor's office, a room in which the Walter Reed Performance Assessment Battery was administered, and a classroom/open area.

The simulator room contained two simulator modules and a Barany chair. The AH-l simulator modules are six degree of freedom motion-based weapons systems trainers. The modules had a high fidelity visual terrain board with a laser light source which produces the high resolution imagery. The pilot and gunner stations are separate modules but operate in such a way that they are perceived as tandem stations of the same aircraft. That is, to the simulator pilot and gunner, the events are presented so as to appear to be occurring to a single AH-1 attack helicopter with tandem crew seating.

A Barany chair was installed between the pilot and gunner simulator modules. The chair, provided by the Naval Aerospace Medical Research Laboratory, was calibrated to spin at 25 revolutions per minute.

The doctor's examination room was used periodically throughout the experiment to monitor the physical condition of the crew members.

The Walter Reed Performance Assessment Battery (PAB) room contained a Compaq portable computer installed with a Scientific Solutions Lab Tender card. The Lab Tender card is a multifunction data processing board which provides response time measures accurate to 1 millisecond. The computer system had a monochrome monitor. PAB responses were recorded via the computer's keyboard. The PAB is a computerized psychological test battery that is designed to measure psychomotor, perceptual, and cognitive functions (see Thorne, Genser, Sing, & Hegge, 1985 for a more complete description of the WRPAB). Sixteen subtests from the PAB were used in the experiment. The following presents a listing of the PAB tests that were used:

- Mood Scale I
- Mood Scale II
- Encode/Decode
- 2-Letter Search
- 6-Letter Search
- 2-Column Addition
- Logical Reasoning
- Digit Recall
- Stanford Sleepiness Scale
- Serial Addition/Subtraction
- Pattern Recognition 1
- Pattern Recognition 2
- Choice Reaction Time
- Timewall
- Interval Production
- Manikin

The classroom/open area was used for briefing/debriefing subjects, administering the PDQ, for most of the exercises, and for subject idle time.

A Performance Decrement Questionnaire was used to obtain subjective estimates of AH-I task time. Estimates were obtained for six pilot tasks and six gunner tasks from pilot gunner subject matter experts. The PDQ was completed early in the study after each SME had participated in 2 full simulator sessions involving 10 TOW and 10 Rocket scenarios each. Table 3-1 presents the gunner and pilot tasks sequentially as they were experienced in the simulated tank engagements. Some of the tasks were part of a tube-launched, optically-tracked, wire-guided (TOW) launch scenario, and some were part of a rocket launch scenario. The pilot tasks were:

(1) unmask and identify target (TOW and rocket),
(2) position aircraft into pre-launch constraints (TOW),
(3) position aircraft, fly reticle to target, and fire (rocket),
(4) end of firing (rocket), and
(5) remask AH-1 to 5 feet AGL (TOW and rocket).

The gunner tasks were:

(1) acquire target (TOW and rocket),
(2) track target and switch to high magnification (TOW and rocket),
(3) action bar (TOW),
(4) fire (TOW),
(5) track missile to target (TOW), and
(6) fine adjust, lase target and confirm range (rocket).

Time estimates were obtained for performance under each of 43 symptom complexes. Each symptom complex was described on a separate sheet of paper. At the top of the sheet the "symptom" associated with the symptom complex was described. Below the symptom description was the question "how sick are you?" Two responses were solicited to this question: (I) a sickness rating on a scale from 1 to 20 where 1 is well and 20 is most sick, and (2) a general performance rating in percent, where 100% would indicate no performance decrement. Below this question was the typical PDQ questionnaire asking for discrete estimates of the amount of time specific tasks would take given the described symptom. Table 3-2 lists the symptom complexes that were described in the PDQ questionnaire. Table 3-1 provides an example of one of the PDQ response sheets, i.e., that for symptom complex 111311.

Table 3-1. PDQ response sheet for one of the symptom complexes.

SYMPTOM: Unsteady upon standing quickly.

How sick are you? Scale 1-20 _____ Overall performance _____%

TOW LAUNCH TASKS			HOW LONG DO YOU THINK IT WOULD TAKE YOU TO DO EACH IF YOU HAD THESE SYMPTOMS?		
			NO INCREASE IN TIME	INCREASE IN TIME	COULD NOT DO IT AT ALL
1.	PILOT:	Unmask and Identify Target			
2.	GUNNER:	Acquire Target			
3.	GUNNER:	Track target and Switch to High Magnification			
4.	GUNNER:	Action Bar			
5.	Pilot	Position Aircraft Into Prelaunch Constraints			
6.	GUNNER:	Fire TOW			
7.	GUNNER:	Track Missile to Target			
8.	PILOT:	Remask AH-1 to 5 Ft. AGL			
ROCKET LAUNCH DIRECT MODE TASKS					
1.	PILOT:	Unmask and Identify Target	SAME AS TOW LAUNCH		
2	GUNNER:	Acquire Target			
3.	GUNNER:	Track Target and Switch to High Magnification			
4.	GUNNER:	Fine Adjust, Lase Target and Confirm Range			
5.	PILOT:	Position Aircraft; Fly Reticle to Target and Fire			
6.	PILOT:	End of Firing			
7.	PILOT:	Remask AH-1 to 5 Ft. AGL			

3.3 PROCEDURE.

Each volunteer participated for a period of 36 hours in which he:

(1) remained awake,
(2) had food withheld after the first 12 hours,
(3) took the WRPAB approximately every 2 hours,
(4) filled in the symptom checklist every 2 hours,
(5) flew four simulator missions,
(6) answered the PDQ,
(7) performed vigorous exercises approximately 30 hours into the experiment, and
(8) was spun in the Barany chair at approximately 34 hours into the experiment.

A time line of the events for the 36 hour period is displayed in Appendix A. This procedures section roughly follows the time line.

3.3.1 Briefing.

As depicted in Table 3-3, the experiment was conducted over a two and one-half week period. Two subjects, one pilot and one gunner, reported each weekday morning at 0700.

Immediately upon arrival at the experimental test cite, the volunteers were briefed on the purpose of the experiment. The briefing contents were part of the Volunteer Agreement Affidavit (VAA). The VAA is included in Appendix B. A tape recording of the affidavit was played to each volunteer in the presence of the principal investigator and the physician. The volunteers were asked to read the VAA as the tape was played. The principal investigator and physician answered any questions the volunteer had to insure that the purpose, objectives, and risks associated with participation in the experiment were understood. Volunteers initialed each page of the affidavit to acknowledge understanding of its contents. Signatures were obtained on the last page of the affidavit and on the privacy act statement (Appendix C).

Table 3-2. The 43 symptom complexes investigated in the present study.

Complex	UG	LG	FW	HY	IB	FL
1	1	1	1	1	1	1
2	2	1	1	1	1	1
3	3	1	1	1	1	1
4	4	1	1	1	1	1
5	5	1	1	1	1	1
6	1	2	1	1	1	1
7	1	3	1	1	1	1
8	1	4	1	1	1	1
9	1	5	1	1	1	1
10	1	1	2	1	1	1
11	1	1	3	1	1	1
12	1	1	4	1	1	1
13	1	1	5	1	1	1
14	1	1	1	2	1	1
15	1	1	1	3	1	1
16	1	1	1	4	1	1
17	1	1	1	5	1	1
18	1	1	1	1	2	1
19	1	1	1	1	3	1
20	1	1	1	1	4	1
21	1	1	1	1	5	1
22	1	1	1	1	1	2
23	1	1	1	1	1	3
24	1	1	1	1	1	4
25	1	1	1	1	1	5
26	5	1	4	1	1	1
27	4	1	4	1	1	2
28	3	1	4	1	1	2
29	3	1	5	1	1	3
30	5	1	5	2	2	3
31	5	1	5	4	3	1
32	1	1	2	1	2	1
33	1	1	3	1	2	1
34	1	1	4	1	1	2
35	2	1	3	1	1	1
36	2	1	4	1	1	2
37	2	1	4	1	1	3
38	3	1	2	1	1	1
39	3	1	3	1	1	1
40	4	1	2	1	1	1
41	4	1	3	1	1	1
42	4	1	4	1	1	1
43	5	1	3	1	1	1

Table 3-3. Schedule of simulator usage.

Week 1	Monday 20 June	Tuesday 21 June	Wednesday 22 June	Thursday 23 June	Friday 24 June
Session 1: 0800-1000	Subjects 1&2 Practice	Subjects 3&4 Practice	Subjects 5&6 Practice	Subjects 7&8 Practice	-
Session 2: 1000-1200	Subjects 1&2 Baseline	Subjects 3&4 Baseline	Subjects 5&6 Baseline	Subjects 7&8 Baseline	-
Session 3: 1400-1530	-	Subjects 1&2 Practice	Subjects 3&4 Practice	Subjects 5&6 Practice	Subjects 7&8 Practice
Session 4: 1600-1730	-	Subjects 1&2 Measurement	Subjects 3&4 Measurement	Subjects 5&6 Measurement	Subjects 7&8 Measurement
Week 2	Monday 27 June	Tuesday 28 June	Wednesday 29 June	Thursday 30 June	Friday 1 July
Session 1: 0800-1000	Subjects 9&10 Practice	Subjects 11&12 Practice	Subjects 13&14 Practice	Subjects 15&16 Practice	-
Session 2: 1000-1200	Subjects 9&10 Baseline	Subjects 11&12 Baseline	Subjects 13&14 Baseline	Subjects 15&16 Baseline	-
Session 3: 1400-1530	-	Subjects 9&10 Practice	Subjects 11&12 Practice	Subjects 13&14 Practice	Subjects 15&16 Practice
Session 4: 1600-1730	-	Subjects 9&10 Measurement	Subjects 11&12 Measurement	Subjects 13&14 Measurement	Subjects 15&16 Measurement
Week 3	Monday 14 July	Tuesday 15 July	Wednesday 16 July	Thursday 17 July	
Session 1: 0800-1000		Subjects 17&18 Practice	Subjects 19&20 Practice		
Session 2: 1000-1200		Subjects 17&18 Baseline	Subjects 19&20 Baseline		
Session 3: 1400-1530		-	Subjects 17&18 Practice	Subjects 19&20 Practice	
Session 4: 1600-1730		-	Subjects 17&18 Measurement	Subjects 11&12 Measurement	

3.3.2 Vital Signs.

After signing the consent forms each crew member was examined by the physician. Blood pressure, heart rate, and weight measures were obtained. No abnormalities were found in any of the volunteers. After the physical examination, the volunteers began pre-flight activities.

3.3.3 Pre-flight Activities

Pre-flight activities began with completion of a pre-flight questionnaire. The pre-flight questionnaire consisted of a biographical data sheet, and questions on previous experience with the symptoms described in the PDQ. After pre-flight questionnaires were completed, the volunteers were separated. One volunteer performed a practice simulator session while the other volunteer performed a practice PAB session.

Prior to entering the simulator the subjects reviewed the simulator mission. The review included observation of the engagement location on a map, and review of weather conditions, aircraft weight and balance, weapons load, and radio frequencies. Mission briefing information is included in Appendix D.

3.3.4 Symptom Check List (SCL).

Before and after every simulator session, each subject completed a SCL (see Table 3-4). The SCL was a listing of the symptoms shown in Table 1-1 with instructions to circle those symptoms currently experienced. In addition to SCLs before and after simulator sessions. subjects completed an SCL every two hours when simulations were not conducted.

3.3.5 Walter Reed Performance Assessment Battery.

After initial introduction to operation of the computer, the PAB was self-administered. The PAB was performed approximately once every 2 hours throughout the course of the experiment.

3.3.6 Simulated Tank Engagements.

A total of four simulator sessions were presented to each crew member, two on the first day and two on the second day. The remainder of this section first discusses procedures common among all four sessions, followed by a discussion of differences among the sessions.

Procedures Shared Among All Simulator Sessions.

Within each session, two types of tank engagements were conducted in the AH-1 weapon system trainer, one employing TOW missiles, and the other using 7 pair of 2.75 inch rockets. Both engagement types were part-mission simulations consisting of unmasking, engaging a tank target, and remasking.

For each crew member, there was a total of 20 trials per session, 10 TOW engagements and 10 rocket engagements. Each trial began with the AH-1 already in a masked position at the engagement location. The simulator was reset at the beginning of every trial. Thus, for every trial the simulated helicopter had the same fuel and armament load, i.e., full fuel, 8 TOWs, 7 pairs of 2.75 inch folding fin aerial rockets, and 750 20mm rounds.

Dependent measures were the time to complete engagement tasks and accuracy of the TOW missile, or 7 pairs of rockets. Task durations were measured from analysis of audio tapes of pilot, gunner, and simulator operator verbal behavior. Although limitations in the design of the training simulator precluded use of automatic collection of task times, accuracy data were obtained from a video display at the simulator's instructor station. A complete description of the scenarios and the verbal ques for measuring each task time follows.

Table 3-4. The symptom checklist given every two hours, and before and after each simulator session.

How do you feel right now? (Please circle one number under each section below.)

UPPER GASTROINTESTINAL DISTRESS

1. No effect.
2 Upset stomach; clammy and sweaty, mouth waters and swallows frequently.
3 Nauseated; considerable sweating; swallows frequently to avoid vomiting.
4. Vomited once or twice; nauseated and may vomit again.
5 Vomited severely times including the dry heaves; severely nauseated and will soon vomit again

LOWER GASTROINTESTINAL DISTRESS

1. No effect
2. Feels uncomfortable urge to defecate.
3. Occasional diarrhea; recently defecated and may again.
4. Frequent diarrhea and cramps; defecated several times and will again soon.
5. Uncontrollable diarrhea and painful cramps.

FATIGABILITY/WEAKNESS

1. No effect
2. Somewhat tired with mild weakness.
3. Tired, with moderate weakness.
4. Very tired and weak.
5. Exhausted with almost no strength.

HYPOTENSION

1. No effect.
2. Slightly light-headed.
3. Unsteady upon standing quickly.
4. Faints upon standing quickly.
5. In shock; breathes rapidly and shallowly, motionless, skin cold, clammy, and very pale.

INFECTION AND BLEEDING

1. No effect
2. Mild fever and headache - like starting to come down with flu.
3. Joints ache. considerable sweating; moderate fever; does not want to eat; sores in mouth/throat.
4. Shakes and chills and aches all over; difficult in stopping any bleeding.
5. Delirious, overwhelming infections; cannot stop any bleeding.

FLUID LOSS AND ELECTROLYTE IMBALANCE

1. No effect
2. Thirsty and has dry mouth; weak and faint.
3. Very dry mouth and throat, headache, rapid heartbeat and may faint with moderate exertion.
4. Extremely dry mouth, throat, skin and very painful headache; has difficult moving; short of breath, burning skin and eyes.
5. Prostrate.

Symptom Checklist

TOW Scenario Tasks.

1) PILOT: Unmask and identify target. On a scout's order to attack (the scout's order actually came from the simulator operator) the pilot was to unmask vertically, visually identify the target of interest (always the same tank), and use standard phraseology to inform the gunner, e.g., "Gunner - target -12 o'clock." Task duration was measured from the onset of the scout's order to the onset of the pilot's announcement to the gunner.

2) GUNNER: Acquire target. Timing of this task began with the pilot's announcement of target acquisition (e.g., "gunner - target - 12 o'clock). The gunner used the telescopic sight unit (TSU) to acquire the target. Timing ended with the gunner announcement "target acquired."

3) GUNNER: Track target and switch to high magnification. Timing began with the "target acquired" announcement. During this task the gunner manipulated the TSU control stick to bring the target image within the inner circle of the TSU reticle. He then switched to high magnification and announced "high mag." Timing of this task ended with the onset of the "high mag" announcement.

4) GUNNER: Action bar. Timing began with the "high mag" announcement. During this task the gunner re-centered the target image on the TSU, depressed and held the action bar on the left hand grip of the TSU, and observed the attack flag appear on the reticle. Timing ended with the gunner's announcement of "Action."

5) PILOT: Position aircraft into pre-launch constraints. Task measurement began with the onset of the gunner's announcement "Action." The pilot positioned the aircraft so that it was within pre-launch constraints displayed on the HUD and announced "ready." Measurement ended with the onset of "ready."

6) GUNNER <u>Fire TOW.</u> Timing began with the pilot's "ready" announcement. During this time the gunner made final sight adjustments and announced "fire." The gunner fired the TOW by squeezing the firing trigger while continuing to depress the action bar. As the missile fired and the gunner released the trigger and action bar, the gunner announced "TOW out." Timing ended with the onset of the latter announcement.

7) GUNNER: <u>Track missile to target.</u> Timing was from the "TOW out" announcement to the gunner's announcement of missile impact. The duration of this task was almost entirely missile flight time dependent and was not expected to vary with treatment.

8) PILOT: <u>Remask to 5 ft. AGL.</u> Time measurement was from the gunner's announcement of missile impact ("hit" or "miss") to when the aircraft was positioned over the original hover position at 5 ft. or less AGL.

<u>Rocket Scenario Tasks</u>.

1) PILOT: <u>Unmask and identify target.</u> This task and its measurement were identical to those for TOW launch.

2) GUNNER: <u>Acquire target.</u> This task and its measurement were identical to that for TOW target acquisition.

3) GUNNER: <u>Track target and switch to high magnification.</u> This task and its measurement were identical to that for TOW launch.

4) GUNNER: <u>Fine adjust, lase target, and confirm range.</u> Timing began with the gunner's "high mag" announcement. During this task the gunner made final sight adjustments, announced "lasing," lased the target to determine range, and announced the range using standard phraseology, e.g., "valid at 2700 meters." Timing ended with the onset of the range announcement.

5) PILOT: Position aircraft, fly reticle to target, and fire. When the gunner announced "ready" the pilot aligned the fire control reticle with the target and fired a pair of rockets. The dependent measure was time from the onset of the "ready" signal to the onset of the sound of the rocket motors.

6) PILOT: End firing. Dependent measure timing began with the onset of the rocket motors of the first rocket pair. The gunner provided the pilot with fire adjust data. The pilot adjusted the aircraft position, if necessary, and fired the remaining rocket pairs. As the last pair of rockets were fired, the pilot announced "rockets out." The end of the task was marked by the onset of that announcement.

7) PILOT: Remask to 5 ft. AGL (rocket launch). Timing of this task began with the onset of the "rockets out" announcement and ended when the aircraft was positioned over the original hover position at 5 ft . or less AGL.

Comparison of Scenario Tasks.

The two preceding sections identified the chronological order of sub-tasks for TOW and rocket scenarios, respectively. Accordingly, there were 8 TOW tasks, and 7 rocket tasks. In both the rocket and TWO scenarios, the first three tasks were identical. First the pilot unmasked the helicopter and identified the target. Second, the gunner acquired the target, and third, the gunner tracked the target and switched to high magnification. Finally, although the last tasks within each scenario (i.e., Remask AH-1 to 5 ft. AGL) were nominally the same, they were analyzed separately because the composition of antecedent tasks was different.

The above rendered 12 unique tasks for the PDQ procedure. The 6 pilot tasks were:

(1) unmask and identify target (rockets and TOW);
(2) position aircraft into pre-launch constraints (TOW);
(3) remask to 5 ft. AGL (TOW);
(4) position aircraft, fly reticle to target, and fire (rockets);

(5) end firing (rockets); and
(6) remask to 5 ft. AGL (rockets).

The six gunner tasks were:

(1) acquire target (rockets and TOW);
(2) track target and switch to high magnification (rockets and TOW);
(3) action bar (TOW);
(4) fire (TOW);
(5) track missile to target (TOW); and
(6) fine adjust, lase target, and confirm range (rockets).

These twelve tasks served as the basis for analyses -- by position (pilot/gunner), and by task (as listed above).

Differences Among Simulator Sessions.

The subjects were run through two simulator sessions during the first day of the experiment. Simulator Session 1 was for practice to provide each crew member some familiarity with the scenario and tasks. Each pilot/gunner pair went through the simulation separately with the "control" crew member performing the duties at the other position. The control crew member was used throughout the experiment to ensure that any performance decrements that appeared were attributable to one crew person's symptoms rather than an interaction between two "sick" crew members.

Simulator Session 2 occured 2 hours after the practice session. Session 2 provided baseline simulator performance data. Session 2 was conducted between 1000 and 1200 hours on the first day when participants were expected to be "healthy, feeling fine"

The subjects were also run through two simulator sessions on the second day. Session 3 began in the early afternoon on the second day and was intended as refresher practice to ensure retention of the scenario specific skills required for the study. Session 4 was the treatment session in which accumulated fatigue and weakness was compounded by the barany chair to stimulate upper gastrointestinal distress. The major sessions for performance comparisons therefore, were the baseline Session 2 on the first day, and the treatment Session 4 late on the second day.

Although all simulator sessions used the exact same target, target range, and target location, the location of the masked starting position of the helicopter was changed with the assumption that there would be no differences in difficulty associated with these different locations. The initial experimental plan called for the use of four separate unmask positions that would be counterbalanced across the four sessions. This was done to provide variability with respect to the visual components of the target acquisition task.

After data were collected on 3 pilots and 3 gunners, it was discovered that, although the wind conditions programmed for each starting location were identical (originating from 200 degrees at 10 knots, with moderate gusts), they systematically affected task times because the relative unmasking position of the helicopter to the wind changed with each of the 4 starting locations, thus varying piloting difficulty. Instead of changing the wind conditions to ensure a constant angle of wind direction for the remaining 14 crew members, it was decided that advantages in maintaining variability in the visual search environment were not worth the loss in data validity due to systematic changes caused by the use of alternative starting locations. Consequently, the unmask starting locations were varied for only the practice sessions (Sessions 1 and 3), and the starting locations were kept constant for the baseline session (Session 2) and the treatment session (Session 4). Therefore, subjects 1 through 6 were excluded from the analyses of simulator performance data. However, the data from all 20 crew members were included in other pertinent analyses.

3.3.7 Performance Decrement Questionnaire.

Following a lunch break on the first day, the subjects completed the 43 PDQ response sheets. The PDQ procedure was to:

(1) estimate task durations for each of the 12 tasks assuming the crew person is healthy and feeling fine;

(2) provide responses to the "How sick are you" question for all 43 symptom complexes;

(3) review each of the 42 symptomatic complexes and determine whether the respondent believed he would;
   (a) experience no increase in time to complete the task,
   (b) experience an increase in time to complete the task, or
   (c) not be able to do the task at all;
(4) estimate an increase in task duration for those descriptions which were sorted into the b category.

3.3.8 Meals.

Meals were served at 1230 and 1630 on the first day. Participants received no other food between reporting to the experiment on day one and completion of all experimental activities on day two. Food deprivation was included in the experimental treatment as a prophylactic measure. That is, because treatment on the second day included inducement of nausea, this procedure was employed to minimize the possible risk associated with aspiration of vomitus.

3.3.9 Exercise.

At either 1000 hours (pilots) or 1100 hours (gunners) on the second day, all participants engaged in a series of physical exercises. The exercise period lasted 42 minutes. During the first ten minutes of exercise, participants were encouraged to stretch and run in place so as to avoid injuries during the upcoming half-hour. During the subsequent 32 minutes the participants engaged in a series of 8 exercises. Each of the 8 exercises was preceded by 2 minutes of rest. The instructions for all exercises were to "do as many (repetitions) as possible in 2 minutes." In order of performance, the exercises were:

(1) jumping jacks,
(2) push ups,
(3) squat thrusts,
(4) leg lifts,
(5) flutter kicks,
(6) body twists,
(7 sit ups, and
(8) shuttle run.

The exercises were selected to enhance fatigue.

Instructions for the exercises were both verbal and by demonstration. The same research assistant instructed all subjects.

The number of repetitions performed was not recorded. However informal observation suggested that all subjects made a serious attempt to comply with the instruction to do as many repetitions as they could. In an effort to provide some extra motivation, the experimenters posted the name and number of repetitions of the subject with the highest number of repetitions on each exercise. The posting was updated in the subject's presence, as he completed each exercise. All the volunteers were from the same squadron, and thus knew each other.

3.3.10 Spin.

Prior to the last simulator session each subject was spun in the Barany chair in order to induce nausea. Participants were asked to remain in the chair until they experienced stomach discomfort. The Barany chair was first accelerated at a rate of 5 degrees per second to a constant velocity of 25 rotations per minute. Beginning at 60 seconds after the start of the rotation, subjects were paced through a series of head movements. The physician paced his instructions to the subjects with a metronome. The head movements were performed in four steps: (1) tilt forward 45 degrees, (2) tilt back 45 degrees, (3) tilt left 45 degrees, (4) tilt right 45 degrees, with return to center following each step. A movement cycle was paced at two seconds such that the movement away from center took one second and the return took one second. The series of head movements were repeated every 20 seconds until the subject expressed stomach discomfort.

Following the last simulator session the subjects were debriefed (Appendix E contains a transcript of the air crew debriefs). After the experiment was completed, each crew member was driven home.

SECTION 4

RESULTS

The focus of this report is the relationship among predicted performance, simulator performance, and reported symptoms. The findings for SCL, AH-I performance, and PDQ are presented first. Next, the relationships between the three sets of measures are described.

4.1 SYMPTOM CHECK LIST (SCL).

Only SCL data from the 14 subjects from whom valid performance data were obtained are reported here. Because the present focus is the relationship between SCL reports and performance, only SCL data recorded in association with performance in baseline and post-spin (session 4) simulator sessions are discussed here; an analysis of all the SCL measures is included in a separate report (see Perez et al, 1991) with the analysis of the PAB data. Two SCLs were recorded at the postspin simulator session. One SCL, referred to here as *pre-sim,* was obtained when the subject entered the simulator after the Barany chair spin. The other SCL, referred to here as *post-sim,* was obtained immediately following the last post-spin trial in the simulator. Together these two SCL ratings are assumed to reflect the subjects' symptom states during the post-spin simulator session.

Mean symptom checklist values are displayed in Figure 4-1. Because the symptom checklist data are ordinal scale (i.e., rank) measurements, and because there was no variance in the baseline symptoms, the Friedman Test for ranked data (Meddis, 1984) was used to test for differences in reported SCL severity as a function of time of measurement. Significant differences ($p < .05$) between baseline, pre-sim and post-sim ratings were obtained for UG, $H(2) = 19.32$; FW, $H(2) = 21.12$, and HY, $H(2) = 21.03$. The figure shows that SCL differences were largely between baseline and the pre- and post-simulation measurements. No significant differences were obtained between pre-sim and post-sim assessments. There was no tendency for pilots to differ from gunners in terms of reported symptom severity. These findings imply that (1) illness was induced in the target UG and FW categories, (2) illness was also induced in the non-target hypotension category, (3) volunteers reported feeling sick throughout session 4, and (4) any improvement in symptoms during the post-spin simulation was small and not statistically reliable. Because hypotension is seen with intermediate doses of radiation (see Figure 1-1), the symptom complex pattern reported by the volunteers is appropriate for assessment of the validity of the IDP methodology.

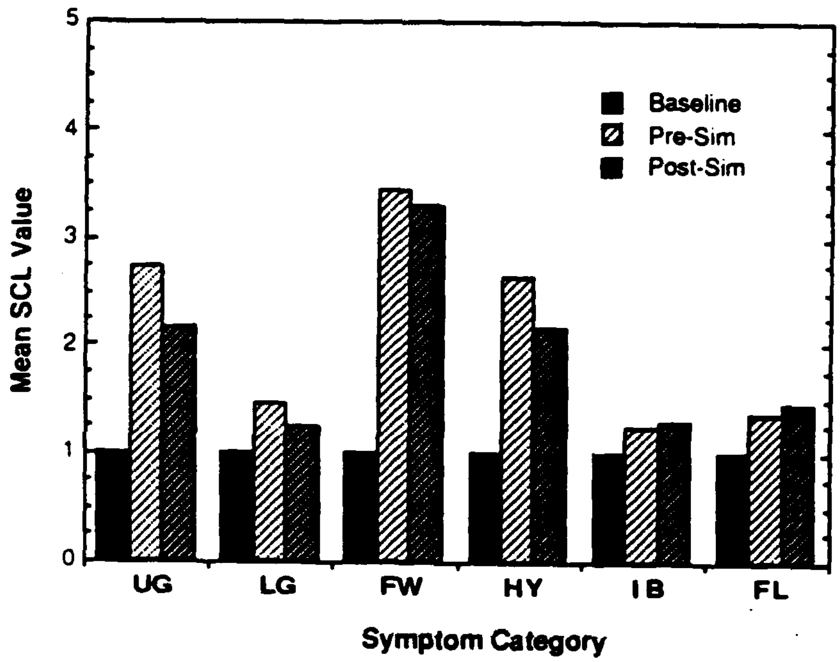

Figure 4-1. Mean Reported SCLs as a Function of Symptom Category and Time of Assessment.

The mean difference SCL between baseline and post-spin was not the result of some volunteers reporting illness and others reporting no change. All 14 subjects reported themselves to be healthy (i.e., reported symptom complex 111111) at the baseline assessment. All the subjects reported illness symptoms both pre- and postsimulation. Minimum and maximum ratings as a function of symptom category and time of measurement are given in Table 4-1.

Given that subject self reports imply the manipulations to induce radiation like symptoms were successful, it is reasonable to analyze the simulator performance data for possible symptom related effects.

Table 4-1. Minimum and maximum reported symptom severity; at baseline and before and after Post-Spin Simulator Session.

	Baseline		Pre-Simulation		Post-Simulation	
	Min	Max	Min	Max	Min	Max
UG	1	1	2	5	1	4
LG	1	1	1	3	1	3
FW	1	1	2	5	2	5
HY	1	1	2	3	1	5
IB	1	1	1	2	1	2
F L	1	1	1	2	1	1

4.2 SIMULATOR PERFORMANCE.

No significant differences in accuracy as a function of simulator session were obtained. Table 4-2 shows the mean proportion of TOW hits over 10 trials for pilots and gunners as a function of session (baseline or post-spin). As can be seen, TOW accuracy was high both for baseline and post-spin and variability was low. Table 4-2 also shows the mean number of rocket hits over 10 trials for pilots and gunners as a function of session. The total possible rocket hits was 14 per trial. Rocket accuracy was poor and did not vary significantly as a function of session. The greater rocket accuracy of gunners is probably attributable to the experience of the always healthy "control" pilot rather than to the actions of the gunners.

Table 4-2. TOW and rocket accuracy; as a function of crew position and simulator session;.

	TOW: Proportion Hits		Rockets: Number of Hits	
Baseline	Pilots	Gunners	Pilots	Gunners
Mean	0.88	0.96	2.62	6.01
Standard Dev.	0.09	0.04	0.85	1.47
Post-Spin				
Mean	0.91	0.92	2.24	7.67
Standard Dev.	0.15	0.08	0.93	0.78

Because there are no differences in accuracy between sessions, *interpretation* of between session task time differences may be attributed to the effects of symptom inducement manipulations, rather than trade-offs between speed and accuracy.

Table 4-3 shows task duration means and standard deviations for the 7 pilot tasks. Table 4-4 shows mean task durations and standard deviations for the 8 gunner tasks. Analysis of variance was used to test for differences between baseline and post-spin performance. Pilots took longer to remask when sick than when they were well. The remask time difference is seen both for rocket launches, $F(1,6) = 18.24$, $p < 0.006$, and TOW launches, $F(1,6) = 15.09$, $p < 0.008$. The unmask task also tended to take longer when pilots were sick than when they were well; this difference was marginally significant for the rocket scenario, $F(1, 6) = 6.49$, $p < 0.05$. None of the other differences between baseline and post-spin pilot performance approached significance.

None of the gunner tasks took significantly longer (either statistically or in a practical sense) post-spin than they did at baseline. The gunner tasks that were assessed appeared insensitive to symptom induction.

4.3 PDQ: PERFORMANCE PREDICTIONS.

The IDP methodology stresses that PDQ data should come from highly trained experts who possess recent experience with the tasks of interest. It was decided that pilot predictions of gunner performance and gunner predictions of pilot performance do not meet these criteria. AH-1 pilots and gunners receive the same (pilot) training, and therefore have a basic understanding of both crew positions. However, upon leaving school they are assigned to one of the two crew positions. As a result, the gunners in the sample did not have extensive or recent experience in the pilot position and likewise, pilots did not have extensive or recent experience in the gunner's position. Therefore, the analyses rely primarily on gunner predictions for the six gunner tasks and pilot predictions for the six pilot tasks.

SCL and simulator performance data are analyzed only for the 14 subjects for whom comparable baseline and post-spin data were available. However, there was no reason to exclude the performance predictions of subjects not included in the performance analysis. PDQ methods do not call for performance predictions to come

Table 4-3. Means and standard deviations of Pilot Task Durations (in seconds) as a function of simulator session.

Task	Baseline	Post-spin	Δ
Unmask and Identify Target (rocket)	11.27 (3 96)†	14.46 (4.63)	3.19
Position aircraft; fly reticle to target; fire	8.05 (3.02)	6.63 (2.16)	-1.42
End firing	27.74 (4.39)	27.91 (4.41)	0.17
Remask to 5 ft. AGL (rocket)	18.93 (4.64)	24.03 (5.26)	5.10**
Unmask and Identify target (TOW)	11.33 (3.54)	13.56 (5 39)	2.23
Position aircraft into pre-launch constraints	1.30 (0.57)	1.36 (0.61)	0.06
Remask to 5 ft AGL (TOW)	17.42 (6.01)	20.63 (6.32)	3.21*
†Standard Deviations in Parentheses			* p < 0 05 **P < 0.01

Table 4-4. Means and standard deviations of Gunner Task Durations (in seconds) as a function of simulator session.

Task	Baseline	Post-spin	Δ
Acquire target (TOW)	1.88 (0.51)	2.14 (0.64)	0.26
Track target and switch to high magnification (TOW)	1.13 (0.20)	1.23 (0.18)	0.10
Action bar	1.29 (0.37)	1.38 (0.54)	0.09
Fire TOW	3.03 (0 29)	2.87 (0.37)	-0.16
Track missile to target	13.85 (O.18)	13.79 (0.72)	-0.06
Acquire target (rocket)	1.66 (0.42)	2.13 (0.77)	0.47
Track target and switch to high magnification (rocket)	1.12 (0.16)	1.09 (0.19)	-0.03
Fine adjust. lase target and confirm range	4.95 (1.11)	4.95 (1.43)	0.00

from the same individuals who may later be exposed to radiation. Therefore validation of predictions against performance does not require the prediction data to come from the same individuals who provide the performance data. The data from all twenty subjects were screened for inclusion in the PDQ analysis.

4.3.1 Data Screening.

The PDQ model requires several assumptions. One of those assumptions is that as the severity of symptoms increases, crew performance will either stay the same or slow. The model assumes performance will never improve, i.e., be of shorter duration, as symptoms become more severe. Correspondingly, data from individuals with an excessive number of reversals were excluded from analysis. A reversal was defined as a shorter predicted performance time with the more severe of two "adjacent" symptom complexes. Adjacent complexes were described as complexes that differed in level of symptom severity by one digit (or two where a one digit difference was not included in the questionnaire) on one, and only one, symptom category.

In Table 4-5, symptom complexes that were defined as adjacent are displayed in rows. The symptom complexes are segregated as "simple" or"complex." Simple complexes are defined as complexes with 1s in all but one symptom category. Complex complexes have values other than 1 in two or more symptom categories. Within rows of Table 4-5, severity increases from left to right. Only complexes immediately to the left or right of a complex were treated as adjacent; that is, reversals between complexes that are not juxtaposed in the table were not considered. There were 43 pairs of complexes in the reversals analysis. The number of reversals was counted for each subject. As there were six pilot tasks and six gunner tasks, each subject had 6 times 43, or 258 opportunities for reversals.

The results of the reversals analysis are shown in Table 4-6. Subjects with reversals on 25% or more of the comparisons were excluded. One pilot and one gunner exceeded this criterion. Therefore, for all subsequent PDQ analyses, the data of that pilot and that gunner were excluded. Thus the PDQ analyses are based on input from 9 pilots and 9 gunners.

Table 4-5. Symptoms defined as adjacent for the performance of the reversals analysis of PDQ Duration Estimates.

Comparison Type:	Symptom Complex			
Simple	211111	311111	411111	511111
	121111	131111	141111	151111
	112111	113111	114111	115111
	111211	111311	111411	111511
	111121	111131	111141	111151
	111112	111113	111114	111115
Complex	112111	112121	113121	
	113111	113121		
	113111	213111	313111	413111
	211111	213111		
	311111	312111	313111	
	411111	412111	413111	414111
	413111	513111		
	511111	513111	514111	515431
	414111	514111		
	414111	414112		
	114111	114112		
	114112	214112		
	214112	214113		
	214112	314112	414112	
	314112	315113	515223	

Other analyses, based on different exclusion criteria, suggest that the results are robust to choice of criteria; the findings are not qualitatively different whether all subjects' data are used, or only the data of the pilot and gunner with the fewest reversals are used. The choice of exclusion criteria does effect the results of the regression analyses (described below) in that the size of the **b** weights of the predictors change markedly with inclusion or exclusion of subjects. The resultant predictions and R^2 values do not change much. The importance of the data screening is largely for consistency with previous studies.

Other data screening considerations were: non-compliance with instructions, excessive consistency, concentration on extremes, and combined causes. All subjects in this study followed instructions.

Table 4-6. Frequency of intransitivities by position and subject.

	Simple	Complex	Total	Percent
Pilot				
1	5	29	34	13.18
3	3	21	24	9.30
5	13	20	33	12.79
7	6	34	40	15.50
9	22	44	66	25.58
11	20	34	54	20.93
13	12	40	52	20.16
15	10	19	29	11.24
17	13	28	41	15.89
19	14	39	53	20.54
Gunner				
2	7	17	24	9.30
4	25	45	70	27.13
6	5	25	30	11.63
8	2	10	12	4.65
10	2	16	18	6.98
12	0	3	3	1.16
14	10	35	45	17.44
16	4	16	20	7.75
18	12	29	41	15.89
20	3	5	8	3.10

Two varieties of excessive consistency were analyzed. With either variety, the subject appears to ignore differences in the unique demands of tasks. Thus, for any given symptom complex, the excessively consistent subject performs the <u>same</u> mathematical transform on healthy duration estimates for <u>different</u> tasks. The two varieties of transformation considered were:

(1) adding a constant time decrement, and

(2) multiplying by a constant.

The data were examined for both types of consistencies. If a subject adds a constant to his time estimates for all tasks; then the variance of the difference between healthy time and sick time will be zero. That is, the variance of

$$\text{Healthy Time}_j - \text{Time}_{ij} \tag{1}$$

will equal zero, where i indexes symptom complex and varies form 1 to 42, and j indexes task and varies from 1 to 6. If the subject multiplies healthy time by a constant to derive sick times, then the variance of the ratio of the difference to healthy time will be zero. That is, the variance of

$$1 - \frac{\text{Healthy Time}_j - \text{Time}_{ij}}{\text{Healthy Time}_j} \tag{2}$$

will be zero. The means and standard deviations of the values obtained using equations 1 and 2 are reported in Appendix F. In that appendix, the number of tasks is less than six where the subject estimated that he could not do one or more tasks.

Only one pilot (subject 13) showed evidence of excessive consistency. For various symptom complexes he appears to have invoked one or the other of the consistency transformations. For other subjects, instances of zero variance for either equation 1 or 2 were associated with an across the board estimate that the complex would not affect performance. Although his data are suspect, subject 13 was not excluded from subsequent analyses because insufficient criteria were available to guide a decision on exclusion of his data. Because numerous analyses with various subjects and transformations all seemed to lead to similar conclusions, subject 13's data were included in the analyses reported here.

4.3.2 Performance Decrement Prediction Equations.

Two sets of least squares regression models were developed. One set generated predictions at the task level by averaging across tasks. The other set generated predictions for each task. Under the *By Position* heading, the models generated for pilot and gunner performance are discussed at the composite task level (i e predicted AH-1 crew member tank engagement performance). Under the *By Task* heading, derivation of task prediction equations (i.e., predictions for each of the six pilot and six gunner tasks) is discussed.

4.3.2.1 By Position. The analysis by position yields two prediction equations, one for the pilot crew position, and another for the gunner crew position. For each crew position, the simulated tank engagement simulation was composed of six tasks. The prediction equations were derived by first averaging across the six tasks of the respective crew positions. The analysis is described in 4 steps.

Step I: Conversion of Estimated Task Durations to Ratios.

The ratio of time "healthy" to time "sick" was computed for each subject, task, and symptom complex. That is

$$P_{ijk} = \frac{\text{Time healthy}_{ij}}{\text{Time}_{ijk}},$$

where k indexes the 42 "sick" symptom complexes, j indexes the 12 tasks (one to six for gunners, and one to six for pilots), and i indexes subjects (one to nine for gunners and pilots respectively). The letter P is used to represent performance predictions. The reader is urged to keep in mind that P is not a performance measure, but rather, P represents a prediction. The purpose of this study is to evaluate the prediction method.

Step 2: Average Ratios Over Subjects.

The ratios that result from step 1 were averaged over subjects, i.e.,

$$\bar{P}_{jk} = \frac{\sum_{i=1}^{n} P_{ijk}}{n},$$

where n (the number of subjects) equals 9 and separate means are obtained for pilot and gunner positions.

Step 3: Average Over Tasks.

Next, predicted performance was averaged over tasks by computing

$$P_k = \frac{\sum_{j=1}^{6} Time_{(healthy)}}{\sum_{j=1}^{6} \overline{P}_{jk}}.$$

Data were examined for consistency with the assumptions of the least squares multiple regression model. One assumption of the regression model is that the predictors are linearly related to the dependent variable. Figures 4-2 and 4-3 present subjects' predictions as a function of severity for each of the symptom categories (i.e., values ranging from 1 to 5 for UG, LG, FW, HY, IB, and FL respectively). Given with the plots is the R^2 for the simple regression of P_k on symptom severity.

The plots can be interpreted to suggest that a linear model is appropriate. They also highlight other aspects of the data. The PDQ symptom categories of most interest were UG and FW. These categories were well sampled across the severity range. The remaining categories had very few samples with severities other than 1. As a result of this sampling pattern, only UG and FW show the expected strong inverse relationship between severity and P_k. The sampling pattern across symptom categories resulted in non-zero correlations between category descriptors (i.e., the severity indices of UG, LG, FW, HY, IB, AND FL). The correlations between category descriptors across the 42 symptom complexes are shown in Table 4-7. Because FW and UG are moderately correlated (r= 0.46), it can be expected that in a multiple regression their ß weights will be reduced relative to their ability to individually predict the dependent measure.

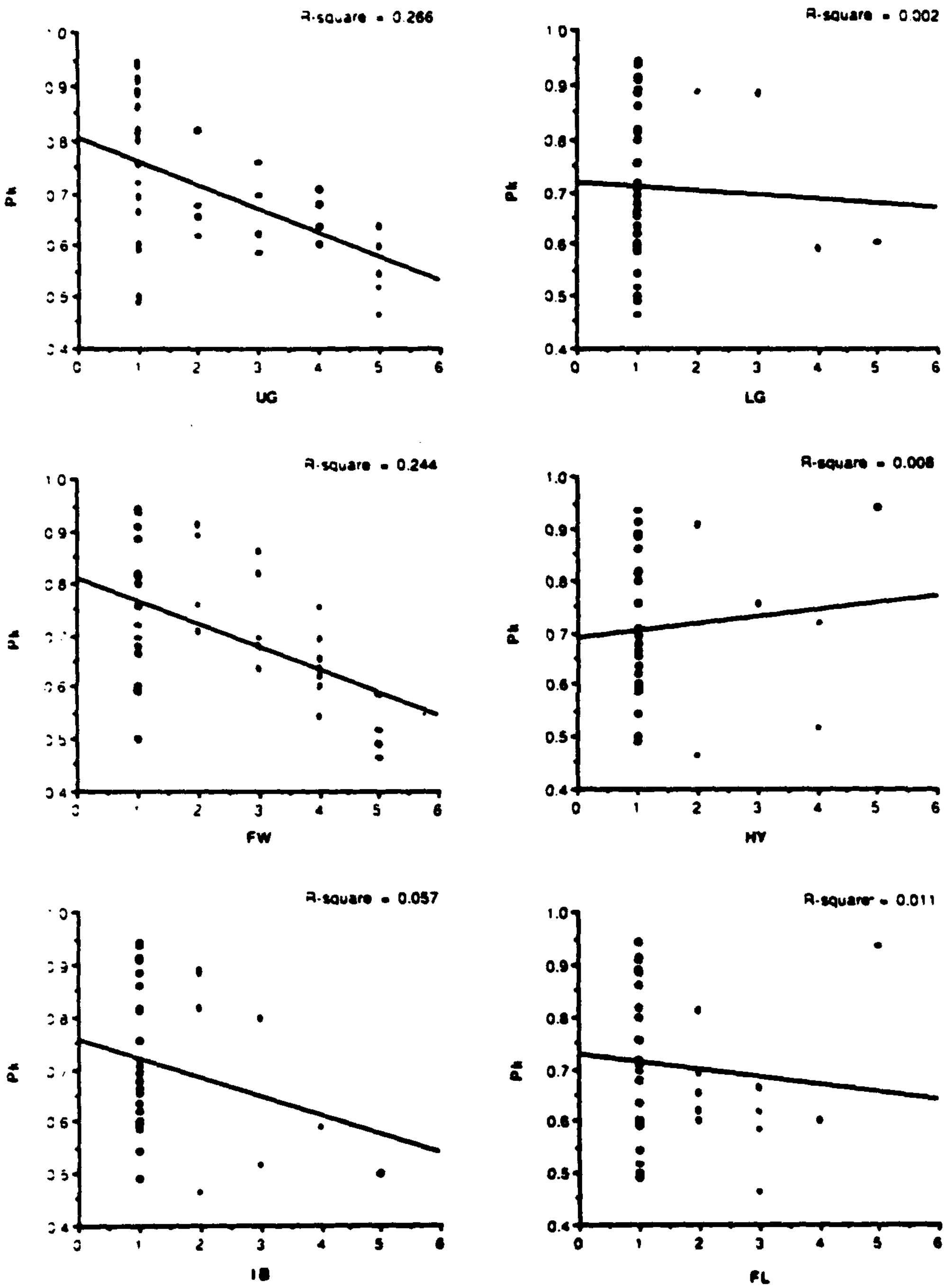

Figure 4-2. Pilot P_K values plotted as a function of symptom severity.

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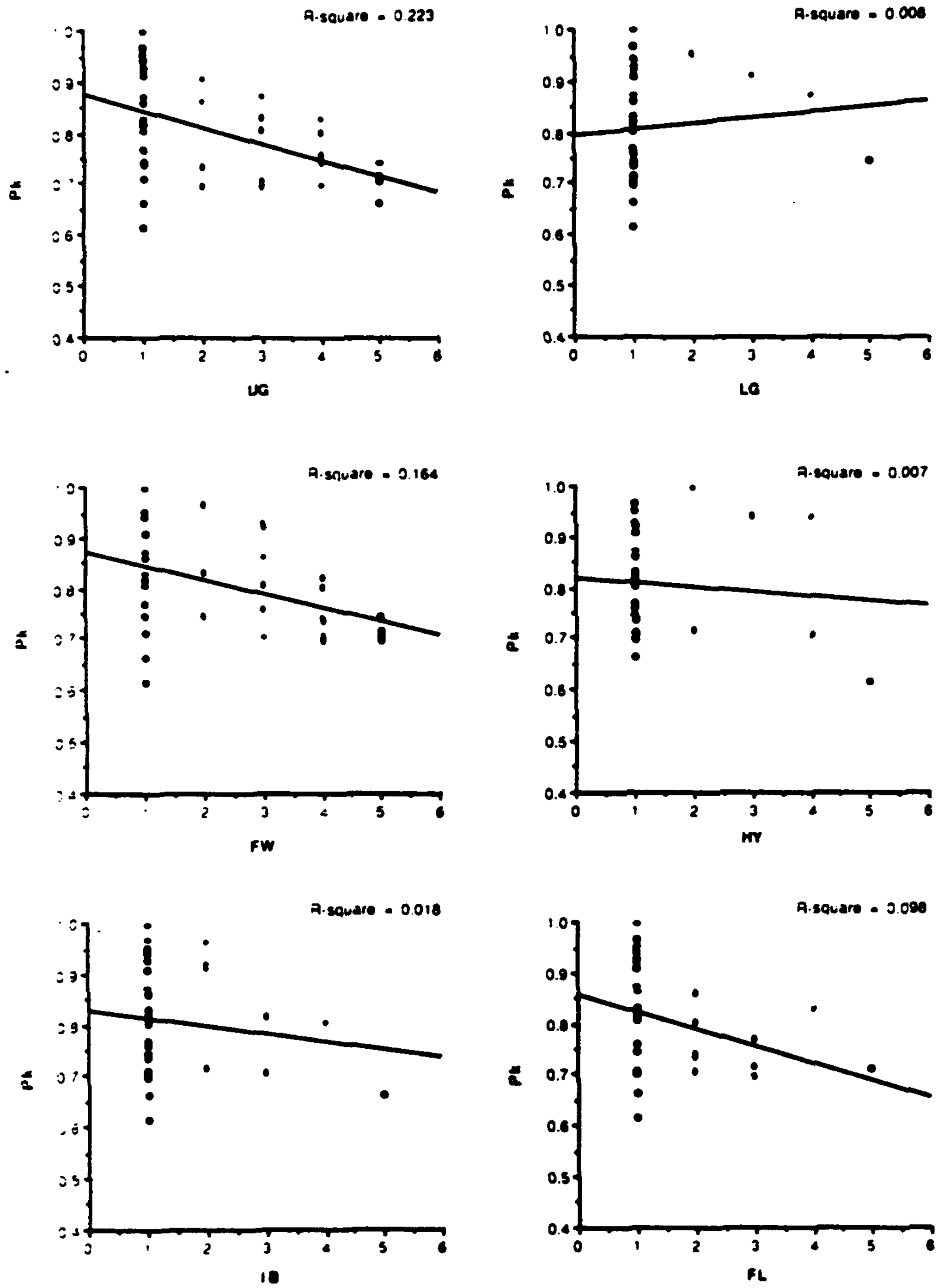

Figure 4-3. Gunner P_K values plotted as a function of symptom severity.

Table 4-7. The correlations between symptom category severity codes in the present study.

	UG	LG	FW	HY	IB	FL
UG		-0.23	0.46	-0.01	-0.10	-0.06
LG			-0.27	-0.11	-0.12	-0.15
FW				-0 05	-0 09	0 13
HY					0.06	-0.13
IB						-0.15

Step 4: Least Squares Multiple Regression.

After averaging over tasks there are 42 data points, one for each symptom complex. These 42 average performance estimates were submitted to a least squares multiple regression where P_k was the predicted variable and the indices of the symptom categories were the predictor variables.

The form of the regression model is:

$$P'_k = b_0 + X_1 b_l + X_2 b_2 + X_3 b_3 + X_4 b_4 + X_5 b_5 + X_6 b_6,$$

where X_1 through X_6 are the symptom category classifications of the 42 complexes (i.e. values 1 through 5), the b weights are the best least squares predictors of P_k

The least squares regression equations derived for the pilot and gunner positions are given in Table 4-8. Both pilot and gunner models provide a significant fit to the data ($p < 0.05$), with the pilot model providing somewhat better fit than that for the gunners. The respective R^2 values for pilot and gunner models are 0.56 and 0.47.

The size or significance of ß weights should not be used to infer which symptom categories the subjects' considered most important. The significance of the 13 weights does indicate which symptom categories the *regression equation* gives the most weight. Other analyses, not reported here, yielded very different b weights with only minor modifications to the input data. Modifications such as dropping or adding one subject or transforming P_k produced very different b weight patterns without substantially changing the performance prediction. With these caveats in mind, for the pilots, UG, LG, FW. and IB contributed significantly to the performance prediction, $p < 0.05$. For the gunners, UG, IB, and FL contributed significantly. Thus for both pilots and gunners, one of the target symptoms, UG, contributed significantly to the prediction of predicted performance.

Table 4-8. Regression equations derived from the *By Position* analyses.

	Pilots	Gunners
INTERCEPT	1.05252	1.06106
UG	-0.04197	-0.03109
LG	-0.05372	-0.02336
FW	-0.03449	-0 01550
HT	0.00434	-0.01627
IB	-0.05511	-0.02943
FL	-0.02657	-0.04085

Figures 4-4 and 4-5 show the respective pilot and gunner predictions that result from application of the regression equations. The predictions are plotted as a function of symptom complex, where predicted performance, represented on the vertical axis, has a possible range of zero (0) to one (1). Zero (0) represents a predicted inability to do the task, and one (1) would indicate no predicted impairment. Symptom complexes have been ordered along the horizontal axis so that the intersection of predictions with complexes falls along a single diagonal line. The data are forced onto a straight line; these figures cannot be used to assess the linear fit of the model to the data.

The Figures 4-4 and 4-5 illustrate: (1) perceived symptom complex severity with respect to predicted performance, (2) standard errors of the predicted means (0.90 confidence limits), and (3) the range of predicted performance decrements.

It appears that the effect of symptoms is predicted to be greater on pilot performance than on gunner performance. There are at least two plausible explanations for this. One is that subjects (gunners and pilots) anticipated that, on average, pilot performance would be more degraded than gunner performance. The

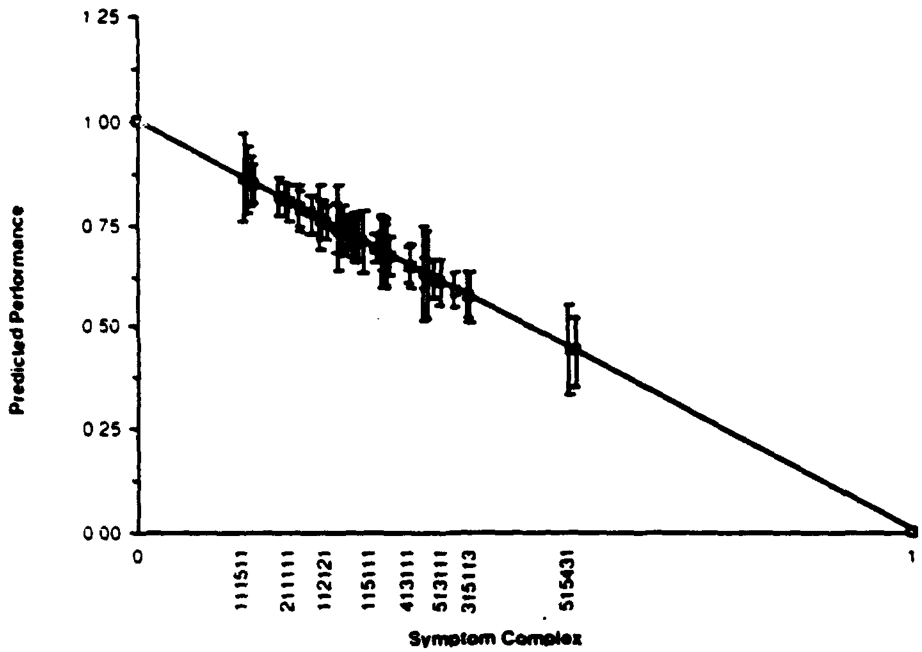

Figure 4-4. Pilot performance predictions, based on derived equations, plotted as a function of symptom complex.

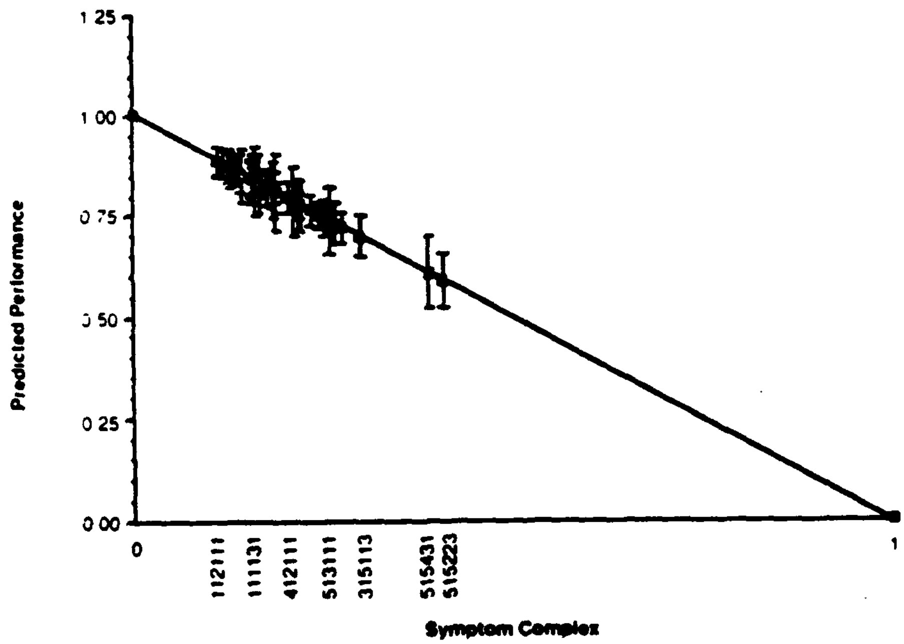

Figure 4-5. Gunner performance predictions, based on derived equations, plotted as a function of symptom complex.

other is that the sample of pilots had a bias towards predicting larger decrements. A bias that is independent of tasks would result in gunner estimates of pilot decrements being less than pilot estimates of pilot decrements, and pilot estimates of gunner decrements being greater than gunner estimates of gunner decrements. If, on the other hand, the subjects (gunner and pilots) viewed the pilot tasks more sensitive to symptom severity, then plots of gunner and pilot predictions should look similar. Figure 4-6 is a plot of gunner predictions of pilot performance and pilot predictions of gunner performance. It appears that, regardless of their own crew position, subjects anticipated that illness symptoms would degrade pilot performance more than gunner performance.

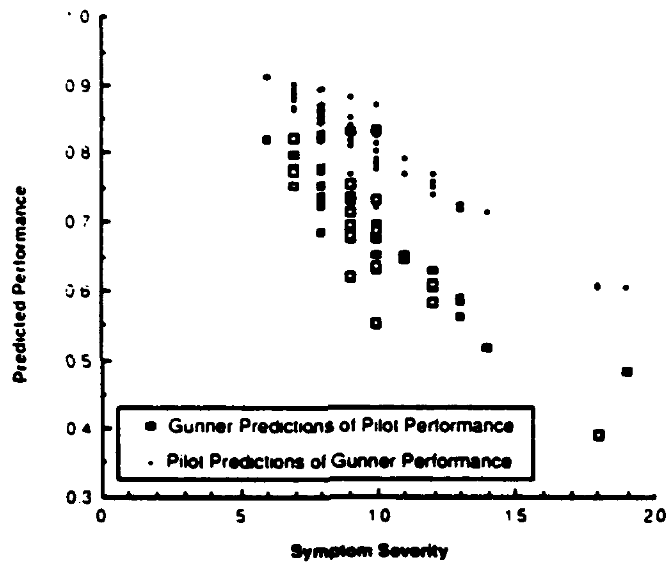

Figure 4-6. Pilot predictions of gunner performance and gunner predictions of pilot performance appear to be similar to predictions of crew members for their own crew position. Values indexing the Symptom Severity axis were created by addition of the symptom complex indices.

4.3.2.2 By Task. The first two steps in derivation of the By Task predictions are the same as the first two steps of the by position analysis: (1) compute the ratio of time sick to time healthy, and (2) average over subjects. Averaging over subjects yields two sets of six P_{jk} values, one set for pilots and one for gunners, where j indexes tasks and varies from 1 to 6, and k indexes symptom complex and varies from 2 to 43. The third step is to perform a separate regression analysis for each of the 12 tasks. Just as in the *By Position* analysis, sample size was 42 and each symptom complex provided one datum. The form of the regression model is the same as for the *By Position* analysis; only the dependent variables (average task duration estimates) are different.

The 12 regression equations that result from this analysis are shown in Tables 4-9 and 4-10. All the regression equations provide a statistically significant fit to the data ($p < 0.01$). The models account for between 36 and 55 percent (i.e., $R2 \cdot 100$) of the variability in the performance estimates. Untransformed data were used in all analyses.

Table 4-9. Regression equations of predicted performance for the six pilot tasks.

	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
INTERCEPT	1.10615	1.01692	1.05521	0.89399	1.09849	1.02589
UG	-0.04600	-0.03595	-0.04568	-0.03785	-0.01474	-0.04466
LG	-0.05790	-0.08131	-0.05230	-0.04135	-0.03562	-0.04257
FW	-0.04013	-0.04985	-0.03690	-0.03254	-0.01882	-0.03571
HT	0.00288	0.02174	0.00955	0.01372	-0.02592	0.00994
IB	-0.05815	-0.09512	-0.06204	0.01671	-0.05527	-0.05471
FL	-0.02766	-0.01390	-0.02151	-0.02198	-0.03465	-0.02048

Table 4-10. Regression equations of predicted performance for the six gunner tasks.

	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
INTERCEPT	1.15289	1.26536	1.16162	1.03999	0.97204	1.02676
UG	-0.06243	-0.03976	-0.02269	-0.01255	-0.00139	-0 05054
LG	-0.04909	-0.05185	-0.02968	-0.02997	0.002312	-0.04687
FW	-0.02444	-0.02417	-0.00512	-0.00501	-0.00059	-0.02630
HT	-0.01136	- 0.070,25	-0.04268	-0.02402	-0.00648	0.00630
IB	-0.06429	-0.07885	-0.06487	-0.03439	0.002017	-0.04848
FL	-0.10009	-0.08796	-0.07338	-0.02234	0.004267	-0.06348

4.4 THE RELATIONSHIP AMONG SYMPTOMS, PERFORMANCE, AND PERFORMANCE PREDICTIONS.

Thus far, results have shown that

(1) subjects did report radiation like symptoms following the experimental manipulations,

(2) subsequent to symptom induction, pilots showed a decrement in simulator performance on at least three of the six pilot tasks,

(3) gunners showed no evidence of a performance decrement with radiation like symptoms,

(4) Predictions of performance are linearly related to symptom severity, and

(5) Both pilots and gunners estimate that the effects of the symptoms are greater on pilots than on gunners.

With performance data for only seven subjects in each of two groups, there are too few data points to support meaningful statistical correlations between reported symptoms and simulator performance. Consequently, a graphical analysis of the relationship between reported symptom complex and actual AH-1 simulator performance is presented.

Simulator performance was computed in a manner similar to that for predicted performance. For each subject, the ratio of baseline to post-spin performance times was computed, i.e.,

$$A_i = \frac{\sum_{j=1}^{6}\left(\frac{\text{Baseline time}}{\text{Post-spin time}}\right)}{6}$$

where i indexes subjects, and varies from 1 to 7, (once for pilots and once for gunners); and j indexes task, and varies from 1 to 6. Baseline and post-spin times are means from ten trials. The resulting ratios are given in Table 4-11.

Predicted post-spin performance was computed separately for each subject. First, each subject's average post-spin symptom complex was computed. That is, if the subject reported "3 1 3 2 1 1" at the start of the post-spin simulation and "3 1 2 3 1

1" at the end of the post-spin session, his average SCL was recorded as "3 1 2.5 2.5 1 1". Second, this value was then plugged into the appropriate regression equation (i.e.,

Table 4-11. Ratios of baseline to "sick" performance times of seven pilots and seven gunners.

Pilots	Gunners
0.98	1.06
0.97	1.05
1.00	0.94
0.94	1.03
1.00	0.89
0.85	0.85
1.10	1.10

weights from Table 4-9 or 4-10). The result was one post-spin performance prediction for each subject. Thus for each subject, performance was predicted based on the individual's symptoms. Third, these performance predictions were plotted against actual post-spin simulator performance. These plots are shown in Figures 4-7 and 4-8. The location of the data points for actual performance is determined with respect to the *horizontal axis by the subject's* average post-spin SCL, and the vertical axis represents actual simulator performance decrement ratios. Performance predictions are represented in the manner described earlier.

Because the gunners showed no performance decrements, it is not surprising that their performance predictions do not correspond to observed performance. It may be of interest to note that the pilot who reported the most severe symptoms had the best performance relative to baseline. Although the pilots did show a significant decrease in performance relative to baseline, the decrease did not approach the magnitude of the decrease derived from the PDQ. However, trends are difficult to distinguish with only seven data points.

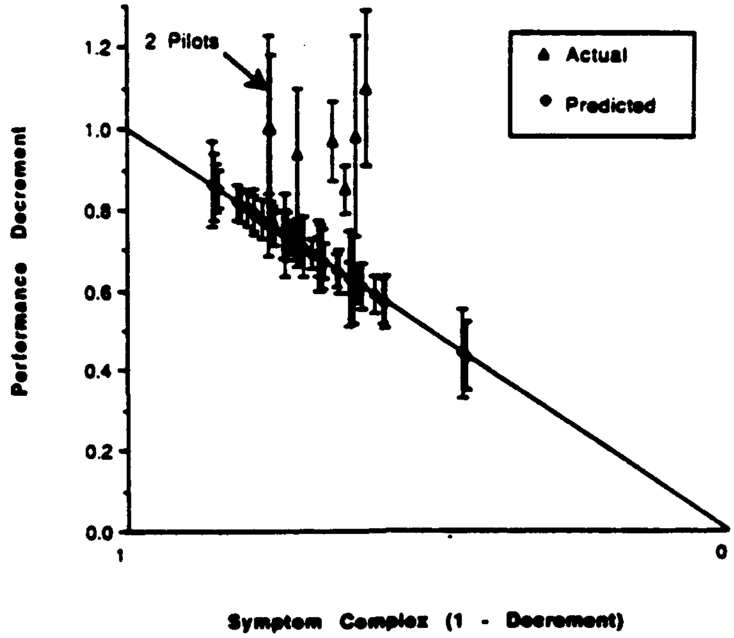

Figure 4-7. Pilot simulator performance decrement ratios overlaid on plot of predicted performance decrement ratios.

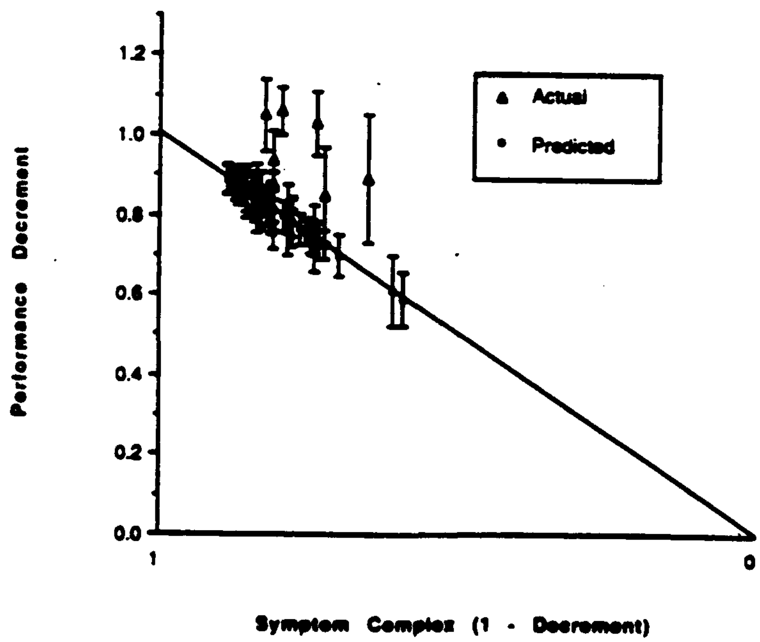

Figure 4-8. Gunner simulator performance decrement ratios overlaid on predicted performance decrement ratios.

SECTION 5

MicroSAINT MODELS

5.1 PURPOSE.

The AH-1 simulation study resulted in means and standard deviations for tasks associated with tank engagements using TOWs or Rockets. The previous section analyzed the results separately for gunners and pilots in the evaluation of the effects of multiple stressors (e.g., mild sleep deprivation, strenuous exercise, and spinning to induce motion sickness) on performance. In this section, MicroSAINT models were developed for the tank engagements using TOWs and Rockets for the purpose of estimating total crew performance and the effects of stressors on overall engagement performance. The measure of merit for the MicroSAINT model was the total engagement time. Total engagement time is a function of the times associated with the separate tasks.

The models were also used to evaluate the degree to which the PDQ methodology can be used to estimate crew performance. In the previous section, the PDQ based estimates did not closely track the actual performance decrements obtained in the AH-1 simulation. One hypothesis was that the SMEs considered crew performance, instead of individual crew member performance, in their estimation of the effects of radiation symptoms on task performance. That is, they may have considered the impact of radiation sickness to both crew members on AH-1 crew/system performance. For the purpose of experimental control, the AH-1 simulations included only a single ill crew member during the Post-Spin test. This could in part result in a lack of fit between the estimated and actual performance decrements. The use of MicroSAINT models allowed the estimation of total crew performance rather than the evaluation of a single crew member's performance.

The MicroSAINT models allowed the execution of multiple "experiments" in which the task completion times and standard deviations were based on the results of the Baseline and Post-Spin simulation sessions. The goodness of fit between PDQ-based and simulation-based (AH-1 simulations) performance decrements were evaluated across these multiple runs rather than with single point estimates as in

Section 4. The AH-1 simulation study included a small number of subjects which affected the power of the statistical tests used to evaluate the relationship between predicted and actual performance. The MicroSAINT models resulted in distributions of crew performance metrics (e.g., engagement times) which presented a greater degree of power for evaluating the relationship between PDQ- and performance-based (simulation) estimations.

5.2 APPROACH.

The following steps were followed in the modeling of crew performance for TOW and Rocket engagements:

(l) Task network models for TOW and Rocket engagements were developed and programmed with MicroSAINT. The tasks were those evaluated in the AH-1 simulation study. For completeness sake, tasks associated with flight management were represented in the model; however, these tasks had no effect on the model results.

(2) The means and standard deviations from the Baseline (HFF) and PostSpin AH-1 simulations were entered in the models.

(3) For each TOW and Rocket task, the PDQ equations presented in Section 4 were used to develop task time multipliers that reflected the increase in task times associated with reported illness.

(4) The above resulted in three different models for the TOW and Rocket engagements, respectively. The three models were (l) task times and standard deviations based on the Baseline AH-1 simulation, (2) task times and standard deviations based on the Post-Spin AH-1 simulation, and (3) a model with PDQ based task time multipliers that were applied to the Baseline task times.

(5) Each of the MicroSAINT models were executed 100 times. The results present averages, and frequency distributions for the resulting engagement times. Also, performance ratios were computed for the Post-Spin and PDQ models. The performance ratios were computed by

dividing engagement times from the baseline model by engagement times from the Post-Spin and PDQ models. This procedure resulted in 100 performance ratios for each of the TOW and Rocket Post-Spin and PDQ models.

5.3 MODEL DEVELOPMENT.

The TOW and Rocket tasks that were evaluated in the AH-1 simulation study were incorporated into two MicroSAINT models: (1) TOW engagement, and (2) Rocket engagement model. Figures 5-1 and 5-2 present the structure of these two models.

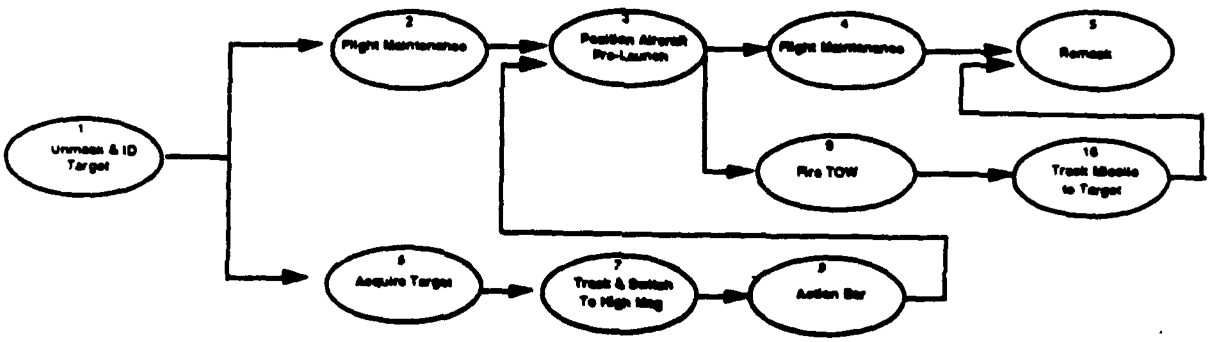

Figure 5-1. TOW engagement model;.

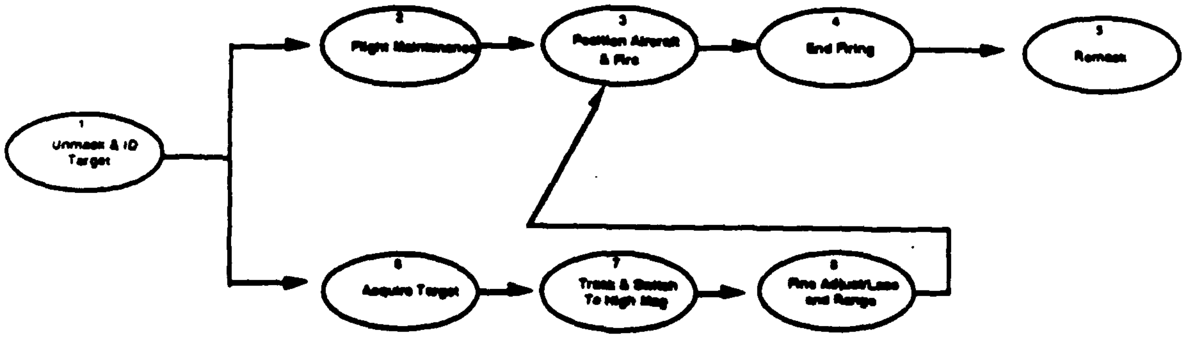

Figure 5-2. Rocket engagement model;.

The mean and standard deviations presented in Tables 4-3 and 4-4 of Section 4 were entered into the models. For each task in the MicroSAINT models, the distribution of times were assumed to be positively skewed (Gamma distributions).

5.4 APPLICATION OF PDQ TO MODELS.

The equations presented in Tables 4-9 and 4-10 of Section 4 were used to derive PDQ-based performance predictions for each of the TOW and Rocket tasks. Two sets of predictions were derived (1) performance predictions under all 1s for UG, LG, FW, HT, IB and FL, and (2) performance predictions based on the average SCL responses reported for the Post-Spin AH-1 Simulation (2.75, 1.5, 3.5, 2.625, 1.25, and 1.375 for UG, LG, FW, HT, IB, and FL, respectively). Table 5-1 presents the predicted performance for each task with the above two sets of symptom categories.

The PDQ equations derived for this study do not result in predicted performance equal to 1 (no decrement) for a symptom description of all 1s (healthy feeling fine). The equations appear to yield underestimates of performance. PDQ-based task time multipliers for the MicroSAINT models were developed with the following procedure: (1) for each subtask the difference between the predicted performance for HFF (all 1s) and the SCLs reported Post-Spin were computed; and (2) to each of these differences a 1 was added. The resulting values were used as task time multipliers for estimating engagement times based on PDQ. The following is a numerical example illustrating the above procedure:

(1) In Table 5-1, two predicted performance values were computed for the TOW engagement task of Unmask and ID Target. The first is for an average SCL response of 2.75, 1.5, 5.2, 6.25, 1.25, and 1.375 which was the average SCL reported prior to the AH-1 simulation following the spinning treatment. The predicted performance is equal to 0.6492. The same equation was used to compute the predicted performance for an average SCL response of all 1s (healthy feeling fine) which was equal to 0.8792.

(2) These two predicted performance scores were used to compute the PDQ multipliers presented in Table 5-2. For the TOW engagement task of Unmask & ID Target the multiplier is equal to 1 + (0.8792-0.6492) or 1.23.

Table 5-1. Predicted performance for TOW and Rocket tasks based on PDQ equations.

TOW Engagement								
SCL Response	Unmask & ID Target	Acquire Target	Track Target & Switch to High Magnification	Action Bar	Position A/C in Pre-Launch Constraints	Fire Tow	Track Missile to Target	Remask
2.75,1.5, 5.2 6.25,1.25, 1.375	0.6492	0.5742	0.58897	0.7428	0.5407	0.8062	0.9610	0.6399
1,1,1,1,1,1	0.8792	0.8412	0.9125	0.9232	0.7625	0.9117	0.9722	0.8466
Rocket Engagement								
SCL Response	Unmask & ID Target	Acquire Target	Track Target & Switch to High Magnification	Fine Adjust Lase Target & Confirm Range	Position A/C and Fire	End Firing	Remask	
2.75,1.5, 5.2 6.25,1.25, 1.375	0.6492	0.5742	0.5897	0.5941	0.6407	0.7539	0.6438	
1,1,1,1,1,1	0.8792	0.8412	0.9125	0.7974	0.7907	0.9135	0.8377	

Table 5-2 presents the PDQ task time multipliers, Baseline task times, and the PDQ adjusted task times as a function of TOW and Rocket tasks. These adjusted task times were entered into the MicroSAINT PDQ TOW and Rocket engagement models. This method appears to improve the fit between PDQ predictions and actual performance obtained in the AH-1 simulation.

Table 5-2. Baseline task times for TOW and Rocket tasks with associated PDQ task time multipliers and PDQ adjusted task times.

TOW Engagement			
Tasks	Baseline Times	PDQ Multiplier	PDQ Adjusted Task Times
Unmask & ID Target	11.33	1.23	13.94
Flight Maintenance	N/A	N/A	N/A
Position A C in Pre-Launch Constraints	1 30	1.22	1.59
Flight Maintenance	N/A	N/A	N/A
Remask	17.42	1.21	21.08
Acquire Target	1.88	I .27	2.39
Track and & Switch to High magnification	1.13	1.32	1.49
Action Bar	1.29	1.18	1.52
Fire TOW	3.03	1.11	3.36
Track Missile to Target	13.85	1.01	13.99
Rocket Engagement			
Unmask & ID Target	11.27	1.23	13.86
Flight Maintenance	N/A	N/A	N/A
Position A/C and Fire	8.05	1.15	9.26
End Firing	27.74	1.16	32.18
Remask	18.93	1.19	22.53
Acquire Target	1.66	1.27	2.11
Track & Switch to High Magnification	1.12	1.32	1.48
Fine Adjust Lase and Range Target	4.95	1.20	5.94

5.5 MODEL EXECUTION AND RESULTS.

Each TOW and Rocket MicroSAINT model was executed 100 times. Figures 5-3 and 5-4 present frequency distributions for the empirically-based HFF, empirically-based Post-Spin, and PDQ-based Rocket and TOW models.

The frequency distributions for Post-Spin and PDQ are shifted to the right relative to HFF. The PDQ distributions indicate that the performance estimates based on the PDQ equations are longer (i.e., greater degradation) than those based on observed simulator performance. The fit between Post-Spin and PDQ appears to be better for TOW than for Rocket engagements.

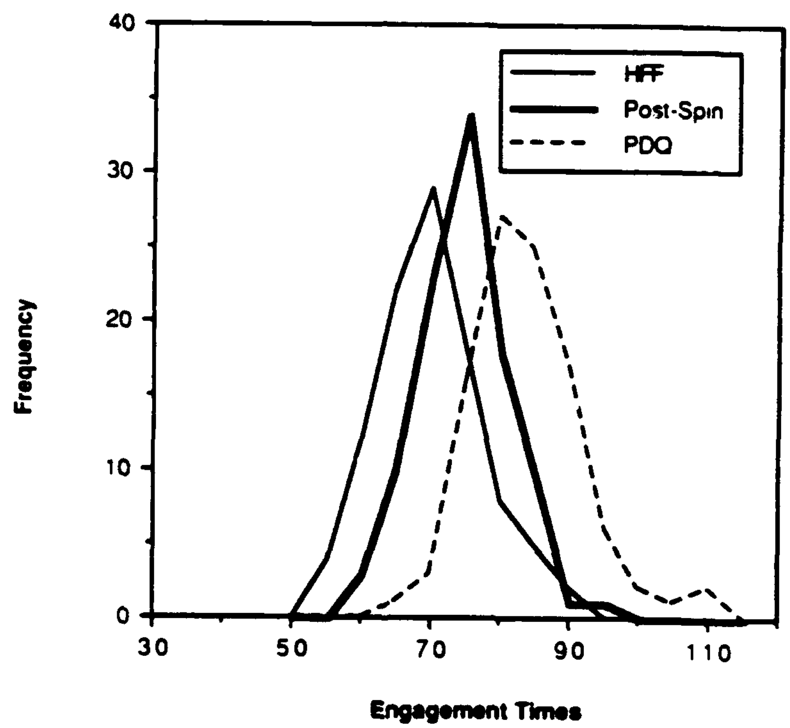

Figure 5-3. Engagement times for empirically-based HFF, empirically-based Post-Spin and PDQ-based Rocket Models (longer times indicate worse performance);.

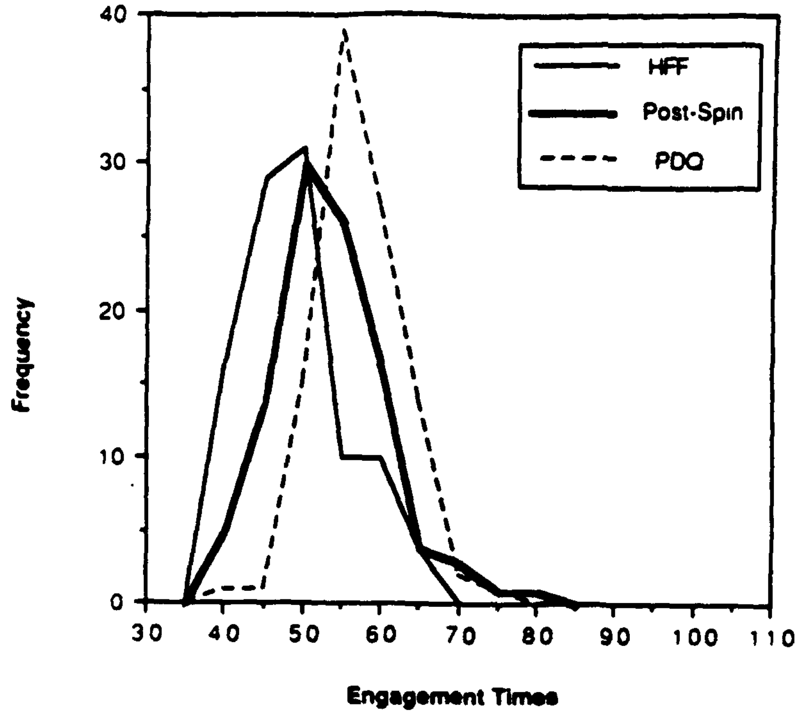

Figure 5-4. Engagement times for empirically-based Baseline, empirically-based Post-Spin and PDQ-based TOW Models;.

Performance ratios were computed for the 100 Post-Spin and PDQ model executions. That is, 100 ratios of HFF engagement times divided by Post-Spin and PDQ engagement times were computed. Figures 5-5 and 5-6 present frequency distributions for the Rocket and TOW performance ratios, respectively.

The functions indicate that the PDQ-derived predictions are within the limits of the function derived from actual performance. The fit appears to be better for the TOW engagements relative to the Rocket engagements. For the Rocket engagements, there were more ratios greater than 1 for the Post-Spin model than predicted by PDQ. A similar effect is observed for the TOW engagements. The method for employing the PDQ regression equations in the prediction of performance resulted in greater performance decrements than those based on the AH-1 Post-Spin simulation data.

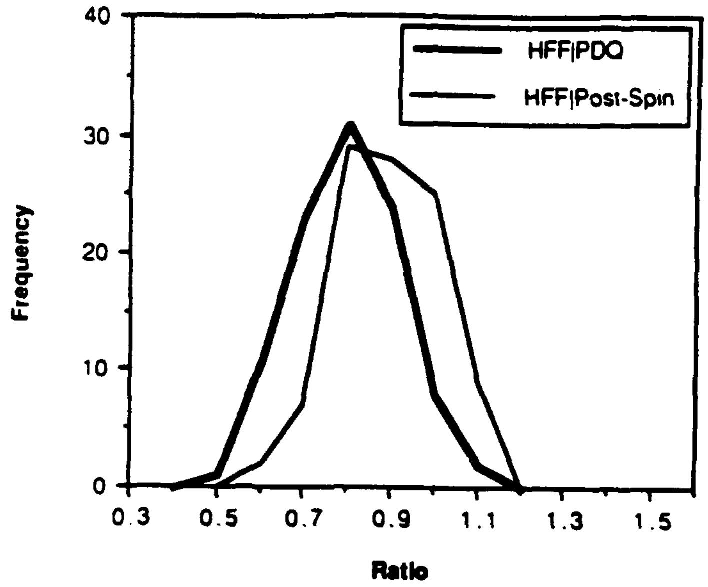

Figure 5-5. Performance ratios for the Post-Spin empirically-based and PDQ-based Rocket engagement models.

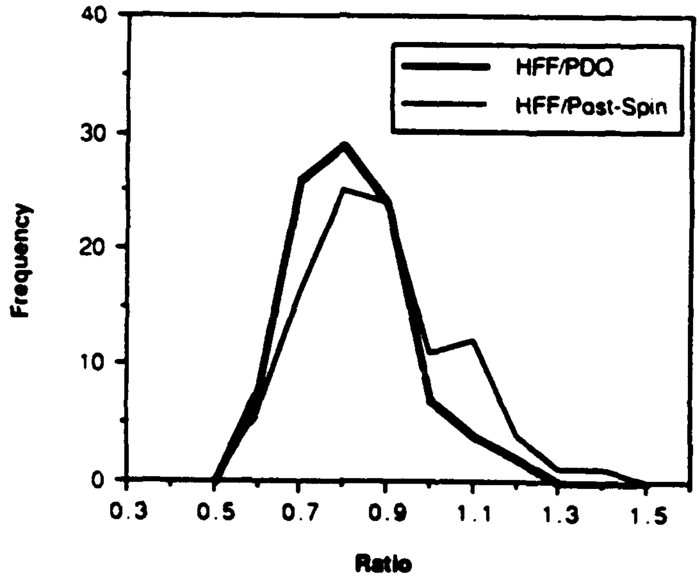

Figure 5-6. Performance ratios for the Post-Spin empirically-based and PDQ-based TOW engagement models.

5.6 SUMMARY.

The modeling studies indicate that the PDQ based performance predictions fall within the bounds of actual performance obtained in an AH-1 simulation. The method used in this modeling study combined the results of a simulation study with PDQ derived task time multipliers. The PDQ appeared to do a reasonable job of estimating proportion or percent task time increase that can be translated to increases in engagement times. Furthermore, our approach combined the results from simulations that included only a single ill crew member. The MicroSAINT models allowed us to estimate system performance when data from two sick crew members are combined.

The method used to adjust the PDQ task time multipliers improved the fit between predicted and actual performance as a function of simulated radiation symptoms. This method requires further investigation to provide theoretical support. The procedure was derived based on the observation that PDQ performance equations, in practice, yield predicted performance values less than 1 for HFF symptom descriptions. This would indicate that the PDQ derived equations have a tendency for under predicting performance (or predicting greater effects of symptoms on performance) in the present study.

In summary, the above modeling approach showed a reasonable fit between PDQ based estimates and estimates based on actual performance as a function of radiation like symptoms for TOW and Rocket engagements.

SECTION 6

DISCUSSION AND CONCLUSIONS

The present experiment was run to examine the ability of the PDQ methodology to predict soldier performance on a nuclear battlefield. Specifically, the experiment examined the use of subject matter experts to estimate the effects of radiation exposure symptoms on AH-1 crew performance decrements.

Two different methods were used in the examination of the PDQ's ability to predict crew performance decrements. The first method entailed the use of correlational and graphical techniques at the task (TOW and Rocket tasks) and position (gunner and pilot) levels of analysis. The second method employed modeling techniques that used the empirical results of the AH-1 simulations and the PDQ prediction equations. The modeling approach examined the predictions at the total crew performance level rather than at the task or by position level.

6.1 CORRELATIONAL TECHNIQUES.

The *By Position* analysis suggests that at the task level, subjects could not predict the magnitude of performance decrements. When filling out the PDQ for symptoms of the severity observed post-spin, both pilots and gunners predicted substantial decrements in performance. On average, pilots actually showed a small decrement post-spin, and the gunners showed no change in performance.

The *By TasK* analysis suggested that subjects can accurately predict performance at the task level. The best example of this ability is in the gunners' correct prediction of a lack of effect of symptoms on the time required to track a TOW missile to a target. Given that a task time is almost totally machine dependent (in this case dependent on the time it takes a rocket motor to move a missile 2700 meters), subjects are able to estimate their ability to affect task duration. For tasks that are not dominated by machine time, the subjects (a) generally overestimated the impact of symptoms on task duration, and (b) did not overestimate according to any discernable pattern. Thus, subjects demonstrated expertise in their weapon system, but appeared to lack the expertise necessary to estimate how the human element of that system would operate under degraded conditions.

It can be speculated as to why the subjects failed to accurately predict performance time decrements due to radiation-sickness-like symptoms. One reason might be that too much constraint was placed on the subjects' responses. The subjects were only permitted to estimate task durations. They might well have correctly surmised that their behaviors when sick would change in other qualitative and quantitative dimensions. Some other effects of symptoms that subjects might have anticipated include:

- a decrease in accuracy
- a decrease in the amount of information attended too,
- alterations in procedures.

For instance, a sick pilot might scan his flight instruments less often. This might increase his possibility of missing a critical anomaly, but might never affect task duration, and might not show up in any measure of effectiveness in some scenarios. The gunner might stop attending to radio traffic. The pilot might not attend as closely to altitude during unmasking. If the pilot flies higher during unmasking, this may or may not be reflected in performance duration since other factors, such as rotor torque and acceleration rates might change as well. Subjects limited to responding with task durations, might simply ignore other anticipated changes in behavior, or they might try to incorporate other anticipated changes into the duration estimate. It was implicitly assumed that subjects would not allow factors not related to task duration to influence their estimates. It may be that the subjects were unable to ignore other changes, and instead generated time decrements to reflect the magnitude of other changes; an approach that would lead to overestimation of performance time decrements.

Such speculations aside, the more recent research literature does not encourage confidence in people's ability to:

(a) accurately imagine the effects of illness on performance, or
(b) provide accurate verbal estimates of performance times.

Decety, Jeannerod, and Prablanc (1989) conducted an experiment that approximates assessing the ability of people to estimate the effects of illness on performance. In their experiment, subjects were asked to imagine the effect of carrying a 25 kg. weight on the time it would take them to walk 5, 10 or 15 meters. Whereas they found some individuals ("good mental imagers") were accurate in imagining the amount of time it would take to walk those distances unencumbered, walking times with the burden were overestimated by about 30 percent.

In their review of the time estimation literature, Peters, Archer, and Moyer (1985) reported several generalizations. People generally overestimate the duration of short intervals and underestimate the duration of long intervals. Findings in the present research tend to reinforce this generalization. Figure 6-1 shows subjects' symptom-free task duration estimates plotted against their actual baseline performance. Subjects tended to overestimate tasks of less than 5 seconds and underestimate the duration of task greater than 20 seconds duration. There were, however, several tasks for which subjects' estimates were nearly perfect (tasks which fall close to the 45 degree diagonal in the figure). If peoples' biases in estimation varied systematically with the length of the estimated interval, one could develop functions that would compensate for the bias. However, the amount and direction of bias varies with a number of factors. Gunners were particularly accurate in estimating the flight time of the TOW missile. This is reflected in Figure 6-1 by the data point which falls close to 15 seconds on both the horizontal and vertical axes. It is probable that the gunners' knowledge of the flight parameters of the TOW aided them in this estimation. Other factors that influence people's duration estimation bias include:

- whether the task is interesting or boring (Gulliksen, 1927),
- the number of salient events that occur during the interval (Zakay, Nitzan, and Glicksohn, 1983),
- the distribution of salient events (Poynter, 1983),
- and subjects' mental workload during the task (Wierwille, Walter, Rahimi, Mansour, and Casali, 1985).

Time estimate accuracy for events where normal health is assumed is affected by many variables. For any military task, several of these variables are likely to co-vary unsystematically. Thus for military tasks where normal health is assumed, obtaining reliable time estimates is a problematic pursuit. Adding subjects' projections of the effects of symptoms to those time estimates is not likely to improve the reliability of duration estimates.

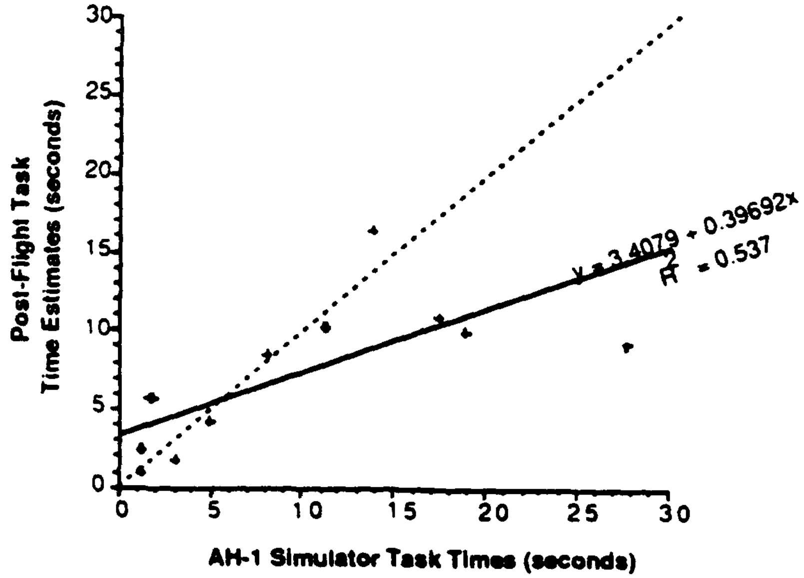

Figure 6-1. Estimates of pilot and gunner task durations plotted as a function of actual task duration; in the AH-1 *simulator*. Points on the dashed line would be perfect estimations. The regression line is the least squares solution for a linear trend. There were 12 estimates and 15 observations because two gunner tasks and one pilot task were performed twice in the simulator, once for TOW fire and once for rocket fire.

6.2 MODELING TECHNIQUES.

MicroSAINT models were developed for the tank engagements using TOWs or Rockets. Our approach combined the empirical results from the AH-1 simulations with the PDQ prediction equations. Furthermore, we applied an adjustment to the PDQ performance predictions to attenuate the fact that our equations tended to underpredict performance (e.g., our equations predicted less than perfect performance for symptoms descriptive of "healthy feeling fine"). The adjustment improved the fit between predictions based on the Post-Spin AH-1simulation and the PDQ equations.

The modeling techniques showed greater concordance between PDQ based and performance based predictions than the correlational techniques. This may be due in part to the fact that correlational techniques require large number of subjects to achieve sufficient statistical power for comparing model results (e.g., PDQ equations) against empirical results (e.g., AH-I simulations). The AH-1 study employed a total of 20 subjects. The modeling approach was not limited by the use of a small sample size as was the correlational approach.

MicroSAINT allowed the examination of total crew performance where a large number of engagements were modeled. On the other hand, the correlational techniques evaluated single point estimates for performance where both ill crew members were not considered simultaneously.

In summary, the modeling technique showed better concordance between PDQ-based and performance-based estimates of the effects of radiation exposure symptoms on AH-1 crew/system performance. The following factors contributed to this finding:

(1) The modeling approach considered total crew performance. The effect of two ill crew members on total crew performance were estimated.

(2) The modeling approach generated data for multiple simulated engagements. The comparisons between PDQ-based and AH-1 simulation-based performance decrements were conducted for distributions rather than for point estimates.

(3) The use of small sample sizes may not have provided sufficient statistical power for the correlational techniques. The modeling approach was not as affected by sample size as was the correlational analysis.

(4) The PDQ equations developed under this effort appeared to underpredict performance. An adjustment was made to the PDQ equations that improved the concordance between PDQ-based and AH-I simulation-based performance predictions.

6.3 RECOMMENDATIONS.

A performance based estimation technique would, in theory, be better than a technique based on projective techniques such as the PDQ. One possible performance based technique would employ a Performance Assessment Battery (PAB) to assess the effect of symptoms on operator performance, and modelling techniques to predict the result of changes in operator performance on system performance. A performance based estimation would not be as easy or inexpensive as the PDQ. It would require the collection of additional PAB data. It would also require additional systematic study with induction of symptoms mimicking the effects of low level radiation exposure. The present experiment was not explicitly designed to develop the WRPAB as a predictor of radiation symptom effects on crew performance. For instance, the current version of the WRPAB does not include tests specifically tailored to predict helicopter crew related tasks. There is no continuous tracking task or other task in the WRPAB that would reasonably be expected to reflect helicopter flight control skills. There is no task tailored to reflect crew coordination or communication skills. There is no task that would be expected to reflect complex cognitive performance tasks (e.g., problem solving). On the other hand, other batteries such as the Unified Tri-Services Cognitive Performance Assessment Battery (UTCPAB, Perez et al, 1987) can provide additional test required to represent the performance domain under study. Thus, changing the WRPAB or selecting tests from other test batteries in response to the needs of DNA's Human Response Program is quite feasible.

The following steps are probable steps in the development of a valid performance prediction model:

(1) identify behaviorally meaningful components of operator performance (e.g., motor, perceptual, cognitive).

(2) identify appropriate PAB measures of each of the components and map the relationship between PAB measures on operational task performance,

(3) use the PAB to identify the effects of symptoms on the components of behavior,

(4) identify operationally valid measures of performance for the systems of interest, and

(5) quantify the relationship between operator performance and system performance.

The proposed method for projecting performance decrements on the nuclear battlefield differs from the PDQ methodology in its use of subject matter experts. Instead of asking the experts to project performance time degradation (something people do not do accurately), experts will be asked for detailed information about what they do. Given proper structure, people are good at describing their jobs, and what they need to do their job. In the proposed method, subject matter experts will support development of detailed task analyses. Operator task analysis is a standard human factors tool.

Currently a demonstration of the proposed technique is in development (Perez, et at, 1991).

The first step in the demonstration is to develop a metric that relates PAB performance to meaningful behavioral components. The second step will be to describe how, in the present study, performance - in terms of the components - changed as a function of reported symptoms.

A third step is to conduct a cognitive task analysis of the AH-1 tank engagement so that identified behavioral components can be mapped onto AH-1 mission tasks. This map will be in the form of a MicroSAINT model. Where PAB data exist to support the AH-1 model, the model will be used to predict changes in AH-1 performance as a function of reported symptoms. Thus data from the present study can be used to conduct a proof-of-concept for the modeling approach.

The results of the analysis of the PAB data collected in the current study will not be conclusive. Although the PAB is composed of a variety of tasks, and presumably taps more than one component of operator behavior, it does not necessarily tap all the Important components of AH-1 task performance. Even if it does tap all the important components, it is likely that some components will be highly correlated with others. To the extent that behavioral components are not isolated to individual PAB tests, it will be difficult to differentiate contribution of those components to performance. Furthermore, the sample size in the present study does not provide sufficient data to adequately specify a performance based model. However, the current analysis is likely to yield recommendations for refinement of the PAB. The AH-1 task analysis may suggest component behaviors for which new PAB tests are needed. The component analysis of the PAB may also suggest alterations in the PAB to isolate contributions of behavioral components. Statistical analysis of the PAB may suggest where changes in the number of trials may be required to achieve desired levels of test reliability.

6.4 CONCLUSIONS.

Correlational techniques showed that SMEs were able to predict performance effects for a subset of AH-1 tasks. The use of a small sample size did not provide sufficient power to statistically demonstrate a relationship between PDQ performance predictions and the results of the AH-1 simulation. On the other hand, modeling techniques (MicroSAINT) showed moderate concordance between PDQ predictions and results of the AH-1 simulation produced increases in task times as a function of radiation like symptoms. This effort presents data and the results of a new approach for the estimation of total crew performance degradation.

SECTION 7

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APPENDIX A

TIME LINE OF EXPERIMENTAL TASKS

Time	Both Crewmen	Pilot	Gunner
0700	• Pre-brief • Vital signs • Pre-Flight questionnaire	• Flight plan	
0800		• SCL • Simulator session #1 (practice) • SCL	• PAB training • Flight plan
0900		• PAB training	• SCL • Simulator session #1 (practice) • SCL
1000		• SCL • Simulator session #2 (baseline) • SCL	• PAB
1100		• PAB	• SCL • Simulator session #2 (baseline) • SCL
1200	• Lunch	• SCL	• PAB
1300		• PAB • SCL • PDQ	• SCL
1400		• SCL	• PAB • SCL • PDQ
1500		• PAB	• SCL

Time	Both Crewmen	Pilot	Gunner
1600		• SCL	• PAB
700		• PAB	• SCL • Vital signs
800	• Vital Signs • Dinner	• SCL	• PAB
1900		• PAB	• SCL
2000		• SCL	• PAB
2100		• PAB	• SCL
2200		• SCL	• PAB
2300		• PAB	• SCL
2400 DAY #2		• SCL	• PAB
0100		• PAB	• SCL

Time	Both Crewmen	Pilot	Gunner
0200		• SCL	• PAB
0300		• PAB	• SCL
0400		• SCL	• PAB
0500		• PAB	• SCL
0600		• SCL	• PAB
0700		• PAB	• SCL • Vital signs
0800		• SCL • Vital signs	• PAB
0900		• PAB •SCL	• SCL
1000		• Physical exercise • SCL	• PAB • SCL
1100		• PAB	• Physical exercise •SCL

Time	Both Crewmen	Pilot	Gunner
1200		• SCL	• PAB
1300		• PAB	• SCL
1400		• SCL • Simulator session #3 • SCL	• PAB
1500		• PAB • SCL • Spin • Vital Signs	• SCL • Simulator session #3 • SCL
1600		• SCL • Simulator session #4 (post-spin) • SCL	• PAB • SCL • Spin • Vital Signs
1700		• PDQ	• SCL • Simulator session #4 (post-spin) • SCL
1800		• SCL • Dinner & Debriefing	• PDQ
1900		• Vital signs • Medical Evaluation • Home or rest on site	• SCL • Dinner & Debriefing
2000			• Vital signs • Medical Evaluation • Home or rest on site

APPENDIX B

VOLUNTEER AGREEMENT AFFIDAVIT

EXPLANATION OF PARTICIPATION IN RESEARCH PROJECT (SIMULATION FLIGHT FOLLOWING MULTIPLE STRESSORS)

INSTITUTE: Defense Nuclear Agency Contract to Science Applications International Corporation, performed at Ft. Campbell, KY.

TITLE OF PROTOCOL: Predicting Effects of Multiple Stressors Simulating Symptoms Of Intermediate Doses of Ionizing Radiation on AH-1 (Cobra) Helicopter Crews

PRINCIPAL INVESTIGATOR:
Joseph I. Peters, Ph.D.
Human Performance Technology Division
SAIC, McLean, VA
(703) 734-5861

PHYSICIAN INVESTIGATOR:
Roy L. DeHart, M.D., M.P.H.
Professor and Director
Division of Occupation Medicine
University of Oklahoma
Oklahoma City, OK 73190
(405)271-8011

RESPONSIBLE INDIVIDUAL:
Robert Young, Ph.D.
Manager, Human Response Program
Office of Science and Technology Radiation Policy
Headquarters, Defense Nuclear Agency
Alexandria, VA 22310-3398
AV 221-2046

PARTICIPATION INFORMATION:

You are invited to participate in a research study conducted at Fort Campbell, KY. It is very important that you read and understand the following general principles which apply to everyone:

Initials ________

Date ________

a. Your participation is entirely voluntary.

b. If you initially decide to participate, you may withdraw from participation in this study at any time. Refusal to participate is without prejudice and will involve no penalty or loss of benefits to which you are entitled.

c. After you read this explanation, please feel free to ask any questions that will allow you to clearly understand the nature and risks of the study.

PURPOSE OF THE STUDY:

The United States Army and the Defense Nuclear Agency need to know how well attack helicopter pilots can fly and perform their missions when they have been exposed to intermediate doses of radiation. Intermediate doses of radiation are those doses which can make you sick. The degree of sickness a person feels depends on how much radiation he received and the time elapsed since he received the radiation dose.

It is important to know the effects of radiation so that Army field commanders and military planners can effectively determine missions and properly employ their forces. Such data are extremely valuable in targeting of friendly nuclear fires in order to assure our troops the desired amount of safety from nuclear weapons effects. In fact, this particular study has been given top priority by the United States Army Nuclear and Chemical Agency. In addition, it responds to a PRIORITY 1A tactical requirement of the Deputy Chief of Staff of the Army for Operations.

The current method adopted by the U.S. Army for estimating the effects of nuclear radiation on Army crews is based on a timeline analysis of critical crew tasks. A critical task scenario for an Army attack helicopter, for example, would focus on those tasks required to successfully pop- up, launch a TOW and remask. Through a series of measurements, the Army already knows how long it takes the average AH-1 crew to perform these tasks.

To determine the effects of radiation sickness on the performance of critical tasks the Army has developed a questionnaire which obtains estimates of how much longer the tasks would take under various sickness conditions. This questionnaire

Initials ________

Date ________

asks soldiers like yourself to estimate how long it normally takes you to do military tasks with which you are very familiar. The questionnaire then describes various symptoms of radiation sickness, and for each description, it asks you to estimate how much longer, if any, it would take you to do those tasks. Answers from these questionnaires have lead to recent changes in FM-101-1, which is the staff officers field manual on; "Nuclear Weapons Employment Doctrine and Procedures." The current study is aimed at validating the current questionnaire technique used by the Army.

PROCEDURES:

Obviously, we can't go around radiating troops to see how well they will perform. We can't, and we have no intention of doing this to you or to anybody. What we can do, with your help, is to try to induce in you, symptoms which we know are the same or similar to symptoms of radiation sickness. These symptoms include weakness, fatigue and nausea. Almost everyone has felt these symptoms before; however, no one has ever had the opportunity to see either how these symptoms affect soldier performance, or what the relationship is between soldiers' actual performance and their estimates of the effects of sickness.

We will be inducing symptoms which mimic those of radiation sickness by means of sleep deprivation and exercise. Motion-induced nausea will be induced just before the end of the study. No drugs or medication will be used and there certainly will be no radiation exposure.

As an attack helicopter pilot, you were selected for invitation to participate in this study because of the extreme criticality of the role you play on the battlefield. You are requested to participate in this study, which will consist of four sessions of simulator data collection over a 36 hour period. Also during this period, you will complete several questionnaires and the Walter Reed Performance Assessment Battery about every two hours. A complete description of this test is attached to this form. You will be allowed to keep a copy of this form and all test descriptions. If you have any questions at any time, please ask any of us on the study team.

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Your participation in this study will essentially be in three phases: Pre-flight; Simulation; and, Post-flight. A brief description of each phase follows:

Pre-flight Phase: On the first day of the study, you and another crew member will be asked to report to the AH-1 simulator building at 0700. There, you will receive a general re-introduction to the study - its purpose and objectives. The introduction will re-affirm that your participation in this study is not required, and is done solely on a voluntary basis. Before further pre-flight activities start, you will be asked to sign this volunteer consent form (the one you are reading now), and the Privacy Act statement attached. If you do not consent to participate further in the study, you will be thanked for coming and cordially dismissed and returned to duty.

If you do sign the consent forms, you will be given a brief physical examination (pulse, weight, and blood pressure) to determine your suitability for inclusion in the study. Any abnormal results from this check-up could lead to your exclusion from the study in accordance with the judgment of the principal and physician investigators. Abnormal results will be discussed with you and your flight surgeon.

Assuming you have no abnormalities in weight, blood pressure or pulse, you will be asked to fill out a pre-flight questionnaire. This questionnaire will ask you about your flight experience, and will ask you to estimate how long you will take to perform tasks required in brief scenarios of TOW and rocket launches. As part of this questionnaire, you will be given a symptom checklist (SCL) which asks whether or not you have ever had certain sickness symptoms, and whether or not you have these symptoms now. You will be given an SCL approximately every two hours until the end of the study.

After you have completed the symptom checklist, you and the other crew member reporting with you will essentially be doing the same things, but will do them at different times (about one hour apart). Among the things that you will be doing is receiving a training session with the Walter Reed Performance Assessment Battery (PAB). After this training session, you will perform the PAB every two hours until the end of the study. You will also be given a flight plan and map which reflect the

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scenario developed for the study. After you have planned your flight, you will begin the simulation phase of the study.

The Simulation Phase is the primary human performance measurement phase. In this phase, your task times, weapons hits and misses, and ability to complete the various tasks will be measured. You will fly the simulator four times, always in the same position (i.e. either as pilot or as gunner). The other position will not be flown by the other crewmember who reported with you, but by an experienced pilot who is fully practiced in the mission tasks of this study and assigned to support this study.

The first simulator session is a practice session to ensure that you become very familiar with the task. The second. session will occur approximately one hour after the first, and will be used to obtain your: baseline performance measurements. Both of these sessions will occur in the morning of the first day.

You will stay with us in the simulator building all night after the day of your arrival and will not be allowed to sleep at all. We will feed you lunch and dinner on the first day, but we must restrict your diet to only the food and drink which we provide. Water will be the only drink provided.

On the second day, you will not be allowed to eat at all until the end of the study; but, you may drink as much water as you want. In the morning of the second day, you will be given exercises to perform. The exercises will be as follows:

1. WARM-UP- 10 MINUTES
   a. Stretches \
   b . Run in Place

2. TESTING REGIME - "DO AS MANY AS POSSIBLE IN 2 MINUTES"
series of 8, 2 minute tests with 2 minute rest between.

a.	Jumping Jacks	e.	Flutter Kicks
b	Push Ups	f.	Body Twists
c.	Squat Thrusts	g.	Sit Ups
d.	Leglifts	h.	Shuttle Run/Star Jumps

3. TOTAL TIME - 42 MINUTES

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In the afternoon of the second day, you will have another practice session (Session #3) in the simulator, much like the day before. After your practice session, we will induce feelings of nausea in you by rotating you in a chair while you turn your head in different directions. When you feel that you are very nauseous, we will ask you to get into the simulator and fly the same missions you did during practice. We will then measure your performance in this fourth and last session.

You will fill out a symptom checklist just before and after all simulator sessions. This is done to practice you on the checklist procedures in the simulator, as well as to see if your symptoms of nausea get better, worse, or remain the same during the last session.

The Post-Flight Phase begins when you leave the simulator after the practice and baseline measurement sessions on the first day, and after the practice and treatment measurement sessions on the second day. After the measurement sessions, you will perform the PAB, fill out the SCL, and then fill out the USANCA/DNA performance decrement estimation questionnaire. After the last simulator session, you will additionally receive a physical checkup (pulse and blood pressure), and will be offered nourishment and a cot to sleep on after the questionnaires are completed. Based on the physician's evaluation of your physical condition, you will either be allowed to sleep on a cot or will be driven home provided you go directly to bed, and stay home the next day. The data collection team here at the simulator will contact you on the following day to ensure that you are feeling fine.

When data collection is complete and everybody goes home, we will then analyze everybody's estimates of performance degradation and their actual performance. As far as we are concerned, there are no right answers in this study. All we really need to know is how you perform and how you say you'll perform. If you over or under estimate, it doesn't matter because we can adjust our prediction techniques accordingly.

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RISK/INCONVENIENCES/DISCOMFORTS:

Risks from a physical or psychological point of view are expected to be minimal. As a combat ready, AH-1 helicopter crewman, you will have undergone repeated physical examinations as part of your flying career, and you will have fully met the physical standards for aircrew including a normal electrocardiogram. As a group, attack helicopter pilots are far more healthy than the United States standard population.

As a volunteer for this study, you will have recently received a standard flight physical. Your medical records will be reviewed prior to the initiation of any stressor. Any finding in the medical record or at the time of the review physical examination which, in the opinion of either your flight surgeon or the study physician, increases the risk to you will be cause for withdrawal.

Discomforts which you may experience are several. Once the activities begin, no food will be allowed after 9 PM of the first day, although water will be available. Knowing that you cannot eat for 20 hours often magnifies the sensation of hunger and this should be anticipated. Strenuous physical exercise will be required but will not be particularly stressful for operational Army aircrews such as yourself.

You will not be allowed to sleep for the full period of study (36 hours). This will be difficult as no stimulants such as coffee or tea will be allowed. Although activities are planned through the program, you can expect to be bored, and this will make you want to go to sleep. As a result of the combined stressors of sleeplessness, fatigue, hunger and weakness, you can expect to have feelings of anger, frustration and general emotional unsteadiness.

To the above combined stress, we will add motion sickness just prior to the simulator flight. The method for producing motion sickness will be a rotating chair in which you will be instructed to move your head in a specific pattern while rotating at 25 revolutions per minute. We recognize that each person has his own tolerance to motion, but the stress will be continued for 30 minutes or until the symptoms of nausea are achieved, whichever comes first.

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While in the rotating chair, you will be asked to try to stop rotation just before you think you will vomit. If you do vomit, don't worry. We will have "puke bags" available inside and outside of the simulator.

After rotation has stopped, it is possible that you will experience headache, persistent lightheadedness and vomiting. You may continue to feel nauseous when you begin the flight simulator task during which you may continue to be ill. Although it is the intent of the project to make each crew member uncomfortable and ill, the actual hazards to health are very low.

Some risk is involved in this study. It is our responsibility to tell you all of the possible hazards which you may encounter as a participant in this study. These possible risks include any of the following:

Risks related to acute and total fasting include:

1. Hunger
2. Low Blood Sugar
3. Aggravation of gastritis or ulcer disease
4. Weakness
5. Light-Headedness
6. Fainting
7. Low Blood Pressure
8. Headache

Risks related to physical exercise include:

1. Strains and Sprains
2. Muscle Soreness
3. Cardiac Arythmia
4. Heart Attack
5. Shortness of Breath
6. Exercise-Induced Asthma

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Risks related to forced sleeplessness are known to include:

1. Fatigue
2. Short Tempers
3. Hallucinations
4. Headache
5. Poor Concentration
6. Light-Headedness
7. Weakness

Risks related to rotational induced motion sickness include:

1. Nausea
2. Vomiting with Aspiration (inhaling particles of vomitus)
3. Headache
4. Reduced motivation
5. Visual disturbances
6. Dizziness
7. Light-Headedness
8. Limited seizure activity

The combined effects of all the stressors could increase the degree and variety of previously described symptoms.

If these symptoms and hazards occur, they are anticipated to be of short duration with complete recovery and resolution within six hours. Following the simulated flight task, you will be given food, beverages and rest, as well as a physical evaluation.

BENEFITS:

As a helicopter crewman, you may appreciate the potential value of this study as it attempts to validate previously obtained questionnaire data. The results may have major bearing on operational decisions prior to and during combat. These decisions will affect the health, safety and war- fighting capability of future helicopter crews. Data from this study will directly affect revisions to existing handbooks and field

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manuals. You will not, however, receive any direct monetary benefit by participating in this study.

DURATION OF STUDY:

Your participation in this study will be limited to approximately 48 hours, plus a day immediately following. You will not be charged leave for the time during the study or the day following your participation.

SAFEGUARDS:

The flight simulation task is similar to many such tasks flown in helicopter simulators routinely throughout Army aviation. None of the short term stressors are considered particularly hazardous to life or limb. Many are events of normal living although at the extremes of such activities: dieting, awake around the clock, strenuous physical exercise, motion sickness. No drugs or medications will be used. The only physical stressor is the use of the rotational device.

All participants are active duty military aviators, physically fit for world wide duty and combat. Accordingly, recent flight physical examinations will have been performed and on record for review. All medical records will be reviewed and a brief physical check-out will be performed prior to participation.

As a participant, you may withdraw at anytime. A physician will be on-site to assure that undue risk is avoided and to provide medical intervention should an unexpected event occur. The facility will be equipped with appropriate medical equipment. The Post hospital will be prepared to provide necessary medical transport and specialty care.

You are encouraged to discuss any health related issues or questions regarding the study protocol with either your flight surgeon or the study physician.

CONFIDENTIALITY OF RESEARCH RECORDS:

Records are kept of the study results and may be published in a report or research literature, but you will not be identified by name in any such publication. In fact, most of the data reported will be in the form of summary statistics on the entire

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group of pilots. The results may be reviewed by representatives of the Department of Defense, Department of the Army or their designees for compliance to appropriate regulations governing research.

ALTERNATIVES TO PARTICIPATION IN THIS STUDY:

You are not required to participate in this study for any reason and may elect not to participate at any time for any reason.

CIRCUMSTANCES UNDER WHICH YOUR PARTICIPATION MAY BE TERMINATED WITHOUT YOUR CONSENT:

a. Any unwaivered medical condition which would disqualify you as an aviator.

b. Any health conditions under which your participation possibly would be dangerous.

c. Other conditions which might occur that would make your participation detrimental to your own health.

COSTS TO YOU FROM PARTICIPATION: None

SIGNIFICANT NEW FINDINGS:

Any significant new information regarding new findings that develop during this study will be made available to you. You have access to all your own records related to this study.

FOR FURTHER INFORMATION:

Please contact the principal investigator, Dr. Joseph Peters, SAIC, (703) 734-5861 or Dr. Robert Young, DNA, AV 221-2046. For information regarding the rights of research subjects, or in the event there is a research related injury, please contact the local Judge Advocate's Office at AV 635-4927 or (502) 798-4927.

YOU ARE AUTHORIZED ALL NECESSARY MEDICAL CARE FOR INJURY OR DISEASE WHICH IS THE PROXIMATE RESULT OF YOUR PARTICIPATION IN THIS RESEARCH.

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Date ______

IF THERE ARE ANY PARTS OF THIS EXPLANATION WHICH YOU DO NOT UNDERSTAND, PLEASE ASK EITHER THE FLIGHT SURGEON OR THE PHYSICIAN INVESTIGATOR TO CLARIFY THEM BEFORE YOU SIGN THIS FORM.

SIGNATURES:

I have read this explanation of participation in this research project, was given a summary briefing of its contents and was provided the opportunity to ask any questions related to research participation. I understand that my participation is voluntary and can withdraw from participation without penalty or prejudice.

In addition to signing below, please initial the first 8 pages of this informed consent explanation.

______________________	______________________	______________
VOLUNTEER	DATE	TIME
______________________	______________________	______________
PHYSICIAN/INVESTIGATOR	DATE	TIME
______________________	______________________	______________
WITNESS	DATE	TIME

Initials ______
Date ______

APPENDIX C

PRIVACY ACT STATEMENT

PRIVACY ACT STATEMENT

The purpose for requesting personal (e.g., health, sleep habits) information is to provide the minimum information necessary to determine if you satisfy the specific criteria for participation in this study.

This information may be used to provide full documentation of investigative studies; conduct further research; teach; compile statistical data; adjudicate claims and determine benefits; and report medical conditions required by law to other federal, state, and local agencies. It may be used for other lawful purposes including law enforcement and litigation. Even though permitted by law, whenever possible, these personal data will not be released without your consent.

The disclosure of requested information is voluntary. If the information is not furnished, and/or not available from other sources, your voluntary participation in this investigational study may be precluded.

I understand that a copy of the Volunteer Consent Sheet, together with a copy of this form, may be placed in my records as evidence of this notification,and additional copies may be retained permanently by the investigator and the U.S. Government. I have received or have declined to accept a copy of the Volunteer Consent Sheet and a copy of this form which I may keep.

X____

Volunteer Signature and Date Signed

APPENDIX D

MISSION BRIEFING

<u>INTRODUCTION.</u>

In the portion of the study which uses the AH-1 simulator, we will record the times for the successful completion of individual tasks performed during an engagement by crew members who are healthy. To do this, time data will be collected from two engagement sequences that have been previously defined for this study: TOW launch, and direct mode attack using 2.74-inch rockets. It is essential that you complete these engagements as planned so different crews' performances can be compared. All crews will perform the same two engagements.

The two types of engagement sequences will be a pop-up with TOW launch and pop-up with rocket launch (direct mode, single pairs) against multiple armored vehicles. In order to simulate a combat situation, all cockpit switches will be set for either the TOW or rocket engagement as appropriate prior to starting each engagement. Each of the engagements starts with your aircraft in a firing position named target engagement point #13 which is located at map coordinates FK16005173. The aircraft will be on the ground with the engine running. Coordinating with the console operator, pickup the aircraft to a hover hold of two feet above the ground. The console operator will act as the scout effecting the target handoff. On the scout's signal, you will unmask and attack one of the targets at FK136628 using either a single TOW or seven pairs of 2.75-inch rockets. You will then remask the aircraft by descending into the firing position to a height of five (5) feet above the ground. This will mark the end of theat engagement.

FLIGHT MISSION DATA

- Environment

Condition	- Day
Visibility	- 18,000 ft.
Ceiling	- 1,000 ft.
Barometer	- 29.99 in.
OAT	- 27.0 C/81 F (S.L.)
WD/WV	- 200/10

- Aircraft

Fuel Loading - 1104 lbs.
Gross Weight - 9940 lbs.
CG - 194.0 in.

BRIEFING

1. Situation:

- Threat: Multiple armored vehicles in grid square FK136528.

2. Mission: Engage targets with TOW and rockets as directed by Air Mission Commander- Scout.

3. Execution:

- This is to be a tactical mission in Day/VMC.
- Mission will start in TEP #13 (FK16005173).
- Authorized Ammunition Loads: 8 TOW, 14 2.75 FFAR, and 750 rds 20 mm.
- Safety Considerations: moderate wind gusts.
- All cockpit switches pre-set for TOW/rocket firing as required by Scout, i.e. ATS = Low Mag/Stow Position
  RMS= Pairs/Single/Range Laser

4. Command and Signal:

- Air Mission Commander: Scout (console operator).
- Signal: Frequency = 38.4 FM \
  Scout= kilo 16
  Attack= kilo 50

5. Additional Remarks:

- Rockets are to be fired in single pairs. Gunner will provide fire adjust data to pilot for first pair after which remaining six pairs are to be rapidly fired.
- Scout will give command to unmask and begin attack.
- After launching each TOW or seven FFARS the helicopter will remarks in the original firing position.

You will be given a practice session during which you will rehearse both the TOW and rocket engagements exactly as presented. Your crew's goal is complete the final practice engagements as quickly and as accurately as possible so realistic measurements may be obtained from this study. This practice session is to develop crew integration and to ensure that all tasks are being accomplished as described during each engagement.

After completion of the practice engagements, you will be timed. Your crew will be asked to perform the engagements at battle speed. Times for individuals to perform their tasks as well as total engagement times will be recorded. Each of the two types of engagements will be performed at least ten times by each crew.

TOW LAUNCH TASKS

1. PILOT <u>Unmask and Identify Target</u>
On the Scout's order to attack, and starting from a two foot hover, vertically unmask, identify target of interest (TOI), and inform the gunner, e.g., "Gunner- Target -12 o'clock".

2. GUNNER <u>Acquire Target</u>
From the pilot's announcement of the target, look into the TSU to determine the TOI then announce, "Target Acquired".

3. GUNNER <u>Track Target and Switch to High Magnification</u>

Use TSU control stick to bring TOI within inner circle of sight reticle, then while switching to high magnification announce, "High Mag".

4. GUNNER <u>Action Bar</u>

After switching to high magnification, re-center target in TSU. Depress action bar on TSU left hand grip making the attack flag light up on the sight reticle and causing TOW prelaunch mode to be displayed on the HUD. Announce, "Action".

5. PILOT <u>Position Aircraft Into Prelaunch Constraints</u>

Maneuver aircraft to within the prelaunch constraints as shown on the HUD then announce "Ready".

6. GUNNER <u>Fire TOW</u>

From the pilot's announcement of "Ready", the gunner makes the final sight adjustments, and announces "Fire" keeping the action bar depressed and squeezing the TOW firing trigger. Release the action bar and trigger, announce, "TOW Out".

7. GUNNER <u>Track Missile to Target</u>

After Missile has left aircraft, gunner tracks it to target then observes and announces the impact, e.g., "Hit".

8. PILOT <u>Remarks AH-1 to 5 Ft. AGL</u>

From the gunner's announcement of the missile impact until the aircraft is returned to the original firing position at 5 feet above ground level (AGL).

Rating Scale To Be Used After Simulator Performance.

How Sick Are You?

20 = Completely incapacitated, cannot move or talk
10= Fairly ill
1 = Feel Good; a good night's sleep the night before

ROCKET LAUNCH DIRECT MODE TASKS

1. PILOT: Unmasks and Identify Target
Same as TOW.

2. GUNNER: Acquire Target
Same as TOW

3. GUNNER: Track Target and Switch to High Magnification
Same as TOW

4. GUNNER: Fine Adjust, Lase Target, and Confirm Range
After switching to high magnification, the gunner makes a final sight adjustment, then announcing "Lasing", lases the TOI, then confirms by announcing "Valid at 2700 meters".

5. PILOT: Position Aircraft: Flies Reticle to Target and Fires
From the time the gunner lases the target, the pilot aligns the fire control reticle with the target and fires first pair of 2.75 in. FFARS.

6. PILOT: End of Firing
From the firing of the rockets, the gunner provides fire adjust data to the pilot on the first pair shot. The pilot then adjusts and proceeds to shoot the remaining rockets. As the last rockets are fired he announces, "Rockets Out".

7. PILOT: <u>Remarks AH-1 to 5 Ft. AGL</u>

From the time the last rocket is fired and the pilot begins his descent, until the aircraft is returned to the original firing position at 5 feet above ground level (AGL).

APPENDIX E

AH-1 CREW DEBRIEFING SUMMARY AND TRANSCRIPTS

INTRODUCTION

The following is a transcript of successive interviews and debriefings held with Army helicopter pilots. Each interview contains the comments of one pilot, one gunner, and several interviewers. Twenty pilots in all were interviewed for their subjective opinions, individual experiences, thoughts and insights after the actual testing and simulation took place. Below is a key of important abbreviations and connotations found in the transcription.

Key

P1 = Pilot Position, #1
G2 = Gunner Position, #2
C1 = Contract Person #1
C2 = Contract Person #2
DR = Defense Nuclear Agency Representative
FS1 = Flight Surgeon 1
FS2 = Flight Surgeon 2
OCM = Other Crew Member
SO = Simulator Operator
NR = Navy Representative

Occasionally in the transcriptions a ". . ." appears. This convention denotes a phrase or sentence that was unintelligible to the transcriber.

CREW #1 INTERVIEW
21 JUNE 1988

C1 It's 21 June. 1988. It's 6:54 PM and we just finished data collection on our first crew on the Helicrews Study. G2 is the gunner on my left and P1 is the pilot on my right. and I think the kinds of things I'd like to get from you guys essentially is the kinds of things you felt from the results of the chair. I know when we went through it the night before, it took me seven minutes to feel rather nauseous, and I got rather sweaty. I didn't get to the point of gagging or vomiting. I could see you sweat, soaked in sweat, and I felt very confident I probably would have gagged.

C1 And now, P1 what I would like to do is ask you to repeat what you already told us once. When we observed you, it seemed it took forever, and we didn't thinkyou would ever get sick. Then all of sudden, after eighteen minutes -- Why don't you tell us how you felt as you went through it. At first you started off closing your eyes?

P1 Right.

C1 Did that seem to make it worse, or better, or what?

P1 I thought it seemed to help because I didn't really have the sensation of spinning until I moved my head in different directions. Then I could definitely tell I was spinning. But as soon as I stabilized my head within two to three seconds, I didn't realize I was spinning anymore, other than the feeling of the wind going across my face and seeing the light through my eyelids.

C1 Then I guess I think we had you close your eyes for the first ten to fifteen minutes worth.

P1 Yeah, it was around ten minutes, because I had my eyes opened when I asked how long we had been there. It was eleven minutes.

C1 So as soon as you opened your eyes it started to get tougher?

P1 Well, not really as soon as I opened my eyes. The first thing that I noticed is my eyes kept wanting to look at something, whether it was the doctor's blue jacket or your white shirt. As I was rotating, my eyes wanted to stop and look at something, and what I had to do is I forced myself to stop and stare at something -- Or not really to stare, but to concentrate and focus my attention to something straight ahead, and to really concentrate on what was happening. And as soon as I did that. it was O.K., but it was difficult. As time went on, it was more and more difficult to concentrate.

C1 When did you start feeling some sensation that you were going to vomit? Did you have much of a warning?

P1 No, I felt my stomach tighten and it was like the very next revolution I said something to the doctor. I don't remember what exactly I said, but I think I said it's coming, and at the very next revolution, I started heaving up. Until that time, I didn't have any sensation whatsoever. I didn't feel dizzy, I didn't feel I was sweating, I was just sitting there. I was totally relaxed and I knew that -- I could tell because I was having trouble maintaining my concentration. I was trying to concentrate and I was having trouble doing that. Very shortly after that, my stomach tightened and that was it.

C1 And then you just gagged about several times?

P1 Yeah, I don't know how many it was. It was a bunch, though.

C1 Did you feel sicker when the motion stopped? As it was coming down, did that help?

P1 I don't think I felt it when it was slowing down. I could tell I was slowing down, but I was heaving. I was heaving pretty heavy. My biggest concern was if anything was going to come out, that it went into the bag. But I realized I was slowing down. I could tell when I was looking that I was slowing down. As soon as it got to half the speed, my eyes could focus. Then there was no problem. I was just trying to stop heaving. I didn't feel like dizzy or anything. I didn't feel like getting out of the chair.

C1 Now G2, you were a little different?

G2 Yes.

C1 You got in the chair, what was it three minutes, FS1, about 3 minutes. You heard what P1 had to say. Did you have the feeling of nausea as soon as you got in the chair, as you started?

G2 Initially, when I started going in circles, I felt fine, even before the doctor started telling me to bow my head on command, I knew right then and there it wouldn't take long. Then bingo, I think it was only the second one when I felt it coming up already, and that's all she wrote.

C1 Did you have a sense of nausea?

G2 Yeah, my stomach started cramping up. I felt a little light headed. The head moves I followed after him didn't actually do it.

C1 And then you gagged. You didn't gag as quite as much as P1.

G2 No, just two or three times, and then it stopped. I stood up. I felt a little light headed. I started sweating really quick. By the time I got to the cockpit, I started to settle down, but the first couple of TOW shots -- I could feel it -- the motion of the aircraft and simulator. Then it started to dissipate from there.

C1 Did it seem to distract your concentration, or did you think you were getting the job done?

G2 The first couple of shots my wrist was moving more than it should. I had to correct it to get it back on target. But it was still hits. Through it, I was a little bit more steady. I didn't feel like that.

C1 How did you feel by the end of your ride?

G2 I was feeling pretty good until I got back on the computer. Then I could feel it again .

C1 So after the actual ride was finished and you got out of the simulator and were going into the last PAB, you started feeling some more nausea again? How do you feel now?

G2 I feel a lot better now.

C1 How about you? When you got in the sim, how were you feeling?

P1 I felt pretty good going up the steps. About half way up the steps I felt like I had not even been in the chair. I knew that I had -- Then when I crawled in the seat, I felt real good. I went through the TOW shots first, and all I had to do is hover the aircraft, and it gave me a chance to recover so during the rocket firing I didn't have to hover any more. Hovering was not a problem; I just had to worry about the radical again.

C1 So if you were in the gunner spot you think you would have been a little worse off?

P1 I think I would have been a little worse off, or if I would have had to fire rockets first from the back seat before we did the TOW engagements, I think it would've affected my ability to move that radical because I was feeling a little tipsy. But not bad, then being able to sit there and move that aircraft ten times -- to sit there and hover that aircraft, mask, unmask, and reposition it enabled me to recover. By the time it was time for me to shoot, I didn't feel anything. I felt real good.

C1 You seemed to be perkier after your physical exercise. It seemed to perk you up in then you seem to back down low again. So you won't be surprised if your performance last time may have been better than the one earlier today?

P1 My performance this time is better than any.

C1 Your accuracy?

P1 Yes.

C1 How about the time it took you to do it? Did it depreciate in that?

P1 I think the third time was the worst. This last time I was on the target quick, if not quicker than the first and second time.

C1 Why do you think that was?

P1 At first I was having problems because of the conditions in the simulator, getting the radical where I wanted it to go. I couldn't do it because of the conditions.

C1 What do you mean about the conditions?

P1 Due to the conditions that were placed in the simulator and the out of ground effect hover. I ran out of left pedal up on the -- so I couldn't bring the nose to the left, and if I brought the nose to the amiss that was given in the target hand-over, then if the radical shifted to the right I couldn't get it back.

C1 So it had to do if you were in a different location. So the location of your target in you third run was different than that in the fourth, and that might have accounted for something?

P1 Yes, it did. It was easier too because I was on top of a hill and I was shooting down. I didn't have to raise the nose and the third engagement, I had to raise the nose a little bit. I was tired and I felt uncomfortable. I could tell when I was drifting backwards. But on the last one, I had to lower it just a little bit, and it enabled me to stay in perfect form.

C1 How about the position effect, did you notice that between one run and the other?

G2 No, because the ranges were about the same. I don't think I missed any at all.

C1 So the positioning affected the pilot more than the gunner? Well, what do you guys think now? Do you have any insight with regards to before you started this thing, now that you've gone through it, about your own performance or how you think you might do?

G2 I think, well, like Michael was saying, he had more problems in the front seat, but I think I probably had more problems in the back seat. Just controlling the aircraft especially if I'd be tired or something like that. Towards the end when I was lasing the target for the pilot., my head was just crashed in the front. I wanted to sleep. I know if I was in the back seat, I probably wouldn't have control of the aircraft at all.

P1 I learned that was one of the reasons why I wanted to be in the back seat, to see if I could still control and maneuver the aircraft when I was tired. I discovered that I could. The hardest part for me of all the tests was to move the radical on the target and re-mask after the engagement because the roms was more difficult. Because it took more time to get the radical on the target, I was tired. I was chasing it a little bit, and once I did that, I was trying to get the rounds down the range to hit the target. I'll drift or whatever I had to try and correct and to roms. The last time it was good firing position, and I didn't have much to do. When I started hitting, my enthusiasm increased about 1000%, and I just felt terrific. And from then on, I felt I did really well.

C1 You had a rush.

C1 Another question about this whole business is the psychological effect, if you were in a war and you started to feel this way. Some people hypothesize that a crew, knowing you were in a position that you were vomiting, you might be thinking you're dying. And you would wonder should you take your last act and go at it harder and do that, or would you turn back and come home? Do you have any insight what you might do?

G2 It's so hard explaining just sitting here. You have to be in the situation. I know one thing. When your actually flying an aircraft, your adrenalin has so much to do with it, which you can't actually feel sitting here. I know I felt that a lot of times before. You can't experience that right here. That may be the deciding factor, adrenalin flow.

P1 I don't think personally I would throw up while flying an aircraft. Just because of that adrenalin rush, you're so busy concentrating on what's going on. I mean maybe I would, but I think in a combat situation, if I was concentrating on the target, and surviving, and doing everything I was supposed to, I don't think I would vomit until I departed the battle area and was returning home. Then, I'd stop to take a breather in the cockpit. Then, if I was probably about to, would. As soon as that weapon engagement began, then I'd probably automatically stop, just because of the adrenalin. I know because I realize that right here. As soon as I started hitting, I felt excellent.

C1 FS1 is here, even though you can't see him, do you want to switch seats? Do you have any insights, any questions?

FS1 I think the point is that each person varies individually. Response to stress and response to what really happens in combat is very hard to estimate.

C1 I want to thank you gentlemen. It's certainly been an . . . experience for us. We got a lot of data, and we've got our work cut out for us in getting the results of this data, and figuring where to go. Thank you very much.

CREW #2 INTERVIEW
22 JUNE 1988

C1 I thought this was such a good idea yesterday that we made it a little more formal today. This is the close-out of the second crew coming in. This is the twenty-second of June 1988, and we have with us Pilot number Three (P3) and Gunner number Four (G4). I thought it important enough to include with us the other crew member (OCM) when these guys went through. And, of course, the flight surgeon (FS1) is with us, and the simulator operator (SO) who was at the console is behind us as well. This is such an investment in peoples' time and effort, and I want to get the subjective opinions of these people. To start off, again we experienced another example of individual differences in the way you people react to motion in the chair. I guess the first question I have in talking to P3 is - I guess when I was in the chair it took me seven minutes to get pretty nauseous. It took the first two crew members about eighteen minutes and the other one about three minutes, and it took you about thirty minutes. One of the objectives of this was to make people nauseous and get them feeling sick, can you describe your experience in the chair and then relate that experience to how you thought you performed in the simulator after you'd gotten in and did your first couple missions?

P3 I started feeling clammy. I started sweating almost immediately after I started spinning and started with the head motions, and I guess my complexion started to pale. I did feel a little nauseous at first, but it went away. I wasn't trying to hold it back and trying to set a record. It just happened that way. And then when it finally happened, I just went one spin more than what I should have, and that's when it just started, and I knew it was going to happen.

C1 So you told the flight surgeon, "Hey, I think I'm getting sick"?

P3 It's time to stop." I think I told him a couple of times I probably wouldn't be able to make it all the way through. But it wasn't ready to come up until it was right at the last minute. Once I got up, I walked up the stairs. Once I got up level on the ramp there, I was O.K. I got in the simulator and I don't know if I flew any better or any worse than what I'd been flying in the last few days. I didn't -- the only effects I felt was just the effects of not having slept. I didn't feel nauseous I don't think. Once I was in the cockpit, after I sat down, by the time we got it started, I wasn't nauseous any more.

C1 How about your control of the aircraft. Did you think that you might have over controlled or under controlled as a result of being tired?

P3 I think I was probably over controlling it.

C1 OCM, did you have any feel for that, sitting in the gunner's seat?

OCM Yeah, well I spoke to P3 about it a little bit. Mostly not necessarily when he was firing the rockets, but when I was firing the TOW and when I was in the TSU firing the TOW missile and he was trying to maintain the aircraft in the post-launch constraints he was really trying hard to keep it there. What happens normally, cause you're tired, it's going to start going off a little bit and then you've got to kind of overcorrect cause I could feel my head kind of popping back and forth in the TSU. I think when you looked at the numbers, I think my miss rate is a lot higher with the TOWs in that sequence. And so I think that could have been a factor.

C1 How about you, G4? Your experience in the simulator, I don't know how long Keith went. It was about eight minutes. Why don't you describe your feelings in that scenario and how you did in the gunner's seat.

G4 Well in the chair after about two or three minutes I could feel my hands or my palms start to sweat. I didn't know if it was the bag or not. Then as time went on I could feel the sweat starting to form on the inside of my arms. But I could feel the sweat coming, but I didn't really feel that nauseous feeling until right there towards the end when I could feel my stomach starting to tighten up. I had to swallow a little bit to keep it down and that's when I called it quits.

C1 How about when you got into the simulator? Were those feelings maintained when you just sat in the simulator?

G4 Well by the time I got into the aircraft I had lost the dizziness, but I still was a little light-headed and had a little bit of a headache. There was still a turning sensation in my stomach.

C1 When you got up on motion did that irritate it more?

G4 No, in fact it made it go away. About half way through the flight I felt like I did before I had even gotten into the chair.

C1 Was that pretty much the same for you?

P3 Yeah. The motion helps a lot.

C1 It helps you to get better?

P3 Yeah.

OCM I think the gunner's proficiency or whatever, it's a little bit tougher to find the degradation in his proficiency when he's -- I think he got probably ten out of how many?

G4 I did better.

OCM He did better on the last one than he did on the first. We were doing some pretty good rocket shots. It worked out really well.

C1 SO, any observations from your part?

SO No real big observations other than the fact that I could tell that P3 was tired back there. I could see some tracking radar between the pilot and the gunner mostly within opposition to each other and that's where we ended up losing opposite motion coupled with a lot of other things. I could see it on the screen, the gunner kind of stayed on it. Everything else was being forced off because of something in the backseat. As far as the gunner, initially I could see kind of like a lazy-daisy going around the target and as the shots and it was standing more and more concentrated on the center.

C1 And that would have happened if he'd been coming in fresh?

SO I do not know. If he was fresh, waking up first in the morning, that's the first place he'd be is probably in the center line. But even from the gunner's seat, in respect to the TOWS, when you're stabling back to the TOW . . . to keep the crosshairs on the target, you have to have a lot of effort to maintain guide on the target. You don't have that much power to maintain the accuracy. Winds will be some what of a factor as long as you ....

C1 FS1, any observations?

FS1 The one question I'd like for them to address, because there's been some concern about it, is dizziness. You did mention it because spinning like that does cause one to become dizzy and nauseous and feeling lousy. P3 what about you? When were you aware that there was no dizziness left?

P3 It pretty much went away by the time I. walked onto the ramp into the simulator, I was fine to stand by myself. When I first got out of the chair I couldn't stand by myself.

FS1 G4?

G4 It was about the time I was shutting the door to the simulator. I did notice after I got up onto the . . . I turned around real quick or made any quick moves, I could make myself dizzy real quick. Walking up the stairs I felt pretty sure-footed.

FS1 That's pretty much what we thought. The dizziness would be pretty much washed out in about thirty seconds.

C1 How about after effects once you got out of the simulator after it was all over and you're sitting down doing your computer tests? Were there any flashbacks or any weird things that happened? If you moved your head did you feel nauseous or anything like that?

G4 I still have a little bit of a headache, but I seemed a little more alert. Throughout the night I was having a hard time with the computer in there. I was wondering how long have I been out of it, cause I know that I've been staring at this thing for at least ten or fifteen minutes. At the computer right after the -- I don't know if it was getting a chance to get in the aircraft and getting a chance to get the adrenaline flowing again. I felt a lot more alive and a lot more alert.

C1 Did you learn anything about yourself after doing this in relationship to you as your part in the Army and your mission in the Army? Did you think about war or how you might behave in war as a result of this?

P3 I didn't think I was going to be affected quite like that. I'd never tried to stay awake for that long without drinking coffee or any special reason to be awake that long. Especially I found that I was really slow. I'm sure that if I would have been flying the simulator at 2:00 this. morning, I would have probably crashed into a lot. I was really out of it until daylight came back on.

C1 There's a whole related aspect to this and that has to do with not only the physical effects of these conditions -- here we made you tired and we made you sick and there's an overriding question of well, [expletives deleted] how's all this going to affect you in a war and what the psychological effects of all of this are going to be. It's very tough for us to get a handle on that. Some people say, "Well guys if they feel this sick they think they are going to die." Whether or not they will -- Some people say, "Well those guys are going to go all out and try and kill as many people as they can before they go down." And others are going to say, "Well they're going to think more about their survival and want to get back to see if they can get a medic to help them out." And then there's another view that was expressed and that was, "Well, if I were really doing my job and I felt as though I were dying, the best thing to do would be to get the aircraft back and save the aircraft so that someone else could use it." Any reflections on all of that?

G4 That's a pretty broad statement. Each situation is going to be different. Whether the guy is going to say, "Well I'm going to stay out here until I can't sit up in the cockpit any more and [expletives deleted] it up wherever that may be, or to go back, that would depend on the unit.

C1 Yeah, it's very situational. Any other comments? We have some guests from the Defense Nuclear Agency here with us. Do you guys have any outstanding questions that you want to ask?

NR I don't have any questions. I'm just very interested . . . P3's comments about being tired. Not necessarily feeling the effects of the spin, but just being tired and being spun . . .

G4 You really don't get the opportunity to fly long hours with the Army's Crew Rest policy. It's trying to keep a good safety record. As we did quite a few years ago. It brought back to me --

C1 Memories of the old days?

G4 What it's like to fly before we had the Crew Rest policy. You were out there because you really wanted the opportunity to go out and fly. If your CO didn't tell you to come back, you could stay out there all day and all night.

C1 Any other questions?

NR I'm interested to see what a difference in time will be after the performance data.

C1 Yeah, the performance data is going to tell a lot.

C2 One thing on tapes that I noticed as I was listening through the headset, second session, second day, it seems just a case of a very big effort of trying to do things. I mean, to the point of even an effort of trying to talk. I could sense a concentration of trying to do those things which they knew everybody had to do and needed to be accomplished, to give time hacks and everything else. There was just a big effort from my perspective.

C1 I know that you mentioned that. Was there any change in pitch of voice or anything or was it just this effortful speech?

C2 I think the tone goes down and in one sense it almost seems like a resignation in the tone of voice like, "Well, [expletives deleted] here we go again. It's another process and I'm going to do it because I'm a professional, and [expletives deleted] I don't want to be up here." And not just here, I mean in the second set it shows in everybody's voice on the way to run.

NR I have a question, C1. With the pilot, did the difference in terrain on one run to another run make a difference in how much time it took you to line up and hook up and shoot.

P3 Certainly, especially on this last one. Because this last one the winds they had --I guess they had the same scenario yesterday -- we ran out of tail rudder. I'd get with OCM on the front trying to get -- the TOWS weren't so hard as trying to get the pipper lined up on the rockets. And I'd stand on the left pedal even knowing that standing on it as hard as I could wasn't going to do any good. So I'd have to drop it to try and get a little more power in the tail and then it would finally swing around. I found that because I was all the way to the limit that it was really hard to get the rockets lined up. And it was a different scenario than what I was used to. I think that the one we had this morning was a pretty easy one to deal with. I think basically it was come up to a hover and shoot. This one was come up to a hover and then do almost a 180 turn or a lot of turn and then try to shoot. And then because the winds are blowing me sideways, I'm trying to compensate and keep the nose of the airplane on the target. When it's time to go back down to the mask area, it's quite a distance away now because the winds and the simulator are blowing the aircraft away.

NR So the different terrain and the winds?

P3 Right.

OCM The winds were the same in each scenario. The difference being the heading that you were firing under. So the wind direction has a different effect. Also the firing positions were somewhat easier to maneuver than others. Some were a little bit tighter so you've got to be really cautious when maneuvering and that slows you down a little bit. Because the aircraft is maxed out, we were really pushing them there on the edge which is really a good factor because that's where they need to be. They're riding it at almost maximum weight on the aircraft.

C1 One other question, when we gave you these Performance Decrement questionnaires, we gave them to you again at the very end and asked you to adjust up or down based on your more recent experience. I noticed a trend in remasking. The time seemed to go up. Is that a function of location? I think I saw it in yours as well as the previous pilot's. Do you know why that was?

P3 It was, the ones that I changed, just a function of me realizing the effects that the chair had had on me the tiredness and that. At first I didn't really think it would make much difference on performance, but then I realized that it would slow your flying performance, trying to get in without running into the tree.

C1 So it wasn't a function of the wind?

P3 Not really.

C1 OK.

FS1 What were the stressors that you underwent that were more difficult? Was it more difficult staying awake, spinning, going without food, the physical activity?

G4 Staying awake between the hours of about midnight and 5:00. That's real tough. P3 and I were out walking up and down this street. We knew if we sat down it would be all over. So basically we just stayed awake and just walked around. It would have helped if we'd had a stimulus, some coffee or something like that.

FS1 The reason to stay awake was not to keep you awake. It was to make you tired. Stimulate the fatigue aspect. I wish we could let you go to sleep and then be tired, but there wasn't a way of doing that.

C1 Anything else? Well I'd like to thank you gentlemen very much for your participation and I think this is a very valuable segment. I know that you guys are anxious for dinner. So, dinner's here. O.K. that's it.

Crew #3 Interview
23 JUNE 1988

C1 The date is the 23rd of June. The time is 6:16 PM. We just finished crew number three. That means we've had six pilots go through the whole scenario. We will use this opportunity to get subjective opinions of each pilot as they went through the scenarios and the whole stressor environment of sleep deprivation and food deprivation and physical exercise and also the addition of nausea with the chair. The other crew member (OCM) is here and we have Pilot number Five (P5) and Gunner number Six (G6) here with us. FS1, the attending physician, is here too. I think what I'd like to do, as we've done with the others is start focusing in on the spin scenario. That's the thing that we had some uncertainty about. The literature shows that the spinning does create nausea. Our concern was how long the nausea lasts, and once after we've spun you, once in the cockpit does that maintain? Let me just ask you that. Now in some cases we've had people actually gag and in other cases we've had people who say, "Hey, I'm feeling nauseous," and we'll stop the spin and they'll get in the cockpit and there is no gagging associated with that. In this case P5, when he spun, felt queazy and uneasy. I'll let you speak to that. We didn't notice any gagging there. We didn't witness what happened in the cockpit, so you can tell us that. G6 did come to a point where he gagged a bit. Let me stop talking and let you start. Let's begin with G6. This was an anomaly to a certain degree because we had a little bit of a simulator problem with the visuals. We reversed the order. Usually the pilot goes first, but this time we had the gunner go first. I don't think there was any after- effect of that. I think things went pretty well that way. G6, how about explaining how you felt in the chair and how you felt once you got in the cockpit. Pretty much just go through the scenario.

G6 After I was done spinning in the chair, I was nauseous to the point where I don't think I could have flown. I don't think I could have even put a TOW on the wire. All I was thinking about at that time was myself and what was happening in my own body, not what was happening around me. Once I got up out of the chair and walked towards the cockpit I felt a whole lot better, but I was still nauseous.

My stomach still hurt. My head was hurting. It took a lot of the attention away from the tasks assigned in the cockpit. It didn't degrade it to the point where I couldn't have done attacks.

FS1 Had the spinning pretty well stopped by the time you'd gotten out of the seat?

G6 The spinning had stopped.

C1 How about you?

P5 Well getting right out of the chair proved pretty difficult to even fly the aircraft because you have that spinning sensation and you're trying to control the aircraft. But once we got up into the simulator, the spinning sensation was less. You still have the effects of the spinning, the light-headedness. The nausea feeling lasted for about 10 minutes through the rocket engagements. By the time I got through the TOW engagements, the majority of the feelings had already disappeared.

C1 We did change our procedures a bit from what we'd initially planned. Because the pilot's most difficult task is the rocketry, we had the rocketry first in the scenarios with pilots, and then the TOWS with the gunners. You said that about that first ten minutes you got through? You were still in rockets then and you started feeling better?

P5 Right, as time progressed of course I felt better, but I could still feel the effects up through the entire rocket engagements and at the start of the TOW engagements.

C1 One of the things we did do is ask you to take a look at your Performance Decrement Questionnaires. You estimated how long it would take to do certain tasks and under certain symptom conditions, how much longer it would take you to do them if you felt that way. You did that before you were actually made sick/nauseous. G6, let me ask you, when I handed you yours, I asked you to fill in, in red, any changes you might have. Can you give me a feel for how that went with you? Just to summarize before versus after, having felt like that? You did make some changes.

G6 When I originally filled out the report, I think I overestimated the amount of time that it would take somebody -- a gunner -- to acquire a target and track it with a TSU. It really didn't take that long at all. If you're in a pretty stable platform, as long as you're the TSU, and you're not associating with the aircraft movement. I wasn't that nauseous. When I came out of the TSU I got a little nauseous. It didn't take me any two to three seconds to acquire the target and even less to track it.

C1 Now P5, when you filled out the questionnaire and after you were made sick, and asked to revisit it, you indicated that you didn't think there were many changes. You felt pretty confident in the estimates.

P5 Yes, I did. The original estimates when you're not feeling sick, I thought were pretty accurate. As far as the induced nausea feelings and all of that, I found that it was more difficult to control the aircraft and the rocket firing. But I think that the initial times that I gave were pretty close to what it took me to get back to remask.

C1 One of the questions that FS1 had yesterday with regard to stressors -- you know we used food deprivation, sleep deprivation, physical exercise, as well as the nausea inducement. Which was the worst?

G6 Lack of sleep.

P5 The nausea, because I've gone many times without sleep. As far as food deprivation, I'm not hungry now. I don't think that the food deprivation is really significant. If you want to make food deprivation, go three or four days without food, and just give them minimum rations. Extend us out to get either a better feel for it. Or we could do the physical exercise or . . . in the cockpit plus the physical exercise.

C1 That's a good point. That's something we noticed. Let me ask you about that. With regard to what the most optimum time to have shown the degraded performance, would there have been some other time? You've indicated yes, after the physical exercise. What if I painted the scenario where by it was four in the morning and then you had to do the physical exercise, and we put you in right after that. Do you think that would have been even worse?

P5 I think so, because that's the time of the morning that you're trying to fight going to sleep the most. The exercise might counter or wake you up. But then again, the physical exercise thrown in there and getting put behind the simulator probably about thirty minutes after the physical training at that time of the morning. If you have enough time to get nauseated again, plus the physical training, the effects would still be there.

C1 What about the scenario where we didn't have any physical training? Do you think, given what we did today and we tested you at this time, do you think the physical training had any effect on your performance?

P5 No. None whatsoever.

G6 I agree. I don't think so.

C1 How about a worst case scenario, for you, given what we did. Do you think we would have had worse performance if we had tested you at four in the morning?

G6 Yeah.

C1 Yeah that seems to be true. Are there any other observations?

OCM I think if you would have reversed the cycle right from the start to have brought them in at, instead of 7:00 in the morning, 7:00 at night. They'd been out that day and you bring them in at 7:00 that night and you start the cycle that you ran and you see how that works.

C1 That's one thing that I didn't ask. What were your perceptions as the alternate crew member in this. Did you pick up any new insights or would you like to reinforce any that you had in your position as the alternate or other crew member?

OCM It's difficult to tell if there are any major differences. There aren't any major differences that I've been able to pick up on in performance. It's going to be time. Time is really the factor. We talked about it yesterday. You get a little bit choppy with the pedals. You overcontrol. You may be getting a little short or a little tired and you start fighting the aircraft. So you're not as smooth. As P5 was saying you're having to work for it.

C1 How about the differences in location? Did you find some scenarios in various locations in the map? We tried to keep the range to the target rather constant. Did you find some locations easier than others?

P5 The last location was the most difficult. I was fighting a headwind and a pretty steep embankment there. At the time I was unmasking and so I had to get into an attitude which allowed the aircraft to move back in order to reach the target where I could see it. It was pretty hard within the constraints.

C1 How about you?

G6 No, not just operating one of the systems.

C1 So most of the location differences in the pilot?

P5 Yeah in the pilot.

C1 Would you say that it was mostly in the masking and the remasking phases, or pretty much throughout?

P5 Yeah, both phases, masking and unmasking.

NR P5, when you were flying and you had felt better then, do you think that you would have performed better as a pilot as far as time, unmasking and masking as far as the . . . was concerned?

P5 I would have to say yes. Any time that you fly and you're graded, your ability to engage with the aircraft is going to be . . . How far, it's really hard to say; at that point if I was feeling a whole lot better, I'd try to pull myself up on schedule...

NR Suppose you had more motivation to do better? Suppose there was a big reward, could you get yourself to perform better?

P5 What kind of reward?

C1 The question is one of motivation, and it is a very good, pertinent question I think. It has to do with in a wartime versus an experimental setting. Is that what you're getting at?

NR Yeah.

P5 If there were a Vulcan shooting at me, I think I would be a lot more attentive.

NR Even....

P5 There's no doubt about it. If tracers are coming all at me.

OCM Get the adrenaline pumping.

P5 That's right. The adrenaline would be pumping and you'd be a lot more attentive. A lot more.

OCM That's something you can't simulate.

C1 If I asked you to venture a guess, do you think you could guess? It gets along the lines of motivation and the psychological effects of warfare. There are certain hypotheses that say, "If you were in this situation, feeling this way, would you have the tendency to go down, killing as many people as you could, or would you try and get back and get medical help or return your aircraft to someone else? Do you have any depth feels for that kind of thing?

P5 At the point that I was in the cockpit today, I would probably continue shooting. I couldn't see going back at that point.

C1 How do you feel?

G6 I agree with that. There was no point in going back. . . If you get to the point where you are incapable of many functions and you are putting the aircraft in jeopardy, it doesn't do you any good to go out there and shoot and fight.

C1 I think this is valuable and I appreciate your comments. This is the kind of thing that we don't get with stopwatches and any other measurements. It's very valuable. Thank you very much. We've got dinner here for you.

FS1 Whatever it may be.

Crew #4 Interview

24 JUNE 1988

C1 Here we are once again. It's 5:57 PM on the 24th of June. It's a Friday and everybody's tired and they want to go home, but we are going to take advantage of the experiences of this crew. We've got here Pilot number Seven (P7) and Gunner number Eight (G8). The other crew member (OCM) is here with us and so is the flight surgeon (FS1). What I'd like to do is just go through this scenario with you guys, the spinning on the chair, and get your personal reactions to not only the spin on the chair, but how you felt once you got off of the chair. Describe how you felt once you plopped into the sim. And, if there were any effects, how long they lasted and that kind of thing. Let me start with P7. So just give us a feel for how things went. Now you went to the point where you got sick. Now let's see, I don't know how long you were on the chair.

FS1 Both were relatively short periods of time. Three minutes approximately.

C1 How was it?

P7 I didn't like the chair at all. It did what it was supposed to do. It made me sick and dizzy. The dizziness didn't last for a whole long time. As soon as I got to the top of the steps and gone up to the cockpit, it seemed like the dizziness was gone. But I was sick the whole way through the whole flight.

C1 You were nauseous?

P7 The whole time.

C1 Did the motion in the simulator help or hurt the nausea?

P7 It seemed to aggravate it a little bit. It didn't get any worse, it just stayed constant when I was up in the simulator. I was fighting to keep it down.

C1 So you thought that you might actually lose it when you were in the cockpit?

P7 Yeah.

C1 Do you think your performance degraded?

P7 A little bit but not a whole lot, because I tried to just put it out of my mind. I don't really know how much time difference, but I don't think it was degraded that much. I'm sure it was some, but not that greatly.

C1 When I handed you that questionnaire, at the very end and asked you to readjust any times that you thought that experience might change your estimates, was there a lot of that that you did re-adjust?

P7 Yes.

C1 How did you go, up or down? Or was it certain tasks were more?

P7 Certain tasks were more. Like maneuvering the airplane into constraints, which is when you have to fine tune the airplane to get it into constraints. And I found that that was a little bit more difficult because I was fighting with myself and trying to fight with the airplane at the same time. So I adjusted the times for like getting the aircraft into constraints and maneuvering it to where the target was. I adjusted it for that by about two or three seconds at most.

C1 G8, how about you?

G8 The effects of the chair, the spinning, were gone by the time I got to the top of the stairs on the simulator. The other effects only lasted a couple of minutes. By the time I filled out my SCL and we got ready to shoot the first TOW, the nausea was pretty much gone. It didn't really seem to affect the performance up front. Being in the front seat, I didn't have to worry about looking out as much. I could wait until he had the target in sight and keep my head in the TSU so the motion of the simulator didn't really bother me that much. FS1 asked me to time the nausea and it was only like two minutes and forty-five seconds. The solo time on my period that I was nauseated, but other than that it really didn't bother me. As far as adjusting times, I adjusted the gunner's tasks, because that's the position that I was coming at. I adjusted some of them down, back to normal because I found that the "moderately sick", not the "really extremely sick" one, because it didn't really seem to bother me that much -- A couple of them changed to "could not complete the task" because if you were really dizzy or really sick as far as tracking -- Tracking is one thing, but as far as being able to hit the targets, that's something else. If you can't hit the target, you might as well put down "can't do that". You can't do the task.

P7 That's another thing I noticed, on those questionnaires you handed out, those PDQ's or whatever you call them. You should have a section on there of the probability of you getting hit. Your probability of getting a hit.

C1 One thing we did ask you very early on was to estimate the workload. And one thought occurred to us is perhaps giving an estimate of the task criticality or of something of that nature, of being able to hit the target, or something of that nature.

P7 Because our end of the system is relatively simple, it's getting the ammunition where you want it to go that's the hard part. Now anybody can go up there and push a button. Now to get it where you want it to go is the difficult part.

C1 The chair wasn't the only thing that we used to, or attempted to use to mimic the symptoms of radiation sickness. We made you stay awake overnight. We didn't anticipate that the food deprivation would bother you that much. The food deprivation would mostly keep you from, if you did gag, just to keep the vomiting down. And we did some physical exercise in there as well. Can you give us a feel for which of those things may have affected you the most?

P7 I think the staying up all night long was probably the worst for me. The food didn't really bother me. It's just psychological. The exercise worked good because that pretty much wore me out afterwards. I think the sleep was the worst for me.

G8 There was a longer recovery time after the exercise than there was after the chair. I think if we'd gone right up into the simulator after we did the exercise, our performance would have been degraded more than just the chair.

P7 The chair and then the exercise.

FS1 That's been suggested.

C1 Another scenario would have been to have exercised you at three in the morning. There's an indication that there might have been a cyclical, maybe if we looked at the PAB performance, you might have done worse at three in the morning than you did now.

G8 I'm sure. A couple of times the alarm woke me up and I started pushing buttons.

C1 You feel pretty much the same?

P7 Exactly. That was the worst time, probably about between two and five. The worst time, when your head is slamming up.

C1 So the scenario should be about three in the morning, we give you exercise, plug you in the chair and then put you in the simulator?

P7 You probably wouldn't be able to exercise.

C1 Did you notice in filling out the symptom checklist there was variability? Did you go up and down in the way that you checked that out during the night? How did you fill it out in your most recent checkout? Did you have any degradation or was there no effect?

P7 The only problem that I found was through the night on that one section where it talked about fatigue, I was tired and a little bit weak. And then when I got up in the cockpit after the chair, then I filled out a whole bunch of them. That was about the only time that it might have ever changed.

C1 OCM, how about observations from you in the other seat?

OCM We used 5.3 today, because of the changing pitch attitude, I would assume to be the most difficult. That's the one which is good for the pilot. The only effect that that would have on the gunner is the motion in the aircraft in order to get back down and see where I was at. To get the nose down there and to get the aircraft down and get it in there. It could have some effect on motion sickness if he would have been looking outside versus looking . . . So it could have had some effect on getting sick or getting better in the simulator. So there's a lot more aircraft movement or simulator movement from that, from that target engagement. Other than that, it was pretty much standard.

G8 Another thing to consider is the combined problem of having a sick pilot and a sick copilot, because tracking a target when the aircraft is nice and steady for someone who isn't affected is a lot easier. Because if you're not feeling a hundred percent and you have a guy back that's going to get a little sloppy on the pedals, it's going to be harder to hold the crosshairs on the target.

C1 So if OCM were feeling as sick as you, the sum of the two would have been worse than rated in the --

OCM I think that's the way that you're probably going to have to look at it. I'm sure that it's true probably anyway. It's going to be a sum of his and his even though they were evaluated on separate times.

C1 Well it could very well be OCM, that the sum of his and his may be less than the combination of the two. And that's a very good research question and we'll ask you guys back next summer. FS1, did you have any questions?

FS1 No, just my appreciation to both of them for participating.

C1 How about you C2?

C2 We had talked earlier about SERE training and the sleep deprivation that you had gone through during that time period. Did you find that that helped you in this scenario or had no effect? And when I phrase that I'm talking about the psychological impact of staying awake for twenty-four hours.

G8 Well with that we had several things compounding on that. We were out for five days. Four or five days on the evasion course with people chasing us and trying to hunt us down. So you had a lot of physical activity there before you were brought into the prison camp setting. And the sleep deprivation got to the point where you actually started having hallucinations. It was a lot worse than the ones here. And they would actually not let you sleep. They were constantly coming by and grabbing you and having you do something and asking you questions. That with the other type of psychological pressures that they were putting on you, it wound up a lot worse than here, not sleeping for a night and not eating, just a couple of meals.

C1 How long was the sleep deprivation in that?

G8 We didn't have a good night's sleep for almost a week. During the three days of the resistance training lab it was virtually no sleep. Unless, points when we were locked in small cages, and you could get some sleep in there. That was about it. You had no sense of time at all. While we were out in the evasion course you might get an hour here and an hour there. That was it. We'd travel at night and try to sleep during the day. It was hot like this out during the day, so you didn't really sleep that well.

C1 I think the only other question we bounced off the guys was the whole idea of motivation and wartime and getting reflections on -- I don't know -- the first question is did you learn anything about yourself that this study did that you might not have had any insight on? Your performance in the cockpit? Any insights? Did you do better than you thought that you did, or worse?

P7 No, actually it bothered me more than I thought it was going to. Being sick. I thought because you're flying that you have all of the flying tasks to do so the sickness really shouldn't enter your mind. But I found myself worrying more about being sick, than I did worrying about flying the [expletive deleted] airplane.

C1 Anything?

G8 No, I didn't think that the induced sickness really bothered me that much, because like you say, I didn't really have anything to do except put my head in the TSU and, I didn't have to worry about anything else. When I got out there, I double-checked all of the switch positions. We had one problem, the first rockets because the laser filters wasn't tightened. That's the only thing that jiggled to me. The laser started working again. But other than that, we didn't have to worry about that. Nobody came in and set the switches up so you had to tell -- check them, and get frustrated by not being able to get a missile off. You know, that can happen. And I learned that next time I go to the carnival and I'm on one of those spinning rides that I'm not going to move my head. I'm not going to even get on those spinning rides.

C1 Most of this study was focused on the physical effects of radiation on performance. We really didn't try and tap too hard into the psychological effects. There are a lot of hypotheses about what one might do in a real wartime condition and what the psychological effects would be, ranging from scenarios from, "Well if I'm vomiting, then I've probably been radiated and I'm probably not going to live and therefore I'm going to go out and kill as many guys as I can. Others might think, well I might turn around and get to some medical attention as soon as I can, and there are some other variants of this scenario. Do you have any insight, any projections, or hypotheses in regard to that kind of thing?

P7 I don't really know. I guess it would all depend on how sick I was. If it got to the point where I couldn't fly the airplane, which I don't think it would take a lot at this point, there's really not a whole [expletives deleted] lot that you can do, if you can't fly the airplane.

OCM Do you think the study could have been used if you'd have gone out there and flown from point A to say point B and you would have had a lot of terrain and a lot of movement for navigation tasks?

P7 I think that that would have better. It would have been more realistic.

G8 More crew members involved.

P7 Yeah.

OCM And then gotten you into position, and then had you fire.

P7 It would have been more realistic. Your performance would have been degraded a lot more than it was coming out of the hover hole and coming to a zero G hover and then coming back down.

OCM It would have frustrated you a lot more.

C1 Yeah, we realized that this was a highly practiced kind of thing and that was one of the kinds of considerations that we had to make in this thing.

OCM Well that's a very subjective scenario too, other than if he doesn't make it from point A to point B, or if he gets lost. How long did it take him to get there? If he never gets there. You run into a lot of problems.

G8 If he shoots back at you.

C1 Yeah we tried some of that out with a forty-seven as a matter of fact. We had radar lock ons and some things like that. Both situations have pros and cons to them.

OCM This is the most objective for being able to evaluate performance.

C1 Did you feel like you were well practiced? In other words, one of the concerns we had was well [expletives deleted], by the time that they get to the end of it, they are going to be so well practiced that they are going to be doing better than when they started. Did you feel that the very first practice session, you felt fairly comfortable and that you really weren't on the practice curve the other times that you were up?

G8 Well we just got done doing the AGST with our squadron, the annual gunner's skills testing and training. So we were pretty much up on it. We'd just got back from the range, shooting TOWS and rockets.

P7 That's normal stuff that we have do all the time in the simulator, so it wasn't anything that we had to get used to I don't think.

G8 The only other thing to consider is if we were in a nuclear environment, we probably would be wearing a mask which degrades your use of the TOW system without having any sickness and compound it when there was.

C1 Any other questions or comments? Thank you very much gentlemen.

FS1 Let's eat.

Crew #5 Interview
28 JUNE 1988

C1 Well here we are. It's the 28th of June and it's 6:48 PM. We have just finished up with Pilot number Nine (P9) and Gunner number Ten (G10). The other crew member (OCM) is here with us. We also had a Navy representative (NR) join us. The NR tried to get in as much of the normal routine as he could given the schedule that we have, including his participating in the sleep deprivation, the food deprivation, the spinning in the chair, some sessions with the PAB and he got in most of the sessions with helicopters. The purpose of this session is just to get subjective comments from the participants. Let's start right off doing that. NR, what were your experiences with regard to the chair? How were your expectancies for what the chair might do to you -- with what actually happened and your performance after you climbed into the simulator?

NR I felt coming off of the chair that I had several of the radiation sickness symptoms. I had nausea. I had a headache. The dizziness went away before I got to the simulator, so it seemed like it was a pretty realistic scenario for what you were trying to do. When I got in the simulator, however, I started flying. I'm not a helicopter pilot so I had to really work to make that helicopter really stay airborne. I was so involved with doing that work that I didn't feel any of the symptoms when I was flying the simulator. And I don't think my performance really varied that much after the rotating chair. When I finished the session I felt the same symptoms again because I wasn't flying. I was thinking about the symptoms. I guess the bottom line is, in a real situation, after an actual radiation, if you have a lot of motivation or initiative to get something done, you'll be able to come alive if you really want to.

C1 You're a special case, because as you did each mission, you may be gaining much more on the practice curve than the more experienced pilots. But did you think that there was any effect just of the overnight sleep deprivation from the time we measured you in day one versus the time that we measured you in day two, but before we spun you?

NR I noticed a difference also. I think another difference today, I think we competed more on the physical exercise that we had. I think that everybody came out pretty beat up from that. And in my case, that lasted on, into the simulator session. I've been talking to the other two guys, and I think we all felt more of the symptoms during the whole evolution than I heard from the previous participants. I think everything added up. It's an interesting effect. In my case, when I got into the simulator, I was able to overcome all of that and just concentrate on what I was doing.

C1 Did you have nausea associated with your physical exercise?

NR A little bit.

C1 How about you P9? P9 was the pilot in the pilot's seat.

P9 The biggest thing, when I got into the chair, I came back and I was nauseous, sweaty, cold, clammy. I had to also go to the bathroom. I couldn't walk straight. I thought to myself just then, if I've got to fly the way I feel right now, I would not be able to do almost any basic task that we have in our training manual. By the time we got to the cockpit, I was no longer dizzy. The nausea was starting to subside a little bit and I was a little bit uncomfortable. But it really didn't stop me from performing any task. Whether I was able to do it with the same proficiency as I could the day before, it's hard to say because I hadn't slept the entire night. I went through physical activity and I did get sick when I exerted myself after not have eaten anything. I was fatigued when I got in there. I was still able to function as a pilot. Whether my judgment and motor skills were as precise and with the same finesse as they would have been normally, it's hard to say. I think if there were some way that you could induce the feelings of nausea and light-headedness while you're in the cockpit flying, the results would be tremendous. Because I don't think a pilot, with all of these things actually going through his physical being, regardless of what you might be able to overcome of course --Throughout the entire flight I had a headache, but it really didn't affect that much myself being able to put rockets on targets. I had hits today. I had misses today, and I had misses yesterday too.

C1 Of all the stressors, which affected you? Well you didn't experience the nausea in the cockpit, but did you feel that out of the stressors we did give you, which had the most effect on you?

P9 I had a feeling of discomfort. I guess the psychological feeling of going into the cockpit thinking of all of the stuff that just happened to me. What's this going to be like? Am I going to be able to hover the aircraft? I guess it bothered me a little bit. But as soon as I got in there, and everything sort of settled down, it didn't bother me as much. I guess I've learned a little bit about myself in this thing, is the idea of no sleep, what it will actually do to you. Taking the tests every other hour. It was physically and notably on the screen -- I could see myself going down. After no sleep, I couldn't concentrate on figures and things that were being said. I ended up staring at the screen, and lights were kind of meshed together. It was disturbing.

C1 If we had put you in the chair at 4:00 in the morning, do you think there would have been any difference?

P9 I don't think so. I think the chair is something that's temporary. I think it's too temporary a device to compare to flying a four, five hour mission having undergone severe dosage of radiation. The chair gives me the idea of all of those symptoms. I made changes on here. It said, "Do you think you'd be able to fly this mission with bombing?" And I say, "Oh, a little bit of bombing isn't going to hurt." You know, "I'll be able to do this, this, and this in so many seconds." And after really experiencing and noting the discomfort, I changed my mind and I said, "I don't think I'll be able to do certain things."

C1 So your estimates changed definitely?

P9 Absolutely.

C1 But because of the fact that you didn't feel that way when you were in the cockpit, you're doubtful that your performance was affected, but that it would be affected if indeed you felt that way?

P9 Yes, yes.

C1 How about you G10?

G10 I was just surprised how powerful the chair affected me personally. Five minutes, sitting there going around, I felt nothing. Then ten seconds, it was time to stop or I'd lose it that fast. The symptoms persisted the entire flight.

C1 So you did feel nausea when you were in the cockpit?

G10 I felt it every bit during the entire flight. The front seat in the cobra shakes more than the backseat and I could feel the whole thing. I had my head down in the TSU, the optic system, and so this went around like that. I was dizzy the entire time. My stomach was upset the entire time. I was cold, sweating and clammy the entire time. However, I don't think that affected the performance. We did our best rocket shooting this last period. We had certain targets with fourteen rockets. I did miss a TOW shot, so I was forty-two out of forty-one TOW shots. Forty-one out of forty-two, excuse me. I don't think that the performance -- I was just surprised at how it affected myself personally. I think for all pilots, they get in there and say, "This is a temporary effect." By the end of the flight I was O.K. - but say listen guys if this were to happen to you, this is just a simulator. Try it. I think they'd be surprised.

C1 How about the PAB, the infamous PAB? Did you feel sick when you got in there the last time? Did the nausea carry over into the PAB?

G10 The PAB puts you to sleep. It's the green lights on the green background, and by the time you hit the time wall, you're asleep and you just can't concentrate. It's amazing how fast it can put you to sleep. Like I'll come in here, and we'll have been playing the video games. We'll be wide awake, we'll be, everything the task says: we'll be active, we'll be enthusiastic. And you get in there ten minutes on that computer and you're out.

NR I think in that regard, the PAB isn't really a good indicator of how you would perform in the airplane. The PAB you tend to fall asleep in because it's a mundane type of task. You can't get excited about it. You jump in an airplane and your heart's pumping or whatever, you wouldn't have that type of feeling of falling asleep.

P9 It gave me a good idea, however, certain skills that you may not recognize in the aircraft that are a little bit more noticeable when you get on the computer, because you are concentrating on specific items. And if it were a flight plan or figuring out something a little bit more complicated than just putting a reticle on a target and shooting rockets. You notice the fatigue. The fatigue has taken it's toll.

G10 You did notice that it took you maybe two or three times to add the column of numbers than the first time you did it, you breezed right through it. I mean adding the three numbers up.

P9 On the wall, I found myself tracking the ball down the wall. And the next thing I know, I'd snap out of it, almost into a trance. I noticed there's no ball on the screen and there was an empty block right there, so I'd immediately hit the button. They didn't post the results on that one unfortunately. At certain times *of the day, I'd go in there to take the PAB test and I was amazed.*

C1 Did your falling asleep occur just in the wee hours of the morning?

P9 No. It occurred all the way to the end. It wasn't that I'd just fall asleep, I was looking at numbers, thinking of numbers, and all of a sudden the number would pop something else into my head and I'd end up daydreaming, going off. I couldn't specifically concentrate on any of these numbers. I'd add up a six and then remember some ballgame score that was six. I'd forget what I had the number on and I'd end up using my finger. Times increased and everything. That was a good practical exercise.

G10 Yeah, it was, even though I [expletive deleted] about it. My sense of timing, I just tracked it when I was doing the clock where you count the seconds. At first I was just nailing it, and by the last PAB I just took, I was a good quarter second off. My average second stroke was .75 of a second. I thought I was just taking my time, one, two, but I just blew right through it.

P9 It was the same thing with me on the clock. My times throughout, consistently, except for the last time, were all within hundredths of a second. This last one I felt myself getting into the trance and I looked up and it was sitting on fifteen. I wondered how long was it there? So I kind of went up a couple times and tried to pick up where I left off.

C1 Fix the average?

P9 It didn't quite come out right. It ended up .77 of a second or something, and that's the worst I've done all day.

C1 OCM, what are your observations sitting in the other seat?

OCM Well the only difference about sitting in the other seat in my case, because I was sitting there for so long, that I can see what they're talking about. see, they spend a very limited time in the cockpit. What they're seeing in front of the screen is what's going to happen in the cockpit when they start spending eight to ten hours in the aircraft. In the combat situation that's very likely. What's going to happen is, what you're doing on the screen in front of the computer is what's happening to me sometimes looking in the TSU. It's so repetitive going over and over again in about eight hours. Like today we included NR in there so that was some extra time. So we're spending at least eight hours in the cockpit. Over half of that is in the front seat. What is happening is that when you are looking down into the TSU the same thing happens to me. Then he says gunner-target 12:00. Then suddenly runs through my head, are we firing? Are we firing TOWS or are we firing rockets? Oh [expletive deleted]. And then I grab the action bar and we go through the whole sequence. Just looking through there when you're concentrating, same thing. Something goes through your mind and then your mind starts wandering on something else and suddenly you're off target. It's just a concentration that's needed. It's just a short period of time, but it's an intense concentration. And then when you get so tired, warping. It's difficult to keep it on the specific point. So what's happening to them is very applicable and it's going to carry forward when they start flying a lot of hours. Not only for radiation sickness, but just for fatigue or long periods of time.

C1 One of the things that we've asked folks -- and this is a little bit off of the topic, pertaining more toward the topic of motivation. It's something of interest to me, and that has to do with just some hypotheses with regard to what might happen in an actual wartime situation. Just see if you have any thoughts or comments on the scenario in which someone would say, "If we were really in a war and guys were vomiting and they'd think, 'Well I've bought the farm, [expletives deleted], I'm going to go out and kill as many enemy soldiers as I can before it's over." And another one would say, "Well let's get back and maybe some medics can fix me up or let's get the aircraft back." Does anything go through your mind with regard to your experiences and the way you felt and what the effects of motivation are going to have in a conflict in which this, would really happen? Do you have any sense in how you might react in that kind of a situation?

P9 I'm not a combat veteran. On the contrary. But from what I've seen today, I've often gone over this thing in my head. What if? And I think that little things that you may say like, "I've got this headache right now, I really wouldn't fly right now." But if it came down to it where your presence was mission crucial, you would have a tendency of course to overcome certain personal discomforts or inconveniences. Whether you would take it to the extent of sacrificing yourself, the aircraft and another crewmember, or other crewmembers for example. Not necessarily even in a two-seater helicopter. It would cross my mind twice. Whether I would make the decision to -- I mean gung ho is great, but when it comes down to lives and your own life, if you don't feel that you can handle the aircraft in an appropriate manner, a successful manner, then going out on a mission -- the odds are of not being as successful -- you'd take that into consideration and possibly not go. Depending really on how you felt, I think that there's a line that you would draw. Certain inconveniences, yes. But as any pilot, it's a position of a lot of responsibility not just for yourself.

G10 There's a lot of factors that might affect that line. The morale of the unit. How you feel about your fellow pilots. If they're the greatest guys in the world and you'd do anything for them, that line would be a little bit farther beyond discomfort level if you really care about the guys next to you.

C1 What do you think the role of leadership is in that?

G10 It's crucial. That's what's going to make that deciding factor where that line is farther down the pain, illness, discomfort area. Or whether it's, "Hey by the book C1. I don't feel good so I'd better not go."

P9 There's plenty of pilots around now that can talk about that in Vietnam when they had to make a decision whether to go into Haldasi and pick those other guys up and quite possibly taking the chance of losing the aircraft and the other crewmembers on the aircraft. Or going down and sacrificing the six or seven people in the aircraft to pick up two, because you knew them or you met them or you ate dinner with them in the chow hall. To me, that would all have an effect on the decisions.

NR I would think in a nuclear environment, leadership would be a major factor in how people behave after exposure. Also most pilots are aggressive and will go ahead and press on with the mission even though they felt bad. I think it will tend to result in a lot of accidents also. I think with the aggressive nature of a good pilot and leadership, that would tend to make people perform above 100 percent if necessary.

P9 I would think also that if the United States were in a situation where we were being forced to use pilots in this state of being, it would be one of those last type ditch efforts. Your morale and esprit de corps and the patriotism of the United States would just flare. They'd do everything that they could do to stop and crush the enemy.

OCM I think one of the major problems that you are going to have is the ability to determine -- and I think NR could probably vouch for that -- the ability to determine the real ability at that specific time. Of course you're going to have a tendency to underplay or underestimate the risk and the danger involved in performing that mission.

C1 Well that's going to be one of the big outcomes of this study. We are getting subjective opinion, and now we're going to look at some of the data from the PAB as well as performance in the-cockpit. And although the accuracy may have not faded, we were timing the tasks, so we'll really see what kind of decrement we get.

G10 That's brought out right here in these PDQ's. It said when we first sat down, we had no idea, if you read it, "If you're nauseated, you've vomited once, you will do so again, you're bleeding. How will this affect you? We'll give you ten more seconds to acquire a target."

P9 I've seen John Wayne movies too. He takes some spit, and he puts it on the wound and then he keeps going.

G10 But here we went right back and we changed it. A little more practical experience.

C2 I think the area where we talk about judgment and it's been mentioned, but the question comes down to the question of whether you can take it up. If you think you can and go for it, it becomes a case of easy to be hard, hard to be smart sometimes. It's great to have a gung ho attitude. I'm all for a gung ho attitude, but if you're going to take the airplane up and park it, you've got this aircraft that conceivably somebody else could have flown. That's the tradeoff. And at the same time, the idea of, "[expletive deleted], I know what kind of pilot I am. "I'm [expletives deleted] good and there isn't anybody else." I think that any true warrior, whatever level he's at, has that esprit and wants to go forward. And particularly in the crunch, because you feel you can make a difference. Then comes the question of judgment. As NR said, how many accidents? The accident rate would obviously go up. How do we determine the cutoff point? Is there a point where we can say "No"? Are there certain things that we can say, "O.K., these symptoms, you don't fly. You get back and turn the aircraft over so that somebody that has symptoms that are less can go out. So that you still have a plane that you'll be able to operate." One other thing I'd like to mention about this crew that we ran through, and I mean all three. The one thing that I noticed out of all of this was that I think that everybody stayed more chipper, more upbeat when they were in the cockpit, than anybody else. I didn't have my head bitten off today and I did ask for extra missions and what have you. And people stayed motivated the whole time. I don't know, there may be some hypotheses on that. I don't know if it was because they had the weekend before or whatever. I don't know, OCM, how did you feel about it?

OCM Yeah, I agree.

C1 Let me ask you one more question about that. That has to do with the interaction of crew members and the fact that C2 was in there more as a rock. You know that this guy has had his sleep the night before and he's very experienced in the simulator. What do you think if you had to work together as a team? Do you think the performance of the crew -- being you two together -- would it have been worse than the sum of both of you together? In other words, looked at your performance-with OCM, and your performance without OCM.

G10 Obviously yes, because OCM has how many thousand of hours in the Cobra?

P9 You're always going to put your most experienced people with your least experienced people. So that you have a coordinated crew that has experience in the aircraft. You never put two very young, inexperienced pilots that are, yes capable of performing the mission, but not to the degree if you'd had one experienced person. You could have one super Cobra putting two highly experienced individuals. Or you could have two super Cobras putting one in each.

G10 It's just a crew mixture problem. P9 and I are the two junior corps pilots in the battalion, or very close. You stack us up together it would not be a smart move on any commander's part.

C2 What about, and I think the thing that C1 was driving at here was what about performance? Did the fact that you had a "Well person," in there -- if OCM was sick, as opposed to a variety of ways. If OCM had the same symptoms and was degraded, do you feel that you would find a doubling of the effects that happened in the helicopter? Or do you think that as a result you would both be sick, but probably you'd end up at about the same level because it just wouldn't add up to just two and two coming to four? - It would maybe come out as a two and one.

G10 I don't think it would be a two and two situation. It's all individual. Like you said, I had all of the symptoms, yet we'd get in the cockpit and do our job. It wasn't comfortable. It wasn't pleasant. It wasn't fun for a while. Then it went away until -- so we could do the job. I'm sure the same thing that OCM went through: thirty-six hours of no sleep, no food and everything. You would have done the same thing. You would have gone in there and you would have been a little more miserable. You wouldn't be able to concentrate. So, I don't think it would have been a summation of the parts.

NR I think it could even be where two and two add up to five. There's a chance, depending on how the mission goes. Say OCM is out there and we're shooting rockets, and I know OCM is sick, and I shoot ten rockets and none of them hit. Then I say, "[expletives deleted] OCM isn't putting the pipper on the target." I lose confidence in OCM. And here I am, just about hitting trees. OCM says, "That [expletives deleted] is going to kill me." That could be an effect that could add up to . . . I think it could go either way.

P9 I would agree also with what NR said, but that could happen with any crew. That could happen with someone who has very little hours. Knowing that he was on the other side, I think that if I were a little more shaky on holding my 150 foot hover, while he was firing TOWS, then he may have been able to get a hit that I wouldn't be able to get. If he were in the pilot's seat and I were in the gunner's seat, he may have been able to hold it just a little bit steadier so that an inexperienced TOW gunner would be able to find it a little bit easier to get a hit. To me it's always a better confidence booster to have somebody with a wealth of experience in the other seat. If I could have my choice, I would always rather have somebody in the cockpit that could fly better than I could. I don't care if I'm an incredible pilot. If I'm going to have somebody that's going to fly better than me, then that's even better. I'm that much better off.

C1 Well I think we can close now. I want to ask one question, and that's to NR. We had the experience of having NR with us, and it's been really enlightening for me to see NR perform here. He learned how to fly a helicopter after having never flown one before. He did the physical exercises along with these studs, stayed up all night and [expletive deleted] if he didn't beat some of these stud's scores in physical exercise. Were you surprised NR?

NR No!

P9 NR is a PT madman.

C1 He really did a number.

P9 He comes in real quiet and then he comes out and does . . . .

NR I wasn't really sure what I could do with the helicopter simulator. Fortunately I grew enough to be able to compare results from one night to the other.

C1 Wow. I'm proud of you. I really am. You did a good job. O.K., I guess that's about it. Thanks very much.

Crew #6 Interview

29 JUNE 1988

C1 This is June the 29th 1988. It's 5:24 PM. One more time. We're with Pilot number Eleven (P11) and Gunner number Twelve (G12). We are in the debrief mode. The purpose of this thing is just to get your subjective opinions. We collect all kinds of data, but some of the key things are your personal reactions. We food deprived you. We spun you in the chair. We kept you up at night. Then we put you in the simulator one last time. Can you give me a feel P11, for what you felt when you went in the chair? How long the symptoms that you had were maintained in the cockpit? And whether or not you had thought that there were any effects on the performance as a result of that?

P11 The chair itself wasn't bothering me that much until I started moving my head around . . . I think it was about the second or third time that I said finally we were about to lose it here. I began to feel nauseous. I was feeling very clammy. I felt that way all the way up into the cockpit and five minutes into the flight. I did not feel any clamminess anymore, although I still felt nauseous. I still felt nauseous about fifteen minutes after I got down. I had just a slight pound of a headache. That's about it.

C1 Were you conscious of the nausea at that point?

P11 Yes, I was.

C1 How about you G12? How did you react to all of this?

G12 About the same way P11 did. Once I got in the chair, it was no big deal until I started moving my head around about the third time. Then I got sweaty and clammy. I had to swallow pretty hard. Then we stopped, got out, climbed into the cockpit. I lost the dizziness on the way up the ladder. The nausea -- I had a slight headache -- stayed with me about ten, fifteen, twenty minutes until I got out of the cockpit.

C1 What bothered you the most: the nausea, the headache, the dizziness? Well, you lost the dizziness.

G12 The nausea. Because in the gunner's seat, the seat shaker is pretty prevalent and it kept adding to what was already there.

C1 We gave you several opportunities to estimate how long it took you to do the tasks. Once before you even climbed into the simulator and then after you climbed out of it, and then again after we went through the whole protocol. Do you have any summaries of your reactions as a result of having gone through the simulator? Did you change many of your estimates or did they stay about the same?

G12 They stayed about the same to me. The things we went through in there, compared to what you've got written on the paper are a whole lot less. My estimates are probably about right.

C1 P11?

P11 I added a couple of more seconds in there, for the dizziness, the nausea -- it worked out to where it was about the same.

C1 I haven't looked at your breakdown of times. Did you think that some of the subtasks were more susceptible to feeling bad than others?

G12 Yes, such as acquiring the target. I'm sure that if I was a pilot, in the pilot's position, I'd have a problem unmasking and positioning the aircraft to fire and stuff like that.

C1 How about you P11?

P11 I did have a little bit of a problem with aircraft control, but I would think that the gunner would have more of a problem because he's looking into the telescopic sight. Where the pilot would be able to be looking around and move around, he has his head stuck in a little hole there and it's worse for him.

G12 The vision does get a little blurrier. If you had some sweat in there, it would be worse. Just the fact that having your head down inside there with the pilot maneuvering the aircraft it makes it that much worse.

OCM Normally that would be more pronounced if the aircraft is moving. Normally what happens is if the gunner's tracking the target like 90 degrees from the flight path, because he's looking 90 degrees and he thinks he's moving straight ahead, his body is moving straight ahead but he's looking 90 degrees to the right. When you initially first start using the TSU you really get nauseated because of that. If the aircraft is flying and you're maneuvering around, and you're pulling not really a lot of G's or anything else, but you're maneuvering the aircraft around, you really get sick when you first start using the TSU. So, in this position here, because you're not maneuvering a lot, it's not that pronounced. But if you're maneuvering the aircraft quite a bit, going from point A to Point B and the gunner's in the TSU looking for targets and things, it would be more pronounced for the gunner.

C1 Among all of the stressors we used: the sleep deprivation and we kept food away from you to keep your stomach empty -- but I'm sure that not having food didn't help things much -- and the nausea. Do you have a feeling for rank order of the effects of these things: the sleep deprivation, the physical exercise? Which one hit you the hardest?

G12 The spin in the chair and the lack of sleep.

C1 How about you?

P11 I agree, the same with him. The same thing. The lack of food really didn't bother me at all.

C1 If we had not done any physical exercises, do you think that would have changed your performance?

P11 I don't know, it's hard to say.

C1 Did your performance change at all? Do you think that you did worse today than you did at the second simulator run yesterday or the one before?

P11 Well the last simulator run was definitely the worst I think.

C1 So even though your accuracy might have been -- I don't know, was your accuracy the same? How did you do as far as --

G12 I'd say it was about eighty percent on the fourth period.

C1 Were you noticing it took you longer to --

P11 Oh yeah .

FS1 Did it give you any general insight on how you would really be performing in a similar battle environment? If you had these kinds of symptoms would you go ahead with the mission or bring back the aircraft?

P11 Well we definitely would not stay in the area.

FS1 You think you'd be risking the aircraft?

P11 Yeah.

FS1 Same with you?

G12 Yeah. We weren't in any sort of MOPP configuration either. That's going to compound the factor even worse.

C1 Do you do MOPP practice at all? Do you mock in the actual aircraft?

G12 Yes.

C1 How frequently do you do that?

G12 About twice a year.

C1 Is it MOPP IV, the whole bit?

G12 Yes.

C1 How do you fire a TOW in MOPP IV?

G12 Very carefully.

FS1 With difficulty.

C1 But you can't see through. Can you put your head through? Do you have to unmask to do it?

G12 No. You can put your mask down, but at gunnery you won't fire with your mask on .

C1 So you take your mask off to stick your head in there?

G12 No. Your mask is flat around so it'll fit down in there.

C1 Oh, I see. Any other comments? C2? OCM, any new insights?

FS1 We periodically ask folks whether you got any insights because you're the ones flying the aircraft? Is there any insight on that experience?

C1 Or in other words, did you do as well as you thought you might? Do you have any feeling for what your expectancies were and if they were better?

P11 I thought I would have a little less aircraft control than what I had.

G12 I thought with the lack of sleep and being tired that I'd be a lot slower in the airplane than I was. I don't think one day is going to vary something that much.

C1 Yeah, that brings up the whole question of motivation too. If you were in an actual war, the adrenaline might have been pumping more. You might have even done better than you think you did. What this study did was focus largely on the physiological responses to things that might mimic what radiation symptoms would be. Then there's the whole other side of the psychological issue. Some scenarios that say, "Well, if I were in this scenario, if I were - vomiting or feeling this way, I would probably think that I was dying and I would kill as many bad guys as I could before I got back." And others would say that if you were feeling that way, you'd want to get back to your family and get back to a physician and maybe you might survive. Any insights on that kind of a scenario? You'd already mentioned that you'd probably leave the area. Any projections on what you might do in a real nuclear environment if you were vomiting and you thought that you might be dying? Any wild guesses?

G12 I'm not a medical doctor, but I don't think they'd just pop up like that. I think you'd know before you got to that point that you were having radiation sickness.

C1 We certainly appreciate your participation. Dinner's almost ready.

C2 One other thing. I'd said yesterday that the crews yesterday had been very upbeat and on top of things throughout. I think that this crew, both P11 and G12, also maintained a very upbeat posture throughout the whole thing. Where that tracks to, as I said yesterday, an internal motivation -- It's something that you have to concentrate on even when you really feel bad, to think the positive and come across positively. Both P11 and G12 did come across that way, which I think is a strong measure of their internal motivation.

C1 Thank you very much again. That's it for today.

Crew #7 Interview
30 JUNE 1988

C1 O.K. it's June the 30th and it's 5:54 PM. We're here with Pilot number Thirteen (P13) and Gunner number Fourteen (G14). The flight surgeon (FS1) and the other crew member (OCM) are here with us once more again. Pretty much the routine we use here guys is to recap. We've done a lot of data collection. Your times to deliver weapons in various scenarios and your accuracy we've been taking a look at. God knows how many PABS we've put you through. The one thing that we really haven't systematically obtained in this is -- that is just as important if not more important in many ways -- your subjective comments with regard to just these two days. Our particular focus is going to be on the actual effects that the stressors had on you. In particular. I think what we'd like to talk to you about first are the effects that the chair had on you. We have in the room FS2 from the hospital. She's not in our field of view, but of course if you wish to take a seat back there that'd be fine. If you have any questions, feel free to ask. NR is with us as well from the Navy. Let's just jump right into that. P13, maybe you can tell us what your experience was in the chair, what your expectancies were, and then whether or not those expectancies were met and how you felt. And in particular, how you felt in the simulator after the spin. Particular interest is in dizziness and did that hang around while you were in there and what levels of nausea you achieved and that kind of thing.

P13 When I first got into the chair, I really didn't feel too much until I started going through the head movements, forward. and backward and from side to side. Once I started doing that, each time I did it, it started getting a little worse. It just built up every time and I did it about five times. I felt myself getting real nauseated so I told the doctor to stop. That's about what I expected it to be. I didn't realize that just a small . . . would give me that much of a feeling of nausea. Once I got off of the simulator, I maintained that feeling of nausea for about ten more minutes. Then it gradually dissipated to just an upset stomach. I was sweating during this time. Filled with sweat. Just spinning in the chair didn't affect me that much. It probably affected me a lot when I started doing the head movements.

C1 How about feelings of dizziness or the room moving after you stopped? Did that hang in there a lot?

P13 It hung in until I got to the top of the steps of the simulator. The feeling of dizziness kind of went away, but all of the other symptoms remained.

C1 How about you, G14?

G14 The chair experience was about the same. The dizziness went away pretty much by the time we reached the stairs. In the cockpit it was a little bit different cause I was in a different -- being in the front seat, I kept my head down in the TSU most of the time. The only time I would feel any nausea or anything was when I put my head above the TSU.

C1 The stressors that we've been giving you are or a number of them: we kept you up all night, we gave you physical exercise, spun you in the chair. We did do some food deprivation. Again that was largely for reasons of if you did vomit, to keep those problems down. If you had to rank order them, or give us a feel for which of those stressors seemed to hit you the worse, what would you say to that P13?

P13 For me personally, and I'm just speaking for myself, it would be the sleep deprivation.- That just affects me more than having food deprived. The food affects me a good bit, but the sleep affects me more.

C1 Did you notice that the sleep deprivation might have affected you even more earlier in the morning? Did you notice that after you'd done your physical exercise or when the morning hours hit, it was harder to pick up again?

P13 I noticed that the worst part of the sleep deprivation was when I was normally sleeping, from 12:00 midnight to 6:00 in the morning. After I did my physical exercise, it pretty much went away. I still had that feeling of exhaustion, weakness, and tiredness. But the drowsiness/sleepiness kind of subsided. Then I guess in the morning hours I had more of a feeling of hunger than anything else. That started to take over and become more important than sleep.

C1 If we hadn't have given you the PE in the morning, would it have affected your performance in the simulator do you think?

P13 I'm sure that it would have affected it some. I think it kind of woke me up some and got the blood flowing.

C1 So you think it helped?

P13 I think it helped some. It also made me more tired. It took away the sleepiness, but it made me more physically tired. There is a difference there, between your body being tired and sleepy.

C1 How about you G14, about the rank order of the stressors?

G14 I think the chair was probably the worst. Then the sleep.

C1 How do you feel? It's been about an hour since you got out of the simulator. It's been about an hour and a half since we spun you. How do you feel right now?

G14 I feel O.K. That has more affect than this sleep thing.

C1 No nausea? Any discomfort at all?

G14 No.

C1 How about you?

P13 No.

C1 OCM, any observations from the guy in the other seat?

OCM Nothing unusual with this crew that we haven't already discussed.

C1 For FS2's benefit, some of those things you might want to reiterate. The fact that perhaps the wind conditions that we had set up in this thing created some hard pedal activity.

OCM Yeah, we've got the aircraft at about, just about a max gross-weight, less 60 pounds. The winds are two-hundred degrees and ten knots. With that heavy gross weight in most firing positions we had out there, you could usually run on the left pedal. Depending on each, target engagement points had a different heading to the target. There was one target and four target engagement points. The wind had a little bit different effect depending which target engagement points you're at because of the wind direction. The other factor was the altitude. One target engagement point, you've got to unmask to 95 degrees. The others - one's like 35. They vary in the amount of power application you put into the aircraft. But, most cases, you're just about maxed out for that left pedal, especially if the wind had a pretty good velocity. Those were obviously a lot of factors involved in trying to get the aircraft on target. It really challenges the individuals out there. The simulator is a little bit tougher to fly than the aircraft itself.

FS2 How long are the flights?

OCM It varies. Normally it's about forty-five minutes. When the pilot is flying the aircraft it's about forty-five, when the gunner's functioning -- I'm flying because I've done it so many times -- it's usually about thirty-minutes. But the actual course that the pilot flies is at least forty-five minutes.

C1 We structured it so that the tougher tasks would be at the beginning. So, when the pilot was in the seat, we would have him pop off rockets and when the gunner was in there we'd have him start with TOWS. Each would have a series of ten rockets and ten TOWS and we'd want to make the most difficult and that which is most sensitive to the nausea occur first so that we could pick up sensitivities there.

OCM They were firing in the indirect mode. It's a very difficult mode of rocket firing. When you're maxed out and you're running on the left pedal, it's sometimes difficult to keep your . . .

C1 FS1 any questions?

FS1 One of the questions I would ask you that I haven't asked the other pilots. Are either of you having trouble focusing your vision . . .

G14 No.

P13 I haven't had any problem. The only problem I had was early in the morning. I was feeling kind of fuzzy.

C1 I think that pretty much covers it. The only other issue has to do with motivation. This is a provocative question. Certainly something that we're interested in is the psychological effects associated with a potential nuclear conflict. There are a number of hypotheses as to what might happen in such a situation in which a crew might find themselves nauseous, or even as far as vomiting at that point in time. The association of that with the fact that if nuclear weapons were around, one might get the impression that they are dying. Some hypotheses are that such a person, in-that type of situation would have a motivation to go out and kill as many bad guys as he could. Another scenario would be that one would be motivated to get back to their unit to seek medical attention as quickly as possible. After having experienced this, do you have any insight or any comment with regard to what you might do in this situation? Any feelings of how your expectancies were met? Did you feel as though your performance was more degraded than you thought it might be or less degraded? Any of those kinds of comments stir any thoughts?

G14 In the front seat it seems to me that your performance is much less degraded than expected. All it is up there is a matter of just focusing. You really don't have to control. As far as motivation to do whatever you had to do, I think that'd be more dependent on where you were at that time. You can't really sit here and say, "I'm going to kill the bad guys." It's going to depend on what's happening.

P13 I pretty much agree with him. Of course there's no way for me to know exactly how I'm going to feel in that nuclear environment if I've been radiated in large dose. As far as the simulator today, I think that my performance I expected to be a little bit lower than where it was. I think on a battlefield it's going to be much lower than it was today- in the simulator. I think the effects, the radiation on us as pilots, is going to be worse than what we've been experiencing here over the last few days.

C1 Do you think that if you'd flown together in the cockpit, you would have -- what do you think the OCM factor was?

P13 Well of course he's been around a while. He's had a lot of experience in the simulator and the aircraft. So I think that played a big factor. If they'd a put G14 and I in the same aircraft at the same time, you probably would have had a little bit different results. I don't know if they'd be significant or not, but I think you could tell the difference.

C1 FS2, do you have any questions?

FS2 Why did you volunteer for this?

OCM We volunteered.

G14 Well nobody really explained -- they said, "Do you want to do this?" You can always learn something any time you get in a simulator. In my opinion, it just makes you that much better of a pilot.

FS2 Basically, the simulator?

G14 Yeah.

NR If you hadn't have been here today, what would you have been doing?

G14 Working on helicopters.

P13 I agree with him about the experience, not necessarily to fly in the simulator, but to see what it would be like going twenty-four hours without sleep, without food all day.

OCM Do you think you could relate to a lack of sleep a lot more or a lot closer now, than you could have?

G14 I think that . . . could be extended more. If you're in the situation where you had to be extended -- as long as you have something to do, you stay awake. Like last night if we ran out of things to do, for instance the target machine went blank, you started dragging. As long as you're moving around and doing stuff, it keeps you up. I think the situation was there that you could extend your . . . but also it makes you realize -- the situation we're in now where you want to be concerned about safety all the time . . .

OCM Also if you're in a very controlled environment and the maneuvering of the aircraft is very limited -- if we were to put you in a situation and spun you on a chair, took you in with night vision and goggles, had you maneuver from one point to another, and then fired, I think that probably would have been a different story than right now. You have to be very cautious when you look at . . and say now that I can stay up forty-eight hours and go out there and fly -- You've got a lot tougher scenario than what we were using out there today.

C1 The other person that just joined us is C2. He's been in the simulator with the tape recorder in hand, observing all of the crews since day one. C2 did you have any observations with regard to today's crew?

C2 I think that today's crew maintained a very, again one of the positive, upbeat outlooks on the thing. This thing has kind of shown that positive attitude, possibly more than last week. Exactly why again -- I don't know whether it's people got more rest prior to coming in here, although I don't think in one case that's the way it was. The thing that OCM hit on as far as the longer period of time and also the flight. Do you feel, not even necessarily putting night vision goggles on, but let's say you had been given a course to fly and then gone through the two evolutions . Then came back and were spun, I'm not just talking cross country, I'm talking N.O.E. daylight, what do you think that would have done to you? What do you think the spin would have done to you? What do you think the spin would have done if you had to track a target ninety degrees off?

P13 As far as navigation is concerned, it would have been much harder navigating a lead -- say in the simulator plotting this point to this point -- it would have been much harder to do that because you probably . . . The gunner would go up there right after he got out of the chair; you feel a little bit nauseated and you have an upset stomach. You're looking down at the map, looking outside of the cockpit along with the thinking process of actually figuring out where he is and where he was going. I think it would make it a lot harder.

C2 Do you think you'd have to back off on your speed? Would you slow down or what do you think the effect would be? How would you compensate for that? Do you think it would be a time function? Do you think you would find yourself gaining altitude to keep yourself out of trouble? How do you feel you would compensate?

P13 I feel it would be a combination of both. The time factor would be involved. I think you'd need to slow down a little bit and actually try and think about where you are, if you really are where you think you are? And also you might tend to climb up a little bit in altitude, because usually the higher you get, you can get a better idea of where you really are.

C1 Any other comments or questions? Well I'd certainly like to thank you gentlemen for participating in this. It did take some sacrifice on your part and we certainly appreciate the contribution very much. Dinner should be here any minute.

Crew #8 Interview
1 JULY 1988

C1 Hello! We're with Pilot number Fifteen (P15) and Gunner number Sixteen (G16) today. This is July the first. It's 5:43 in the evening. We're getting kind of punchy.

FS1 Hi Mom.

C1 It's been another good week. The purpose of this is to debrief the crew today. We've collected a lot of data on the PAB. These guys are sick of the PAB. We've collected a lot of data in the simulator and they're sick ot the simulator by now.

FS1 Sick of the chair.

C1 Sick of the chair. The only thing we haven't gotten from them is what they really think of us. More seriously, their subjective impressions of the sickness in the simulator are very important to us. They mean a lot more than just the numbers. What I'd like to do is ask each pilot how they reacted in the simulator. P15 is our pilot and G16 is our gunner. Let's start with P15. Can you tell us what your subjective experiences were in the chair, compared to what you expected? How you felt on your way up into the simulator and actually how you felt during the actual mission?

P15 I thought I'd last in the chair a little longer than I did. It only took me a little over three minutes to be sick enough that I needed to get out of the chair and get up into the aircraft. When I got out of the chair, the first three steps I couldn't figure out why I was even going to the aircraft, because I couldn't do a thing. By the time I got half way up the steps, the dizziness effect had already worn off. If I could get control of either my stomach or my head, I'd be half way there. I was sweating a lot. When I got in the aircraft I could make the aircraft do what I wanted it to do, but not quite as well as what I had the three previous times I had flown it. My pilot technique and my control technique were off. I was thinking about my head and my stomach and what I had just gone through downstairs and everything that was going on and I was trying to execute the mission. We were able to get TOWS down so it wasn't a total loss. I was able to perform in the cockpit accurately. I think the only thing that I really slowed up on, if anything, was putting the pipper on the target. Masking and unmasking were about the same. Just getting the pipper on the target, I just couldn't get it together.

C1 A common observation -- when we look at human performance, there's a speed/accuracy trade off. You can do things more quickly and perhaps not quite as accurately, or you can spend more time and therefore your accuracy increases. How were you on that? Do you think your accuracy suffered and your speed increased or do you think you did both slow?

P15 Up to that point I'd been able to get at least half the pipper inside the box. I was right on the button. At least I thought I was. I wasn't able to do that here. I tried and tried and tried until I got to a point where I said, "I've been exposed too long, I'm going to have to get back masked before I get blown away." When I first became unmasked and launched the first two I was going for complete accuracy. Then it got to a point, just a mental decision on my part, of hey, times up. I would go.

C1 G16, what do you have to say?

G16 What we're looking at here is we've got a crew that's going to be basically working in a nuclear environment where they've been contaminated by nuclear radiation. When you first come out of the chair, you feel like crap. But you're able to walk it off a little bit and stop feeling bad. I think in a nuclear environment that's not going to happen. I think you're going to have to do your work load when you're feeling like you did when you first came out of the chair. That's going to either stop the crew from completing their work load -- it's definitely going to increase your time.

C1 So you felt pretty bad in the chair and then as P15 found, your symptoms quickly washed out? By the time you sat in there you were a lot better off?

G16 As time went by, you start to function a little better, but that's probably not going to be the case in a natural environment.

C1 Of the stressors that we did give you, we kept you up all night; we made you do a lot of physical exercise; we did keep you from eating some food; and then we spun you in the chair. Do you have a feeling for which of those stressors most affected your performance?

G16 Definitely the chair for me. You can function without sleep to a certain degree and without eating.

P15 I've got to agree with that. The mission I flew right before I got spun, I thought was as good as the other two. As tired as I was, and I couldn't hardly stay awake back on the computer. Once I got into the cockpit, and I started going, I got all pumped up and I could fly. I thought I flew a real good mission. But coming out of the chair was a whole new ball game. That was by far the biggest stressor.

NR You told us how you felt when you came out of the chair. How did you feel when you were in the simulator? Did you have nausea, headache? What kind of symptoms did you have?

P15 The only thing that really left the whole time I was up in the simulator for me was the dizziness when I was going up the stairs. My stomach was killing me and my head hurt. The first symptom that I did notice was my stomach coming up to about here. And then once the dizziness went away, I figured out that I had a headache. They stayed with me until I sat in there and worked on the computer and got out.

C1 Vision was fine? Did you have any blurred vision?

P15 No.

G16 I had a little bit of light-headedness coming out of the chair and a bit of the time during the flight.

C1 How about your vision, pretty sharp?

G16 Yeah, being the gunner and having to track the TOW missile on the target.

C1 You did better than you thought?

G16 Yeah.

C1 OCM, what are your thoughts?

OCM Well I thought I noticed P15's performance -- the difference of the before and after -- with P15's performance more than I did with any of the other pilots. He was doing really well initially and everything else. After the spin, he had a tendency to overcontrol like he was talking about. He was kind of just hurrying, and when you do that you start overcontroling the aircraft. He was fighting it. I could just see, being in the TSU and you're trying to keep the reticle on target, lay it in there. It makes it really hard to keep it on target. It complicates things. I noticed his performance degradation probably more than anyone else.

C1 Was it very consistent throughout the run? One of the things that we had to deal with was once we make you sick and you get in the cockpit and we measure your performance, are you constantly getting better as far as your feelings go, or are you getting worse, or are you about the same? That's one of the things that we're going to have to ravel with in the analysis of this data.

OCM I think one of the things you're going to need to look at is the first five and then the last five. I think if you look at his, you'll find probably that the first five were worse and he gets better as he goes along.

C1 So like the first five minutes?

OCM Well I was thinking more along the lines of the first five iterations, not minutes, out of ten of each of the most critical, in his case of firing rockets. So it could be about ten minutes, but after that he improves.

C1 The reason we did ten and ten is because last summer we had done both and we wanted to put the more critical one up front -- we figured because for the pilot he does rockets and for the gunner it'd be the TOWS.

P15 I didn't really see a big degradation in my TOW engagements. But the pilot workload for a TOW engagement, for me it was so much less than it was on rocket engagements. It was a matter of pulling up to a hover.

C1 Still OCM experienced some personal workload?

OCM No, that was when he was firing rockets.

C1 Oh I see.

OCM In the TOW mode later in the second sequence, really that wouldn't mind.

FS1 Just to comment on radiation sickness. You really, as far as we know, would not experience the dizziness -- that's an effect of the chair itself -- But the nausea, the headaches, the feeling lousy, that you would feel. Do you think it would compromise -- remember you're each using OCM-- do you think that the two of you together in the same aircraft could carry a mission feeling as you did when you began? What do you think would be the result of the mission? Do you think you'd be able to handle it without too much trouble?

P15 I wouldn't wanted to have been flying. Me as the pilot, being the one that was actually flying the aircraft, the way I was feeling, I wouldn't have wanted anything to do with an aircraft. There comes a time when you've got to be out there, and somebody says to you, "Yeah, I know, but I need you to go and do this." That's one thing. I'm sure they won't send me out to kill myself. I wouldn't want to fly though, in that.

NR Do you think if it were a very serious mission that you had to do and you tried harder, that you could have done better?

G16 I think any time that there's a job that you have to do, you're going to go out to do your best to try to get the mission complete.

C1 I think what NR is getting at and it's always very hard for those of us in the research business, is to get a handle on motivation. How does your performance today reflect how you would do in a real war time situation. There are a number of hypotheses with regard to that.

P15 Personally, I'm a very competitive type person. If I'm not competing with somebody else, I'm competing with myself. I'm not sure if I could have done any better than what I did. The first rocket engagement I did was twelve out of fourteen hits. That's probably what screwed me up so much was that I was trying to get fourteen out of fourteen, or thirteen out of fourteen, or at least twelve out of fourteen by getting it right on the target. But I probably could have accepted eight or ten or six or four in the area. But no sir, I was trying as hard as I could, as when I walked in the first day. I think that I was doing the best that I could.

C1 I think that's reflective. You take a look at these video game scores, you can see that the lieutenant has beaten many of those records and there's an obvious motivation on that part and it's just as well reflected in the cockpit.

OCM Did you compete in the . . . G16 won that thing. Do you think it would have been --

C1 Can you backtrack?

OCM What happened was we set up a scenario here to run a competition in the simulator. We were trying to find the best Cobra crew in the division. It was open to all of the Cobra crews. We set up a scenario -- Andy and SO are the one's who worked on that -- in the simulator which covered flight planning. The really biggest problem was getting shot down, because we had the threat radar system turned on so if it got up to altitude or flew in the wrong place, they would get shot down. A lot of factors on there that really governed how the flight went. How many crews did we have, SO?

SO We had seven crews.

OCM We had seven different crews and G16's crew was the only one that made it through the whole scenario without getting shot down. So what I was saying was, if you would had been asked to go through that scenario after you'd been through the chair, both of you -- let's say both of you put in the aircraft simulator and run through that task, how do you think you would have felt? Would it have been a little bit more realistic than say in a fixed scenario like we're doing here?

G16 It would have been a lot more challenging. If we had gone through that, feeling the way that we did today after coming out of the chair, it would have been tough to come through that mission complete the way that scenario was set up. It would have definitely been causing problems.

OCM . . . .hey had a lot of times. They had to cross lines at certain times. They had targets they had to engage, this many points for hits.

C2 How long was that mission?

OCM What was the flight time? Was it about an hour?

SO ..

C1 So not everyone made it all the way through?

OCM No. So that's about a forty minute flight.

FS1 Were there any surprises to you in this exercise? Did it give you any insight of how you would perform stressed -- course not that scenario, the stress would be even greater -- based on what you've learned here?

G16 Personally I thought I could perform a lot better feeling nauseated. Then after coming out of the chair, I realized that it's just a hard task to do -- to fly a helicopter, when you're feeling that bad and to try and engage a target. I didn't realize it was going to be that bad.

C1 The single thing that nausea affected most was your attention?

G16 Concentration. Worrying about yourself and focusing on what's going on.

C1 So focusing on yourself as opposed to the whole situation.

P15 I was surprised at how fast the symptoms came on. That was an eye opener to me -- exactly how severe. The whole two days I had sat there and checked there. I was reading about all of these symptoms as I was walking up. I sat there and I could feel the sweat all up and down my arms. I was breathing; my head hurt; my stomach hurt. This is just from spinning in the chair. This isn't anything like the real stuff -- how easy you could be affected by it all.

C1 Did you find yourself swallowing a lot? I'd seen that. I personally didn't think I had done that much.

G16 A lot of heavy breathing?

C2 A lot of heavy breathing on the mike.

G16 But you know what it comes down to? Any time an air crew experiences symptoms like that, their performance is going to go way down.

FS1 That's the whole purpose of trying to estimate the difference. Doing things like this are the only way we could ever get a handle on it.

G16 You can sit and go through one of those pamphlets and say, "Well this is how I felt" and add on a few more seconds on here. Until you get up there and you have the symptoms, that's where you add another six seconds or eight seconds.

C1 So when you had your PDQ, this questionnaire, you found yourself adding time?

G16 Oh yeah.

C1 But you didn't do that as much did you?

P15 On the target -- I didn't think I was taking any more longer time on that. One thing I didn't think about though, was looking back at the percentages. Looking at the symptoms now. I took a list of symptoms and said O.K. if I have those symptoms I would probably be seventy-five percent . That's probably something that I should go and look at again, now that I know what those symptoms feel like.

C1 Any other comments or observations?

SO Just between the two of you, do you think your exposure time to the unmasked position was more prolonged, i.e. exposure to what you were shooting at, or what . . .

G16 I couldn't really say because OCM was in the back. Now if it had been me and P15 in the cockpit together, and found out what was really going to happen, it would have been a lot more difficult.

SO Focusing in on you P15, do you feel like your exposure time was increased?

P15 It didn't seem to me like my exposure times were any longer.

C2 You were thinking of that -- if I recall your earlier comments -- and made a conscious decision that I've got to get rid of ordinance or sacrifice accuracy for --

C1 Sacrifice accuracy for maintaining your [expletive deleted].

P15 I do think, even with that, that my exposure time -- one I was too high most of the time, and I knew that, but there were so many other things going through my mind at the time. When I was up at one-hundred and eighty-five degrees, I knew I was a hundred feet too high. I was engaged in other things. Being in the scenario that I was, the flight simulator, I knew I didn't have to worry about SAMS coming at me. That wasn't high on my priority list at the time, being up that high. Another thing too, that simulator is peculiar, because in a real aircraft I don't think that would have been a problem for me, staying just above the three . . . Because in the simulator, I have a hard time distinguishing between going up and backing up.

C1 Anything else? Well we certainly want to thank you for your participation. I think every time we sit with a crew, we learn something new. There are some common themes, but there's always a sense of accent in one particular area. We really do appreciate your participation and your sacrifice. You would have had leave today if it hadn't been for us.

P15 One more point. The first time I flew, I was doing my first engagements, I was doing a lateral unmask. Right after I laterally unmasked, I did my engagement, turned broadside and hovered back in. After about two or three of those, I started thinking about what I was doing out here. I was getting more into the tactile situation rather than -- forget about the guys in the back and whatever their doing, I was trying to do a good tactical engagement on the target. Then I started laterally unmasking out this way, and then I started to come back in and then turn off. Today there were other things going on that I had to worry about. Things that I had a chance to think about the day before, but they weren't going through my head today.

C2 Do you think that there's an appreciation at say the battalion commander level. If we put a PDQ in front of all of the battalion commanders on base, do you think that they would have a concept of being able to fly under those conditions? That question is put there because often decisions are made by senior personnel based on their own experience. You're sitting there and you know what it feels like. You're being given a mission. You are going, "You don't understand sir." Is there a grasp? Do you feel at that level that there is a grasp of how much it may compromise the ability of the pilots within the battalion?

G16 I don't know, I think that there is, but we never deal with it or sit down and think about it.

C1 Any other comments? O.K., thank you very much.

Crew #9 Interview
6 JULY 1988

C1 It's now July the sixth. It's 6:27 PM, the year of 1988. We are pleased to be with Pilot number Seventeen (P17) and Gunner number Eighteen (G18). What we like to do at the end of all of this is get the perspective of each of the participants, as well as your other crew member (OCM), the flight surgeon (FS1), and we also have a DNA representative (DR) with us today. What we find is that although we can collect a lot of data on speed and accuracy, there's still one component missing out of all of this, and that is the subjective perspectives of the participants. The first question I'd like to ask you guys, is your description of your feelings when you got in the chair. What your expectancies were, were they met, how you were feeling actually in the cockpit after you were spun? One of the things that we have to deal with is how long these symptoms last. You're in there for a goodly period of time. We start the pilot off with rockets and the gunner off with TOWS because those are the most critical tasks for each of those. We'd like to get a feel, just subjectively, of how long those symptoms affected your performance. Did you notice any changes during that duration? So let's start with P17. Just give your impressions of from the chair on in.

P17 Going into the chair, I expected the nausea from what I had heard was going to happen. I didn't quite know how long it was going to take for the effect to hit me. Whether it was going to be when you started to rotate, or when you moved your head, after two minutes, three minutes, whatever. As I got in, I tried to keep myself calm to maybe hold off the nausea. I was taking deep breathes. The spinning wasn't too bad. I had a hard time focusing in on anything, which made me get a slight headache, but I really wasn't nauseous. At the point where we started making the head movements, just placing the head forward, back, to each side, there was a noticeable loss of balance and spatial perception. At that point, that's when it really hit you in the stomach. You feel your color drain out. You break out into a sweat, not so much the first time you did the head movements. The second, and then the third time is when it came almost increasingly worse, the last time we did head movements. That's the point where we stopped the rotating. I think if I would of went one more time, it would have been on the floor. That's the way I felt. Then I walked up to the simulator. I was sweating on the way up there. I had to swallow. I was holding myself. I was taking deep breathes. I pretty much had to do that to calm myself down -- calm my stomach down going into the simulator. That didn't wear off until probably about ten minutes into the flight. Ten to fifteen minutes before I had to kind of consciously calm myself down. I think that was apparent in the difficulty I had in chasing the reticle, trying to fire rockets. Your ability to calm down, settle down, and make your body do what your mind is telling you; it's just not there when you're under that kind of stress.

C1 So chasing the reticle or following the rockets, was that due to a visual focus or dizziness, or just the ability to attend?

P17 I think the ability to attend; the ability to settle yourself down. If you're breathing heavy, if you're sweating, you don't feel well and you're conscious about your physical state, it's going to be that much harder to settle down and make the aircraft do what you want it to do. Later on in the flight, I started to feel a little bit better. The nausea wore off. The second half of the flight was much more enjoyable than the first.

C1 Did that break occur at the beginning of the TOWS or were you feeling it all the way through the rockets?

P17 No, just at the last engagement of rockets I felt a little bit better. I was able to concentrate a little bit more on what I was doing. - Then on the TOWS, I felt fairly well given the circumstances. The actual effects didn't wear off until a good forty-five minutes to an hour after.

FS1 What about the dizziness itself? When did that leave you, when you got out of the chair?

P17 The dizziness, by the time I had walked from the chair, up the stairs to the back of the simulator, the dizziness was pretty much gone. At that point all that was left really was the cold sweat and the nausea. The dizziness was the first thing to go.

OCM Did you find yourself at the beginning -- real early at the first part of the rocket firing, getting frustrated? Kind of giving up and just firing a pair of rockets just to get --

P17 Yes. I felt like I was wasting entirely too much time chasing the reticle around. When I was coming around to the bore side of reference, I would try to punch off a couple if I could and get them down range. The longer you wait, the more frustrated you get yourself, and more worked up. That just aggravates the situation. Like I said, if you calm yourself down, normally you'd feel better.

C1 Two of the measures we've been looking at are speed and the accuracy of the task that you do. Other pilots have commented on the fact that there are other thi;ngs that have occurred. Those things have to do with altitude and the control or altitude. Did you find, for example when you unmasked, did you unmask at the same altitude or were you going higher up?

P17 No. I went up at one point to about two-hundred, two-hundred and fifty feet. I was up there and simply because of the increased workload of having to chase reticles and not paying attention to the other factors of the flight.

C1 What were you doing in the simulator practice, the one just before that? The one that occurred today, but before that? Were you doing that same kind of thing ?

P17 No, I was able to control my altitude and I had my altitude where I wanted it in the practice session.

OCM Max of about a hundred feet would you say?

P17 Yep. I didn't go above a hundred in practice.

C1 How do you feel now?

P17 I feel fairly good. I'm alright, especially after having not eaten. Up until about a half an hour ago, I was still burping. I had slight pressure in the head. The headache went away. That was one of the more persistent things; my head felt pretty lousy for about a good hour after the chair.

DR So you felt a pressure in your head?

P17 Yes, almost like a headache pressure or a sinus thing. It's something I noticed after the flight, not during. This is something that persisted after the flight.

DR You say the nausea started . .

P17 Right, that's the first place it hit me. As soon as you started those head movements, it went right to your stomach. I don't know whether the tension because of that -- I don't know why. The nausea goes away after about twenty minutes to a half an hour. But the headache stayed with me for about an hour.

C1 One of the things that we noticed is a lot of individual differences in the way people react in the chair. Now I can't recall, did you come to the actual point of gagging? Or, you didn't get to that point did you?

P17 No. I was just swallowing and breathing heavy.

C1 On the other hand, Daren got to a point where he did do considerable gagging. You gagged in the simulator, as well as while you were coming out. Why don't you describe to us your experience.

G18 I was fairly nauseous anyway. I thought that the spinning in the chair was going to put me over the brink, but it didn't until I put my head down and right then I knew it was all over.

C2 You were nauseous prior to getting to the chair?

FS1 He had nausea and had been feeling lousy since the exercises earlier this morning.

C1 We have experienced that in some people. Just the exertion of the physical exercise in the morning creates nausea. And that's happened with you. Did you vomit as a result of the physical exercise?

G18 No. Once I turned my head in the chair, that was all she wrote. I had to stop. It continued on right through the entire flight. I felt nauseous, sick, sick to my stomach .

C1 How did you think that affected your performance? Did you think you did as good as before, worse?

G18 I'm sure I did worse. The main thing was I was all tense and nervous, being sick like that, being in the simulator.

C1 You actually did heave in the simulator?

G18 Right.

C1 Did it occur at a point that was critical to getting your job done or was the pilot doing his thing? Can you talk about that?

G18 It was during rocket engagement. I had just lased a target for an initial pair of rockets. They were being fired and I was puking.

C1 Is that right?

OCM We lost a laser. We had to wait until he was done and then we came back on and then we continued.

C1 So the rocket didn't go out?

OCM We couldn't because it was dependent on him lasing the target and it's only good for fifteen seconds or so.

C2 The first set of rockets didn't go out, but the adjustment rounds did. Then there was a space in there and then it came back on. One of the things I'd like to comment on, is in spite of that -- I've been keeping track of the lasing engagement by the gunner during the rocket phase. It's important that the gunner lays an accurate distance to target so that the pilot can put rockets on target. The way I grade is that anything under ten meters from the actual target distance as shown in the computer, if it's lased within ten meters of that range, it's a good. In spite of the fact that G18 was ill and obviously ill -- and even though we were in different cockpits, we could hear that he was ill -- he had all his lases were good. That would say that he was in ten meters. But I can say that he was within two to three meters on every lase that he put down. How he did it, I don't know, but he was certainly paying attention to detail and overcoming his symptoms and executing what had to be done.

OCM So the only problem is going to be the time factor because we had to wait until he was done and then lase it again. He did lase it. His accuracy was super. I don't remember about the TOW engagements.

C2 I looked here. The first shot was a miss and his tenth of eleventh was a miss. Compared to his third run, which was the pre-spin run of today, he had a ten out of ten. Here he had a nine out of eleven after the spin.

C1 What if you had been in the pilot's seat? One of the things that we're looking at are the differences between the gunner and the pilot position. If you'd been in the pilot's seat, do you think you would have been able to keep up the accuracy as well? Do you have any insights with regard to what would have happened if you were in the pilot's seat?

G18 I doubt that I could have been as accurate. Being in the gunner's seat, once I was done with the target, I'd just sit back and rub my stomach, pound on the floor, beat my knees. I was trying to get rid of the hangover of being sick like that. You can't do that in the pilot's station if your going to be stuck controlling.

DR That was one of the things I was going to comment on. I was watching you very closely and you were doing everything you could -- the times when he wasn't actually on sight -- to get himself together so that he'd be ready for the next one. It was obvious to see you doing that. If you hit that sight, go for it. It was incredible . . . I didn't even really know whether you were going to make it.

G18 Yeah, I was wondering that myself.

C1 OCM, do you have some of the observations that you've made in the past, in that constant other position? Whether it be in the gunner or the pilot's position in the aircraft. Any new insights from today?

OCM Well I think we pretty much talked about G18's performance. I think on P17's that when you look at the TOW shots you'll see -- I forgot how many we fired there, but I missed like three or four I think out of about twelve, which was probably the highest miss rate I've had for the past two to three --

C2 You had five misses out of twelve.

OCM Five out of twelve, yeah. Again, sometimes it's difficult for me to tell. Usually what would happen would be we'd be at a critical point when it's just ready to impact. You'd be trying to fly the aircraft and try to maintain its position and when you do that again, you're overcontrolling. When you kick it out just a little bit when its ready to hit the target, and by the time you get ready to put an input, bam it misses the target and you;'ve lost it. It seems like most of them were at that critical point when it was getting ready to hit. In the vertical he was having problems maintaining the aircraft in the pitch attitude and also in the YAW.

C1 Did you also experience the same problems in the pre-spin mission, do you recall?

P17 No.

C1 In the pre-spin mission, that is a different location. We purposely did that to practice these guys. Did you notice those differences?

P17 Yeah. You're absolutely right. I was having a lot of problems like I said, maintaining proper altitude. I needed to keep a minimum of ninety meters to get him over the hill to our front and still be able to see the target. At the same time, I didn't want to -- if I was getting myself up to one hundred and fifty BAGL's, that's too high. You expose the aircraft to too much threat. I'm trying to jockey with that and no doubt about it, it affects the gunner's accuracy.

OCM If he's climbing like that and suddenly he realizes that he's in two-hundred feet, the next thing he's going to do is lower it . . . and when he does that it requires a pedal input to compensate for the reduction in the power. So then not only is the aircraft moving vertically, but the aircraft is yawing.

P17 The nose of the aircraft is going --

OCM I think the DR was able to observe from the same firing position when I was in the back seat doing the pilot performance and the gunner was in the front seat doing the gunner performance. He could probably comment as an observer for a different perspective.

DR It was obvious -- having done the two back to back -- it was obvious that it was a whole lot steadier and you didn't have the yawing problem. In all the runs that I've been at, I don't even know who all was there most times, it was noticeably different during that period of time. The effects were obvious. There was a degree of unsteadiness that I hadn't experienced before, just looking over the shoulder. That's when I appreciated what a critical job it was of the pilot, of keeping the thing just rock steady. You get used to the thing, once you're in position -- that the chopper is pretty steady. Then all of a sudden, you've got trouble controlling and you can almost feel it slipping away as you're trying to control it.

P17 It gets very frustrating because you know that you're not where you're supposed to be. You're basically compounding the problem trying to fix it, because you're at the point where you don't have your control touch. You're overcontrolling the aircraft.

FS1 What do you two feel would have happened if you'd been together in the aircraft?

C1 Instead of having OCM as the other crewmember.

FS1 Stabilizing either the gun position or the pilot position. The two of you.

P17 I think it's fair to say that it's a fair assumption to say that it would have been a mishap. There's no doubt about it. Your ability to control the aircraft, when you're feeling bad, unless it's an absolutely crucial mission, you've got no business being in the control.

C1 One of the things that we're very much interested in --and this particular study is focusing in on what the physical effects of having radiation sickness are on your ability to perform. I'd like to ask a provocative question just to get your reaction. This touches on the topic of motivation. If you were in a real war, would your performance have been any different? That's one question. The other question was if you were vomiting and you knew you were in a nuclear scenario, some people would say, well [expletive deleted] this guy would react in such a way that if you were vomiting and you'd think you might have gotten dosed and you would think that I am dying, you would try and kill as many bad guys as you could. Another hypothesis would be that a guy would be running back to try and get to the medics as quick as possible and see what he could do. Essentially two questions: one, do you think if you were in a more competitive environment that your performance would have changed or you would have been more up, your adrenaline would have been more flowing? secondly, given the actual nuclear type of scenario, do you have any reflections on what one might expect from a crew.

P17 I don't know, having not had actual combat experience. I don't know that adrenaline could overcome, if you had the serious type of symptoms such as those. If you're simply tired, simply hungry, something like that, those types of stressors I think could be overcome by adrenaline. If you're vomiting and you've got radiation sickness to that degree, I think if anything, the back of your mind is telling you, "Yeah I probably took a lethal dose of radiation." It's going to be an additional stressor and if anything add to the detrimental effects of flying the aircraft. It's hard to say. I don't think that you'd necessarily rise to the occasion or something like that if you truly had that type of sickness, because no matter how hard you try, it's not something that you can shut off.

C1 G18, how about you?

G18 I agree. If we had both been in the simulator at the same time, I would not have been able to just sit back after an engagement and try and collect myself again. In the real world situation they're going to have to be looking out for possible targets, things you could run into. I could sit back because I knew the aircraft was going to be a steady platform. I didn't have to concern myself with it. In an actual real world situation you're going to be overloaded.

OCM That's a big factor that no one's ever brought up before. Depending on who you're flying with, regardless of how good you are, if they're in the situation where you're concerned about their ability to fly the aircraft, then that's going to bring on a lot more tension and anxiety on your part and you can't sit down and relax and enjoy the flight because you know that this guy may be out to get you -unintentionally. So it's really a big factor, a concern that goes through people's mind. If you're not able to relax like that it's going to be one additional thing that you're adding to the workload.

FS1 One of the comments made by another crew was given the situation, if the two of you were in the aircraft, the other crew said I'm going to turn around. It wouldn't have mattered what the mission was, because if I pressed on, I would lose the aircraft. That's a vital resource. What would you do if you were out there?

P17 I think that that's an entirely reasonable thing to do. I'd agree. I think if you're that sick and your ability to perform the total mission at that point -- especially if both persons in the cockpit are in that situation, which they almost always would be in radiation type of problem. If you've got a crew that can fly that aircraft and complete that mission, then by all means, get back and get yourself taken care of. Get that aircraft in the hands of someone who could perform that mission. Given the state of initially, of how we felt, coming out of the chair, if that were the case in the aircraft, not only would I think that the mission wouldn't get accomplished, but we'd probably end up being fatalities from an aircraft crash.

C2 G18, let's for instance, put you in. Just out here in the field running a practice and you were the pilot. What would you have done given your symptoms right then? What would have been your reaction in a practice just flying right out here?

G18 If I had come down with those symptoms I would land immediately. I would have a troop send someone out to fly the aircraft back.

DR There's a lot of things I want to add just to comment based on some of the things you have said. Radiation sickness is a lot like your spin on the chair. Believe it or not, the kinds of symptoms that you see there are not necessarily associated with a lethal dosage at all. The kinds of symptoms that I saw, you get in particular, I would expect from somebody who had gotten about two hundred rads exposure. I would expect somebody of your age and your health to completely survive even if you didn't have medical care. If you did have medical care, your chances of surviving are near one hundred percent. It's important that if you ever had a situation like that, that you remember that just because you are really nauseated, even vomiting profusely, and that you feel bad, it doesn't necessarily mean that you've gotten a lethal dose. It would be important for you to save the physical asset of the chopper and yourself. I think your judgement is right. That's one of the reasons we're doing this work is to point out what these non-lethal doses of radiation can do, just in terms of wiping out combat effectiveness. This sort of thing even without medical treatment, even if it were from radiation, would dissipate in about twenty-four to forty-eight hours.

P17 NR and I discussed this yesterday just in the course of conversation. He brought out a chart and it showed, given certain doses of radiation, when these types of severe symptoms would occur. If you're knowledgeable about that, which until yesterday, I hadn't seen that information and didn't know. If you've been exposed to radiation, within an hour of knowing that fact you get sick. Odds are that you've got a lethal dose. If you get sick, a day later--

DR If you got those symptoms three hours ago, it probably means you didn't get a lethal dose. If you get them in less than three hours, it's shaky, but your right, if it's inside an hour, you probably did. See it's more the onset time than it is the severity of the symptoms.

P17 Now the problem is, now if you're the crew out there, I would venture to say nine times out of ten it's not going to be a flash-to-bang thing. You're going to be flying through residual radiation or what have you. You're not going to be quite aware of when that moment is. If all of a sudden you start coming down with symptoms like these, the question is going to run through your mind, "Are you a radiation casualty." You don't know these things. The anxiety level of that crew has just gone through the roof

DR Let me ask you this: If you guys had those symptoms and you were flying MOPP, what would you do? If you had your MOPP gear on? You've got a problem, you either throw up in the mask or you take the mask off.

C2 You've got a choice, you either drown or --

P17 If you're in full MOPP gear when you're flying and you come down with those symptoms, obviously the suit hasn't been doing you any good. At that point, you take the risk of acquiring any chemical agents in addition to what you've already got. Sure, I wouldn't fly around vomiting in my mask.

DR That's a question we sometimes get posed to us. Hypothetical types . . .

C1 Any other questions or comments? I'd certainly like to take this opportunity to thank you gentlemen. It's certainly not one of the easiest things to do. It takes a lot of guts to get sick and go through all of this. It means a lot to DNA and I think it means a lot to the way we are going to be disseminating information in the future -- making our best recommendations to the Army as to how operations should be handled. Dinner is here for G18 and we'll let you get to that. Once again thank you very much.

Crew #10 Interview
7 JULY 1988

C1 This is the last session. It's July the 7th at 5:51 PM. We have Pilot number Nineteen (P19) and Gunner Twenty (G20) with us tonight. As usual, what we do as part of the debriefing is to include comments from the pilots, because we think that given the fact that we've collected speed and accuracy and those kinds of measures, one thing that we don't get are the subjective feelings of the way the guys are feeling. Their observations are important. What I'd like to do -- start off asking the question about the chair and just your recollection of the effects it had on you and did it meet your expectancies? What your description of how you felt in the cockpit. from the moment you got in the chair, out of the chair, up to the gang plank, into the cockpit. One of the things we're concerned with is how long these effects last. Is your performance at the beginning of our measurement phase reflecting the same kinds of symptoms as at the end? How long do you think certain symptoms lasted -- feelings of nausea, and those kinds of things. Let me start with P19 and get your impressions first.

P19 Well first right out of the chair, I felt nauseous for about five minutes. Then of course the dizziness went away, but I had a headache after I got into the simulator and started flying. The nausea was with me continually until I got out and I was still working on the PAB test.

C1 Had you had a headache before you had gotten into the chair?

P19 No, I didn't.

C1 What were your feelings up to that point before you'd gotten into the chair, other than sleepiness? Any other feelings that you had?

P19 No. That was it, just kind of fatigued.

C1 How did you think you performed in the simulator, compared to how you'd done, the practice session just before you'd spun?

P19 Well I felt warmer. I was sweating a little bit. I didn't feel well.

C1 Were you getting as many hits? Were you as accurate in your--

P19 I could line it up, but I think it was taking me more time. I could line up the target, but it was taking me a little bit longer.

C1 How do you feel now?

P19 I feel much better. Still a little funny, but that could be because I'm so tired.

C1 How about the physical exercise?

P19 That really tired me out. It put the whammy to me.

C1 It was a significant contributor to your performance in the cockpit?

P19 Yes.

C1 Even before you had gotten into the chair? In other words, you've been in the simulator four times. Twice today and twice yesterday. The third time, that is the first time today, do you think that was affected by your physical exercise?

P19 I'm not sure if my performance was affected, but the level of fatigue was definitely. It's hard to estimate the exact times, but I'd say it affected me some amount.

C1 In the last trial when you'd gone through the spin and gotten in the cockpit, you'd say your symptoms were about the same throughout? Did you say that you'd had a headache?

P19 Headache, and felt nauseous.

C1 And that lasted about the same throughout?

P19 As a matter of fact, it started to get a little bit worse.

C1 Worse. Did the motion of the simulator aggravate it?

P19 I think that helped induce it.

C1 G20, how about you?

G20 Well as far as the spinning chair, it certainly lived up to my expectations. I was rather nauseous prior to getting into the chair from the physical exercise we had had earlier on. I had some light cramping and I was nauseous, and when I got in the chair, I didn't last long there. The feelings of spatial disorientation and dizziness did not last for maybe half a day. By the time I was helped up the stairs, up the gang plank, for the most part that had subsided. I still had nauseousness. That was greatly enhanced once I got in the simulator and became in motion. Once again, trying to look inside the TSU . . . I felt considerably worse as the crew . . . However all in all it did not adversely affect my performance. I'd been in the actual aircraft engaging targets in training scenarios and been considerably sicker and still performed. My only problem in the simulator was due to the prolonged fatigue and so forth, my eyes were not even focused on the digital target. I basically could barely see the target, it was such a blur. That's why I was having so much trouble keeping the crosshairs on the laser.

C1 You don't think the focus problem was due to the spinning in the chair?

G20 Not at all. I was having a hard time keeping my eyes open. Of course, as you get more fatigued, gunners tend to make more erratic control movements on their sight-hand control stick. All in all, I think the physical conditioning we had earlier in the day, actually improved my alertness and my awareness, because it basically woke me back up and got my blood running. It made me nauseous and made me feel sick, but other than that, it actually woke me up. I think I was able to perform better on the PAB tests and get my act together.

C1 You intrigued me when you said that you felt sick or sicker in other circumstances. You want to talk about that?

G20 Oh yeah. Twice I've been to hot desert scenarios in California . . . and being the type of aircraft we have and environmental conditions, we would not be able to use our environmental control system -- it normally got to be about one hundred and thirty degrees in the cockpit about six hours a day. Of course, just so life would be miserable, when you team a crew together each guy would alternate. One day one guy would be the gunner in the front seat, and the next day -- the gunner was always the guy that got sick. I got sick basically every other day that we were flying these missions for a few weeks at a time. When I'd get in the front seat I'd get sick.

C1 Really?

G20 We'd be to the point at the National Training Center where we were engaging sixty to a hundred targets a day at least. When it's one hundred and thirty degrees inside of the cockpit, and you've only maybe gotten three or four hours of sleep that -- well maybe I shouldn't say that -- we were constantly in the situation where we'd have to land . . . many of my fellow aviators, more experienced pilots that had the --

C1 So you'd tell your pilot, "Hey I'm really getting sick," and he'd drop you down --

G20 Yeah, we'd take turns and we would rest. Once again, with regards to actually being sick, I was able to, in the aircraft, under those two different desert circumstances, to feel much sicker than I was and still be able to perform. There'd be a tendency when I was sick, your coordination would be a little -- wouldn't be so good. You'd tend to get a little restless. So at times you'd have trouble actually acquiring a target, and perhaps tracking a target because you're controlling is particularly jerky. Whether it'd be pilot on controls or the gunner on the sight-hand control system. However, I look at that and then I look at combat situations where you're adrenaline would certainly be flowing. I think your body's natural endorphines or whatever -- you're trying to counter a lot of that.

C1 OCM, what are your observations?

OCM This crew was not quite as obviously -- except the pilots I think especially initially again on the first half of the rocket firing sequence, I think you could see a lot of dispersion. I could see he was getting a little aggravated with the aircraft and trying to keep it on target. He wasn't feeling well and everything else combined. He was having to work quite hard at it. He was the only one, prior to the spin who had -- of the twenty or ten pilots -- that ever got a fourteen on a target engagement. I don't know how many he specifically got after the spin, but they were a lot fewer than that on the hits. Performance is going to show that the accuracy is going to be a factor. As far as the gunner is -- it is going to be hard to say. You're going to have to go back through and look at the numbers. Again, the gunner's not quite as affected as is the pilot. I think we had one miss. A little bit on the lasing, the laser thing caused a little problem. Those are the things that happen when you get a little tired.

C1 I'll ask you the same question I've asked others. G20's already touched on it to a certain degree. That has to do with the concept of motivation. If in an actual warfare scenario, do you think your performance would be considerably enhanced due to the adrenaline pumping? Or do you think you gave it as much as you could in the circumstances in the simulator? Do you think the warfare environment would help you overcome some of the problems you had?

P19 I think it would help a lot, but you still have that fatigue. It's still going to affect the outcome to a certain point. Also that adrenaline will help iron that out. I think there's going to be a degrading of your abilities to a certain point.

G20 If pilots are ill and they know they've been radiated . . . they basically know, deep down in their hearts that they're flying dead men. Things would get entirely worse the entire scenario. There would probably be a feeling of helplessness, not being able to do much of anything.

C1 Would you try and kill more enemy soldiers, or would you try and retreat and get your aircraft to somebody else?

G20 I personally think that if I was feeling that ill, I would face the facts and say,"Hey, I'm a dead man." I'd just go do what I can, while I can . . .

P19 I'd probably have to say the same. There's really no place to go after that I would imagine. It's really a difficult question.

C1 It's very situational. Any other questions or comments?

C2 I think something that DR brought up yesterday, you carry essentially a radbadge if you're looking at it. The symptomology that can be experienced -- it depends on the onset. The severity and everything else isn't necessarily dose dependent. This is, I think, the second or third crew that have discussed the fact that you take a radiation hit, you feel you're flying dead men. In fact you may have these symptoms and not actually be in that case. It may be that you've taken radiation, you have radiation sickness, but actually you can overcome --not overcome the symptoms initially -- but you can be well because you haven't absorbed a lethal dose of radiation. Essentially on that concept, education in that area of what the effects are may alleviate that idea and help us better on the battlefield if people know what they have and can read their concerns.

C1 SO, do you have any observations?

SO Well that brings up a good question. I don't think I've ever been in a field when they've given me a radbadge. Mostly what I've observed with almost all of the crews that have come up here, has been some degradation of performance. Specifically, whether it's through a stressed out control touch, a little lazy tracking initially on the targets as far as the gunner's optics are concerned, it's really hard to be graded up on the TOW missile from the gunner's standpoint. As a crew combined, you could probably see a combined culminated or cumulative effect that would definitely pose a problem for any crew for performance. What you're going to do is be adding time to engagement of the target. Any time that you add on to the time that you are exposed to the enemy threat, threat radar, ground troops, small arms, anything, someone's got a chance to see you as well as you see them. And the obviousness is, if they can see you they can shoot you. That's where it becomes critical, because we're in an even low intensity to high intensity. It's shoot move, shoot move. Get covered, get moved around and take another shot somewhere else. Never strike from the same place twice. So any effects of ionizing radiation or whatever you were talking about, or whether it's a lack of sleep, will literally cause us to be poor performers the following day, the following morning, the following evening with goggles or whatever. There's a lot of stressors all over the place. It's not necessarily how you would react to these things. It's how we would react with them. The difference being, being able to accept them or conquer them. That's just a personal opinion. It seems to me that anything that adds on to the time which you're going to be exposed to in the threat scenario increases your vulnerability.

C1 Anything else? I'd like to take this opportunity -- this is the last run that we're doing in this study. We got through twenty pilots, and that is to the credit of Bill Blackburn. We appreciate that and we certainly appreciate you guys participating. Especially G20, the guy who's out processing. You sure didn't have to do this. It took a lot to want to do this before getting out. Thanks again guys. Appreciate it.

APPENDIX F

SCL SCREENING SUMMARY

SCL SCREENING SUMMARY (Pilots)

Subject	Symptom Complex	Number of SCLS	MEAN healthy-sick	Mean Ratio	Standard Dev (mean)	Standard Dev. (ratio)
1	211111	6	0.83	0.94	2.04	0.14
1	311111	6	3.67	0.36	2.16	0.69
1	411111	6	3.67	0.36	2.16	0.69
1	511111	5	6.80	-0.40	4.60	1.52
1	121111	6	1.67	0.89	4.08	0.27
1	131111	6	0.83	0.94	2.04	0.14
1	141111	6	3.00	0.43	1.90	0.72
1	151111	4	11.25	-0.13	7.50	0.75
1	112111	6	0.83	0.94	2.04	0.14
1	113111	6	0.83	0.94	2.04	0.14
1	114111	6	9.50	-0.19	6.89	0.73
1	115111	5	13.40	-1.30	9.04	0.97
1	111211	6	0.83	0.94	2.04	0.14
1	111311	6	9.17	0.14	7.36	0.74
1	111411	6	9.50	-0.19	6.89	0.73
1	111511	0				
1	111121	6	0.00	1.00	0.00	0.00
1	111131	6	0.00	1 .00	0.00	0.00
1	111141	6	7.00	0.06	4 69	0.65
1	111151	0				
1	111112	6	0.83	0.94	2.04	0.14
1	111113	6	6.17	0.11	4.49	0.69
1	111114	6	6.17	0.11	4.49	0.69
1	111115	6	0.83	0.94	2.04	0.14
1	514111	5	12.60	-0.50	10.19	0.87
1	414112	6	9.50	-0.19	6.89	0 73
1	314112	6	1.67	0.89	4.08	0.27
1	315113	6	5.83	0.44	4.92	0.50
1	515223	2	2.00	-1.00	2.83	2.83
1	515431	1	0.00	1.00		
1	112121	6	0.00	1 00	0.00	0.00
1	113121	6	1.17	0.61	2.04	0.80
1	114112	6	1.67	0.89	4.08	0.27
1	213111	6	7.00	0.06	4.69	0.65
1	214112	6	6.17	0.11	4.49	0.69
1	214113	6	7.00	0.06	4.69	0.65
1	312111	6	0.83	0.94	2.04	0.14
1	313111	6	0.83	0.94	2.04	0.14
1	412111	6	3.67	0.36	2.16	0.69
1	413111	6	7.00	0.06	4.69	0.65
1	414111	5	12.80	-1.00	9.96	1.41
1	513111	6	6.67	0.39	5.16	0.49

SCL SCREENING SUMMARY (Pilots)

Subject	Symptom Complex	Number of SCLS	MEAN healthy - sick	Mean Ratio	Standard Dev (mean)	Standard Dev. (ratio)
3	211111	6	0.00	1.00	0.00	0.00
3	311111	6	0.00	l.00	0.00	0.00
3	411111	6	1.17	0.70	0.98	0.37
3	511111	6	1.50	0.64	0.84	0.34
3	121111	6	0.00	1.00	0.00	0.00
3	131111	6	0.00	1.00	0.00	0.00
3	141111	6	3.67	0.28	1.75	0.23
3	151111	6	4.50	0.17	2.59	0.21
3	112111	6	0.00	1.00	0.00	0.00
3	113111	6	0.50	0.90	1.22	0.24
3	114111	6	0.00	1.00	0.00	0.00
3	115111	6	2.83	0.48	2.04	0.32
3	111211	6	0.00	1.00	0.00	0.00
3	111311	6	0.50	0.90	1.22	0.24
3	111411	6	2.83	0.48	2.04	0.32
3	111511	0				
3	111121	6	0.00	1.00	0.00	0.00
3	111131	6	0.00	1.00	0.00	0.00
3	111141	6	2.83	0.48	2.04	0.32
3	111151	5	6.80	-1.05	7.19	2.36
3	111112	6	0.50	0.77	0.84	0.41
3	111113	6	4.00	0.22	2.00	0.25
3	111114	6	3.67	0.28	1.75	0.23
3	111115	0				
3	514111	6	2.83	0.48	2.04	0.32
3	414112	6	2.83	0.48	2.04	0.32
3	314112	6	2.17	0.52	1.72	0.43
3	315113	6	3 .83	0.26	1 .94	0.23
3	51 5223	6	4.50	0.03	1 .87	0.55
3	51 5431	6	4.50	0.03	1 .87	0.55
3	112121	6	0.00	1.00	0.00	0.00
3	113121	6	0.00	1.00	0.00	0.00
3	114112	6	2.83	0.48	2.04	0.32
3	213111	6	0.50	0.77	0.84	0.41
3	214112	6	2.83	0.34	1.94	0.69
3	214113	6	3.67	0.33	2.50	0.41
3	312111	6	0.00	1.00	0.00	0.00
3	313111	6	2.83	0.48	2.04	0 32
3	412111	6	0.00	1.00	0.00	0.00
3	413111	6	0.50	0.90	1.22	0.24
3	414111	6	0.33	0.93	0.82	0.16
3	513111	6	0.50	0.90	1.22	0.24

SCL SCREENING SUMMARY (Pilots)

Subject	Symptom Complex	Number of SCLS	MEAN healthy - sick	Mean Ratio	Standard Dev. (mean)	Standard Dev. (ratio)
5	211111	6	0.00	1.00	0.00	0.00
5	311111	6	4.33	0.32	1.21	0.18
5	411111	6	2.67	0.63	1.63	0 21
5	511111	6	6.67	0.03	2.80	0.18
5	121111	6	0.00	1.00	0 00	0.00
5	131111	6	0.00	1.00	0.00	0.00
5	141111	6	7.17	-0.14	1.94	0.28
5	151111	0				
5	112111	6	0.00	1.00	0.00	0.00
5	113111	6	3.33	0.45	1.37	0.26
5	114111	6	3.33	0.45	1.37	0.26
5	115111	6	19.17	-2.05	4.62	0.66
5	111211	6	0.00	1.00	0.00	0 00
5	111311	6	4.17	0.33	0.98	0.19
5	111411	0				
5	111511	0				
5	111121	6	0.00	1.00	0.00	0.00
5	111131	6	4.00	0.43	2.00	0.34
5	111141	6	7.5 0	-0.25	1.6 4	0.54
5	111151	0				
5	111112	6	3.33	0.45	1.37	0.26
5	111113	6	3.67	0.50	1.97	0.27
5	111114	6	4.83	0.15	0.41	0.44
5	111115	6	0.00	1 .00	0.00	0.00
5	514111	6	7.83	-0.25	1.72	0.24
5	414112	6	10.00	-0.59	3.35	0.53
5	314112	6	7.50	-0.25	1.64	0.54
5	315113	6	6.67	0.03	2.80	0.18
5	515223	6	9.33	-0.47	3.39	0 47
5	515431	6	17.50	-1.61	7.12	0.59
5	112121	6	0.00	1.00	0.00	0.00
5	113121	6	2.67	0.63	1.63	0.21
5	114112	6	5.67	-0.03	1.51	0.69
5	213111	6	4.33	0.32	1.21	0.18
5	214112	6	4.00	0.38	1.26	0.10
5	214113	6	4.00	0.43	2.00	0.34
5	312111	6	2.67	0.63	1.63	0.21
5	313111	6	3.67	0.50	1.97	0.27
5	412111	6	3.33	0.45	1.37	0.26
5	413111	6	3.67	0.50	1.97	0.27
5	414111	6	8.33	-0.42	1.37	0.60
5	513111	6	6.33	0.14	3.50	0.43

SCL SCREENING SUMMARY (Pilots)

Subject	Symptom Complex	Number of SCLS	MEAN healthy - sick	Mean Ratio	Standard Dev. (mean)	Standard Dev. (ratio)
7	211111	6	0.00	1.00	0.00	0.00
7	311111	6	2.67	0.22	2.42	0.85
7	411111	6	0.33	0.89	0.52	017
7	511111	6	3.33	0.13	2.07	0.67
7	121111	6	0.00	1.00	0.00	0.00
7	131111	6	0.00	1.00	0.00	0 00
7	141111	6	1.50	0.52	2.07	0 70
7	151111	6	2.17	0.43	1 17	0 39
7	112111	6	0.00	1.00	0.00	0.00
7	113111	6	0.00	1.00	0.00	0.00
7	114111	6	0.00	1.00	0.00	0.00
7	115111	6	4.50	-0.17	2.35	0.78
7	111211	6	0.00	1.00	0.00	0.00
7	111311	6	0.00	1.00	0.00	0.00
7	111411	6	0.00	1.00	0.00	0.00
7	111511	6	0.00	1.00	0.00	0.00
7	111121	6	0.00	1.00	0.00	0 00
7	111131	6	2.50	0.28	2.17	0.76
7	111141	6	2.67	0.29	1.63	0.57
7	111151	0				
7	111112	6	0.00	1.00	0.00	0.00
7	111113	6	3.50	0.03	2.35	0.86
7	111114	6	2.50	0.37	1.22	0.37
7	111115	0				
7	514111	6	3.67	0.11	2.94	0.86
7	414112	6	1.67	0.58	0.82	0.24
7	314112	6	4.17	-0.14	2.71	0.97
7	315113	6	2.67	0.27	2.07	0.71
7	515223	6	3.83	0.06	1.94	0.49
7	515431	6	1.67	0.58	0.82	0.24
7	112121	6	0.00	1.00	0.00	0.00
7	113121	6	0 00	1.00	0.00	0.00
7	114112	6	0.83	0.79	0.41	0.12
7	213111	6	0.00	1.00	0.00	0.00
7	214112	6	0.83	0.79	0.41	0.12
7	214113	6	4.83	-0.23	2.56	0.78
7	312111	6	1.83	0.43	2.14	0.74
7	313111	6	1.17	0.68	0.75	0.28
7	412111	6	0.00	1 00	0.00	0.00
7	413111	6	0.00	1.00	0.00	0.00
7	414111	6	1.00	0.73	1.55	0.43
7	513111	6	1.67	0.58	0.82	0.24

SCL SCREENING SUMMARY (Pilots)

Subject	Symptom Complex	Number of SCLS	MEAN healthy - sick	Mean Ratio	Standard Dev. (mean)	Standard Dev. (ratio)
11	211111	6	2.00	0.49	1.26	0.74
11	311111	3	4.67	-0.07	2.31	0.81
11	411111	6	2.67	0.68	3.01	0.41
11	511111	0				
11	121111	1	2.00	-1.00		
11	131111	1	2.00	-1.00		
11	141111	6	6.00	-0.10	3.85	0.47
11	151111	1	2.00	-1.00		
11	112111	6	2.33	0.44	2.25	0.74
11	113111	6	1.50	0.68	0.84	0.35
11	114111	6	3.00	0.39	2.00	0.70
11	115111	1	4.00	-3.00		
11	111211	6	2.50	0.60	2.17	0.35
11	111311	6	5.33	-0.14	3.93	0.72
11	111411	1	10.00	0.00		
11	111511	0				
11	111121	6	1.67	0.81	2.34	0.24
11	111131	6	1.67	0.52	0.82	0.75
11	111141	6	4.83	0.01	3.37	1 06
11	111151	0				
11	111112	6	4.50	0.19	3.15	0.28
11	111113	6	1.00	0.88	1.10	0.14
11	111114	1	4.00	-3.00		
11	111115	0				
11	514111	0				
11	414112	4	6.25	-0.13	4.35	0.63
11	314112	1	2.00	-1.00		
11	315113	6	6.17	-0.69	3.25	1.70
11	515223	2	5.50	-4.50	3.54	3.54
11	515431	5	7.60	-0.80	4.34	1.30
11	112121	6	0.00	1.00	0.00	0.00
11	113121	6	1.33	0.70	1.21	0.37
11	114112	6	3.33	0.36	2.34	0.30
11	213111	6	5.83	-0.36	3.49	0.96
11	214112	1	2.00	-1.00		
11	214113	4	3.50	0.17	1.73	0.78
11	312111	1	2.00	-1.00		
11	313111	2	6.00	-0.50	5.66	0.71
11	412111	2	6.00	-0.50	5.66	0.71
11	413111	6	5.50	-0.17	3.78	0.68
11	414111	1	2.00	-1.00		
11	513111	1	2.00	-1.00		

SCL SCREENING SUMMARY (Pilots)

Subject	Symptom Complex	Number of SCLS	MEAN healthv - sick	Mean Ratio	Standard Dev. (mean)	Standard Dev. (ratio)
13	211111	6	23.00	-1.00	9.78	0.00
13	311111	0				
13	411111	6	23.00	-1.00	9.78	0.00
13	511111	0				
13	121111	6	5.33	0.46	0.52	0.25
13	131111	6	4.50	0.59	1.38	0.09
13	141111	6	28.50	-1.50	20.24	1.22
13	151111	0				
13	112111	6	4.67	0.51	0.82	0.28
13	113111	6	10.67	0.08	5.57	0.20
13	114111	6	13.83	-0.35	3.92	0.54
13	115111	4	27.00	-1.00	8.87	0.00
13	111211	6	4.50	0.58	4.55	0.38
13	111311	6	10.67	0.08	5.57	0.20
13	111411	6	11.00	0.15	8.29	0.39
13	1 11511	0				
13	111121	6	4.17	0.63	1.60	0.13
13	111131	6	4.33	0.62	1.63	0.13
13	111141	6	21.33	-0.83	11.15	0.41
13	111151	0				
13	111112	6	3.33	0.63	2.58	0.38
13	111113	6	11.50	0.00	4.89	0.00
13	111114	0				
13	111115	0				
13	514111	0				
13	414112	6	23.00	-1.00	9.78	0.00
13	314112	0				
13	315113	0				
13	515223	0				
13	515431	0				
13	112121	6	8.33	0.22	4.72	0.45
13	113121	6	4.17	0.62	1.72	0.13
13	114112	6	11;50	0.00	4.89	0.00
13	213111	6	23.00	-1.00	9.78	0.00
13	214112	6	8.83	0.21	3.13	0.23
13	214113	0				
13	312111	0				
13	313111	1	12.00	0.00		
13	412111	5	11.80	0.00	5.40	0.00
13	413111	6	23.00	-1.00	9.78	0.00
13	414111	6	12.83	-0.28	2.56	0 49
13	513111	0				

SCL SCREENING SUMMARY (Pilots)

Subject	Symptom Complex	Number of SCLS	MEAN healthy - sick	Mean Ratio	Standard Dev. (mean)	Standard Dev. (ratio)
15	211111	6	1.83	0.84	1.83	0.14
15	311111	6	1.33	0.87	1.03	0.11
15	411111	6	3.67	0.63	2.94	0.34
15	511111	6	3.67	0.44	1.97	0.50
15	121111	6	0.00	1.00	0.00	0.00
15	131111	6	0.00	1.00	0.00	0.00
15	141111	6	6.17	-0.13	3.25	1.44
15	151111	6	1.83	0.62	0.98	0.56
15	112111	6	0.00	1.00	0.00	0.00
15	113111	6	0.00	1.00	0.00	0.00
15	114111	6	1.17	0.88	0.98	0.11
15	115111	6	4.17	0.19	2.14	1.09
15	111211	6	0.00	1.00	0.00	0.00
15	111311	6	0.00	1.00	0.00	0.00
15	111411	6	1.33	0.87	1.03	011
15	111511	0				
15	111121	6	0.00	1.00	0.00	0.00
15	111131	6	3.17	0.69	2.48	0.25
15	111141	6	3.00	0.63	2.10	0.22
15	111151	6	7.00	-0.22	3.69	1 41
15	111112	6	1.33	0.87	1.03	0.11
15	111113	6	0.83	0.92	0.98	0.10
15	111114	6	2.33	0.77	2.25	0.23
15	111115	0				
15	514111	6	3.00	0.72	2.45	0 23
15	414112	6	3.17	0.69	2.48	0.25
15	314112	6	3.67	0.38	1.97	0.70
15	315113	6	4.17	0.38	2.40	0.52
15	515223	3	3.33	0.21	3.51	0.75
15	515431	3	3.00	0.38	3.61	0.54
15	112121	6	.0.00	1.00	0.00	0.00
15	113121	6	1.33	0.87	1.03	0.11
15	114112	6	0.67	0.93	0.52	0.05
15	213111	6	1.33	0.87	1.03	0.11
15	214112	6	3.67	0.38	1.97	0.70
15	214113	6	4.00	0.28	2.00	0.89
15	312111	6	2.83	0.52	1.94	0 54
15	313111	6	2.83	0.34	2.23	1.15
15	412111	6	3.83	0.24	2.32	1.11
15	413111	6	1.33	0.87	1.03	0 11
15	414111	6	1.33	0.87	1.03	0.11
15	513111	6	4.17	0.61	3.43	0.32

SCL SCREENING SUMMARY (Pilots)

Subject	Symptom Complex	Number of SCLS	MEAN healthy - sick	Mean Ratio	Standard Dev. (mean)	Standard Dev. (ratio)
17	211111	6	2.67	0.48	0.52	0.49
17	311111	6	7.67	-0.84	3.56	2.33
17	411111	6	8.17	-0.59	3.06	1.35
17	511111	4	11.25	-1.66	2.22	2.57
17	121111	6	3.17	0.43	1.17	0.48
17	131111	6	6.17	-0.18	1.72	0.95
17	141111	4	7.50	-0.72	0.58	1.52
17	151111	0				
17	112111	6	2.00	0.54	1.10	0.53
17	113111	6	2.00	0.58	2.28	0.59
17	114111	6	4.33	0.29	2.66	0.52
17	115111	6	8.50	-0.66	5.28	1.53
17	111211	6	4.33	0.29	2.66	0.52
17	111311	6	1.00	0.67	1.55	0.61
17	111411	6	2.50	0.47	1.05	0.52
17	111511	0				
17	111121	6	4.50	0.24	1.97	0.45
17	111131	6	2.83	0 45	0.75	0.50
17	111141	6	9.83	-1.00	3.37	2.24
17	111151	0				
17	111112	6	4.33	0.29	2.66	0.52
17	111113	6	4.50	0.12	1.52	0.82
17	111114	6	9.83	-1.08	3.06	2.21
17	111115	0				
17	514111	4	15.00	-2.15	2.31	2.24
17	414112	6	8.17	-0.59	3.06	1.35
17	314112	6	8.17	-0.59	3.06	1 35
17	315113	6	9.83	-0.67	3.06	1.17
17	515223	4	15.00	-1.71	4.69	0.89
17	515431	4	13.75	-2.46	2.87	3.69
17	112121	6	2.67	0.48	0.52	0.49
17	113121	6	4.17	0.30	0.98	0.41
17	114112	6	9.00	-0.64	3.90	1.29
17	213111	6	7.33	-0.45	1.37	1.30
17	214112	6	5.17	0.03	1.60	0.79
17	214113	6	8.67	-0.51	4.18	0.93
17	312111	6	8.17	-0.59	3.06	1.35
17	313111	6	4.50	0.12	1.52	0.82
17	412111	6	7.33	-0.45	1.37	1.30
17	413111	6	8.17	-0.59	3.06	1.35
17	414111	4	11.25	-1.21	2.22	1.20
17	513111	6	9.33	-0.70	3.44	1.25

SCL SCREENING SUMMARY (Pilots)

Subject	Symptom Complex	Number of SCLS	MEAN healthy - sick	Mean Ratio	Standard Dev. (mean)	Standard Dev. (ratio)
19	211111	6	4.00	0.22	2.76	0.97
19	311111	6	5.33	0.02	3.14	1.06
19	411111	6	4.67	0.26	0.82	0.22
19	511111	6	3.83	0.52	3.19	0.44
19	121111	6	2.00	0.53	2.76	0.92
19	131111	6	0.33	0.97	0.82	0.08
19	141111	6	4.17	0.06	4.17	1.52
19	151111	6	5.83	-0.05	3.31	1.05
19	112111	6	0.00	1.00	0.00	0.00
19	113111	6	0.00	1.00	0.00	0.00
19	114111	6	1.00	0.87	1.26	0.17
19	115111	6	4.33	0.36	2.66	0.41
19	111211	6	0.00	1.00	0.00	0.00
19	111311	6	3.83	0.27	3.06	0.88
19	111411	6	3.67	0.23	3.08	1 12
19	111511	1	10.00	-1.00		
19	111121	6	2.50	0.71	2.74	0.32
19	111131	6	2.33	0.42	3 S0	1.19
19	111141	6	2.50	0.46	2.59	0.89
19	111151	1	25.00	-4.00		
19	111112	6	1.67	0.80	2.58	0.32
19	111113	6	5.33	0.02	3.14	1.06
19	111114	6	4.33	0.45	3.61	0.51
19	111115	1	10.00	-1.00		
19	514111	6	5.33	0.02	314	1.06
19	414112	6	0.00	1.00	0.00	0.00
19	314112	6	7.00	-0.33	2.97	1.03
19	315113	6	3.83	0.37	2.04	0.56
19	515223	4	9.50	-1.07	1.9i	1.35
19	515431	6	4.33	0.36	2.66	0.41
19	112121	6	3.83	0.27	3.06	0.88
19	113121	6	5.33	0.02	3.14	1.06
19	114112	6	4.00	0.22	2.76	0.97
19	213111	6	2.17	0.73	1.94	0.27
19	214112	6	3.67	0.23	3.93	1.17
19	214113	6	0.83	0.92	1.33	0.13
19	312111	6	3.83	0.27	3.06	0.88
19	313111	6	8.00	-0.55	2.76	1.32
19	412111	6	5.33	0.02	3.14	1.06
19	413111	6	3.67	0.23	3.08	1.12
19	414111	6	5.33	0.00	3.67	1.09
19	513111	6	5.33	0.00	3.67	1.09

SCL SCREENING SUMMARY (Gunners)

Subject	Symptom Complex	Number of SCLS	MEAN healthy - sick	Mean Ratio	Standard Dev. (mean)	Standard Dev. (ratio)
2	211111	6	0.33	0.93	0.82	0.16
2	311111	6	0.33	0.93	0.82	0.16
2	411111	6	0.67	0.82	1.03	0.29
2	511111	6	3.67	-0.53	3.50	0.78
2	121111	6	0.00	1.00	0.00	0.00
2	131111	6	0.00	1.00	0.00	0.00
2	141111	6	0.83	0.83	2.04	0.41
2	151111	6	2.00	0.19	2.00	0 48
2	112111	6	0.00	1.00	0.00	0.00
2	113111	6	0.00	1.00	0.00	0.00
2	114111	6	2.00	0.19	2.00	0.48
2	115111	6	0.50	0.90	1.22	0 24
2	111211	6	0.00	1.00	0.00	0.00
2	111311	6	0.00	1.00	0.00	0.00
2	111411	6	0.00	1.00	0.00	0.00
2	111511	0				
2	111121	6	0.00	1.00	0.00	
2	111131	6	0.00	1.00	0.00	0.00
2	111141	6	1.33	0.67	2.16	0.52
2	111151	6	2.00	0.19	2.00	0.48
2	111112	6	0.00	1.00	0.00	0.00
2	111113	6	2.50	-0.04	2.59	0.71
2	111114	6	2.00	0.19	2.00	0.48
2	111115	6	2.00	0.19	2.00	0.48
2	514111	6	2.67	-0.01	2.73	0.57
2	414112	6	2.00	0.19	2.00	0.48
2	314112	6	2.00	0.19	2.00	
2	315113	6	2.00	0.19	2.00	0.48
2	515223	6	3.67	-0.53	3.50	0.78
2	515431	6	2.00	0.19	2.00	0.48
2	112121	6	0.00	1.00	0.00	0.00
2	113121	6	0.00	1.00	0.00	0.00
2	114112	6	2 00	0.19	2.00	0.48
2	213111	6	0.00	1.00	0.00	0.00
2	214112	6	2.00	0.19	2 00	0.48
2	214113	6	2.00	0.19	2.00	0.48
2	312111	6	2.00	0.19	2.00	0.48
2	313111	6	2.00	0.19	2.00	0.48
2	412111	6	2.00	0.19	2.00	0.48
2	413111	6	2.00	0.19	2.00	0.48
2	414111	6	3.50	-0.42	3.78	0.92
2	513111	6	2.00	0.19	2.00	0.48

SCL SCREENING SUMMARY (Gunners)

Subject	Symptom Complex	Number of SCLS	MEAN healthy - sick	Mean Ratio	Standard Dev. (mean)	Standard Dev. (ratio)
6	211111	6	0.00	1.00	0.00	0.00
6	311111	6	0.17	0.98	0.41	0.05
6	411111	6	0.67	0.78	1.03	0.34
6	511111	6	1.33	0.40	0.82	0.40
6	121111	6	0.00	1.00	0.00	0.00
6	131111	6	0.00	1.00	0.00	0.00
6	141111	6	0.83	0.91	1.60	0.20
6	151111	6	0.83	0.91	1.60	0.20
6	112111	6	0.00	1.00	0.00	0.00
6	113111	6	0.17	0.98	0.41	0.05
6	114111	6	0.00	1.00	0.00	0.00
6	115111	5	1.60	0.20	1.34	0.45
6	111211	6	0.00	1.00	0.00	0.00
6	111311	6	0.00	1.00	0.00	0.00
6	111411	6	0.00	1.00	0.00	0.00
6	111511	0				
6	111121	6	0.00	1.00	0.00	0.00
6	111131	6	0.00	1.00	0.00	0.00
6	111141	6	1.67	0.39	0.52	0.37
6	111151	1	0.00	1.00		
6	111112	6	0.00	1.00	0.00	0.00
6	111113	6	0.50	0.92	0.55	0.13
6	111114	6	1.33	0.83	3.27	0.41
6	111115	0				
6	514111	6	0.83	0.84	0.98	0.27
6	414112	6	0.33	0.96	0.82	0.10
6	314112	6	0.67	0.86	0.52	0.16
6	315113	5	2.00	0.18	1.00	0.40
6	515223	6	3.17	-0.01	2.04	0.61
6	515431	6	3.17	-0.01	2.04	0.61
6	112121	6	0.00	1.00	0.00	0.00
6	113121	6	0.00	1.00	0.00	0.00
6	114112	6	0.33	0.96	0.82	0.10
6	213111	6	0.17	0.99	0.41	0.02
6	214112	6	0.33	0.96	0.82	0.10
6	214113	6	1.17	0.73	0.98	0.32
6	312111	6	0.67	0.86	0.52	0.16
6	313111	6	0.00	1.00	0.00	0.00
6	412111	6	0.17	0.98	0.41	0.05
6	413111	6	0.83	0.84	0.98	0.27
6	414111	6	1.17	0.73	0.98	0.32
6	513111	6	0.33	0.97	0.52	0.05

SCL SCREENING SUMMARY (Gunners)

Subject	Symptom Complex	Number of SCLS	MEAN healthy - sick	Mean Ratio	Standard Dev. (mean)	Standard Dev. (ratio)
8	211111	6	0.00	1.00	0.00	0.00
8	311111	6	0.33	0.75	0.52	0.42
8	411111	6	0.33	0.75	0.52	0 42
8	511111	6	0.50	0.58	0.84	0.80
8	121111	6	0.00	1.00	0.00	0.00
8	131111	6	0.50	0.67	0.84	0.52
8	141111	6	0.67	0.42	0.82	0.80
8	151111	6	0.83	0.33	0.98	0.82
8	112111	6	0.00	1.00	0.00	0.00
8	113111	6	0.33	0.75	0.52	0.42
8	114111	6	0 33	0.75	0.52	0.42
8	115111	3	1.67	-0.33	0.58	0.58
8	111211	6	0.00	1.00	0.00	0.00
8	111311	6	0.50	0.58	0.55	0.49
8	111411	6	0.83	0.25	0.98	0.99
8	111511	0				
8	111121	6	0.33	0.75	0.52	0.42
8	111131	6	0.67	0.50	0.82	0.55
8	111141	4	1.50	-0.13	0.58	0.63
8	111151	0				
8	111112	6	0.33	0.75	0.52	0.42
8	111113	6	0.83	0.33	0.98	0.82
8	111114	2	2.00	-0.50	0.00	0.71
8	111115	0				
8	514111	6	0.33	0.75	0.52	0.42
8	414112	6	0.50	0.58	0.84	0.80
8	314112	6	0.67	0.50	1.03	0 84
8	315113	6	0.33	0.75	0.52	042
8	515223	4	1.50	-0.25	0.58	0.87
8	515431	5	1.00	0.20	1.00	0.84
8	112121	6	0.00	1.00	0.00	0.00
8	113121	6	0 33	0.75	0.52	0.42
8	114112	6	0.67	0.50	1.03	0.84
8	213111	6	0.67	0.50	1.03	0.84
8	214112	6	1.00	0.17	1.10	0.98
8	214113	6	0.83	0.33	0.98	0.82
8	312111	6	0.17	0.83	0.41	0.41
8	313111	6	0.33	0.75	0.52	0.42
8	412111	6	0.33	0.75	0.52	0.42
8	413111	6	0.33	0.75	0.52	0.42
8	414111	6	0.50	0.58	0.84	0.80
8	513111	6	0.67	0.50	0.82	0.55

SCL SCREENING SUMMARY (Gunners)

Subject	Symptom Complex	Number of SCLS	MEAN healthy - sick	Mean Ratio	Standard Dev. (mean)	Standard Dev. (ratio)
10	211111	6	0.00	1.00	0.00	0.00
10	311111	6	0.50	0.95	1.22	0.12
10	411111	6	0.67	0.93	1.63	0.16
10	511111	6	4.17	0.18	1.33	0.44
10	121111	6	0.50	0.95	1.22	0.12
10	131111	6	0.00	1.00	0.00	0.00
10	141111	6	2.67	0.39	1.63	0.36
10	151111	6	2.67	0.39	1.63	0.36
10	112111	6	0.00	1.00	0.00	0.00
10	113111	6	1.33	0.67	1.03	0.37
10	114111	6	2.67	0.39	1.63	0.36
10	115111	6	3.33	0.22	2.07	0.51
10	111211	6	0.00	1.00	0.00	0.00
10	111311	6	0.00	1.00	0.00	0.00
10	111411	6	2.00	0.67	2.19	0.39
10	111511	6	3.00	0.36	2.28	0.43
10	111121	6	0.83	0.92	2.04	0.20
10	111131	6	2.50	0.44	1.76	0.37
10	111141	6	3.33	0.22	2.07	0.51
10	111151	2	2.50	-0.08	0.71	0.59
10	111112	6	2.50	0.44	1.76	0.37
10	111113	6	2.67	0.39	1.63	
10	111114	6	3.33	0.22	2.07	0.51
10	111115	0				
10	514111	6	3.33	0.22	2.07	0.51
10	414112	6	3.33	0.22	2.07	0.51
10	314112	6	3.17	0.31	2.14	0.40
10	315113	6	6.83	-0.61	4.02	1.02
10	515223	6	3.33	0.22	2.07	0.51
10	515431	6	3.00	0.36	2.28	0.43
10	112121	6	0.00	1.00	-0.00	0.00
10	113121	6	0.33	0.97	0.82	0.08
10	114112	6	3.00	0.36	2.28	0.43
10	213111	6	3.33	0.22	2.07	0.51
10	214112	6	2.50	0.44	1.76	0.37
10	214113	6	2.50	0.44	1.76	0.37
10	312111	6	0.50	0.95	1.22	0.12
10	313111	6	3.33	0.22	2.07	0.51
10	412111	6	2.67	0.39	1.63	0.36
10	413111	6	3.33	0.22	2.07	0.51
10	414111	6	3.00	0.36	2.28	0.43
10	513111	6	3.33	0.22	2.07	0.51

SCL SCREENING SUMMARY (Gunners)

Subject	Symptom Complex	Number of SCLS	MEAN healthy - sick	Mean Ratio	Standard Dev. (mean)	Standard Dev. (ratio)
12	211111	6	0.00	1.00	0.00	0.00
12	311111	6	0.00	1.00	0.00	0.00
12	411111	6	5.50	-1.00	8.57	3.63
12	511111	6	5.50	-1.00	8.57	3.63
12	121111	6	0.00	1.00	0.00	0.00
12	131111	6	0.00	1.00	0.00	0.00
12	141111	6	2.50	0.50	6.12	1 22
12	151111	6	9.00	-3.33	6.51	3.20
12	112111	6	0.00	1.00	0.00	0.00
12	113111	6	0.00	1.00	0.00	0.00
12	114111	6	0.00	1.00	0.00	0.00
12	115111	6	5.50	-1.00	8.57	3.63
12	111211	6	0.00	1.00	0.00	0.00
12	111311	6	0.00	1.00	0.00	0.00
12	111411	0				
12	111511	0				
12	111121	6	0.00	1 .00	0.00	0.00
12	111131	6	5.50	-1.00	8.57	3.63
12	111141	0				
12	111151	0				
12	111112	6	5.50	-1.00	8.57	3.63
12	111113	6	5.50	-1.00	8.57	3.63
12	111114	3	11.67	-6.33	5.51	2.89
12	111115	0				
12	514111	6	5.50	-1.00	8.57	3.63
12	414112	6	5.50	-1.00	8.57	3.63
12	314112	6	5.50	-1.00	8.57	3 63
12	315113	6	3.83	-0.42	6.01	2.62
12	515223	6	7.17	-1.83	11.84	5.60
12	515431	0				
12	112121	6	0.00	1.00	0.00	0.00
12	113121	6	0.00	1.00	0.00	0.00
12	114112	6	5.50	-1.00	8.57	3.63
12	213111	6	0.00	1.00	0.00	0.00
12	214112	6	5.50	-1.00	8.57	3.63
12	214113	6	5.50	-1.00	8.57	3.63
12	312111	6	0.00	1.00	0.00	0.00
12	313111	6	5.50	-1.00	8.57	3.63
12	412111	6	5.50	-1.00	8.57	3.63
12	413111	6	5.50	-1.00	8.57	3.63
12	414111	6	5.50	-1.00	8.57	3.63
12	513111	6	6.83	-1.67	8.16	3.56

SCL SCREENING SUMMARY (Gunners)

Subject	Symptom Complex	Number of SCLS	MEAN healthy - sick	Mean Ratio	Standard Dev. (mean)	Standard Dev. (ratio)
14	211111	6	23.33	-5.96	18.53	5.49
14	311111	6	20.83	-5.54	19.16	719
14	411111	6	9.17	-0.58	10.53	1 24
14	511111	6	24.17	-5.04	21.33	5 04
14	121111	6	4.67	-0.57	6.98	3.64
14	131111	6	25.00	-6.79	17.86	5.78
14	141111	0				
14	151111	0				
14	112111	6	5.50	-0.60	7.31	3.63
14	113111	6	4.67	-0.18	5.72	2.61
14	114111	6	19.17	-3.88	19.77	430
14	115111	6	23.33	-2.92	32.76	2.80
14	111211	6	0.00	1.00	0.00	0.00
14	111311	6	6.33	-1.54	10.89	5.63
14	111411	0				
14	111511	0				
14	111121	6	18.33	-5.33	14.68	8.05
14	111131	6	19.17	-3.88	19.77	4.30
14	111141	2	8.50	-5.50	0.71	3.54
14	111151	0				
14	111112	6	10.50	-1.54	14.47	5.63
14	111113	6	18.33	-4.79	15.73	7.87
14	111114	0				
14	111115	0				
14	514111	6	18.00	-2.71	21.60	3.49
14	414112	0				
14	314112	6	20.83	-5.88	13.89	6.16
14	315113	6	14.17	-2.96	12.29	5.10
14	515223	0				
14	515431	0				
14	112121	6	11.33	-1.96	15.77	6.65
14	113121	6	5.50	-0.60	7.31	3.63
14	114112	6	23.00	-5.63	18.86	5.40
14	213111	6	11.67	-2.13	9.87	3.18
14	214112	6	19.17	-3.88	19.77	4.30
14	214113	6	20.00	-4.71	19.36	5.56
14	312111	6	1917	-4.68	18.95	5.59
14	313111	0				
14	412111	6	27.50	-6.13	24.91	6.55
14	413111	6	19.33	-4.54	15.17	5.19
14	414111	6	25.83	-8.88	17.23	10.51
14	513111	6	18.33	-4.71	12.14	5.19

SCL SCREENING SUMMARY (Gunners)

Subject	Symptom Complex	Number of SCLS	MEAN healthy - sick	Mean Ratio	Standard Dev. (mean)	Standard Dev. (ratio)
16	211111	6	0.67	0.72	0.52	0.38
16	311111	6	0.67	0.72	0.52	0.38
16	411111	6	0.00	1.00	0.00	0.00
16	511111	6	0.83	0.67	0.75	0.41
16	121111	6	0.00	1.00	0.00	0.00
16	131111	6	0.00	1.00	0.00	0.00
16	141111	6	0.67	0.72	0.52	0.00
16	151111	6	2.17	-0.31	0.75	0.82
16	112111	6	0.00	1.00	0.00	0 00
16	113111	6	0.00	1.00	0.00	0 00
16	114111	6	0.67	0.72	0.52	0.38
16	115111	6	0.67	0.72	0.52	0.38
16	111211	6	0.00	1.00	0.00	0.00
16	111311	6	0.00	1.00	0.00	0.00
16	111411	6	0.00	1.00	0.00	0.00
16	111511	0				
16	111121	6	0.00	1.00	0.00	0.00
16	111131	6	0.00	1.00	0.00	0.00
16	111141	6	0.50	0.74	0.55	0.39
16	111151	6	2.00	-0.14	0.89	0.75
16	111112	6	0.00	1.00	0.00	0.00
16	111113	6	0.00	1.00	0.00	0.00
16	111114	6	1.17	0.58	1.17	0.44
16	111115	0				
16	514111	6	0.67	0.72	0.52	0.38
16	414112	6	0.67	0.72	0.52	0.38
16	314112	6	1.00	0.63	0.89	0.41
16	315113	6	0.50	0.89	0.55	0.15
16	515223	6	1.33	0.38	1.51	0.80
16	515431	6	1.67	0.19	1.03	0.37
16	112121	6	0.00	1.00	0.00	0 00
16	113121	6	0.00	1.00	0.00	0.00
16	114112	6	0.50	0.74	0.55	0.39
16	213111	6	0.67	0.68	0.82	0.42
16	214112	6	0.67	0.72	0.52	0.38
16	214113	6	1.50	0.36	1.38	0.79
16	312111	6	1.17	0.46	0.98	0.77
16	313111	6	1.17	0.46	0.98	0.77
16	412111	6	1.00	0.63	0.89	0.41
16	413111	6	0.67	0.72	0.52	0.38
16	414111	6	0.83	0.68	0.75	0.39
16	513111	6	1.00	0.63	0.89	0.41

SCL SCREENING SUMMARY (Gunners)

Subject	Symptom Complex	Number of SCLS	MEAN healthy - sick	Mean Ratio	Standard Dev. (mean)	Standard Dev. (ratio)
18	211111	6	0.83	0.67	1.33	0.61
18	311111	6	0.83	0.67	1.33	0.61
18	411111	6	0.83	0.67	1.33	0.61
18	511111	6	2.00	0.17	3.35	1.60
18	121111	6	0.67	0.75	1.03	0.42
18	131111	6	0.50	0.79	0.84	0.40
18	141111	6	0.50	0.88	1.22	0.31
18	151111	6	2.00	0.25	3.10	1.25
18	112111	6	0.00	1.00	0.00	0.00
18	113111	6	0.00	1.00	0.00	0.00
18	114111	6	1.00	0.58	1.67	0.80
18	115111	6	0.50	0.75	1.22	0.61
18	111211	6	0.17	0.96	0.41	0.10
18	111311	6	0.00	1.00	0.00	0.00
18	111411	6	0.50	0.88	1.22	0.31
18	111511	4	6.00	-3.21	2.00	3.72
18	111121	6	0.00	1.00	0.00	0.00
18	111131	6	2.83	-0.42	2.56	1.02
18	111141	6	1.33	0.50	2.07	0.84
18	111151	4	4.25	-2.00	2.63	1.41
18	111112	6	0.33	0.83	0.82	0.41
18	111113	6	0.50	0.79	0.84	0.40
18	111114	6	0.00	1.00	0.00	0.00
18	111115	1	9.00	-8.00		
18	514111	6	0.83	0.67	1.33	0.61
18	414112	6	2.00	0.21	2.45	1.01
18	314112	6	3.50	-0.67	3.83	1 33
18	315113	6	3.17	-0.75	3.60	2.23
18	515223	6	2.67	-0.50	3.27	1.97
18	515431	6	3.00	-1.00	3 79	3.51
18	112121	6	0.00	1.00	0.00	0.00
18	113121	6	0.83	0.67	1.33	0.61
18	114112	6	1.67	0.13	2.07	1.12
18	213111	6	0.50	0.75	1.22	0.61
18	214112	6	2.00	0.08	2.53	1.02
18	214113	6	2.00	-0.17	1.90	1.29
18	312111	6	1.67	0.08	1.86	1.20
18	313111	6	1.83	0.13	2.23	1.00
18	412111	6	1.67	0.17	1.51	0.75
18	413111	6	0.50	0.75	1.22	0.61
18	414111	6	2.83	-0.25	3.37	1.25
18	513111	6	1.33	0.50	2.07	0.84

SCL SCREENING SUMMARY (Gunners)

Subject	Symptom Complex	Number of SCLS	MEAN healthy - sick	Mean Ratio	Standard Dev. (mean)	Standard Dev. (ratio)
20	211111	6	0.00	1.00	0.00	0.00
20	311111	6	0.17	0.83	0.41	0.41
20	411111	6	0.17	0.83	0.41	0.41
20	511111	6	0.67	0.57	0.52	0.48
20	121111	6	0.00	1.00	0.00	0.00
20	131111	6	0.00	1.00	0.00	0.00
20	141111	6	0.17	0.83	0.41	0.41
20	151111	6	0.50	0.74	0.55	0.41
20	112111	6	0.00	1.00	0.00	0.00
20	113111	6	0.17	0.83	0.41	0.41
20	114111	6	0.17	0.83	0.41	0.41
20	115111	6	0.33	0.75	0.52	0 42
20	111211	6	0.00	1.00	0.00	0 00
20	111311	6	0.17	0.83	0.41	0.41
20	111411	6	0.17	0.92	0.41	0.20
20	111511	0				
20	111121	6	0.17	0.83	0.41	0.41
20	111131	6	0.00	1.00	0.00	0.00
20	111141	6	0.17	0.83	0.41	0.41
20	111151	1	2.00	-1.00		
20	111112	6	0.17	0.83	0.41	0.41
20	111113	6	0.33	0.75	0.52	0.42
20	111114	6	0.17	0.83	0.41	0.41
20	111115	3	2.00	-0.83	2.65	2.75
20	514111	6	0.17	0.83	0.41	0.41
20	414112	6	0.33	0.82	0.52	0.40
20	314112	6	0.17	0.83	0.41	0.41
20	315113	6	0.17	0.83	0.41	0.41
20	515223	6	0.17	0 83	0.41	0.41
20	515431	5	1.00	0.20	0.71	0.76
20	112121	6	0.00	1.00	0.00	0.00
20	113121	6	0.17	0.83	0.41	0.41
20	114112	6	0.17	0.83	0.41	0.41
20	213111	6	0.00	1.00	0.00	0.00
20	214112	6	0.17	0.83	0.41	0.41
20	214113	6	0.50	0.74	0.55	0.41
20	312111	6	0.00	1.00	0.00	0.00
20	313111	6	0.17	0.83	0.41	0.41
20	412111	6	0.17	0.83	0.41	0.41
20	413111	6	0.17	0.83	0.41	0.41
20	414111	6	0.17	0.83	0.41	0.41
20	513111	6	0.50	0.58	0.55	0.49

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