



**AFRL-HE-WP-TP-2006-0089**

**Neck Muscle Fatigue with  
Helmet-Mounted Systems**

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**Air Force Research Laboratory**

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**September 2006**

**Interim Report for May 2004 to October 2005**

**20061102004**

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# REPORT DOCUMENTATION PAGE

*Form Approved*  
**OMB No. 0704-0188**

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.  
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<b>1. REPORT DATE (DD-MM-YYYY)</b> 25-08-2006		<b>2. REPORT TYPE</b> Interim		<b>3. DATES COVERED (From - To)</b> May 2004 - October 2005	
<b>4. TITLE AND SUBTITLE</b> Neck Muscle Fatigue with Helmet-Mounted Systems				<b>5a. CONTRACT NUMBER</b> N/A	
				<b>5b. GRANT NUMBER</b> N/A	
				<b>5c. PROGRAM ELEMENT NUMBER</b> 62202F	
<b>6. AUTHOR(S)</b> Edward S. Eveland, Joseph A. Pellettiere				<b>5d. PROJECT NUMBER</b> 7184	
				<b>5e. TASK NUMBER</b> 03	
				<b>5f. WORK UNIT NUMBER</b> 04	
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b> Air Force Materiel Command Air Force Research Laboratory, Human Effectiveness Directorate Biosciences and Protection Division Aircrew Performance and Protection Branch Wright Patterson AFB OH 45433-7028				<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>  AFRL-HE-WP-TP-2006-0089	
<b>9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b>				<b>10. SPONSOR/MONITOR'S ACRONYM(S)</b>  AFRL/HEPG	
				<b>11. SPONSOR/MONITOR'S REPORT NUMBER(S)</b>  AFRL-HE-WP-TP-2006-0089	
<b>12. DISTRIBUTION / AVAILABILITY STATEMENT</b>  Approved for public release; distribution is unlimited. Slides AFRL-WS-06-1200; Abstract AFRL-WS-0951					
<b>13. SUPPLEMENTARY NOTES</b> Panel presentation at the 77 <sup>th</sup> Scientific Meeting of the Aerospace Medical Association, Orlando FL, 17 May 06					
<b>14. ABSTRACT</b>  Helmet-mounted systems (HMS) allow aircrew to perform more efficiently in poor conditions. Optics allow improved visibility, night vision, helmet-mounted displays, and targeting capability. The cost to use them in high performance aircraft is unknown. Test flights were made with pilots wearing HMS and neck muscles were evaluated. Objectives were to test the functionality of the helmet-mounted devices and to determine the impact on pilots using them during high G acceleration. Changes in neck muscle strength were identified along with EMG evidence of fatigue. When flights occurred on an almost daily basis over 4 days, the force imparted to the neck was reduced each day. After recovering for five days, the neck muscle force returned to approximately original values.					
<b>15. SUBJECT TERMS</b> Muscle fatigue, electromyography, helmet-mounted systems, Dynamic Environment Simulator (DES)					
<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b>	<b>18. NUMBER OF PAGES</b>	<b>19a. NAME OF RESPONSIBLE PERSON</b>
<b>a. REPORT</b> U	<b>b. ABSTRACT</b> U	<b>c. THIS PAGE</b> U			<b>19b. TELEPHONE NUMBER (include area code)</b>
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## **Neck Muscle Fatigue with Helmet-Mounted Systems**

**Ed Eveland, PhD  
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## **Background**



- **High incidence of in-flight neck pain**
- **“Acute need for guidance on the maximum mass distribution characteristics of head-mounted devices” – Advisory Group for Aeronautical Research and Development, 1990**
- **Entry of more women into fighters**

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## Objectives



- **Primary Objective** – consolidate findings and define research scope to quantitatively determine risk of injury to include strains and fatigue as well as ligamentous and bone failure induced from added head-supported mass and offset center of gravity
- Formalized requirements from Army, Navy, and Air Force
- Benefits to: aviators, small fast boat operators, other vehicle-mounted occupants

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## Goals

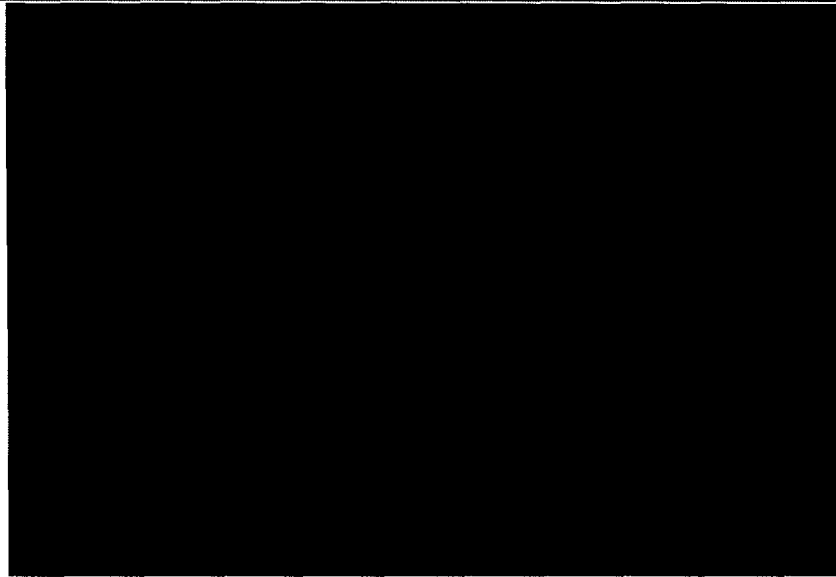


- Determine broad effects of helmet system characteristics and interactions on performance
- Develop understanding of criteria effects for designers of helmet systems
- **➡ Muscular ability to stabilize the neck \***
- Characterize neck muscle electrical activity
  - Any differences between males and females?

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## Film Clip - Demo



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## Implications



- **Expect continued high incidence of neck pain**
  - Working close to maximum strength capability
  - Females used 80% of maximum capability (males 29%)
- **Not able to move head with these weights**
  - Tasks requiring movement may be limited by HMDs
  - USAF operations often require G levels greater than the 6.5 G used in this research
- **Muscle strains**
- **Continued concerns for smaller individuals with small, less muscular necks**

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## Developmental Flight Testing (DT)



- Gathered data to assess the potential for neck muscle fatigue
- Changes in neck strength and electromyography (EMG) from before and after test flights were evaluated for indications of neck muscle fatigue.
  - Interest in how well heavy helmets are tolerated by pilots
  - Effects on the human
    - Heavier helmets
    - No data for use as control condition
  - Changes in neck force and/or myoelectric activity may provide information to help refine helmet system design criteria.

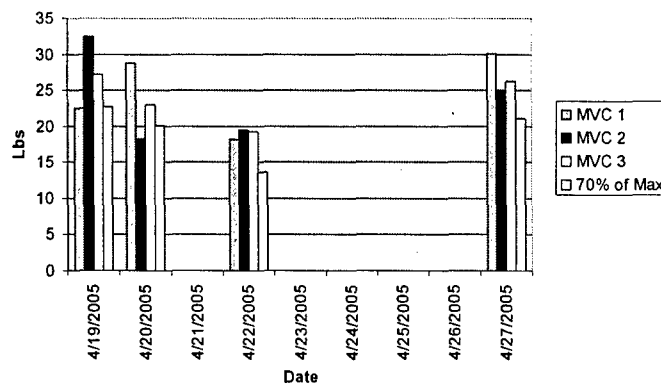
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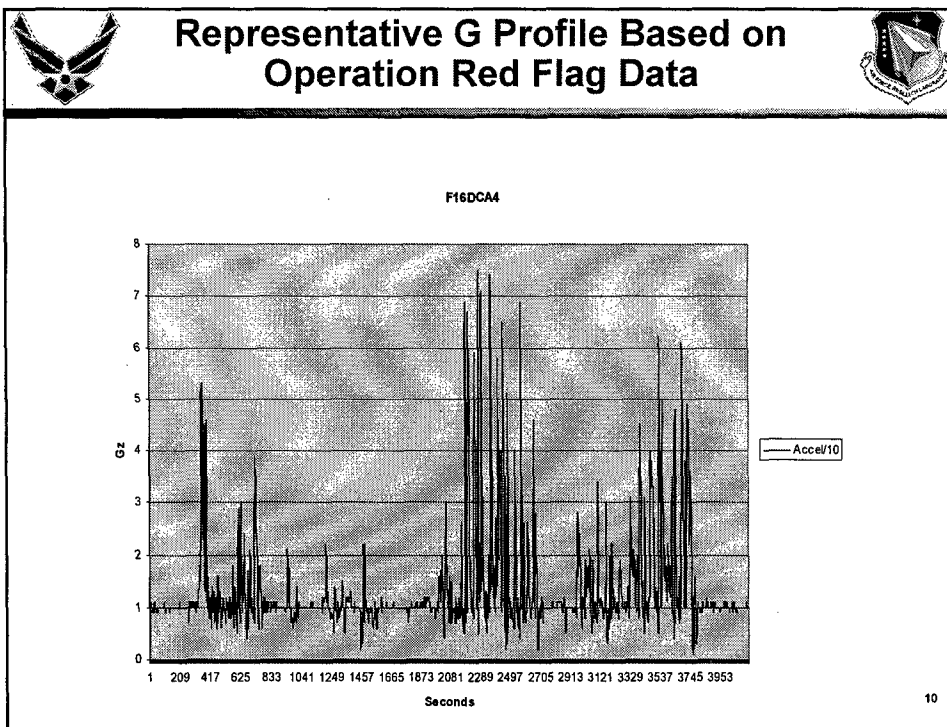
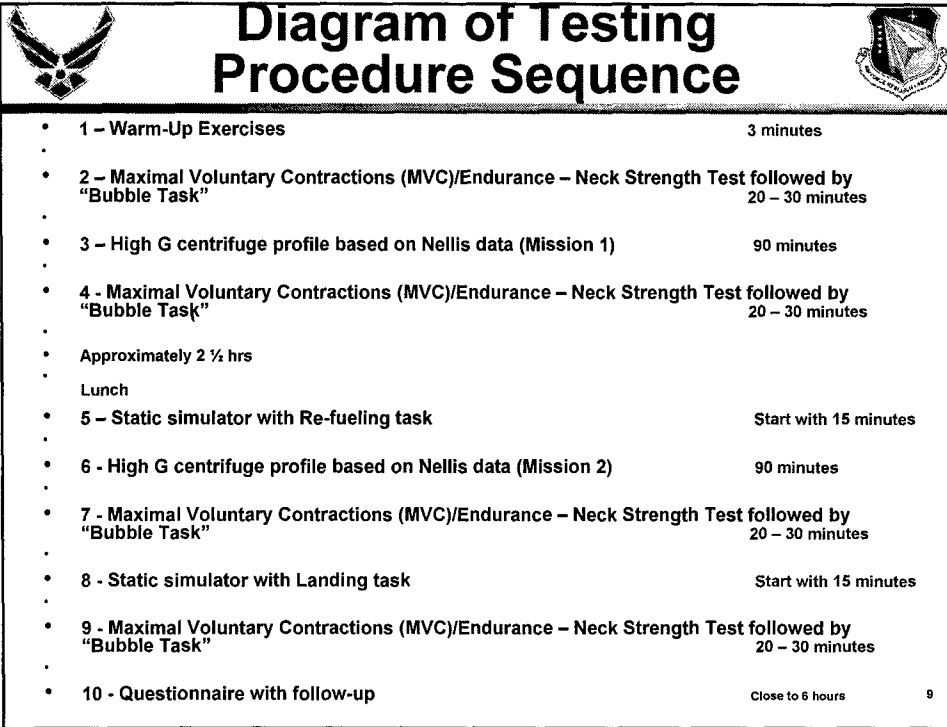
## Subject #1 Pre-Flight Strength



Subj 1 Summary Pre Fly



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## Current Research



- **24 subjects with 3 helmet systems**
  - 12 males, 12 females
  - Active-duty military from sustained acceleration panel
  - Basic helmet for control
  - Heaviest helmet approaching 6 pounds
- **Provide guidance for acquisition process**
  - Program managers can guide designers on weight limits

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