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3.2 Medical Requirements Overview

TABLE 3.2: MEDICAL REQUIREMENTS OVERVIEW

MRID# and Title:	MR087L EVA Exercise Pre-breathe Protocol for ISS Crewmembers
Sponsor:	Medical Operations
Discipline:	EVA
Category:	Medical Requirements (MR)
References:	ISS Medical Operations Requirements Document (ISS MORD) SSP 50260
Purpose/Objectives:	To mitigate the risk of Decompression Sickness (DCS) in crewmembers participating in EVA activities.
Measurement Parameters:	Heart rate, oxygen consumption, exercise power output, Rating of Perceived Exertion (RPE)
Deliverables:	An individualized exercise prebreathe prescription for the crewmember
Flight Duration:	$\geq$ 30 days
Number of Flights:	Available for all flights with scheduled EVAs
Number and Type of Crew Members Required:	All ISS crewmembers
Notes:	Additional References: MEDB 4.1 Cycle Ergometer Test/Aerobic Capacity EVA Pre-Breathe Reduction Protocol Flight Rule B13-107.

3.3 Preflight Training

TABLE 3.3: PREFLIGHT TRAINING

Preflight Training Activity Description:	Training for the EVA Exercise Pre-breathe Protocol will be conducted by CMS instructors, EVA trainers, and EXL trainers.			
Schedule:	**Duration:**	**Schedule:**	**Flexibility:**	**Personnel Required:**
	CMS Ops 1 45 min. Prebreathe Class & 120 min. Protocol Verification EVA Prep and Post 1 45 min. EVA Prep and Post 2 45 min. EVA Prep and Post 3 45 min.	L-330 days L-240 days L-230 days L-130 days L-28 days	N/A	CMS Instructor EXL Trainers, MOD EVA trainers MOD EVA trainers MOD EVA trainers MOD EVA trainers/CMS Instructors
Ground Support Requirements Hardware/Software	**Preflight Hardware:**	**Preflight Software:**	**Test Location:**	
	CEVIS Upright electronic cycle ergometer (LODE) Theraband Tubing Heart Rate Monitor PCMCIA Card for CEVIS Metabolic Gas Analysis System RPE Chart	CEVIS software MEC Software	U.S.	
Training Facilities	**Minimum Room Dimensions:**	**Number of Electrical Outlets:**	**Temperature Requirements:**	**Special Lighting:**
	8’ x 10’ room	2-110 Volt outlets	20-25 degrees C	N/A
	Hot or Cold Running Water:	**Privacy Requirements:**	**Other:**	
	N/A	Controlled access		
Constraints/Special Requirements:	The L-240 Prebreathe Class must occur after the L-270 peak Cycle Test.			
Launch Delay Requirements:	N/A			
Notes:	▪ The EVA Prep and Post lessons are taught by MOD and are 8.0 hours, take place in building 9, and the Prebreathe portion of the lesson is approximately 45 minutes. ▪ During the L-240 Prebreathe Class, 60 minutes is devoted to classroom instruction and 60 minutes is devoted to protocol verification and hands-on crew training. ▪ Crewmembers should limit caffeine 8 hours prior to the Pre-breathe Class & Protocol Verification (1 cup (8 oz or less of regular coffee or equivalent) permitted up to 60 minutes before test). No alcohol or nicotine 8 hrs prior to test.			

3.4 Preflight Activities

TABLE 3.4: PREFLIGHT ACTIVITIES

<table>
<tr><td>Preflight Activity
Description:</td><td colspan="5">Preflight activities will include the Peak Cycle Test, Pre-breathe Class (protocol verification), and Submaximal Cycle Exercise Test.</td></tr>
<tr><td rowspan="3">Schedule:</td><td colspan="2">Duration:</td><td>Schedule:</td><td>Flexibility:</td><td>Personnel Required:</td></tr>
<tr><td colspan="2">Peak Cycle Test (MEDB 4.1): 60 min.</td><td>L-270</td><td>± 3 weeks</td><td>EXL/Medical monitor (Level 1)</td></tr>
<tr><td colspan="2">Submaximal Cycle Exercise Test (MEDB 4.1): 60 min</td><td>L-45-L-30</td><td>± 5 days</td><td>EXL/Medical monitor on-call (Level 3)</td></tr>
<tr><td rowspan="2">Ground Support Requirements Hardware/Software</td><td colspan="2">Preflight Hardware:</td><td colspan="2">Preflight Software:</td><td>Test Location:</td></tr>
<tr><td colspan="2">Electronic upright cycle ergometer (LODE), metabolic cart, theraband tubing, 3-lead EKG, blood pressure device, heart rate monitor, RPE chart</td><td colspan="2">Software in the metabolic cart</td><td>U.S.</td></tr>
<tr><td rowspan="4">Testing Facilities</td><td>Minimum Room Dimensions:</td><td>Number of Electrical Outlets:</td><td>Temperature Requirements:</td><td colspan="2">Special Lighting:</td></tr>
<tr><td>Approximately 15’ x 15’</td><td>4 -110 Volt outlets</td><td>20-25 degrees C</td><td colspan="2">N/A</td></tr>
<tr><td>Hot or Cold Running Water:</td><td>Privacy Requirements:</td><td>Vibration/Acoustic Isolation:</td><td colspan="2">Other:</td></tr>
<tr><td>Sink required
Drinking water available</td><td>Controlled access</td><td>N/A</td><td colspan="2">ACLS/MEDB 4.1</td></tr>
<tr><td>Constraints/Special Requirements:</td><td colspan="5">▪ Peak Cycle Test and Pre-breathe Class schedule are driven by MEDB 4.1 and EVA Prep and Post Class requirements. The Peak Cycle Test should not be scheduled any earlier than L-330.
▪ Submax Cycle test requirements for the US crewmembers are driven by MEDB 4.1
▪ No testing or training will be conducted with the crewmembers within 72 hours of returning from overseas travel.
▪ No testing or training will be conducted with the crewmembers within 48 hours of domestic travel.
▪ Wear workout clothing.
▪ No max exercise 24 hours prior to testing and training; no regular exercise 8 hrs prior to testing.
▪ No NBL training 48 hours (prefer 72 hours) prior to exercise testing and training.
▪ Limit food 2 hours prior to testing and training (light meal permitted up to 60 minutes before test).
▪ No alcohol, nicotine, or other vasoactive substances (e.g., cold medications) 8 hours prior to testing (Peak Cycle and Submaximal Cycle Tests)</td></tr>
</table>

	▪ Limit caffeine 8 hours prior to testing (1 cup (8 oz or less of regular coffee or equivalent) permitted up to 60 minutes before test). (Peak Cycle and Submaximal Cycle Tests) ▪ The L-240 Prebreathe Class must occur after the L-270 Peak Cycle Test. ▪ The Submaximal Cycle Test for US and IP crewmembers will be scheduled with consideration for crew availability due to training trips to other sites. ▪ The Submaximal Cycle Test for the US crewmembers will be coordinated within the constraints of MEDB 4.1 such that the data may be shared and repeat testing is not required. ▪ See Appendix for additional restraints and special requirements for International Partner (IP) crewmembers.
Launch Delay Requirements:	If launch delay is greater than 90 days, the EVA crewmember will repeat L-30 submax cycle test.
Notes:	See Appendix
Data Delivery	**Data/Report to Designated Recipients (Nominal/Contingency):**
	▪ The Pre-breathe Exercise Prescription will be incorporated into a report from the EXL to the crewmember's flight surgeon. After acceptance of the protocol by the Crew Surgeon, the prescription will be delivered upon request to the EVA trainer for Prep and Post Classes, to the crew Astronaut Strength, Conditioning, and Rehabilitation specialist for use in the gym, and to the crewmember. ▪ A second report will be delivered to the crew surgeon after the L-30/45 Submaximal Cycle Exercise Test (MEDB 4.1) to report changes in the physical fitness of the crewmember and/or any required changes to the EVA Pre-breathe Exercise Prescription.

3.5 In-Flight Activities

TABLE 3.5.1: IN-FLIGHT ACTIVITIES

In-Flight Activity Description:	This protocol is required for all crewmembers performing EVAs in the EMU. Prior to EVA, crewmembers will perform a Submaximal Cycle Exercise Test (MEDB 4.1) to assess current aerobic capacity, and perform a practice session of the prebreathe exercise protocol. Crewmembers also will perform the prebreathe exercise protocol as part of the nitrogen wash-out protocol prior to EVA.				
Schedule:	**Activity:**	**Duration:**	**Schedule:**	**Flexibility:**	**Personnel Required:**
	Submaximal Cycle Exercise Test (MEDB 4.1)	60 min.	See Constraints/Special Requirements	±1 week	1 crewmember
	Practice Session of EVA protocol	60 min.	1 week before EVA		3 crewmembers (2 EVA, 1 IVA)
	EVA Pre-breathe Exercise Protocol	10 min./crewmember	Before EVA		3 crewmembers (2 EVA, 1 IVA)
Procedures:	EVA prebreathe protocol is located in the ISS EVA Systems Checklist.				
Constraints / Special Requirements:	If a CEVIS failure is detected, the Shuttle ergometer can be used instead of CEVIS during docked operations. Since power outputs on the Shuttle ergometer increase in 25 watt increments, the power outputs in the pre-breathe exercise prescription should be "rounded" to the nearest 25 watt setting. Submax Exercise Test for MEDB 4.1 (Cycle Ergometer Test/Aerobic Capacity]: If planned EVA is from flight day 0 to flight day 90, a PFE should be done at least 14 days prior to the EVA. If a planned EVA is after flight day 90, a PFE should be conducted at least 30 days prior to the EVA. A practice session of the EVA protocol may be scheduled at the discretion of the Crew Surgeon. Crewmembers are requested to report any medication usage in the 24 hours prior to any scheduled EVA activities. See Appendix for additional restraints and special requirements for international crewmembers.				
Photo / TV Requirements:	N/A				
Cold Stowage Requirements:	N/A				
Mission Extension Requirements:	N/A				
Landing Wave-Off Requirements:	N/A				

Data Delivery	Data/Report to Designated Recipients (Nominal/Contingency):
	▪ Heart rates, perception of effort, and any deviation from protocol during practice session of EVA protocol reported by crew to Crew Surgeon/BME (EVA IPT Lead, EXL representative, or designee) prior to EVA. ▪ Heart rates during in-flight Submaximal Cycle Exercise Test (MEDB 4.1), Exercise Pre-breathe Practice, and EVA Exercise Pre-breathe Protocol are stored on PCMCIA cards and must be downloaded, downlinked to the Crew Surgeon/BME and delivered to the EVA IPT Lead, EXL representative, or designee within one week. ▪ A data report from these tests (EVA Pre-breathe Exercise Practice and Submaximal Cycle Exercise Test) must be delivered to the Crew Surgeon/BME and EVA IPT Lead within 72 hours of the receipt of the data. ▪ If CEVIS fails and Shuttle ergometer must be used for Submaximal Cycle Exercise Test, exercise pre-breathe practice, and EVA exercise pre-breathe protocol, crewmembers must wear the heart rate monitor watch, record heart rate data, and download the data to the MEC. Download of the data, delivery to the Crew Surgeon/BME, and delivery to the EXL must be completed within one week of each activity.

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In-Flight Activities, (cont.)

TABLE 3.5.2: IN-FLIGHT HARDWARE

Hardware/Software Name	P/N
ISS Ergometer (CEVIS)	SEG46115811-301
Shuttle Ergometer*	SDD46106864-301
Heart Rate Monitor Kit	SED46115818-xxx
PCMCIA Cards for CEVIS	SEG46116005-XXX
Pistol Grip Tool (PGT)	GE1557000
Prebreathe Hose Assy. Kits	SJG33112241-XXX
Prebreathe Hose Spare Kit	SJG33112747-XXX
Thera-band Tubing	SEZ33112286-301 HYG03318 (black)
Ergometer Shoes	528-20627-1,2 528-43063(no cleats)
CSA-O2	SED46115800-xxx
Metabolic Gas Analysis System	
RPE Chart	

3.6 Postflight Activities : N/A

3.7 Summary Schedule

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TABLE 3.7: SUMMARY SCHEDULE

ACTIVITY	DURATION	SCHEDULE	FLEXIBILITY	BLOOD VOLUME	PERSONNEL REQUIRED	CONSTRAINTS
Preflight Training						
CMS Ops 1	45 min.	L-330	N/A	N/A	CMS Instructor	The L-240 Prebreathe Class must occur after the L-270 Peak Cycle Test.
Prebreathe Class & Protocol Verification	120 min.	L-240			EXL Trainers, MOD	
EVA Prep and Post 1	45 min.	L-230			MOD EVA trainers	
EVA Prep and Post 2	45 min.	L-130			MOD EVA trainers	
EVA Prep and Post 3	45 min.	L-28			MOD EVA trainers/CMS Instructors	
Note:	During the L-240 Prebreathe Class, 60 minutes per crewmember is devoted to protocol verification.					

ACTIVITY	DURATION	SCHEDULE	FLEXIBILITY	BLOOD VOLUME	PERSONNEL REQUIRED	CONSTRAINTS
Preflight Activities						
Peak Cycle Test (MEDB 4.1) Submaximal Cycle Exercise Test (MEDB 4.1)	60 min. 60 min.	L-270 L-45-L-30	± 3 weeks ± 5 days	N/A	EXL/medical monitor EXL	▪ Peak Cycle Test and Pre-breathe Class schedule are driven by MEDB 4.1 and EVA Prep and Post Class requirements. The Peak Cycle Test should not be scheduled any earlier than L-330. Submax Cycle test requirements for the US crewmembers are driven by MEDB 4.1 ▪ No testing or training will be conducted with the crewmembers within 72 hours of returning from overseas travel. ▪ No testing or training will be conducted with the crewmembers within 48 hours of domestic travel. ▪ Wear workout clothing. ▪ No max exercise 24

						hours prior to exercise testing; no regular exercise 8 hrs prior to testing. ▪ No NBL training 48-72 hours prior to exercise testing. ▪ No heavy meals permitted 2 hours prior to testing ▪ No alcohol, nicotine or other vasoactive substances (e.g., cold medications) 8 hours prior to testing (Peak Cycle and Submaximal Cycle Tests). ▪ Limit caffeine or 8 hours prior to testing (1 cup (8 oz or less of regular coffee or equivalent) permitted up to 60 minutes before test) (Peak Cycle and Submaximal Cycle Tests). ▪ The L-240 Prebreathe Class must occur after the L-270 Peak Cycle Test. ▪ The Submaximal Cycle Test for US and IP

						crewmembers will be scheduled with consideration for crew availability due to training trips to other sites. ▪ The Submaximal Cycle Test for the US crewmembers will be coordinated within the constraints of MEDB 4.1 such that the data may be shared and repeat testing is not required.

Activity	Duration	Schedule	Flexibility	Blood Volume	Personnel Required	Constraints
In-Flight						
Submaximal Cycle Exercise Test (MEDB 4.1)	60 min.	See Constraints/Special Requirements		N/A	1 crewmember	This protocol is required for all crewmembers performing EVAs in the EMU. If a CEVIS failure is detected, the Shuttle ergometer can be used instead during docked operations. Since power outputs on the Shuttle ergometer increase in 25 watt increments, the power outputs during the prebreathe prescription should be "rounded" to the nearest 25 watt setting. Also, crewmembers must wear heart rate monitor watch when using Shuttle ergometer. Submax Exercse Test: If planned EVA is from flight day 0 to flight day 90, a PFE should be done at least 14 days prior to the EVA. If a planned EVA is after flight day 90, a PFE should be conducted at least 30 days prior to the EVA. A practice session of the EVA protocol may be scheduled at the discretion of the Crew Surgeon.
Practice run of EVA exercise pre-breathe*	60 min.	1 week before EVA			3 crewmembers (2 EVA, 1 IVA)	
EVA exercise pre-breathe	10 min. (per crewmember)	Before EVA			3 crewmembers (2 EVA, 1 IVA)	

Wheels-Stop: N/A
Postflight : N/A
Postflight Debrief
An EVA Debrief (Med Ops or EVA Office) will be scheduled where specific questions regarding the EVA exercise pre-breathe will be addressed.

APPENDIX

L-270 Peak Cycle Test performed in JSC Exercise Physiology Lab (EXL).

All ISS crewmembers will be scheduled for the cycle peak test regardless of EVA assignment in case of contingency operations. All Peak Cycle Tests will be conducted in the NASA-Johnson Space Center Exercise Physiology Laboratory, unless otherwise approved by the EVA IPT Lead.

1. The Peak Cycle Test for US and IP crewmembers will be scheduled with consideration for crew availability due to training trips to other sites.
2. The Peak Cycle Test for US and IP crewmembers is scheduled to allow adequate time for the reduction of data and the completion of the Pre-Breathe Class prior to the EVA Prep and Post Classes. At least 72 hours should separate the Peak Cycle Test from the Pre-breathe Class and the Pre-breathe Class from the Prep and Post Class. In the event that this is impossible to complete the Peak Cycle Test as planned, if there is available previously acquired exercise capacity data for the crewmember and with the consent of the crew surgeon, a preliminary exercise pre-breathe prescription can be supplied for the first Prep and Post Classes.
3. The Peak Cycle Test for the US crewmembers will be coordinated within the constraints of MEDB 4.1 such that the data may be shared and repeat testing is not required.

The pre-flight EVA cycle peak test uses the same protocol documented for ISS crewmembers to assess physical fitness at L-270 (MEDB 4.1).

The Crew Surgeon or a monitoring physician shall be present during the cycle peak test. When the Crew Surgeon is not available to monitor the cycle peak test, the monitoring physician shall contact the Crew Surgeon for flight-assigned crewmember or the Flight Medicine Clinic for unassigned crewmember(s). The flight surgeon will review the crewmember's medical record, and will discuss any potential medical issues or concerns with the crewmember. The flight surgeon will then communicate with the monitoring physician regarding any potential medical contraindications to the crewmember's performance of the peak test. The flight surgeon and the monitoring physician will also specifically review cardiac rhythm anomalies that have been previously observed and should determine how similar anomalies will be managed should they be noted during the peak test. The peak test shall not be performed if the medical monitor has not communicated with the Crew Surgeon about the individual's medical readiness for the test.

ECG data are archived as per MEDB 4.1. Should an adverse medical event occur during the cycle peak test, the monitoring physician shall immediately notify the Flight Medicine Clinic. The Flight Medicine Clinic will provide any additional medical evaluation that may be required. If a crewmember cannot perform this test for non-cardiovascular medical reasons (e.g. orthopedic problems), the test may be postponed with concurrence of the flight surgeon

The cycle peak data will be analyzed by the EXL to determine whether the test can be considered a "peak exertional effort". The test will be considered valid based on the individual's heart rate, respiratory exchange ratio, oxygen consumption, and ventilation responses to the exercise. If the results are determined to be unacceptably below values expected at peak exertion, the crewmember will be asked to repeat the test on a subsequent day.

L-240 Prebreathe Class (Protocol Verification): This session should occur about 1 month following the peak cycle test (above).

1. The Pre-Breathe Class for US and IP crewmembers will be scheduled with consideration for crew availability due to training trips to other sites.

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2. The Pre-Breathe Class for US and IP crewmembers is scheduled to allow adequate time for the reduction of data prior to the EVA Prep and Post Classes (at least 48 hours). In the event that this is impossible to complete, with the consent of the crew surgeon a preliminary exercise pre-breathe prescription can be supplied for the first Prep and Post Classes.

The crewmember will perform according to the exercise pre-breathe prescription, with measurements of oxygen consumption and heart rate (heart watch). The protocol consists of exercise for one minute at 37.5%, one minute at 50%, one minute at 62.5%, and seven minutes at 75% VO2pk as predicted by the results from the cycle peak test. The crewmember will perform 88% of each target workload with the legs on the upright electronic ergometer and approximately 12% of the work with the arms using elastic tubing. For the pre-breathe exercise prescription to be "verified", the oxygen consumption measured during the final 2 minutes of the 75% power output should be within 10% of the targeted VO_2 value. If the measured VO_2 is not within 10% of the expected value, the pre-breathe exercise prescription is revised, and the crewmember will be asked to complete another verification session. Pre-Breathe Class will be conducted in the NASA-Johnson Space Center Exercise Physiology Laboratory, unless otherwise approved by the EVA IPT Lead.

CONSTRAINTS/SPECIAL REQUIREMENTS FOR INTERNATIONAL CREWMEMBERS PARTICIPATING IN EMU EVAs

- The Peak Cycle Test should not be scheduled any earlier than L-330 from the scheduled launch date.
- International Partner (IP) crewmembers are required to perform the Peak Cycle Test in the US as conducted by the EXL. This test will be scheduled at L-270.
- IP crewmembers are required to perform the Pre-breathe Class (protocol verification) as conducted by the EXL. This test must be completed by L-240.
- IP crewmembers shall participate in the Submaximal Exercise Test (PFE) as conducted by the EXL. The test will be scheduled at L-30.
- IP crewmembers will participate in the PFE (MEDB 4.1) prior to flight and will be required to perform the PFE during flight as defined by MEDB 4.1. These data are required to track changes in aerobic capacity to be prepared to perform the EVA exercise pre-breathe as required. The PFE must be performed within 2±1 weeks prior to a scheduled EVA. These data will be delivered to the Crew Surgeon/BME for delivery to the EVA IPT Lead or EXL.
- If the above activities are not completed by an IP crewmember, then the crewmember will not be certified to participate in the EVA exercise pre-breathe.
- All test data for IP crewmembers will be shared with their respective sponsoring country and will be delivered to the designated IP Crew Surgeon.
- IP crewmembers who will be flying on ISS and are not scheduled for an EMU-based EVA within the first 21 days of the mission may, with the consent of the IP and US crew surgeons as well as the US flight director, opt to perform the pre-flight Submaximal Cycle Exercise Test any time after the Pre-breathe Class following the normal constraints for this activity. In general, it is preferred that this test be performed during the IP crewmember's last scheduled training rotation in the U.S. prior to flight. At minimum, the pre-flight Submaximal Cycle Exercise Test must be completed to qualify for participation in the EVA exercise pre-breathe protocol for on-orbit EMU-based EVA activities.
- The in-flight Submaximal Cycle Exercise Test also must be completed within two weeks of the scheduled EVA. As a special situation, if an EVA is scheduled within the 21 days of launch and the crewmember's last Submaximal Cycle Test was performed between L-30 and L-60, then the in-flight Submaximal Exercise Test may be waived with the consent of the crew surgeon.