Hypobaric Chamber Assessment (HCA) Kick Off Meeting

2024.11.22

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EVA and Environmental Physiology Lab (EEPL)

Biomedical Research and Environmental Sciences Division (SK)

Human Health and Performance Directorate

Outline/Agenda

Agenda Topics	Details	Time (CST, UTC-6)
Introduction & Welcome	EEPL, Chamber teams, Acronyms, Purpose	0800 – 0815
Background	Prebreathe Protocols at NASA, Exploration Atmosphere, AETHER Solicitation	0815 – 0830
HCA Project Overview	Test protocol and objective	0830 – 0845
Test Planning	Project Timeline, test day overview, exercise timeline	0845 - 0900
Deliverables	Chamber documents, major milestones/deliverables	0900 – 0915
Communication	Meeting expectations, file sharing platforms, contact, actions, etc	0915 – 0920
	10 min break	
Technical Topic Overview – Test Prep	Test prep events overview: roles and responsibilities in hardware, science, training preparation	0930 – 1000
Technical Topics Overview – Key areas	Highlight key points in test preparation areas: Subject screening, hardware preparation, document preparation	1010 – 1045
Closing	Path forward and Q&A	1045 – 1100

Acronyms

- AETHER – Aerospace Estimation Tool for Hypobaric Exposure Risk
- DCS – Decompression Sickness
- EA – Exploration Atmosphere
- EEPL – EVA and Environmental Physiology Lab
- HCA – Hypobaric Chamber Assessment
- HITL – Human-In-The-Loop
- IRB – Institutional Review Board
- JSC – Johnson Space Center
- PB – (Oxygen) Prebreathe
- POC – Point of Contact
- RFP – Request For Proposal
- VGE – Venous Gas Emboli
- VNSCOR – Virtual NASA Specialized Center of Research

Introduction and Welcome

Contact List - EEPL

EEPL	Details	Email	Phone	When to contact
Alejandro Garbino	Principal Investigator (PI)	alejandro.garbino@nasa.gov		All questions/requests
Monica Hew	Project Lead (PL)	Monica.hew@nasa.gov	+1.817-896-9274	All questions/requests
Karina Marshall-Goebel	NASA Technical Monitor (TM)			NA
Patrick Estep	Technical Area Lead (TA)			NA
Ben Estep	Project Engineer			NA
Brett Siders	Operator/Instructor			NA
Bob Smetanka	Operator/Instructor			NA

Your main POC going forward will be Monica/Alex, please reach out to them if you have any questions/request. They will direct your questions to the appropriate POC. However, note that some of these teammates might contact you for specific actions.

Contact List – Facility Participants

COMEX	Duke University	NSMRL	Brooks
Yann Chouard	Richard Moon	Neal McNeal	Daren Chauvin
Asmaa Dennay	Mike Natoli	Luke Belval	Todd Dart
Jean-Charles Reynier	Eric Schinazi	John Connors	Jeffrey Mock
Mikael Giret		Connor Houtchens	

Please let us know if we are missing anyone from your team.

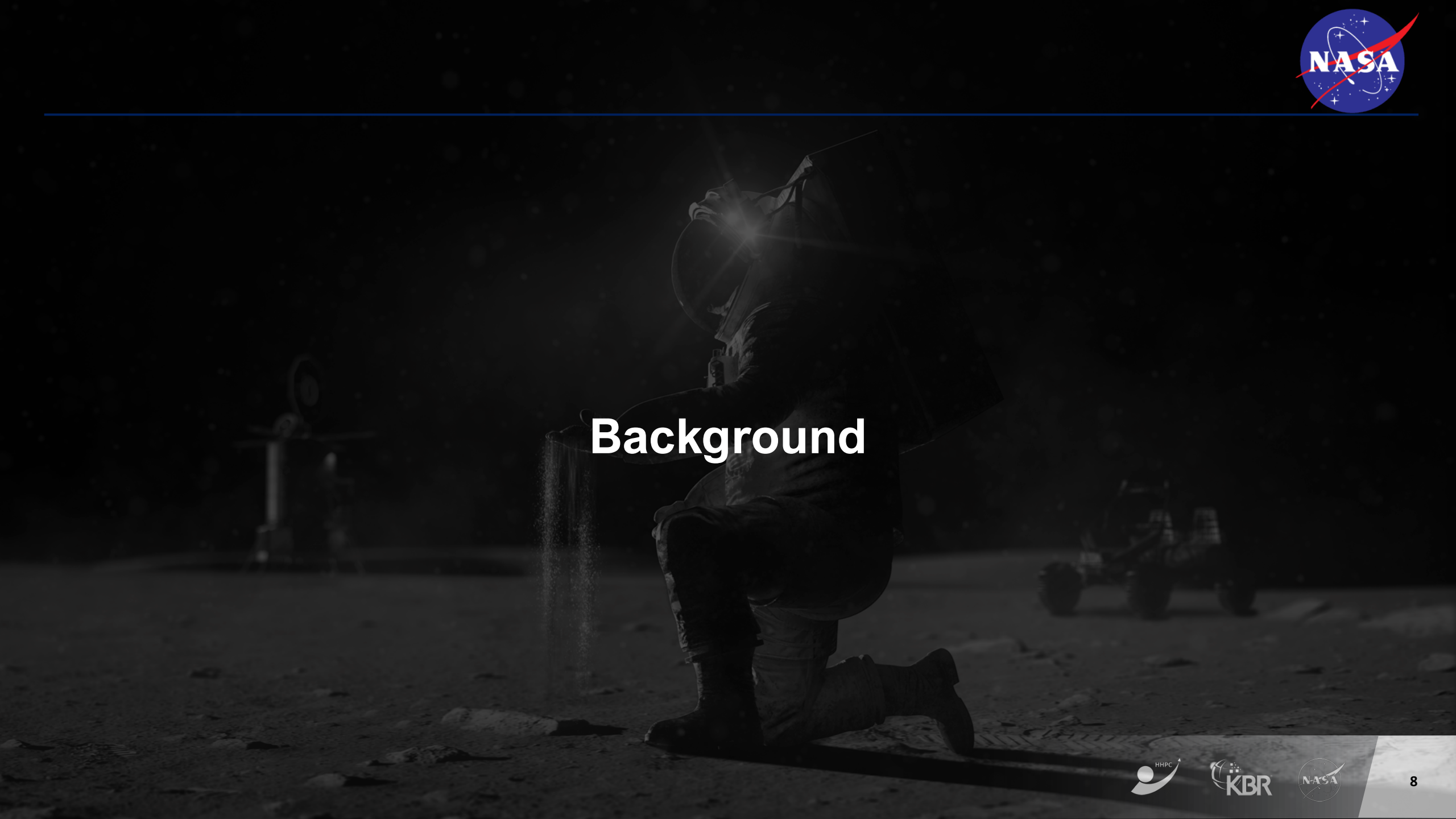
Purpose

- Purpose of this kick-off meeting is to provide **an overview of the project and establish working structure/expectations** for the Hypobaric Chamber Assessment (HCA) project.

- **AETHER Studies:**
  - HRP released a VNSCOR solicitation July 2024 for hypobaric scientific studies that will address knowledge gaps for future Exploration-class EVAs (Moon/Mars)
  - Most of those studies will require specialized hypobaric chamber facilities

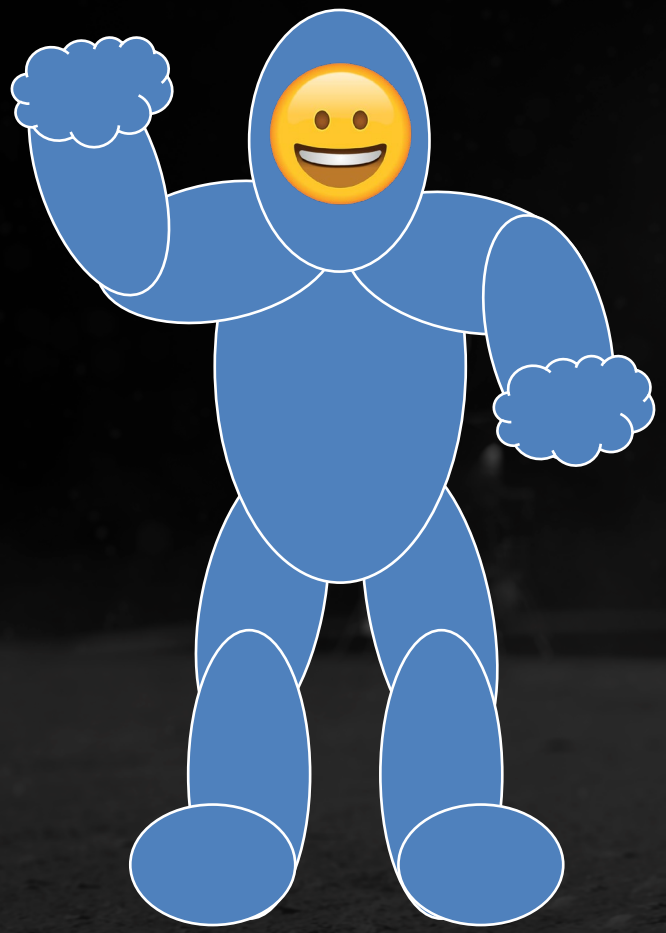
- **Hypobaric Chamber Assessment: a precursor to AETHER studies**
  - To ensure hypobaric facilities will be available to meet the needs of the study proposals, HRP released an RFP for “Calibration Runs” – the “Hypobaric Chamber Assessment” project – a series of 1-day chamber tests so Facilities can demonstrate and verify they can perform AETHER-type studies

AETHER: Aerospace Estimation Tool for Hypobaric Exposure Risk
VNSCOR: Virtual NASA Specialized Center of Research



Background

Background - Suit Pressure Selection



Δ Pressure

ISS is at 14.7 PSI/21% O2

> 4.1 PSI; > 95% O2 provides Normoxia

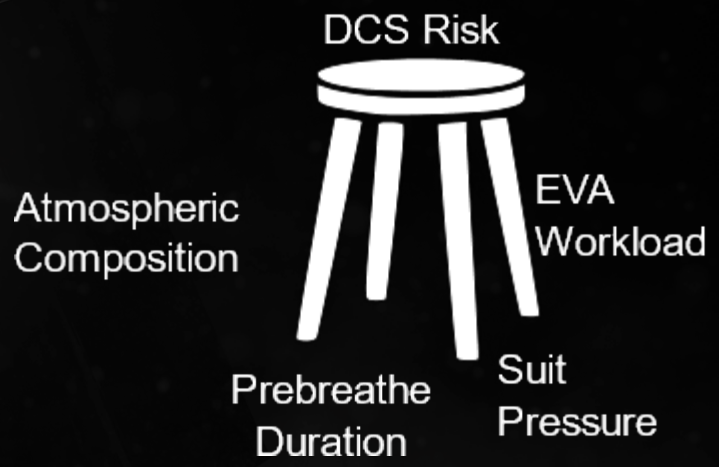
> 3.2 PSI avoids Severe Hypoxia

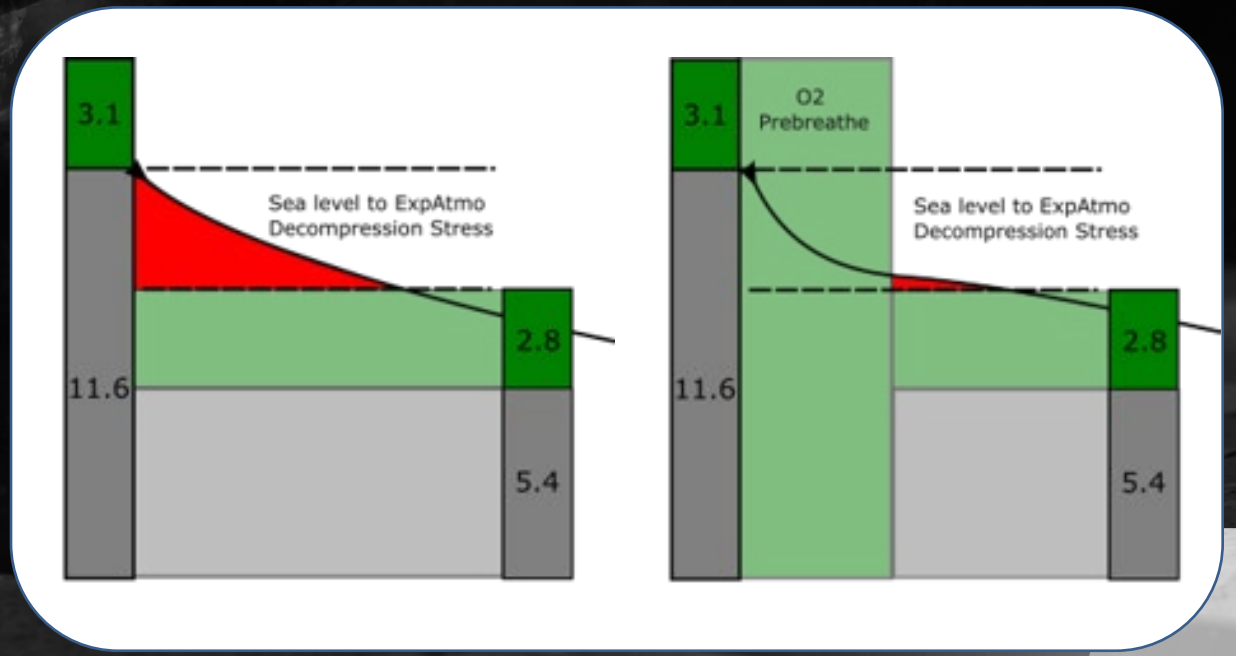
> 2.2 PSI allows ~ 30 min TUC
Avoids Life Threatening Hypoxia

> 1.0 PSI prevents Ebullism

Fundamentals of Decompression Risk Mitigation

- ↓pressure:
  - tissues release nitrogen bubbles
  - Too much bubbling: Decompression Sickness
    - **Type I DCS: Mild/Joint pain**
    - **Type II DCS: Severe/life threatening**
- High workload/ambulation = higher risk
- Pre-EVA de-nitrogenation via oxygen prebreathe *reduces* DCS risk during EVA
  - Can still result in hours of prebreathe
- Mitigations:
  - Decrease starting nitrogen load (Exploration Atm)
  - Accelerate denitrogenation (e.g. exercise)
  - Etc.





EVA: Microgravity vs. Exploration

- **Increased physical & cognitive workload**
  - Effectively adding lower body into EVAs again
  - Increased autonomy, less mission support, especially for Mars
- **Additional injury mechanisms**
  - Lower body and back injuries more likely in Surface EVAs
- **Increased opportunities for injury and compromised performance**
  - Only three Apollo missions had back-to-back EVAs.
  - With reduced recovery time between EVAs (higher EVA density), possible fatigue and repetitive / cumulative effects become an increased concern
- **Uncertainty in Lunar Surface EVA ConOps, Equipment, and Tasks**
  - Limited number of relevant Lunar EVA physiological datasets.
  - Currently defining exploration EVA training pipelines and facilities

Parameter	Current ISS EVA	Exploration EVA
Tempo	8hrs EVA / ~ 2 months	**24hrs EVA / 1 week**
Environment	Engineered Completely Characterized Microgravity Uncontaminated	Natural & Engineered Incomplete Characterization Partial Gravity Dust
Tasks	Construction Maintenance	Science Construction Maintenance
Skills	Specific Skills/task-based	Generic Skills Specific Skills/task-based (Tool-based)
Mission	Specific tasks	Broadly scoped timelines Real-time adjustments *("Flexecution")*
Ops Support	MCC-centric Extensive personnel support	Crew-centric Delayed ground support

Future Exploration EVA will be quite different from ISS and Shuttle EVA, and even previous Apollo EVAs!

How is Artemis different from current NASA DCS mitigations?

- Artemis will have significantly increased frequency of EVAs is expected during Lunar operations compared to International Space Station (ISS) operations
  - Up to 24 hrs / person / week in Artemis
- DCS risk is increased by ambulation and physical activity vs microgravity[1]

Current microgravity prebreathe protocols used on the ISS are NOT validated for planetary EVA

Apollo missions had a 100% O_2 cabin and zero EVA prebreathe

[1]Conkin J, et al. Venous gas emboli and ambulation at 4.3 psia. Aerosp Med Hum Perform. 2017; 88(4):370–376.

Exploration Atmosphere Study

- **Primary purpose:** validate **prebreathe protocols** to reduce decompression sickness (DCS) risk during surface extravehicular activities and characterize hypoxic effects of the Exploration Atmosphere (EA) via a multi-year mission series
- **Protocol:** 11-day **e**xposure to a habitat "exploration atmosphere" consisting of lower pressure (8.2 psia) and higher O_2 (34%) [partial pressure (P_IO_2) = 128 mmHg]
  - Test point (O_2 and psia) varies each test mission (EA1,2,3…)
- **Subjects:** up to 8 test subjects (including 2 Doppler Techs)
- **Location:** 20-foot hypobaric chamber facility, Building 7 NASA Johnson Space Center (JSC)

20-Foot Chamber Facility Exterior, NASA JSC

Photo Credit: NASA/H-3PO

Note: Chamber is NOT intended to represent a flight-like habitat

HCA Protocol – “A Calibration Protocol for AETHER”

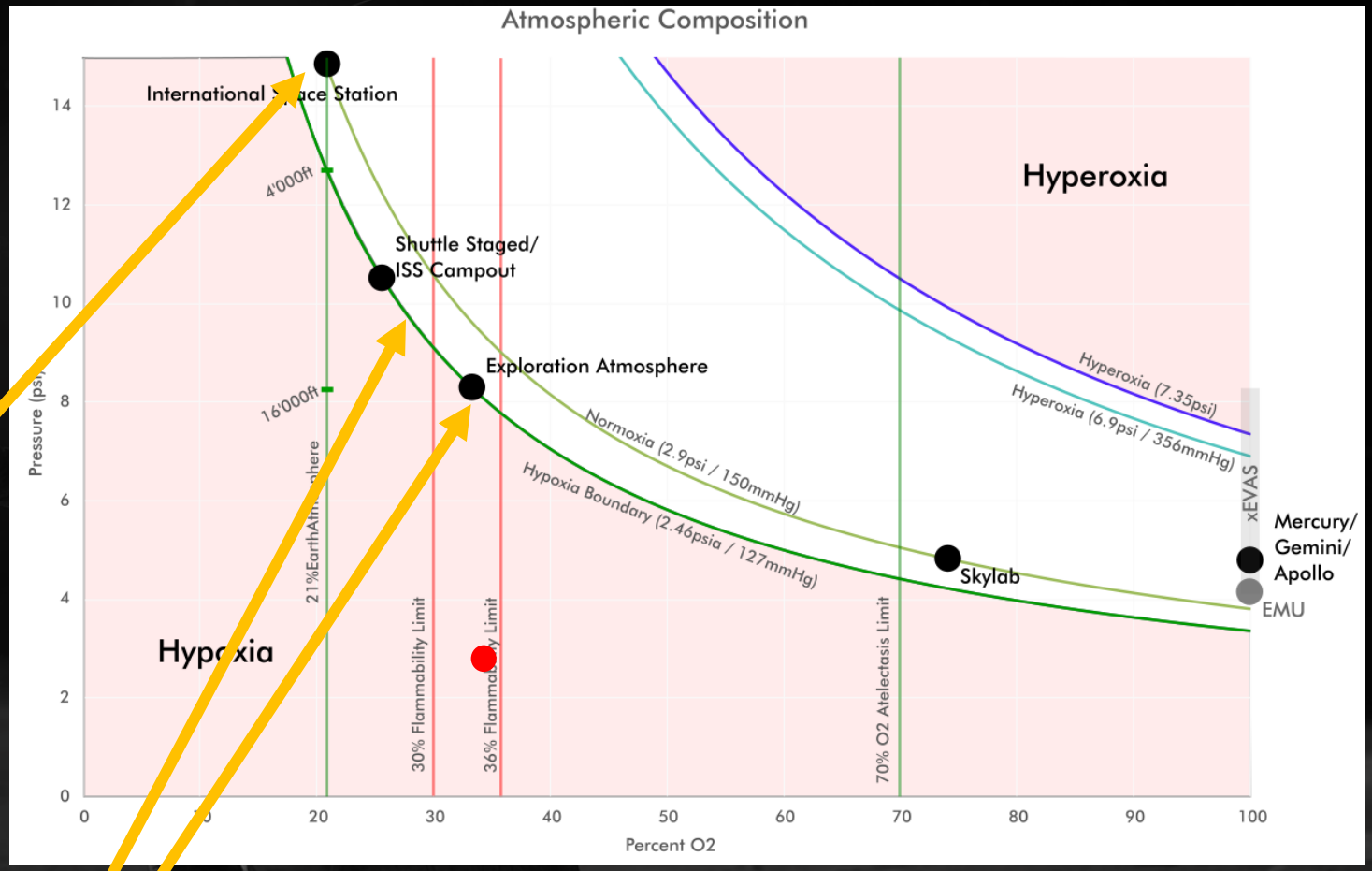
- HCA will use a protocol similar to the “Exploration Atmosphere Prebreathe Studies” (EA) – a series of multi-day decompression studies performed at NASA/JSC
  - These studies compare the modeled prebreathe duration needed from various starting atmospheres

Calibration Protocol

Saturation Atmosphere	Planetary Prebreathe
14.7 psi, 21% O2	6:30
9.6 psi, 28.5% O2	**2:30**
8.2 psi, 34% O2	**0:20**

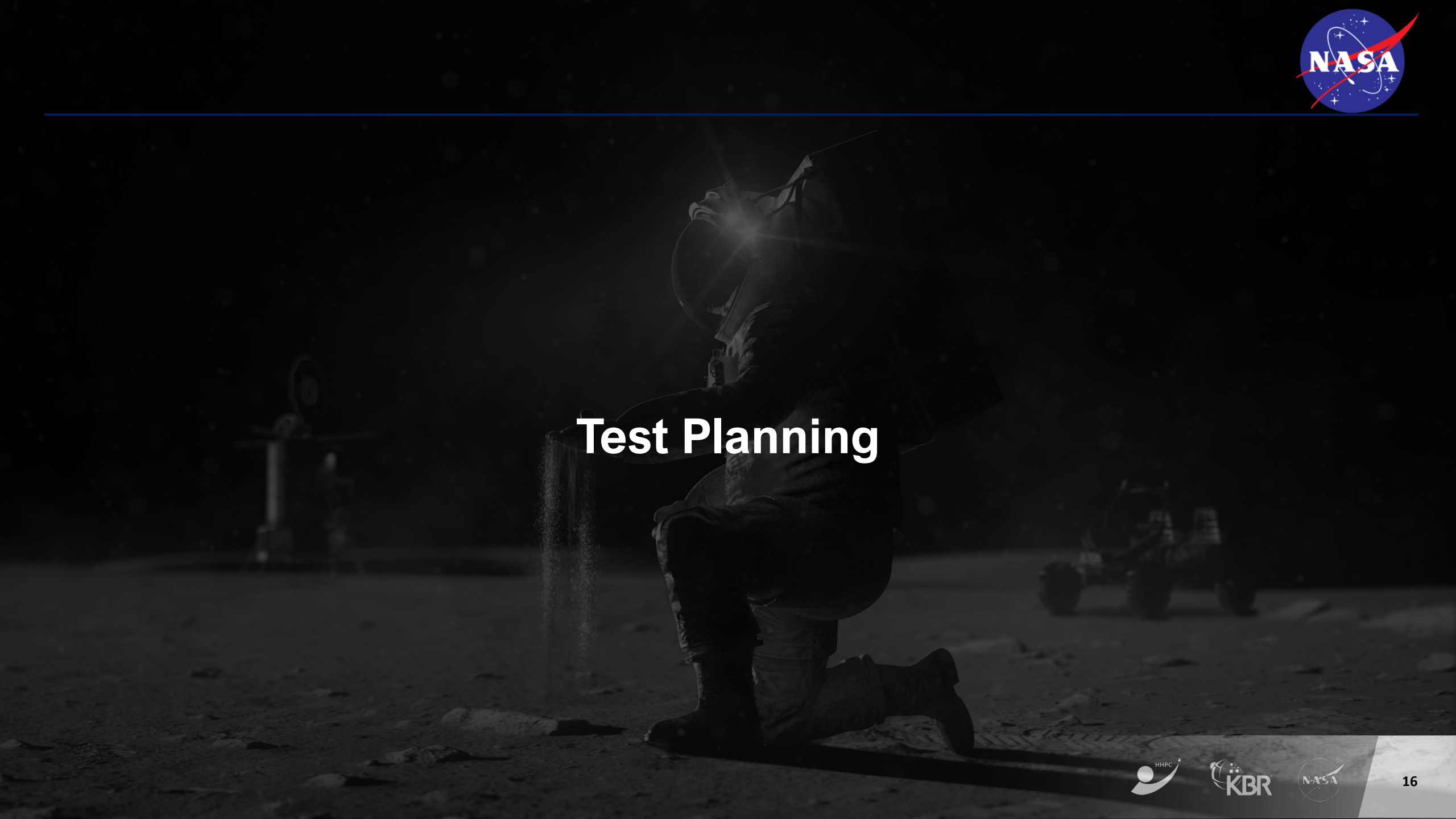
EA3,4 (2023,2024)

EA1,2 (2022/2023)



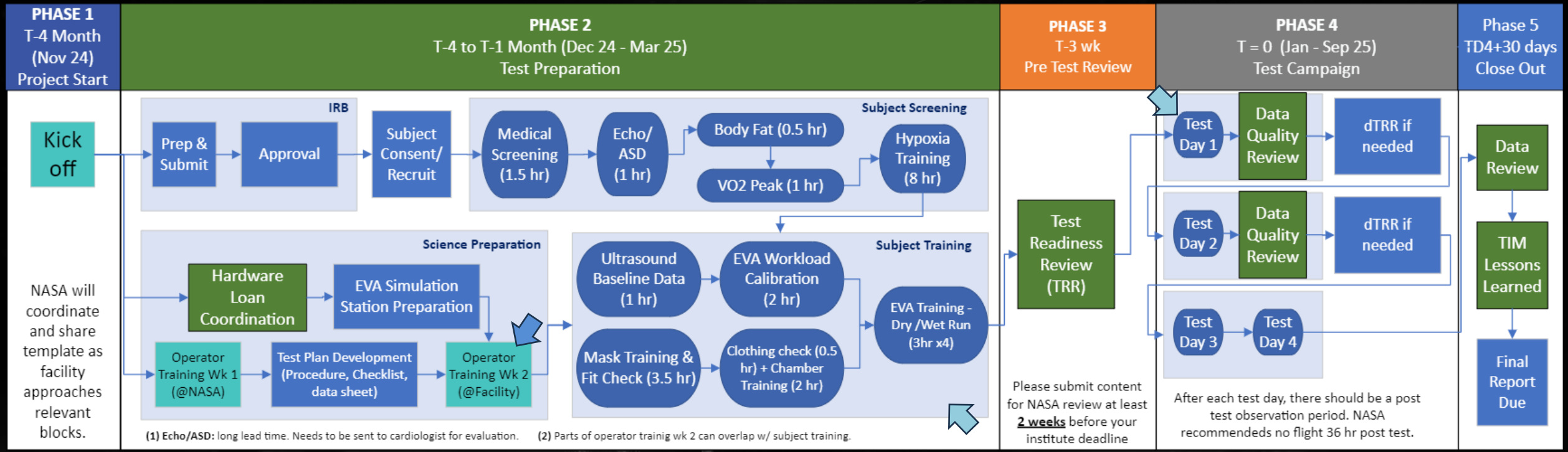
HCA Protocol – "A Calibration Protocol for AETHER"

- **Test objectives:** validate chamber facility and test team capabilities to support NASA DCS studies for future AETHER studies. Specifically, NASA is interested in demonstration of following attributes:
  - Back-to-back EVAs, human in the loop testing (HITL), unique capability highlights, and access to test subject population.
  - Ability to complete IRB, subject/screening/recruitment
  - Data collection and quality assurance
- Starting from 14.7psi/21% is optimal for the demonstration of facility capabilities:
  - No need to provide in-chamber multi-day accommodation (48hr saturation period)
  - No need for enriched oxygen environment (flammability restrictions)
  - Highest decompression stress – most demanding, highest 'signal to noise' ratio
- Single (long) day test runs:
  - Demonstrates capability to support extended hours/multiple shifts
  - Flexible/rapid rescheduling in case of hardware/operations failures
- Scope: Pilot testing consists of up to 4 hypobaric test days.
  - Test day 1, 2: separated by several days/weeks, to allow for corrective actions
  - Test Day 3&4: occur in the same week, demonstrates increased tempo capability
  - **UPDATE – Some chambers opted to skip 'test day 2'**



Test Planning

Project Timeline



Tips: Consolidate subject training events into a week to optimize efficiency and resource utilization

Note: General timeframe is provided above, but each chamber will follow this timeline based on their progress.

Facility | Joint | NASA

Shows tentative NASA travel to site

Shows tentative facility travel to JSC

What is your facility's Test Readiness Review (TRR) equivalent?
When are you doing subject screening week? Operator training week ?

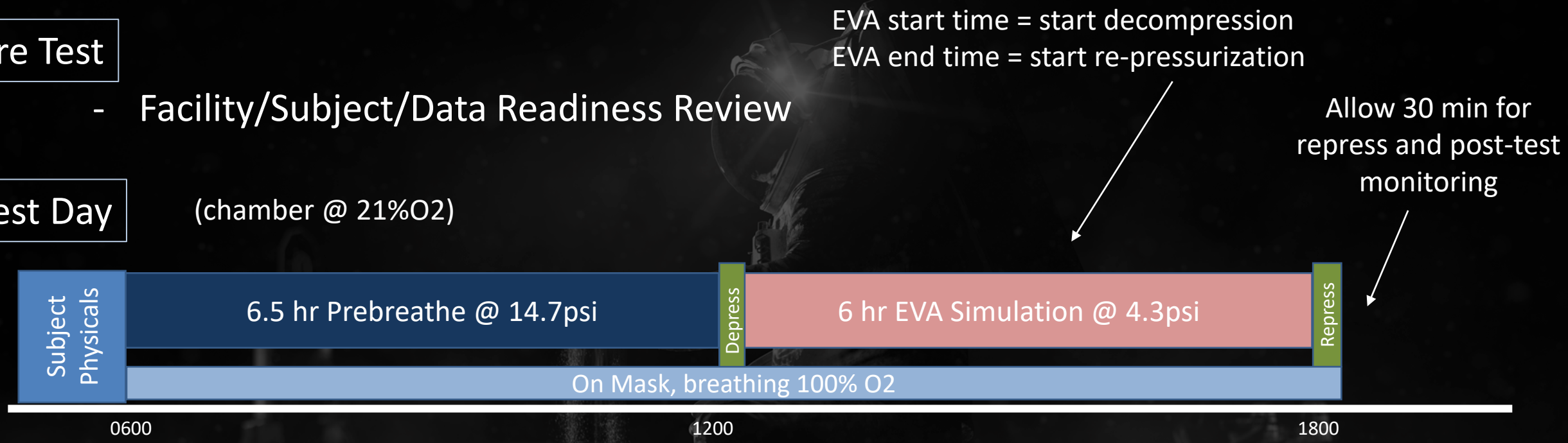
Test Protocol – Example Test Day Overview

Pre Test

- Facility/Subject/Data Readiness Review

Test Day

(chamber @ 21%O2)



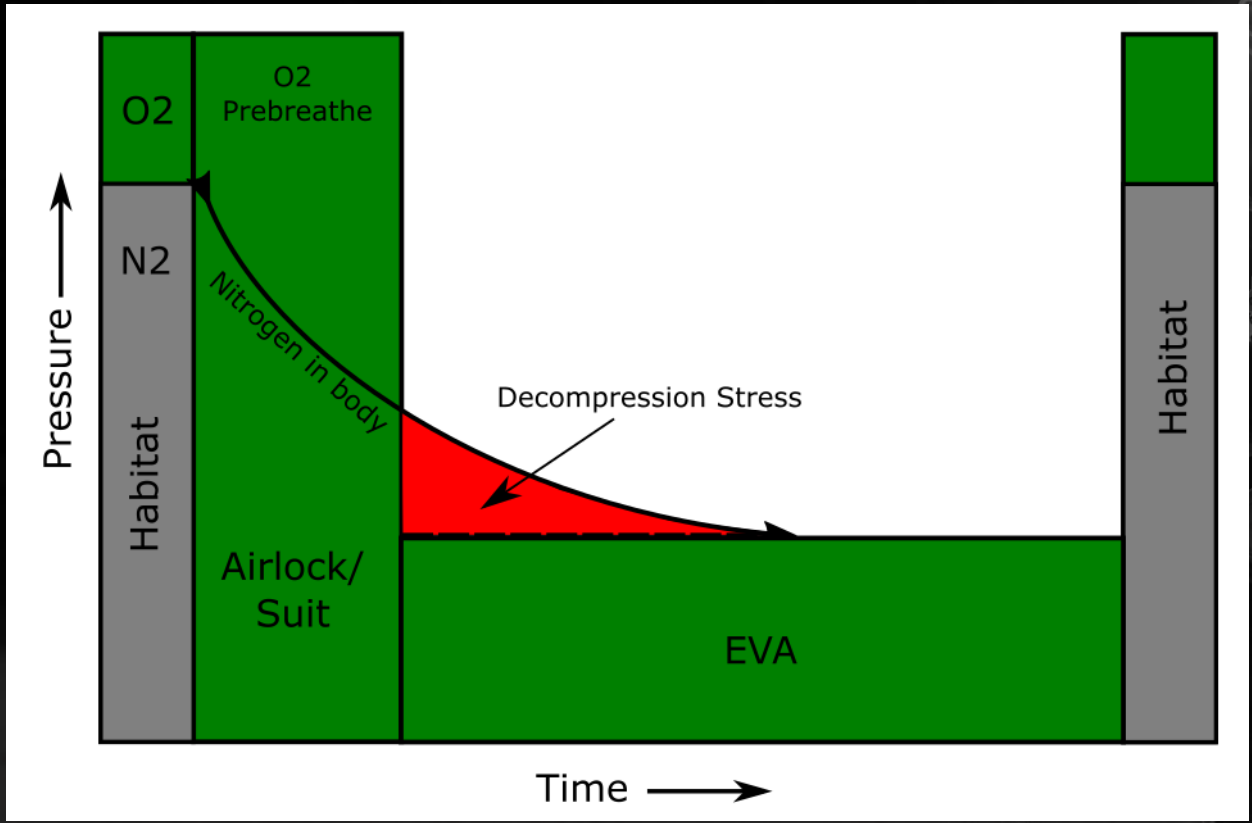
(No food but water is available via drink port during test protocol)

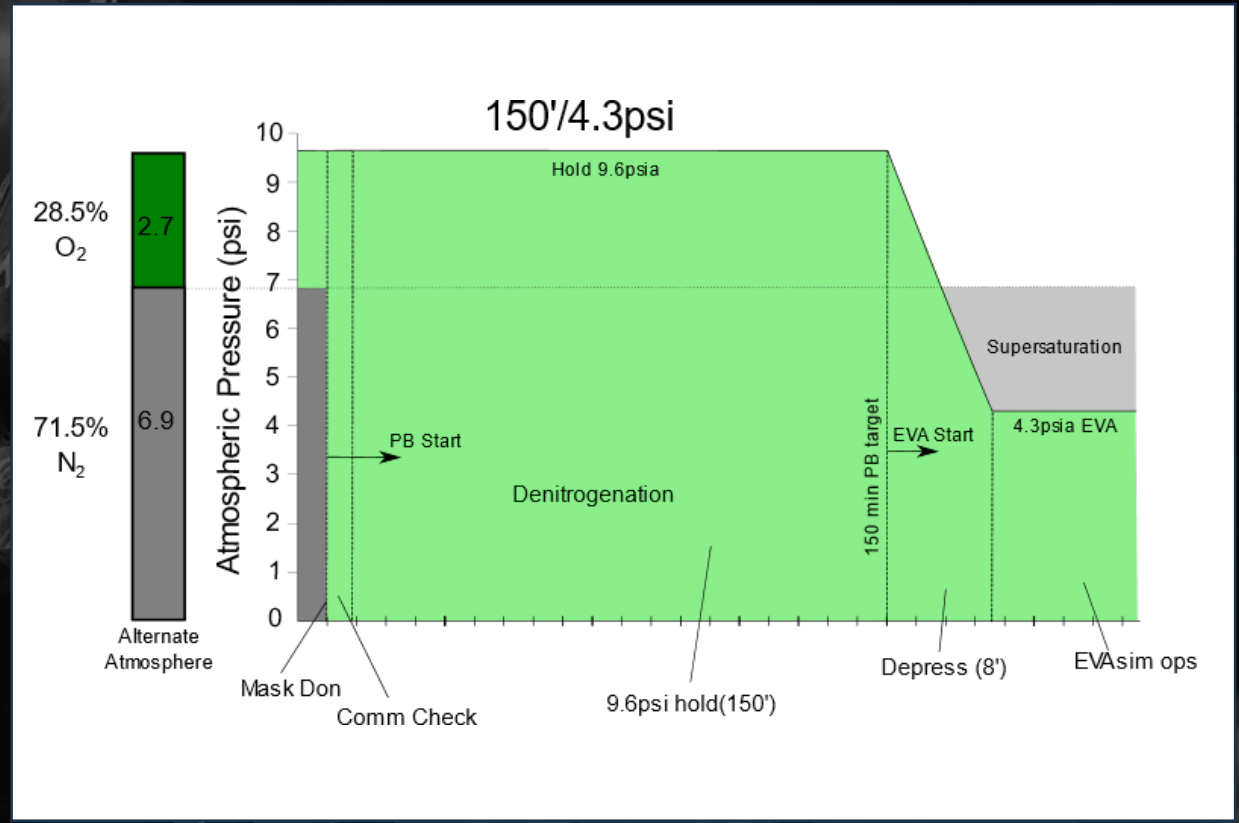
Post Test

- Subject Monitoring for delayed symptoms (recommend no flying 36hr after exposure)
- Data and Procedural Quality assurance checks

Prebreathe Timeline

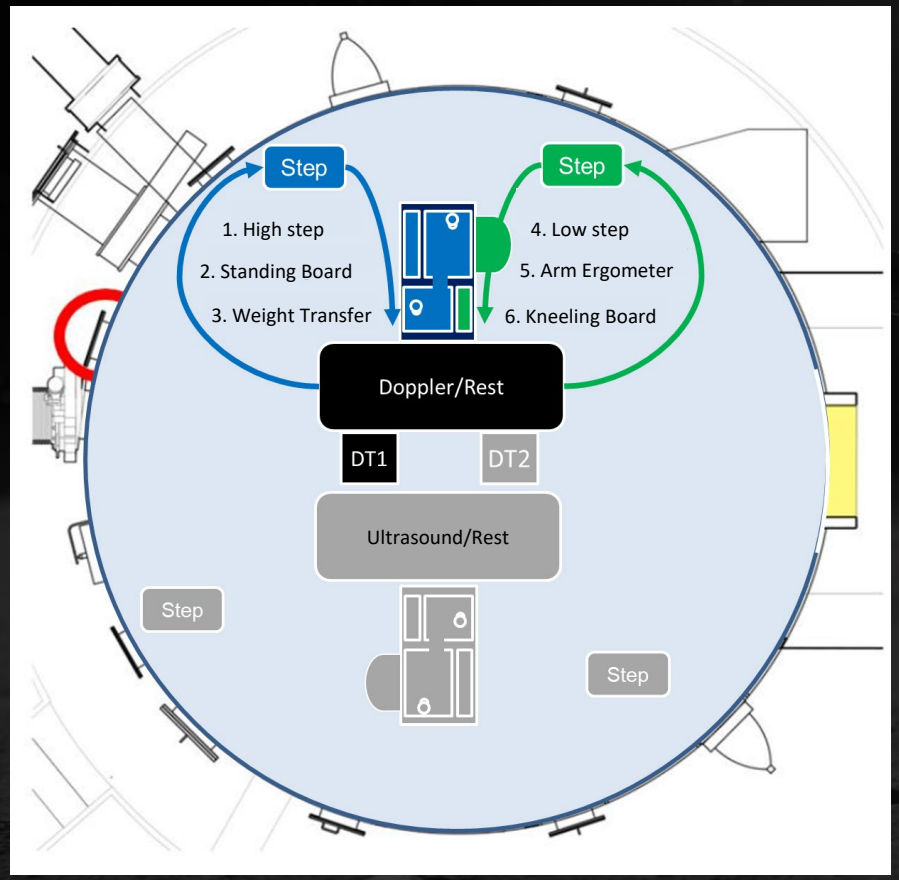
Example: Exploration Atmosphere Mission 3 (EA3)





Exercise Timeline

- 6 exercise + 2 scanning (rest) stations
  - 5 minutes per station, 40 minutes per cycle
  - Different tasks: aerobic steps, ergometer, weight transfer, kneeling/cognitive task, etc.



ID	TIME	CREW 1	CREW 2	CREW 3	CREW 4	CREW 5	CREW 6	CREW 7	CREW 8	NOTES
1	00:00	PREP	PREP	PREP	PREP	PREP	PREP	PREP	PREP	
2	00:05	1	3	5	7	2	US (8)	6	DOP (4)	1 - 2 minutes have elapsed
3	00:10	2	DOP (4)	6	US (8)	3	5	7	1	7 to 8 - watch your head
4	00:15	3	5	7	1	US (8)	6	DOP (4)	2	
5	00:20	DOP (4)	6	US (8)	2	5	7	1	3	1 - 2 minutes have elapsed
6	00:25	5	7	1	3	6	DOP (4)	2	US (8)	7 to 8 - watch your head
7	00:30	6	US (8)	2	DOP (4)	7	1	3	5	
8	00:35	7	1	3	5	DOP (4)	2	US (8)	6	1 - 2 minutes have elapsed 7 to 8 - watch your head
9	00:40	US (8)	2	DOP (4)	6	1	3	5	7	
10	00:45	REST	REST	REST	REST	REST	REST	REST	REST	PRICE checklist, mask fit, water bottle check, PMCs
11	00:50	1	3	5	7	2	US (8)	6	DOP (4)	1 - 2 minutes have elapsed
12	00:55	2	DOP (4)	6	US (8)	3	5	7	1	7 to 8 - watch your head
13	01:00	3	5	7	1	US (8)	6	DOP (4)	2	
14	01:05	DOP (4)	6	US (8)	2	5	7	1	3	1 - 2 minutes have elapsed
15	01:10	5	7	1	3	6	DOP (4)	2	US (8)	7 to 8 - watch your head
16	01:15	6	US (8)	2	DOP (4)	7	1	3	5	
17	01:20	7	1	3	5	DOP (4)	2	US (8)	6	1 - 2 minutes have elapsed 7 to 8 - watch your head
18	01:25	US (8)	2	DOP (4)	6	1	3	5	7	
19	01:30	1	3	5	7	2	US (8)	6	DOP (4)	1 - 2 minutes have elapsed
20	01:35	2	DOP (4)	6	US (8)	3	5	7	1	7 to 8 - watch your head
21	01:40	3	5	7	1	US (8)	6	DOP (4)	2	
22	01:45	DOP (4)	6	US (8)	2	5	7	1	3	1 - 2 minutes have elapsed
23	01:50	5	7	1	3	6	DOP (4)	2	US (8)	7 to 8 - watch your head
24	01:55	6	US (8)	2	DOP (4)	7	1	3	5	
25	02:00	7	1	3	5	DOP (4)	2	US (8)	6	1 - 2 minutes have elapsed 7 to 8 - watch your head
26	02:05	US (8)	2	DOP (4)	6	1	3	5	7	
27	02:10	REST	REST	REST	REST	REST	REST	REST	REST	PRICE checklist, mask fit, water bottle check, PMCs

EVA Simulation Rationale

- Slides available in Box
- Detailed Discussion in Part 3


10 min Break
We will return at _____ CST

Data Deliverables :

	Facility (Data Products Expected in the Report)	NASA (Provides…)
EVA Data	1. US VGE scored by 3 reviewers (blind) 2. US VGE recordings with clear annotation and voice overlay 3. Medical monitoring logs (incl. DCS symptoms & case description) 4. Questionnaires during EVA stations: RPE, pain 5. Workload calibration data 6. (optional) HR, Pulse Ox 7. In-chamber video of EVA workstations; record EVA time, EVA station schedule, subject feedback/debriefing	• Provide operator training & protocol • Provide sample data analysis code (matlab) • Provide data template • Provide questionnaires (RPE, pain) training and template
Chamber Data	1. Console and/or operator's logs: Incl chamber event time, prebreathe records, test operator observation 2. Final protocol/Detail test procedure (including EVA) 3. Chamber pressure recordings: demonstrate depress and repress rates as well as sustained chamber pressure (4.3 +/- 0.1psi) 4. Chamber environmental conditions (partial pressures of O_2, CO_2, and N_2, temperature, humidity), and DCS case descriptions.	• Provide templates, example test procedures
Subject Data	1. Subject demographics data (incl VO2 peak, skin fold data…) 2. Screening records (incl consent forms…)	• Provide protocol • Provide templates

Document Preparation - Data Item Description (DID)

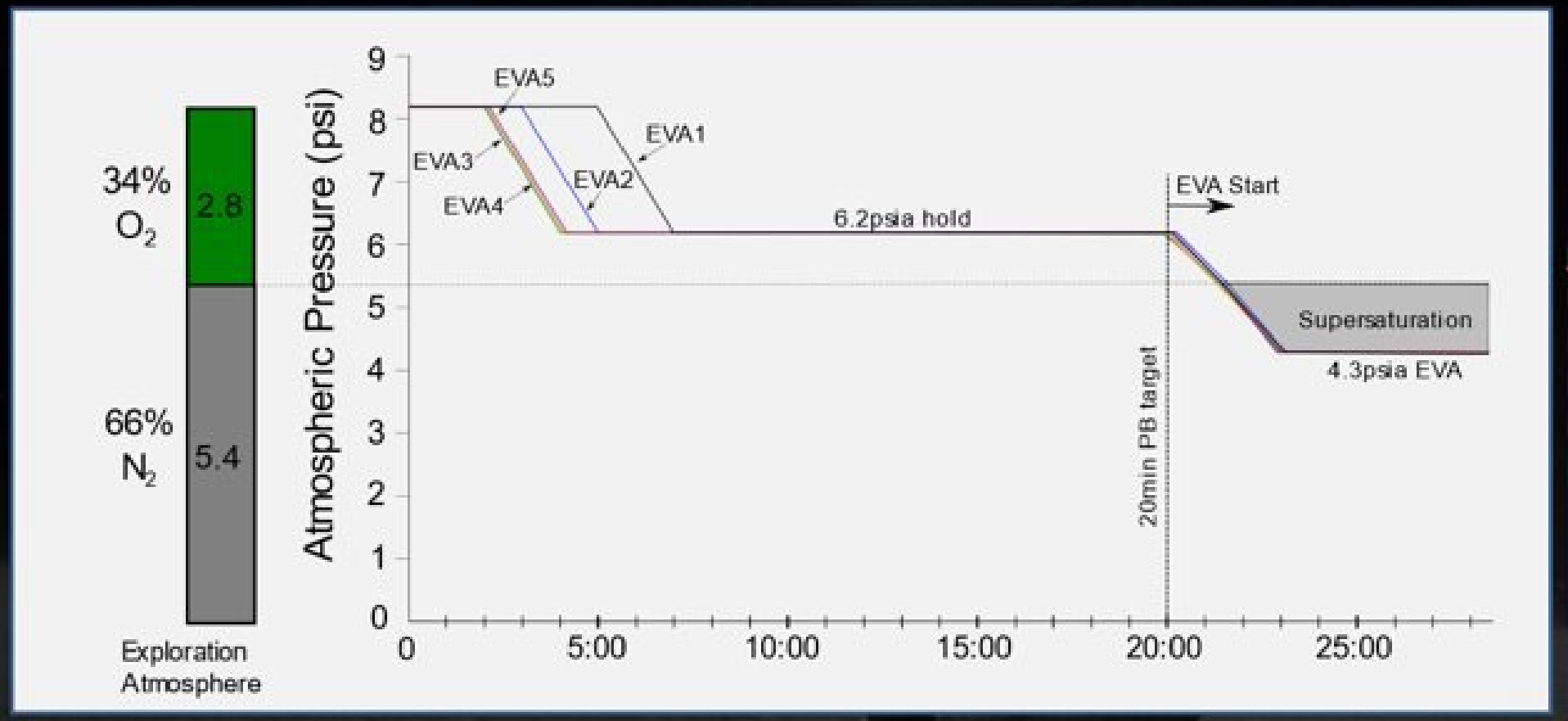
- This is a full list of documents that we will be working together throughout this project.
  - **[Facility][Inputs]:** Facility is responsible for developing these documents. NASA will provide examples and/or templates and help provide inputs. These documents are deliverables to NASA during TRR and final report package.
  - **[Facility]:** NASA will provide examples and/or templates and can help provide inputs. These are helpful documents for your reference only. NASA doesn't need them in final report.

  - This list will be updated with links within Box. It will be used as an index to quickly track yours/our documents.
    - EEPL_HCA_Progress Tracker
    - Further discussions will take place at each integration meeting.

Category	Document	Org	Status (GR/RED) (DID = YELLOW)
PM - Int	Progress Tracker	EEPL	
PM - Int	Project Schedule	EEPL	
PM - Ext	HCA Notebook (External)	EEPL	
PM - Ext	Facility Team Folder	EEPL	
IRB	Science & Ops Summary PPT (include pressure profile p	Facility	
IRB	IRB Protocol	Facility	Input
IRB	Informed Consent (signed)	Facility	Input
IRB	Layman's Summary	Facility	Input
IRB	IRB Determination	Facility	Input
Ops	Subject Recruitment Timeline	Facility	
Ops	Test Readiness Review Slides/Package	Facility	Input
Ops	Subject screening criteria, subject readiness list, medi	Facility	Input
Ops	Operator Certification Letter/Readiness List	Facility	Input
Ops	Detail Test Procedures (DTP): incl EVA procedure	Facility	Input
Ops	Science Test Schedule	Facility	Input
Ops	Console Log: Test Checklist, and science tracker	Facility	Input
Ops	Hardware List (JF1850 former)	Facility	
Ops	Training lesson plans (Ultrasound, EVA, Mask)	Facility	
Ops	Hazard Analysis	Facility	
Ops	EVA Sim Station - CAD + BOM	Facility	
Data	Subject meta data (demographic, EVA Workload calibration data, VO2 data, Skin fold, questionnaire)	Facility	Input
Data	Data Analysis Plan	Facility	Input
Data	Ultrasound Scoring Datasheet	Facility	Input
Data	EVA Workload Calibration Datasheet	Facility	Input
Data	Chamber Parameter Data	Facility	Input
Data	Chamber video + US video/audio	Facility	Input
Data	Final Report	Facility	Input

Example – Depress Rate Verification

EA2 Prebreathe Timelines



Prebreathe Times:
EVA1: 19min 56 sec
EVA2: 20min 01 sec
EVA3: 20min 00 sec
EVA4: 20min 01 sec
EVA5: 20min

*Transition from 6.2 psi to 5.4 psi (supersaturation point) added ~80-90 sec

Communication

- Meetings: **biweekly** between NASA and each chamber team via Microsoft Teams
  - EEPL will send out meeting agendas at least 24 hr prior. Please ensure you have the right personnels attending.
  - These are working meetings, feel free to submit agenda items to us at least 24 hr prior or add as walk-on topics.
  - We are here to help you make a successful test. Please bring your questions.
  - Some meetings might require pre-work or have follow-up actions, please be prepared.
  - Meeting notes will be uploaded here ___NASA Box - Notes_____
  - Meetings will be conducted **biweekly (or more frequently as required)** on Microsoft Teams
- Actions tracking via __NASA Box - Action__
  - How to track actions
- File Sharing Structure via __NASA Box_____
  - Everyone here should have been added for access. Please verify and contact us if you have any questions
  - Do not save subject sensitive data on this platform without coordinating with us.
  - This will be the main platform for file sharing, joint-editing --> **Box for Office for Web**
  - We will also establish FAQ section to answer some common questions.
- Calendar via Outlook invites
- Instant Messaging:
  - Emails
  - Meeting/Chats via Microsoft Teams

KBR Holidays for 2025

Date	Day of Week	Holiday Name
January 1	Wednesday	New Year's Day
January 20	Monday	Birthday of Martin Luther King, Jr.
May 26	Monday	Memorial Day
June 19	Thursday	Juneteenth
July 4	Friday	Independence Day
September 1	Monday	Labor Day
November 11	Tuesday	Veterans Day
November 27	Thursday	Thanksgiving Day
December 25	Thursday	Christmas Day

- Please let us know if you have major restrictions on communication hours (4-day work week vs. flex Friday etc.).
- Share major holiday information to us for planning purposes.

Biweekly integration meeting potential time slots

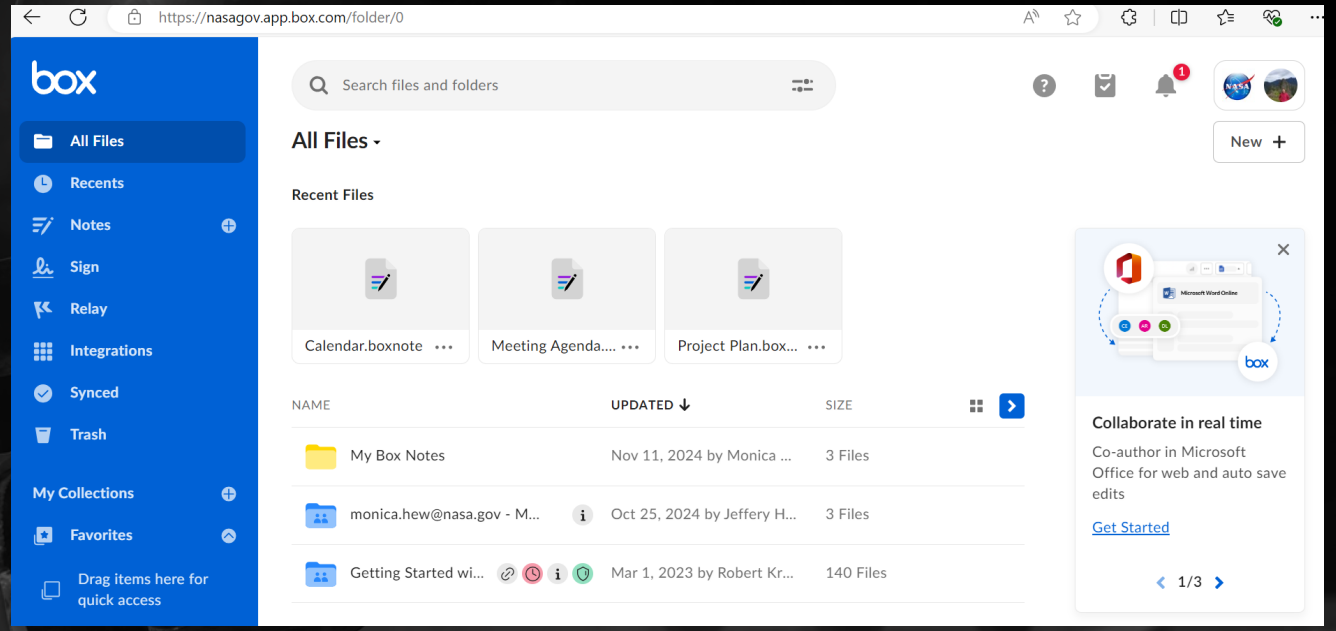
CST (UTC-6)	M	T	W	Th	Fri
AM					
PM					

Sign up for biweekly meeting spots!

How to use NASA Box

- The files share on Box is not controlled nor sensitive data. However, please refrain from sharing with others and/or use it for purpose outside of supporting Hypobaric Chamber Assessment or AETHER projects.
- Please ensure PII data is properly protected per your institution guideline.
- Collaborate real-time in documents
- Follow folder structures

[(1) All Files | Powered by Box]



- We will coordinate ahead of time for information, documents, etc., regarding export and import control of documents to and from NASA through our Export Compliance Tool (NASA Internal only), if needed.
  - May ask for details regarding foreign nationals who might see this, personal info (i.e., emails, addresses, phone numbers, etc.), other misc. details – we will NOT distribute this information but sometimes do require it for export control regulations.

Folder Structure

- Chamber 1
  - Test Documentation
    - Operator Certification
    - Project Planning
    - Standard Operating Procedure
    - Technical Reference
    - Test Day Documentation
    - Training Materials
  - Subject Management
    - Consent Forms
    - Subject ID Key
    - Subject Readiness
    - Subject Remunerations and Timesheets
  - IRB Documentations
  - Data
  - Deliverables
  - TRR


10 min Break
We will return at _____ CST

Technical Topic Overview – Test Prep

This section is meant to provide a quick overview on critical test preparation areas. We will do in-depth discussion in biweekly integration meetings for each of these topics

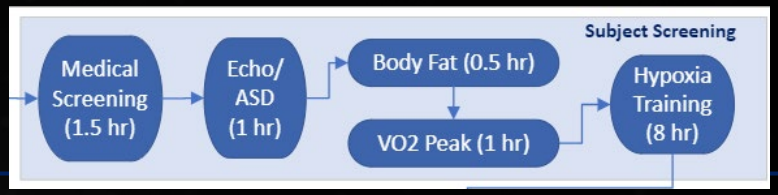
IRB/Ethical Committee Approval

Facility	NASA

• Prepare and submit IRB documentation based on your institutional guidelines
• Acquire and maintain IRB approval throughout the study
• Ensure your study team satisfy IRB requirements, such as CITI trainings and conflict of interest determinations, etc.
	• Provide sample approved NASA
	  • IRB protocol
	  • Layman Summary
	  • Informed consent forms
	• Provide feedback and inputs to your documents

Templates: Calibration_Example_IRB_Protocol.docx
FAQ:

Subject Recruiting and Screening



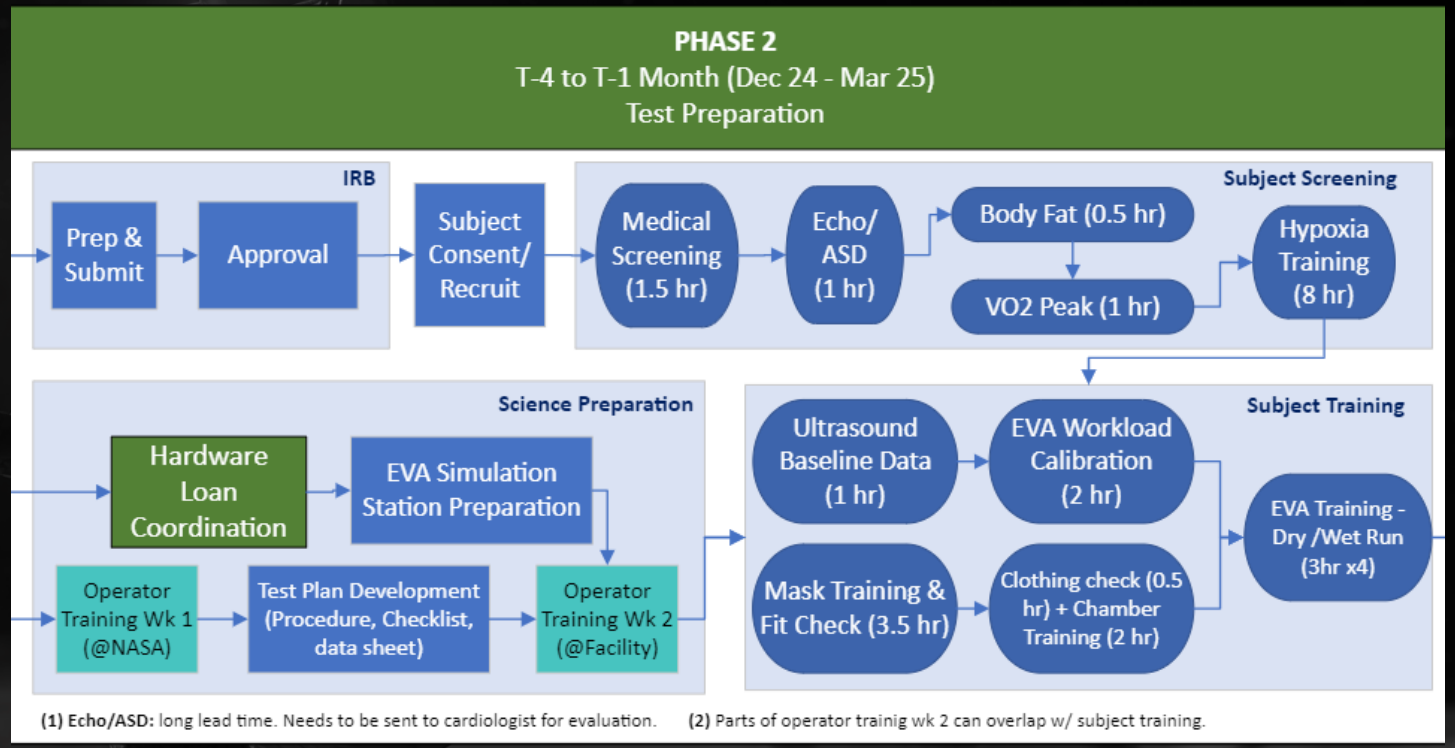
Facility	NASA

• Provide 3 subjects + 1 sonographer per test day
• Subject recruit, consenting, screening, and training
• **Conduct screenings**: medical (dictated per facility), Echo/Atrial septal defect (ASD), VO_2 peak, body fat & BMI, hypoxia training (dictated per facility)
• **Conduct trainings:** EVA workload calibration, EVA familiarization, Chamber, mask system, baseline ultrasound data, clothing
	• Provide inclusion and exclusion criteria consistent with astronaut corps
	• Provide the following protocols & data templates
	  • VO_2pk cycle ergometry
	  • Skin fold (body fat)
	  • EVA simulation and workload calibration
	  • Ultrasound

- Age 25-60
- VO_2 Max >35ml/kg/min (male), >30ml/kg/min (female)
- Must be healthy and non-smoking with physical and biological characteristics comparable to those of astronauts currently involved in NASA's human space flight program.
- Subject does not take (or has medically cleared) over-the-counter or prescription medication to control: a chronic painful condition, anxiety or stress disorder, psychosis, a sleep disorder, a breathing disorder or blood pressure
- No current sprains/fractures of any joints. No respiratory illness.

Subject Recruiting and Screening: survival tips

- Some tips and lessons learned to share….
- The recommended order of screening is provided in the flow chart.
  - Consider doing the **“lowest cost”** screening first, e.g., medical screening vs. VO2 peak.
  - Consider doing the **“highest exclusion rate”** events early, e.g., VO2 peak
  - Have your **test dates and training dates set as early as possible.** Preferably before you start consenting subjects, so that you can factor in subject availability.
  - Specialty gear size availability (e.g., mask and clothing) can limit your subject pool.
  - Echo needs to be read by cardiologist, so factor in additional lead time.



Science Preparation – equipment loaned from NASA

Equipment	Qty	Notes
GE Vivid iQ Ultrasound	2	Loaners available. NASA will provide operator trainings.
COSMED K5 (including mask gears) & laptop	2	Loaners available. NASA will provide operator trainings.
Gentex Phantom masks	TBD	Loaners available. Chamber facilities shall go through manufacturer training on their own or develop own procedures based on manufacturer manual.
Oxygen Treatment Hood	TBD	TBD

- Qty = allowable for loan for each chamber site.
- Chamber facility can select their own mask systems, and shall be responsible for their own mask fit and operation trainings. NASA will only provide generic mask fit procedure overview/lessons learned training.
- Since these equipment are shared across chamber teams, the equipment loan is subject to availability.
- Chamber facility is responsible for all other hardware/equipment.
- NASA will arrange for delivery and return of the hardware through NASA shipping resources, but facility will need to provide personnel to receive the hardware and prepare the hardware for return

Science Preparation – provided by facility

Equipment	Qty	Facilities need to provide (Examples of items)	Support Provided by NASA
EVA Simulation Station	2	EVA stations (incl cooling bins for ultrasound, cooling gel packs, surgical maker, metronome, weight bags, cots…), umbilical management system, printed procedures	1. EVA Training, protocol & CAD/BOM 2. Workload training & protocol 3. Mask gear lessons learned
Ultrasound Station	2	HDMI cables or other ways to stream/record videos, surgical markers, hardware drive, US gel, wipes	1. GE Vivid iQ Ultrasound x2 2. Ultrasound training & protocol 3. Ultrasound scoring training & protocol
VO_2 Peak Screening	AR	ECG*, Metabolic Cart*, Cycle Ergometer (e.g., Lode Bike that can connect to metabolic cart), medical monitoring (MDs)	VO_2 peak protocols and data template
Subject	AR	Clothing, drinkware/hydration, toiletry/hygiene, mask gears, handheld mirrors, skin fold calipers	Example list of items used by subjects
Chamber	AR	Chamber hardware, communication system, medical, toilet, trash cans…	Relevant Lessons Learned, Quick Tour

- **Chamber is responsible for "everything else that is NOT listed in previous page."**
- **Here is a high-level overview. We will have integration meetings to cover each of these areas to help you prepare what you need.**
- **BOM = bill of materials**

Trainings: Overview of Training Activities (1/4)

- This slide provides a list of trainings to be provided by NASA (at JSC or at facility) and facility.
- *Some trainings will only be provided as an **"overview" for reference** since individual facility shall develop their own training based on facility hardware ("per facility").
- NASA also provide the typical "subject training time" for each event to give you a rough idea of the expected average subject time commitment. Actual time varies.
- Note : time listed under subject training does not include operator setup/cleanup time. It is just an estimated subject participation time required for the given activity for your reference.
- Operator training can be spread across training week 1 (at JSC) and 2 (at facility).

Trainings	Subject Training (provided by facility)	Operator Training (provided by NASA)
EVA* Workload Calibration	2 hr – subject time 1 hr – setup/cleanup	1 hr – EVA hardware overview 2 hr – Procedure training 2 hr – COSMED training
EVA & Console	6 hr – 3 hr dry fam x2 6 hr – 3 hr wet fam x2	3 hr – wet/dry fam 1 hr – Console overview
Ultrasound	1 hr – baseline data collection	10 hr – didactic + hands-on 2 hr – console training
Mask*	Per facility (e.g., 3.5 hr)	2 hr - Overview only
Clothing*	Per facility (e.g., 0.5 hr)	30 min - Overview only
Body Fat Measurement	30 min	1 hr

Overview of Training Activities (2/4)

- Summary of the highlights in each operator trainings.
- Trainings might be broken down into sub-sections and provided at training week 1 and/or 2.
- Details in later slides

Trainings	What's covered in these operator trainings?
EVA Workload Calibration	• EVA simulation procedures, hardware/setup overview • Workload calibration protocol: calibrate metabolic rate to verify the cadence/work rates required for the exercise prescription. • Operation of the metabolic analyzer (COSMED)
EVA & Console Ops	• How to train subjects on EVA procedure, key points to cover and practice during EVA training, • EVA & ultrasound console management and setup overview
Ultrasound	How to perform VGE ultrasound monitoring and scoring on test subjects during EVA in chamber and post-test
Mask	Lessons learned on EVA mask sizing for EVA, and key areas on training test subjects to use masks system for EVA safely and correctly
Clothing	Lessons learned related to impacts of chamber clothing on EVA and ultrasound activities
Body Fat	How to perform skin fold measurements on subjects, and how to use the data sheet to calculate body fat

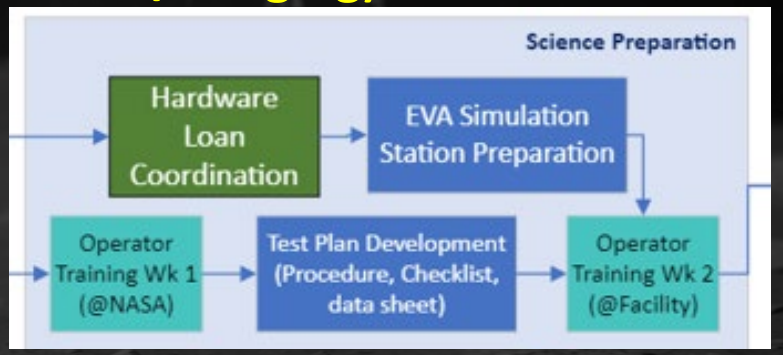
Anything else your facility is interested in getting help on?

Trainings: HCA training week 1 at JSC (3/4)

- Purpose: Two-day training at JSC to provide hands-on training your facility need to prepare for test
  - NASA provides training and hardware.
  - Facility provides operators to receive training and travel.

- **Instructions and final agenda will be distributed at least 1 week prior.**
  - Some pre-readings will also be assigned at that time.
  - Be prepared for a fully packed day from 0800 to 1700 with a 1-hr lunch break.
  - Focus is on Ultrasound, COSMED, EVA Sim Station, and EVA console. We will also overview some subject screening (VO2 peak and skin fold).

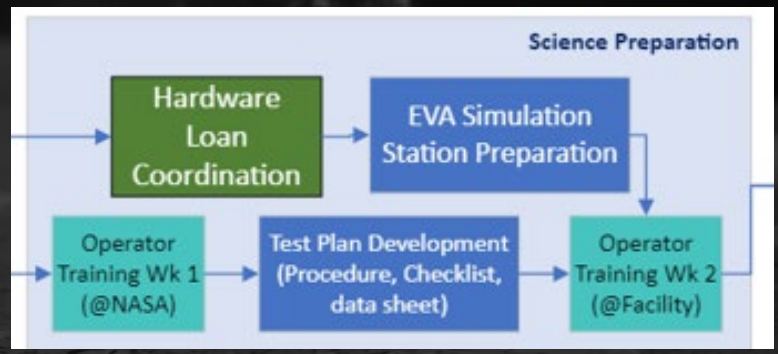
- **Three identical NASA Operator Training weeks scheduled: (day 1 is for travel/badging)**
  - **HCA Training Wk at JSC : Dec 11-13**
    - Duke: Natoli, Schinaz
    - NSMRL: Houtchens, Belval, Connors, McNeal
  - **HCA Training Wk at JSC: Jan 8-10**
    - COMEX: Chouard, Dennay, Reynier



Trainings: HCA training week 2 at facility (4/4)

- Purpose: NASA team to provide additional hands-on training at each facilities.
  - This training week **(2-3 days)** can overlap with facilities' subject training week or other weeks.
  - NASA travels to facility and provide trainings and support.
  - Facility provides operators to receive training.

- **Action - Please let us know NLT Dec 15th if your facility would like to receive this training service and <u>when</u> would you like it.**
  - NASA will need to coordinate personnel and equipment availability across different chambers + export control/requests for travel. Thus, your timely response is appreciated.



When are you planning on doing subject training weeks?
Are you interested in training week 2?

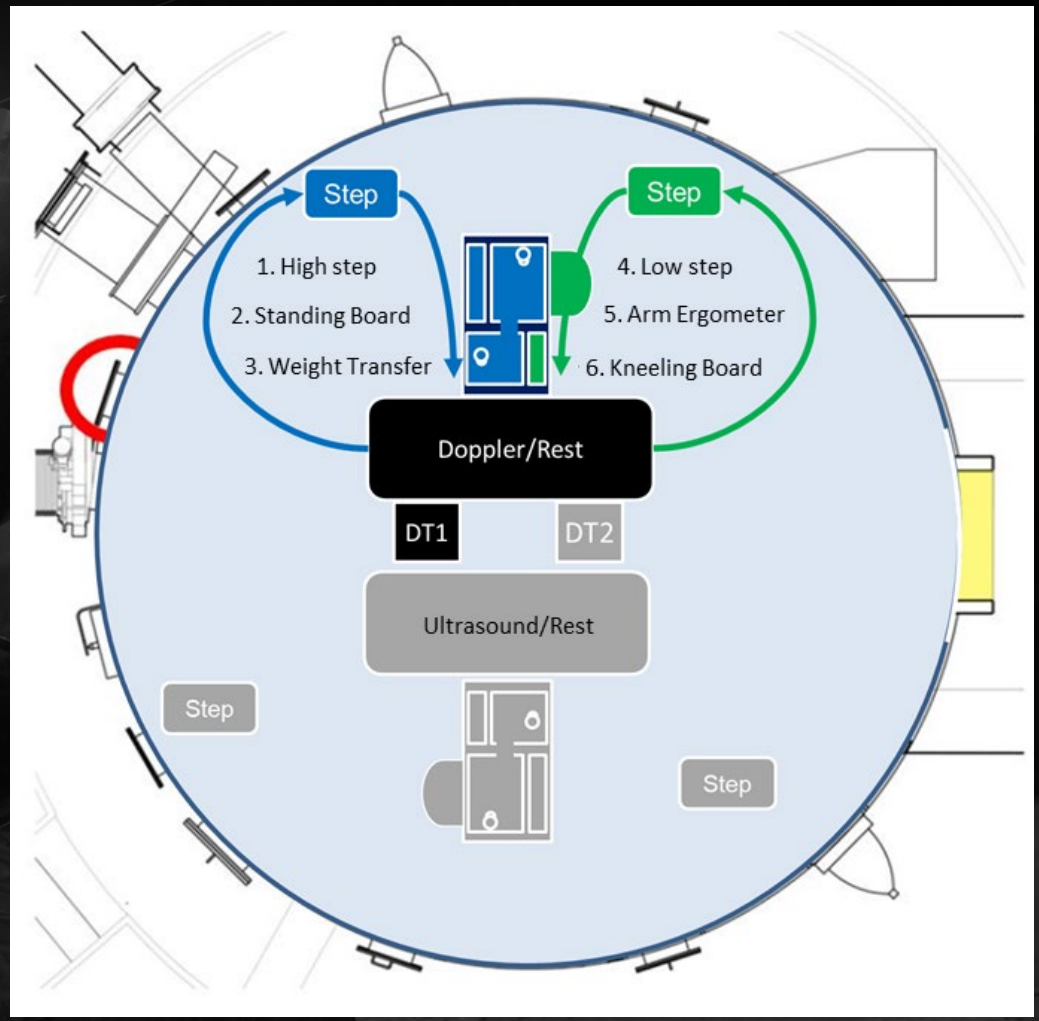
Technical Topic Overview – Key Areas Overview

This section provides a quick overview on critical test preparation areas.

We will do in-depth discussion in biweekly integration meetings for each of these topics AND/OR at training weeks.

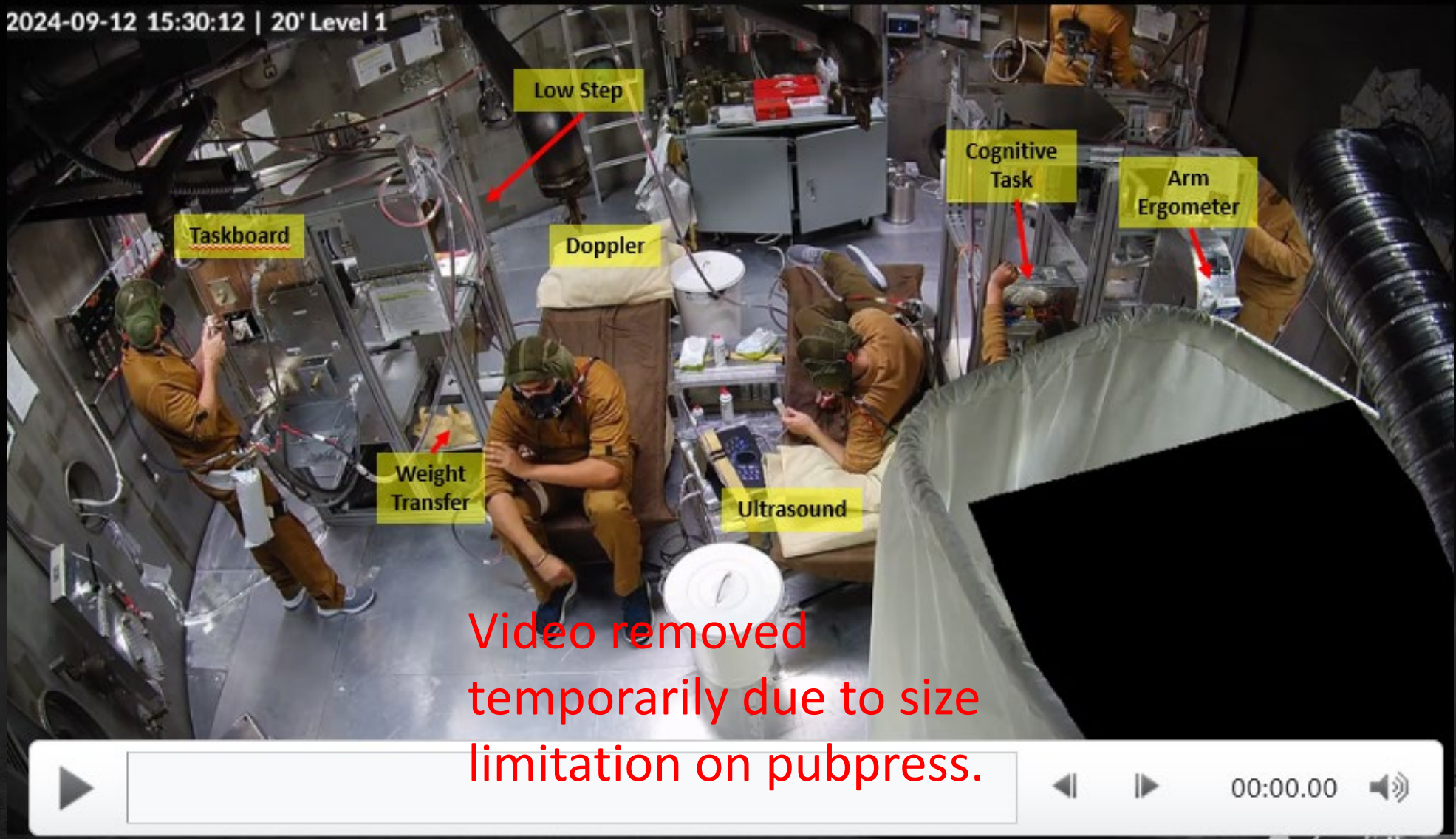
EVA Simulation Stations (1/4) – Overview

- EVA sim station allows subject to perform repeated and timed EVA-simulated tasks in a confined area with average work rates of 30-40% VO_2 max (with peaks up to 70%+).
- Facility constructs their own EVA simulation station **following NASA instructions** that is compatible with their chamber layout.
- Facility provides the required test support:
  - Conduct EVA workload calibration for subjects
  - Conduct EVA training for subjects
  - Document time at each station, work rates (cadence and load), symptoms reported by the subjects, and test operator observations.
- Note: EVA workload calibration requires VO2 peak data. (see next sections)



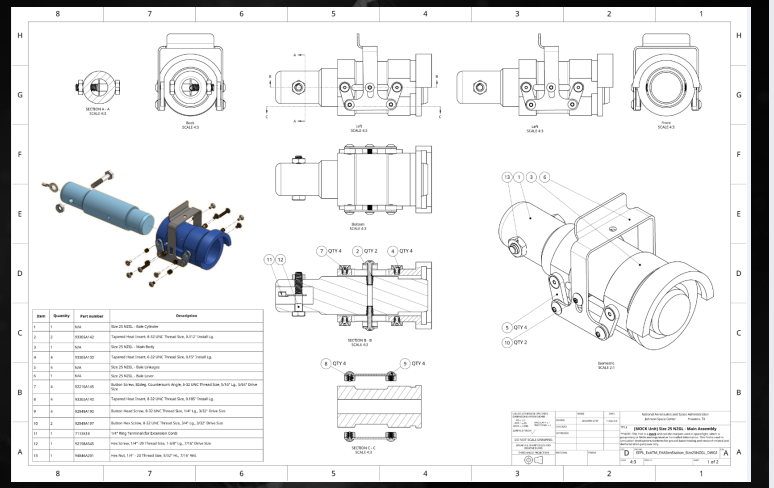
Dunn, J. *et al*. Development of an Extravehicular Activity Physical Workload Simulation for Use in Ground Validation of Exploration Prebreathe Protocols. May, 2022. Aerospace Medical Association Annual Science Meeting.

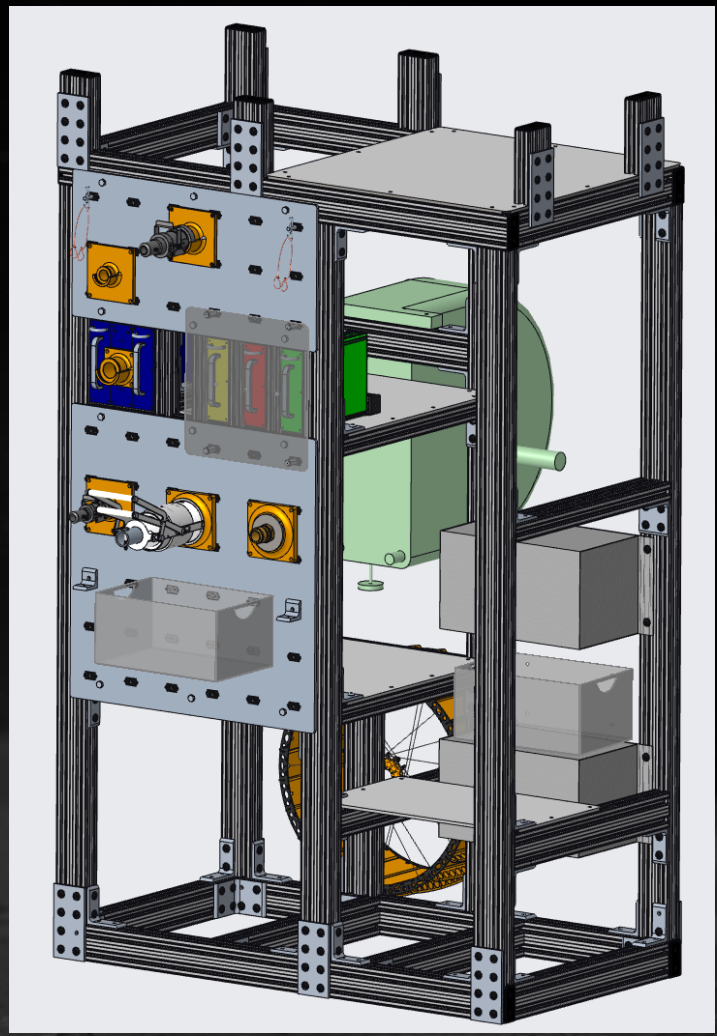
EVA Simulation Stations Video (2/4) – EA Example



EVA Simulation Stations (3/4) – Hardware Instruction

- NASA will provide Bill of Materials (BOM) and CAD .stl or .prt files and assembly files/drawings for EVA simulation station.
- NASA will provide general assembly instructions for task board connectors and drawings/schematics + exploded views for Sim Stations.
- Facilities will procure items, including custom 3D printed pieces, peripheral items (cots, cooling gel pack), and build Sim Stations that fits their facility layout.





Simulation Station Itemization (for ONE SimStations)

Label	Part	Part/Model #	Vendor	Material/Alloys	CAD File	CAD File	Description/Specifications	Notes	Use	Qty.	UoM	Total Indv. Qty.
							Frame					
A	T-Slotted Framing Rail, Hollow	47065T101	McMaster-Carr	6020 Aluminum			Double Six Slot, Silver, 3" High x 1-1/2" Wide, 5-ft. Lg., Grooved Rail Texture	-	Used as General Frame Structure	6	Indv.	6
B							Double Six Slot, Silver, 3" High x 1-1/2" Wide, 44 in. Lg., Grooved Rail Texture	Vendor: cut-to-length (per inch)	Used as General Frame Structure	4	$1.62/inch	4
C	T-Slotted Framing Rail, Hollow	47065T103	McMaster-Carr	6020 Aluminum			Double Six Slot, Silver, 3" High x 1-1/2" Wide, 21in. Lg., Grooved Rail Texture			16		16
D							Double Six Slot, Silver, 3" High x 1-1/2" Wide, 19 in. Lg., Grooved Rail Texture			1		1
E	T-Slotted Framing Rail, Hollow	4659N31	McMaster-Carr	6020 Aluminum			Double Six Slot, Silver, 3" High x 1-1/2" Wide, 6 in. Lg., Smooth Rail Texture	-	Used as Corner Posts for Umbilical Mgmt.	6	Indv.	6
F	T-Slotted Framing Rail, Hollow	47065T108	McMaster-Carr	6020 Aluminum			Single Four Slot, Silver, 3/92" High x 1-1/2" Wide, 21in. Lg., Grooved Rail Texture	Vendor: cut-to-length (per inch)	Used as Back Support for Taskboards	4	$0.92/inch	4
G2							Single Four Slot, Silver, 1-1/2" High x 1-1/2" Wide, 7.5 in. Lg., Grooved Rail Texture	Vendor: cut-to-length (per inch)	Used for Taskboard BH-220 Units	4	$0.92/inch	4
G1							Single Four Slot, Silver, 1-1/2" High x 1-1/2" Wide, 7 in. Lg., Grooved Rail Texture	Vendor: cut-to-length (per inch)	Used for Taskboard BH-220 Units	4	$0.92/inch	4
H	Oversized Multipurpose 6061 Aluminum Sheet	89f59c12	McMaster-Carr	6061 Aluminum			3/8" Thick, 24" x 48" LV	(Stock Material)	Raw Material	2	Indv.	2
I							Cut to **22" x 29-3/4" LV**, round corners to 92" radius. **5/16" holes for mounting** to AL frame, 3/4" margin from	-	Platforms for Weight Transfer Bags	2	-	2
J							Cut to **20" x 12" LV**, round corners to 92" radius. **5/16" holes for mounting** to AL frame, 3/4" margin from	-		1	-	1
K							Cut to **24" x 24" LV**, round corners to 92" radius. **5/16" holes for mounting** to AL frame, 3/4" margin from	-		1	-	1
L	Silver Corner Bracket	47065T241	McMaster-Carr	Anodized 6105 Aluminum			3" Long for 1-92" High Rail T-Slotted Framing	Fasteners included	Bracket for Frame Structure	52	Indv.	52
M	Silver Corner Bracket	47065T254	McMaster-Carr	Anodized 6105 Aluminum			3" Long for 3" High Double/Quad Rail T-Slotted Framing	Fasteners included	Bracket for Frame Structure	24	Indv.	24
N	Silver Surface Bracket	47065T264	McMaster-Carr	Anodized 6105 Aluminum			6" Long for 3" High Double/Quad Rail T-Slotted Framing	Fasteners included	Bracket for Frame Structure	12	Indv.	12
O	Silver Surface Bracket	47065T256	McMaster-Carr	Anodized 6105 Aluminum			3" Long for 1-92" High Rail T-Slotted Framing	Fasteners included	Bracket for Frame Structure	8	Indv.	8
P1	Plastic End Caps	2058223	McMaster-Carr	ABS Plastic			End Cap for 3" High Double Rails	Push-In Rivets Included	End caps for rails (sharps	14	Indv.	14
P2	Plastic End Caps	1858N27	McMaster-Carr	ABS Plastic			End Cap for 1.5" High Single Rails	Push-In Rivets Included	End caps for rails (sharps	2	Indv.	2
Q	T-Slotted Framing End-Feed Nuts	47065T907	McMaster-Carr	Steel			5/16" - 18 Thread Size, End-Feed Nut and Flanged Button Head for 1-92" Rails	-	Fasteners for brackets to frame (included with brackets)	2	Pack/25	32
R	Hex Screws	92949A581	McMaster-Carr	18-8 SS			5/16" - 18 Thread Size, 3/4" Long	Use with 6020 end-feed nuts	Fasteners for brackets to AL plates to frame	2	Pack/25	32
S	Hex Screws	92949A592	McMaster-Carr	18-8 SS			5/16" - 18 Thread Size, 1" Long	Use with 6020 end-feed nuts	Fasteners for AL plates to frame	1	Pack/25	20
T	Sheet Metal Boxes	-	[Custom] ProtoLabs	316 SS			Custom metal box w/ mounting holes. 13.75" x 6" x 7.94" Lg. Ht. Oph. With 1.5" extended edges and 9/3" holes for mounting to AL frame. 0.06" thickness.	Use with 6020 end-feed nuts	Used for kneeling task/ flammability mit.	2	Indv.	2

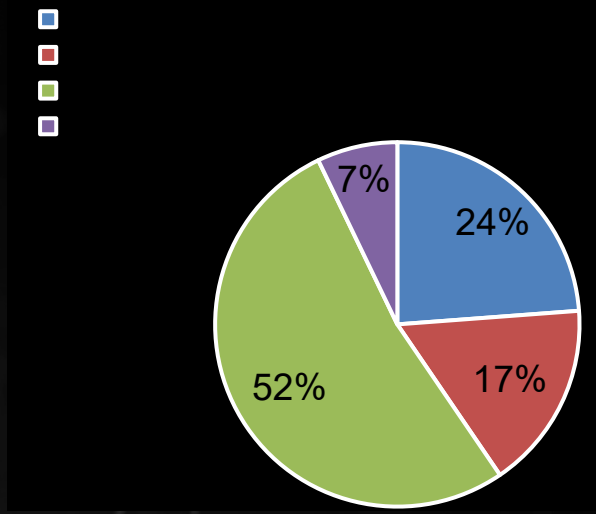
Example EVA Station Rotations (4/4) – Console Support

ID	TIME	CREW 1	CREW 2	CREW 3	CREW 4		CREW 5	CREW 6	CREW 7	CREW 8		NOTES
1	00:00	PREP	PREP	PREP	PREP	PREP	PREP	PREP	PREP	PREP	PREP	
2	00:05	1	3	6	DOP - 4		1	3	6		U/S - 8	1 - 2 minutes have elapsed
3	00:10	2	DOP	7	DOP - 2		2	U/S	7		U/S - 6	7 to 8 - watch your head
4	00:15	3	5	U/S		DOP - 7	3	5	DOP	U/S - 3		
5	00:20	DOP	6	1	DOP - 1		U/S	6	1		U/S - 5	1 - 2 minutes have elapsed
6	00:25	5	7	2		DOP - 8	5	7	2	U/S - 4		7 to 8 - watch your head
7	00:30	6	U/S	3		DOP - 6	6	DOP	3	U/S - 2		
8	00:35	7	1	DOP	DOP - 3		7	1	U/S		U/S - 7	1 - 2 minutes have elapsed 7 to 8 - watch your head
9	00:40	U/S	2	5		DOP - 5	DOP	2	5	U/S - 1		
10	00:45	REST	REST	REST	REST	REST	REST	REST	REST	REST	REST	PRICE checklist, mask fit, water bottle check, PMCs
11	00:50	1	3	6	DOP - 4		1	3	6		U/S - 8	1 - 2 minutes have elapsed
12	00:55	2	DOP	7	DOP - 2		2	U/S	7		U/S - 6	7 to 8 - watch your head
13	01:00	3	5	U/S		DOP - 7	3	5	DOP	U/S - 3		
14	01:05	DOP	6	1	DOP - 1		U/S	6	1		U/S - 5	1 - 2 minutes have elapsed
15	01:10	5	7	2		DOP - 8	5	7	2	U/S - 4		7 to 8 - watch your head
16	01:15	6	U/S	3		DOP - 6	6	DOP	3	U/S - 2		
17	01:20	7	1	DOP	DOP - 3		7	1	U/S		U/S - 7	1 - 2 minutes have elapsed 7 to 8 - watch your head
18	01:25	U/S	2	5		DOP - 5	DOP	2	5	U/S - 1		
19	01:30	1	3	6	DOP - 4		1	3	6		U/S - 8	1 - 2 minutes have elapsed
20	01:35	2	DOP	7	DOP - 2		2	U/S	7		U/S - 6	7 to 8 - watch your head
21	01:40	3	5	U/S		DOP - 7	3	5	DOP	U/S - 3		
22	01:45	DOP	6	1	DOP - 1		U/S	6	1		U/S - 5	1 - 2 minutes have elapsed
23	01:50	5	7	2		DOP - 8	5	7	2	U/S - 4		7 to 8 - watch your head
24	01:55	6	U/S	3		DOP - 6	6	DOP	3	U/S - 2		
25	02:00	7	1	DOP	DOP - 3		7	1	U/S		U/S - 7	1 - 2 minutes have elapsed 7 to 8 - watch your head
26	02:05	U/S	2	5		DOP - 5	DOP	2	5	U/S - 1		
27	02:10	REST	REST	REST	REST	REST	REST	REST	REST	REST	REST	PRICE checklist, mask fit, water bottle check, PMCs
28	02:15	REST	REST	REST	REST	REST	REST	REST	REST	REST	REST	PRICE checklist, mask fit, water bottle check, PMCs
29	02:20	1	3	6	DOP - 4		1	3	6		U/S - 8	1 - 2 minutes have elapsed
30	02:25	2	DOP	7	DOP - 2		2	U/S	7		U/S - 6	7 to 8 - watch your head
31	02:30	3	5	U/S		DOP - 7	3	5	DOP	U/S - 3		
32	02:35	DOP	6	1	DOP - 1		U/S	6	1		U/S - 5	1 - 2 minutes have elapsed
33	02:40	5	7	2		DOP - 8	5	7	2	U/S - 4		7 to 8 - watch your head
34	02:45	6	U/S	3		DOP - 6	6	DOP	3	U/S - 2		
35	02:50	7	1	DOP	DOP - 3		7	1	U/S		U/S - 7	1 - 2 minutes have elapsed 7 to 8 - watch your head

KEY		
Station 1	High Step	"2 minutes have elapsed"
Station 2	Task Board	
Station 3	Weight Transfer	ensure crew uses both hands
Station 4	Doppler	
Station 5	Low Step	
Station 6	Arm Ergometer	
Station 7	Kneeling Task	"watch your head"
Station 8	Ultrasound	
REST		bottle check, PRICE checklist

EVA Simulation – Rationale for Tasks

- 61 exploration EVA tasks[2] were decomposed into 126 subtasks then characterized by functional requirements of each subtask
- **Categories:**
  - **Body Positioning:** Seated, Kneeling, Standing, Mobile, etc.
  - **Muscle Groups:** Whole/Both, Upper, Lower
  - **Ambulation:** None, Walking, Walking (terrain), Walking (slopes), Crawling, Climbing
  - **Loading Bearing:** None, Carrying, Pushing/Pulling, Attached to Suit
  - **Loads:** None, Minimal (<5 lbs), Variable, Heavy (>30 lbs)
  - **Upper Body Reach (Workspace):** None, Standard, Extended
  - **Hand Usage:** None, Fine Motor Skills, Grip Strength, Vibration, Shock, Other/Combination
  - **Task Occurrence:** Rare (<10% of EVAs), Some (~30%), Many (~50%), Most (~75%), Nearly All (>90%)
  - **Task Duration (expected)**
  - **Task Frequency:** 1-2 times per EVA, Every 2 hours during EVA, Every hour during EVA, 1-30 minutes during EVA

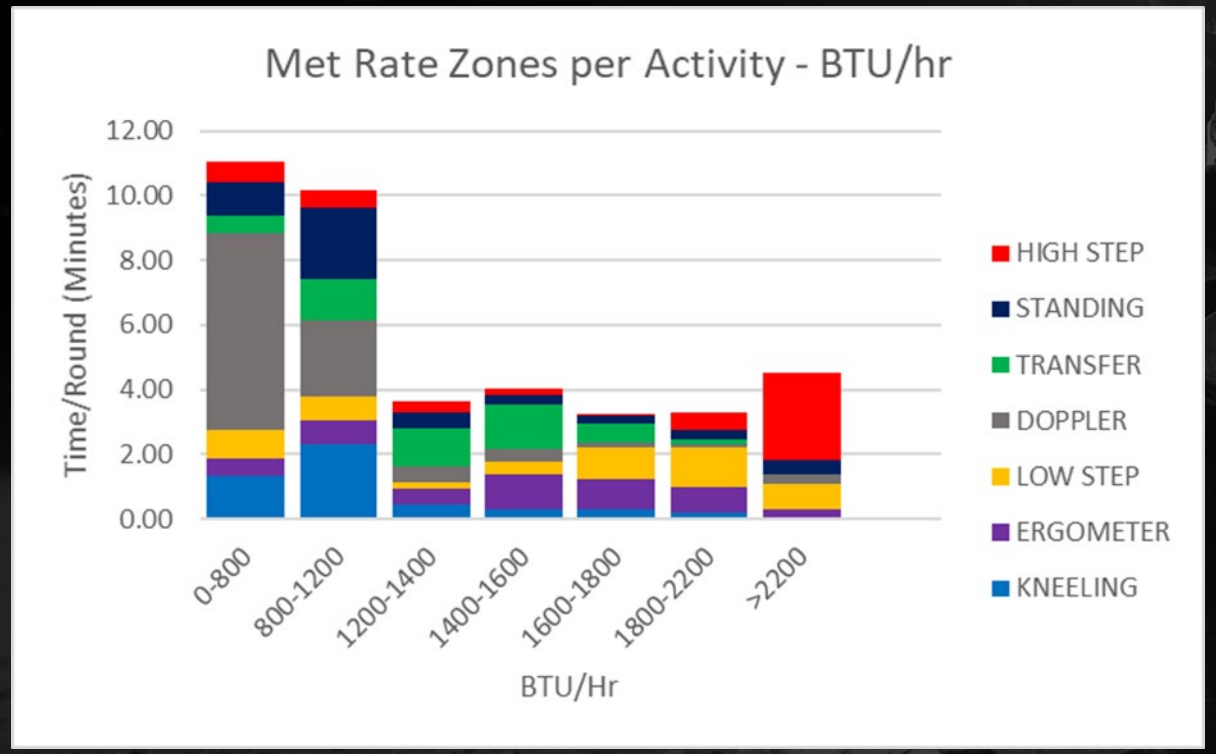


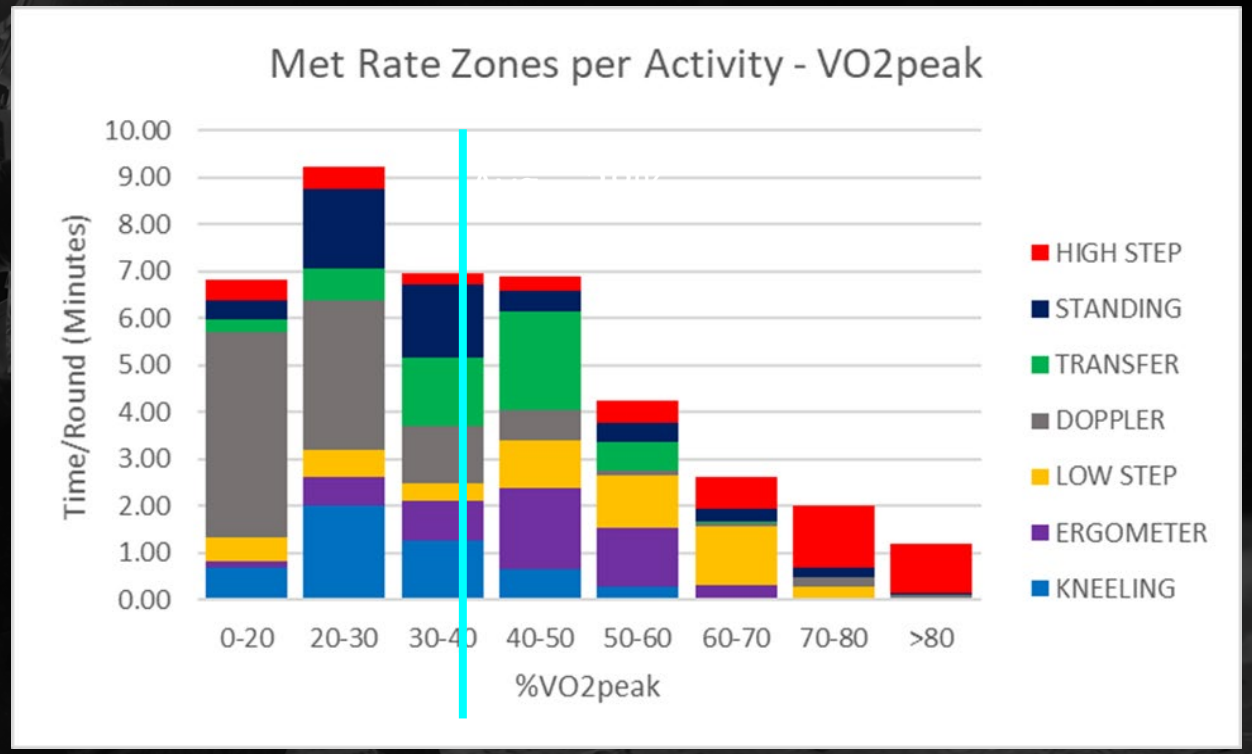
Parent Task Title	Children of the Parent Task	Load Bearing Type	Upper Body Loads	Upper Body Reach	Fine Motor / Grip	Task Occurrence	Task Duration	Task Frequency
Offload Equipment from Landers	mobile, upper and lower body work	Carrying Load	Variable Load (minimal to heavy)	Extended Workspace	Grip Strength	Rarely Occurs in any EVA (<10%)	5-15 minutes	Every 1-30 minutes during EVA
Offload Equipment from Landers	mobile, upper and lower body work	Pushing / Pulling Load	Heavy Load (> 30 lbs.)	Extended Workspace	Grip Strength	Rarely Occurs in any EVA (<10%)	5-15 minutes	Every 1-30 minutes during EVA
Load Equipment onto Rovers	mobile, upper and lower body work	Carrying Load	Variable Load (minimal to heavy)	Extended Workspace	Grip Strength	Occurs in many EVAs (~50%)	5-15 minutes	Every ~1 hr during EVA
Clean Equipment	stationary, upper body work while kneeling	No Load	No Significant Loading	Extended Workspace	Fine Motor	Occurs in some EVAs (~30%)	15-60 minutes	Total of 1-2 times during EVA
Clean Equipment	stationary, upper body work while standing	No Load	No Significant Loading	Extended Workspace	Fine Motor	Occurs in most EVAs (~75%)	15-60 minutes	Total of 1-2 times during EVA
Conduct Visual Inspection / Examine Surroundings	mobile, ambulation	No Load	No Significant Loading	None	Fine Motor	Occurs in nearly all EVAs (90-100%)	1-5 minutes	Every 1-30 minutes during EVA
Conduct Visual Inspection / Examine Surroundings	seated	No Load	No Significant Loading	None	None	Occurs in nearly all EVAs (90-100%)	1-5 minutes	Every ~1 hr during EVA
Conduct Photo Documentation	stationary, upper body work while kneeling	Other / Unknown	Minimal Load (less than 5 lbs.)	Standard Workspace	Fine Motor	Occurs in nearly all EVAs (90-100%)	1-5 minutes	Every 1-30 minutes during EVA
Conduct Photo Documentation	stationary, upper body work while standing	Other / Unknown	Minimal Load (less than 5 lbs.)	Standard Workspace	Fine Motor	Occurs in nearly all EVAs (90-100%)	1-5 minutes	Every 1-30 minutes during EVA

[2]Coan D. Exploration EVA System Concept of Operations. NASA TR, EVA-EXP-0042 RevB. 2020

Workload Calibration

- The average %VO_2peak across all tasks was ~38% (1274 BTU/hr)





EVA Workload Calibration (1/2) - COSMED K5 Metabolic Cart

- EVA Workload Calibration is performed to determine the **appropriate work rate (e.g., Step-up and arm ergometry cadences)** to achieve desired workload prescription.
  - Calibration - Cadences are adjusted to meet metabolic rates for each subject
  - NASA provides COSMED K5 (incl mask system, laptops, calibration eqpt.), protocols, operator training, and data sheet.
  - NASA provides the following trainings: general equipment instruction, calibration procedure, mask fit check + breathing gas lines/turbine gear, OMNIA software operation and data collection, data exporting, "Workload Calibration" calculations and measurements.
- Facilities performs subject training, workload measurements and calculations, equipment calibration, and data recording, etc.
- Note: Metabolic Parameters (VO_2, VCO_2, RR, metabolic rate) will be measured using a COSMED K5.

EVA Workload Calibration (2/2) - Workload Calculator

- Individual work rate prescriptions can be calculated using the workload calculator (to be provided to facilities as part of the data sheet package)

SUBJECT

ID	[redacted]		
Female or Male:	[redacted]		
Weight	[redacted]	lbs	**82** kg
Cycling VO2peak (measured)	[redacted]	L/min	**49** ml/min/kg
Treadmill VO2peak (calculated)	**4.4**	L/min	**54** ml/min/kg

TASKS

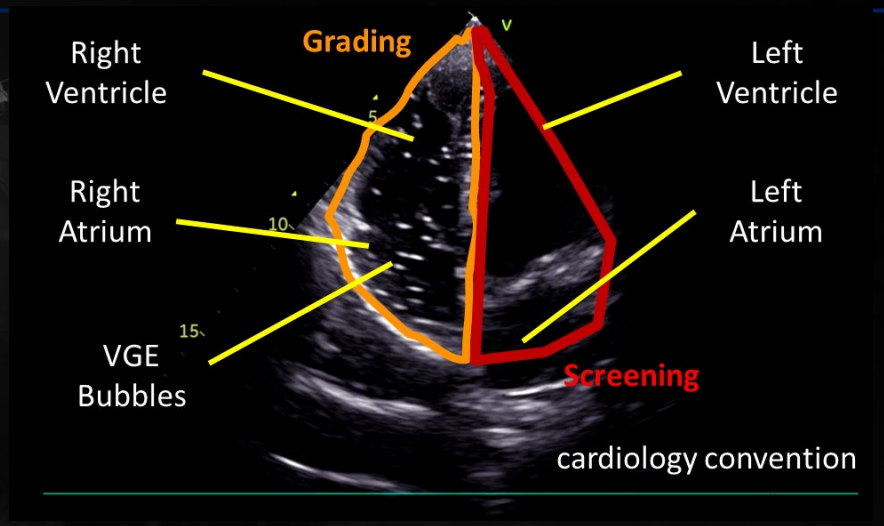
		Reference Equivalent	Target VO2 (% of peak)	Target VO2 (ml/min/kg)	Calculated BTU/hr	PILOT BTU/hr	Task VO2 (L/min)	total hours	Fractional VO2 (L/min * total hrs)	Task Parameters	Task Rate		
1	**Low step**	Target VO2	[redacted]	**22**	**2038**		**1.76**	0.75	1.32	Step height (inch) = [redacted]	**22 steps/min**	-->	45 cadence (compare to PILOT study)
2	**Standing Task Board**	PILOT DATA: BUSY BOARD				1149	0.97	0.75	0.72				
3	**Weight Transfer**	PILOT DATA: UNLOAD / LOAD				2144	1.80	0.75	1.35				
4	**Rest**	PILOT DATA: MOCK DOPPLER / REST				924	0.78	0.75	0.58				
5	**High Step**	Target VO2	[redacted]	**22**	**2038**		**1.76**	0.60	1.06	Step height (inch) = [redacted]	**19 steps/min**	-->	39 cadence (compare to PILOT study)
		2 min at 70-80%!	[redacted]	**40**	**3822**		**3.30**	0.15	0.50	Step height (inch) = [redacted]	**40 steps/min**	-->	79 cadence (compare to PILOT study)
6	**Kneeling Task Board**	PILOT DATA: FINE MOTOR / KNEELING				1442	1.21	0.75	0.91				
7	**Arm Ergometer**	Target VO2	[redacted]	**16**	**1529**	1496	**1.32**	0.75	0.99	Monark Power setting (W at 50RPM)= [redacted]	**96 rpm**	-->	345 kg*m/min (Work Rate)
8	**Rest**	PILOT DATA: MOCK DOPPLER / REST				924	0.78	0.75	0.58				
								6 hours					
					Avg BTU/hr:	**1589**		**Average VO2:**	**1.34** L/min				
									30 % <-- Target 30-40% VO2peak				

red = above target
green = within target
blue = below target

Dunn, J. *et al*. Development of an Extravehicular Activity Physical Workload Simulation for Use in Ground Validation of Exploration Prebreathe Protocols. May, 2022. Aerospace Medical Association Annual Science Meeting.

Ultrasound Station (1/5) - Overview

- 2D Ultrasound imaging is performed to monitor the venous gas emboli (VGE) during the EVA.
  - NASA provides GE vivid iQ ultrasound device, ultrasound scoring data sheet, training and protocol for ultrasound VGE monitoring.
  - Training weeks cover (1) ultrasound VGE imaging, (2) ultrasound console overview, (3) ultrasound scanning in EVA configuration, (4) data collection overview
- **Facility provides the following required equipment:**
  - Store data electronically with relevant metadata for post-exposure review/analysis
- **Facility provides the required test support:**
  - Trained operators to collect baseline and in-test ultrasound imaging
  - Trained operators to monitor LVGE conditions
- **Protocol: collecting a 4-chamber apical view**
  - **Conduct a 5 min scan** every 15 minutes: monitor & record at least 10 cardiac cycles in each of three conditions in sequential order: rest, flexing/bending of the arms and legs, and rest.
  - Ultrasound scoring to be performed real time and post test by 3 blinded operators using the **modified Eftedal-Brubbak (EB) scale** (0-7).



Ultrasound Station/Ultrasound Monitoring

Video removed temporarily due to size limitation on pubpress.

Note: in this video, the sonographer is conducing “self-scan”. In the protocol, the sonographer will conduct both self-scan and scanning of other subjects.

Modified Eftedal Brubakk Score - Ultrasound

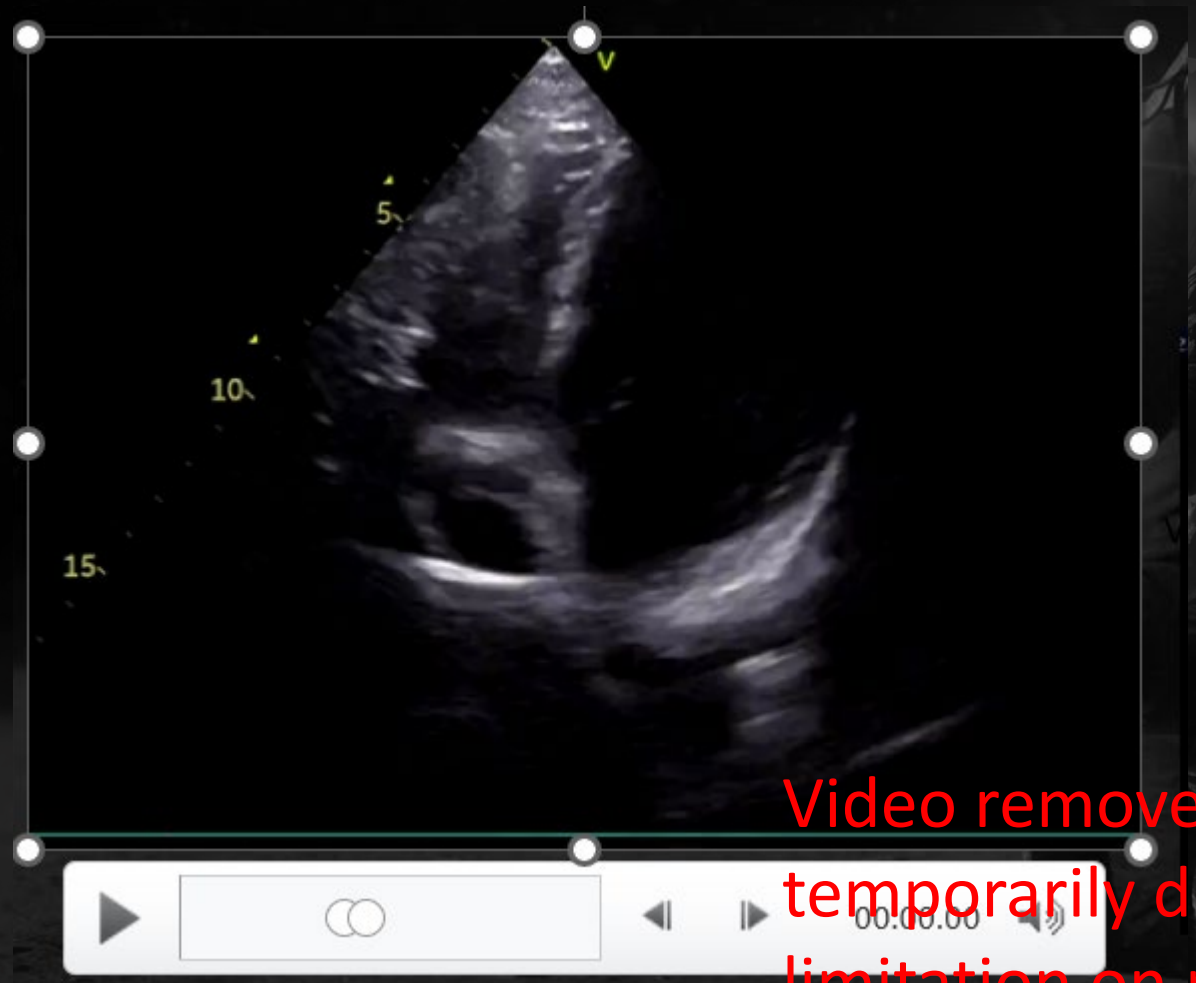
- HCA VGE Scoring uses the Modified Eftedal Brubakk Score. Scoring is done only considering right atrium & ventricle.*

Score	Definition
0	No Visible Bubble
1	Occasional bubbles
2	At least 1 bubble every 4-heart-cycle
3	At least 1 bubble every heart cycle
4	Not more than one thirds of every image
5	Not more than two thirds of every image
6	Near whiteout; individual bubbles still discerned
7	Whiteout; individual bubbles can't be discerned

* No LVGE detected.

Eftedal O, Brubakk AO. Agreement between trained and untrained observers in grading intravascular bubble signals in ultrasonic images. Undersea Hyperb Med. 1997 Winter;24(4):293-9. PMID: 9444060.

EB Score 1



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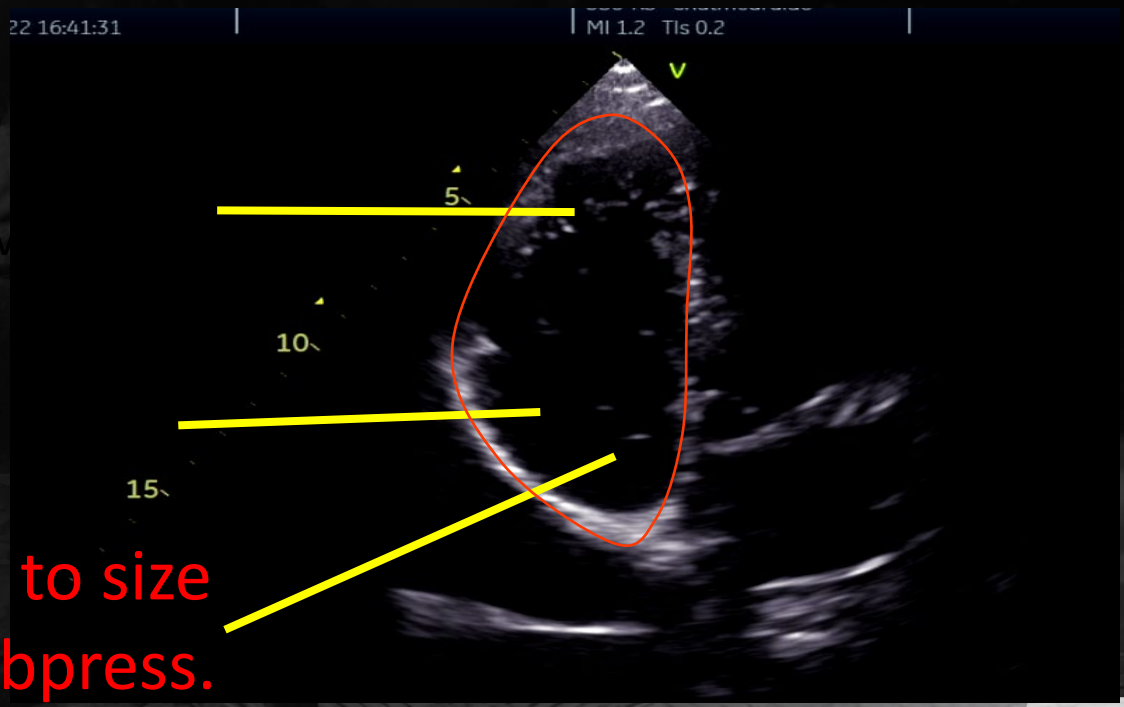
Score	Definition
0	No Visible Bubble
1	Occasional bubbles
2	At least 1 bubble every 4-heart-cycle



EB Score 7

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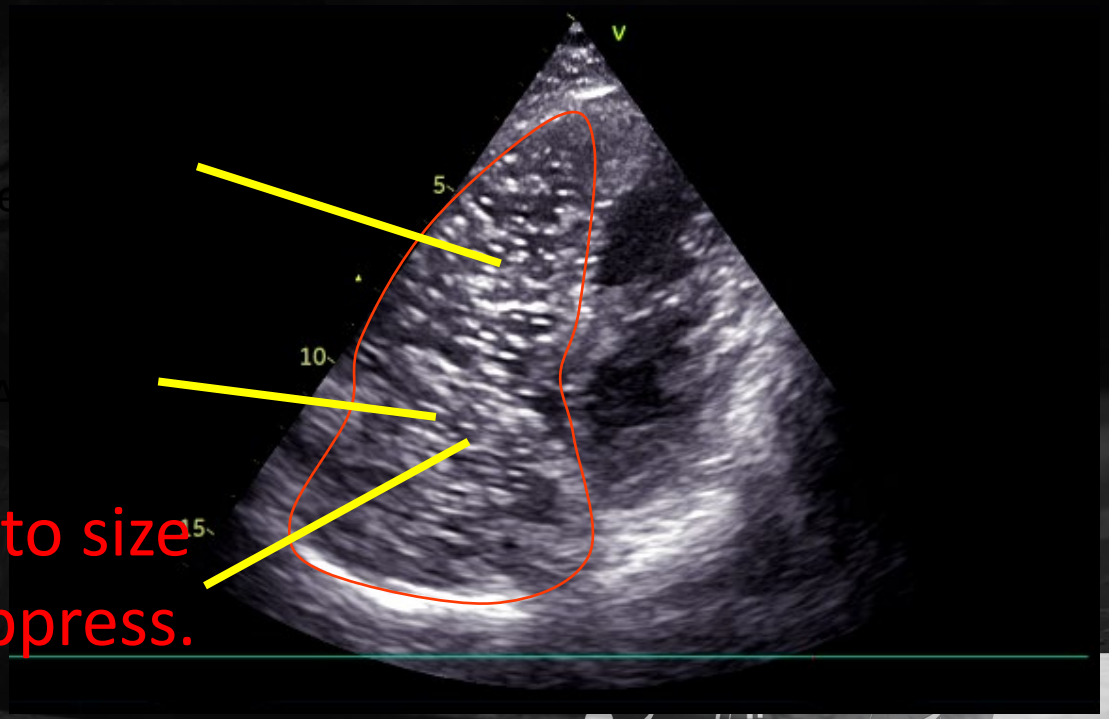
Score	Definition
5	Not more than two thirds of every image
6	Near whiteout; individual bubbles still discerned
7	Whiteout; individual bubbles can't be discerned



Subject Screening - VO2 Peak Testing

- VO2 peak protocol is performed as a subject screening test and provides workload inputs required for EVA workload calibration.
  - NASA will provide protocol and data format template.
  - Training week: a quick tour to showcase the system.
- **Facility provides the following required equipment:**
  - Metabolic cart (Parvo TrueOne 2400 or COSMED K5*) + mask/hose system
  - Cycle Ergometer (Lode Bike)
  - ECG (GE Case Cart + CardioSoft or COSMED K5?*)
  - Note: NASA prefers integrated system which allows metabolic data to be synced automatically with ECG and workload.
- **Facility provides the required test support:**
  - Medical monitoring required at NASA (MD monitoring in the room)
  - Personnel ability to read ECG
- This is the biggest screen out event in the subject screening process and shall be conducted as early as possible in the subject screening process (after medical screening).
- *COSMED K5 can be provided by NASA if no other met cart available at facility.

Does your facility have equipment to support VO2 peak screening events ?
Does your facility have experience in conducting peak testing before ?

Subject Screening - Body Fat/Skin fold Protocol

- Skin fold measurements are performed to estimate body fat %. This information will be used for subject screening.
  - NASA provides the protocol and data sheet.
  - Training week covers skin fold protocol overview.
- Facility provides/procures **own skin fold caliper.**
  - NASA can provide recommendations on caliper.
- Facility provides trained operators to perform skin fold measurements, screen subjects, and record data according to protocol.

	A	B	C	D	E	F	G	H	I	J	K
	Female										
	Subject:	**Crew**	**Age:**	**25**	**Height:**	**66**	**Weight:**	**134**			
	Trial	Subscapular	Tricep	Chest	Midaxillary	Suprailliac	Abdomen	Thigh			
	1	8.5	15	7	5	13	23	22			
	2	8.5	15	8	5	14	21	21			
	3	9	14	7	5	14	21	22			
	Average	8.666666667	14.6667	7.33333	5	13.6666667	21.6667	21.6667			
	Sum of 7	92.66666667									
		Body Density	1.0551		**Body Fat % Average**		**Fat lbs**		**Fat lbs Average**		
		%BF Brozek	19.16		**19.05**		**Brozek**	25.68	**25.53**		
		%BF Siri	18.94				**Siri**	25.39			

Questionnaires

- Subjective scales are used to assess subjective workload and pain levels during EVA.
  - NASA provides the rating of perceived exertion (RPE) and pain subjective scales for the questionnaire.
  - During training week or test planning meetings, NASA covers how and when to administer these scales.

- **Facility provides the following required equipment:**
  - Printed template for these scales for subject to reference during test.

- **Facility provides the required test support:**
  - Test operators to query subjects for responses to these questionnaires during each rotation through the resting/ultrasound station.
  - Subjects will report RPE and pain using NASA-defined scales at the end of each exercise bout (i.e., after 5 minutes of arm ergometry, stepping).
  - Operators should record these data in the console log.

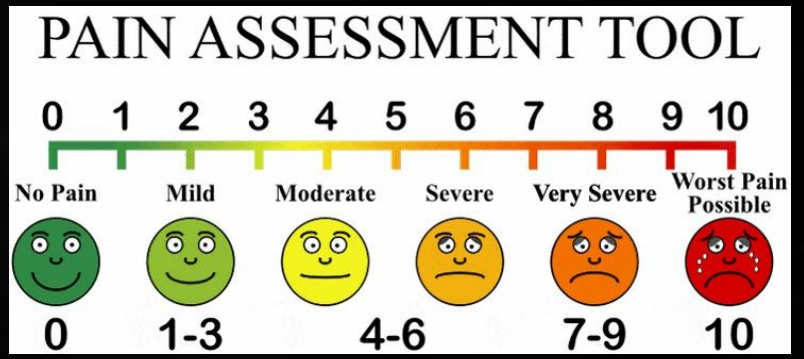


Figure: Pain Scale

Borg CR10 Scale (1982)[12]	
0	Nothing at all
0.5	Extremely weak (just noticeable)
1	Very weak
2	Weak (light)
3	Moderate
4	Somewhat strong
5	Strong (heavy)
6	
7	Very strong
8	
9	
10	Extremely strong (almost max)
•	Maximal

Figure: Borg CR 10 Workload Scale RPE

Summary

- Path forward
  - Stay tune for biweekly integration meeting invitations and Box invitations.
  - We plan on sharing this slide deck on Box soon.
  - Provide inputs to the **red questions** throughout the presentation ASAP.

- Q&A

Thank you!

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The presented efforts were primarily funded by the following organization(s):

- Human Research Program (HRP)

NASA JPR 1800.3 E

- Mild DCS (Type I), Uncomplicated
  - Symptoms involving joint pain, peripheral nervous system, or simple skin bends that resolve upon repress (spaceflight) or within the first 20 minutes of treatment (terrestrial).
- Mild DCS (Type I), Complicated
  - Symptoms involving joint pain, peripheral nervous system, or simple skin bends that DO NOT resolve upon repress or within the first 20 minutes of treatment.
- Mild DCS (Type I) - Repetitive
  - Mild DCS symptoms involving joint pain, peripheral nervous system, or simple skin bends that occur after a successful treatment and within 30 days of a prior case of DCS for ground-based exposure or within a single flight for space flight operation. These are considered discrete occurrences of DCS in response to chronologically discrete alternobaric exposures.
- Serious DCS (Type II)
  - Symptoms involving the Central Nervous System (CNS), cardiovascular system (circulatory collapse/shock), pulmonary system (chokes).
- Cutis Marmorata
  - (Described as skin marbling/mottling)

DCS Definitions

- DAN (Ref US Navy):
  - Type II/Serious (0.1%)
    - (1) serious neurological
    - (2) cardiopulmonary
    - (3) mild neurological [DAN also considered it Type “A” (mild)]
  - Type I/Mild (5%)
    - (4) pain
    - (5) lymphatic or skin
    - (6) constitutional or nonspecific manifestations.

The probability and severity of decompression sickness

Laurens E. Howle[1,2,3☯*], Paul W. Weber[1,3☯], Ethan A. Hada[2‡], Richard D. Vann[4‡], Petar J. Denoble[4‡]

Decompression sickness (DCS), which is caused by inert gas bubbles in tissues, is an injury of concern for scuba divers, compressed air workers, astronauts, and aviators. Case reports for 3322 air and N_2-O_2 dives, resulting in 190 DCS events, were retrospectively analyzed and the outcomes were scored as (1) serious neurological, (2) cardiopulmonary, (3) mild neurological, (4) pain, (5) lymphatic or skin, and (6) constitutional or nonspecific manifestations. Following standard U.S. Navy medical definitions, the data were grouped into mild—Type I (manifestations 4–6)–and serious–Type II (manifestations 1–3). Additionally, we considered an alternative grouping of mild–Type A (manifestations 3–6)–and serious–Type B (manifestations 1 and 2). The current U.S. Navy guidance allows for a 2% probability of mild DCS and a 0.1% probability of serious DCS. We developed a hierarchical trinomial (3-state) probabilistic DCS model that simultaneously predicts the probability of mild and serious DCS given a dive exposure. Both the Type I/II and Type A/B discriminations of mild and serious DCS resulted in a highly significant ($p << 0.01$) improvement in trinomial model fit over the binomial (2-state) model. With the Type I/II definition, we found that the predicted probability of ‘mild’ DCS resulted in a longer allowable bottom time for the same 2% limit. However, for the 0.1% serious DCS limit, we found a vastly decreased allowable bottom dive time for all dive depths. If the Type A/B scoring was assigned to outcome severity, the no decompression limits (NDL) for air dives were still controlled by the acceptable serious DCS risk limit rather than the acceptable mild DCS risk limit. However, in this case, longer NDL limits were allowed than with the Type I/II scoring. The trinomial model mild and serious probabilities agree reasonably well with the current air NDL only with the Type A/B scoring and when 0.2% risk of serious DCS is allowed.

Summary

PB Time (min)	PB Time (hr)	P(DCS) TR20	P(DCS) BGI15	P(serious DCS)
180	3:00	62.90	33.05	0.41
240	4:00	35.67	24.42	0.17
360	6:00	7.79	13.25	0.04
375	6:15	6.43	12.28	0.04
390	**6:30**	**5.32**	**11.38**	**0.04**
405	6:45	4.42	10.55	0.04
420	7:00	3.69	9.77	0.04

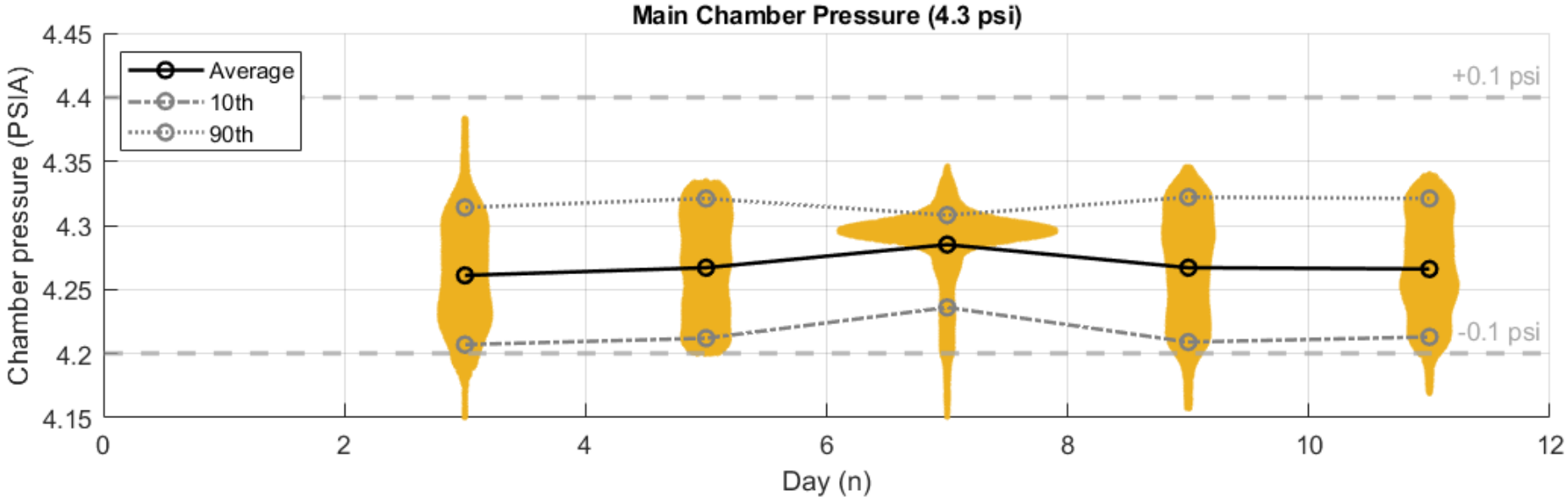
Garbino, A. "**AETHER Calibration Run**," 25 Jan 2024.

Actions

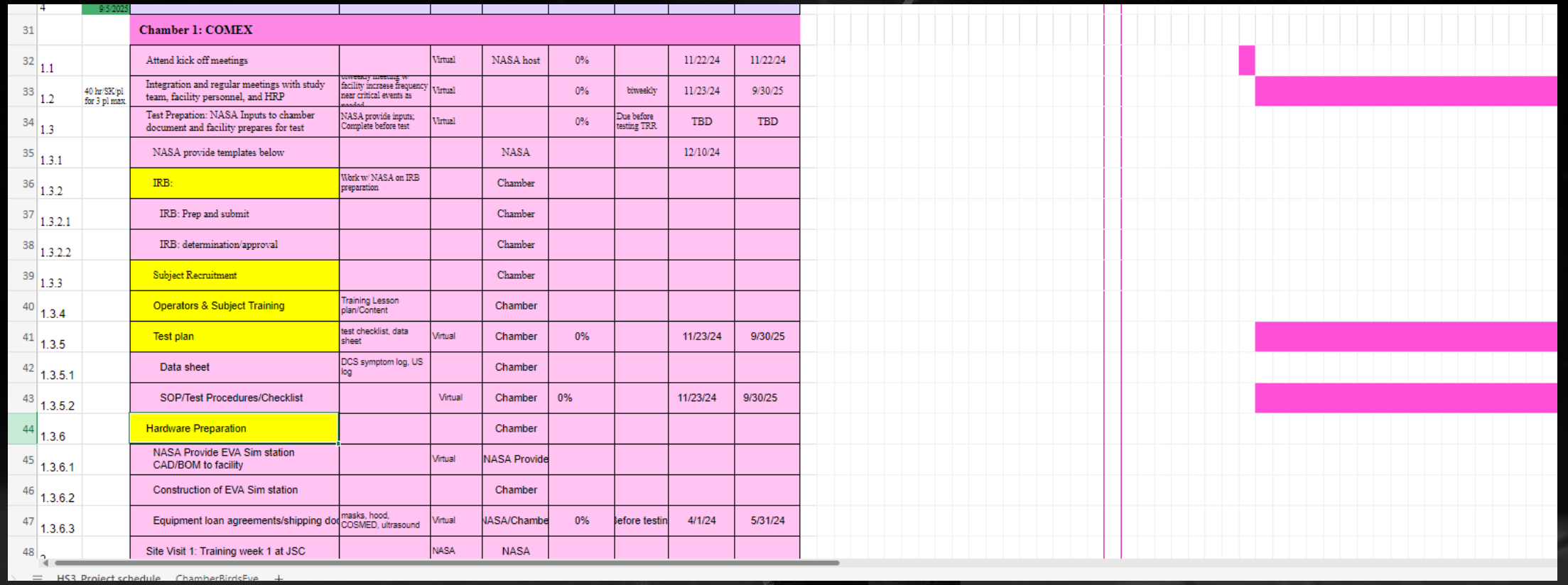
- EEPL/EPC:
  - COSMED x4 (AETHER, Lab): Compare difference between AETHER version and lab version
  - Did we invited everyone needed for kick off ? Laura ?
- Monica
  - Skin fold – Monica needs to be sign off.
  - Export control for some chart content
- HCA week
  - Apply for internet
  - Schedule: set aside 20 min to show case task board components, EVA Simulation Station – each station, how to assemble NZGL etc
- Brett:
  - **COSMED masks ?**
  - **Training Monica up more for COSMED operation and setup.**
  - Then they are doing subject recruitment/baseline data collection, as that's when it's needed
  - **Teach cleaning and break-down**

Example: "Quality of EVA Pressure"

- Sampling at 1 Hz



	3	5	7	9	11
Average (PSIA)	4.2610	4.2670	4.2850	4.2670	4.2660
10th (PSIA)	4.2070	4.2120	4.2360	4.2090	4.2130
90th (PSIA)	4.3140	4.3210	4.3080	4.3220	4.3210
Max (PSIA)	4.3830	4.3350	4.3460	4.3460	4.3400
Min (PSIA)	4.1470	4.1990	4.1280	4.1570	4.1690



4		9/5/2025							
31			**Chamber 1: COMEX**						
32	1.1		Attend kick off meetings		Virtual	NASA host	0%		11/22/24	11/22/24
33	1.2	40 hr/SK/pl for 3 pl max	Integration and regular meetings with study team, facility personnel, and HRP	[illegible] facility increase frequency near critical events as needed	Virtual		0%	biweekly	11/23/24	9/30/25
34	1.3		Test Prepation: NASA Inputs to chamber document and facility prepares for test	NASA provide inputs; Complete before test	Virtual		0%	Due before testing TRR	TBD	TBD
35	1.3.1		NASA provide templates below			NASA			12/10/24	
36	1.3.2		IRB:	Work w/ NASA on IRB preparation		Chamber				
37	1.3.2.1		IRB: Prep and submit			Chamber				
38	1.3.2.2		IRB: determination/approval			Chamber				
39	1.3.3		Subject Recruitment			Chamber				
40	1.3.4		Operators & Subject Training	Training Lesson plan/Content		Chamber				
41	1.3.5		Test plan	test checklist, data sheet	Virtual	Chamber	0%		11/23/24	9/30/25
42	1.3.5.1		Data sheet	DCS symptom log, US log		Chamber				
43	1.3.5.2		SOP/Test Procedures/Checklist		Virtual	Chamber	0%		11/23/24	9/30/25
44	1.3.6		Hardware Preparation			Chamber				
45	1.3.6.1		NASA Provide EVA Sim station CAD/BOM to facility		Virtual	NASA Provide				
46	1.3.6.2		Construction of EVA Sim station			Chamber				
47	1.3.6.3		Equipment loan agreements/shipping do	masks, hood, COSMED, ultrasound	Virtual	NASA/Chambe	0%	before testin	4/1/24	5/31/24
48	2		Site Visit 1: Training week 1 at JSC		NASA	NASA				

HS3_Project schedule ChamberBirdsEye +