3.2 Medical Requirements Overview

TABLE 3.2: MEDICAL REQUIREMENTS OVERVIEW

MRID# and Title:	MR078L Physical Fitness Evaluation: Functional Fitness
Sponsor:	Medical Operations
Discipline:	Bone, Muscle & Exercise
Category:	Medical Requirements (MR)
References:	International Space Station Medical Operations Requirements Document (ISS MORD), SSP 50260: Section 3.5 Preflight Medical Evaluations Section 3.7 Post-flight Medical Evaluations Astronaut Medical Evaluation Requirements Document (AMERD), JSC 24834: Appendix A, Section II Physical Fitness Assessment (2.3.2) Appendix B, Section V Pre-and Postflight Medical Evaluation Requirements For Long Duration Flights 5.1 & 5.2
Purpose/Objectives:	Physical fitness is assessed pre- and post-flight to guide individual physical training and to determine individual responses to training countermeasures.
Measurement Parameters:	Skeletal muscle strength, endurance, flexibility, agility, balance, and hand grip.
Deliverables:	Assessment of skeletal muscle strength, endurance, flexibility, agility, balance, and hand grip.
Flight Duration:	≥30 days
Number of Flights:	Every Expedition
Number and Type of Crew Members Required:	All primary U.S. crewmembers. Back-up crew will only complete preflight MATs greater than L-45 days unless specifically waived by crew surgeon. If crew swap does occur, back-up crew will complete all preflight MATs.
Other Flight Characteristics:	N/A

3.3 Preflight Training: NA

3.4 Preflight Activities

TABLE 3.4: PREFLIGHT ACTIVITIES

<table>
<tr><td>Preflight Activity
Description:</td><td colspan="4">The battery of tests will be administered over a 3-day period to reduce the risk of injury and fatigue, as well as optimize the accuracy of the results. Flexibility, Muscle Strength and Muscle Endurance will be assessed by simple, “in the gym” exercises defined on page 3.
Pre-flight activities will include:
Sit & Reach Bench Cone Agility Test
Push-ups Crunches Single Leg Stand Test
Pull-ups Leg Press Hand Grip</td></tr>
<tr><td rowspan="2">Schedule:</td><td>Duration:</td><td>Schedule:</td><td>Flexibility:</td><td>Personnel Required:</td></tr>
<tr><td>60 minutes
60 minutes</td><td>L-180 d
L-45/30 d</td><td>+/- 2 Days
NA</td><td>Astronaut Strength, Conditioning and Rehabilitation (ASCR)/Crewmember</td></tr>
<tr><td rowspan="2">Ground Support Requirements Hardware/Software</td><td colspan="2">Preflight Hardware:</td><td>Preflight Software:</td><td>Test Location:</td></tr>
<tr><td colspan="2">Leg Press (Cybex) Smith Bench
Sit & Reach Bench Padded Exercise Mat
Hand Grip Dynamometer 4 cones</td><td>NA</td><td>U.S. and Russia</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>Special Lighting:</td></tr>
<tr><td>35ft x 35ft Room</td><td>NA</td><td>20-25°C</td><td>N/A</td></tr>
<tr><td>Hot or cold running water:</td><td>Privacy requirements:</td><td>Vibration/Acoustic Isolation:</td><td>Other:</td></tr>
<tr><td>NA</td><td>Access to room must be controlled during testing</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Constraints/Special Requirements:</td><td colspan="4">No maximal exercise 4 hours prior to testing. No food 90 minutes prior to testing.
Test Termination Criteria:
▪ Volitional Fatigue
▪ Pain
▪ Orthostatic Hypotension</td></tr>
<tr><td>Launch Delay Requirements:</td><td colspan="4">L-45/30 tests will be repeated if launch is delayed by more than 3 months.</td></tr>
<tr><td>Notes:</td><td colspan="4">Pre-flight activities will be scheduled outside normal exercise periods.</td></tr>
<tr><td>Data Delivery</td><td colspan="4">Data/Report to Designated Recipients (Nominal/Contingency):</td></tr>
</table>

	Preliminary MAT reports for all sessions will be delivered to Crew Surgeon via Mission Integration Coordinator (MIC) within 48 hours of test completion. A final report shall be delivered to the Crew surgeon via the MIC within 14 days following the final preflight test session. The MAT data is due to the Data Archivist within 14 days after completion of each MAT.

Exercise Definitions:

- **Flexibility:** The range of motion around the joint.
  Sit and Reach
  Measures lower back and hamstring flexibility. The test is more reliable if the astronaut has warmed up and has completed some static stretching prior to the test.
  - The astronauts sit with their bare feet flat against the "sit-and-reach box", legs extended. Knees should be straight as possible.
  - One hand is place on top of the other and arms extended forward.
  - Reach forward (exhaling) slowly and as far as possible at the hip.
  - The score is the best of three trials, is measured in inches using the D scale, and is the most distant point on the box contacted by the fingertips.

- **Muscle Strength:** The force that a muscle or muscle group can put forth against a prescribed load in one maximal effort; 1 repetition max (1RM).
  Smith Bench Press
  Measures upper body strength in a controlled environment. Proper warm up and static stretching is required prior to the test.
  - The astronaut will complete 2-3 sets of warm up beginning with a subjective predicted maximum of 30% for 10 repetitions.
  - The weight is increased conservatively, 10 to 20%, each trial. At the same time the number of repetitions is decreased until reaching 1 repetition.
  - Repeat sets of 1RM until the astronaut fails to complete the lift.
  - 3-5 minutes rest between each successful set is recommended.
  - The astronaut should use that rest time to stretch.
  - Record the 1RM value as the maximum weight lifted for the last successful trial.

  Leg Press
  Measures lower body strength by performing the leg press.
  - The subject begins with a 50 percent of a subjective predictive maximum, for about 10 repetitions.
  - The weight is increased conservatively about 15 to 20 percent each trial at the same time the number of repetitions is decreased.
  - If the lift is successful, the subject should rest 3 to 5 minutes before attempting the next weight increment. During the rest the subject should stretch the muscle group.
  - Follow this procedure until the subject fails to complete the lift. The 1 RM is typically achieved within 3 to 5 trials. Record the 1-RM value as the maximum weight lifted for the last successful trial.

- **Muscle Endurance:** the ability to do a continuous physical activity without advantageous rest stops or nonessential body movements.
  Pull ups/Assisted
  Measures local muscle endurance of the latissimus dorsi, elbow flexors & pectoral muscles.
  - Use an overhand or underhand grip. Must use same grip for all sessions.
  - Pull up is completed when chin reaches above the bar.
  - Movement is through a full range of motion.
  - Number completed is score.

Push ups/Modified

Measures local muscle endurance of the pectoral and shoulder muscles.

- Begin movement in an "up" position, back straight, head up, hands shoulder-width apart.
- Modified position is with back straight, head up; hands shoulder width apart and knee bent at 90-degree angle with ankles crossed.
- Each repetition should be completed with the same range of motion, back straight and pushing up to a straight arm position.
- Maximum completed in 2 minutes will be the score recorded.

Sliding Crunches

Measure local abdominal endurance.

- Begin exercise by lying on back, legs flexed to 90 degrees, chin at chest and arms at the side of the body.
- Pressing back into floor and contracting abdominal muscles, slide hands to the heel of the foot. Keep arms and forearms on the floor, chin on the chest. If necessary head can be supported with one arm.
- Maximum completed in 2 minutes will be the score recorded.

Agility

Measures the ability to move and change directions quickly

- Cones should be placed at corners of 15ft x 15ft square
- Movement pattern diagram. Note shuffle
- The score is the best of 3 time trials
- See Appendix A

Stand Test

Measures the ability to balance.

- Begin by standing on one leg for 15 seconds.
- At the end of 15 seconds, switch to opposite leg for 15 seconds.
- Each trial is performed 3 times.

Hand Grip Test

Measures local strength of the hands.

- Begin by measuring the device to proper fit of the hands.
- Squeeze the dynamometer with one hand. At the completion of the trial, switch hands.
- Repeat each hand 3 times.
- Score is the total force of both hands

3.5 In-Flight Activities: No In-Flight Activities

3.6 Postflight Activities

TABLE 3.6: POSTFLIGHT ACTIVITIES

<table>
<tr><td>Postflight Activity
Description:</td><td colspan="5">See Descriptions on page 3.

Bench, Push-ups, Pull-Ups, Crunches, Sit & Reach Leg Press (R+5/7 @ 60 minutes)
Leg Press (R+30 @ 45 minutes)</td></tr>
<tr><td rowspan="2">Schedule:</td><td>Duration:</td><td colspan="2">Schedule:</td><td>Flexibility:</td><td>Personnel Required:</td></tr>
<tr><td>75 Minutes
60 Minutes</td><td colspan="2">R+5/7
R+30</td><td>NA
+/- 2 Days</td><td>ASCR/
Crewmember</td></tr>
<tr><td rowspan="2">Ground Support Requirements Hardware/Software</td><td colspan="2">Postflight Hardware:</td><td>Postflight Software:</td><td colspan="2">Test Location:</td></tr>
<tr><td colspan="2">Leg Press (Cybex)
Sit & Reach Bench
Hand Grip Dynamomometer
Smith Bench
Padded Exercise Mat
4 cones</td><td>N/A</td><td colspan="2">U.S. and Russia</td></tr>
<tr><td rowspan="4">Testing Facilities</td><td>Minimum room dimensions:</td><td colspan="2">Number of electrical outlets:</td><td>Temperature requirements:</td><td>Special lighting:</td></tr>
<tr><td>35ft x 35ft Room</td><td colspan="2">NA</td><td>20-25°C</td><td>N/A</td></tr>
<tr><td>Hot or cold running water:</td><td colspan="2">Privacy requirements:</td><td colspan="2">Other:</td></tr>
<tr><td>NA</td><td colspan="2">Access to room must be controlled during testing</td><td colspan="2">N/A</td></tr>
<tr><td>Constraints/Special Requirements:</td><td colspan="5">No maximal exercise 4 hours prior to testing. No food 90 minutes prior to testing.
Test Termination Criteria:
▪ Volitional Fatigue
▪ Pain
▪ Orthostatic Hypotension</td></tr>
<tr><td>Notes:</td><td colspan="5">Post flight Activities are scheduled during rehab period.</td></tr>
<tr><td rowspan="2">Data Delivery</td><td colspan="5">Data/Report to Designated Recipients (Nominal/Contingency):</td></tr>
<tr><td colspan="5">Preliminary MAT reports for all sessions will be delivered to Crew Surgeon via Mission Integration Coordinator (MIC) within 48 hours of test completion. A final report shall be delivered to the Crew surgeon via the MIC within 14 days following the final postflight test session. The MAT data is due to the Data Archivist within 14 days after completion of each MAT.</td></tr>
</table>

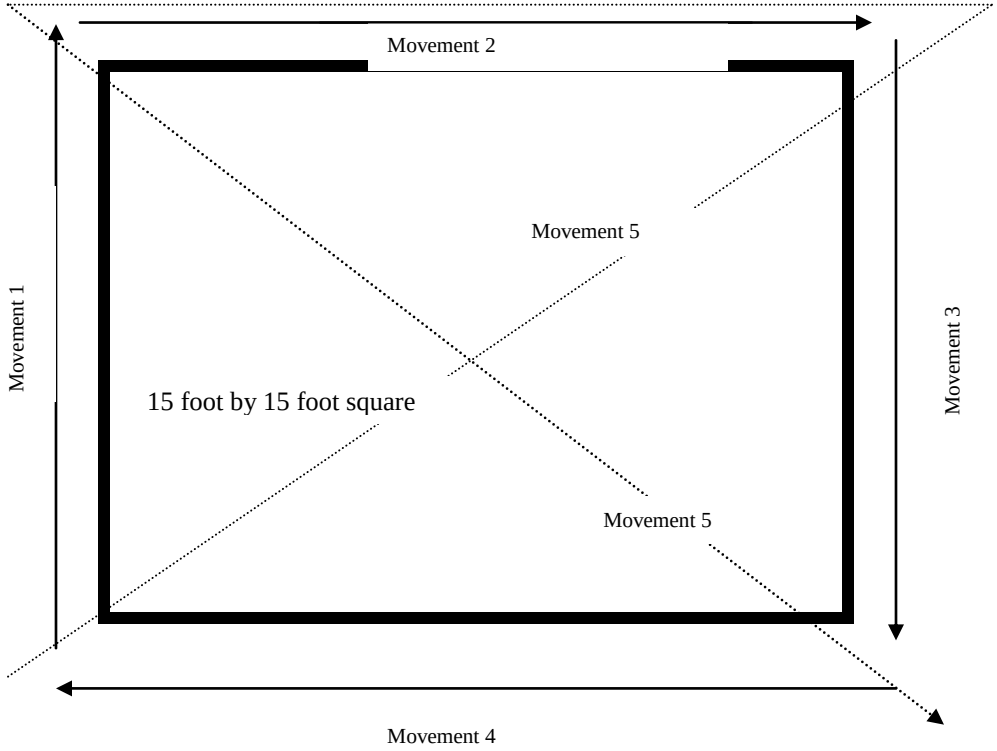
3.7 Summary Schedule

TABLE 3.7: SUMMARY SCHEDULE

ACTIVITY	DURATION	SCHEDULE	FLEXIBILITY	BLOOD VOLUME	PERSONNEL REQUIRED	CONSTRAINTS
Preflight						
▪ Sit and reach ▪ Smith Bench ▪ Push-ups ▪ Sliding Crunches (sit-ups) ▪ Pull-ups ▪ Leg Press ▪ Cone Agility Test ▪ Stand Test ▪ Hand Grip	60 minutes 60 minutes	L-180 L-45/30	+/- 2 Days NA	N/A	ASCR/ Crewmember	No maximal exercise 4 hours prior to testing. No food 90 minutes prior to testing. L-45/30 implemented during normally scheduled preflight exercise session.
Postflight						
▪ Smith bench ▪ Push-ups ▪ Pull-ups ▪ Sliding crunches ▪ Sit and reach ▪ Leg Press ▪ Cone Agility Test ▪ Stand Test ▪ Hand Grip	75minutes 60 minutes	R+5/7 R+30 (Leg Press)	N/A +/- 2 Days	N/A	ASCR/ Crewmember	No maximal exercise 4 hours prior to testing. No food 90 minutes prior to testing.

Appendix: A

Agility – Cone Test



Movement 1 - Crewmember is to move forward
Movement 2 - Crewmember is to shuffle to the right
Movement 3 - Crewmember is to move backwards
Movement 4 - Crewmember is to shuffle to the left
Movement 5 – Crewmembers is to complete half a figure 8 moving forward only