



**2019 NSCA TACTICAL
ANNUAL TRAINING**

Conflict of Interest Statement

We have no actual or potential conflict of interest in relation to this presentation.



U.S. Customs and Border Protection Marine Interdiction Agent Occupational Safety & Health Study

In Partnership with
Dr. Tim Doyle, Macquarie University



U.S. Customs and
Border Protection



MACQUARIE
University

Office of Human
Resources Management



Marine Interdiction Agent OSH Study

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Introduction and Background

- From March 2017 to September 2018 a Marine Interdiction Agent Occupational Safety and Health Assessment was initiated to identify specific factors that may contribute to potential acute and chronic injuries or illnesses associated with maritime operations in Customs and Border Protection (CBP) Air and Marine Operations (AMO) and to provide recommendations to CBP senior leadership for consideration.
- A study similar to this was last completed in 1991, when Federal Occupational Health (FOH) conducted an assessment of marine operations in Miami, Florida. While this assessment addressed issues such as training, new vessel procurement, physical evaluations and safety equipment, significant changes to the mission, operations, and vessels have occurred since then.
- This study represents a joint initiative between the Office of Human Resources Management (HRM), and Air and Marine Operations (AMO) leadership and management.
- The study team included AMO Headquarters staff, HRM Occupational Safety and Health Division (OSH) leadership and staff, and an external subject matter expert with experience in biomechanical evaluation.

Core Study Team

- HRM, Occupational Safety and Health Division
 - Garth Spendiff, Exercise Physiologist and Scientific Advisor
 - Steve Tilden, Deputy Director
- Independent Expert
 - Tim Doyle, PhD, Biomechanist and Sr. Lecturer, Macquarie University
- AMO, Operational MIA Marine Safety Officers
 - Shawn Considine, MIA – Rochester Marine Unit
 - Eric Faria, MIA – Bellingham Marine Unit
- Key Partners
 - AMO, HQ, TSS
 - AMO MIA Focus Group
 - AMO, Operational Units
 - All MIA's



Objectives & Scope

- Identify hazards and causal factors that can lead to potential acute or chronic injuries or illnesses associated with maritime operations at CBP
- Baseline whole body vibration exposure to MIAs during typical mission requirements
- Develop practical recommendations for mitigating any identified hazards
- Identify future studies, training, and additional mitigation to further reduce injury or harmful exposures in the workplace

Maritime Platforms

- 39' Midnight Express
- 39' Interim Midnight Express
- 33' and 38' SAFE Boats
- 41' SAFE Boat CIV



Fixed & Rotary Wing Platforms

- A-STAR



- MEA

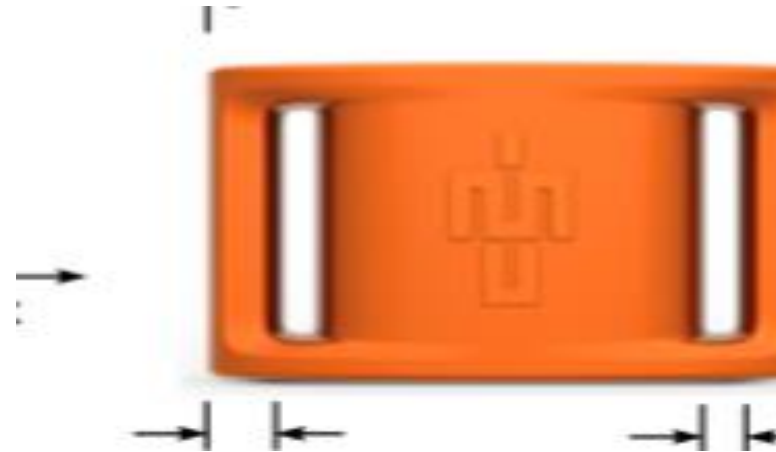


- Black Hawk



Methods

- Historic review of maritime safety and health literature/studies/data
- The CBP Marine Interdiction Agent OSH Survey
- Vibration assessments with inertial measurement units (IMUs)
- Site assessments and focus group discussions on MIA safety and health experience



Tools and Technology

- VICON – I Measure U (Blue Thunder)
 - IMU Sensors
 - Accelerometer/Gyroscope/Magnetometer
 - Real Time Data Acquisition Up to 1 KHz
 - Triaxial - Records accelerations in X, Y, and Z-Axis
 - Attached to center lower back and distal tibia
 - Tibia side randomized



IMU Field Methodology

- Standardized measurements at each location and for each vessel type
- Data collected during typical simulated operational activities
- Acceleration data assessed for
 - A(8) – Average Exposure Over 8 Hours
 - VDV – Vibration Dose Value
 - Peak G-forces
- Additional Data:
 - Location
 - Body Weight (nude & full kit) of VC and Crew
 - Vessel Type
 - Time of operation (day/night)
 - Sea Conditions (vessel commander's rating, 1-5 scale)
 - Specific Activity Protocol (transit/pursuit)
 - Body Position (seated/standing)
- Imaging: GoPro Video Synced with IMUs



IMU Testing Protocol

- 10 minute transits 
 - Seated and standing and,
 - Against and following waves
- 4 minute pursuits repeats 
 - wake crossing 1 min., wide radius turns 1 min., rabbit-boat chase 2 min.
- 6 minute disabling maneuvers 



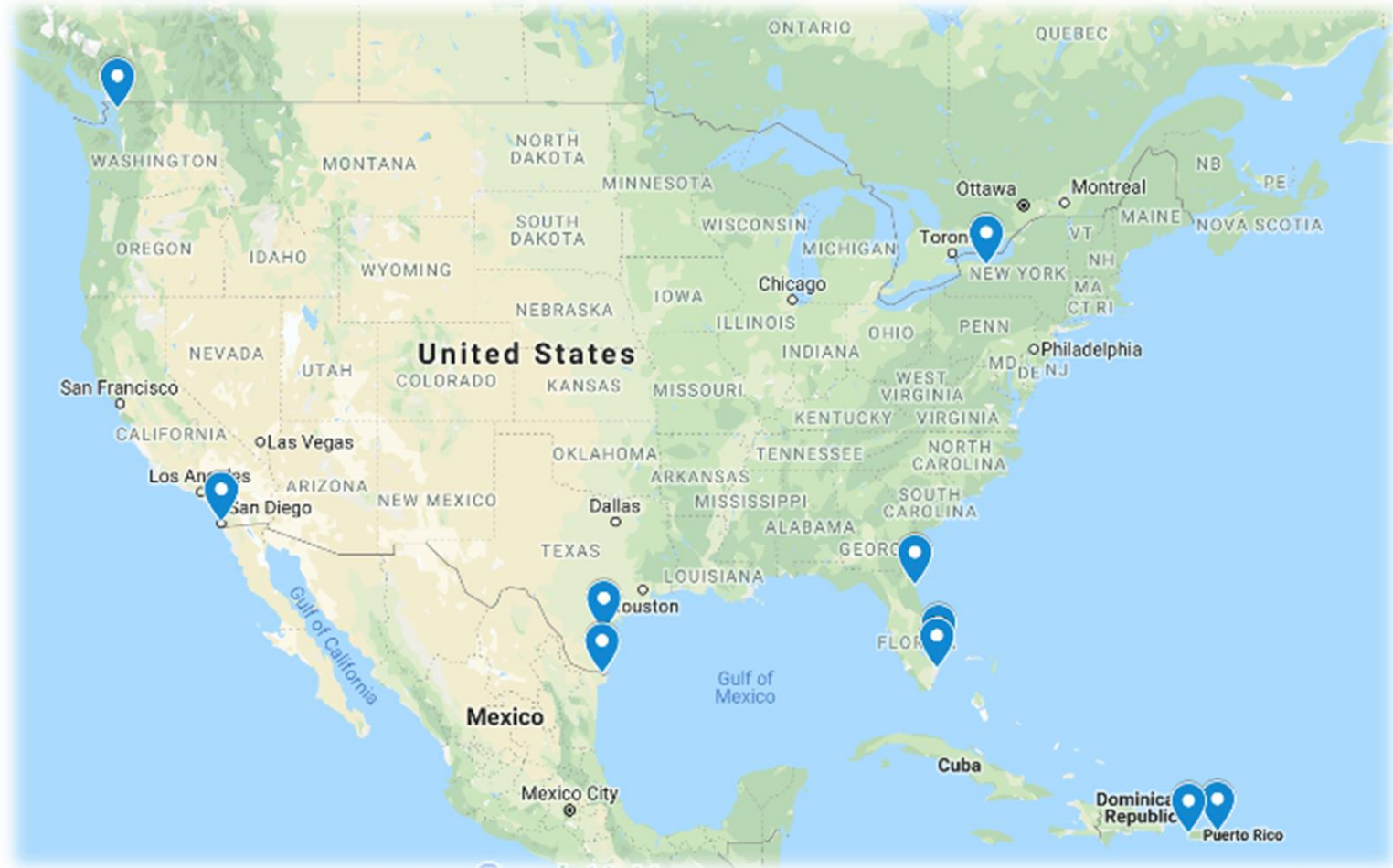
Vessel Scenario	# of IMU tests	~ Collection Time / Test
Transit	96	10 minutes
Pursuit	106	4 minutes
Disabling Manvrs.	8	6 minutes

Vessel / Aircraft Platform	Number of IMU tests
39' Midnight Express	64
39' Interim Midnight	4
33' SAFE Boat	24
38' SAFE Boat	60
41' SAFE Boat (CIV)	58
A-Star	12
MEA King Air 350	12
Blackhawk	14

Site Evaluations

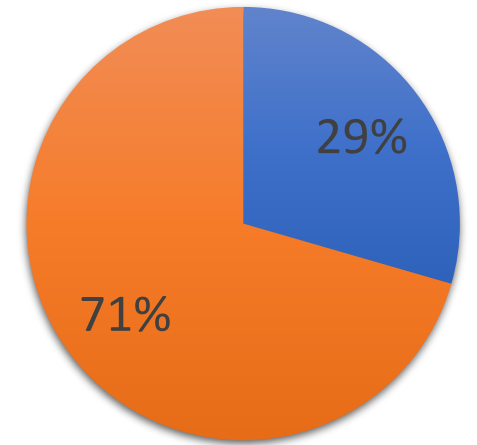
- Bellingham, WA
- San Diego, CA
- Great Lakes, NY
- Corpus Christi, TX
- *Brownsville, TX
- St. Augustine, FL (NMTC)
- West Palm Beach, FL
- *Fort Lauderdale, FL
- Fajardo, Puerto Rico
- Mayaguez, Puerto Rico

*Focus group only, no IMU data collection
NMTC = National Marine Training Center



MIA Survey

- The survey was anonymous and made up of 43 questions aimed at collecting health and safety input from MIA's
- A total of 232 agents out of the FY18 work force of 329 (70.5%) participated in the survey
- Geographically, the survey participants represented 31 different unit locations
- The high number of respondents helped reduce the statistical margin of error (3.5%, 0.95 CI) and improved the teams overall confidence that the responses represent the MIA workforce accurately



Results

- Historic Injury Rates
 - MIA had ~ 48 compensable injuries in 2017
 - MIA average number of injuries per year is ~48.3
 - AMO Injury/illness frequency rate = 7.4
 - MIA Injury/illness frequency rate = 14.6
 - Field Operations rate = 6.0
 - Border Patrol rate = 19.0
- Typical Injury Locations
 - Knee
 - Low Back
 - Shoulder
 - Ankle



$$\text{IR} = \frac{\text{Number of OSHA Recordable Cases X 200,000}}{\text{Number of Employee labor hours worked}}$$

Survey Results

- Work on a boat 13.4 years, with 8.1 years as an MIA
- Average underway hours was 519 hours/year since working as an MIA
- Average float time on a typical workday was ~5 ½ hours
- 82% of respondents are \geq 36 years, with 18% $>$ 46 years. Only 1.3% of the workforce is \leq 30 years
- Average MIA Body Composition
 - Height = 70 in, Body Mass = 204 lbs, Body Mass Index = 29.3 (overweight)
- 100% of respondents were male, currently only one female MIA
- 55% suffered “lost time” injury during CBP maritime operations
- 58% suffered chronic pain or injury preventing them from getting underway a few times/yr or more
- Injuries reported are mostly back, knee, shoulder, neck, and ankle
- 67% of respondents indicate having chronic pain related to MIA work
- 52% believe the injuries are preventable

Survey Results, Cont.

- Top 10 factors that increase injury risk:
 1. Rough seas
 2. Lack of physical fitness
 3. Work-related fatigue
 4. Inadequate boating equipment
 5. Vessel speed
 6. Staffing (understaffed)
 7. Transitioning from vessel or dock
 8. Judgement and poor situational awareness
 9. Overly aggressive work behavior
 10. Experience level
- 89% of respondents get underway \geq 3 days per week
- 62% getting underway \geq 4 days per week
- 70% believe physical or mental fatigue affects them or co-workers ability to perform job safely



Survey Results, Cont.

- 13% report having had a significant head injury or concussion while on the job
- 60% are frequently exposed to fuel or other harmful chemicals/materials
 - Only 7% reported that they rarely or never get exposed
- 54% are occasionally and 23% are frequently exposed to biohazards and or other harmful hazardous materials (e.g., narcotics, persons with infectious conditions)
- 60% are not satisfied with the available footwear
- 91% report staying hydrated most or all of the time
 - 3% rate their hydration practices, to avoid heat related injuries, as being poor or very poor
 - 85% rate their practices to be good or excellent
- 84% do not use tobacco products
 - < 3% smoke (U.S. rate = 15.5%)
 - 13% use smokeless tobacco
- 13% always eat healthy
- 80% eat healthy most of the time
- 64% get less than seven hours of sleep per night
 - 78% report needing at least seven hours of sleep to feel rested

Survey Results, Cont.

- 94% wear UV protective eye wear during daytime operations
 - 68% wear eye protection during night operations
- 69% use caffeine / energy drinks to boost energy levels or alertness
- 63% rate themselves as having good or excellent physical fitness
 - 33% rate themselves as average
 - 3% rate themselves as poor
- 42% report getting enough physical activity*
 - 58% are not getting enough physical activity
- 38% are not confident or do not know how to fill out CBP injury/accident forms

* according to Department of Health and Human Services (DHHS) Healthy People 2020 initiative

Whole Body Vibration

- Whole-body vibration (WBV) is vibration transmitted to the whole body by the vessel surface or supporting structures of the boat
- Daily vibration exposure A(8) is the quantity of WBV a worker is exposed to during a working day
 - normalized to an eight hour reference period
 - takes account of the magnitude and duration of vibration
 - derived from the magnitude of the vibration on the axis which has the highest weighted vibration magnitude and the daily exposure duration
- Vibration dose value (VDV) is a preferred measurement for exposure to jolts, shocks and intermittent vibration because it is sensitive to peaks in acceleration levels.

**GUIDE TO MEASURING AND ASSESSING WORKPLACE EXPOSURE
TO WHOLE-BODY VIBRATION, SAFE WORK AUSTRALIA, 2016**

Health Complaints & Symptoms of WBV

Orthopedic and neurological system

- Localized or radiating pain,
- Discomfort, numbness, tingling, loss of feeling and muscle control in spine or extremities

Gastro-intestinal system

- Nausea, vomiting, indigestions
- Flank pain (renal)
- Hemorrhoids-related seating discomfort

Female reproductive organs

- Localized pain, discomfort, irregular periods, concern for pregnancy

Prostate

- Burning sensation, urgency,
- Concern for cancer – symptoms: hematuria or prostate enlargement/PSA marker elevation
- Peripheral veins

Cochlea-vestibular system

- vertigo



Johanning E (2015)

Whole Body Vibration

- “In many industrialized countries, WBV is principally recognized as a physical hazard in the workplace; however, only in few countries with a long history of WBV-related research and a tradition of institutionalized workplace health and safety is WBV-injury specifically recognized in the national labor laws”.
- “ In some of these countries, it is defined as a compensable occupational disease limited to non-inflammatory and mechanical spinal injuries with painful neurological complications (i.e. disc herniation and nerve root disorders), primarily of the lumbar spine”.

Johanning E (2015)

Whole Body Vibration and Performance

Dyson R, McMorris T, Dobbins T, and Myers S (2008)

- Design of High-Performance Marine Craft from a Human Factors Perspective
- 15-25% decrements in fitness performance following 2-3 hour high-speed ribbed boat transits

McMorris T, Myers S, Dobbins T, Hall B, Dyson R (2009)

- Seating type and cognitive performance after 3 hours travel by high-speed boat in sea states 2-3
- Fixed vs. Suspension Seats
- Pre / post salivary cortisol, post-transit perceptions of exertion, fatigue, and sleepiness
- Results show that the use of suspension seats during transit in high-speed marine craft may be advantageous with regard to cognitive performance



Whole Body Vibration Guidelines

- Take action if daily vibration exposure is likely to exceed an A(8) of 0.5 m/s² or a VDV of 8.5 m/s^{1.75}
- Implement controls to ensure a worker is not exposed under any circumstances to daily vibration exposure A(8) of more than 0.9 m/s² or VDV of 17 m/s^{1.75}

American Conference of Government Industrial Hygienists (ACGIH)
Physical Agents (Vibration) Directive

WBV Risk Matrix

Acceleration x k (m/s ²)	2	50	100	200	400	600	800	1000	1200	1600	2000	2400
	1.9	45	90	180	360	540	720	905	1100	1450	1800	2150
	1.8	41	81	160	325	485	650	810	970	1300	1600	1950
	1.7	36	72	145	290	435	580	725	865	1150	1450	1750
	1.6	32	64	130	255	385	510	640	770	1000	1300	1550
	1.5	28	56	115	225	340	450	565	675	900	1150	1350
	1.4	25	49	98	195	295	390	490	590	785	980	1200
	1.3	21	42	85	170	255	340	425	505	675	845	1000
	1.2	18	36	72	145	215	290	360	430	575	720	885
	1.1	15	30	61	120	180	240	305	365	485	605	725
	1	13	25	50	100	150	200	250	300	400	500	600
	0.9	10	20	41	81	120	160	205	245	325	405	485
	0.8	8	16	32	64	96	130	160	190	255	320	385
	0.7	6	12	25	49	74	98	125	145	195	245	295
	0.6	5	9	18	36	54	72	90	110	145	180	215
	0.5	3	6	13	25	38	50	63	75	100	125	150
	0.4	2	4	8	16	24	32	40	48	64	80	96
0.3	1	2	5	9	14	18	23	27	36	45	54	
0.2	1	1	2	4	6	8	10	12	16	20	24	
	15m	30m	1h	2h	3h	4h	5h	6h	8h	10h	12h	
Daily Exposure Duration												

MIA A(8) – Transits

Location	Min	Max	Mean	25 th Percentile	75 th Percentile
Bellingham	0.94	2.03	1.48	1.07	1.78
Buffalo	2.24	3.96	3.07	2.72	3.42
Corpus Christi	1.44	4.28	2.41	1.69	3.02
Fajardo, Puerto Rico	1.68	3.68	2.60	1.94	3.47
Mayaguez, Puerto Rico	1.72	3.04	2.23	1.96	2.38
San Diego	2.16	3.81	2.97	2.65	3.38
West Palm Beach	1.29	3.14	1.92	1.48	2.25
All Locations	0.94	4.28	2.43	1.81	3.07

MIA VDV – Transits

Location	Min	Max	Mean	25 th Percentile	75 th Percentile
Bellingham	3.91	9.08	6.16	4.42	7.61
Buffalo	11.90	23.20	17.10	15.60	19.00
Corpus Christi	5.78	22.40	11.70	7.64	14.70
Fajardo, Puerto Rico	8.62	23.80	14.30	10.60	17.30
Mayaguez, Puerto Rico	7.21	13.60	9.58	8.14	10.80
San Diego	8.69	18.20	13.20	10.40	15.70
West Palm Beach	6.10	23.10	10.60	7.48	11.60
All Locations	3.91	23.80	11.90	7.83	15.80

MIA A(8) – Pursuit (Wake Crossing)

Location	Min	Max	Mean	25 th Percentile	75 th Percentile
Bellingham	0.27	0.74	0.47	0.39	0.57
Buffalo	0.24	0.84	0.50	0.29	0.76
Corpus Christi	0.95	1.97	1.41	1.16	1.61
Fajardo, Puerto Rico	0.75	1.57	1.16	1.00	1.37
Mayaguez, Puerto Rico	0.49	0.73	0.58	0.55	0.58
San Diego	0.58	1.65	0.87	0.69	0.88
West Palm Beach	0.47	0.90	0.65	0.56	0.72
All Locations	0.24	1.97	0.69	0.43	0.78

MIA A(8) – Pursuit (Turns)

Location	Min	Max	Mean	25 th Percentile	75 th Percentile
Bellingham	0.27	0.79	0.51	0.43	0.58
Buffalo	0.25	0.77	0.46	0.31	0.62
Corpus Christi	0.69	2.10	1.42	1.12	1.76
Fajardo, Puerto Rico	0.90	1.45	1.16	0.96	1.43
Mayaguez, Puerto Rico	0.55	0.71	0.61	0.58	0.61
San Diego	0.64	1.37	1.01	0.90	1.07
West Palm Beach	0.39	0.71	0.54	0.48	0.58
All Locations	0.25	2.10	0.70	0.47	0.77

MIA A(8) – Pursuit (Freestyle)

Location	Min	Max	Mean	25 th Percentile	75 th Percentile
Bellingham	0.37	1.26	0.67	0.53	0.81
Buffalo	0.26	1.45	0.66	0.43	0.79
Corpus Christi	1.27	3.61	1.99	1.45	2.36
Fajardo, Puerto Rico	0.98	3.01	1.81	1.33	2.21
Mayaguez, Puerto Rico	0.59	1.40	0.88	0.75	1.02
San Diego	0.60	2.06	1.22	0.98	1.41
West Palm Beach	0.54	2.07	1.09	0.75	1.59
All Locations	0.26	3.61	0.99	0.58	1.24

MIA VDV – Pursuit (Wake Crossing)

Location	Min	Max	Mean	25 th Percentile	75 th Percentile
Bellingham	1.71	4.62	2.76	2.25	3.18
Buffalo	1.19	5.09	2.56	1.36	3.42
Corpus Christi	3.58	7.18	5.06	4.26	5.91
Fajardo, Puerto Rico	3.26	7.15	5.35	4.34	6.90
Mayaguez, Puerto Rico	2.05	3.89	2.83	2.46	3.31
San Diego	2.27	6.70	4.46	3.54	5.41
West Palm Beach	2.40	5.57	3.84	3.31	4.68
All Locations	1.19	7.18	3.41	2.36	4.24

MIA VDV – Pursuit (Turns)

Location	Min	Max	Mean	25 th Percentile	75 th Percentile
Bellingham	2.21	7.88	4.32	3.44	5.17
Buffalo	1.88	7.83	4.79	3.04	6.78
Corpus Christi	6.31	23.90	10.50	7.37	10.20
Fajardo, Puerto Rico	5.21	11.00	8.18	6.94	9.88
Mayaguez, Puerto Rico	3.28	5.39	3.99	3.72	3.92
San Diego	4.82	21.50	7.99	5.61	7.55
West Palm Beach	4.28	14.70	8.11	5.22	11.10
All Locations	1.88	23.90	6.01	3.81	6.96

MIA VDV – Pursuit (Freestyle)

Location	Min	Max	Mean	25 th Percentile	75 th Percentile
Bellingham	2.26	9.84	5.27	3.96	6.38
Buffalo	2.38	8.51	4.93	2.80	6.90
Corpus Christi	4.64	16.40	9.89	7.57	12.50
Fajardo, Puerto Rico	5.58	12.10	8.82	6.58	10.60
Mayaguez, Puerto Rico	3.53	5.89	4.30	3.97	4.52
San Diego	4.81	17.90	10.60	8.42	13.10
West Palm Beach	3.89	13.80	6.73	4.85	8.33
All Locations	2.26	17.90	6.46	4.25	7.94

AMO Vessel and Aircraft Comparison

A_y(8)	Location	Min	Max	Mean	25 th Percentile	75 th Percentile
	MIA Transits	0.94	4.28	2.43	1.81	3.07
	A-Star	0.15	1.06	0.49	0.33	0.64
	MEA	0.04	2.46	0.64	0.18	0.90
	Blackhawk	0.14	1.59	0.71	0.37	0.96
VDV	Location	Min	Max	Mean	25 th Percentile	75 th Percentile
	MIA Transits	3.91	23.80	11.90	7.83	15.80
	A-Star	0.81	5.25	2.63	1.73	3.61
	MEA	0.20	12.30	3.90	1.33	6.38
	Blackhawk	0.79	9.21	3.97	2.09	5.27

Relevant Observations

- Early evaluation and analysis of the vibrations MIAs experience lead the team to recognize these as whole body vibration (WBV)
 - which are a possible contributor to acute and chronic injuries
- Vessel transits resulted in WBV levels in excess of accepted safety standards at all locations assessed
- Pursuit scenarios resulted in WBV levels that exceeded action or exposure limits in five of the seven locations assessed
- When cross referenced to fixed and rotary-wing aircraft:
 - WBV A(8) levels are 3-5 greater
 - VDV levels are 3-4 greater
- Need for extensive ergonomics and safety engineering evaluation of all platforms

Recommendations

- Reduce WBV exposure (reduce time, lower vibration)
- Improve general fitness and fitness related to improved bracing against external force and dealing with high impacts
 - In-house S&C Coach
- Options to reduce and / or manage overall body stress and deal with daily exposure issues
 - float tanks, Yoga, inversion tables, chiropractic care, massage, ATC
- Consider the use of emerging technologies (gyroscopic stabilization)
- Improved injury surveillance, documentation, and reporting (MIA ICC)

Future Physical Training Intervention

- 3-6 month small team injury and stress reduction intervention
- Healthy People 2020 Fitness Guidelines
 - 150 min. of moderate or 75 min. of vigorous aerobic activity
 - Progress to 300 min. of moderate or 150 min. of vigorous aerobic activity
 - Reduce proportion of MIA's who are overweight
 - Focus on general multi-jointed S&C (Squat, Push, Pull undulating program)
 - Trunk strengthening
- Pre- and post-shift range of motion and spinal load reduction modalities
 - Low impact cardio and traditional stretching
 - Yoga
 - Inversion table, incline bench, glute ham raise spinal release
- Other recovery concepts: Massage, chiropractic care, float tank, rollers, hot and cold tubs

Suggested Core/Trunk Exercise Guidelines

- Curl-up x 10 sec
- Side bridge x 10 sec
- Bird dog x 10 sec
- Rotate (isometric) x 10 sec
- Bridge 10 sec
- 1-5 sets with 60 sec rest / circuit
- 3-6 days per week
- Add general strength training 2-3 times per week, daily flexibility exercises, and various types of cardio at least 4 times per week for 30 or more minutes



McGill S (2010) Core Training

Suggested Core/Trunk Exercise Guidelines, Cont.

- Master the “Big 3” stabilization exercises
 - Curl-up
 - Bird dog
 - Side bridge
- Keep duration of isometric exercise under 10 seconds.
- Start with 1-2 sets and build to 5, maintain with 3 sets.
- Maintain impeccable form (neutral spine)
- Add bridge, rotation, carry, pull, push, and catch exercises to enhance performance

The BIG 3 All Have More Advanced Options to Allow for Progression

Example RX for Performance

- Curl-up x 10 sec
- Side bridge x 10 sec
- Bird dog x 10 sec
- Vertical push (single arm) x 10-12 reps
- Vertical pull x 10-12 reps
- Rotate (isometric) x 10 sec
- Carry (suit case) x 10 sec
- Horizontal push x 10-12 reps
- Carry (upper chest) 10 sec
- Bridge 10 sec



- Progress from 1 to 3 sets
- 60 sec. rest / circuit

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Q & A

- Please share your questions and thoughts....
- If you prefer a more involved discussion please grab us after the talk....

