



Research Product 2005-08

**AH-64A Back Up Control System (BUCS)
Familiarization Training:
Instructor Pilot's Guide for the AH-64 Simulator**

Mike Couch
Arrow Research, Inc.

David M. Johnson
U.S. Army Research Institute

August 2005

Rotary-Wing Aviation Research Unit

**United States Army Research Institute
for the Behavioral and Social Sciences**

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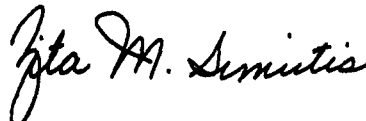
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MICHELLE SAMS
Technical Director



ZITA M. SIMUTIS
Director

Technical Review by

Michael Reese, Directorate of Evaluation and Standardization,
Fort Rucker

John Rivenbark, Directorate of Simulation, Fort Rucker

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Mike Couch
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David M. Johnson
U.S. Army Research Institute

**Rotary-Wing Aviation Research Unit
William R. Howse, Acting Chief**

**U.S. Army Research Institute for the Behavioral and Social Sciences
2511 Jefferson Davis Highway, Arlington, Virginia 22202-3926**

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AH-64A BACK UP CONTROL SYSTEM (BUCS) FAMILIARIZATION TRAINING: INSTRUCTOR PILOT'S GUIDE FOR THE AH-64 SIMULATOR

EXECUTIVE SUMMARY

Research Requirement:

The Rotary-Wing Aviation Research Unit (RWARU) of the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) is located at Fort Rucker, Alabama. In response to a series of incidents and mishaps involving the AH-64A, the U.S. Army determined in 1999 that AH-64A aviators needed flight training in a device capable of accurately simulating the necessary control handovers and handling qualities of the Back Up Control System (BUCS). None of the AH-64A training devices in the Army inventory at that time were capable of simulating BUCS or the control feel and flight behavior after BUCS activation. The ARI Simulator Training Research Advanced Testbed for Aviation (STRATA) simulator was capable of simulating the full range of BUCS flight procedures. A Memorandum of Agreement (MOA) among Product Manager Apache Modernization at Redstone Arsenal, Aviation Training Brigade (ATB) at Fort Rucker, and ARI was signed in January 2001. This MOA was to be in force through January 2004. ARI agreed to create a model BUCS familiarization training program, make STRATA available for the training of all Apache pilots in the Aviator Qualification Course (AQC), and provide a senior subject matter expert to provide instruction alongside ATB personnel.

Procedure:

ARI created an experimental BUCS familiarization training course. This course provided simulator-based hands-on instruction of 44 BUCS-related tasks. Instruction included pilot tasks as well as co-pilot/gunner (CPG) tasks. All participants received training in both the pilot station and the CPG station. The categories of tasks taught were jammed mechanical flight controls, severed mechanical flight controls, crew contention of controls causing inadvertent activation of BUCS, and related system failures that result in BUCS failure.

Findings:

BUCS familiarization training in STRATA began on 25 January 2001. Between that date and 21 January 2005, 978 Army aviators received this program of instruction.

Utilization and Dissemination of Findings:

ARI worked closely with ATB on this familiarization training from the beginning. BUCS training in STRATA was a part of the course syllabus for AQC. In addition, Apache personnel from the Instructor Pilot Course, the Maintenance Test Pilot Course, the Individual Ready Reserve, the Army Reserve, and the Army National Guard

received BUCS training in STRATA. Representatives of ATB were briefed on this BUCS program monthly beginning in 2001. On 13 November 2003 ARI briefed representatives of the Apache Program Manager's Office, the Program Executive Office for Simulation Training and Instrumentation (PEO-STRI), and the Directorate of Simulation Fort Rucker on the status of BUCS familiarization training. The present ARI research product is published in order to provide an archival record of this unique and valuable BUCS training program.

**AH-64A BACK UP CONTROL SYSTEM (BUCS) FAMILIARIZATION TRAINING:
INSTRUCTOR PILOT'S GUIDE FOR THE AH-64 SIMULATOR**

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AH-64A BACK UP CONTROL SYSTEM (BUCS) FAMILIARIZATION TRAINING: INSTRUCTOR PILOT'S GUIDE FOR THE AH-64 SIMULATOR

Brief Description of the Back Up Control System (BUCS)

Unlike other fielded Army helicopters, the AH-64 Apache has an emergency back up, electro-hydraulic, fly-by-wire system available to the crew in the event of a jammed or severed flight control. This back up control system (BUCS) allows the crew to bypass damaged mechanical flight controls and safely land the aircraft. The BUCS can be found on both A- and D-model Apaches.

In the AH-64A normal flight control inputs from the pilot or copilot/gunner (CPG) are relayed to the hydraulic servo-actuators, which control the flight surfaces, using mechanical linkages (push-pull tubes, bellcranks, etc.). If this mechanical system is jammed or severed by combat damage or maintenance problems, the BUCS will recognize the problem and enable fly-by-wire control of the affected axis.

The BUCS uses linear variable differential transducers (LVDTs) to signal flight-control position, and shear-pin-actuated decouplers (SPADs) to separate flight controls from the mechanical linkages. Eight LVDTs are located in the cockpit to sense flight-control positions from the pilot and the CPG. Other LVDTs transmit the servo-actuator positions to the Digital Automatic Stabilization Equipment Computer (DASEC). Among its other functions, the DASEC recognizes problems with the mechanical control system and enables the BUCS. SPADs are located at the base of each control axis (cyclic longitudinal, cyclic lateral, collective, and pedals) for each crew station. There are eight SPADs in all.

When a jam occurs, either crewmember can decouple, or "break out," of the jammed axis by pushing hard on the affected flight control and breaking the SPAD on that axis. As soon as the SPAD is broken the BUCS is enabled. All other undamaged axes will continue to function normally using mechanical linkages. The crew can safely land the helicopter.

In the event of a severed control linkage, the DASEC recognizes the mistrack between the flight-control position and the position of the hydraulic servo-actuator. With sufficient mistrack (17.5 percent, or approximately two inches of control movement), the DASEC automatically enables the BUCS for the defective axis. All other undamaged axes will continue to function normally using mechanical linkages. The crew can safely land the helicopter.

Purpose of this Research Product

This report provides AH-64A Instructor Pilots (IPs) and Commanders with the same BUCS familiarization training method of instruction (MOI) used to train 978 AH-64A aviators between January 25, 2001 and January 21, 2005. The MOI presented in

this report is recommended, but not mandatory. However, the section of this report entitled "Instructor Requirements" is meant to be mandatory. The simulator used for this training was the Simulator Training Research Advanced Testbed for Aviation (STRATA) AH-64A flight simulator. It is located at the Army Research Institute (ARI) facility, building 5100, Fort Rucker, Alabama.

During the past four years, many aviators including students, IPs, Standardization IPs, and Commanders stated that this training was valuable to them and to their units. In FY 2004, it was reported to ARI that personnel who had completed a single training session remembered the material well enough to successfully fly and land their aircraft using BUCS after the mechanical flight controls were damaged by hostile fire in Afghanistan.

Hands-on BUCS training is important for safety-of-flight because of the Apache's frequent close proximity to the ground and other obstacles. Immediate, correct, and coordinated actions by the crew are vital to reestablishing safe flight control using BUCS. It was the purpose of this block of BUCS instruction to provide such a high-level of hands-on training in STRATA.

Prior to this ARI program, emergency flight using BUCS in AH-64A Apaches presented two problems for crews. First, simulator-based training was unavailable because no existing U.S. Army AH-64A training device simulated the flight control feel and flight behavior of a BUCS engagement. Only classroom instruction was provided. Second, BUCS training in the actual aircraft was prohibited for obvious reasons of safety and cost.

In 1999 the Army increased its emphasis on BUCS training for Apache crews. A U.S. Army "Red Team" recommended hands-on BUCS familiarization training for Apache crews in a suitable flight simulator (Johns, 2000, March; Little, 2000). The Red Team determined that pilots need training in the detection and diagnosis of flight-control problems and correct operation of the flight controls when the BUCS is engaged. The Program Manager for Apache at Redstone Arsenal identified STRATA as being capable of supporting BUCS. STRATA supports BUCS familiarization in these critical categories: 1) jammed mechanical flight controls; 2) severed mechanical flight controls; 3) crew contention of controls causing inadvertent activation of BUCS; and 4) related system failures that result in BUCS failure.

The BUCS familiarization training tasks and MOI contained in this document were designed to train aviators who had never before learned BUCS, or those who had lost proficiency through lack of practice. If one is training BUCS for the sustainment of skills, the MOI can be adjusted based on individual or crew proficiency. If proficiency is high, little MOI is required.

Simulator Set-Up for Initial BUCS Training

Brief Description of the STRATA AH-64A Simulator

The STRATA training device is a fixed-base, full-mission simulator for the A-model Apache. The pilot and CPG cockpits were taken from aircraft 83-23789, the rest of which was scrapped. CAE Corp. designed, built, operates, and maintains the Apache research simulator at the ARI facility. The simulator, which incorporates a modular design capable of software modification, uses the hydraulic CAE digital control loading system to simulate all of the flight-control characteristics of the AH-64A, including BUCS.

A G-seat and active five-point shoulder harness provide acceleration, deceleration, and motion cues. All controls, instruments, and displays are functional and integrated with each other. Both cockpits are provided with three 100-inch, rear projection visual displays providing each station with a 180-degree horizontal by 45-degree vertical out-the-window field of view. What the aviators see out their windscreens is a highly detailed, geo-specific terrain database rendered by three CAE Medallion™ image generators, which are capable of presenting 16,000 polygons per frame at a rate of 60 frames per second.

Simulator Set-Up

Before beginning the first training period of the day, the instructor should perform a short test flight to insure that the simulator is ready to support training. During the test flight, the instructor should fly the ownship to the desired takeoff position on the runway and land (on ground, flat pitch, engines 100%). Then press the **COND STORE** button on the console at the instructor/operator (I/O) station. The ownship will be reset to this position several times during training at the airfield on the database by activating the **COND RESET** button. The **COND RESET** function repositions the ownship to the previously stored location (**COND STORE**) and removes any current malfunction.

After the test flight and the **COND STORE** are completed, you may want to teach the BUCS test. In that case set the ownship on a parking pad with APU on and engines off. Complete all checklist items up to, but not including, the BUCS test. The initial simulator set-up conditions for the BUCS test are presented below. This set-up is to be completed by the IP at the I/O console prior to beginning the BUCS test.

- Illumination: Day, out-the-window (OTW)
- Present position (PPOS): Parking pad, may be start position
- Outside temperature: +20 C
- Pressure altitude (PA): Field elevation
- Pressure setting for altimeter Kolsman window (Hg): 29.92
- Gross weight (GW): Approximately 16,300 lbs (8 missiles, 38 MK66 M-151 rockets, 1200 rounds 30mm, 2350 lbs fuel)
- Winds: Calm
- APU: On

- Engines: Off
- Doppler route programmed: Correct FLY-TO selected
- All system checks: Completed up to, but not including, BUCS test
- Weapons: Off

If desired, a performance planning card (PPC) may be completed for the simulator flight conditions to validate hover checks. However, fuel burn rates will be inaccurate due to using the **COND RESET** button (which refills tanks automatically).

During BUCS training sessions, it is highly recommended that the IP direct the crew to skip engine start and run-up checks. Do not waste BUCS training time doing starts and run-ups. This is especially important if BUCS training for the crew will not be scheduled again for a considerable length of time. Engine start and run-up checks can be done in the actual aircraft. BUCS training cannot. To restart the engines, the IP should perform an engine "quick-start" from the I/O console with the **START ENGINES** button (if so equipped) or with the **COND RESET** function.

Figure 1 (below) presents a view of the BUCS control page used by the author (M.C.) at the STRATA I/O station for control of BUCS training sessions at ARI. It is the considered opinion of the author (M.C.) that the instructional features and capabilities programmed into this control page represent the minimum required to provide adequate BUCS training. The importance of the features presented in Figure 1 will become apparent when the reader gets to the section of this report entitled "Task Descriptions and Method of Instruction (MOI)."

Status	Quick Setup	Ownship	Environment	Communications	Tools	Map	BUCS	Experiment
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Control Condition			SPAD Breakage & Control		
CONTROL AXIS	CONDITION	ACTIVATE	AXIS	PLT	CPG
Cyclic Long	Sever Aft CPG	Apply	Longitudinal	┘	┘
Cyclic Lateral	Sever Aft PLT		Lateral	┘	┘
Collective	Control Jam		Pedals	┘	┘
Pedals			Collective	┘	┘
			Apply		

Total System Malfunctions						SPAD Bias	
BUCS Failure	Partial BUCS Failure	DASE Failure	Primary Hydraulics	Generator 1 & 2	Apply	Weaker PLT	Weaker CPG

Repositions & Total Resets				
In Air 500 feet	In Air NOE	On Ground	Cond Reset	Flight Freeze

Caution / Warning Panel							
BUCS ON	ASE	PRI HYD PSI	GEN 1 RECT 1	GEN 2 RECT 2	APU ON	APU BRK	

CPG BUCS TRIGGER ACTIVATIONS --> 0

Figure 1. View of BUCS control page at STRATA instructor/operator console.

Instructor Requirements

BUCS familiarization training in the simulator is essentially emergency procedures training. As such, a rated AH-64 IP is required to teach and evaluate BUCS emergency procedures and techniques in the simulator. IP duties can be performed from the I/O console, or to a limited extent from either crew station. Since many

simulator control pages are not accessible from the crew station seat, it is recommended that the IP use an I/O station assistant if teaching from the cockpit.

Use of the phrase "Pilot/CPG" in the title of a BUCS task means that the Pilot initiates the emergency procedure, becomes verbally incapacitated by the IP, and then the CPG completes the landing. This counts as two tasks. The phrase "CPG/Pilot" in the title means that the CPG initiates the emergency procedure, becomes verbally incapacitated by the IP, and then the Pilot completes the landing. This also counts as two tasks.

The MOI for each BUCS task is preceded by the acronym "MOI – " and enclosed with bold quotation marks ("..."). The MOI in this document has been refined over a period of four years. It includes flight techniques. Since techniques are not requirements, those parts of the MOI are suggested but not mandatory. For example, the transfer of flight controls with BUCS active employs the following technique. The Pilot is flying under BUCS, due to a jam, and becomes incapacitated. The CPG takes the controls using the following steps: 1) CPG gets hands and feet on the controls; 2) CPG decouples affected axis shear pin; 3) CPG centers the affected flight control; 4) CPG presses and holds the BUCS trigger; 5) CPG displaces affected flight control to minimum mistrack point; 6) CPG visually and physically verifies BUCS control belongs to him/her on affected axis; 7) CPG releases BUCS trigger; and finally 8) CPG verbalizes control transfer by saying "I have the controls." Techniques such as this have proven effective during past BUCS training. Ultimately, students learn to complete these control transfer steps in approximately five seconds or fewer.

Many BUCS tasks and procedures occur in quick succession. These tasks need to be performed properly, and rapidly, to keep the aircraft flying safely. An IP's responsibilities during BUCS training are considerable. The IP must: 1) Monitor crewmember actions during the emergency; 2) Be prepared for expected events in each task; 3) Deliver rapid-fire MOI (including verbal corrections) as the task is performed; and 4) Synchronize MOI with the actions of the crew, and the condition of the aircraft.

Correct application of MOI is critical to BUCS training, so the IP must be proficient. Teaching BUCS properly requires considerable practice. Remember an IP's rule of thumb: What is first learned is best remembered. Psychologists call this a primacy effect. Use this primacy effect to your advantage. It is better to train BUCS right the first time. If your students have to unlearn poorly trained BUCS tasks, and then relearn them correctly, your work as an IP is increased.

The result of this work will be BUCS training that is more effective, that is executed at speed, and that catches and corrects mistakes during the training session. Typical mistakes made by aviators—including improper operation of the BUCS trigger, delayed reaction time, improper emergency diagnosis, or excessive flight control movement resulting in over-control—require immediate correction by the IP to help aviators avoid unsafe habits early in training.

The guiding principles for BUCS instructional design were taken from the Instructor Pilot Course at Fort Rucker (USAAVNC, 1994, January). The instructional strategy used at ARI was the classic "crawl, walk, run." At the beginning of the training period, the IP alerted the crew to what malfunction was going to be invoked, described its identifying features, described what should be done and in what order, and then, after invoking the malfunction from the instructor interface console, walked the crew through it step by step. Verbal instructions were provided before and during the training task. Feedback was provided after the event, along with the opportunity for questions. This strategy has been adhered to in the instructional lessons that follow.

Video Monitoring of the Crew

To train BUCS properly the simulator must provide the IP with a video monitoring system. This includes low-light-level cameras, as well as repeater monitors at the I/O station to observe the OTW view. This allows the instructor to watch the crew perform BUCS procedures. This capability facilitates monitoring of and providing feedback to the crew being trained.

Using the video monitoring system on STRATA, the author (M.C.) has observed several common mistakes aviators make during familiarization training. For example:

- Does the CPG center the affected flight control prior to activating the BUCS trigger?
- To gain control, does the CPG appropriately mistrack the affected flight control after the BUCS trigger is pressed and held?
- Do crewmembers forget to reset their Master Caution lights?
- During breakout for a collective jam, is the Pilot or CPG setting the collective friction?
- How often does the Pilot or CPG interrupt the force trim during flight, and how does this degrade a BUCS control handover?
- Is the appropriate type of force used on the jammed flight control (pushing, not hitting) to decouple a SPAD?
- When taking over BUCS control from the Pilot, at what point in the process does the CPG press the BUCS trigger?

BUCS Familiarization Training History

BUCS familiarization training was integrated into the AH-64A Aviator Qualification Course (AQC) program of instruction at Fort Rucker, Alabama in January 2001. The AQC schedule was modified to accommodate BUCS on training days 11 and 12 (later changed to days 12 and 13). Each pair of students received 1.5 to 1.8 hours of BUCS training in the STRATA simulator. Forty-four (44) BUCS tasks were included in the program of instruction.

All students were trained in both Pilot and CPG stations. There were several reasons for this. Crewmembers learned the specific operation of BUCS at each station. Flight control differences between the front and back seats, during jams and

severances, were demonstrated. Emergency procedures and techniques that were unique to each station were learned and practiced. BUCS flight control transfers were taught for Pilot to CPG, and CPG to Pilot. Control transfers, with BUCS activated, are different than normal flight control transfers. These differences were explained and practiced until the students became proficient. Crewmembers were able to practice crew coordination, both as Pilot and as CPG, during flight control emergencies involving activation of BUCS.

Crewmembers learned to identify and correctly respond to jams, severances, BUCS-related system failures, and inadvertent activation of BUCS through contention of the flight controls. They learned to activate BUCS safely, to transfer controls if necessary, and to complete the emergency procedure.

Initial BUCS familiarization training was typically completed in one flight. Since this initial training was usually a student's only exposure to hands-on BUCS, a balance had to be found between competing constraints. Each session needed to train students in the detection and operation of BUCS, in both seats, using repetition to reinforce instruction, while not overloading the students with too much information in a single session. The course material presented below in the Task Descriptions and Method of Instruction section was the compromise reached among these multiple constraints.

BUCS continuation (refresher) training for fielded units was typically not as dependent upon achieving this balance. Instruction for continuation training was partly based upon crew proficiency. It included MOI, as necessary, to achieve proficiency. However, if a crew was already adept at the skills of BUCS, an increased percentage of their training time included no-notice flight control emergencies.

BUCS Familiarization Training Features

There were a number of instructional features of the BUCS program that made it "good training." Some of the more important of these features are briefly described below. Montague (1988) provided a comprehensive discussion of the instructional features that have been shown to be effective in military training.

Imitating the Working Environment for Learning

Students learn and retain knowledge and skills best when the learning environment incorporates the critical, functional features of the working environment. For maximum transfer from the training to the work, the learning environment should include the context, tasks, procedures, and materials of the job. Training situations should relate to specific job situations as well as to the knowledge students already have. The training situation should involve the same operations, the same tools, and the same machines (or their functional equivalents) as the actual job. BUCS training incorporated this important feature. Students performed the same tasks, using the same procedures, in the same cockpit, and in the same (albeit simulated) flight

environment that they would confront if they should ever need to engage BUCS in the aircraft.

Training Devices for Task Simulation and Practice

Simulators enable learners to acquire the knowledge they need to operate and repair devices, to practice at speeds not constrained by real time, and at a fraction of the cost of using actual equipment. Simulators offer many advantages for training. For example, they are both cheaper and safer to practice on than the actual equipment. This is particularly true of flight simulators, such as STRATA, and emergency procedures training, such as BUCS. Both from a safety and a cost standpoint, it is impossible to conduct BUCS training in the Apache aircraft. In addition, thanks to the unique instructional features of simulators, many more practice trials can be run within a constant training period than is possible in the aircraft. For example, during BUCS training the aircraft engines were started with a single button push. For another example, during BUCS training the simulator was repeatedly repositioned to a preset starting point to begin a new training scenario with a single click of the mouse. This saved the time the crew would otherwise use flying back to the reset point and then landing.

Giving Feedback to Students

Students who receive constructive feedback about the accuracy and adequacy of their performance become more interested in the lesson and learn more. Giving constructive feedback to students about their actions is an effective way for instructors to aid student learning. Timely comments about their performance provide important recognition of their efforts and help correct errors. Feedback should be prompt and provide useful information. During BUCS training both the IP and Mr. Couch provided immediate, detailed feedback that was credible because it was both technically correct and transmitted by instructors with thousands of hours of flight experience. The STRATA simulator is particularly well suited for the provision of immediate, detailed feedback. While at the instructor/operator station, one can observe in real time the OTW view of the simulator, the pilot and CPG cockpits, the flight instruments, the flight controls, other flight parameters, the BUCS condition, as well as communicate directly with the crew. The instructors were effectively monitoring all pilot activity, at both cockpits, in real time. In addition, the instructors could click the **FLIGHT FREEZE** button at any time and stop the simulator in mid trial. This allowed for detailed feedback to be provided, whenever it was needed, based on valid flight information. With the click of a button the crew could be unfrozen to continue the training task or reset to begin it again. Feedback is a powerful feature of simulator-based training in general and BUCS training in particular.

Practicing Lesson-Related Tasks Promotes Learning New Skills

Students learn more by doing than by watching or listening. They should have opportunities to practice the steps of any procedures they are learning. They should

practice the new behaviors in a variety of situations that represent job conditions. Instructors need to provide opportunities for students to practice since practice improves performance. Practice is important. Practice was a large part of the reason for BUCS training in the form described in this report. BUCS familiarization training was created to allow Apache pilots to practice detecting, identifying, and taking appropriate action upon flight control malfunction—all within a safe environment. All crews received practice on the major categories of control malfunctions (jams, severances, contention) on all axes (longitudinal cyclic, lateral cyclic, collective, pedals) during BUCS training. Safe, low-cost practice is one of the chief advantages of simulator-based flight training.

These four examples of instructional features that contributed to BUCS training success are by no means an exhaustive listing. BUCS training also: 1) *Promoted development of mental models*; 2) *Built upon students' existing knowledge*; and 3) *Provided students with representative good examples contrasted with bad examples*.

Task Descriptions and Method of Instruction (MOI)

Task B001: BUCS Test – Pilot/CPG

Task – Perform BUCS test.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; with APU on; with engines off. All start and run-up checks up to, but not including BUCS test, will be completed by IP or staff. Simulator operation and safety briefings completed.

Standard – IAW Operator's Manual TM 1-1520-238-10 (Department of the Army, 1994, August).

MOI – "Pilot and CPG, all checks up to, but not including, the BUCS test have been completed. When you are ready, begin the BUCS test in accordance with the checklist presented in the TM. Note that the flight controls in this simulator will move similarly to the aircraft's as you run the test. So if you are blocking a flight control during it's movement, you could break a SPAD shear pin, just like you could in the aircraft. Make sure you really are clear of the controls."

"CPG, whenever the Pilot announces that he is initiating the BUCS test, you need to tell him that you are clear of the controls. Additionally, when you see caution or warning lights going on or off in your station, you need to verbalize those events to the Pilot. By verbalizing, both of you know that the systems are working properly in both stations, and it's part of crew coordination."

BUCS test (Department of the Army, 1994, August) as follows:

- a. RTR BK switch – BRAKE
- b. Controls – Friction off, centered, and cleared*

*MOI – "Pilot, in case someone accidentally rolls the collective friction full-on instead of full-off, we recommend that you move the collective up and down one time to insure that both frictions are really off. If one of the collective frictions is set to full-on, and you run the BUCS test, it could break a collective SPAD shear pin."

- c. Announce to CPG – you are initiating a BUCS test. Remain clear of the flight controls.
- d. BUCS TST switch – PLT and hold. BUCS ON caution light should go out in approximately 20 seconds. Release switch and wait 15 seconds to see if BUCS FAIL warning light illuminates. If BUCS FAIL warning light illuminates, do not fly the helicopter. If not, proceed to step e.

- e. BUCS TST switch – CPG and hold. BUCS ON caution light should go out in approximately 20 seconds. Release switch and wait 15 seconds to see if BUCS FAIL warning light illuminates. If BUCS FAIL warning light illuminates, do not fly the helicopter. If not, proceed to step f.
- f. BUCS select trigger (CPG) – Press. Verify illumination of the BUCS FAIL warning light in both crew stations.
- g. Collective – Full down.
- h. RTR BK switch – As desired.

I/O Action – After BUCS test is completed, instructor gives aircraft an engine quick-start using the following MOI and steps.

MOI – “Pilot, bring the power levers to FLY. I am going to give you a quick-start from the console. Stay clear of the controls.”

I/O Action – Before activating **COND RESET**, the crew must acknowledge that power levers are to FLY and that they are clear of the controls.

I/O Action –

- In STRATA: Execute **Eng – Quick Start** from I/O console, then execute **COND RESET*** to runway.
- In CMS: **COND RESET*** to runway.

*Note to IP: Prior to activating **COND RESET**, make sure that rotor brake switch is set to OFF, and power levers are set to FLY. If rotor brake switch is not OFF prior to **COND RESET**, the power levers may jam against the rotor brake safety interlock pin when the simulator attempts to back drive them to the FLY position.

Task B002/B003: Warm-Up Flight – Pilot/CPG

Task – Perform warm-up flight.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; before takeoff check complete.

Standard – Perform takeoff, traffic pattern flight (avoid extended patterns), and landing IAW operator's manual, ATM, and BUCS familiarization procedures.

Description – This task consists of pick up to hover, hover power check, normal takeoff, left or right closed traffic pattern, and VMC approach to the approach end of the runway.

MOI – “Pilot, you have the controls. Once you have completed the first before takeoff check by the book, go ahead and pick up to a five-foot hover.”*

*Note to IP: If the Pilot or CPG have trouble with initial hover, do not force them to hover while their control touch is poor. Just tell the Pilot or CPG to execute a normal takeoff, pulling in 10% above predicted hover power of ____%, and complete the traffic pattern and landing. Forcing the students to try and hold the ownship still on their first attempts to hover may induce nausea, frustration, or a crash; none of which will have a positive effect on BUCS training. Typically, hovering proficiency in the simulator will improve to an acceptable level during the training period. So take it easy on them in the beginning.

MOI – “Predicted hover-torque is ____%. After completing the hover power check, execute a normal takeoff, and complete one left (or right) closed traffic pattern. This will be a practice pattern so you can get used to how the simulator flies normally, before I start putting in BUCS-related malfunctions. Downwind altitude at Illesheim is 1600 ft (or approximately 500 ft AGL). Plan your approach to the runway approach-end numbers, to the ground.”

I/O Action – After Pilot lands, continue MOI.

MOI – “Pilot, after landing, and with the collective full down, transfer the flight controls to the CPG. CPG, you will do the same tasks: pick-up to a hover, hover power check, normal takeoff, traffic pattern, and landing.”

“For the remainder of the period, in order to save time, I would like both of you to look at all of your before takeoff check items and acknowledge ‘Good in the front’ and ‘Good in the back.’ But make sure you look at everything first. We have approximately 50 tasks to do in this period, and I want you to complete these takeoff and landing checks more quickly so we will have time to cover all of the BUCS tasks.”

I/O Action – Once the flight control transfer is completed, continue the MOI.

MOI – “CPG, you are cleared for pick-up to a hover, hover power check, and takeoff when ready. Same traffic pattern and land to the approach-end numbers, please.”

I/O Action – After the CPG completes the landing, tell the crew to clear the controls, and then press **COND RESET**. This will reposition the aircraft to the stored takeoff position for the next task.

Task B004/B005: DASE-Off Flight – Pilot/CPG

Task – Perform DASE-off flight.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; before takeoff check complete.

Standard – Perform takeoff, brief DASE-off flight, and landing IAW operator's manual, ATM, and BUCS familiarization procedures.

Description – Pilot picks up aircraft to hover, releases DASE with cyclic release switch, and executes altitude-over-airspeed takeoff over runway. Upon reaching 150 ft radar altitude, Pilot transfers flight controls to the CPG, and turns off force trim switch. CPG completes DASE-off landing on departure end of runway.

MOI – "Pilot, you have the controls. Once you have completed the expedited before takeoff check, go ahead and pick up to a five-foot hover."

"Once you are established at a five-foot hover, punch off your DASE using the DASE release switch on the cyclic. As you hover, you will notice that the aircraft is slightly unstable and slower to respond because the DASE is off. There is a tendency to apply excessive control inputs because of the delayed response, but this can cause PIO, or pilot-induced-oscillation. We suggest that you give the aircraft about one-half second to respond to a control input before you add more input. This may help you avoid getting into PIO."

I/O Action – Once Pilot has disengaged DASE, continue MOI.

MOI – "DASE-off flight has the same flight control response as BUCS ON. With all three DASE axes off line, the aircraft handles as though you were flying BUCS ON for those same three axes. This is a confidence builder, because if you can fly DASE-off, then you should not have a problem flying BUCS ON."

"When ready, Pilot, execute an altitude-over-airspeed takeoff staying over the runway*. Once you have climbed through 150 ft AGL, transfer the controls to the CPG, and turn off the force trim switch."

*Note to IP: Avoid doing a traffic pattern with DASE off. At this early stage, it can induce nausea due to overcontrol. If the crew gets sick flying DASE off, you are defeating your purpose because this could diminish the effectiveness of BUCS training.

I/O Action – After control changeover, continue MOI.

MOI – "CPG, I want you to land on the departure end of the runway. You will notice that the force trim is turned off and the cyclic and pedals are now very sloppy. This

simulates how your controls would feel in the CPG station if you broke shear pins on the pitch, roll, and yaw axes, or had a severance between crew stations on those axes and were flying with BUCS. As you can see, a loss of force trim means that the CPG has to work a little harder to fly and land while in BUCS.”

“CPG, go ahead and land on the departure end of the runway. You can make a normal approach to a hover, and then set the aircraft down from a hover. There is no requirement to do a roll-on landing with a BUCS ON light, unless you have a problem with power or controllability, which you do not have right now. Landing to a hover also gives you more options on where you can land, such as unimproved surfaces and open fields. If you develop a habit of doing roll-on landings with BUCS ON, then you are going to limit your landing area options. So as a technique, we recommend you try doing your BUCS approaches to a hover and then sit down.”

“CPG, once you complete the landing and the collective is full down, the Pilot will turn the force trim switch on, and then I will reset you to the takeoff position.”

I/O Action – After the CPG completes the landing, tell the crew to clear the controls, and then press **COND RESET**. This will reposition the aircraft to the takeoff location for the next task.

Task B006/B007: Contention of Pedals During Ground Taxi – Pilot/CPG

Task – Perform contention of pedals during ground taxi.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; before takeoff checks complete.

Standard – Perform pedal contention demonstration and BUCS operation IAW operator's manual, ATM, and BUCS familiarization procedures.

Description – The task 'perform contention of pedals during ground taxi' is intended to demonstrate what will happen if the crew contends the pedals during ground taxi. In other words, the crew demonstrates to themselves what pedal contention feels like, what pedal response is using BUCS during ground taxi, what happens after the BUCS ON light illuminates, what back-driven pedals feel like in the CPG station, what the BUCS trigger will do, and what a crew should NOT do with the pedals to get into this situation. (Remember, in a BUCS aircraft, contending flight controls should always be avoided. That being said, the CPG 'guards' the pedals when the Pilot requests assistance while setting or releasing the parking brake. The CPG does not 'block' them as he would in a non-BUCS aircraft.)

The Pilot begins ground taxi on runway centerline, tail wheel unlocked, and adjusts ground speed to a brisk walk. Once ground taxi is established, the IP verbally directs CPG to put his feet on the pedals and exert smooth, increasing pressure on right pedal. He also tells the CPG to relax pressure as soon as the BUCS ON caution light illuminates so that the CPG's SPAD is not decoupled. (If the CPG does not relax pressure as soon as BUCS ON illuminates, he will decouple his yaw axis SPAD by pushing against the back-driving servo.)

As the CPG makes a right pedal input, the Pilot counters by applying pressure on the opposite (left) pedal. When sufficient force is exerted, a pedal SPAD will decouple. Typically, the Pilot's shear pin will break first. As the BUCS ON caution light illuminates, the IP immediately tells the CPG to get off the pedals. (To confirm that only the Pilot's pedal SPAD is decoupled, check the SPAD status graphic on the I/O station BUCS control page. If the CPG did break his shear pin, the instructor has the option of telling the Pilot to break out and continue to taxi, or he can reset the simulator and start the contention process over again.)

If the Pilot breaks out and the CPG does not, the Pilot will continue to ground taxi with the BUCS ON light illuminated. The IP tells the CPG to place his feet lightly on the pedals, and asks him if he can feel his pedals move with Pilot inputs. Once CPG acknowledges the movement, the IP informs him that the pedals are still moving because they are being back-driven by the servo. The CPG can feel movement but cannot make any inputs, short of breaking the SPAD, which he will not do until directed to do so by the IP.

The IP then verbally incapacitates the Pilot. This forces the CPG to take over by getting on the controls, breaking pedal shear pin, re-centering the pedals, pressing the BUCS trigger, off-setting the pedals to the minimum mistrack point until pedal control is confirmed, releasing the trigger, and finally verbalizing 'I have the controls.' CPG taxis the aircraft with BUCS ON for a short distance. Then the IP resets the simulator.

MOI – “Pilot, you have the controls. I am going to talk you through a controlled contention of the pedals to demonstrate what you should NOT do in the aircraft, and what would happen if you and the CPG accidentally, or deliberately, contended the pedals in a BUCS aircraft.”

“Pilot, unlock the tail wheel and ground taxi down the runway centerline at a brisk walk. In just a moment, I will ask the CPG to get on the pedals and begin applying smooth, increasing pressure on the right pedal to attempt to turn the aircraft. Because you are trying to keep the aircraft on the runway centerline, you will counter the CPG's input to do this. Eventually a SPAD shear pin will break. Most likely it will be the Pilot's first. When you get the BUCS ON caution light and DASE caution light, you are in BUCS on the yaw axis. You will also notice that the yaw switch on the DASE panel has disengaged. The DASE must always disengage before the BUCS can engage if the engagement occurs on the cyclic or pedals.”

“CPG, when you are pushing on the right pedal to contend with the Pilot, as soon as you see the BUCS ON light illuminate, immediately relax your pressure so that you don't break your SPAD. We will do that a little later.”

“OK, we will begin the demonstration. CPG, when you are ready, start applying smooth, increasing pressure on right pedal. Pilot, you counter this and continue to taxi on runway centerline.”

I/O Action – Start MOI immediately when BUCS ON and DASE caution lights illuminate.

MOI – “CPG, relax and take your feet off the pedals. The Pilot is BUCS ON for the yaw axis.”

I/O Action – IP checks SPAD status on BUCS page at I/O console. The Pilot pedal shear pin should be broken. The CPG pin should not be broken.

MOI – “Pilot, you have broken the yaw axis shear pin. That took about 76 pounds of pressure. Notice that you have a BUCS ON light, a DASE light, and the yaw switch has disengaged. Aircraft handling on the yaw axis is slightly sluggish and sloppy, but is still manageable and safe to ground taxi. You will also notice that you still have force trim on the pedals. In fact, the Pilot will never lose force trim for any jam or severance, unless he turns the force trim switch off.”

I/O Action – If CPG pedal SPAD is not broken, continue MOI.

MOI – “CPG, if you put your feet back on the pedals lightly, you will notice that the pedals are still moving with Pilot inputs, but you cannot make any inputs on them with moderate pressure. The reason for this is that the pedals are being back-driven by the servo. Since the linkage is not jammed or severed, and your pedals are still attached to the linkage, they are back-driven. Back-driving is a good thing, because it gives you something to push against in case you have to break your shear pin to transfer control of BUCS to your station.”

“How is it possible for the opposite crew member to take over BUCS, since that person must break his own shear pin to do so? The question being: Who would I push against to break my shear pin?”

“The answer is, you would push against the back-driving servo to break out and take control in your station, (BUCS logic permitting).”

“CPG, the Pilot has just been wounded by small arms fire, but will hold the aircraft steady and continue ground taxi until you take over.”

“CPG, get on the controls. Break your pedal shear pin by pressing right pedal. It will take about 90 pounds of force. Once you break the shear pin, re-center the pedals. Now press and hold the BUCS trigger, located underneath the collective head. As you are holding the BUCS trigger, offset your pedals left or right until you see the yaw axis respond to your inputs. Once you see that you have control of the yaw axis, release the BUCS trigger, and as a last step, say ‘I have the controls.’”

“Saying ‘I have the controls’ is always the last step of a BUCS control transfer. Because most BUCS engagements are controlled by only one person in the crew at a time, you would not want to say ‘I have the controls’ before you had verified that you have them, because if the other crewmember still has control of the BUCS axis and lets go of the controls, the aircraft could crash. The BUCS control transfer is much different than a routine flight control transfer, and it is important that you do the BUCS control transfer the right way.”

“CPG, you have taken control using the BUCS trigger. This is the final control transfer and you will not be able to give the pedals back to the Pilot. This means that you will have to manage the flight controls 100 percent of the time until the blades stop turning during shut-down.”

“CPG, you will also notice that you have lost force trim on the pedals. Anytime the CPG breaks a shear pin on the cyclic or pedals, or has a severance between the crew stations, he will always lose force trim on the affected axis. All other axes that are operating normally will still have force trim, as long as the Pilot does not turn it off. This means that if you are using BUCS in the front seat, you will lose force trim on the affected axis. There is one exception to this, which we will look at later.”

"Pilot, go ahead and lock the tail wheel switch. As soon as the light goes out, I will reset you back to the approach end of the runway."

I/O Action – After the tail wheel light goes out, tell the crew to clear the controls. Then press **COND RESET**. This will reposition the aircraft to the takeoff position for the next task.

Task B008/B009: Single Axis Jam – Longitudinal Cyclic – Pilot/CPG

Task – Perform immediate actions and emergency procedure for jam on longitudinal cyclic.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; above 300 ft AGL, with IAS (indicated airspeed) 80 – 100 knots.

Standard – Perform immediate actions, crew coordination, and emergency procedure for jammed longitudinal cyclic IAW operator's manual, ATM, and BUCS familiarization procedures.

Description – Pilot is on the controls for takeoff. Recognize jam on longitudinal cyclic. After verbally confirming that CPG is not blocking flight controls, decouple the longitudinal SPAD using sufficient force (approximately 42 pounds of force required on longitudinal cyclic by Pilot to breakout). After SPAD shear pin is broken, confirm BUCS ON and DASE caution lights are illuminated. Confirm that pitch DASE switch is disengaged. Correctly recite and perform BUCS ON emergency procedure IAW operator's manual.

Once the Pilot has verbalized these steps, the IP will verbally incapacitate the Pilot. This will force the CPG to take over the controls and land the aircraft.

After the CPG lands, the crew completes the emergency procedure steps. Additional advice is given to the crew about the CPG landing the aircraft with a BUCS ON caution light, and how to shut the aircraft down if the Pilot is unable to start the APU.

MOI – “Pilot, you have the controls. Next, we will look at flight control jams. We will begin with single-axis jams, and I will give both crewmembers a chance to fly for each axis that is jammed. First of all, crew coordination is an important part of flight, including BUCS operations. If you feel that a flight control is binding or jammed, before you break the SPAD, try to confirm that the other crewmember is not blocking the controls. But obviously, if you do not have time to confirm this, then just break the SPAD and complete the BUCS ON emergency procedure.”

“Another rule to keep in mind is that whoever initiates the BUCS ON condition should be the same person that lands the aircraft. You do not want to do a BUCS control transfer unless the person that initiated the BUCS ON is unable to continue flight (such as by becoming wounded or otherwise incapacitated).”

“Pilot, when ready, you are cleared for takeoff straight ahead.”

I/O Action – Let the Pilot climb above 300 ft AGL, and accelerate to or above 80 KIAS before inserting the longitudinal cyclic jam from the instructor console. Once

altitude/airspeed requirements are met, and aircraft is not pitching excessively, insert longitudinal cyclic jam and immediately start MOI.

MOI – “Pilot, you have a jam on your longitudinal cyclic. Once you have verbally confirmed that the CPG is clear of the controls, break the longitudinal shear pin by pulling aft or pushing forward. It will take approximately 42 pounds to break the shear pin.”

“Pilot, once you break the shear pin, you will get the BUCS ON and DASE caution lights. You will notice the three-second wash-in time for 100 percent BUCS authority. You will notice some sluggishness in the pitch axis, similar to DASE off, but all other control axes will still feel and function normally. Also, you will notice that the pitch switch has kicked off line. The DASE must disengage before the BUCS can engage for a given axis.”

“Also notice that you still have your force trim on the BUCS-ON axis. The Pilot will never lose force trim on the cyclic or pedals for any jam or severance, unless he turns the force trim switch off.”

“Pilot, what is the emergency procedure for the BUCS ON caution light?”

I/O Action – Once the Pilot completes verbalizing the emergency procedure, continue with MOI.

MOI – “CPG, the Pilot has just been hit by ground fire, but will continue to fly the aircraft straight and level until you can take over.”

“CPG, I will talk you through, step-by-step, a BUCS control transfer. Get on the controls and break your cyclic longitudinal shear pin. It will take about 50 pounds of pressure. Do not say that you have the controls just yet. Once you break the shear pin, re-center the cyclic. While re-centered, press and hold the BUCS trigger underneath the collective head. As you hold in the BUCS trigger, mistrack the cyclic in pitch until you can visually and physically confirm that you have control of that axis with BUCS. When you have confirmed that you have the controls, especially the BUCS-ON axis, release the BUCS trigger, and as a last step say ‘I have the controls.’”

“Remember, CPG, you do not want to say that you have the controls until you have confirmed the BUCS-ON control is yours. If you say it early, and the Pilot lets go of the flight controls, and accidentally bumps the force trim switch off in the process, this may cause his cyclic to fall forward, and the aircraft will dive towards the ground. If this happens, you will be trying to press the BUCS trigger to get control. Improper flight control transfers with BUCS can lead to a very dangerous situation. So, to avoid that problem, the last step of a BUCS control transfer is saying ‘I have the controls.’”

“CPG, you will notice that when you decouple the SPAD, you lose force trim in the pitch axis. The reason for this is that the only force trim on the aircraft is in the Pilot’s station.

You have force trim in the front seat because your controls are mechanically attached to the Pilot's controls. But if you break a shear pin in the CPG station, or have a severance between crew stations, then you will always lose force trim on that axis. In this case, you were attached to jammed control linkage on the longitudinal axis, and when you broke your SPAD you lost force trim on pitch cyclic."

"Without force trim, the affected control feels similar to a wet noodle to the CPG. So you have to work a little harder than the Pilot to land with BUCS. In addition to the sluggish control response, you must hold on to the BUCS-enabled flight control because it will fall over if you take your hand off of it."

"Also, because you used the BUCS trigger, you have completed the final control transfer on that axis. This means that you will have to maintain positive hands-on flight control until the rotor stops during shutdown. Once the BUCS trigger is used, no further control transfers back to the Pilot are possible on that axis. However, any new BUCS activations on other axes are considered separate engagements, so it is possible to end up with mixed control under BUCS. We will talk more about that later."

"CPG, after you have completed your landing as soon as possible, the Pilot will start the APU."

I/O Action – After the CPG completes the landing, continue with MOI.

MOI – "While starting the APU, terminology is important. Since the CPG does not have an APU ON caution light, he needs to get positive confirmation from the Pilot that the APU is really on. The Pilot should say 'Starting APU,' rather than 'APU coming on.' We have seen situations where the CPG misinterpreted what the Pilot said about APU status and pulled off the power levers for the emergency shutdown, which in turn caused a hard shutdown. Hard shutdowns are potentially very dangerous when you have a BUCS ON caution light and the rotor is still turning."

"Pilot, once you see the APU ON light, tell the CPG. Either one of you can pull the power levers off, but the Pilot must turn the fuel switches off."

I/O Action – Once the emergency shutdown is complete, continue with MOI.

MOI – "In this scenario, I verbally incapacitated the Pilot, which forced the CPG to take BUCS control using the BUCS trigger. What if the incapacitated Pilot was unable to start the APU once the aircraft was on the ground?"

"If the Pilot could not start the APU, the CPG would have to do a hard shutdown. Once power levers are pulled back, the generators will kick off line at 89 percent Nr (assuming the aircraft is sitting on the squat switch and the APU is off). Once the generators kick off, the BUCS ON light will go out and the BUCS FAIL warning light will illuminate; meaning that you will lose all control of the axis that was previously under BUCS control."

“The loss of BUCS control from loss of AC electrical power means that the servo (longitudinal in this case) might stay in the current position; or it might go full in; or it might go full out. We just don't know. The servo will still have most or all of 3,000 psi of hydraulic pressure available at 88 percent Nr. This could potentially drive the servo, and rotor system, to an undesirable position very quickly.”

“The fact that this particular BUCS ON was on the longitudinal (pitch) cyclic means that a hard shutdown could angle the rotor blades into the cockpit area or tail boom. If BUCS ON were on the lateral (roll) axis, a hard shutdown could possibly roll the aircraft over.”

“Therefore, it is recommended that if the APU is not running, and the CPG has to do a hard shutdown on the aircraft with a BUCS ON caution light, before pulling the power levers out of the FLY position the CPG should complete the following steps: 1) Lower the seat as far as it will go; 2) manually lock the shoulder harness; 3) slouch down in the seat to get lower; and 4) put helmet visor down. These four suggested steps should help protect the CPG if he is forced to do a hard shutdown with a BUCS ON caution light.”

I/O Action – After completion of emergency procedure, do the following. Tell the Pilot to turn the fuel switches on and bring the power levers to FLY. When in FLY, I/O selects engine quick start from console (if available). Tell the crew to clear the controls, and then press **COND RESET**. This will reposition the aircraft to the takeoff position for the next task.

Task B010/B011/B012: Single Axis Jam – Lateral Cyclic – CPG/Pilot/CPG

Task – Perform immediate actions and emergency procedure for jam on lateral cyclic.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; climbing above 300 feet AGL, IAS 80 – 100 knots.

Standard – Perform immediate actions, crew coordination, and emergency procedure for jammed lateral cyclic IAW operator's manual, ATM, and BUCS familiarization procedures.

Description – Prior to inserting the jam, IP will advise the CPG that two options are available to him if a jam occurs while CPG is flying the aircraft. One option for the CPG is simply to transfer the controls to the Pilot without decoupling first, if it is safe to do so, and the Pilot can break out and land. The other option is to break out in the front seat and use BUCS to land. For this particular task, the IP will inform the CPG of the options, and tell him to break out in the front seat, being mindful not to pull the BUCS trigger since the CPG will be the 'first breaker.'

CPG does the takeoff. Above 300 ft AGL and 80 KIAS or greater, IP directs the CPG to start a right turn and then inserts a lateral cyclic jam while he is in the turn. IP informs the CPG of the two options and tells him to break out and continue in BUCS flight. CPG verbally confirms that Pilot is not blocking flight controls. Then CPG decouples the lateral SPAD using sufficient force (approximately 30 pounds). After lateral SPAD shear pin is broken, CPG confirms BUCS ON and DASE caution lights are illuminated. CPG correctly verbalizes and performs BUCS ON emergency procedure IAW operator's manual. CPG confirms with Pilot that roll DASE switch is disengaged.

Once the CPG has completed verbalizing the emergency procedure steps, and has initiated the start of landing as soon as possible, the IP will verbally incapacitate the CPG. This will force the Pilot to break his lateral shear pin, take over controls, and continue making the approach to land the aircraft.

When the Pilot is established in flight, the IP will then verbally incapacitate the Pilot. The Pilot will continue straight and level flight until the CPG says 'I have the controls.' The CPG will get on the controls, center the lateral cyclic, press and hold the BUCS trigger, mistrack the lateral cyclic, visually and physically confirm the BUCS control is to the CPG flight control, release the BUCS trigger, and then verbalize the flight control change. Once the control transfer is complete and the CPG is established in flight, the IP will **FLIGHT FREEZE** the simulator and then press **COND RESET**.

MOI – "CPG, you have the controls. Cleared for takeoff when ready, straight out. In just a moment, I am going to jam your lateral cyclic. As the CPG, you have two options if you get a jam in the front seat. One option is, if conditions permit and it is safe to do so, you can simply describe what the problem is to the Pilot, give him the controls, and

he can break out in the back seat. The advantage to this is that the Pilot will not lose force trim on the decoupled axis, like you would in the front.”

“The other option is you can break out in the front seat. Since you are the first breaker, you will get BUCS ON right away. No BUCS trigger is required. As the saying goes, ‘First breaker is the taker.’ In fact, if you break out first, you will want to stay away from the BUCS trigger. Because if you accidentally hit it, you will still have BUCS control in the front, but you will not be able to transfer the controls to the Pilot later if something happens to you. The BUCS trigger is the final control transfer.”

I/O Action – Let the CPG climb above 300 ft AGL and accelerate to or above 80 KIAS. Then tell him to start a right turn, before inserting the lateral cyclic jam.

MOI – “CPG, begin a right turn.”

I/O Action – Insert lateral jam while CPG is turning right.

MOI – “CPG, you have an apparent jam on the lateral cyclic. Once you have confirmed that Pilot is not blocking, break the lateral shear pin. It will take about 30 pounds of force.”

I/O Action – Once CPG breaks lateral SPAD, continue MOI.

MOI – “CPG, you have decoupled the lateral SPAD. Notice that you have BUCS ON and DASE lights, and a three-second wash-in on the lateral axis. There is no need to press the BUCS trigger. Also, you have lost force trim on lateral cyclic. What are the emergency procedure steps for BUCS ON?”

I/O Action – Once CPG has completed verbalizing the emergency procedure steps for BUCS ON, verbally incapacitate him.

MOI – “Pilot, the CPG has just been hit by ground fire, but will continue to maintain straight and level flight until you can take over. Get on the controls and break your lateral shear pin. Notice how the aircraft will jump slightly in roll when you break the SPAD. This jump tells you that BUCS control is now yours on the affected axis, and once again you will get the three-second wash-in time. When you have confirmed BUCS control in the back seat, say ‘I have the controls.’”

I/O Action – Once Pilot has broken out and taken control, continue with MOI.

MOI – “Pilot, you have control with BUCS on the roll axis. What would it mean if you had broken the SPAD and the aircraft did not jump to your stick position? It would mean that the CPG has inadvertently pressed his BUCS trigger and you will not get BUCS control of that axis by breaking your lateral shear pin. So, you will have to coax him into controlling the roll axis while you do your landing. Not the best way to land.”

I/O Action – Once the Pilot is established in level flight, continue with MOI.

MOI – “CPG, the Pilot has been hit with a larger bullet than yourself, so you need to take over the controls and land. Get on the controls, center the lateral cyclic, press and hold the BUCS trigger, and then mistrack the lateral cyclic. Once you see that you have lateral control in the front, release the BUCS trigger and say ‘I have the controls.’”

“CPG, you probably noticed that during the final control transfer with the trigger that you did not get the three-second wash-in time. Since your SPAD was already decoupled, you got almost instantaneous response as you mistracked the lateral cyclic with the BUCS trigger pressed. It is very important when you use the BUCS trigger in the CPG station that you center the affected flight control as much as possible before you press the BUCS trigger. Then mistrack the control while the trigger is pressed. If you don’t center before you press the trigger, you may get a very large flight control input, which you want to avoid. We have seen cases where the CPG pressed the BUCS trigger while the control was resting against the mechanical stop, which caused the aircraft to do a complete barrel roll or inside loop. Those maneuvers don’t work very well when you are at terrain flight altitudes, and recovery can be difficult or impossible. Large fuselage movements can be very hazardous, especially when the aircraft is at low altitudes or when you are flying under the night system.”

I/O Action – Once CPG is established on final approach for landing as soon as possible, press **FLIGHT FREEZE**.

MOI – “CPG and Pilot, in order to save time you will not have to physically land, start the APU, and perform the emergency shutdown every time we have another BUCS engagement. That way, you will have more time to practice with jams and severances.”

I/O Action – After **FLIGHT FREEZE**, tell the crew to clear the controls and then press **COND RESET**. This will reposition the aircraft to the takeoff position for the next task.

Task B013/B014: Single Axis Jam – Collective – Pilot/CPG

Task – Perform immediate actions and emergency procedure for jam on collective.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; climbing above 300 ft AGL, with IAS 80 – 100 knots.

Standard – Perform immediate actions, crew coordination, and emergency procedure for jammed collective IAW operator's manual, ATM, and BUCS familiarization procedures.

Description – Pilot does the takeoff. Above 300 ft AGL and 80 KIAS or greater, IP inserts collective jam. IP informs the Pilot that he has a collective jam, and to take appropriate action. Pilot verifies collective jam and confirms with CPG that he is not blocking. IP advises the Pilot to break the collective shear pin by pushing down, altitude permitting. (Obviously, one would not want to push the collective down if one were flying along at 10 ft and 100 knots.) Pilot then breaks collective shear pin. Pilot correctly verbalizes and performs BUCS ON emergency procedure IAW operator's manual. Pilot confirms that no DASE switches are disengaged.

Once the Pilot has completed verbalizing the emergency procedure steps for BUCS ON collective, IP informs the Pilot that collective friction must be applied. This is so the collective will hold it's position if the Pilot has to remove his hand from it momentarily. Setting the friction will also reduce unwanted collective oscillations.

When the Pilot is established in flight, has set his collective friction, and has completed verbalizing the emergency procedure, the IP will verbally incapacitate the Pilot. This will force the CPG to take control and land the aircraft.

After instructing the CPG on how to take BUCS control of the collective, the IP will cover the loss of the Droop Potentiometer and have the CPG demonstrate the effect to the crew. After the demonstration of the loss of the Droop Potentiometer, the IP will **FLIGHT FREEZE** the simulator, have crew turn their collective frictions off, have crew clear controls, and then press **COND RESET**.

MOI – “Pilot, you have the controls. When ready, you are cleared for takeoff straight ahead.”

I/O Action – Let the Pilot climb above 300 ft AGL, and accelerate to or above 80 KIAS before inserting the collective jam. Once altitude/airspeed requirements are met, and aircraft is not pitching excessively, insert collective jam and immediately begin MOI.

MOI – “Pilot, you have a jam on your collective. Once you have verbally confirmed that the CPG is clear of the controls, break the collective shear pin by pushing down or

pulling up. It will take approximately 40 pounds to break the shear pin. We recommend you push down to break the pin if altitude permits."

"Pilot, once you break the shear pin, you will get the BUCS ON caution light but no DASE light, because the collective doesn't use DASE. You will notice the three-second wash-in time for 100 percent BUCS authority, and a change in the one-G-spring effect. When you get the aircraft under control, walk your hand down the collective and apply enough friction so the collective will stay where you put it."

"There are three reasons that you should consider pushing the collective down to break the shear pin, if altitude permits. One, by pushing the collective down to break out, BUCS ON will result in a reduction of torque on the main rotor, rather than an increase. This may prevent an engine over-torque. Two, for most people it is easier to break the collective shear pin by pushing down rather than by pulling up. Three, if you pull up on the collective to break out, you may ram the tip of your left elbow into the armor panel on the left side of the seat. This can hurt. It has happened before."

I/O Action – When the Pilot is established in flight, has set his collective friction, and has completed verbalizing the emergency procedure, verbally incapacitate the Pilot. Then instruct the CPG on how to take BUCS control of the collective.

MOI – "CPG, the Pilot has been hit but will keep the aircraft straight and level until you can take control. Get on the flight controls and break your collective shear pin by pushing down on the collective. Then re-center the collective. Press and hold the BUCS trigger. While holding the trigger, move the collective up or down until you see that you have control of the torque. Once you have BUCS control of torque with your collective, release the BUCS trigger and tell the Pilot, 'I have the controls.' Also, you will need to adjust friction as necessary on your collective."

I/O Action – Once the CPG is established in flight and has set his collective friction, describe the effect of the loss of the Droop Potentiometer. Then direct the CPG to demonstrate this effect to the crew.

MOI – "On the collective in BUCS there is a performance difference between the Pilot and the CPG that we don't see on the other controls. At the base of the Pilot's collective only, there is a device called a Droop Potentiometer that provides electrical information to the engines about the position of the collective. This is different than the Load Demand Spindle, which is mechanical."

"In normal flight, when the CPG is flying he is moving the Pilot's collective in tandem through the control linkages. Now, however, the CPG's collective is moving independently of the Pilot's collective because of the jam and subsequent breakout. So the Droop Potentiometer is not providing any input to the engines on what the CPG's collective movement is."

“To demonstrate what effect this has when the CPG is flying BUCS collective, I want the CPG to do the following: 1) First, make sure your altitude is at least 400 ft AGL; 2) once at altitude, bottom the collective; 3) once bottomed, pull in 80 percent torque as fast as you can and watch the Np for droop; 4) note that there can be a very substantial Np droop.”

“The point here is that if the CPG has to fly BUCS on the collective after breaking out of a jam, make normal collective movements and this will keep Np droop within limits. Avoid quick, abrupt movements.”

I/O Action – Once CPG is established on final approach for landing as soon as possible, press **FLIGHT FREEZE**. Tell the crew to turn their frictions off, clear the controls, and then press **COND RESET**.

Task B015/B016: Single Axis Jam – Pedals – CPG/Pilot

Task – Perform immediate actions and emergency procedure for jam on pedals.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; climbing above 300 ft AGL, with IAS 80 – 100 knots.

Standard – Perform immediate actions, crew coordination, and emergency procedure for jammed pedals IAW operator's manual, ATM, and BUCS familiarization procedures.

Description – Prior to takeoff and inserting the jam, IP will again advise the CPG that two options are available to him if a jam occurs while the CPG is flying the aircraft. One option for the CPG is simply to transfer the controls to the Pilot, without decoupling first, if it is safe to do so. Then the Pilot can break out and land. The other option is to break out in the front seat and use BUCS to land. For this task, the IP will inform the CPG of the options, and tell him that this time he will transfer the controls to the Pilot, and the Pilot will break out on pedals using the right pedal.

CPG does the takeoff. Above 300 ft AGL and 80 KIAS or greater, the IP inserts a pedal jam. The IP informs the CPG of the two options, and then tells him to confirm verbally that the Pilot is not blocking the flight controls. The CPG will then transfer controls to the Pilot. The Pilot will break the pedal shear pin using the right pedal, conditions permitting. Once the Pilot decouples the pedal SPAD (approximately 76 pounds of force), he will confirm the BUCS ON and DASE caution lights. The Pilot will also note that the yaw switch is off-line, and verbalize the BUCS ON emergency procedure.

Once the Pilot has completed verbalizing the steps of the emergency procedure, and has initiated the start of landing as soon as possible, the IP will verbally incapacitate the Pilot. This will force the CPG to break his pedal shear pin, take over controls, and continue making the approach to land the aircraft.

MOI – “CPG, you have the controls. You are cleared for takeoff straight out. In just a moment, I am going to jam your pedals.”

I/O Action – Let the CPG climb above 300 ft AGL and accelerate to or above 80 KIAS before inserting the pedals jam. Once altitude/airspeed requirements are met, insert pedals jam and immediately begin MOI.

MOI – “CPG, you have an apparent jam on the pedals. Once you've confirmed that the Pilot is not blocking them, you have two available options. I want you to transfer controls to the Pilot, and he will break out from the back seat using right pedal. The advantage of this option being that the Pilot will not lose force trim on the pedals like the CPG would after breaking out.”

I/O Action – Once the control transfer is completed, ask the Pilot what the emergency procedure is for the BUCS On caution light. After the Pilot verbalizes all steps of the emergency procedure, continue the MOI.

MOI – “The reason that the Pilot is asked to break out using right pedal when able is because it is a transient reduction of torque on the tail rotor when the BUCS ON light illuminates, rather than an increase.”

“Pilot, once you break out on the pedals, you will notice that the BUCS ON and DASE lights illuminate. Also, you will notice that the yaw switch is off line, which is correct. Additionally, you still have force trim on the pedals.”

I/O Action – Verbally disable the Pilot, which will force the CPG to take over.

MOI – “CPG, the Pilot has just been hit by ground fire but will continue to maintain straight and level flight until you can take over. CPG, get on the controls and break your pedal shear pin using right pedal. Once you break the pin, re-center the pedals and press and hold the BUCS trigger. As you hold the trigger, move the pedals left or right until you can visually and physically confirm that you have control of the pedals and the yaw axis. When confirmed, release the BUCS trigger and say, ‘I have the controls.’”

I/O Action – After the CPG gets control of the aircraft and initiates the land-as-soon-as-possible approach, press **FLIGHT FREEZE**, tell the crew to clear the controls, and then press **COND RESET**. This will reposition the aircraft to the takeoff location for the next task.

Task B017/B018: Severance Aft of Pilot – Longitudinal Cyclic – Pilot/CPG

Task – Perform immediate actions and emergency procedure for severance aft of Pilot on longitudinal cyclic.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; at or above 500 ft AGL, with IAS 80 – 100 knots.

Standard – Perform immediate actions, crew coordination, and emergency procedure for severance aft of Pilot on longitudinal cyclic IAW operator's manual, ATM, and BUCS familiarization procedures.

I/O Action – Tell the Pilot to depart for the Doppler waypoint, climbing to 500 ft and 100 knots.

MOI – “Pilot, you have the controls. Cleared for takeoff when ready, flying to the Doppler waypoint. Climb to 500 ft AGL and 100 knots enroute.”

I/O Action – Let the Pilot climb to 500 ft AGL and accelerate to 100 KIAS. Then start a brief explanation of indications of a severance aft of Pilot before inserting the severance.

MOI – “On the Apache a flight control severance is either aft of the Pilot or between crew stations. The DASEC will detect mistracks between cockpit LVDTs and servo LVDTs and, thereby, identify which type of severance has occurred.”

“If the severance is aft of the Pilot, the BUCS ON will activate as soon as the minimum mistrack point is reached. The minimum mistrack for all control axes is 17.5 percent, with the exception of forward cyclic which is 22.5 percent.”

“Prior to the BUCS ON light illuminating, the DASE caution light will illuminate if the severance is on the cyclic or pedals. The DASE caution light illuminates at 10 percent mistrack. If the severed control (cyclic or pedals) is moved slowly, you will see a distinct point where the DASE caution light illuminates before the BUCS ON light. Until the BUCS ON light illuminates from a severance aft of Pilot, the severed flight control can be moved without getting any response on the affected axis even with illumination of a DASE caution light.”

“However, once the BUCS ON light illuminates, BUCS will activate and the aircraft may lurch slightly in the direction of the flight control position. You will have 100 percent flight control authority on the severed axis in one second with BUCS. Since there is no SPAD to break during a severance, the wash-in time is one second instead of the three seconds it takes for a jam.”

“Pilot, once the BUCS ON caution light illuminates, continue with the emergency procedure. That is, land as soon as possible, start the APU, and perform an emergency engine shutdown.”

“If you have to transfer controls, for this type of severance only, you can do a normal flight control transfer and the CPG would NOT use the BUCS trigger.”

“CPG, the Pilot has been shot, take the controls. CPG, once you get the controls, moving your longitudinal cyclic will cause the Pilot's longitudinal cyclic and LVDT to move, which will control BUCS. As long as the aircraft is flying correctly, do not press the BUCS trigger. Doing so would transfer the BUCS reference to the CPG cyclic. But why would you do that if the aircraft were flying correctly? Remember, do not add extra or unnecessary steps to BUCS, because this may cause problems later.”

“You will also notice that you still have force trim on that axis.”

I/O Action – After the CPG gets control of the aircraft and initiates the land-as-soon-as-possible approach, press **FLIGHT FREEZE**. Tell the crew to clear the controls and then press the **IN AIR 500 FEET** reset. This will reposition the aircraft to 100 KIAS and 500 ft AGL.

Task B019/B020/B021: Severance Between Crew Stations – Longitudinal Cyclic – Pilot/CPG/Pilot

Task – Perform immediate actions and emergency procedure for severance between crew stations on longitudinal cyclic.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; at or above 500 ft AGL, with IAS 80 – 100 knots.

Standard – Perform immediate actions, crew coordination, and emergency procedure for severance between crew stations on longitudinal cyclic IAW operator's manual, ATM, and BUCS familiarization procedures.

I/O Action – Tell the Pilot to continue to the Doppler waypoint, maintaining 500 ft AGL and 100 knots.

MOI – “Pilot, you have the controls. Coming out of freeze when you are ready. Maintain 500 ft AGL and 100 knots toward the Doppler waypoint.”

I/O Action – As the Pilot flies toward the Doppler, begin a brief explanation of the indications of a severance between the crew stations before inserting the severance.

MOI – “Pilot, in just a moment I will insert a severance between the crew stations on the longitudinal cyclic. Before I do that, I want to point out a few things about this type of severance. First, as the mistrack is detected by the DASE computer, the DASE caution light will come on at 10 percent mistrack if the severance is on cyclic or pedals. This will be followed by the BUCS FAIL warning light at 17.5 percent, or 22.5 percent for forward cyclic.”

“Since this severance occurs in front of the Pilot, you get a BUCS FAIL light not a BUCS ON light. This is because the Pilot still has mechanical attachment to the servo and, therefore, he controls that servo mechanically. BUCS is not authorized by the DASE computer at this point.”

“There are a number of things that can cause a BUCS FAIL warning light, but it is the looseness or unusual position of one or more of the CPG's flight controls that tell you the BUCS FAIL is illuminated because of a severance between crew stations.”

“If the Pilot flies and lands the aircraft using mechanical control, this does not require the use of BUCS. The advantage here is that mechanical control inputs do not have the exacting system requirements that BUCS has. Mechanical inputs operate on either of the hydraulic systems, as well as the Emergency hydraulic system. Also, mechanical controls need no electricity.”

“However, if the CPG presses the BUCS trigger to go into BUCS, then Primary hydraulic pressure and AC electrical power must be available 100 percent of the time. If either of these is lost, then BUCS will fail.”

“To demonstrate this: CPG, the Pilot has been shot but will maintain straight and level flight until you can take over. CPG, get on the controls, center your longitudinal cyclic, press and hold the BUCS trigger, mistrack the cyclic until you see an aircraft response to your stick, verbalize transfer, and release the trigger.”

“Pilot, as the CPG flies the aircraft, you will notice that your longitudinal cyclic is being back-driven by the servo. I don’t want you to do this, but if you were to push hard enough, you could break your SPAD in the Pilot station. However, you would not regain control of the longitudinal cyclic. That is an example of adding an extra, unnecessary step.”

“More importantly, if you broke your longitudinal shear pin in the Pilot station, you would be breaking away from a functional mechanical flight control. Although the Pilot’s longitudinal cyclic is being back-driven right now, if the BUCS system were to fail, the servo would revert to mechanical control.”

“To demonstrate this, I am going to fail the Primary hydraulics. Pilot, as soon as you see the BUCS FAIL light illuminate, I want you to take the controls. Make sure you tell the CPG that you have the controls.”

I/O Action – Fail the Primary hydraulics from the console.

MOI – “Pilot, the reason you can control the axis again after the BUCS failure is because the BUCS plunger will retract when Primary pressure is lost, which re-allows mechanical control. Because your mechanical linkage was not jammed or severed, and you did not break your shear pin, you have good attachment with the servo. The Pilot is now operating the longitudinal servo with the Utility hydraulic system.”

“Pilot, for demonstration purposes, I am going to show you what would have happened if you had broken your longitudinal SPAD while the CPG was flying in BUCS, and then the BUCS failed.”

I/O Action – Break the Pilot’s longitudinal SPAD shear pin from the console. Then, be prepared to **FLIGHT FREEZE** the simulator immediately to avoid a crash.

I/O Action – After the **FLIGHT FREEZE**, tell the crew to clear the controls, and then press the **IN AIR 500 FEET** reset. This will reposition the aircraft to 100 KIAS and 500 ft AGL.

Task B022/B023/B024: Severance Between Crew Stations – Longitudinal Cyclic – CPG/Pilot/CPG

Task – Perform immediate actions and emergency procedure for severance between crew stations on longitudinal cyclic.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; at or above 500 ft AGL, with IAS 80 – 100 knots.

Standard – Perform immediate actions, crew coordination, and emergency procedure for severance between crew stations on longitudinal cyclic IAW operator's manual, ATM, and BUCS familiarization procedures.

I/O Action – Tell the CPG to continue to the Doppler waypoint, maintaining 500 ft AGL and 100 knots.

MOI – “CPG, you have the controls. Coming out of freeze when you are ready. Maintain 500 ft AGL and 100 knots toward the Doppler.”

I/O Action – As the CPG flies toward the Doppler waypoint, start a brief explanation of indications of a severance between the crew stations before inserting the severance.

MOI – “CPG, in just a moment I will insert a severance between the crew stations on the longitudinal cyclic. Before I do that, I want to point out a few things about this type of severance when the CPG is flying.”

“One of the worst situations for this type of severance is for the CPG to be on the controls when the severance between crew stations occurs. This is because the CPG has to detect the severance, and perform one of two immediate actions: Either transfer flight controls to the Pilot without delay, or use the BUCS trigger and complete the emergency landing from the CPG station with BUCS ON.”

“Of the above two options, the best one (in terms of aircraft systems) is to transfer controls to the Pilot. Since the Pilot's flight control is still physically attached to the servo (because the severance occurred in front of him), the axis is under mechanical control and the BUCS system is not activated. The mechanical flight control does not have the same stringent requirements as BUCS. Mechanical control does not require electricity, and it can operate on Primary, Utility, or Emergency hydraulics.”

“If BUCS were activated by the CPG pulling the BUCS trigger, then Primary hydraulics and AC electrical power would be required 100 percent of the time. For these reasons, the best option for the CPG (if it is safe to do so) is to transfer the flight controls immediately to the Pilot, and let the Pilot land with mechanical control.”

“Obviously, if the CPG can’t safely transfer controls to the Pilot, then by all means he should center the affected control, press and hold the BUCS trigger, mistrack the control to capture the axis, release the trigger, and land using BUCS.”

“CPG, in just a minute I will insert a severance between the crew stations on the longitudinal cyclic. As the DASE computer detects the mistrack, the DASE caution light will come on at 10 percent mistrack if the severance is on cyclic or pedals. This will be followed by the BUCS FAIL warning light at 17.5 percent, or 22.5 percent if on forward cyclic. Since the severance is between the crew stations, you will get a BUCS FAIL light not a BUCS ON light. This is because the Pilot still has mechanical attachment to the servo, and so BUCS is not authorized at this point.”

“The first thing the CPG will probably notice, before any caution or warning lights come on, is a single axis loss of force trim. Normally if force trim is interrupted or turned off, it will affect three axes. But a single-axis severance between crew stations will only affect force trim on that axis.”

“CPG, when you feel the single axis loss of force trim, move that control a little. You will eventually see a DASE caution light. Move it a little further and you will see the BUCS FAIL warning light illuminate. When you see the BUCS FAIL warning light, transfer controls immediately to the Pilot. CPG, I am putting in the severance now.”

I/O Action – As the CPG flies toward the Doppler waypoint, insert the severance between crew stations on the longitudinal cyclic.

MOI – “CPG, the severance is in. Once you feel the looseness of the longitudinal cyclic, and see the DASE and BUCS FAIL lights, transfer controls immediately to the Pilot. While you are in the process of discovery, do not interrupt the force trim. Even though you are severed from the Pilot’s cyclic, you can still interrupt his force trim. If he is not guarding his cyclic, your force trim interrupt can cause his cyclic to fall over. If his longitudinal cyclic falls, the aircraft goes with it, possibly causing a crash.”

I/O Action – After CPG transfers controls to Pilot, continue with MOI.

MOI – “Before we reset, let’s cover a couple of follow-ons to this emergency procedure.”

“CPG, the Pilot has just been shot but will hold the aircraft straight and level until you can take over. Get on the controls and center your longitudinal cyclic. Once you have centered it, press and hold the BUCS trigger. While you are pressing the trigger, move the longitudinal cyclic until you see the BUCS ON caution light illuminate, the BUCS FAIL warning light extinguish, and the aircraft responds to your control inputs in pitch. When you have confirmed that you have BUCS control of the severed axis, release the BUCS trigger and say, ‘I have the controls.’”

“Pilot, as the CPG is flying the aircraft, I want you to look at your longitudinal cyclic. You will see that it is moving, but if you put moderate hand pressure on fore and aft cyclic, you cannot move it. Once again, this is what we call back-driving of the controls.”

“Pilot, would you break the shear pin? The answer is no. Once again, you do not want to add extra steps to BUCS emergency procedures.”

“Pilot, I am failing the Primary hydraulics. Take the controls when you see the BUCS FAIL warning light and make sure you verbalize the transfer.”

I/O Action – Insert Primary hydraulics failure from the console, then continue MOI.

MOI – “Pilot, take the controls. You will notice that you have regained control of the pitch axis.”

“Bonus question: Right now, with the Primary hydraulics failed and with BUCS failed, if the Pilot and CPG begin fighting over the controls and break shear pins, who will most likely end up with controls on the remaining axes?”

“Answer: When BUCS has failed, if the CPG and Pilot start contending with enough force to break shear pins, the CPG should end up with the remaining three axes under mechanical control. This is based on Boeing aircraft specifications of the Pilot breaking out with about 15 percent less force than the CPG. Since BUCS FAIL is present, there is no back-driving and no opportunity to break out for the second person.”

“The resulting mixed mechanical control between both crew members is difficult to coordinate and makes operation hazardous. This reinforces my recommendation of not ever adding extra steps to any BUCS emergency procedure. Don’t break shear pins if you don’t have to. Don’t pull the BUCS trigger unless you have to.”

I/O Action – Press **FLIGHT FREEZE**. Tell the crew to clear the controls, and then activate the **IN AIR 500 FEET** reset.

Task B025/B026: Multi-Axis Jam – Longitudinal, Lateral Cyclic – Pilot/CPG

Task – Perform immediate actions and emergency procedure for multi-axis jam on longitudinal and lateral cyclic.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; at or above 500 ft AGL, with IAS 80 – 100 knots.

Standard – Perform immediate actions, crew coordination, and emergency procedure for multi-axis jam on longitudinal and lateral cyclic IAW operator's manual, ATM, and BUCS familiarization procedures.

I/O Action – Tell the Pilot to continue to the Doppler waypoint, maintaining 500 ft AGL and 100 knots.

MOI – “Pilot, you have the controls. Coming out of freeze when you are ready. Maintain 500 ft AGL and 100 knots toward the Doppler.”

I/O Action – As the Pilot flies toward the Doppler waypoint, insert a jam on the longitudinal and lateral cyclic. Then continue with MOI.

MOI – “Pilot, you have a multi-axis jam on the longitudinal and lateral cyclic. Once you have confirmed that the CPG is not blocking, break-out of the jam, highest priority axis first.”

“Pilot, once you have broken the longitudinal and lateral shear pins, you will get control of those two axes with BUCS. You will see that the pitch and roll DASE switches have disengaged.”

“CPG, you will notice that your cyclic is frozen in pitch and roll because it is still attached to the jammed linkage.”

I/O Action – After approximately 30 seconds, verbally incapacitate the Pilot.

MOI – “CPG, the Pilot has been hit by ground fire but will continue to fly until you can take control in the front.”

“CPG, get on the controls. Break your longitudinal and lateral shear pins and re-center the cyclic. Once you have re-centered, press and hold the BUCS trigger. As you are holding the BUCS trigger, mistrack the lateral and longitudinal cyclic until you have control of both axes. Once you have control of both axes, release the BUCS trigger and say, ‘I have the controls.’”

“Once again, the CPG has done the final control transfer with the BUCS trigger, so he will have to maintain hands and feet on the flight controls until the rotor stops turning during shutdown.”

“I will give you a flight freeze and reset. We will skip the second and third steps to save time.”

I/O Action – Press **FLIGHT FREEZE**. Tell the crew to clear the controls. Then activate **IN AIR 500 FEET** reset.

Task B027: No-Notice Severance Aft of Pilot – Longitudinal or Lateral Cyclic – Pilot

Task – Perform immediate actions and emergency procedure for severance aft of Pilot.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; at or above 500 ft AGL, with IAS 80 – 100 knots.

Standard – Perform immediate actions, crew coordination, and emergency procedure for severance aft of Pilot on longitudinal or lateral cyclic IAW operator's manual, ATM, and BUCS familiarization procedures.

I/O Action – Tell the Pilot to continue to the Doppler waypoint, maintaining 500 ft AGL and 100 knots.

MOI – “Pilot, you have the controls. Coming out of freeze when you are ready. Maintain 500 ft AGL and 100 knots toward the Doppler.”

I/O Action – As the Pilot flies toward the Doppler waypoint, insert a severance aft of the Pilot on longitudinal or lateral cyclic. When the BUCS ON caution light illuminates, ask the Pilot what he has.

MOI – “Pilot, what type of control problem do you have? Don't help him answer, CPG.”

“Was it a jam or a severance? Where did the severance occur, aft of Pilot or between crew stations? On what axis?”

“If you don't know what axis, look at your DASE switches. They will tell you where the BUCS engagement occurred, except in the case of the collective.”

“Remember, if you get a BUCS ON light, the severance is behind the Pilot. If you get a BUCS FAIL warning light, the severance is between the crew stations. In this case, you got a BUCS ON light, indicating the severance was behind the Pilot.”

I/O Action – Press **FLIGHT FREEZE**. Tell the crew to clear the controls. Then activate **IN AIR 500 FEET** reset.

Task B028: No-Notice Severance Between Crew Stations – Longitudinal Cyclic – CPG

Task – Perform immediate actions and emergency procedure for severance between crew stations.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; at or above 500 ft AGL, with IAS 80 – 100 knots.

Standard – Perform immediate actions, crew coordination, and emergency procedure for severance between crew stations on longitudinal cyclic IAW operator's manual, ATM, and BUCS familiarization procedures.

I/O Action – Tell the CPG to continue to the Doppler waypoint, maintaining 500 ft AGL and 100 knots.

MOI – “CPG, you have the controls. Coming out of freeze when you are ready. Maintain 500 ft AGL and 100 knots toward the Doppler.”

I/O Action – As the CPG flies toward the Doppler, insert a severance between crew stations on the longitudinal cyclic. When the BUCS FAIL warning light illuminates, ask the CPG what he has.

MOI – “CPG, what type of control problem do you have? Pilot, don't say anything yet.”

“Was it a jam or a severance? Where did the severance occur, aft of Pilot or between crew stations? On what axis?”

“What are you going to do?”*

*Note to IP: The CPG should either transfer controls immediately or press the BUCS trigger, get the BUCS ON light, and continue flight.

I/O Action –

- If the CPG transfers controls to the Pilot: MOI – “CPG, of the two options available, the best one is transferring controls to the Pilot. But if you don't have time, the second best option is using the BUCS trigger, going into BUCS, and landing from the front seat.”
- If the CPG uses the BUCS trigger and goes into BUCS ON in the CPG station: MOI – “CPG, you have used the BUCS trigger and the aircraft is under control again. That was a good choice, but was it the best choice? Would you do anything differently?”

I/O Action – When you have finished discussing this lesson with the CPG, press **FLIGHT FREEZE**. Tell the crew to clear the controls. Then activate **IN AIR 500 FEET** reset.

Brief Intermission: Seat Change

I/O Action – Press **FLIGHT FREEZE**. Have the crew change seats. Once changed, complete communication checks. Pilot has the controls.

Task B029/B030: Single Axis Jam – Longitudinal Cyclic – Pilot/CPG

Task – Perform immediate actions and emergency procedure for jam on longitudinal cyclic.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; at or above 500 ft AGL, with IAS 80 – 100 knots.

Standard – Perform immediate actions, crew coordination, and emergency procedure for jammed longitudinal cyclic IAW operator's manual, ATM, and BUCS familiarization procedures.

Description – Pilot on the controls. Pilot recognizes jam on longitudinal cyclic. After verbally confirming that CPG is not blocking flight controls, Pilot decouples the longitudinal SPAD using sufficient force (approximately 42 pounds of force). After SPAD shear pin is broken, confirm BUCS ON and DASE caution lights are illuminated. Confirm that DASE pitch switch is disengaged. Correctly recite and perform BUCS ON emergency procedure IAW operator's manual.

Once the Pilot has completed these steps, the IP will verbally incapacitate the Pilot. This will force the CPG to take over controls and land the aircraft. After the CPG lands, the crew completes the steps of the emergency procedure. The IP then gives additional advice to the crew about the CPG landing the aircraft with a BUCS ON caution light, and how to shut down the aircraft if the Pilot is unable to start the APU.

I/O Action – Tell the Pilot to maintain 500 ft AGL and 100 knots toward the Doppler waypoint.

MOI – “Pilot, you have the controls. Coming out of freeze when you are ready. Maintain 500 ft AGL and 100 knots as you continue toward the Doppler waypoint.”

“You are training in the other crew station because the requirements and control feel for BUCS can be different between Pilot and CPG. We will not perform all the jams and severances again, but we will do enough so that you understand the requirements of the new crew station.”

I/O Action – Insert jam on longitudinal cyclic.

MOI – “Pilot, you have a jam on one of your controls. Once you have verified that the CPG is not blocking, break the shear pin.”

“Pilot, you will notice that, unlike the CPG station, you still have force trim available on the longitudinal cyclic. Also, the DASE switch will kick-off on the BUCS ON axis.”

“CPG, the Pilot has been hit but will maintain straight and level until you can take over controls. Get on the controls, break the longitudinal shear pin and re-center the cyclic. Once re-centered, press and hold the BUCS trigger under the collective head. As you hold the trigger, move the longitudinal cyclic until you see that you have control of the pitch axis. Once you have control of pitch, release the BUCS trigger and say, ‘I have the controls.’ Saying ‘I have the controls’ is always the last step of a BUCS control transfer.”

“CPG, you will notice that you have lost force trim on the longitudinal cyclic, but the other controls feel normal. Since you have used the BUCS trigger, that is the last control transfer that is possible on this axis. After landing, you will have to keep hands and feet on the controls until the rotor stops turning during shutdown.”

“Since this is the first malfunction after the seat change, I want you to physically complete all three steps of the emergency procedure.”

I/O Action – After landing, continue with MOI.

MOI – “Now that you have landed, the Pilot will start the APU. As the APU is starting, you may want to consider getting rid of the Shaft Driven Compressor caution light. You can either wait 60 seconds for it to extinguish, or you can recycle the FUEL BST circuit breaker in the Pilot station. It is center panel, bottom row, third from left.”

“The reason you may want to get rid of the SDC light is because if it is illuminated, and if you need to motor an overheating engine with PAS air during the emergency engine shutdown, you will not have PAS air available to do it as long as the SDC light is ON.”

“Once the APU ON light is illuminated, the Pilot will let the CPG know. Either one of you can pull off the power levers, but the Pilot must turn off the fuel switches in the Pilot station.”

“CPG, remember to maintain positive control of the flight controls until the rotor stops on shutdown.”

“CPG, do you remember the precautionary steps to take before pulling the power levers off, if the Pilot cannot start the APU and you have to do a hard shutdown with a BUCS ON caution light?”

I/O Action – If the CPG cannot remember, the suggested steps are these: Lower the seat as far as it will go; manually lock the shoulder harness; slouch down in the seat to get lower; and put helmet visor down.

I/O Action – Once the third step of the emergency procedure is completed, do not continue any further with shutdown.

MOI – “That completes the emergency procedure. Now we’ll get the aircraft reset.”

I/O Action – Tell the Pilot to bring power levers to FLY and to turn fuel switches on. Give an engine quick start from the console (if available) or have Pilot start engines. Tell the crew to clear the controls. Then activate **IN AIR 500 FEET** reset.

Task B031/B032/B033: Single Axis Jam – Lateral Cyclic – CPG/Pilot/CPG

Task – Perform immediate actions and emergency procedure for jam on lateral cyclic.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; at or above 500 ft AGL, with IAS 80 –100 knots.

Standard – Perform immediate actions, crew coordination, and emergency procedure for jammed lateral cyclic IAW operator's manual, ATM, and BUCS familiarization procedures.

Description – Prior to inserting the jam, IP will advise the CPG that two options are available to him if a jam occurs while CPG is flying the aircraft. One option for the CPG is simply to transfer the controls to the Pilot, without decoupling first, if it is safe to do so. The Pilot can break out and land. The other option is to break out in the front seat and use BUCS to land. For this particular task, the IP will inform the CPG of the options and tell him to break out in the front seat, being mindful not to pull the BUCS trigger since the CPG will be the 'first breaker.'

CPG has the controls coming out of freeze. At or above 500 ft AGL and 80 KIAS or greater, IP directs the CPG to begin a right turn and then inserts a lateral cyclic jam while he is in the turn. The IP informs the CPG of the two options, and tells him to break out and continue in BUCS. The CPG verbally confirms that the Pilot is not blocking the flight controls. Then the CPG decouples the lateral SPAD using sufficient force (approximately 30 pounds). After the lateral SPAD shear pin is broken, CPG confirms that BUCS ON and DASE caution lights are illuminated. CPG correctly verbalizes and performs BUCS ON emergency procedure IAW operator's manual. CPG confirms with Pilot that roll DASE switch is disengaged.

Once the CPG has completed verbalizing the emergency procedure steps and has initiated the start of landing as soon as possible, the IP will verbally incapacitate the CPG. This forces the Pilot to break his lateral shear pin, take over controls, and continue making the approach to land the aircraft.

When the Pilot is established in flight, the IP will then verbally incapacitate the Pilot. The Pilot will continue straight and level flight until the CPG says 'I have the controls.' The CPG will get on the controls, center the lateral cyclic, press and hold the BUCS trigger, mistrack the lateral cyclic, visually and physically confirm that BUCS control is to the CPG flight control, release the BUCS trigger, and then verbalize the flight control change. Once the control transfer is complete and the CPG is established in flight, the IP will **FLIGHT FREEZE** the simulator and perform an **IN AIR 500 FEET** reset.

I/O Action – Tell the CPG to maintain 500 ft AGL and 100 knots toward the Doppler waypoint. Then begin a short discussion of the two options available to the CPG if a jam occurs while he is flying the aircraft.

MOI – “CPG, you have the controls. Coming out of freeze when you are ready. Maintain 500 ft AGL and 100 knots as you continue to the Doppler waypoint.”

“I am going to jam your lateral cyclic. As the CPG, you have two options if you get a jam in the front seat. One option is, if conditions permit and it is safe to do so, you can simply describe the problem to the Pilot, give him the controls, and he can break out in the back seat. The advantage to this is that the Pilot will not lose force trim on the decoupled axis like you would in the front.”

“The other option is you can break out in the front seat. Since you are the first breaker, you will get BUCS ON right away. No BUCS trigger is required. As the saying goes, ‘First breaker is the taker.’ In fact, if you break out first, you will want to stay away from the BUCS trigger. Because if you accidentally hit it, you will still have BUCS control in the front, but you will not be able to transfer the controls to the Pilot later if something happens to you. This is because the BUCS trigger is the final control transfer.”

“CPG, for this jam, I want you to break out. Remember, you do not need to use the BUCS trigger, so stay away from it.”

I/O Action – When the aircraft is established in level flight at or above 500 ft AGL and 100 KIAS, direct the CPG to begin a right turn. Then insert a lateral cyclic jam while he is in the turn.

MOI – “CPG, you have an apparent jam. Once you have confirmed that the Pilot is not blocking, break the shear pin. It will take about 30 pounds of force.”

I/O Action – Once CPG breaks lateral SPAD, continue MOI.

MOI – “CPG, you have decoupled the lateral SPAD. Notice that you have BUCS ON and DASE lights, and a three-second wash-in time on the lateral axis. There is no need to press the BUCS trigger. Also, you have lost force trim on lateral cyclic. What are the emergency procedure steps for BUCS ON?”

I/O Action – Once the CPG has completed verbalizing the emergency procedure for BUCS ON, IP will verbally incapacitate him.

MOI – “Pilot, the CPG has just been hit by ground fire, but will continue to maintain straight and level flight until you can take over.”

“Pilot, get on the controls and break your lateral shear pin. Notice how the aircraft will jump slightly in roll when you break the SPAD. This jump tells you that BUCS control is now yours on the affected axis. Once again you will get the three-second wash-in time. When you have confirmed BUCS control in the back seat, say ‘I have the controls.’”

I/O Action – Once Pilot has broken out and taken control, continue with MOI.

MOI – “Pilot, you have control with BUCS on the roll axis. What would it mean if you had broken the SPAD and the aircraft did not jump to your stick position?”

“It would mean that the CPG has inadvertently pressed his BUCS trigger and you will not get BUCS control of that axis by breaking your lateral shear pin. So you will have to get him to control the roll axis while you do your landing.”

I/O Action – Once the Pilot is established in level flight, continue with MOI.

MOI – “CPG, the Pilot has been hit with a larger bullet than yourself, so you need to take over controls and land. Get on the controls, center the lateral cyclic, press and hold the BUCS trigger, and then mistrack the lateral cyclic. Once you see that you have lateral control in the front, release the BUCS trigger and say, ‘I have the controls.’”

“CPG, you probably noticed that during the final control transfer with the trigger, you did not get the three-second wash-in time. Since your SPAD was already decoupled, you got an almost instantaneous response as you mistracked the lateral cyclic with the BUCS trigger pressed. It is very important that when you use the BUCS trigger in the CPG station, you center the affected flight control as much as possible before you press the trigger. Then mistrack the control while the trigger is pressed. If you don’t center before you press the trigger, you may get very large fuselage movements, which you want to avoid.”

I/O Action – Once the CPG is established in flight, press **FLIGHT FREEZE**. Tell the crew to clear the controls, and then press **IN AIR 500 FEET** reset. This will reposition the aircraft to 500 ft AGL and 100 knots.

Task B034/B035: Severance Aft of Pilot – Longitudinal Cyclic – Pilot/CPG

Task – Perform immediate actions and emergency procedure for severance aft of Pilot on longitudinal cyclic.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; at or above 500 ft AGL, with IAS 80 – 100 knots.

Standard – Perform immediate actions, crew coordination, and emergency procedure for severance aft of Pilot on longitudinal cyclic IAW operator's manual, ATM, and BUCS familiarization procedures.

I/O Action – Tell the Pilot to maintain 500 ft AGL and 100 knots toward the Doppler waypoint.

MOI – “Pilot, you have the controls. Coming out of freeze when you are ready. Maintain 500 ft AGL and 100 knots as you continue toward the Doppler waypoint.”

I/O Action – When the aircraft is established in level flight at 500 ft AGL and 100 knots, begin a brief explanation of the indications of a severance aft of Pilot. Then insert the severance.

MOI – “On the Apache, a flight control severance is either aft of the Pilot or between crew stations. The DASEC will detect mistracks between cockpit LVDTs and servo LVDTs and identify which type of severance has occurred.”

“If the severance is aft of the Pilot, the BUCS ON will activate as soon as the minimum mistrack point is reached. The minimum mistrack point for all control axes—except forward cyclic—is 17.5 percent. For forward cyclic the minimum mistrack point is 22.5 percent.”

“Prior to the BUCS ON light illuminating, the DASE caution light will illuminate if the severance is on the cyclic or pedals. The DASE caution light illuminates at 10 percent mistrack. If the severed control (cyclic or pedals) is moved slowly, you will see a distinct point where the DASE caution light illuminates before the BUCS ON light.”

“Until the BUCS ON light illuminates from a severance aft of Pilot, the severed flight control can be moved several inches without getting any control response on the affected axis, even with illumination of a DASE caution light. However, once the BUCS ON light illuminates, BUCS will activate and the aircraft may lurch slightly in the direction of the flight control position. You will have 100 percent flight control authority on the severed axis in one second with BUCS. Since there is no SPAD to break during a severance, the wash-in time is one second instead of the three seconds it takes for a jam.”

"Pilot, once the BUCS ON caution light illuminates, continue with the emergency procedure. As before, the emergency procedure is land as soon as possible, start the APU, and perform an emergency engine shutdown."

"If you have to transfer the controls, for this type of severance only, you can do a normal flight control transfer and the CPG would NOT use the BUCS trigger."

"CPG, the Pilot has been shot, take the controls. All you have to say is, 'I have the controls.'"

"CPG, once you get the controls, moving your longitudinal cyclic will cause the Pilot's longitudinal cyclic and LVDT to move, which will control BUCS. As long as the aircraft is flying correctly, do not press the BUCS trigger. Doing so would transfer the BUCS reference to the CPG cyclic. But why would you do that if the aircraft were flying correctly? Remember, do not add extra or unnecessary steps to BUCS, because this may cause problems later."

"You will also notice that you still have force trim on that axis."

I/O Action – After the CPG gets control of the aircraft and initiates the land-as-soon-as-possible approach, press **FLIGHT FREEZE**. Tell the crew to clear the controls. Then press **IN AIR 500 FEET** reset to reposition the aircraft to 500 ft and 100 KIAS.

Task B036/B037/B038: Severance Between Crew Stations – Longitudinal Cyclic – CPG/Pilot/CPG

Task – Perform immediate actions and emergency procedure for severance between crew stations on longitudinal cyclic.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; at or above 500 ft AGL, with IAS 80 – 100 knots.

Standard – Perform immediate actions, crew coordination, and emergency procedure for severance between crew stations on longitudinal cyclic IAW operator's manual, ATM, and BUCS familiarization procedures.

I/O Action – Tell the CPG to maintain 500 ft AGL and 100 knots as he continues to the Doppler waypoint.

MOI – “CPG, you have the controls. Coming out of freeze when you are ready. Maintain 500 ft AGL and 100 knots toward the Doppler.”

I/O Action – As the CPG flies, begin a brief explanation of indications of a severance between crew stations before inserting the severance.

MOI – “CPG, in just a moment I will insert a severance between crew stations on the longitudinal cyclic. Before I do that, I want to point out a few things about this type of severance when the CPG is flying.”

“One of the worst situations for this type of severance is for the CPG to be on the controls when the severance between crew stations occurs. This is because the CPG must detect the severance, and then perform one of two immediate actions: Either transfer flight controls to the Pilot without delay, or use the BUCS trigger and complete the emergency landing from the CPG station with BUCS ON.”

“Of the above two options, the best one (in terms of aircraft systems) is to transfer controls to the Pilot. Since the Pilot's flight control is still physically attached to the servo (because the severance occurred in front of him), the axis is under mechanical control. The BUCS system is not activated. The mechanical flight control does not have the same stringent requirements as does BUCS. Mechanical control does not require electricity, and it can operate on Primary, Utility, or Emergency hydraulics.”

“If BUCS were activated by the CPG, then Primary hydraulics and AC electrical power would be required 100 percent of the time. For these reasons the best option for the CPG, if it is safe to do so, is to transfer the flight controls immediately to the Pilot, and let the Pilot land with mechanical control.”

“Obviously, if the CPG can’t safely transfer controls to the Pilot, then he should center the affected control, press and hold the BUCS trigger, mistrack the control to capture the axis, release the trigger, and land using BUCS.”

“CPG, in just a minute, I will insert a severance between the crew stations on the longitudinal cyclic. As the DASE computer detects the mistrack, the DASE caution light will come on at 10 percent mistrack if the severance is on the cyclic or pedals. This will be followed by the BUCS FAIL warning light at 17.5 percent, or 22.5 percent if on forward cyclic.”

“Since the severance is between the crew stations, you will get a BUCS FAIL light rather than a BUCS ON light. This is because the Pilot still has mechanical attachment to the servo, and so BUCS is not authorized at this point.”

“The first thing the CPG will probably notice—before any caution or warning lights illuminate—is a single axis loss of force trim. Normally if force trim is interrupted or turned off, it will affect three axes. But a single-axis severance between crew stations will only affect force trim on that axis.”

“CPG, when you feel the single axis loss of force trim, move that control a little and you will eventually see a DASE caution light. Move it a little further and you will see the BUCS FAIL warning light illuminate. When you see the BUCS FAIL warning light, transfer controls immediately to the Pilot.”

“CPG, I am now putting in the severance.”

I/O Action – As the CPG flies toward the Doppler waypoint, insert a severance between crew stations on the longitudinal cyclic.

MOI – “CPG, the severance is in. Once you feel the looseness of the longitudinal cyclic and see the DASE and BUCS FAIL lights, transfer controls immediately to the Pilot. While you are in the process of discovery, do not interrupt the force trim. Even though you are severed from the Pilot’s cyclic, you can still interrupt his force trim. If he is not guarding his cyclic, your force trim interrupt can cause his cyclic to fall over. If his longitudinal cyclic falls forward, the aircraft goes with it, possibly causing a crash.”

I/O Action – After CPG transfers the controls to the Pilot, continue with MOI.

MOI – “Before we reset, let’s cover a couple of follow-ons to this emergency procedure.”

“CPG, the Pilot has just been shot, but will hold the aircraft straight and level until you can take over. Get on the controls and center the longitudinal cyclic. Once you have centered, press and hold the BUCS trigger. While you are pressing the trigger, move the longitudinal cyclic until you see the BUCS ON caution light illuminate, the BUCS FAIL warning light extinguish, and the aircraft responds to your control input in pitch.

When you have confirmed that you have BUCS control of the severed axis, release the BUCS trigger and say, 'I have the controls.'"

"Pilot, as the CPG is flying the aircraft, I want you to look at your longitudinal cyclic. You will see that it is still moving, but if you put moderate hand pressure on fore-and-aft cyclic, you cannot move it. Once again, this is what we call back-driving of the controls."

"Pilot, would you break the shear pin? The answer is no. Once again, you do not want to add extra steps to BUCS emergency procedures."

"Pilot, I am failing the Primary hydraulics. Take the controls when you see the BUCS FAIL warning light and make sure you verbalize the transfer."

I/O Action – Insert a Primary hydraulics failure from the console.

MOI – "Pilot, take the controls. You will notice that you have regained control of the pitch axis."

"Bonus question: Right now, with the Primary hydraulics failed and BUCS failed, if the Pilot and CPG start fighting over the controls and break shear pins, who will end up with control of the remaining axes?"

"Answer: When BUCS has failed, if the CPG and Pilot contend with enough force to break shear pins, the CPG should end up with the remaining three axes under mechanical control. Since BUCS Fail is present, there is no back driving and no opportunity for the second person to break out. The resulting mixed mechanical control between both crew members is difficult to coordinate and makes operation hazardous."

I/O Action – Press **FLIGHT FREEZE**. Tell the crew to clear the controls. Then activate **IN AIR 500 FEET** reset.

Task B039/B040: Contention of Flight Controls – Pilot/CPG

Task – Perform immediate actions and emergency procedure for contention of flight controls.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; at or above 500 ft AGL, with IAS 80 – 100 knots.

Standard – Perform immediate actions, crew coordination, and emergency procedure for contention of flight controls IAW operator's manual, ATM, and BUCS familiarization procedures.

I/O Action – Tell the Pilot to maintain 500 ft AGL and 100 knots as he continues toward the Doppler waypoint.

MOI – “Pilot, you have the controls. Coming out of freeze when you are ready. Maintain 500 ft AGL and 100 knots toward the Doppler.”

I/O Action – As the Pilot flies the aircraft, begin a brief explanation of the contention-of-flight-controls exercise.

MOI – “Pilot, in just a moment, I am going to have the CPG get on the cyclic and start adding smooth increasing pressure on forward cyclic. Because you are trying to keep the aircraft straight and level, you will resist his input. Eventually a SPAD shear pin will break, activating BUCS. Most likely the Pilot's shear pin will break first, but that's not guaranteed.”

“CPG, put your hand on the cyclic and start adding smooth increasing pressure on forward cyclic. Pilot, you will resist to maintain straight and level flight.”

“CPG, do not use the BUCS trigger for this.”

I/O Action – Once the BUCS ON light illuminates, check the BUCS control page at the console for indications of broken longitudinal SPAD shear pins.

MOI – “Pilot, you are in BUCS on the longitudinal cyclic.”

“CPG, begin adding smooth increasing pressure on right lateral cyclic. Pilot, keep the aircraft wings level.”

I/O Action – Once the BUCS ON light illuminates, check the BUCS control page at the console for indications of broken lateral shear pins.

MOI – “Pilot, you are now in BUCS for lateral cyclic also.”

“During contention, the Pilot always has priority for BUCS. No matter if he breaks out first or second, as long as the CPG does not use the BUCS trigger, the Pilot has priority.”

I/O Actions – Verbally incapacitate the Pilot, forcing the CPG to take over BUCS and fly the aircraft.

MOI – “CPG, the Pilot is becoming incapacitated. I want you to get on the controls and then center your cyclic in pitch and roll.”

“Once you are centered, press and hold the BUCS trigger. As you hold the trigger, mistrack the cyclic in pitch and roll until you see that you have control of both axes. Now, as a final step, release the BUCS trigger and say, ‘I have the controls.’”

“CPG, you will notice that your cyclic is sloppy because you have lost force trim.”

“Any questions on contention of flight controls? Clear the controls.”

I/O Action – After you have directed the crew to clear the controls, activate the **IN AIR 500 FEET** reset.

Task B041: No-Notice Severance Aft of Pilot – Longitudinal or Lateral Cyclic – Pilot

Task – Perform immediate actions and emergency procedure for severance aft of Pilot.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; at or above 500 ft AGL, with IAS 80 – 100 knots.

Standard – Perform immediate actions, crew coordination, and emergency procedure for severance aft of Pilot on longitudinal or lateral cyclic IAW operator's manual, ATM, and BUCS familiarization procedures.

I/O Action – Tell the Pilot to maintain 500 ft AGL and 100 knots as he continues toward the Doppler waypoint.

MOI – “Pilot, you have the controls. Coming out of freeze when you are ready. Maintain 500 ft AGL and 100 knots toward the Doppler.”

I/O Action – As the Pilot flies, insert a severance aft of Pilot on longitudinal or lateral cyclic. Once the BUCS ON caution light illuminates ask the Pilot what he has.

MOI – “Pilot, what type of control problem do you have? Don't help him answer, CPG.”

“Was it a jam or a severance? Where did the severance occur, aft of Pilot or between crew stations? On what axis?”

“If you don't know what axis, look at your DASE switches. They will tell you where the BUCS engagement occurred, except on the collective.”

“Remember, if you get a BUCS ON light, the severance is behind the Pilot. If you get a BUCS FAIL warning light, the severance is between the crew stations. In this case you got a BUCS ON light, indicating that the severance was behind the Pilot.”

I/O Action – Press **FLIGHT FREEZE**. Tell the crew to clear the controls. Then activate **IN AIR 500 FEET** reset.

Task B042: No-Notice Severance Between Crew Stations – Longitudinal Cyclic – CPG

Task – Perform immediate actions and emergency procedure for severance between the crew stations.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; at or above 500 ft AGL, with IAS 80 – 100 knots.

Standard – Perform immediate actions, crew coordination, and emergency procedure for severance between crew stations on longitudinal cyclic IAW operator's manual, ATM, and BUCS familiarization procedures.

I/O Action – Tell the CPG to maintain 500 ft AGL and 100 knots as he continues toward the Doppler waypoint.

MOI – “CPG, you have the controls. Coming out of freeze when you are ready. Maintain 500 ft AGL and 100 knots toward the Doppler.”

I/O Action – As the CPG flies toward the Doppler, insert a severance between crew stations on the longitudinal cyclic. Once the BUCS FAIL warning light illuminates, ask the CPG what he has.

MOI – “CPG, what type of control problem do you have? Pilot, don't say anything yet.”

“Was it a jam or a severance? Where did the severance occur, aft of Pilot or between crew stations? On what axis?”

“What are you going to do?”*

*Note to IP: The CPG should either transfer controls immediately or press the BUCS trigger, get the BUCS ON light, and continue flight.

I/O Action –

- If the CPG transfers controls to the Pilot: MOI – “CPG, of the two options available, the best one is transferring controls to the Pilot. But if you don't have time, the second best option is using the BUCS trigger, going into BUCS, and landing from the front seat.”
- If the CPG uses the BUCS trigger and goes into BUCS ON in the CPG station: MOI – “CPG, you have used the BUCS trigger and the aircraft is under control again. That was a good choice, but was it the best choice?”

I/O Action – When you have finished discussing this lesson with the CPG, press **FLIGHT FREEZE**. Tell the crew to clear the controls. Activate **IN AIR 500 FEET** reset.

Task B043/B044: Mixed Control with BUCS After Contention of Flight Controls – Pilot/CPG

Task – Perform immediate actions and emergency procedure for contention of flight controls.

Condition – In an AH-64A flight simulator that is BUCS capable, with a qualified AH-64 IP providing BUCS instruction at the instructor console or in the opposite seat; Np/Nr-100%; at or above 500 ft AGL, with IAS 80 – 100 knots.

Standard – Perform immediate actions, crew coordination, and emergency procedure for contention of flight controls IAW operator's manual, ATM, and BUCS familiarization procedures.

I/O Action – Tell the Pilot to maintain 500 ft AGL and 100 knots toward the Doppler waypoint.

MOI – “Pilot, you have the controls. Coming out of freeze when you are ready. Maintain 500 ft AGL and 100 knots toward the Doppler.”

I/O Action – As the Pilot flies the aircraft, begin a brief explanation about mixed control under BUCS.

MOI – “Pilot, in just a moment I am going to have the CPG get on the cyclic and start adding smooth increasing pressure on forward cyclic. Because you are trying to keep the aircraft straight and level, you will resist his input. Eventually a SPAD shear pin will break, activating BUCS. Most likely the Pilot's shear pin will break first, but that's not guaranteed.”

“CPG, put your hand on the cyclic and start adding smooth increasing pressure on forward cyclic. Pilot, you will resist to maintain straight and level flight. CPG, after you see the BUCS ON light continue to push until you break out in the CPG station.”

I/O Action – Once the BUCS ON light illuminates, check the BUCS control page on the console for indications of broken longitudinal SPAD shear pins in both stations.

MOI – “Pilot, you are in BUCS on the longitudinal cyclic.”

“CPG, I want you to get on the controls, center the longitudinal cyclic, press and hold the BUCS trigger, mistrack and capture the longitudinal cyclic, and release the trigger. As a last step say, ‘I have the longitudinal cyclic.’”

“Pilot, the CPG controls longitudinal cyclic with BUCS. You control the other three axes mechanically: lateral cyclic, collective, and pedals.”

“CPG, I want you to start adding smooth increasing pressure on right lateral cyclic. I want both of you to break out on lateral. CPG, this time do not press the BUCS trigger.”

I/O Action – Once both crewmembers break their lateral shear pins, continue with MOI.

MOI – “Pilot, since the CPG did not use the BUCS trigger for the lateral cyclic, you now have control of the lateral cyclic with BUCS at your seat.”

“This is an example of mixed control under BUCS. The CPG has BUCS control of the longitudinal cyclic and the Pilot has BUCS control of the lateral cyclic.”

“Unless you suspect further damage that might compromise a control transfer, it is generally a good idea to consolidate BUCS control to a single seat. Since the BUCS trigger has already been used once, the only consolidation that is now possible is to the CPG position by using the BUCS trigger.”

“CPG, center your lateral cyclic. Press and hold the BUCS trigger. As you are holding the BUCS trigger, mistrack the lateral cyclic until you confirm that you have BUCS control of it. Then release the trigger and say, ‘I have the controls.’”

“Pilot, you will notice that your cyclic is completely back-driven by BUCS. But remember, you do not want to break those shear pins because if the BUCS system fails, you may be able to fly mechanically from the Pilot station and save the aircraft and yourselves.”

“Any questions on mixed control under BUCS? Clear the controls.”

I/O Action – BUCS training is complete. Press **FLIGHT FREEZE**. After telling the crew to clear controls, press **COND RESET**.

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List of Acronyms

AC – Alternating Current
AGL – Above Ground Level
Alt – Altitude
APU – Auxiliary Power Unit
ATM – Aircrew Training Manual
CPG – Copilot/Gunner
DASE – Digital Automatic Stabilization Equipment
DASEC – Digital Automatic Stabilization Equipment Computer
Fuel BST – Fuel Boost
GW – Gross Weight
Hg – Pressure setting for the altimeter Kolsman window
IAS – Indicated Airspeed
IAW – In Accordance With
I/O – Instructor/Operator
IP – Instructor Pilot
KIAS – Knots Indicated Airspeed
LVDT – Linear Variable Differential Transducer
MOI – Method of Instruction
Np – Speed of engine power turbine in percent
Nr – Speed of main rotor in percent
OTW – Out The Window
PA – Pressure Altitude
PAS air – Pressurized Air System air
PIO – Pilot Induced Oscillation
PPC – Performance Planning Card
PPOS – Present Position
SDC – Shaft Driven Compressor
SPAD – Shear Pin Actuated Decoupler
TM – Technical Manual
VMC – Visual Meteorological Conditions