COE CST Second Annual Technical Meeting:

Wearable Biomedical Monitoring Equipment for Spaceflight Participants on Suborbital & Orbital Flights

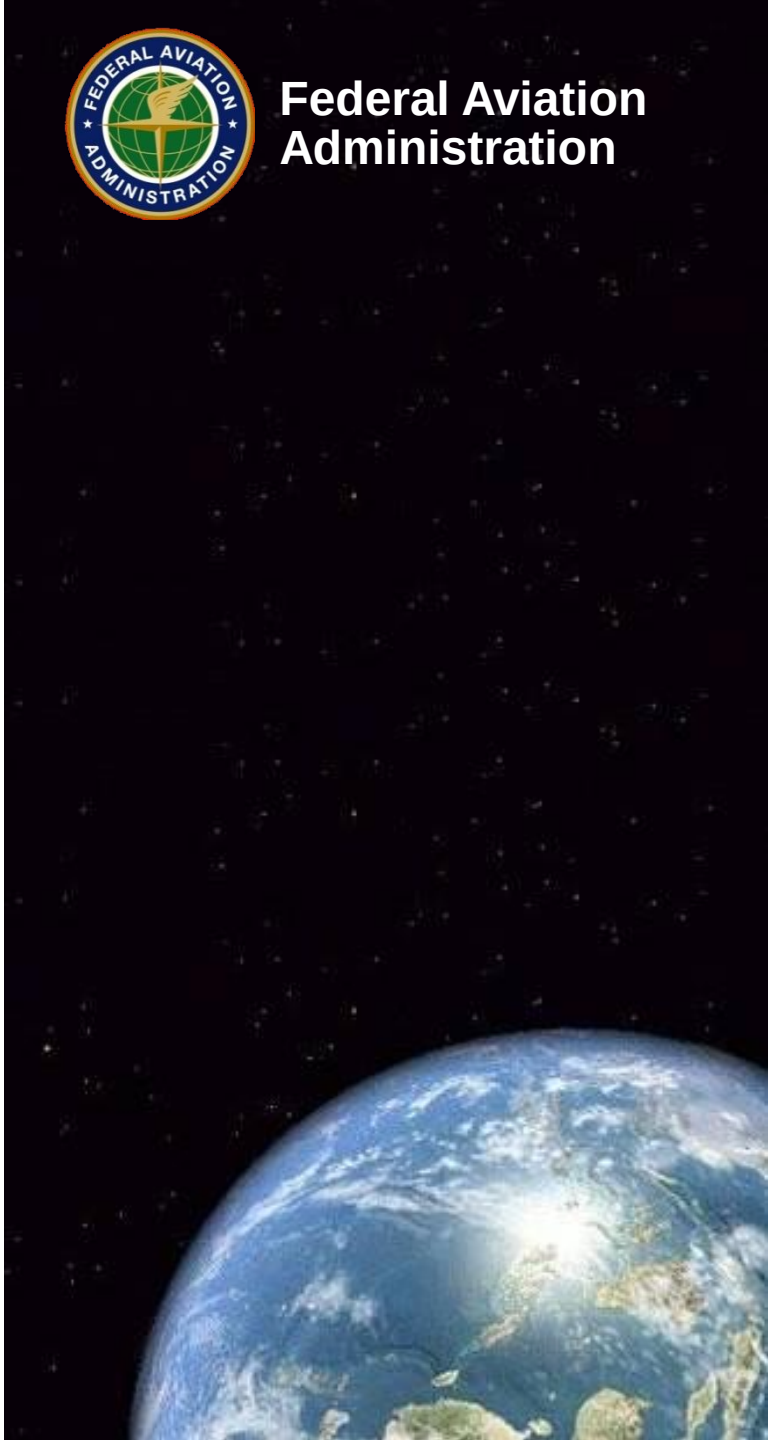
Richard T. Jennings, MD

utmb Health
Aerospace Medicine

November 1, 2012

COE CST

Federal Aviation Administration



Overview

- Team Members
- Purpose of Task
- Research Methodology
- Results or Schedule & Milestones
- Next Steps
- Contact Information

Team Members

- Jon Clark, MD Baylor Center for Space Medicine
- Duane Chin, Christine Smith, Kate Kubicek, and Jack Rasbury, Wyle
- Sharmi Watkins, MD, USRA/NASA
- Anil Menon,MD, Jennifer Law, MD, Rebecca Blue, MD, and James Pattarini, MD (Residents)
- Wes Persall, Virgin Galactic and Brienna Henwood, NASTAR, ad hoc
- Jim Vanderploeg, MD, UTMB (Co-PI)

Objectives

- Enable human physiological data to be collected for operational, medical or research interests
- Identify and determine appropriate design assumptions and operational constraints
- Test prototype monitoring equipment that integrates into a wearable garments, harnesses, or flight suits to support monitoring by flight surgeons, operators, or scientists

Objectives

- Assure that hardware is compatible for multiple operational and environmental parameters
- Avoid setting monitoring requirements or regulatory monitoring requirements for operators

Research Methodology

- Comprehensive survey of existing wearable biomedical monitoring equipment to determine availability of off-the-shelf hardware. Leverage previous NASA work.

- Survey flight surgeons, scientists, and space vehicle operators to seek input on the features and capabilities needed from biomedical monitoring.

- Compare capabilities of existing hardware and software with the needs and desires of the operational and research community to identify gaps.

Research Methodology

- Using gap analysis, identify technologies needed to fill gaps and explore which existing technologies can be repackaged and incorporated into a wearable system.

- Prototype hardware configurations will be purchased and tested under expected G profiles in various operator's launch/landing systems using the NASTAR Center.

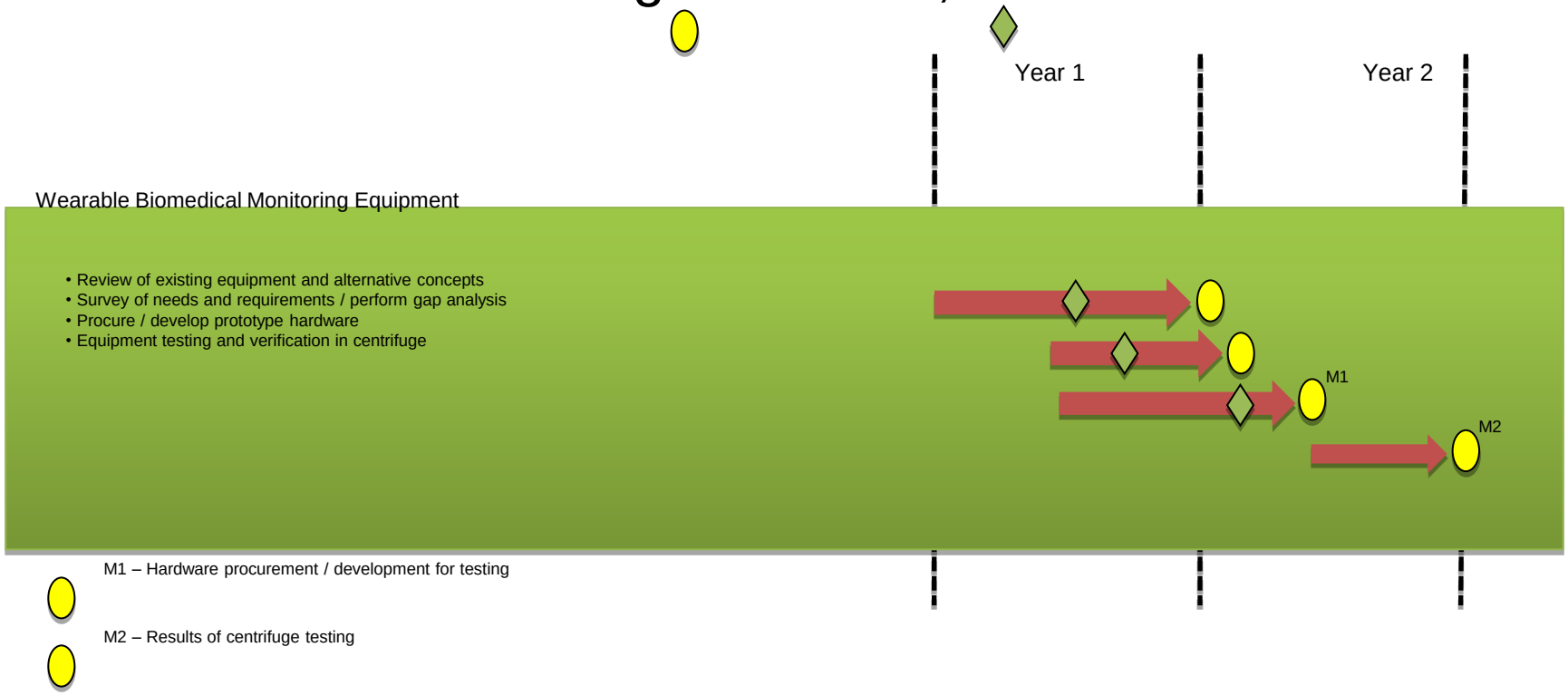
- Test hardware when opportunities arise in environments such as altitude chambers and zero-g flights


NASTAR
CENTER

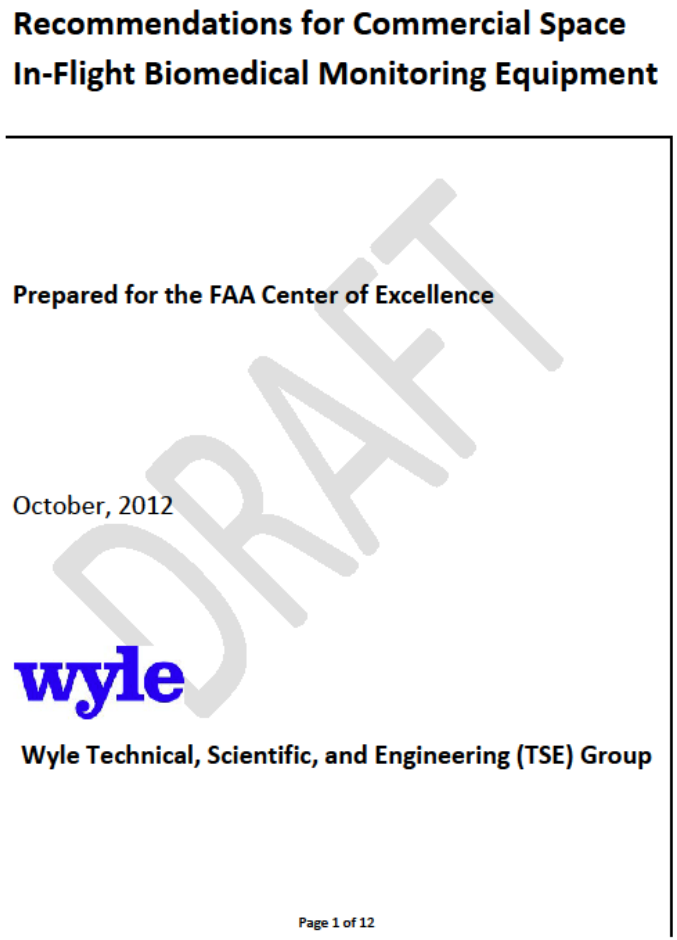
“ I see that you’ve been to NASTAR.”

Results and Schedule

- Initial Team Meeting April 27, 2011
- Market Survey Completed(NASA Partnership)
- Draft Recommendations Document Completed
- Second Team Meeting October 3, 2012



Draft Document Finalized



Recommendations for Commercial Space In-Flight Biomedical Monitoring Equipment

Prepared for the FAA Center of Excellence

October, 2012

wyle

Wyle Technical, Scientific, and Engineering (TSE) Group

Page 1 of 12

Operational Monitoring Capability

#	Capability	Design Criteria
M1	ECG/Heart Rate	• One lead • Range: 0 to 240 beats per minute • Accuracy: +/- 10 % / 5 beats per minute • Non-wet prep electrodes preferred • Continuous data collection
M2	Respiratory Rate	• Range: 5 to 50 breaths per minute • Accuracy: +/- 1 breath per minute • Continuous data collection
M3	Blood Oxygen (SpO2)	• Range: 70 to 100 % • Accuracy: +/- 4 % • Fingertip, earlobe, toes, or forehead • Continuous data collection
M4	Blood Pressure	• Range: 10 to 300 mmHg • Accuracy: +/- 5 % • Continuous data collection
M5	Acceleration	• Range: 0 to 7 G • Accuracy: +/-0.1 G/second • Multi-axis • Head/body acceleration matched to vehicle • Time/event matched (e.g. launch) • Synched with physiological data

Enhanced Monitoring Capability

#	Capability	Design Criteria
R1	ECG	• 12 leads • Range: 0 to 250 beats per minute • Accuracy: +/- 10 % / 5 beats per minute
R2	EtCO2	• Range: 0 to 99 mmHg • Accuracy: +/- 2 mmHg / 6 % • Microphone mounted?
R3	Anxiety	• Eye movements and dilation • Galvanic skin resistance
R4	Blood Sugar	• Range: 20 to 500 mg/dL • Accuracy: +/- 20 %
R5	Core Temperature	• Range: 25 to 45 degrees Celsius • Accuracy: +/- 0.1 degrees
R6	EEG	• Helmet monitoring • IR spectroscopy a consideration • EEG durability for centrifuge • Data transmission with monitoring
R7	Thoracic Bioimpedance	• Cardiac output •
R8	Intracranial Pressure (ICP)	• Difficult with LP requirements • Consider less invasive monitoring such as optic nerve ultrasound
R9	Neuro-vestibular	• Camera on the passenger • Eye motion • Video recording • Kinetic post flight monitoring

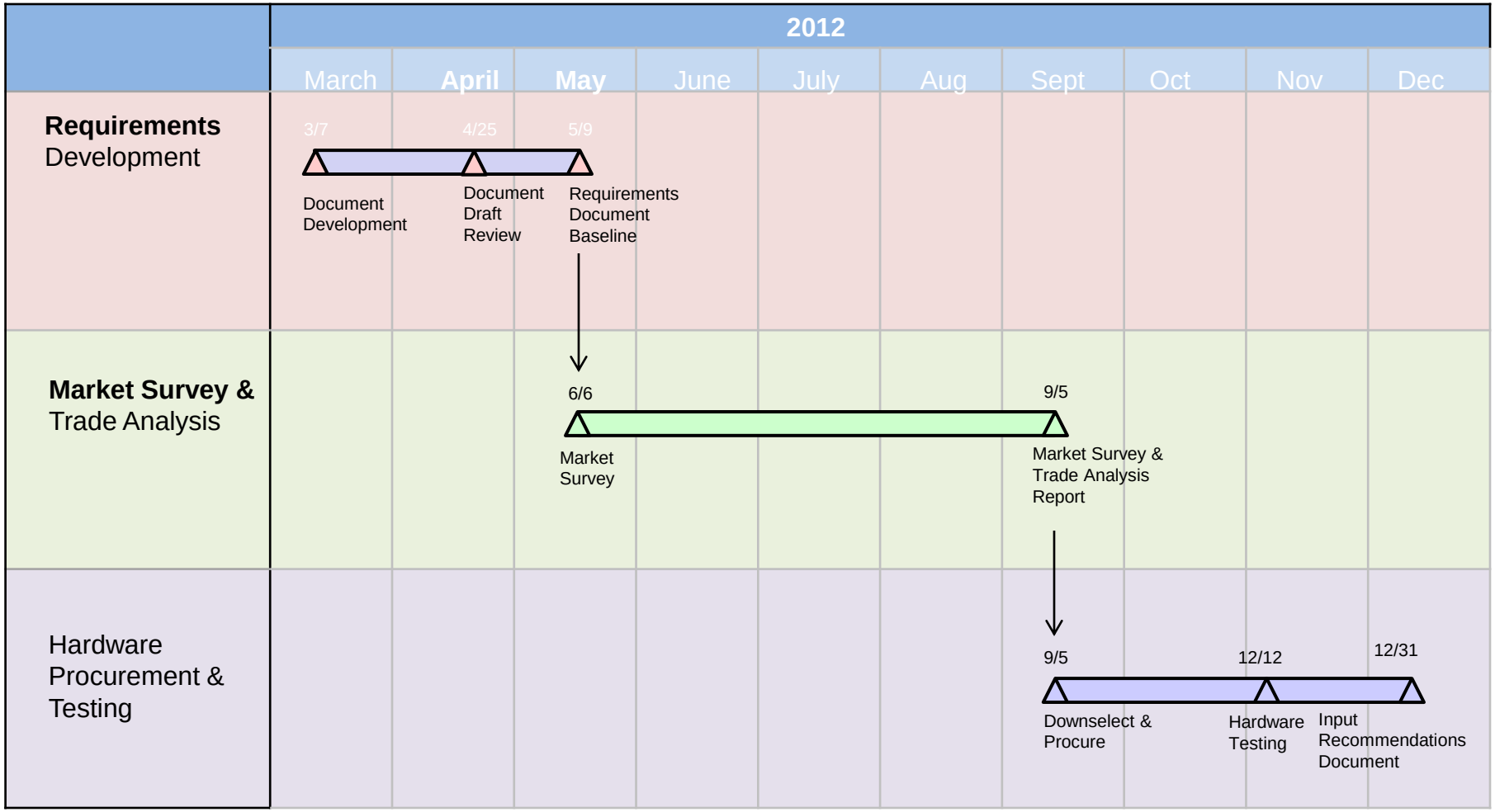
Market Survey Categories

- Multi-parameter
- Respiration
- ECG
- Acceleration
- Blood Pressure
- SPO2

Market Survey Multi-parameter

Device	Manufacturer
Autogenic feedback system	NASA ARC
Equivital EQ02	Hidalgo
VisiMobile	Sotera
Lifeguard (CPOD)	Astrobionics
MW1000A	Mindware Technologies LTD
EQ01-1250	bio-lynx
LINK Armband	BodyMedia
Minitor AR7000	Atlas Researches Ltd.
Wireless Physiological monitor	Biocontrol
ProPaq LT	Welch Allyn
Mini-Medic	Athena GTX
WVSM	Athena GTX
VitaGuard	getemed
ApexPro	GE Medical
MobileMe	Biosentient Corporation
MicroPaq	Welch Allyn
Watch_PAT200	Itamar
BioRadio 150	Cleveland Medical Devices
SmartShirt	Sensatex
g.MOBIlab	Guger Technologies
NeXus-10 MKII	Mind Media
HealthVest	SmartLife Technologies
Spot Vital Signs LXi	Welch Allyn

Biomedical Monitoring Schedule



What We Have To Date

- Assumptions
- Market Survey
- Draft Recommendations Document
- Procuring Hardware
  - Equivital EQ02 by Hildalgo
  - ViSi Mobile by Sotera
- Initial Centrifuge Testing Scheduled December, 2012


SMALL ADULT 10
20-26cm
NASA
AEROSPACE MEDICINE

Conclusions and Future Work

- Distribute draft recommendations document for review
- Determine best fit hardware during centrifuge studies
- Finalize recommendations document

Future

- Test in other analog environments (eg zero-g or altitude chamber)
- Compare flight data to analog environment data
- Peer-reviewed publications and presentations

TASK 255: Wearable Biomedical Monitoring Equipment for Spaceflight Participants on Suborbital & Orbital Flights

MAJOR MILESTONES - PAST	MAJOR MILESTONES - FUTURE
• Assumptions and Constraints • Market Survey • Draft Recommendations Document • Hardware Procurement	• Initial Centrifuge Test Monitoring Capability • Industry Input Recommendations Document • Finalize Recommendations Document
SCHEDULE	**BUDGET**
• December 12, 2012 Centrifuge Testing • Document Input December 31, 2012 • Final Recommendation Document June 30, 2012	• FY13 - FY14 - FY15 - FY16 - FY17 • $23.5K -$00K - $00K - $0 - $0K

Contact Information

- Richard Jennings

University of Texas Medical Branch

301 University Blvd

Galveston, TX 77555-1110

409-747-6131

rjenning@utmb.edu