European Space Science Committee **Space Studies Board**

Committee on the Review of Planetary Protection Requirements for Sample Return from Phobos and Deimos

FINAL AGENDA

7-9 November, 2017

Imperial Hotel ***Bedford Room***
61-66 Russell Square ***London, WC1B 5BB***

Tuesday, 7 November

08:00 a.m.	Breakfast	*Available in the Hotel's restaurant*

CLOSED SESSION

9:00 a.m.	Welcome	Emmanouil Detsis European Science Foundation
9:05 a.m.	Introductions and Agenda Review	David Pearce Northhumbria University
9:30 a.m.	Introduction to the National Academies and Composition and Balance Discussion	David H. Smith National Academies

OPEN SESSION

10:30 a.m.	Break	
10:45 a.m.	Planetary Protection Basics, Context for Study and ESA Expectations	Gerhard Kminek European Space Agency
11:45 a.m.	NASA's Expectations for Study	Catharine Conley NASA Headquarters
12:00 a.m.	Introductory Comments from JAXA	Akihiko Yamagishi Institute for Space and Astronautical Science Japan Aerospace Exploration Agency

12:15 p.m.	Lunch	*Lunch at hotel*
1:30 p.m.	SterLimTeam Presentation	Manish Patel
	Guests	SterLim team

- *Manish Patel,*
- *Vic Pearson (Open University)*
- *David Evans (Fluid Gravity Engineering Ltd)*
- *David Summers (Thales Alenia Space).*
- *Pete Truscott (Kallisto Consultancy).*
- *Allan Bennett (Public Health England).*

Presentation Topics (5-10 mins per topic)
- Introduction to study and requirements
- Phase 1 biological models
- Heat test setup and test plan
- Heat test results and sterilisation modelling
- Impact test setup and test plan
- Impact test results and sterilisation modelling
- Impact modelling results
- Radiation test setup and test plan
- Radiation test results, re-test and sterilisation modelling
- Radiation modelling results
- Statistical modelling analysis

3:30 p.m.	Break	
3:45 p.m.	Discussion of Sterilization Limits (TN-13)	Kai Finster
4:15 p.m.	Discussion of Radiation Simulation (TN-15)	Michael Daly
4:45 p.m.	Discussion of Hypervelocity Impacts (TN-17/18)	K.T. Ramesh, Robin Putzar, Megan Bruck Syal and Akiko Nakamura
5:15 p.m.	Discussion of Biological Models (TN-21)	David Pearce
5:45 p.m.	General Discussion to Identify Areas of Consensus/Disagreement	Committee and Guests
6:30 p.m.	Adjourn for dinner	
7:30 p.m.	Working Dinner	*Hubbard & Bell* 199-206 High Holborn WC1V 7BD 020-7661-3030

9:30 p.m.	Adjourn for the Day	

Wednesday, 8 November

08:00 a.m.	Breakfast	*Available in the Hotel's restaurant*

OPEN SESSION

9:00 a.m.	General Discussion of the Committee's Task	Committee and Guests
10:15 a.m.	Break	
10:30 a.m.	General Discussion (continued)	Committee and Guests
12:30 p.m.	Lunch	*Lunch at hotel*
2:00 p.m.	General Discussion (continued)	Committee and Guests
3:30 p.m.	Break	

CLOSED SESSION

3:45 p.m.	Draft Outline for Report	David Pearce
4:00 p.m.	Comments from Committee Members (5 minutes each)	Committee members
5:00 p.m.	Discussion of Conclusions and Recommendations	Committee
5:30 p.m.	Schedule for Completion of the Report	Emmanouil Detsis and David H. Smith
5:45 p.m.	National Academies Report Review Process	David H. Smith
6:00 p.m.	Adjourn	

Thursday, 9 November – Jason Room

08:00 a.m.	Breakfast	*Available in the Hotel's restaurant*

CLOSED SESSION
REPORT DRAFTING SUBGROUP ONLY

9:00 a.m.	Discussion of Report Outline	David Pearce and Subgroup
10:15 a.m.	Break	
10:30 a.m.	Formulate Draft Conclusions and Recommendations	David Pearce and Subgroup
12:30 p.m.	Lunch	*Lunch at hotel*
2:00 p.m.	Writing Assignments	David Pearce
3:30 p.m.	Break	
3:45 p.m.	Reports from Writing Groups	Writing Groups
4:30 p.m.	Finalize Draft Conclusions and Recommendations	David Pearce and Subgroup
5:30 p.m.	Meeting Adjourns	

NOTES

Dress Code: Business casual.

Note to Presenters: If your presentation contains unpublished data, ITAR controlled and/or other sensitive information, please be aware that any and all materials presented in open session and otherwise given to the committee may be posted on a publicly accessible website. Please edit your presentations accordingly.

Note to Observers: This meeting is being held to gather information to help the committee conduct its study. This committee will examine the information and material obtained during this, and other public meetings, in an effort to inform its work. Although opinions may be stated and lively discussion may ensue, no conclusions are being drawn at this time and no recommendations will be made. In fact, the committee will deliberate thoroughly before writing its draft report. Moreover, once the draft report is written, it must go through a rigorous review by experts who are anonymous to the committee, and the committee then must respond to this review with appropriate revisions that adequately satisfy the Academy's Report Review committee and the chair of the National Academies before it is considered a report of the National Academies. Therefore, observers who draw conclusions about the committee's work based on today's discussions will be doing so prematurely. Furthermore, individual committee members often engage in discussion and questioning for the specific purpose of probing an issue and sharpening an argument. The comments of any given committee member may not necessarily reflect the position he or she may actually hold on the subject under discussion, to say nothing of that person's future position as it may evolve in the course of the project. Any inference about an individual's position regarding findings or recommendations in the final report is therefore also premature.

Remote Access to Meeting: Not available

Hotel: Blocks of rooms for the use of committee members and guests has been reserved at the Imperial Hotel. The hotel is located at 61-66 Russell Square, Bloomsbury, London WC1B 5BB; a 5-minute walk from the British Museum and 4 minutes from Russell Square Underground Station, with direct connection to Heathrow airport via the Piccadilly Line. The telephone number is +44 20 7837 3655. Additional information can be found at https://www.imperialhotels.co.uk.

Working Dinner: There will be a working dinner at Hubbard & Bell, 199-206 High Holborn, London, WC1V 7BD. The telephone number for the restaurant is 020-7661-3030. More information can be found at the following website: http://www.hubbardandbell.com/. All meeting participants can attend.

Wi-Fi Connection: To connect to the Wi-Fi chose "XXXXXXXX" then open up a browser and click "Accept terms and conditions." You will then be connected to the internet.

Committee on the Planetary Protection Requirements for Sample-Return Missions from the Martian Moons

DAVID PEARCE (Chair) is a professor of environmental microbiology in the Department of Applied Sciences at Northumbria University in the United Kingdom. The underlying theme of his research is the use of microbiology to understand polar ecosystem function and the potential for shifts in biogeochemical activity that may result from environmental change. He has worked with the British Antarctic Survey as a microbiologist, head of the Genomic Analysis Section of the Biological Sciences Division, and as an aquatic microbial ecologist. His research interests include microbial biodiversity, environmental microbiology, microbial ecology, molecular ecology, microbial physiology, environmental genomics, extremophiles, life in extreme environments, exploring and applying new technology, and the potential of unknown ecosystems. He is a member of the British Ecological Society and the International Society for Microbial Ecology. He earned his Ph.D. in microbiology from King's College, University of London. Dr. Pearce previously served on the joint National Academies-ESF Committee on the Review of MEPAG Report on Planetary Protection for Mars Special Regions.

ATHENA COUSTENIS is a director of research with the National Centre for Scientific Research of France and is currently based at Paris Observatory in Meudon. Dr. Coustenis works in the field of planetology. Her research focuses on the use of ground- and space-based observatories to study solar system bodies. Dr. Coustenis' current interests include planetary atmospheres and surfaces, with particular emphasis on the satellites of the giant planets. She is also interested in the characterization of the atmospheres of extrasolar planets. In recent years, she has been leading efforts to define and select future space missions to be undertaken by the European Space Agency (ESA) and its international partners. She is the chair of the European Science Foundation's European Space Science Committee—the nearest equivalent to the SSB in Europe. She has also chaired and served on numerous ESA and NASA advisory groups. She earned her Ph.D. in astrophysics and space techniques from the University of Paris. Dr. Coustenis previous served on the Academies' Committee on Survey of Surveys: Lessons Learned from the Decadal Survey Process.

MICHAEL J. DALY is a professor in the Department of Pathology at the Uniformed Services University in Washington, DC. He is an expert in the study of bacteria belonging to the family deinococcaceae, which are some of the most radiation-resistant organisms yet discovered. He received his Ph.D. at Queen Mary University of London. His Academies service includes membership on the Committee on Planetary Protection Standards for Icy Bodies in the Outer Solar System, Committee on Planetary Protection Requirements for Venus Missions, Committee on the Origins and Evolution of Life, Committee on the Astrophysical Context of Life, and Task Group on the Forward Contamination of Europa.

ABIGAIL A. FRAEMAN is a research scientist in the planetary science section at the Jet Propulsion Laboratory. Dr. Fraeman specializes in the use of infrared spectroscopy to study the surfaces of Mars, Pbobos and Deimos. She is currently a participating scientist on the Mars Science Laboratory Curiosity rover, a co-investigator on the Compact Reconnaissance Imaging Spectrometer for Mars instrument on the Mars Reconnaissance Orbiter, and deputy project

scientist for the Mars Exploration Rovers. Dr. Fraeman received her Ph.D. in Earth and planetary science from Washington University in St. Louis and her B.S. in physics and geology and geophysics from Yale University. She was selected as a participant in the CAS-NAS Forum for New Leaders in Space Science in 2015, but has not previously served on an Academies committee.

GUY LIBOUREL is a professor at the Observatoire de la Côte d'Azur in Nice, France. Prior to this he was at the Centre de Recherches Pétrographiques et Géochimiques in Nancy and is an affiliated professor at the Hawaii Institute of Geophysics and Planetology at the University of Hawaii, Honolulu. He is an experimental cosmochemist whose research focusses on understanding the formation of the first solid in the solar system using high temperature experimental approaches. His current research is centered on thermal and mechanical properties of the regolith on small solar system bodies. He is a co-investigator on NASA's OSIRIS-Rex and JAXA's Hayabusa 2 asteroid sample-return missions. He is also the OSIRIS-REx coordinating scientist for sample analysis for mission sample science in Europe. Dr. Libourel obtained his Ph.D. at the Université Paul Sabatier de Toulouse. He has not previously participated on an Academies' committee.

AKIKO M. NAKAMURA is an associate professor in the Center for Planetary Science at Kobe University where she performs laboratory impact experiments to study the velocity distribution of fragments from ejecta and the ejecta from particulate layers. These experiments are designed to provide insights into the collisional evolution of small solar system bodies and regolith formation processes. She was a co-investigator on the camera system on the Japan Aerospace Exploration Agency's Hayabusa I asteroid sample-return mission. Dr. Nakamura completed her B.S. in 1988, her M.S., and her Ph.D. in 1993, all at Kyoto University.

ROBIN PUTZAR is a senior scientist in the Space Technology Group at the Fraunhofer Institute for High-Speed Dynamics (also known as the Ernst-Mach Institute (EMI)) in Freiburg, Germany. Dr. Putzar has led several large studies investigating the effects of hypervelocity impacts on spacecraft components and geological material, including ballistic limit analyses. His research interests include hypervelocity accelerators, and he has led the design of such accelerators at EMI. He was delegate at the Inter-Agency Space Debris Coordination Committee and served on the Program Committee of the European Conference on Space Debris. He is currently chairman of the Aeroballistic Range Association. He has a diploma degree in engineering sciences from Technical University of Berlin. He has not previously served on an Academies committee.

KALIAT T. RAMESH is a professor in the Department of Mechanical Engineering at Johns Hopkins University. He is also director of the Center for Advanced Metallic and Ceramic Systems, and director of the Hopkins Extreme Materials Institute. His research interests are in high strain-rate behavior and dynamic failure of materials, nanostructured materials, injury biomechanics and planetary-scale impact problems. He served as a visiting professor at the University of Cambridge. He has published one book, Nanomaterials: Mechanics and Mechanisms; Springer, 2009. After receiving a B.E. from Bangalore University, he continued to Brown University where he completed his M.S. in engineering. He was awarded his Ph.D. and an additional M.S. in applied mathematics from Brown University. Dr. Ramesh completed a

postdoctoral fellowship with the Center of Excellence in Advanced Materials at the University of California, San Diego Dr. Ramesh previously served on the NRC Committee on Opportunities in Protection Materials Science and Technology for Future Army Applications.

NORMAN H. SLEEP (NAS) is a professor of geophysics in the School of Earth, Energy, and Environmental Sciences at Stanford University. Dr. Sleep's research interests include studying convection at the base of the lithosphere and the interaction of the lithosphere with mantle plume material. He is also currently investigating the microphysics of friction and applying the results to nonlinear attenuation and ground damage by strong seismic waves. Dr. Sleep is a fellow of the American Association for the Advancement of Sciences, the Geological Society of America, and the American Geophysical Union. He has received a number of awards for his work including the James B. Macelwane award, the George P. Woollard Award from the Geological Society of America, and the 2008 Wollaston Medal from the Geological Society of London. Dr. Sleep earned a B.S. in mathematics from Michigan State University and a M.S. and Ph.D. in geophysics from the Massachusetts Institute of Technology. He has previously served on the National Academies' Committee on Astrobiology and Planetary Science, the Committee on Survey of Surveys: Lessons Learned from the Decadal Survey Process, the Committee on Earth Resources, the Committee on Planetary Biology and Chemical Evolution, and currently serves as the NAS Section 15 liaison.

MEGAN BRUCK SYAL is a physicist in the Design Physics Division at Lawrence Livermore National Laboratory (LLNL). Dr. Bruck Syal specializes in experimental and numerical simulation of planetary impacts, including hypervelocity impact experiments (with an emphasis on porous and volatile-rich materials) and modeling of impact events in a variety of shock physics codes. Her published and ongoing research includes: impact delivery of carbon and volatiles to Mercury and the Moon, the excavation of Stickney Crater at Phobos, analysis of impactor- and target-derived vapor plumes using high-speed emission spectroscopy, and giant-impact formation of moons in exoplanetary systems. Additionally, Dr. Bruck Syal is very active in the field of planetary defense, supporting: NASA's DART mission with simulations of the planned 2022 spacecraft impact at Didymos B, NASA-FEMA Asteroid Impact Tabletop Exercises, and a NASA-NNSA interagency collaboration on hazardous asteroid mitigation case studies. Her planetary defense work focuses on numerical simulation of deflection and disruption techniques, with a particular emphasis on understanding sensitivities to asteroid initial conditions. Previously, Dr. Bruck Syal was a postdoctoral researcher at LLNL (2014-2016), a Ph.D. candidate in the Geosciences Department at Brown University (2009-2014), and a data specialist at the Smithsonian Astrophysical Observatory's Chandra X-ray Center (2007-2009). She is a recipient of a NASA Earth and Space Science Fellowship, a NASA Group Achievement Award (Deep Impact - EPOXI mission Science Team), and a Brown University Graduate Fellowship. Dr. Syal obtained her Ph.D. in planetary geosciences at Brown University. She has not previously served on an Academies' committee.

Consultant to Committee

KAI FINSTER is a professor at Aarhus University (AU) in Denmark in the Department of Biosciences. He has close to 100 peer-reviewed publications, and has research expertise in

microbial processes in extreme environments which include the search for life on Mars. He works in transdisciplinary fields involving chemistry, physics, geosciences, atmospheric sciences and astronomy. His interdisciplinary Mars research group, has published a comprehensive Mars simulation study and has discovered the role of wind-driven erosion. Saltation-mediated abrasion is a possible quantitatively important but overlooked source of Martian soil reactivity, which could affect the composition of the Martian atmosphere and the persistence of organic matter, including the survival of microorganism, in Martian surface material. In addition, he was involved in designing and building a Mars simulation chamber for microbiological experiments. The chamber was also used to investigate the properties of equipment and material that was sent to Mars with the Phoenix mission in 2008. Since 2012, he has been the head of the astrobiology knot within the Stellar Astrophysics Center at the Department of Physics and Astronomy (AU) that is financed by the Danish Science Foundation. In this function, he has been involved in experimentally and theoretically exploring ways of identifying the presence of life on exoplanets by focusing on exoplanet atmospheres. This integrates also is involvement in determining the role of microbes in atmospheric processes. To strengthen this part of his research, he has initiated a close collaboration with the atmospheric chemistry group headed by Merete Bilde at the chemistry department and by collaborating with other members of transdisciplinary "Atmospherica-network" at AU. As well, his research activities on bacteria in extreme environments have attracted many master and Ph.D. students. Thus, he has successfully supervised about 50 Master-, ten Ph.D. students and two postdocs. Dr. Finster earned his Ph.D. for microbiology from Aarhus University. He has not previously served on an Academies' committee.

Other Meeting Participants

Catharine Conley, Planetary Protection Officer, NASA Headquarters
Andrew Spry, Planetary Protection Office, NASA Headquarters
Gerhard Kminek, Planetary Protection Office, ESA ESTEC
Akihiko Yamagishi, Adjunct Professor, ISAS, JAXA
Manish Patel, Senior Lecturer, The Open University
David H. Smith, Senior Staff Officer, Space Studies Board, National Academies
Emmanouil Detsis, Science Officer, ESSC, ESF
David Evans, Fluid Gravity Engineering Ltd)
David Summers, Thales Alenia Space
Pete Truscott, Kallisto Consultancy
Allan Bennett, Public Health England
Vic Pearson, Open University