



Operational Psychology Perspective

Al Holland, Ph.D.

Medical Operations/NASA Johnson Space Center

November 20, 2009



Acknowledgments

Gary Beven, M.D., NASA Psychiatrist

Walter Sipes, Ph.D., NASA Aerospace Psychologist

Steve Vander Ark, M.A., Wyle BHP Section Lead

Gabrielle Avina, Wyle In-flight Support Lead

Kelly Curtis, Wyle Family Support Lead

The NASA/JSC Behavioral Health and Performance team



Long Duration Spaceflight

- 38 years of space station operations in history
- Space Stations (10 total in history):
 - *Salyut stations 1—7 (Russia)* April 19, 1971—February 7, 1991; 38 Missions (11 long duration)
 - *Skylab (US)* May 14, 1973—July 11, 1974; 3 missions (2 long duration)
 - *Mir (Russia)* February 20, 1986—March 23, 2001; 39 missions (28 long duration)
 - *International Space Station (ISS)* November 20, 1998—present; (22 long duration missions so far)



Long Duration Spaceflight

- US Space Station Astronauts:
 - 9 Skylab astronauts (six long duration mission astronauts) in 1970s
 - 7 US Shuttle-Mir Astronauts (mid 90's)
 - 27 US ISS Astronauts 2000—present (3 have flown twice on ISS)
 - 41 total US space station astronauts (*Mike Foale flew on both Mir and ISS*)
 - **39 total US long duration mission astronauts in 40 years of the space program (11 % of all US astronauts)**



ISS 1 Crew

Bill Sheperd, CDR





The International Space Station

- ISS NASA crew members
 - Expedition 1 Bill Sheperd
 - Expedition 2 Jim Voss & Susan Helms
 - Expedition 3 Frank Culbertson
 - Expedition 4 Dan Bursch & Carl Walz
 - Expedition 5 Peggy Whitson
 - Expedition 6 Ken Bowersox & Don Pettit
 - Expedition 7 Ed Lu
 - Expedition 8 Michael Foale
 - Expedition 9 Mike Fincke
 - Expedition 10 Leroy Chiao



The International Space Station

- **ISS NASA crew members (30 missions, 27 individuals)
+JAXA, CSA, RSA**
 - Expedition 11 **John Phillips**
 - Expedition 12 **William McArthur**
 - Expedition 13 **Jeffrey Williams**
 - Expedition 14 **Michael Lopez-Alegria & Suni Williams**
 - Expedition 15 **Clay Anderson**
 - Expedition 16 **Peggy Whitson (mission #2) & Dan Tani**
 - Expedition 17 **Garrett Reisman & Greg Chamitoff**
 - Expedition 18 **Mike Fincke (mission #2) & Sandy Magnus**
 - Expedition 19/20 **Mike Barratt, Tim Kopra**
 - Expedition 21 **Jeff Williams (mission #2) & Nicole Stott**
 - Expedition 22 **TJ Creamer**



ISS 19 Crew (final 3 person crew)





ISS 20 First Six Person Crew





Changes for ISS

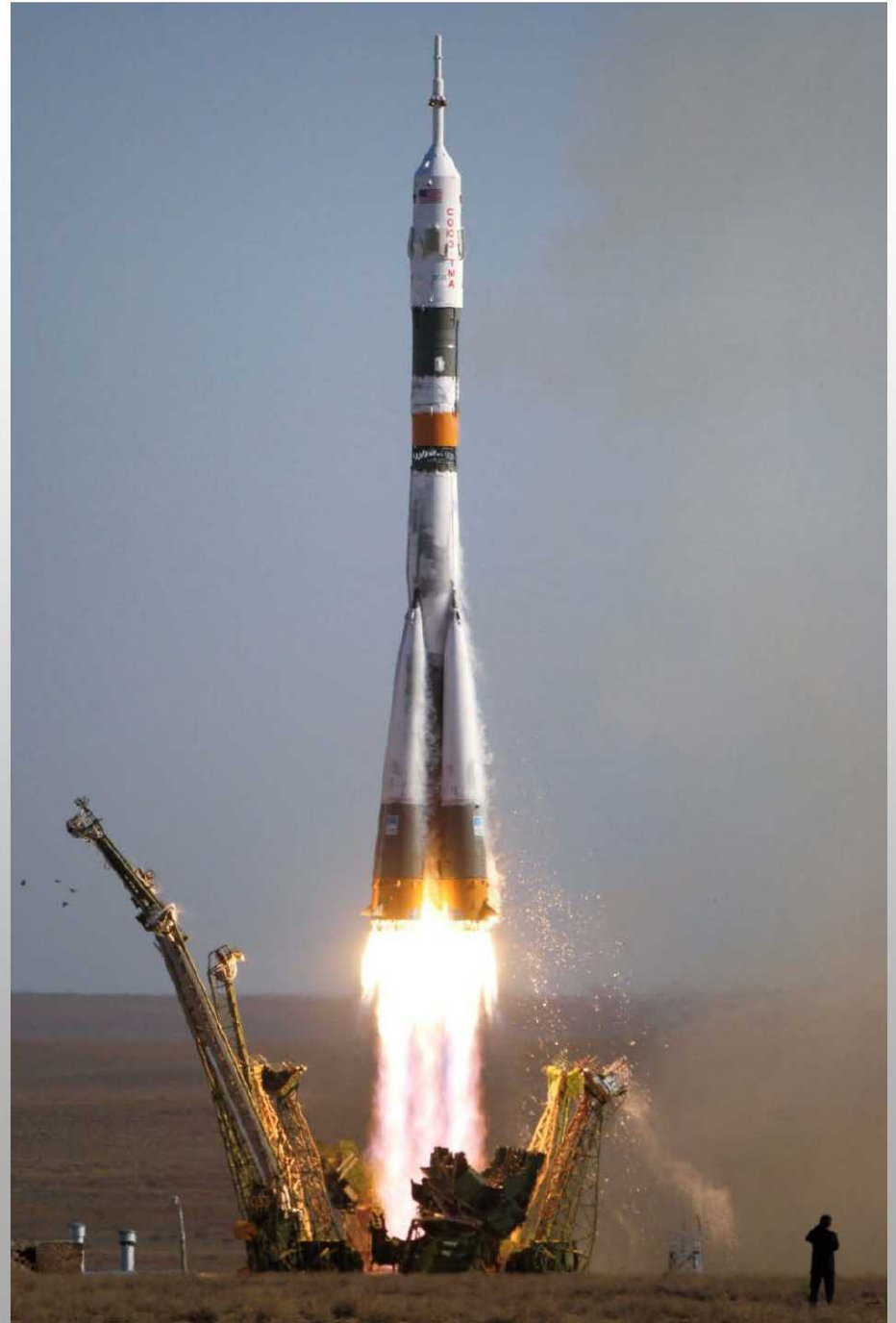
- All ISS partners supplying crewmembers at higher rate
 - BHP supporting NASA, JAXA, CSA crewmembers now
 - Fully functioning multiple ground controls coordinating with one another
- Six-person crews nominal, handovers 9, STS visits 13
 - More social buffering, more coordination
- Overlapping crews and membership, change in CDRs
 - No longer single-crew mentality and integration



11/19/2009



Launch of ISS 20 Crew





Changes for ISS

- Up and down on Soyuz only
 - Limited upmass constraining re-supply, spares and personal/morale items
 - Three re-supply carriers, more frequent unmanned logistical visits
- Currently, excellent young platform of large volume and capability
 - Helps buffer negative effects



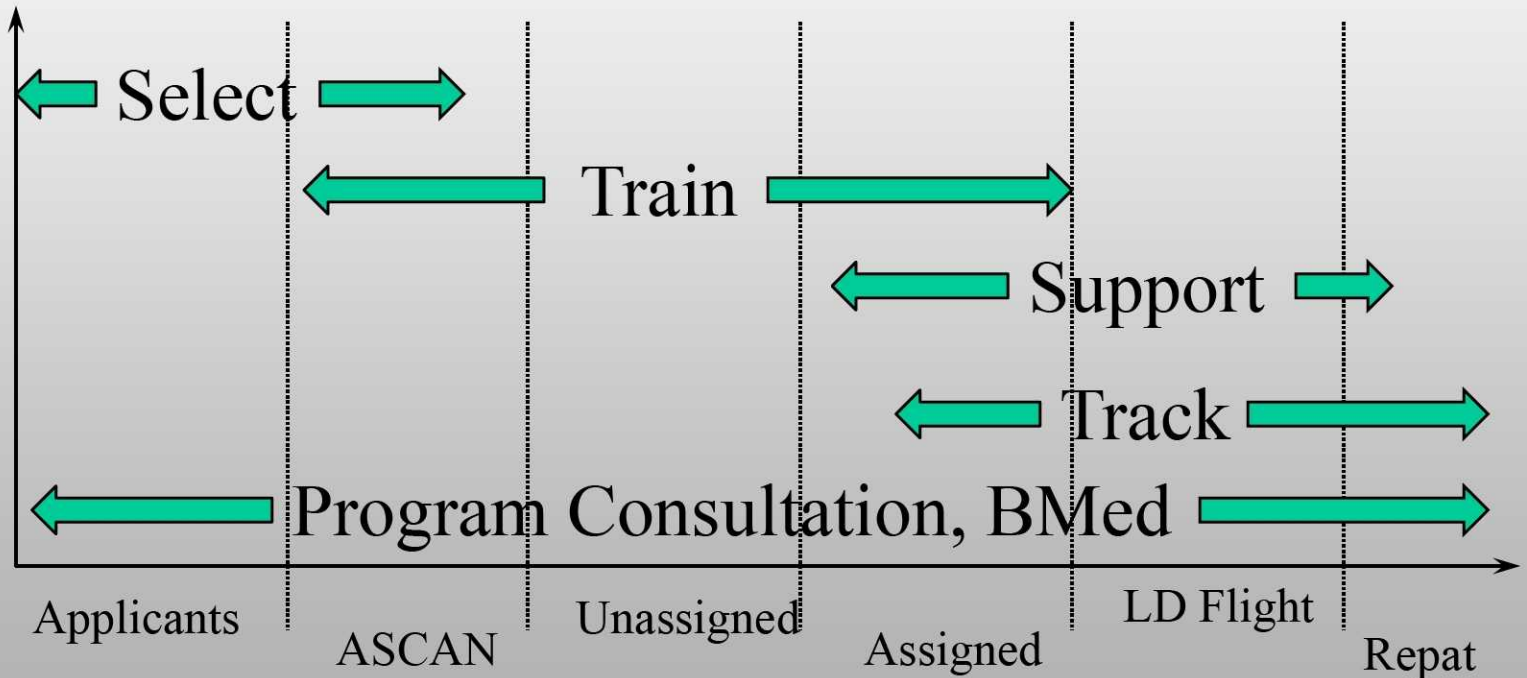
Soyuz Landing Site in Kazakhstan (after 4 to 8 Gz orbital reentry)



ISS 7 Crew recovery from Soyuz landing in Kazakhstan



Basic Operational Functions

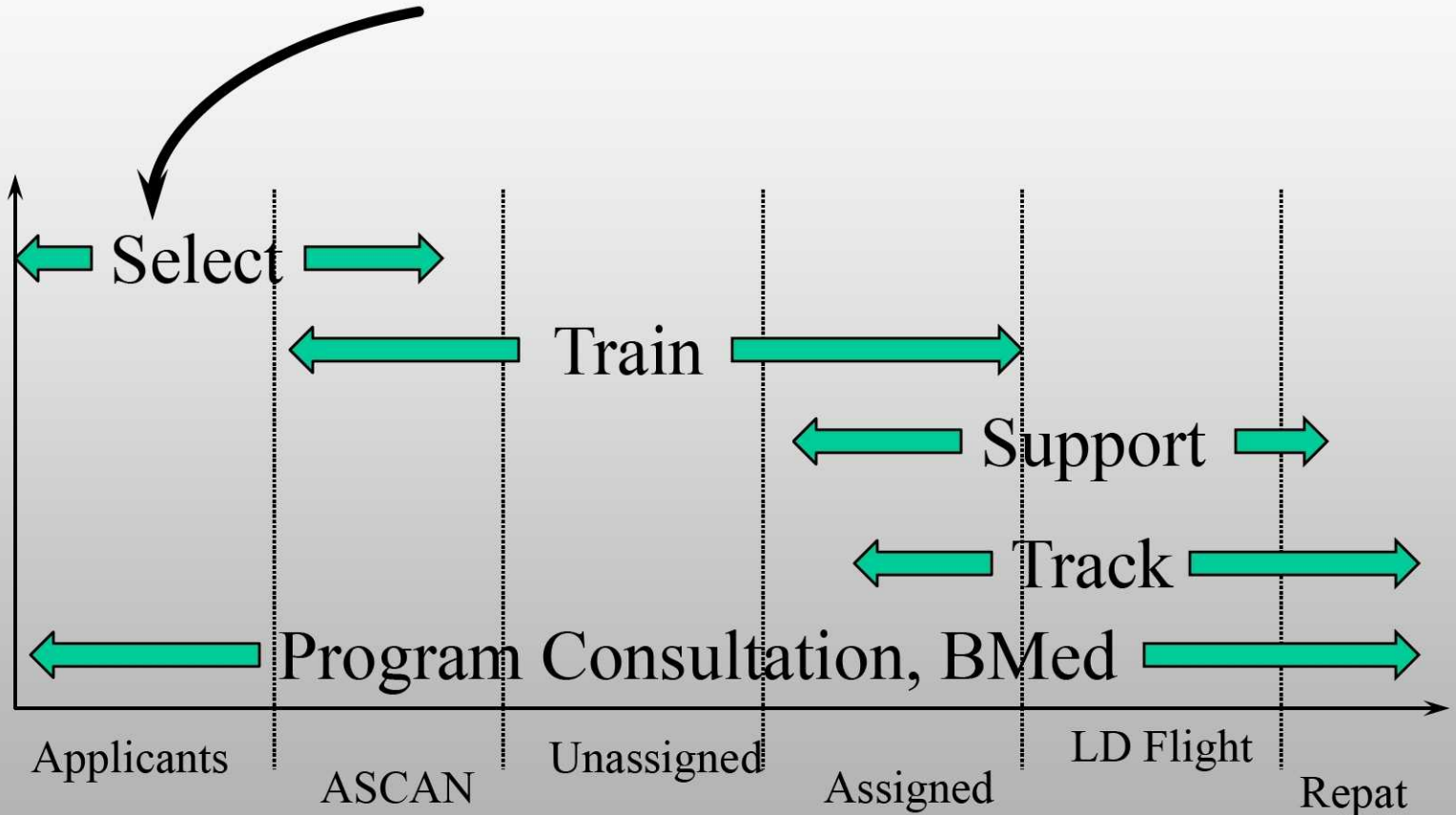


Time / Stage of ISS Operations





Individual Selection



Time / Stage of ISS Operations



11/19/2009



- Selection has evolved in many ways since the inception of spaceflight
 - Both culture and uncertainty about initial conditions, led USSR and US to pick male, military ‘right stuff’ pilots (*acute stress competency*)
 - Psychiatric screening only and emphasis was on tolerance of acute stress
 - Era of long duration flight gradually opened participation first to engineers and later to scientists
 - Psychiatric and psychological interviewing and testing
 - As durations increased and crews became multinational, suitability shared importance with clinical screening
 - Broader clinical and suitability process (*social competency rises*)



Current 'Front Door' Method

- Balance of clinical and suitability, conducted in parallel
- Suitability process
 - Competencies and indicators mapped
 - Gather & integrate main and trial indicator information
 - Personality and cognitive test scales
 - Structured interview ratings, staffing discussions
 - Behavioral scenarios
 - Peer assessments
 - Structured observations
 - Participation in and consultation to ASB process
 - ASB directly presented ISS (180d +) suitability recommendation, plus strengths/vulnerabilities in competency areas



- Definition of target mission(s) along key parameters
 - Duration, volume, crew size and nature, autonomy, environmental conditions, threats, etc.
- Selection and definition of KSAs (competencies) required for successful completion of target mission(s)
 - ISS first formally defined in 1995, used formally in selection in 1996, upgraded and refined over time as long duration flights continued



Critical Proficiencies

- Mental/emotional stability
- Ability to perform under stressful conditions
- Group living skills
- Teamwork skills
- Ability to cope with prolonged family separations
- Motivation
- Judgment/Decision Making
- Conscientiousness
- Communication skills
- Leadership capability



11/19/2009





Backup Slides NRC2-Selection



1958-1988

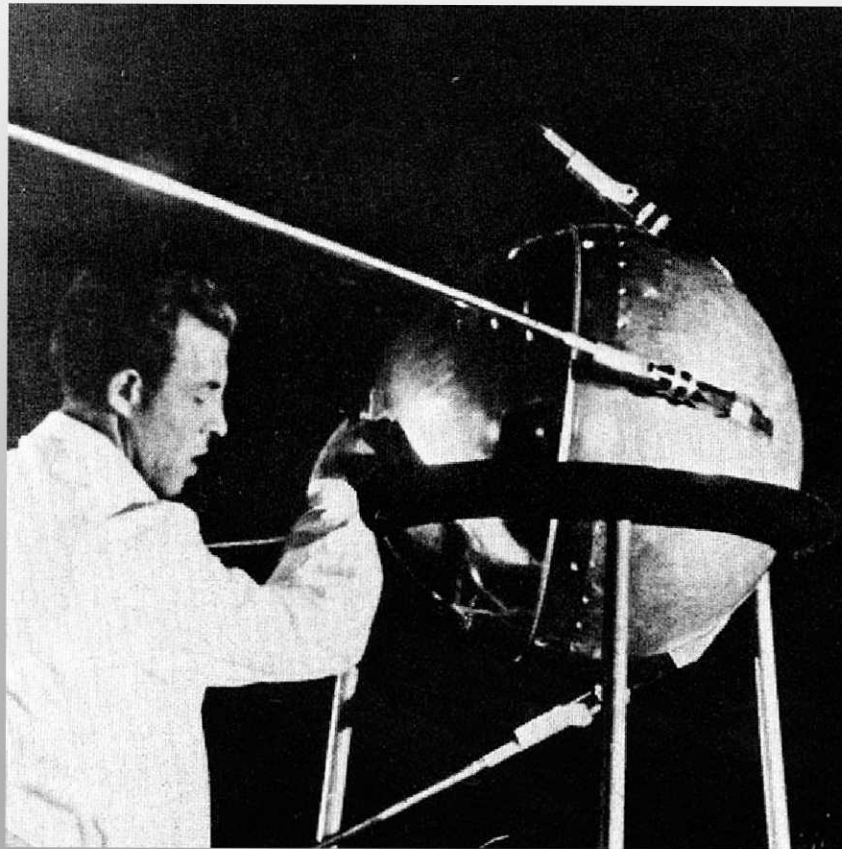
- The Space Race with the Soviet Union
 - Exploration and achieving national ‘firsts’
 - *Mercury* solo Earth orbits
 - *Gemini* 2-Man Crew Earth orbits
 - *Apollo* 3-Man Crew Moon Missions - - non-military geologists
 - Dominance of environmental stressors (experimental machine, thermal, g-forces, etc)
 - Young, male, military test pilots with short-duration “Right Stuff”
 - USSR & US use military/clinical selection model: psychiatry, clinical psychology, multiple reaction-time and personality tests



Sputnik 1

"Простейший Спутник-1", or *Elementary Satellite 1*

October 4, 1957





Salyut 7 (1982-91)

- Six long duration missions
- 12 Expeditions
- EO-3 Expedition in 1984
of **237 days**





- Early Experience with Long Flight
 - *Skylab* Station
 - First physician-astronaut
 - *In situ* Space Sciences emerge
 - Three flights up to 84 days in length
 - Demands of extended missions surprise us
 - Russian *Salyut* Station
 - Demands of extended missions surprise USSR
 - Numerous instances of interpersonal difficulties
 - ‘Firsts’ yield to scientific & military tasks



Skylab—NASA's First Space Station (1973-74)

Skylab 3 (November 16, 1973) was the second long duration crew in History—84 days in space

Gerald Carr, William Gibson, Edward Pogue





- From Exploration to Use
 - U.S. abandons long flight in favor of Shuttle ‘Science Truck’
 - Short-duration Shuttle science and payload deploy/retrieval (5-11 days)
 - Non-military astronaut-scientists proliferate; women enter Corps
 - U.S. psychology recedes
 - No testing
 - 1-hour psychiatric interview only
 - A few difficulties, especially interpersonal, intra-crew
 - Stasis sets in; no preparation for space station
 - Little to no contact with Russians



S128E011001



- Russia refines a continuous military-scientific outpost in *Salyut* and *Mir* stations
 - Continuous LD human presence in space (3-9 mos.) is driver
 - LD ground infrastructure & procedures mature
 - Crew inter-relationships partially addressed in selection and training procedures
 - Clinical testing + psychiatric + anecdotal + compatibility
 - Extensive psychological support & monitoring infrastructure developed due to cosmonaut difficulties on LD missions



- U.S. Struggles toward Long Flight
 - Space Station *Freedom* in design; Shuttles fly
 - 1987 Select-out vs. select-in operationally distinguished
 - Psychological research re-emerges under pressure of *Freedom*;
 - Teams in polar & undersea environments studied from afar
 - Proposals for selection, training, in-flight support had tough sledding
 - 1988-89 Santy Working Group revives operational psychology
 - Expands and extends select-in / select-out concepts
 - Re-institutes personality testing at front door
 - All activities still flow through medical process



1989-Present

- Movement of selection from purely clinical model to broader, mixed model
 - 1989 Select-out standardized interview; clinical testing returns; entirely medical process
 - 1990 Dedicated psychology exchanges with visits to USSR
 - Helmreich & Rose selection study: first systematic study relating personality to peer ratings
 - 1991 First select-in suitability evaluations passed forward to ASB
 - Space Station *Freedom* canceled



- Opportunity Finally Knocks
 - USSR *Mir* Station and US *Shuttle* crew swaps
 - USSR policies of detente & glasnost; NASA negotiates one-time seat on *Mir*
 - Russia abandons communism, transforms economy
 - NASA forms new operational behavioral group in 1994 as Thagard deploys
 - Functionally based on Russian model
 - Everything behavioral: Mission planning, selection, training, inflight support, monitoring, evaluations, issue advocacy, consultation
 - Small NASA infrastructure, none in Russia
 - Direct line to Program; indirect line to Thagard
 - Thagard (1995): “*The most important factors in the success of long-duration missions are psychological.*”



11/19/2009



- The 1994 & 1995 selection cycles added:
 - SI process formalized alongside SO process
 - Model-guided, structured select-in interviews and non-clinical personality testing
 - Non-medical suitability evaluations for Shuttle and long-duration missions
 - Non-medical results routed to Astronaut Selection Board
- I/O psychology techniques added to clinical psychology and psychiatric techniques



Mir (1986-2001)

First Modular Space Station

- 28 long duration missions
- 3 cosmonauts completed single missions greater than one year in duration
- Shuttle—Mir Program (1995-1998)
- Manned continuously for 8 days shy of ten years (1989-1999)—still a record





- Continuous LD US presence on *Mir*
 - Seven *Mir* flights 1995-1997
 - Thagard, Lucid, Blaha, Linenger, Foale, Wolf, Thomas
 - All crew were selected prior to 1994 select-in changes; selection ratio was 1/1
- 1996-97 Select-In Upgrade Project
 - Systematic targeting of short & long proficiencies
 - Greatly improved select-in interview structure and process
 - Expanded predictor types (e.g., biodata instrument)
 - Systematic interviewer training
 - External expert selection participants



- Lunar/Mars Life Support Test Program
 - 1997 Closed chamber tests recycling air, H₂O for autonomous colonization & mission technology
 - Four tests, 1-4 persons, 15-91 day durations
 - Test beds for selection, training, support
 - Formal extension of selection into training period
 - First trial of sociometrics, with psyc and Program input, to select prime and backup crews



LMLSTP

- Layout of the Chamber

- 1st Floor

- Kitchen
 - Full Bath area (urinal/shower/handwash)
 - Pantry for food storage
 - Comm equipment
 - Crew work area
 - Exercise area
 - Advanced life support systems

- 2nd Floor

- Storage
 - Additional exercise equipment
 - Advanced life support systems
 - Work bench/lab area

- 3rd Floor

- Crew Quarters
 - Workstation/TV
 - Bed
 - Personal storage
 - Comm equipment
 - 1/2 Bath (urinal/handwash)





- Preparation for the International Space Station
 - 1997 selection cycle introduced
 - Structured SI interview based on highly targeted proficiencies
 - Test scales chosen for targeted proficiencies
 - 1998 advent of formal, multi-agency working group for behavioral health and performance issues, including selection
 - Separate agency selection & training processes, but high concordance in proficiencies (GCTC/IBMP, ESA, NASDA, CSA)
 - 1999 selection cycle introduced
 - Structured training course for Interviewers
 - Biographical inventory
 - 1999 NASA Expedition Corps formation
 - Training in Individual adaptation, Teamwork, Leadership
 - Post-event training evaluations by trainers & senior astronauts



S126E014780



- 2003 selection upgrade project
 - Re-ground the proficiencies with subsequent long-duration flyers
 - Upgraded SO criteria
- 2004 selection cycle
 - Re-defined medical SO criteria, tests and procedures
 - Fully computer-based testing
- 2009 selection cycle
 - Direct BHP contribution to ASB deliberations
 - Trials of behaviorally-based predictors and peer evaluations
 - Advent of real-time comm by applicants (Twitter, web sites, cell video) and security concerns

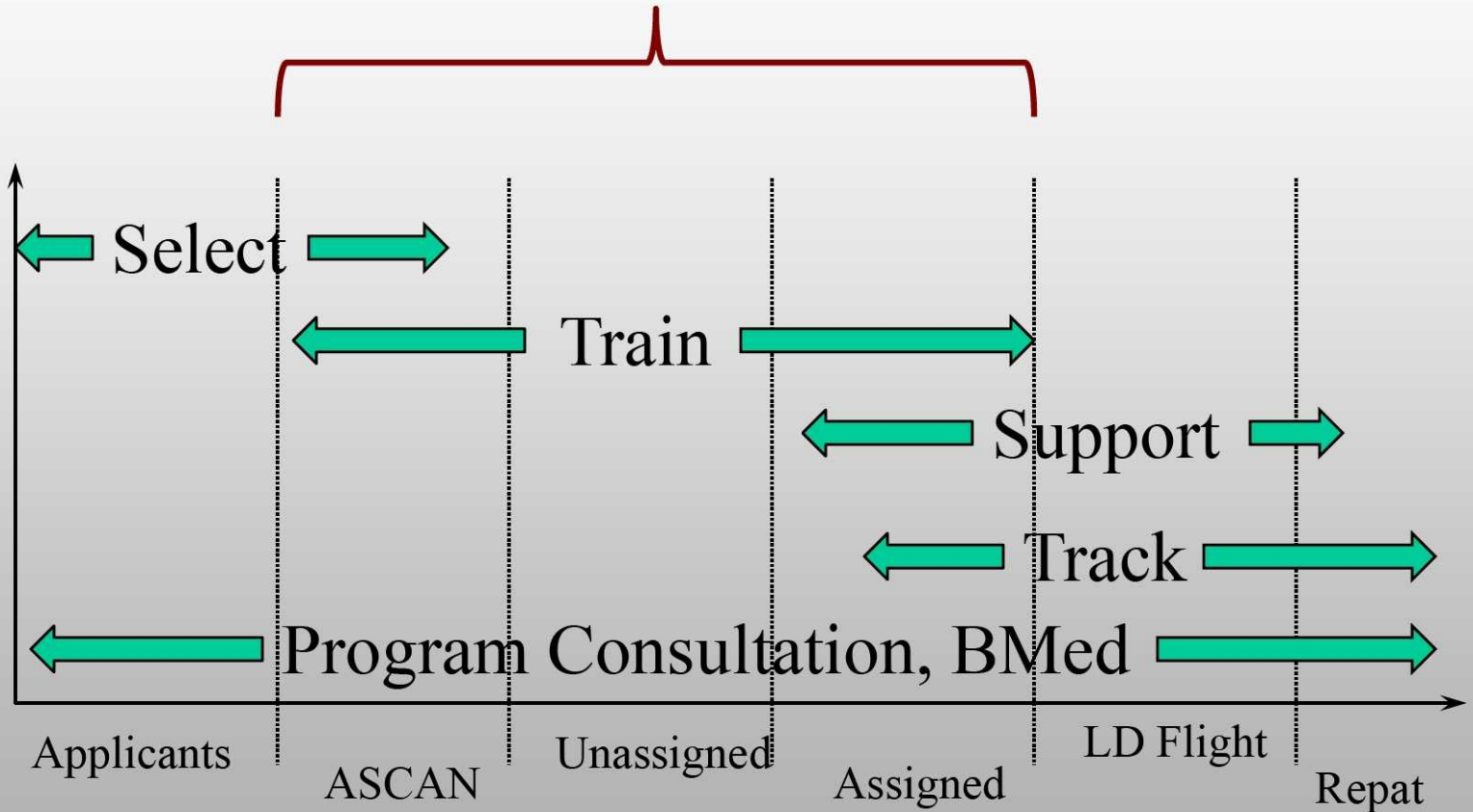


Future Selection Work

- Continue concurrent and criteria-based validation of predictors (test scales, bio items, structured interviews, behavioral scenarios, peers)
- Upgrade behavioral scenarios and equivalents
- Establish wider range of training & job performance criteria
- Once Administration defines target missions, if targets significantly different than ISS, conduct new job analysis
- Use of selection information as part of personal training and development plan for each astronaut



Training

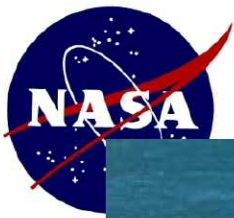


Time / Stage of ISS Operations



Training & Preparation

- US behavioral training originated with Mir
 - Cross-cultural
 - Submarine, Antarctic and Soviet lessons learned
 - Adaptation to extended confinement, culture/leadership, self-monitoring, etc.
 - Families included
 - Strong coordination with Russian behavioral training
- US Lessons Learned were plowed back into training for next Mir flyer, then for early ISS
- Astronaut office & BHP have always collaborated closely on training content.



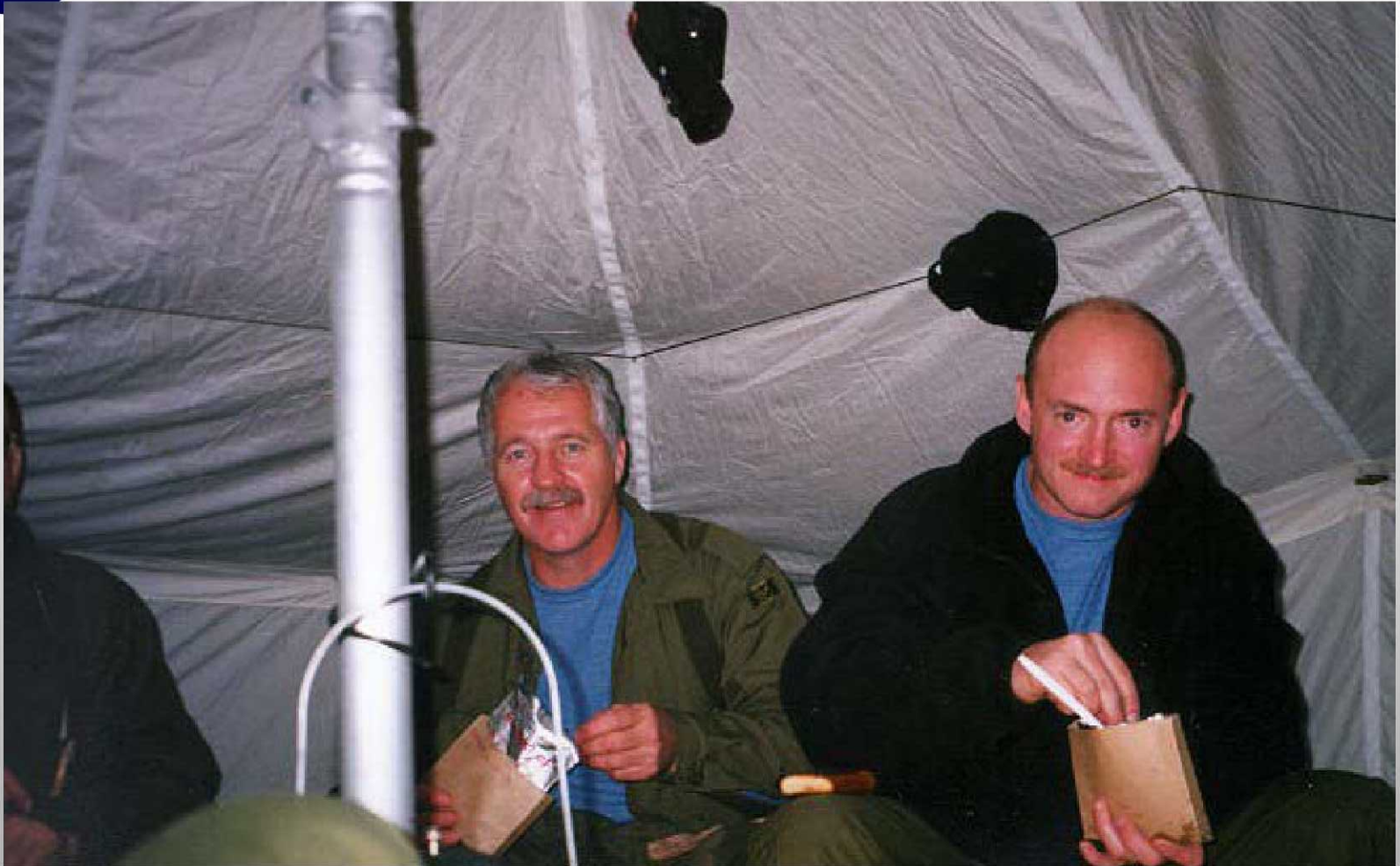
11/19/2009



Current US ISS Training

Activity Type	Activity	When
Basic Training	Behavioral Health & Performance Overview	ASCAN
	Psychological Factors of Spaceflight	ASCAN
	Space Flight Resource Management	ASCAN
	Cross-Cultural Workshop	ASCAN
	Stress Management	ASCAN
	Conflict Management and Resolution	ASCAN
	Expedition Behavior Workshop	ASCAN
	National Outdoor Leadership School (NOLS)	ASCAN, Unassigned
	NASA Extreme Environment Mission Ops (NEEMO)	Unassigned, Assigned
	ISS-Specific Training	Behavioral Medicine Issues for CMOs
Behavioral Medicine Issues for CMOs (Experienced)		L-18 mo
Cognitive Assessment (WinSCAT)		L-13 mo
Psychological Factors of Extended Spaceflight 1		L-12 mo
Psychological Factors (Experienced)		L-12 mo
In-flight Resource Planning 1		L-09 mo
In-flight Resource Planning (Experienced)		L-09 mo
Web Pages, Crew & Ground Based		L-06 mo
Psychological Factors of Extended Spaceflight 2		L-06 mo
In-flight Resource Planning 2		L-03 mo
Post-flight Reintegration with Family & Work		R-45
Ground Personnel Training (FDs, FSSs, BMEs, etc)	Behavioral Health and Performance Overview	Periodic
	Psychological Factors of Extended Spaceflight	Periodic
	Cognitive Assessment (WinSCAT)	Periodic
Training Debriefs	Post-training Debriefs for SFRM, NOLS & NEEMO Missions	Periodic 4



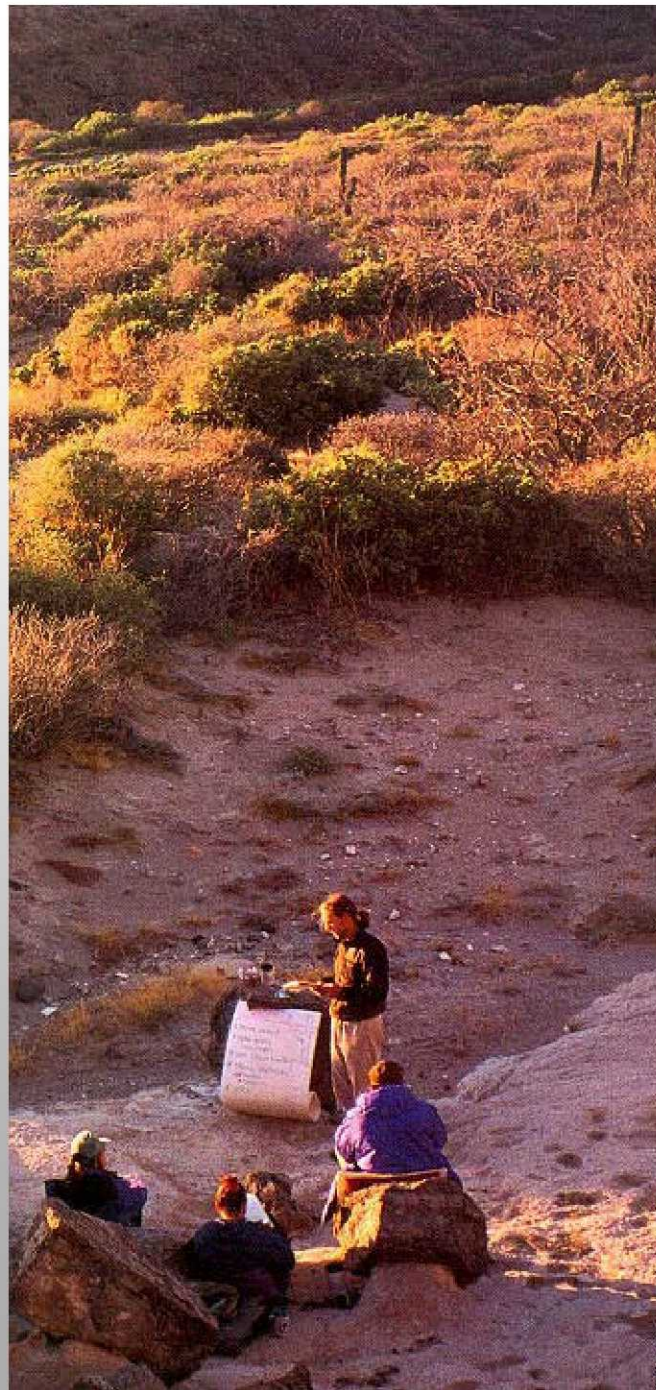


11/19/2009



International Training

- Spaceflight Human Behavior and Performance Working Group (SHBP WG)
 - International group formally organized in 1998 to address behavior & performance issues for ISS
 - Operational behavioral personnel from each ISS partner space agency
- SHBP WG responded to requests by Multilateral Crew Operations Panel (MCOP) to provide information and evaluation consultation for behavioral training of all ISS astronauts & cosmonauts



11/19/2009



Training Content

- SHBP WG with the International Training Control Board (ITCB) held multilateral curriculum design meetings
- Used a structured approach to establish astronaut competency requirements
- Process termed DACUM involved:
 - Facilitator (NASA – experienced training developer)
 - Astronauts (CSA, ESA, JAXA, NASA)
 - Behavioral subject matter experts (All Agencies)
 - Training experts (CSA, ESA, GCTC, NASA)
- Behavioral competency requirements agreed upon by all international partners (2006):
 - Three major categories
 - Eight broad skill categories
 - 28 competencies
 - 120 behaviors defining the competencies



Behavioral Competencies

- Three major areas
 - Intra-personal
 - Inter-personal
 - Inter-team
- Eight skill categories
 - Self-care & Self-management
 - Communication
 - Cross-cultural
 - Teamwork & Group Living
 - Leadership & Followership
 - Conflict Management
 - Situational Awareness
 - Decision Making & Problem Solving



Applications

- Increasing training consistency between international Partners
- Defining objectives for specific behavioral training
 - SFRM training in astronaut basic training
 - Experiential training (field training) during the non-assigned training phase
- Reinforcing behavioral skills
 - During technical , survival and emergency training
 - In complex simulations
 - During robotics and EVA training





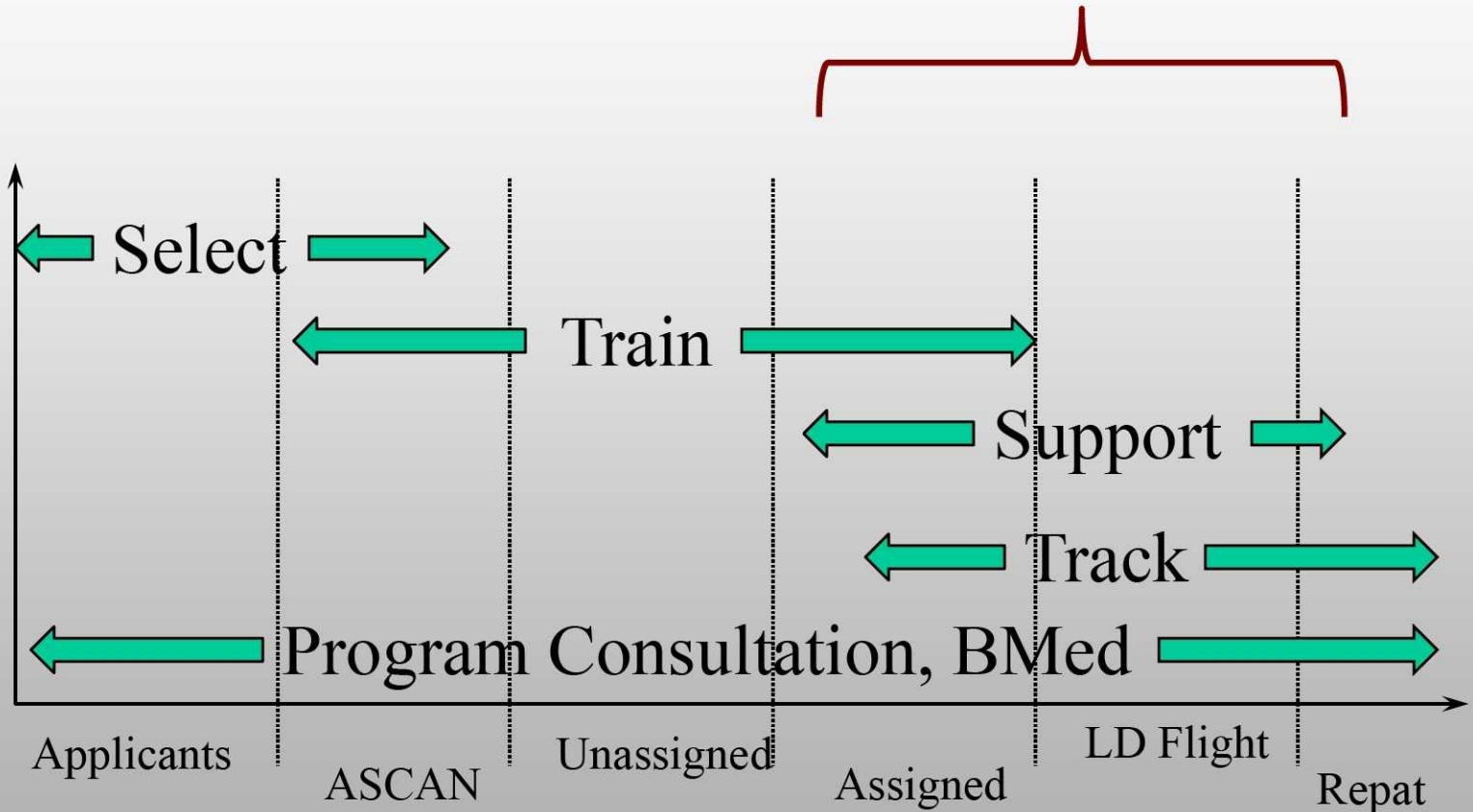
Backup Slides NRC03-Training



- In 2001, consensus reached by SHPB WG on Themes for behavioral training
 - Self-Care and Self-Management
 - Teamwork and Group Living
 - Leadership and Followership
 - Cross-Cultural Aspects (national, organizational & professional)



In-flight Family Support



Time / Stage of ISS Operations



Family Support Office

- Full-time office in astronaut building, dotted line to Astronaut Office ISS Branch
- Pre-flight planning meetings with family members
- Inform and assist with logistical arrangements
 - Assist with badging, passports, home security plan and patrols
 - Hosting plans
 - Self and family management
 - Separation
 - In-mission communications (PFCs, location of equipment, IP phone, email, etc)
 - Managing extended family, friends and media
 - What to expect out of NASA and flyer
 - Onboard and Ground-based web pages
 - Preparing kids art, video clips, pictures, etc.
 - Care packages and when/how to prepare for them



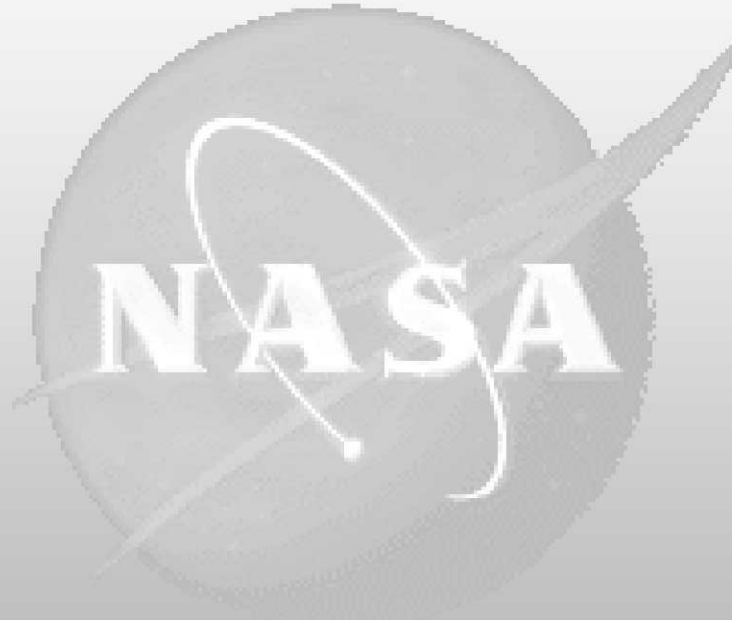


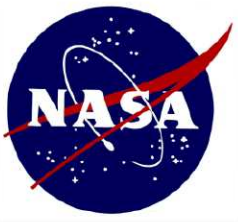
- News and Information for Families
 - CSA (Crew Support Astronaut) will serve as the primary person to communicate official *mission* information to families.
 - BHP provides family notification of ISS PAO (Public Affairs Office) events aired on NASA TV if the family is not already on PAO's distribution.
 - BHP provides one copy per family of Shuttle Flight Day Highlights and, as requested, other events (EVAs, PAO events, launch/landing footage, etc). DVDs are provided during or after the mission.
 - BHP escorts families to MCC viewing rooms for events such as launch, landings, EVA, etc. as requested.
- Multiple informal coffees and tagups with BHP support staff



Post-flight

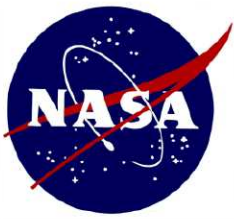
- Optional post-flight family debriefings
- Re-integration following of family as requested
 - Re-integration following of flyer is mandatory
- Assist with post-flight activities as needed
- Provide 1 copy of all in-flight uplinks (e.g. video clips, photo album, etc.) for mementoes





Backup Slides

NRC05-Family Support



FSO Tasks

- Interface includes Astronaut Office Administration, FSO, Behavioral Health and Performance (BHP), Astronaut Spouses Group (ASG), astronauts and families
- Liaison between the FSO and the ASG, the Military Liaison Office, the Flight Medicine Clinic, and the psychological support scientists; point-of-contact between families and the Astronaut Office.
- Assist astronauts and families, in particular International Space Station families, with issues related to family support.
- Develop a centralized clearinghouse of information and coordinate educational events to inform astronaut families of issues related to long-duration missions.
- Coordinate with CB and BHP to facilitate communications for separated families while training and during mission using video-teleconferences
- Assist families with crewmembers on travel with arrangements for communication or security.
- Coordinate with FSO Family Travel Coordinator and BHP to provide escort to MCC viewing area during undocked operations for ISS crew families and other families as needed.
- Assist the Astronaut Office in providing services for International Partner crewmembers and their families deployed to the US.