Update on Artemis Astronaut Training

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Training the Artemis Astronauts

- Multiple forums, including the 2016 LEAG Geologic Astronaut Training SAT (GAT-SAT) and several LSSW papers and break-out sessions have called out the requirement for a well-trained crew, referencing Apollo lessons
  - Geoscience and field training for crew early in the training flow
  - Integrated simulations in relevant field environments
  - Cross training and field training for flight operators, engineers and managers
- A NASA team of planetary and field geologists are already integrated with JSC's Flight Operations Division (FOD) training office and crew office
  - 10 years of close collaboration and coordination with FOD crew and training offices (includes Astronaut Candidate training, and training for ISS Earth Observations)
  - Well-established mechanisms for including external scientist participation
  - Plans underway to integrate fundamental geological sciences, lunar science, planetary processes and field operations into the Artemis training flow for crew and supporting operations staff

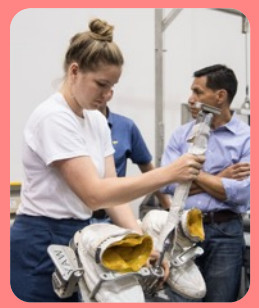
FOD Reference Model: Phased Approach for EVA Skills Training

PHASE 1

EVQ

During astronaut candidacy

- Systems
  - Basic, working knowledge of EMU
  - Caution & Warning interface and boldface response
  - Suit-IV role, understanding of Road-to-EVA activities
- Task
  - Optimize suit fit, safely performing basic skills and proficiency to complete 6.5-hour spacewalk
  - Mastery in self-care and ability to rescue partner within 30 minutes
- Plan/Ops
  - Basic execution and participation in EVA development as EV crew and Ground IV.
  - Assist with crew suit donning/doffing



PHASE 2

Proficiency Training

Between completion of initial training & flight assignment

- Maintain EV-Q Proficiency
  - Periodic NBL Runs to maintain EV-Q skills
  - Periodic Systems courses to maintain Suit-IV skills
- EVA Development
  - EVA Hardware review
  - NBL Development tests
- Leadership and Ground-IV development
  - Optional EV-L flow to increase leadership skills and mentor rookie crew
  - Ground-IV training and execution of EVA from MCC

PHASE 3

Assigned Crew Training

Mission specific science training

- ISS Maintenance
  - Focus on Critical Contingency EVA tasks
  - Skills based for both Nominal and Contingency EVAs
  - Evaluation from EVA Evaluation Board
- EMU & A/L Systems
  - Road-to EVA and EMU Maintenance
  - EVA Prep & Post (EV and Suit-IV roles)
- EVA Specific Training
  - Training Specific EVA content which is scheduled within Increment timeframe
  - Develop crew preferences for EMU and EVA timeline
  - Evaluation from EVA Evaluation Board

Artemis Planetary Science Training - Phased Approach

PHASE 1

Initial Training

During astronaut candidacy

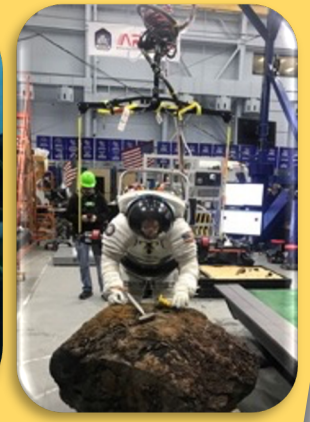
- JSC Classroom Training Modules
  - Geo-Science Fundamentals
  - Earth Systems
  - Planetary Science & Missions
- Field Training
  - Geologic Mapping & Traverse Planning
  - Sampling & Instrumentation
- Expeditionary Components
  - Team Experiences & Leadership Opportunities

PHASE 2

Proficiency Training

Between completion of initial training & flight assignment

- ISS Specific Training
  - Crew Earth Observations
- Analog Mission Operations
  - Science under operational constraints
- Advanced Field Opportunities
  - Astronaut Field Assistantships and other opportunities
- Ops tests in Training Facilities
  - e.g. ARGOS, NBL, Rock Yard, etc.



PHASE 3

Assigned Crew Training

Pre-assigned & Mission specific science training

- Advanced Classroom Instruction
  - Destination-specific training
  - Detailed focus on science objectives & operations
- Facility-Based Mission Simulations
  - In coordination with operations and hardware training and evaluations
- Extensive Field Experiences
  - Numerous geologic/operational training trips to relevant terrains patterned after Apollo

Key Achievements from > 10 years of Phase 1 and 2 Training

- Built a robust geoscience and field training curriculum provided to new astronaut classes (2009, 2013, 2017 classes)
  - Increased field work for new classes (2 weeks) with a focus on mapping
  - Tightly integrated Earth & planetary science classroom and field training, includes capstone exercises
  - Integrated spaceflight/mission relevance by partnering with NASA operational psychologist and including Space Flight Resource Management elements (approaches and language from NOLS classes)
- Established process for field assistantships for trained crew to maintain proficiency
- 2X/year field mapping classes for engineering community (spacesuit engineers, geology tool engineers, flight operators) and management as an introduction to surface operations
- Integrated crew-scientist-engineer operational testing in JSC facilities

South Pole Lighting Tests, JSC Rockyard

Notional Training Schedule (2018 to 2028)

	Training Activity	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
PHASE 1	NASA Astronaut Group 22 (The Turtles – selected 2017)	◆	◆									
PHASE 1	NASA Astronaut Group 23 (projected class selection 2022)					◆ notional schedule	◆					
PHASE 1	Notional Future Class -TBD											
PHASE 1	Support Team Training (provided as demand requires)		◆ ◆			2x/Yr →						
PHASE 2	Advanced Field Opportunities Astronaut Field Assistant Program											
PHASE 2	Crew Earth Observations On-going ISS specific training											
PHASE 3	Operations Tests Science/Ops mission analogs & tests											
PHASE 3	Artemis Training/Ops (early Artemis missions)						notional schedule		Continuing for later flights			
PHASE 3	Mission Specific Training/Ops (lead up to sustained lunar base)							notional schedule				

COVID

Artemis Training – Looking Ahead

- Continue to address GAT SAT, other community findings
- Continue to build partnerships with Crew & EVA training offices
- Develop funding requests for basic science and science ops training for FY22-27 (NASA annual budgeting process)
- Assess relevant astronaut experience within crew office
  - Majority of crew have been through ASCAN training with 1 or more weeks of field experience
  - Significant number have participated in proficiency activities: field assistant, analog exercises
  - Most crew have been to ISS and have basic understanding of Earth geography, planetary processes and the importance of observations

Artemis Training – Looking Ahead

- Fully integrate our phased approach to crew training (based on EVA model) with FOD Artemis training plans
  - Multi-year training schedule w. FOD that integrates planetary/field science with operations training, leading to integrated simulations
  - Includes basic lunar & planetary science that can be provided to pre-assigned crew
  - Targets a subset of basic training for Artemis Support Team, including flight directors & operations engineers
  - Identifies relevant field training locations and required logistics for the basic training and simulations
  - Ongoing operational testing in JSC facilities (RockYard, NBL, ARGOS, VR) with crew, engineers, trainers to test equipment prototypes and develop preliminary operational concepts