Legal Protections for the Health of Astronauts: an Analysis

by

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Abstract

The fundamental objective of this thesis is to combine and assess the legal ramifications of the fact that *i)* space agencies are beginning to prepare for manned space exploration missions which go deeper into space and which are of long-term duration, and *ii)* the crew members of space exploration vessels, be they shuttles or stations, experience adverse effects to both their physical and mental health which increase by virtue of the duration and the purpose of their assigned mission. By focusing on defined physical health issues resulting from the human body's exposure to higher radiation levels and microgravity and concerns relating to the human mind's adaptation to the severely isolated and high-stress environment, this thesis investigates how such health issues have been addressed by the applicable norms of International law, national law, and inter-agency agreements, for the purpose of settling the debate as to whether as *envoys of mankind* spacecraft personnel enjoy sufficient health protection under current legislation.

The thesis arrives at two key conclusions. Firstly, current policies and standards do indeed offer significant health related protection in response to both the physical and mental dangers posed by space travel. However, these are only operate at national level, as demonstrated by the American and Russian examples examined here. Secondly, in order to ensure adequate protective health measures on the international level, a new health-oriented norm must be drafted and widely distributed within the space exploration community, so that it can be included as a general and fundamental principle in future agency and partner negotiations and bilateral agreements, such as the newly proposed U.S. led Artemis Accords and similar multinational space exploration projects involving manned space exploration.

Résumé

L’objectif fondamental de cette thèse et de combiner et d’analyser les conséquences juridiques des deux faits suivants : *i)* que les agences spatiales commencent à préparer des missions spatiales habitées allant plus loin dans l’espace et ce pour une longue durée et *ii)* que les membres de l’équipage des vaisseaux spatiaux, qu’il s’agisse de navettes ou de stations, subissent des effets néfastes à la santé physique et mentale, qui augmentent en vertu de la durée et de l’objectif de la mission que leur a été désignée. En se concentrant sur des répercussions physiques déterminées résultant de l’exposition du corps humain à des niveaux élevés de radiation et de microgravité, ainsi que sur les préoccupations liées à l’adaptation de l’esprit humain à cet environnement fortement isolé et stressant, la présente thèse vise à étudier comment ces enjeux sanitaires ont été abordés par les règles applicables du droit international et national et par les accords interinstitutionnels pour mettre fin au débat autour de la suffisance en l’état du droit actuel des protections de la santé qui sont offertes aux membres des équipages spatiaux, en tant que des « envoyés de l'humanité dans l'espace ».

Cette thèse arrive à deux conclusions principales. Premièrement, il existe bien des politiques et des standards actuels qui offrent d’importantes mesures de protection en réponse aux dangers physiques et mentales liés aux voyages dans l’espace. Cependant, ces mesures protectrices ne sont applicables qu’au niveau national. Il en va notamment ainsi aux États-Unis et en Russie, comme le montrent les exemples considérés ici. Deuxièmement, afin d’assurer des mesures de protection sanitaire adéquates au niveau international, il sera nécessaire d’élaborer et de diffuser, au sein de la communauté des explorations spatiales, un nouveau règle orienté sur la santé, qui puisse être inclus comme principe général et fondamental au cours de futures négociations entre institutions et partenaires, ainsi que ceux qui traitent des nouvelles

conventions bilatérales, telle que les « accords Artemis » nouvellement proposés par les États-Unis, ou tout autre projet impliquant une exploration habitée de l'espace.

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Though many have helped me reach this moment where I am doing the final editing of this thesis, it all started with the support of my family. It is therefore only right that they should be the ones mentioned first. I wish to thank my parents, both individually and as a duo, for having always instilled me with ambition and curiosity. I also wish to thank them for encouraging me to go to Montreal and pursue this odd dream, despite the circumstances. My sister also had a part in this, and I thank her specifically for everything she has carried at home while I have been away.

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1. Introduction

Space exploration, its wonders as well as its dangers, has been in a shared political, scientific, and cultural spotlight since it was first actualized with the Soviet launch of the Sputnik 1 satellite in 1957, and, presumably, the human mind started to ponder those wonders earlier still. In recent years, the film industry has contributed highly to the space-hype by turning out films such as Gravity (2013), Interstellar (2014), and The Martian (2015). These three films all explore the topics of not only the immediate physical danger of being a human in space, but also such topics as isolation, high levels of self- and group reliance, and the psychological ramifications of life in an environment where human existence is all but easy. The films thus touch on issues that are surely interesting as hypotheticals, but also vital to past, present, and future manned space exploration. An indication of the trying nature of the social and living environment of a space explorer is found in the journals of the Soviet cosmonaut, Valery Ryumin, whom, over the span of his career spent a total of 360 days aboard space vehicles and the Salyut-6 space station[1], at some point wrote;

> *"All the conditions necessary for murder are met if you shut two men in a cabin measuring 18 feet by 20 and leave them together for 2 months."*[2]

In 2020, the International Space Station (ISS) celebrated its 20th year anniversary as an operational and permanently manned station. In a historical perspective, the ISS can be pictured as the crowning achievement that rests on top of decades of preceding national and international space exploration. With the launch of Sputnik 1, the Soviet Union launched a space race

[1] NASA Headquarters History Office, "History's Highest Stage" (Accessed 15 June 2020, last visit 4 August 2020) Online: *History of Shuttle-MIR CD-ROM* < https://history.nasa.gov/SP-4225/hhs/hhs.htm#ryumin >

[2] NASA Technical Memorandum, Jack Stuster (July 2010), "Behavioral Issues Associated with Long-Duration Space Expeditions: Review and Analysis of Astronaut Journals – Experiment 01-E104 (Journals): Final Report" at 21.

that still exists today, and which, in its course so far, has resulted in 11 successfully launched and at times manned space stations, including the ISS.[3] However, the ISS is the only station that remains operational, though future stations are also in scope.[4] As States and space agencies have begun to eye future stations and purposes with their space programs, the interest in and intended use of the ISS has started to dwindle. With the U.S., as the leading force and authority of the ISS project, planning a change in its operation of the ISS from 2024 and onwards[5], shifting to a more commercial focus for that station[6], whilst pursuing the lunar focused 'Artemis Program', the missions of American spacecraft personnel aboard the ISS have also changed, with such crewmembers as Scott Kelly, Andrew Morgan and Christina Koch all undertaking missions of extended duration to contribute to research on the human body's reaction and adaptation to the space environment, to be used in the planning of future long-term exploration missions.[7] As such, the future of manned space exploration will be going deeper into space and for longer periods of time.

The plans to start leaving the ISS behind for commercial use and launch State-level space exploration beyond the low Earth orbit("LEO") will cause renewed legal discussions. The outer space treaties of the UN will still prevail, but the detailed multilateral framework created by the parties to the ISS project will not apply to future space stations, leaving behind the cooper-

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[3] David M. Harlan, "Space station" (02 April 2020) Online: *Encyclopædia Britannica* <https://www.britannica.com/technology/space-station>

[4] Both the U.S. and Russia are looking to the Moon. NASA is planning the Lunar Gateway station, Russia has proposed a lunar orbital station. See Kelli Mars, "More About Gateway" (26 June 2020) Online: *NASA* <https://www.nasa.gov/johnson/exploration/gateway>; Anatoly Zak, "Lunar orbital station, LOS" (22 January 2020) Online: *Russian Space Web* < http://www.russianspaceweb.com/los.html>.

[5] See Jessica Nimon, "Space Station 2024 Extension Expands Economic and Research Horizons" (27 January, 2014) Online: *NASA* <https://www.nasa.gov/mission_pages/station/research/news/2024extension/>. There has as of yet been no post-2024 extension.

[6] Stephanie Schierholz & Gary Jordan, "NASA Opens International Space Station to New Commercial Opportunities, Private Astronauts" (7 June 2019) Online: *NASA* <https://www.nasa.gov/press-release/nasa-opens-international-space-station-to-new-commercial-opportunities-private>

[7] Jason Perez, "Extended Stays in Space I About" (15 April 2020) Online: *NASA* <https://www.nasa.gov/1ym/about>

ation and legal stability that have ruled both national and international space exploration so far. At the forefront of the many issues that the current development trickles down into is the concern for crew health. ISS crew members are already experiencing longer missions, accumulating high numbers of days spent in space, both consecutively in one mission and over several missions. It is therefore crucial to establish which rights of health and wellbeing that crewmembers have so that any potential legal loopholes that may occur for future space exploration can be identified and a path for their mending be suggested. This thesis will undertake this task, based on the following problématique:

Acknowledging that astronauts are the envoys of mankind, to what extent is the present international legal framework for astronauts able to regulate and ensure the protection of their mental health?

Answering this question will require other questions to be addressed first. Starting with a literature review on the topic of crewmember health, a discussion and practical definition of "astronaut" will follow, before a substantial review of some of the most pressing health concerns helps identify in part what issues to focus on and what countermeasures should be contained under any health rights. Then, upon having also identified the applicable legislation to be reviewed, the examination of the individual legal sources will cover international legislation, the ISS framework, and two examples of national legislation, comparing their contents to the health issues and necessary countermeasures pinpointed earlier in the thesis. Before culminating in the concluding section, a discussion of both the status quo of health rights found and of the most appropriate paths forward will tie a knot on the main question posed above.

2. Making the case for international legal action – a literature review

When considering a potential international legal framework for the protection of the health of astronauts, an immediate question must be why should there be an *international legal* framework? For astronauts, or *personnel of spacecraft*, as has been the proper term since the entry into force of the 1968 Rescue and Return Agreement, are in fact employees of their respective space agencies. As such, any health protection rights had by any spacecraft personnel comes down to any international regulation on the matter and eventually the employment contract and the national law applicable to said contract. As to the protection of physiological health on an international level, the development of a concise legal field on global health law is relatively new and thus struggles with balancing its international scope between the power attributed to it through international agreements and, in opposition hereto, the sovereignty of States and their interest in preserving their sovereign right to regulate health matters for their populations.[8] From a legal perspective, the push for global health law has been led mainly by the U.N. specialised agencies, like the International Labour Organization (ILO), which pursues an occupational focus, and the World Health Organization (WHO). As an example, the WHO made an attempt at aligning national legislation on the matter of mental health protection in 2005 in their "Mental Health Policies and Programmes in the Workplace" publication.[9] However, many countries have not taken further actions to legislate on the matter or to create national standard policies of an internationally unifying nature, and thus leaving in their wake a thoroughly fragmented legal backdrop for the protection of the health of "spacecraft personnel", as individual humans, as citizens and as workers.

[8] See Lawrence O. Gostin & Allyn L. Taylor, "Global Health Law: A Definition and Grand Challenges" (2008) 1:1 Public Health Ethics 53 at 53 and 55, where the definition of global health law draws upon art. 12(1) of the International Covenant on Economic, Social and Cultural Rights. For more see section 5.1 of this thesis.
[9] Available at https://www.who.int/mental_health/policy/services/essentialpackage1v13/en/

Bearing the non-uniform approach to health regulation in mind, consider this: Humans have been a space fairing species since 1961 when Jurij Aleksejevitj Gagarin became the first person to fly in space. Gagarin managed one orbit of the Earth in 108 minutes. In comparison, the current record for most consecutive days spent in space was set by Cosmonaut Valery Polyakov in 1995 and spans over almost 438 days.[10] While Gagarin has become the more iconic character of these two cosmonauts, it has been the missions and experiences of Polyakov and his like that have sparked multi-field research in physical and mental health and space exploration. Space agencies have been undertaking such research for some time, as noted by Arnauld E. Nicogossian et al. in the 2016 book "*Space Physiology and Medicine*"[11] and Gabriel G. De La Torre et al. in the 2012 article "*Future perspectives on space psychology: Recommendations on psychosocial and neurobehavioral aspects of human spaceflight*"[12].

Whilst Nicogossian et al. describe the physiological risks of space flight in great detail, including high risks to bone- and muscle capacity, De La Torre and his fellow authors discuss the results of the Mars105 pilot study, which was part of the Mars500 study run by the European Space Agency (ESA), Russia and China from 2007 to 2011.[13] Preliminary studies of the Mars105 simulation found that long-term isolation could cause an increase in feelings of loneliness and abandonment, which in turn would have negative effects on the cognitive performance of the study participants.[14]

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[10] Mike Wall, "The Most Extreme Human Spaceflight Records" (23 April 2019), online: *Space.com* <https://www.space.com/11337-human-spaceflight-records-50th-anniversary.html>

[11] Arnauld E. Nicogossian, Richard S. Williams, Carolyn L. Huntoon, Charles R. Doarn, James D. Polk, Victor S. Schneider, ed, "*Space Physiology and Medicine*" 4th edition (New York, Springer, 2016) at 8-23 and 23-31.

[12] Gabriel G. De La Torre, Berna van Baarsen, Fabio Ferlazzo, Nick Kanas, Karine Weiss, Stefan Schneider, Iya Whiteley, "Future perspectives on space psychology: Recommendations on psychosocial and neurobehavioral aspects of human spaceflight" (2012), 81 Acta Astronautica 587, at 595

[13] For more information see The European Space Agency, "Mission Accomplished: 105-day Mars mission simulation ends in Moscow" (14 July 2009), online: *United Space in Europe* <http://www.esa.int/Space_in_Member_States/United_Kingdom/Mission_accomplished_105-day_Mars_mission_simulation_ends_in_Moscow>

[14] *Supra* note 12, at 590

The Mars105 findings, despite being the findings of a simulated space mission experience, have been backed by studies carried out by the National Aeronautics and Space Administration (NASA). In 2010 NASA published the final findings of a psychological study of actual astronaut logbooks and journals wherein personnel aboard the ISS had documented their daily tasks as well as their well-being and changes therein. The logs detailed experiences of sleep deprivation and of trivial issues being exaggerated.[15] Later studies focused on countermeasures to such negative psychological effects and also added feelings of social isolation, sensory deprivation and stress to the list of psychological effects of long-term space travel.[16]

Legal academics have abstained from attempting to criticize the findings of physiological and psychological health researchers, as is appropriate in respect of the different academic fields, and have instead used such research as a basis for promoting the idea of legal intervention. As early as the 1970's lawyers pointed out the need for specified legal attention to the human factors of space exploration and use. See for instance H. Gerald Staub's article "*1975: A Space Odyssey*" from 1974.[17] Staub speaks specifically on the U.S. and USSR relationship, as those were the major spacefaring nations during that period, but his comments reflect a need for a general international effort in order to create an adequate legal framework for extended space flight. Since the adoption of the last UN space treaty in 1979 direct legal regulation within space law, outside of the field of telecommunications which is consistently worked at through the activities of the International Telecommunication Union, has dwindled, perhaps in connection with the decrease in societal popularity of space activities and as a result so has the financial interest in carrying out these activities. However, with the technological evolution over the

[15] *Supra* note 2 at 32, 52 and 57.
[16] NASA Technical Memorandum, Katharine Rigway O'Brien Bachman, Christian Otto, Lauren Leveton, (August 2012), "Countermeasures to Mitigate the Negative Impact of Sensory Deprivation and Social Isolation in Long-Duration Space Flight" at 1-4.
[17] H. Gerald Staub, "1975: A Space Odyssey" (1974) 8:1 Intl Lawyer 41 at 51-52

last few decades space has again become a place of interest for states, and lawyers have continued to try and spark the drafting of an international regulation of human-related issues with space flight.

An example of the continued focus on health issues is Gabriella Catalano Sgrosso. In her paper "*Legal Status, Rights and Obligations of the Crew in Space*" from 1998, Sgrosso reminds the reader of the dangers that space travel presents to the health of astronauts and offers the slight, and compared to her inclusion of the right to health as recognized under the Universal Declaration of Human Rights, art. 25, almost ironic relief that the Code of Conduct of the International Space Station allows astronauts to bring "small personal objects" on board the spacecraft.[18] More recently, Francis Lyall and Paul B. Larsen have discussed, in 2018, the particular problems of long-range and long-duration space missions and noted the possibility of personnel "*illness caused by psycho-social pressures or inherent personality instabilities that lead to diminished competence or reliability*". Lyall and Larsen call for the drafting of provisions to regulate situations where personnel have been aggravated to the point of mental instability due to the extreme environment of a spacecraft or a base on a celestial body, as well as regulation ensuring the physical safety of crewmembers against the hazardous space environment.[19]

The literature thus far has proven two facts: Firstly, that negative physiological and psychological effects resulting from long-term space missions are being widely recognized. Secondly, that international lawyers are attempting to push the idea of legislating ex ante on health issues that may arise in the undertaking of manned space activities. Yet, another finding emerges

[18] Gabriella Catalano Sgrosso, "Legal Status, Rights and Obligations of the Crew in Space" (1998) 26:2 J Space L 163 at 173
[19] Francis Lyall, Paul B. Larsen, "*Space Law: A Treatise*", 2nd edition (Oxford, Routledge, 2018) at 127 and 130

when the well-meaning but generic statements of the legal academics are examined more closely. The referenced legal scholars all agree on the importance of a legal instrument addressing astronaut's health but none of them propose either a full or partial set of rules. Neither do they go into specifics on what areas should be included in potential drafts. In this way, the space law community at large has succeeded at "talking the talk" but not at "walking the walk".

Excuses can be made. From its beginning, space law has focused mainly on establishing a framework for traditional "earth-oriented" law, dealing with more common regulation issues concerning communication satellites, national and private space entities, different kinds of liability, intellectual property rights and similar management-like fields of law. Regulation of the more humanitarian aspects of space activities has taken the backseat and been described as "*exotic, futuristic, and undisciplined*."[20]

One lawyer in particular, Dr. George S. Robinson, has contributed to the discussion on legal and societal space issues by consistently offering draft suggestions for space civilization treaties, from as early as 1984 in his article "*Astronauts and a Unique Jurisprudence: A Treaty for Spacekind*"[21] and as late as 2006 with the article "Transcending to a Space Civilization: The Next Three Steps toward a Defining Constitution"[22]. Robinson, however, focused much of his attention on the argument of pushing for a new space civilization treaty on the basis of biological and technical differences in "space inhabitants", or *spacekind*, and earth inhabitants, *earthkind*. While your present scholar considers this a worthwhile discussion and praises the work

[20] George S. Robinson, "Astronauts and a Unique Jurisprudence: A Treaty for Spacekind" (1984) 7:3 Hastings Intl & Comp L Rev 483 at 483
[21] *Ibid*.
[22] George S. Robinson, "Transcending to a Space Civilization: The Next Three Steps toward a Defining Constitution" (2006) 32:1 J Space L 147

of Dr. Robinson, she remains of the opinion that attention should more appropriately be turned to the humans in space at this current point in time.

With the NASA Authorization Act of 2010 the goal was set to put a human on Mars sometime during the 2030s.[23] Using the currently available technology this trip would take 200 to 300 days[24] - an accumulated 400 to 600 days spent on travel with yet more days to be added should the expedition be of any other type than a flyby expedition. Needless to say, if astronauts on expeditions of about 180 days duration experience the proven negative physiological and psychological effects listed earlier in this literature review, then astronauts on expeditions with twice that duration will experience them too and the effects may be stronger.

This means that time is running out for the international space law community to piece together the necessary regulations that have been attempted for the past fifty years. And while the law itself cannot prevent detrimental effects to the health of spacecraft personnel, the research on countermeasures necessary to inspire and create a preventive legal framework for the protection of the health of such personnel does exist. On the basis of identification of these countermeasures and an analysis of the best regulatory approach from a legal perspective, including an evaluation of the state of the current "personnel" and International Space Station-related legal instruments, this thesis will conclude with a discussion on the best future approach and suggest concrete draft provisions for an international regulatory toolset. Thus, the thesis aspires to provide for a more specified course of action in continuing the work on the protection of health of spacecraft personnel.

[23] National Aeronautics and Space Administration, "NASA's Journey to Mars" (7 August 2017), online: *Moon to Mars* <https://www.nasa.gov/content/nasas-journey-to-mars>
[24] Dietrich Manzey, "Human missions to Mars: New Psychological Challenges and Research Issues" (2004), 55 Acta Astronautica 781 at 782: Nola Taylor Redd, "How Long Does it Take to Get to Mars?" (14 November 2017), online: *NASA* <https://www.nasa.gov/content/nasas-journey-to-mars>

3. What do astronauts, cosmonauts and taikonauts have in common?

Within international space law, the notion of astronauts have been present since the adoption in 1963 of the resolution Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space. The ninth and final principle declares that astronauts shall be regarded, by States, as "*envoys of mankind in outer space*". States shall also provide to astronauts "*all possible assistance in the event of accident, distress, or emergency landing on the territory of a foreign State or on the high seas*". In addition, when astronauts make such landing, they shall be "*safely and promptly returned to the State of registry of their space vehicle*". While the Declaration is a resolution and holds no legally binding effect on its parties, it is evident that its contents set the tone for later developments in space law.

3.1 The withering of a term

There are five UN space treaties in existence.[25] Compared to the 1967 Outer Space Treaty, the principles contained in the Declaration make out a clear and solid foundation for the space law framework and illustrated the most crucial international space-related concerns at the time. It is, however, worth noting that the term "astronaut" has no definition. However, out of the five treaties, only the 1967 Outer Space Treaty, the 1968 Rescue and Return Agreement, and the 1979 Moon Agreement contain provisions relating to astronauts. The 1968 Rescue and

[25] *Agreement governing the Activities of States on the Moon and Other Celestial Bodies,* 5 December 1979, 1363 UNTS 3 (entered into force 11 July 1984) *[The 1979 Moon Agreement]: Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched Into Outer Space*, 22 April 1968, 672 UNTS 119, (entered into force 3 December 1968) [*The 1968 Rescue and Return Agreement*]*: Convention on International Liability for Damage Caused by Space Objects,* 29 March 1972, 961 UNTS 187 *(*entered into force 1 September 1972*) [The 1972 Liability Convention]: Convention on Registration of Objects Launched into Outer Space*, 6 June 1975, 1023 UNTS 15 (entered into force 15 September 1976) [*The 1975 Registration Convention*] *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*, 27 January 1967, 610 UNTS 205 (entered into force 10 October 1967) [*The 1967 Outer Space Treaty*]

Return Agreement contains an interesting contradiction. Per its name it focuses on the rescue and return of "astronauts" but other than in the first paragraph of its preamble the Agreement does not mention the word "astronaut" once. The provisions of the Agreement instead refer to "*the personnel of a spacecraft*", which in the academic literature has been theorized as including both pilots and scientific mission specialists alike[26], and while the Agreement continues to provide obligations for the States party to it, these obligations focus primarily on obligations in relation to the "personnel" and to a space object.[27] It refrains from offering further identification of "personnel". The 1979 Moon Agreement, to the extent it is applicable[28], adds the protection of personnel from the use of force or threatened use of force in its art. 3.2, but returns to the "astronaut" term and sets the scope of "astronaut" within art. V of the 1967 Outer Space Treaty to include "*any person on the Moon*" as well as regarding "any person on the Moon" as "*part of the personnel of a spacecraft*", per the Agreement's art. 10.1. This means that for more than 10 years, the only mention of "astronauts" were in the preambles of the 1972 Liability Convention and the 1975 Registration Convention. Furthermore, this silence happened during a very active period of manned space exploration, including the final half of the U.S.A.'s iconic Apollo program and the early stages of the Soviet, now Russian, Soyuz program.

The de-escalation of the term "astronaut" to first "personnel", then to a long period of non-mention, followed by an inconsequent return to "astronaut" and "personnel" in the 1979 Moon Agreement collectively becomes proof of a term that has become very thin, not from being

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[26] Stephen Gorove, "Legal Problems of the Rescue and Return of Astronauts" (1969) 3 Int. Lawyer 898 at 898-899.
[27] *Supra* note 19 at 123.
[28] The 1979 Moon Agreement has entered into force but has only 18 parties and 11 signatories, of which only a few are active space fairing nations within manned space missions. See The United Nations Treaty Collection, " Agreement governing the Activities of States on the Moon and Other Celestial Bodies" (Accessed 12 May 2020, last visit 3 August 2020) Online: *United Nations Treaty Collection Depositary* <https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXIV-2&chapter=24&clang=_en>

spread out in its coverage, but from its abandon in international legislation. The thinning of the term “astronauts” is also illustrated by the different terms that different States use. The term in itself is a Western one, with the Russian equivalent being “cosmonaut”, and the Chinese use “taikonaut”.[29] The different words suggest that there is also a strong political aspect to the definition issue. Especially in the 1960’s and 70’s, for the West to have accepted a Soviet term, or for the Soviet Union to have had no objections to using a Western term will have been unlikely. The space race and the “personnel” as participants in it were political means as well as scientific ones.[30] As a result, for the purpose of this thesis, the term used shall be “spacecraft personnel” and it shall include all such personnel which has been appointed, trained and sent out as an employee of a space agency and exclude any persons that are not and have not been subject to such appointment, training and employment.

3.2 “Envoys of mankind” as a unifier

One over-all shared trait between spacecraft personnel of a State party to the 1967 Outer Space Treaty, be they entitled astronauts, cosmonauts or taikonauts, is that they are all given rights under the Treaty and the 1968 Rescue and Return Agreement.[31] The rights, as outlined in the earlier section 3.1, revolve around a common theme of protection or safety. This is evident from the contents of the 1967 Outer Space Treaty art. V. The article states as the first matter that astronauts are “*the envoys of mankind*” before proceeding with the rights of having

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[29] *Supra* note 19 at 117.

[30] S.G. Sreejith describes how astronauts and cosmonauts were originally used for political purposes, both nationally and internationally, and became cultural ”heroes” to serve national interests before the reality of the personnel and their tasks required that law-makers reconsidered the appropriateness of the “astronaut” term. See S.G. Sreejith, “The Fallen Envoy: The Rise and Fall of Astronaut in International Space Law”, (2019) 47 Space Policy 130 at 130-131.

[31] The U.S., the Russian Federation and the People’s Republic of China are all parties to both the 1967 Outer Space Treaty and the 1968 Rescue and Return Agreement.

aid provided when required and, following emergency landing in foreign territory, their return to the state of registry of their vehicle. By having placed the envoy-phrase first in the sentence, and not having changed it from when it was first put forward in the 1963 Declaration, it must be regarded as having had some significance during the negotiations of the 1967 Treaty's drafting.[32] The 1968 Rescue and Return Agreement sets out to "*develop and give further concrete expression to*" the duties contained in the 1967 Outer Space Treaty[33] and the fact that the Agreement doesn't contain the "envoys of mankind" wording cannot be read as the Agreement intending to derogate from that notion. It must therefore still be considered of importance and not as an empty statement.[34] It could thus be suggested that the provision of the 1967 Outer Space Treaty should be read as saying that astronauts, in their capacity as envoys of mankind, are given the rights described. In this sense, the protection of the "envoys" is owed to them, by States, due to their function and the purpose of that function.

What, then, is the function of envoys? The term itself is elusive. The Encyclopaedic Dictionary of International Law[35] contains no definition and the Oxford Public International Law ("OPIL") portal only has a page dedicated to special envoys, in which the second paragraph

[32] The initial U.S.S.R draft treaty for the 1967 Outer Space Treaty included the wording "*States Parties to the Treaty shall regard astronauts as envoys of mankind in outer space(…)".* See UNCOPUOS correspondence, 21st session, "LETTER DATED 16 JUNE 1966 FROM THE PERMANENT REPRESENTATIVE OF THE UNION OF SOVIET SOCIALIST REPUBLICS TO THE UNITED NATIONS ADDRESSED TO THE SECRETARY-GENERAL", UN Doc A/6352 (1966) at 4. Using or, at least, building upon the wording of the 1963 Declaration had been part of negotiations of the Treaty and the simultaneous negotiations of the 1968 Rescue and Return Agreement since 1964. See UNCOPUOSOR, 3rd session, UN Doc A/AC.105/C.2/SR.29-37 (1964) at 13 and 31-34 where the Australian representative points out the connection to the Declaration, and both the U.S. and U.S.S.R representatives remark that there are humanitarian concerns connected with providing assistance to spacecraft personnel.
[33] *Supra* note 25, See the Preamble to the 1968 Rescue and Return Agreement.
[34] See *supra* note 30 at 131 and paraphrasing at 133 Nina-Louisa Remuss, "Astronauts: From Envoys of Mankind to Combatants", in Ulrike Landfester et al., ed, "*Humans in Outer Space: Interdisciplinary Perspectives"* 1st Edition (Mörlenbach, Springer, 2011) at 50-51. Both Sreejith and Remuss discuss the "envoys of mankind" phrase as having only a non-pragmatic, metaphysical form as well as an unfathomable and abstract foundation. See also *supra* note 32, UN Doc A/AC.105/C.2/SR.29-37.
[35] John P. Grant & J. Craig Barker, ed, "*Encyclopaedic Dictionary of International Law"* 3rd Edition (Oxford, Oxford University Press, 2009)

states that there is no generally accepted definition of special envoys, which is why the term is used inconsistently.[36] Stepping outside of international law dictionaries and portals, the Cambridge Dictionary defines envoys as "*someone who is sent as a representative from one government or organization to another*".[37] The latter definition is very broad but indicates that the envoy has a diplomatic purpose. The OPIL definition, though it notes the inconsistent use of "special envoy", defines such as "*an individual who (...) represents an international organisation or a State on the basis of a temporary mandate".*

It is difficult to fit the "envoys of mankind" into these definitions. Firstly, they are not sent as representatives of a state but of mankind as a whole. Secondly, they are not tasked with diplomatic affairs such as conflict resolution or international negotiation.[38] And thirdly, they are not sent to another State or organisation but into outer space. As such, it is more befitting to consider the "*envoys of mankind*" phrase as signifying the sending of selected (mandated) humans into the outer space environment to serve the interests not of one State but the interests of mankind[39], as well as an expression of international respect for the "envoys" and the tasks they perform in space. That the "*envoys of mankind*" phrase is an expression of the recognition of and respect for the "personnel" travelling into space and undertaking tasks of high value to mankind as a whole is further supported by the fact that the international community was so

[36] Mehrdad Payandeh, "Special Envoy" (July 2013) Online: *Oxford Public International Law* <https://opil.ouplaw.com/view/10.1093/law:epil/9780199231690/law-9780199231690-e2054>
[37] Cambridge University Press, "Envoy", (accessed 15 May 2020, last visit 3 August 2020) Online: *Cambridge Dictionary* <https://dictionary.cambridge.org/dictionary/english/envoy>
[38] NASA, as an example, works with three types of personnel: Pilots, mission specialists, and payload specialists. Pilots manage the space vehicle, the crew, mission success and safety. Mission specialists conduct crew activity planning, monitor Shuttle consumables, carry out scientific experiments. Payload specialists have been typically payload-specific technical experts. See Kennedy Space Center, "Selection and Training of Astronauts" (accessed 16 May 2020, last visit 3 August 2020) Online: *Kennedy Space Center* <https://science.ksc.nasa.gov/mirrors/msfc/crew/training.html>
[39] That the exploration and use of outer space is in the common interest of mankind and shall be carried out for the benefit and in the interests of all countries was put into law with the preamble and article I of the 1967 Outer Space Treaty and has become a vital principle of international space law. See also *supra* note 30 at 133, quoting Gurbachan Singh Sachdeva on the *"great significance attached to their [astronauts] mission".*

eager so early on to build a framework for the safety of spacecraft personnel. Recognizing the importance of their activities meant also recognizing the importance of their safety.[40] In the 1968 Rescue and Return Agreement the security provided is in the form of varying obligations on States parties to, depending on whether the personnel had experienced an accident, distress, emergency or unintended landing in a State's territory or on the high seas or another place under no State's jurisdiction, notify the relevant launching authority and the UN Secretary-General when the State obtains information of the situation, and upon emergency landing in a State's territory, an obligation to immediately take all possible steps to rescue and render all necessary assistance. Where the personnel have alighted on the high seas or in a place under no State's juris-diction, States parties in a position to help shall do so if necessary. Where an accident, distress, emergency or unintended landing has occurred, the State having jurisdiction over the territory landed in, or the State which found the personnel on the high seas, must safely and promptly return the personnel to representatives of the launching authority.[41]

Clearly the Agreement's focus is on management of the issue post-occurrence and thereby clarifying what was set out relatively briefly in the 1967 Outer Space Treaty. However, it does not build further on the part of art. V of the Treaty that promoted the obligation of assistance upon and between astronauts of different States Parties, nor the part that requires States Parties to "*immediately inform the other States Parties*" of any phenomena they discover, which could pose a danger to the life or health of astronauts. This creates a gap in the regulated situations

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[40] Already in 1963 did the UN General Assembly pass a resolution in which the Assembly requested the study and report on legal problems resulting from exploration and use of space, and in particular to arrange for the "*prompt preparation of draft international agreement[] (…) on assistance to and return of astronauts and space vehicles*". See *International co-operation in the peaceful uses of outer space*, GA RES 1963, UNGAOR, 18th Session, UN Doc A/RES/1963 (1963), para I(1). See also UNCOPUOSOR, 2nd Session, UN Doc A/AC.105/C.2/SR.17 (1963) at 7-8, in which the U.S.S.R representative to the 17th meeting of the Legal Sub-committee of the UNCOPUOS explains its inclusion of a principle on cosmonauts to be regarded as envoys of mankind and an obligation of assistance upon States as "*a basic human principle*".

[41] *Supra* note 25, The 1968 Rescue and Return Agreement, arts. 1, 2, 3, and 4.

where spacecraft personnel may need aid from each other or from States, as no means or system has been established to protect the personnel from accidents, emergencies, or distress by preventing the occurrence of such situations, where the cause for such are health-based, *internal*, to the personnel rather than external. Based on the argument that the international community has attributed certain levels of protection and safety to spacecraft personnel due to their special position as "envoys of mankind" and the importance of their mission, this thesis will in its following sections expand on the most immediate health concerns and the regulation hereof in international and national law and policy in order to assess the availability of countermeasures to negate the eroding health effects resulting from space exploration and thus make an attempt at filling the identified regulatory gap in international space law, in the face of prospective long-duration missions and space travel beyond the low Earth orbit.

4. Identifying health concerns and the necessary countermeasures

The study of human survivability and life in space goes back to the earliest manned space exploration missions. At its most basic core, the central question was how to keep a human alive in space for the duration of the specific mission. This field of medical study has since evolved and covers a variety of areas. For the purpose of centering this thesis, which is focused on legal issues, only selected health implications shall be individually examined, so that the legal analysis can establish whether any of the most important health issues are met with appropriate countermeasures in the applicable law.

4.1 Physiological health[42]

[42] For a detailed scientific explanation of radiation, bone loss and muscle loss see Jay C. Buckey, Jr. "*Space Physiology*" 1st edition (Oxford, Oxford University Press, 2006) chapters 1, 2, 4, and 7.

There is nothing *natural* about humans leaving Earth and going to outer space, no matter the means used or the duration of their stay in the space environment. The most fundamental action necessary for the human body to function, to breathe, is not possible. As a result of this 'humanity hostile' environment, artificial environments in the form of ever-evolving life-sustaining technologies have been invented and utilized in transport means such as shuttles or other space vehicles, the more occupation-suitable space stations, and even in the space suits that crewmembers wear for 'spacewalk' missions. And yet, after decades of technological evolution, some dangers to the human body remain. Many such dangers have been identified but a complete overview hereof lies outside the scope of this thesis. Therefore, the physiological risks posed by the space environment to be reviewed in this thesis will be limited to the most immediate negative effects resulting from exposure to radiation and microgravity.

4.1.1 Radiation

Exposure to radiation is one of the biggest challenges to space exploration. Even on Earth, while its atmosphere and geomagnetic field provides a sheltered environment for human existence, there is a constant but low level of radiation, but upon leaving Earth's atmosphere the radiation exposure is increased and if humans were to leave the LEO, they would be subjected to even higher levels of radiation as they would become very vulnerable to galactic cosmic radiation and radiation resulting from solar particle events.[43]

The danger presented to humans in space by radiation depends on many variables, including the type of radiation, the energy levels, the flux of the specific radiation, how the radiation

[43] *Supra* note 11 at 197 and 203: Dirk C. Gibson, "*Terrestrial and Extraterrestrial Space Dangers – Outer Space Perils, Rocket Risks and the Health Consequences of the Space Environment*" 1st edition (United Arab Emirates, Bentham Science Publishers, 2015) at 61: *Supra* note 42 at 54

interacts with and is absorbed by different kinds of tissue, the dose rate of radiation, the duration of exposure, as well as the individual human's physiology and genetics.[44] While in the LEO, in which most manned space exploration has taken place thus far, the most part of the increased radiation levels can be, and are, countered by appropriate shielding in shuttles, on the ISS, and in space suits. Yet, once aboard the ISS, the levels of radiation can increase when the stations travels through the tip of the inner Van Allen belt[45], where the protection of the Earth's magnetic field is lessened, or during solar particle events when bursts of energy are released from the sun and travels towards Earth.[46] Once outside the protection of the LEO, humans will be exposed to the constant "background" galactic cosmic radiation. Radiation exposure resulting from space travel has been found to cause medical complications such as provoked onset of cataracts and reduced fertility in both males and females, cell damage and cell death[47], and NASA has stated that "*an increase in cancer risk is the principal concern for astronaut exposure to space radiation*."[48] On Earth experience and experiments with radiation have proven the occurrence of radiation sickness, which causes nausea, vomiting, fatigue, fever, light hemorrhaging due to bone marrow shutdown or, in worse situations of bone marrow suppression, death.[49] Certain types of radiation have also been linked to cognitive impairment similar to that of aging.[50]

Countermeasures are in place to provide the best physical safety against radiation for spacecraft personnel. The use of appropriate shielding for different kinds of radiation[51] is probably

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[44] *Supra* note 11 at 206: *Supra* note 42 at 59.
[45] *Supra* note 11 at 203. The Van Allen belts are zones of energetic charged particles held in place by the Earth's magnetic field.
[46] *Supra* note 42 at 57.
[47] *Supra* note 42 at 62 and 64.
[48] *Supra* note 11 at 205.
[49] *Supra* note 42 at 63.
[50] *Supra* note 11 at 215.
[51] *Supra* note 42 at 68.

the most powerful tool, as reduction of exposure effectively levels the chance of radiation doing high-level damage. Another powerful tool is the constant monitoring of radiation exposure to the crewmembers, upon which some space agencies even base retirement of spacecraft personnel, based on a calculation of radiation dose-related limits.[52]

In conclusion, the measures necessary to keep radiation dangers to human health at the lowest possible level are already in place. However, once manned space exploration goes beyond the LEO, the shielding technology will need to be more advanced and monitoring of solar particle events and galactic cosmic radiation levels as well as quick communication to the space vehicle personnel concerning any radiation changes or events will become vital to ensuring the health and safety of the crewmembers.

4.1.2 Muscle loss and cardiovascular changes

The gravity on Earth's surface is *1-g* and to withstand this force some of the muscles of the human body grow to be naturally stronger than others. These muscles, called the antigravity muscles, include those that straighten the spine and extend the hip, knees, and ankles, so that a human can stand up straight, walk without falling over, and raise itself from a sitting or lying position.[53] On the ISS, the crewmembers float around in microgravity. In this environment, the antigravity muscles lose much of their purpose, as control of movement is removed from the hips and legs, with arms, hands, and fingers being used to pull the floating body around the station.[54] This change in the body's regular movement patterns leads to loss of muscle mass and strength. The decrease in mass and strength will plateau over time but the protein synthesis

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[52] *Supra* note 11 at 207
[53] *Supra* note 42 at 80.
[54] *Ibid*.

will be reduced accordingly to the lowered level of activity and the muscle mass will be equally stabilized but at also a lower level.[55]

The argument has been made that some degree of muscle loss is acceptable while the specific crewmember is in microgravity, as the "extra" muscle will not be needed.[56] That may be true for current missions as these have not required that the personnel undertook activities in environments with a higher gravity than the microgravity of the ISS. Christina Koch, an American astronaut who returned from the ISS in February 2020, was interviewed shortly before her departure from the space station, saying that it was her goal to be "*standing and walking on [her] own by landing plus two days*", illustrating that her physical condition had not been severely affected by her record-setting amount of consecutive days in space.[57]

The issue with muscle loss that is the loss itself thus seems appropriately addressed for current missions. However, muscle loss also leads into other physiological problems, such as bone loss, due to the drastic change in what parts of the body is used to move around, as will be described in section 4.1.3 below. Muscle loss is also connected with increased cardiovascular risks.[58] The cardiovascular risks differ from those presented to muscle and bone loss in that the risks increase when the crewmember returns to earth and not so much while the crewmember remains in space, as the cardiovascular system adapts well to the microgravity environment, but due to the living circumstances on the ISS, such as the difficulty of doing an appropriate level of aerobic exercise or the fluid shifts caused by microgravity, the crewmembers may experience changes in their blood volume and as a consequence thereof develop orthostatic

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[55] *Supra* note 42 at 81.
[56] *Supra* note 42 at 95.
[57] Mark Garcia, "Ten Ways Astronaut Christina Koch Will Need to Readjust to Earth After 328 Days in Space" (3 February 2020) Online: *NASA* <https://www.nasa.gov/feature/ten-ways-astronaut-christina-koch-will-need-to-readjust-to-earth-after-328-days-in-space/>
[58] *Supra* note 11 at 348.

intolerance.[59] Identified countermeasures to such development include focused aerobic exercise programs, controlled heat exposure or acclimatization, and strength training including exercises focused on exposing the lower body the negative pressure.[60]

The ISS personnel exercises on almost a daily basis, as will be explained further in section 4.1.3, and the exercise programs are intended to positively affect both muscle loss and bone loss, since the loss of both are connected to each other, though muscle is more easily recovered than bone.[61] In other words, the measures necessary for countering the worst effects of spaceflight conditions on crewmembers' muscles and the resulting adverse effects on bone loss and cardiovascular changes are in place. But for future missions with a goal of setting foot on Mars, or with the goal of establishing any structure on the Moon, maintaining enough muscle mass to complete such missions or building up muscle mass "upon arrival" will be very difficult. Later chapters of this thesis will examine applicable law and the law's management of these present and future health issues.

4.1.3 Bone loss

Bone loss in spacecraft personnel is not only caused by the microgravity environment on the ISS. The microgravity results in minimal skeletal loading, but low light levels, high ambient CO2 concentrations and the resulting need for an extra high calcium-intake causes problems in the biological functions of the individual crewmembers' bones.[62] These problems include an increase in bone resorption whereby bone tissue is broken down, releasing minerals that trans-

[59] *Supra* note 42 at 140 – 141 and 151.
[60] *Supra* note 42 at 154 - 156.
[61] *Supra* note 42 at 78.
[62] *Supra* note 42 at 4.

fer calcium from bones into the blood flow, a decrease in bone formation, bone loss concentrated in weight bearing areas, as well as loss of bone density.[63] The immediate health implication is the bone loss itself, but the loss of density, aggravated resorption and lessened bone formation makes the individual vulnerable to bone fractures not only while he or she is stationed in space, but also upon and after their return to Earth.

An automatic countermeasure is in place, as bone density recovery occurs naturally. Studies up until now have shown bone density recovery after crewmembers' return to Earth. The recovery, however, is slow. A study of data from 45 astronauts and cosmonauts suggested that only 50% of the bone could be expected to be recovered after nine months following their return to Earth, with additional studies showing that recovery of the hip trochanter bone could take up to more than 3 years.[64] Furthermore, recovery will not always result in full recovery.[65] The bone loss also affects bending strength, which recovers slower yet than the bone density.[66]

At present, both preventive measures and reconditioning measures are used to keep the bone loss risks and complications at a minimum. A Russian study of cosmonauts in the 1990's, which set out a four day exercise program for the cosmonauts involved, still showed significant bone loss despite the ongoing exercise.[67] Current exercise modules for ISS Crew-members have been up-scaled from the four day program. Today, a total of 2.5 hours on six out of seven weekdays involving a combination of resistive and aerobic exercises is mandatory for ISS personnel.[68] Post-flight, the crewmembers will start a reconditioning program. An example of such is the program followed by NASA, by which astronauts will be subjected to a 45-day program

[63] *Supra* note 42 at 14 and note 11 at 357.
[64] *Supra* note 11 at 358.
[65] *Ibid*.
[66] *Ibid*.
[67] *Supra* note 11 at 357.
[68] *Supra* note 42 at 15.

focusing on ambulation, flexibility, muscle strengthening, proprioceptive exercise, and cardiovascular conditioning.[69] These measures have proven efficient at rebuilding the bone density and strength lost over the normal duration of ISS missions, but for future and significantly longer missions, spacecraft personnel will not experience the recovery resulting from being back in Earth's *1-g* gravity and undertaking the reconditioning programs before returning to Earth, and there is uncertainty as to whether the bone loss progression will possibly slow or halt with time as a result of the human body's conditioning to microgravity.[70]

In summary, monitoring of and maintenance measures for bone strength are seemingly already taking place and countermeasures are available and applied. However, long-term missions are a concern and discussions as well as recommendations on more individualized in-flight exercise programs and dietary interventions to increase the personnel's calcium, vitamin B and vitamin K intake, as well as other preventive measures, whilst they have already been initiated, are still needed in order to mitigate the risks resulting from long-term missions and the potential effects of long-term bone loss.[71]

In the later chapters of this thesis, applicable law will be analysed in order to establish the foundation for the access to the present health-related countermeasures and to determine the existence of and rights to such measures for future space exploration programmes.

4.2 Psychological health

[69] Bruce Nieschwitz, Mark E. Guilliams, David Hoellen & Jim Loehr, "Post Flight Reconditioning for US Astronauts Returning from the International Space Station" (2011) Online, pdf: *NASA Technical Reports Server* <https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20110020318.pdf>

[70] *Supra* note 42 at 11

[71] *Supra* note 42 at 12, 14-18.

Unlike such risk factors as radiation and microgravity, which are external to the human body, though the physiological effects they have are internal, and which have long been subject to scientific study and regulation by space agencies, the study of exclusively internal health impacts, i.e. psychological risks, is a more recently actively uncovered field.[72] Oleg Gazenko, nicknamed the "father of Soviet space medicine", was quoted stating that the limitations of living in space are not only medical, but also psychological[73], yet it wasn't until 1997 and 1998 that NASA invited experts in behavioral sciences to gather in order to establish the foundations of prior research and create a research plan for future research on psychological matters. This plan detailed four over-all focus areas: i) The sleep and circadian rhythm theme, ii) the behavioral health and cognition theme, iii) the psychological adaptation theme, and iv) the human-to-system interface system. A report published by NASA in 2010 contained the final findings of a psychological study of crewmember's logbooks and journals. These logs proved that the crewmembers still experience sleep deprivation.[74] Later studies that focused on countermeasures to negative psychological effects also described findings of crewmembers experiencing social isolation, sensory deprivation, and stress.[75] And as recently as last year, in 2019, research groups under the 100 Year Starship Project published an article calling for the development of predictive models for both individual and group breakdowns during long-term space travel.[76]

That ISS crewmembers continue to have demonstrated negative psychological experiences while in space indicates that the current measures are not sufficient, and the push from industry parties to develop new measures, preventive or post-factum oriented, further supports this un-

[72] See *Supra* note 11 at 369 and *supra* note 12 at 588.
[73] *Supra* note 11 at 368.
[74] *Supra* note 2.
[75] *Supra* note 16.
[76] Alires J. Almon, "Developing predictive models: Individual and group breakdowns in long-term space travel" (2019) 154 Acta Astronautica 295.

derstanding. The issues to be highlighted in this section will be separated into individual challenges and crew challenges. The individual challenges will assess the persistence of issues relating to or resulting from those four focus points outlined by the 1997 to 1998 expert assembly, while the crew challenges will examine how individual challenges translates in a small, isolated, international group.

4.2.1 Individual challenges

At the present time, only few people have undertaken "long-duration" space travel or have been on missions that lasted for more than the typical four months. As a result, the scientific foundation for psychological examination of the effects of long-duration space travel is largely based on simulations, analog application of situations such as Arctic and Antarctic expeditions, and thorough analysis of journals written by crewmembers on missions of a normal duration to understand the psychological development and adaption to life on the ISS. Preliminary results of the MARS-105 simulation study[77] showed that an environment isolated, confined, and extreme, like the environment of the ISS or a potential Mars mission transport vehicle, increased the participants' feelings of loneliness, likely due to the sudden change in personal and professional network, loss of perceived intimacy and available support, which made the participants more prone to a loss of well-being in the form of, but not limited to, depression, sleeping problems, disturbance in appetite, and perhaps most significantly adaptation disorders, some of which could evolve into feelings of alienation and estrangement.[78] The over-all experience was of an environment with significant risks to the individuals' mental health once they were

[77] A crew of six men spent a total of 105 consecutive days in an isolation facility. For more about the MARS-105 simulation study see Michel Nicolas, Gro Mjeldheim Sandal, Karine Weiss & Anna Yusupova, "Mars-105 study: Time-courses and relationships between coping, defense mechanisms, emotions and depression" (2013) 35 Journal of Environmental Psychology 52

[78] *Supra* note 12 at 589.

in-flight. One positive finding, however, was that the strong feelings of isolation prompted the participants to reflect on the consequences and meaning of loneliness, after which they seemed to experience better adaptability to the isolated environments.[79]

The MARS-105 results are akin to those found by a series of Russian studies of cosmonauts' experiences of adapting to life in space. Per the Russian findings, space travellers experience what can be described as four phases of adaptation.[80] In the first phase, which covers the first 4-6 weeks after arrival, the body as well as the mind adapts to the new physical conditions, the work-rest schedule, and the workload, and most negative experiences come in the form of fatigue from adapting to the new physical reality, including sleep problems. The second phase shows completed adaptation with few negative experiences. The third phase, after up to 12 weeks in space, the routine has set in and the psychological issues increase due to a series of stressors such as social monotony, boredom, hypo stimulation, isolation and restricted social contact. The fourth phase, kicking in shortly before the end of a mission, was far more positive though with crewmembers beginning to have some concerns about the practicality of their return to Earth.

That the ISS personnel experience their missions in phases of which most show positive adaptation but the third phase instead shows a lowered mental well-being has also been backed by recent U.S. studies of crewmember logs. Upon analysis of initially smaller crews, with three or fewer members, experts identified the third quarter of a normal length ISS mission to be the most difficult[81], with more of the work-focused log entries concerning, for instance, frustration and concern, with fewer entries describing that work was going well than had been reported in

[79] *Ibid*.
[80] *Supra* note 24, Manzey, at 784.
[81] *Supra* note 2 at 10.

the remaining four phases.[82] The American studies also show that in relation to work entries, scheduling issues were the second most reported type of entry.[83] One entry cited by the study is as follows: *"Today was a hard day. Small things are getting to me. I am tired. I think that the ground is scheduling less time for tasks than before. So, there is very little, if any fat left in the schedule for me to use to catch up on little things during the day."*[84] This quote expresses an emotion likely known to most who have been overworked and on the "every now and then" basis such emotions are not to be feared. But, as put by another American astronaut, Susan Helms, "*it's not that the crew isn't busy maintaining the station, testing the remote manipulator and conducting science, it's that there remains enough time to look out the window, do somersaults in weightlessness, watch movies, and sit around chatting*."[85]

This inability to "get away from it all" and to unwind both on their own and as a group can cause the individual crewmembers to become stressed and to withdraw, causing further feelings of isolation and potentially resulting in conflict.[86] Work-related frustrations can be further ignited by the sleep deprivation that ISS personnel experience[87], where the consistent circadian rhythms, which are normally maintained on Earth by the change in day and night, are difficult to maintain as the ISS orbits the Earth 16 times in 24 hours.

[82] See also NASA Technical Memorandum, Jack Stuster (April 2016), "Behavioral Issues Associated with Long-Duration Space Expeditions: Review and Analysis of Astronaut Journals – Experiment 01-E104 (Journals): Phase 2 Final Report" at 21, where "work is good" entries are at a minimum during the third phase while teamwork and scheduling entries have increased during that phase.
[83] *Supra* note 2 at 10.
[84] *Ibid*.
[85] Douglas A. Vakoch, ed, "Psychology of Space Exploration" 1st Edition (California, On-Demand Publishing LLC, 2011) at 28.
[86] *Supra* note 16 at 9.
[87] That ISS personnel experiences sleep deprivation has been consistently recognized. See for example Dietrich Manzey, Albrecht Schiewe & Christoph Fassbender "Psychological Countermeasures for Extended Manned Spaceflights" (1995) 35 Acta Astronautica 339 at 351 and *supra* note 43, Gibson, at 193.

After having found these tendencies towards in-flight development of negative psychological effects such as social isolation, stress, and sensory and sleep deprivation, psychologists have taken to propose in-flight countermeasures that may relieve the worst negative effects. Suggested measures include self-monitoring, whereby crewmembers reflect individually on the meaning, purpose and consequences of them being on the ISS, professionally, but also on a personal level reflects on such existential questions, as these exercises have been proven to lower stress levels.[88] Another measure, which is actually already in place as explained in the prior sections 4.1.2 and 4.1.3, is exercise. The crewmembers may exercise daily to maintain appropriate levels of muscle and bone mass, but exercising will also improve cognitive performance both during and after the exercise module.[89]

Other suggestions focus on the importance of new stimuli to lower stress levels resulting from sensory monotony. These stimuli include novelty, perhaps in the form of new and varying available food, virtual reality, including access to different kinds of media during recreational hours to provide a "get away", and the introduction of a greenhouse, as studies have found that ISS personnel responds particularly well to plants on board flights.[90]

A significantly stressed countermeasure, also by crewmembers themselves as per Susan Helms above, is the availability of recreational activities, be they active, like the above mentioned exercise, or passive in the form of photography, listening to music, watching movies or the like.[91] An example of spacecraft personnel reacting to being overworked is the "sit-down

[88] *Supra* note 12 at 595.
[89] *Supra* note 12 at 591.
[90] *Supra* note 16 at 2-3 and 6-9.
[91] *Ibid*.

strike" of 1973, where the three man crew of the Skylab 4 mission turned off the radio link to ground control for a full day.[92] The Skylab 4 mission had a duration of 84 days.

Suggested in-flight psychological support measures involve both remote monitoring of crewmembers' mental and emotional state as a preventive method of identifying negative developments before they escalate and the availability of different types of support to counter the feelings of monotony and social isolation, such as care packages and two-way communications between crewmembers and family or private conferences between a crewmember and psychological support staff on the ground.[93] The private importance of communication outside of the space station was captured in one journal entry assessed by an American study, in which a crewmember wrote "*And the most rewarding tool here – the IP phone! What a treat to talk to family and friends! What a treat to be able to blow them away with a call from space! It brings tears of joy to my eyes every time.*"[94]

When the time comes where long-duration missions and interplanetary missions become a reality, the psychological implications explained in the above will become more prominent as the crewmembers' exposure to the risks involved with space travel will be extended, and many of the suggested countermeasures will become more difficult to maintain as the physical distance between the spacecraft and ground control and launch vehicles increases. This will affect communication channels and the availability of care packages and re-supply, resulting in a

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[92] *Supra* note 85 at 38, see also Michael Hiltzik, "Column: The day when three NASA astronauts staged a strike in space" (28 December 2015) Online: *Los Angeles Times* <https://www.latimes.com/business/hiltzik/la-fi-mh-that-day-three-nasa-astronauts-20151228-column.html>
[93] *Supra* note 24, Manzey, at 786.
[94] *Supra* note 2 at 14.

poorer support system and less variation in foods, special items from home, or new equipment.[95] Therefore, when planning for future missions, rethinking how to provide the proper psychological support, either pre-flight or in-flight, becomes of vital importance.

4.2.2 Crew challenges

Individual crew members together make a team and one of the key factors to mission success is the adequate and effective performance of the crew.[96] Working closely together both figuratively and literally for the entire mission duration, crew members become co-dependant both on a professional and personal level. Their assigned tasks are involved with each other and mistakes will affect all crewmembers. Being functional and well is crucial to the success of all and the first response team in any kind of crisis, also professional or personal, will be the other crew members. This requires that the team is a strong one individually but even more so as a group.

Historically, there have been examples of crew malfunction, either due to conflict between crew members or between ground and ISS crews. The most prominent case was the strike in 1973, as referenced above. Other examples include the difficulties between the Apollo 7 crew and ground control, which resulted in none of the crew members ever returning to space, and the Soyuz 21 and Soyuz T-14 missions where crewmembers experienced problems concerning mood, performance and interpersonal issues, leading to the missions coming to a premature end.[97] Challenges that cause these negative crew developments, other than individual challenges, have been identified.

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[95] *Supra* note 24, Manzey, at 786.
[96] *Supra* note 12 at 590.
[97] *Supra* note 85 at 26.

One challenge that the crew needs to be able to manage properly is the high level of crew autonomy, and especially so during long-duration missions. The restricted communications with ground control and support staff and the sheer physical distance between the crew and any external aid means that the crew must be largely self-reliant when solving problems both external, such as technical problems, or internal, such as serious illness or interpersonal conflict.[98] The psychological pressure on the individual crew members, and specifically on the crew commander, resulting from the situation and necessary decision–making will be incredibly high under such circumstances.[99] At this point, defining the appropriate course for the crew also becomes an ethical decision.

A potential outcome of the high autonomy of the crew that has been observed in analogue situations on Earth is groupthink[100]. Groupthink tendencies develop in groups of high autonomy that are working under high levels of stress and negatively affects the group and the individuals of the group's ability to make decisions, as the group builds delusions of confidence and abilities and forces its members to comply with group decisions thus making the individuals less likely to express disagreement or concern with the group's actions. The group may simultaneously distance itself from non-group members, which are viewed in a stereotyped and non-inclusive way. This eventually results in poor crew performance and disruption in the relationship with the "outsiders" that make up ground control staff.[101]

[98] *Supra* note 24, Manzey, at 785.
[99] *Supra* note 85 at 87.
[100] Defined by Merriam-Webster as "a pattern of thought characterized by self-deception, forced manufacture of consent, and conformity to group values and ethics". See Merriam-Webster, "Groupthink" (Accessed 01 June 2020, last visit 5 August 2020) Online: *Merriam-Webster.com Dictionary* <https://www.merriam-webster.com/dictionary/groupthink>
[101] *Supra* note 24, Manzey, at 785.

For crew challenges related to autonomy and groupthink the best countermeasures may be preventive measures and not in-flight measures. Preventive measures could be in the form of psychological training of the crewmembers pre-flight whereby they learn how to deal with the personal implications of technical problems or another crewmember's illness in a manner that keeps the crewmembers functional until help can be received from Earth.[102] In any such emergency situation, for the crew to be able to make the best decisions is a key factor. The appropriate psychological emergency training pre-flight paired with clear pre-established policies and protocols for medical care decisions, both physiological and psychological, could alleviate the pressure on the crew members.[103] "The right decision" will have been made for them in advance, making it possible for them to make a decision in time and focus energy and resources on maintain control and functionality.

Another preventive measure, which has existed since the origin of manned space exploration but which has been continuously modified, is the selection of crew members. While this selection originally focused on selecting candidates of "the right stuff"[104], the evolution of selection and present day selection of spacecraft personnel candidates is characterized by being open to civilian scientists instead of only drafting military personal, as the crewmembers are no longer exclusively spacecraft pilots but also include mission specialists.[105] With the increase in crew member amount per mission, from the initial single person missions to smaller crews of up to three or bigger crews up to six crew members, the importance of crew composition

[102] *Supra* note 16 at 12 and *supra* note 87, Manzey, Schiewe & Fassbender, at 341 – 342. Specific focus of such training should be on social competence, including training on aspects of human communication and improving interpersonal attitudes and skills, and stress management.
[103] *Supra* note 85 at 87.
[104] "The right stuff" is a phrase that covers the idealistic image of astronauts, as painted by the media and urged by NASA, in the U.S. in the 1960's and 1970's. A man with no cracks in his character, a "virtuous, no nonsense, able and professional astronaut". For more see *supra* note 85 at 23- 26.
[105] *Supra* note 87, Manzey, Schiewe & Fassbender, at 340 and *supra* note 38.

became and now remains important.[106] Different aspects of crew composition include not only the crew size but also the physical health of the candidates and both their professional and personal experience and knowledge. An example of the minimum health requirements was published by the European Space Agency in 2008 and lists: *i)* an applicant should be able to pass a JAR-FCL 3, Class 2 medical examination or equivalent, *ii)* the applicant must be free from any disease, *iii)* the applicant must be free from any dependency on drugs, alcohol or tobacco, *iv)* the applicant must have visual acuity in both eyes of 100%, *v)* the applicant must be free from any psychiatric disorders, and *vi)* the applicant must demonstrate cognitive, mental and personality capabilities to enable him/her to work efficiently in an intellectually and socially highly demanding environment.[107] Only the last two requirements concern the mental condition of the individual candidates but the list does show that already some attention is paid to the mental state and stability of potential crewmembers. On a personal level, composition considerations should include the individuals' attitudes, personalities, and qualities[108] as composing a well-functioning crew will require an intentional composition of personality types to create the best possible group dynamic.[109]

Crew challenges are not limited to problems originating from the crew as a whole but will also include the individual challenges outlined in section 4.2.1 above. As mentioned earlier, the crew on current missions but even more so on future long-duration missions are each other's most immediate source of support. In acknowledging this, one must also acknowledge that crews will need to learn how to work together to counter individual stressors and psychological

[106] *Supra* note 85 at 127.
[107] European Space Agency, "FAQ's Health and physical condition" (27 March 2008) Online: *The European Space Agency* <https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/European_Astronaut_Selection/FAQs_Health_and_physical_condition>
[108] *Supra* note 85 at 128.
[109] *Supra* note 76 at 296.

health issues. They will need to be trained in a type of psychological first aid, and perhaps even more extensive training will be needed for interplanetary missions where the crewmembers have tasks to perform that will be physically demanding after a longer period of travelling. Analogue studies have underlined this importance of designing psychological countermeasures after the demands of the specific mission.[110]

4.3 Summary

The phrase "ad astra per aspera", to the stars through hardships, is strongly indicative of the true nature of the impact of space travel upon the space traveller. This chapter has identified several significant risks inherent to the reality of a life in space, both physiological and psychological. Proven adverse effects on the condition of the human body included heightened radiation exposure. The exposure level is so high that spacecraft personnel in some countries are considered radiation workers for occupational purposes.[111] In addition to this exposure, personnel members also experience loss of muscle mass, which, though the mass is recoverable post-flight, can include complications for the cardiovascular system and increase bone loss. The bone loss is also recoverable but slowly so and in some situations will not happen in full post-flight.

Life in space, at present on the ISS and in the future possibly onboard space vehicles or larger stations and even other planets, also carries many psychological stressors and risks. Studies of ISS personnel journals and experiments of analogue situations have demonstrated that,

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[110] A.W. Holland & K. Curtis, "Operation Psychology Countermeasures During the Lunar-Mars Life Support Test Project" in Helen W. Lane, Richard L. Sauer & Daniel L. Feeback, ed, "*ISOLATION: NASA Experiments in Closed-Environment Living: Advanced Human Life Support Enclosed System Final Report (Science & Technology Series)*" 1st Edition (San Diego, California, American Astronautical Society, 2002) at 152.

[111] *Supra* note 11 at 197.

on an individual basis, personnel members are vulnerable to sleep deprivation which, in connection with the high-intensity workload, lack of privacy and extremely isolated environment, further provokes the pre-existing stress factors of the ISS environment that the personnel resides in for up to typically four months or longer. These stressors, both on their own and when compiled as they will be with time, can lead to the onset of or increase in feelings of anxiety, depression, social isolation, and lack of purpose. The worst imaginable outcome specifically for long-duration missions would be the psychological breakdown of a crewmember.

At present, the ISS crews are very dependent on each other and on ground control, but with long-duration missions being prospected in the near future, the level of autonomy that the crew has, which is already very high, will become even higher. Autonomy means that the crew will become almost solely dependent on each other in situations of crisis, adding additional stress on the crew members. Autonomy in itself also creates the perfect environment for the development of groupthink tendencies, which can hurt both the interpersonal relationship but also the crew's relationship with Earth-based support staff.

In seeking to counter the effects of these risks, measures have been put forward. Some are used even now, such as the 6-day mandatory 2.5 hours of exercise, and pre-flight selection criteria are used to ensure that only physically and mentally capable candidates are selected. For most of the physical risks, and some of the mental risks, the current need for intervention of health policies is low. It was clear, however, that for long-duration missions significant changes must be made to the present procedures, but pre-flight and in-flight.

This health-focused analysis has a legal purpose, too. The most fundamental health risks have been explained, and the necessary countermeasures identified. Some measures were already in place, this being the case mostly for the physical dangers, but common for all were the increased risks connected with the future of space exploration, namely long-term missions either in or beyond the LEO. The legal aspect inserts itself here; what are the rights of the spacecraft personnel? They clearly suffer the exposure risks, but are they legally entitled to any of the necessary countermeasures? What are their rights at present and will these be sufficient for maintaining appropriate levels of physiological and mental health for future missions? Before any of these questions can be answered, the applicable law must be pinpointed.

5. The relevant legislation

5.1 International law

As mentioned, international space law consists, on a fundamental level, of five treaties.[112] These are the 1967 Outer Space Treaty, the 1968 Rescue and Return Agreement, the 1972 Liability Convention, the 1975 Registration Convention, and the 1979 Moon Agreement. Out of these five, only the Outer Space Treaty, the Rescue and Return Agreement, and the Moon Agreement concern spacecraft personnel.[113] On the specific topic of protection of the personnel's health, the treaties have very little to say. In the Outer Space Treaty, articles V and VIII regard "astronauts" and "personnel". The Rescue and Return Agreement is more personnel-focused, its preamble explaining that intentions with the Agreement were, amongst others, to develop upon the duties set out in the Outer Space Treaty pertaining to the obligation on States parties to render all possible assistance to 'astronauts' in the event of accident, distress, or emergency landing, the prompt and safe return of 'astronauts', as well as the return of objects launched into space. The 1968 Rescue and Return Agreement contains provisions with varying

[112] See *supra* note 25.
[113] See section 3.1 of this thesis for the specific contents and compared differences between the three treaties and a note on why the 1979 Moon Agreement's contribution to spacecraft personnel regulation is of limited use.

degrees of obligation on States parties to aid spacecraft personnel under different circumstances of accident, distress, or emergency landing. These obligations vary from an obligation of notification to one of assistance and one of duty. The Agreement is also clear on the obligation of returning personnel "safely and promptly", with the word "safely" being of significance when focusing on personnel health protection.

It follows from art. III of the 1967 Outer Space Treaty that States shall undertake activities in the exploration and use of outer space in accordance with international law, in the interest of maintaining international peace and security and promoting international cooperation and understanding. Thus expanding the scope of law applicable to States' exploration and use of outer space, a discussion of the right to health must be considered. Does it grant any security for the spacecraft personnel in addition to the contents of international space law? The right to health stems most clearly from the International Covenant on Economic, Social and Cultural Rights[114], of which art. 12(1) states "*The States Parties to the present Covenant recognize the right of everyone to the enjoyment of the highest attainable standard of physical and mental health*". The right has been criticised for not having a definitive minimum core of rights and, in turn, obligations, bringing into question whether its content can be described as normative.[115] This is an interesting critique of a piece of international legislation that has gathered a total of 170 States parties and 4 signatories.[116] The right to health might thus have importance in the discussion of the health of spacecraft personnel and the protection hereof.

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[114] *International Covenant on Economic, Social and Cultural Rights,* 16 December 1966, 993 UNTS 3 (entered into force 3 January 1976)

[115] John Tobin, "*The Right to Health in International Law*" 1st Edition (Oxford, Oxford University Press, 2012) at 4-5.

[116] United Nations Human Rights Office of the High Commissioner, "International Covenant on Economic, Social and Cultural Rights" (Accessed 4 June 2020, last visit 6 August 2020) , Online: *Status of Ratification Interactive Dashboard* <https://indicators.ohchr.org/>.

5.2 The ISS legal framework

The ISS project was started by the U.S. in the 1980's[117] and evolved into a more international project which culminated in the 1998 Agreement Among the Government of Canada, Governments of Member States of the European Space Agency, the Government of Japan, the Government of the Russian Federation, and the Government of the United States of America Concerning Cooperation on the Civil International Space Station.[118] The 1998 IGA remains the heart of several bilateral agreements entered into following the creation of the IGA, including four Memoranda of Understanding (MoUs) between the involved space agencies and various implementing agreements.[119] The provisions of this agreement, referred to through this thesis at the 1998 IGA, focus mainly on the relationship between partner states and management, the obligations regarding technical contributions to the Station, and intellectual property and utilization rights. Article 11 sets out firstly that each partner has the right to provide qualified personnel to serve on an equitable basis as ISS crew members and that any decisions on flight assignments will be made according to procedures provided in the MoUs and implementing agreements. Secondly, the article sets out that the Partners to the IGA will develop and approve a crew Code of Conduct, which must be approved by all Partners before they can provide personnel, and in exercising their right to provide crew members they shall in turn ensure that their crew members obey the Code of Conduct. Thus, the Code of Conduct will be a key document when examining crew member rights and activities relating to health.

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[117] See President Ronald Reagan's Statement on the International Space Station, Stephen Garber, "Excerpts of President Reagan's State of the Union Address, 25 January 1984" (accessed 4 June 2020, last visit 6 August 2020) Online: *history.nasa.gov* <https://history.nasa.gov/reagan84.htm>

[118] Agreement Among the Government of Canada, Governments of Member States of the European Space Agency, the Government of Japan, the Government of the Russian Federation, and the Government of the United States of America Concerning Cooperation on the Civil International Space Station, 29 January 1998 [*The 1998 IGA*].

[119] Diane St-Arnaud et al., "The Legal Framework for the International Space Station" (April 17 2013) Online, pdf: The Legal Framework for the International Space Station <https://www.unoosa.org/pdf/pres/lsc2013/tech-05E.pdf>

NASA, representing the U.S. as the biggest stakeholder and leader of the project, is authorized to continue operations on the station until October 1, 2024, after which time the operational responsibilities are planned to be transferred "in whole or in part" to commercial entities.[120] This opens up to many questions. What will happen to the other Parties when the U.S. de-escalate their use and funding? What will happen to the ISS framework? And what does it mean for the future of the station itself, if commercial entities will not participate to an extent financially sufficient to keep the station secure or operational? NASA has suggested extending their operations on the station[121], while industry journalists have speculated that NASA's withdrawal from the ISS project is part of a plan to go back to the Moon[122], a speculation that was confirmed with the public reveal of the 'Artemis Program'. In any case, application of the ISS framework is limited to activities under the ISS project and will be in effect at least until 2024.

5.3 Examples of national law

Following articles VIII of the 1967 Outer Space Treaty and II of the 1975 Registration Convention, States Parties retain jurisdiction and control over any object launched that is carried on their registry and over any personnel thereof. This applies to all launched objects, including the ISS and its different modules. The 1998 IGA art. 5(2) adds that, in accordance with arts.

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[120] Paul K. Martin, "Examining the Future of the International Space Station – Statement of Paul K. Martin, Inspector General, National Aeronautics and Space Administration" (16 May 2018) Online, pdf: *NASA Office of Inspector General, Office of Audits* <https://oig.nasa.gov/docs/CT-18-001.pdf> at 1. *Compare* Jeff Foust, "Senate Bill Seeks Extension of the Space Station" (28 February 2019) Online: *Space.com* <https://www.space.com/senate-bill-seeks-extension-of-the-space-station.html>, where a recent US Senate bill to extend the ISS operations to 2030 failed to win two-thirds majority in the House of Representatives, with some Senators pushing a new amendment also including the 2013 extension.

[121] *Supra* note 120, Martin, at 3-4.

[122] See for example Jonathan O'Callaghan, "The ISS is Getting an Extension – Which Might Detach and Form its Own Commercial Space Station" (28 January 2020) Online: *Forbes Magazine* < https://www.forbes.com/sites/jonathanocallaghan/2020/01/28/the-iss-is-getting-an-extensionwhich-might-detach-and-form-its-own-commercial-space-station/#3b07f33265f1> and Mike Wall, "NASA Plans to Build a Moon-Orbiting Space Station: Here's What You Should Know" (10 September 2018) Online: *Space.com* <https://www.space.com/41763-nasa-lunar-orbiting-platform-gateway-basics.html>

VIII and II mentioned above, each Partner to the IGA retains jurisdiction and control over personnel "in or on" the space station, who are its nationals, subjecting the exercise of such jurisdiction and control to the ISS framework. As such, the legislation of individual crew members' country of nationality remains applicable during their stay in space and the ISS. This includes national legislation on labour and occupational health.

The U.S. is the most spacefaring nation. Occupational health legislation is based on and in the Occupational Safety and Health Act of 1970[123], exempting federal employees. NASA employees, including spacecraft personnel, are federal employees, except if a personnel member is assigned by the military in which case that individual remains military personnel, which are also, with few exceptions, exempt from the Act.[124] The exemption of federal employees means that these employees will be subject to special federal plans made by the different agencies, following the Occupational Safety and Health Act's standards as applicable.[125] NASA is an independent agency under the U.S. Government and has its own health plans. For spacecraft personnel, these standards are enshrined in NASA Space Flight Human-System Standard Volumes 1 and 2.[126]

Russia has contributed 48 visitors to the ISS[127] but was also a major party to space exploration before the creation of the station. Russia has ratified the International Covenant on Eco-

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[123] *Occupational Safety and Health Act,* 29 U.S.C Chapter 15.
[124] 29 U.S.C § 653(b)(1).
[125] 29 C.F.R §1960.8(b) after which *"The head of each Agency shall comply with the Occupational Safety and Health Administration standards applicable to the agency".* A general factsheet on occupational safety and health for federal employees is available online. See Occupational Safety and Health Administration, "Occupational Safety and Health for Federal Employees" (2006) Online, pdf: *OSHA FactSheet* <https://www.osha.gov/OshDoc/data_General_Facts/federal-employee-factsheet.pdf>
[126] NASA Technical Standard, "NASA Space Flight human-System Standard Volume 1, Revision A: Crew Health", Approved 30 July 2014, NASA-STD-3001, VOLUME 1, Revision A w/Change 1: NASA Technical Standard, "NASA Spaceflight Human-System Standard Volume 2: Human Factors, Habitability, and Environmental Health", Approved 9 September 2019, NASA-STD-3001, VOLUME 2, REVISION B.
[127] See National Aeronautics and Space Administration, "Visitors to the Station by Country" (5 June 2020) Online: *Nasa.gov* <https://www.nasa.gov/feature/visitors-to-the-station-by-country/>.

nomic, Social and Cultural Rights[128] and as Russian spacecraft personnel are employees of the Roscosmos State Corporation for Space Activities ("Roscosmos"), which is a state owned corporation, Russian national health and occupational health regulations will apply. Following article 7 of the Russian Constitution[129], the Federation shall aim its policy at "*creating conditions ensuring a worthy life and a free development of Man",* and "*labour and health of people shall be protected*". The Labour Code of the Russian Federation[130] applies to all employment situations regardless of the organizational and legal status or ownership of the employers, with exception of military personnel, board directors in organisations, employees of civil contracts and others exempted by federal law.[131] For the space sector, the Law of the Russian Federation on Space Activities[132] states that payment for cosmonauts' labour and other terms of their professional activity shall be determined by contracts in accordance with laws and other normative legal acts of the Russian Federation[133]. Though the Law on Space Activities predates the Labour Code, the wording of the Labour Code's applicability to all employment situations no matter the structure organization or ownership of the employer with no exceptions made for general federal employees suggests that cosmonauts are employed by the Roscosmos under terms in accordance with the labour law effective at the given moment, and at present the Labour Code. Section X of the Labour Code governs labour safety. Russia also has a mandatory general health insurance system. The European Observatory on Health Systems and Policies

[128] United Nations, "International Covenant on Economic, Social and Cultural Rights" (Accessed 8 June 2020, last visit 6 August 2020) Online: *United Nations Treaty Collection* <https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=IV-3&chapter=4&clang=_en>
[129] For an official English translation of the Constitution of the Russian Federation of 12 December 1993 see The Ministry of Foreign Affairs of the Russian Federation ,"The Constitution of the Russian Federation", Online: *The Ministry of Foreign Affairs of the Russian Federation* <https://www.mid.ru/en/foreign_policy/official_documents/-/asset_publisher/CptICkB6BZ29/content/id/571508>
[130] Labour Code of the Russian Federation, NO. 197-FZ of December 30, 2001 [*the Russian Labour Code*]
[131] *Ibid.* Article 11 of the Russian Labour Code.
[132] Law of the Russian Federation, NO. 5663-1,of August 20, 1993, on Space Activities.
[133] *Ibid*, Article 20(2).

provided an overview of the benefits covered by the mandatory insurance in 2011 which included a wide range of benefits, including disorders of the musculoskeletal system.[134] In addition, Roscosmos follows applicable governmental standards.

6. Analysis of individual sources of legislation and policy

Having identified the specific legal instruments relevant to the analysis of spacecraft personnel's rights of health and access to health services in the previous chapter, this chapter will closely examine the relevant content of the identified instruments and compare it to the necessary countermeasures to health implications of being stationed in space, as discussed in chapter four. Section one will contain an examination of international space law, articles V and VIII of the 1967 Outer Space Treaty as well as articles 1 to 4 of the 1968 Rescue and Return Agreement will be dissected, so that any rights or obligations that may be drawn from them can be established. A deeper analysis of the right to health under public international law and its contents and applicability to spacecraft personnel will follow, in an attempt to fill any holes left in regulation by the space treaties.

In the second section, turning to the ISS framework, article 11 of the IGA will become the main focus point together with the documents referenced in the article, including the four MoUs and the Code of Conduct.

The goal of the third section will be to examine the national health legislation of two major space faring countries in order to establish whether or not spacecraft personnel of different nationalities have any shared rights of health or access to health services in addition to any such

[134] Larisa Popovich et al., "Russian Federation – Health System Review" (2011) 13:7 Health Systems in Transition 1 at 75-76.

rights or access concluded from international space law and the ISS framework. The first country will be the U.S., as it is the most active State when it comes to manned space exploration. The second country will be Russia, as Russia has been involved in space exploration since the beginning of the space age and remains the only other major space fairing country in terms of the number of nationals that have been to space. The combined instruments of these two States will at the very least illustrate that very different legal frameworks apply to spacecraft personnel, expectedly granting some shared but also some unequal rights to health and health services.

6.1 Health rights under international space law

6.1.1 The 1967 Outer Space Treaty and the 1968 Rescue and Return Agreement

Article V of the 1967 Outer Space Treaty is split into three paragraphs. The first paragraph sets out that astronauts are the envoys of mankind in outer space, that States must give all possible assistance in the event of accident, distress, or emergency landing on the territory of another State or on the high seas, and that astronauts must be safely and promptly returned to the State of registry of the spacecraft vehicle. Following the second paragraph, astronauts are obligated to render all possible assistance to each other while carrying out activities in outer space and on celestial bodies. The third paragraph focuses on an obligation of information, ordering States to immediately inform other States parties and the UN Secretary-General if they discover any phenomena in outer space that can constitute a danger to the life and health of astronauts.

Astronauts as a term being undefined and the issues resulting from this have been explained in chapter three, along with The 1968 Rescue and Return Agreement's use of "spacecraft personnel". The notion of "envoys of mankind" has also been discussed and found, at least on its own, not to have explicit or implicit focus on health, though it may in a larger perspective aid the argument for regulating health topics related to manned space activities. However, some experts have asked what, in practice, makes a person an "astronaut" and have pointed to criteria of training, altitude, and selection.[135] Making the conclusion that art. V contains requirements of training, altitude and selection of spacecraft personnel[136] is a mistake, but having kept the "astronaut" term undefined does allow for some development of the understanding that astronauts are not just anyone, but specific "someones". The article in other words contains a gap for the establishment of indicators for what makes an "astronaut". It is merely the practical application that points to training and selection. Training in health countermeasures and selection of individuals that are physically and mentally better suited for the position of spacecraft personnel *could* be contained herein, but it is a stretch from the wording of art. V. The conclusion is then that the unsettled "astronaut" term leaves a door open to policymaking on "astronaut"-making.

The remainder of the first paragraph of art. V, the obligation of rendering all possible assistance in the event of accident, distress, or emergency landing on the territory of another State or on the high seas, and that astronauts must be safely and promptly returned to the State of registry of the spacecraft vehicle, all points to obligations of either in-event or post-event interference. Assistance must be given *in the event of* accident and distress or emergency landing,

[135] See *supra* note 19 at 118-119. Treaty interpretation follows article 31 of the *Vienna Convention on the Law of Treaties*, 23 May 1969, 1155 UNTS 331 (entered into force 27 January 1980). Though the Vienna Convention does not apply directly in a retroactive manner, art. 31 in particular is widely considered as codifying pre-existing customary international law, see Oliver Dörr, Kirsten Schmalenbach, "*Vienna Convention on the Law of Treaties – A Commentary"* 2nd Edition (Berlin, Springer, 2018) at 561. Therefore, art. 31 will be applied in the interpretation of the two space treaties of 1967 and 1968. The interpretation of "astronauts" has not yet led to a decisive understanding of the term, which is why this section applies art. 31(2)(b) and looks at subsequent practice in the application of the Outer Space Treaty.
[136] Following art. 31 of the Vienna Convention on the Law of Treaties, subsequent agreements between States parties will influence treaty interpretation. As "spacecraft personnel" was added by the 1968 Rescue and Return Agreement, the phrase is also used in this section of term interpretation of "astronauts".

i.e. after something has caused the accident, distress, or emergency landing. For the purpose of health protection through the identified countermeasures, two immediate questions arise. Firstly, are events of accident or distress inclusive of events of health-wise accident or distress and alternately are any health measures covered by "all possible assistance"? And secondly, is the obligation of assistance limited to assistance being provided on Earth, post-landing?

As to the first question, asking whether events of "accident or distress" include such events which exclusively affect health, no definition of the two terms are given in the Outer Space Treaty or the Rescue and Return Agreement. Following the general rules of treaty interpretation, the ordinary meaning of accident must consist, at least, of an element of un-intendedness and an element of injury or damage, however small, bodily or material. Read in context with the full provision and the clarifications of the Rescue and Return Agreement, the focus on saving the lives of spacecraft personnel suggests that non-life threatening accidents cannot result in any of the more demanding obligations exceeding a duty of notification. Distress, on the other hand, has a more inclusive dimension, being used both as an expression for a feeling of pain or suffering that affects (a part of) the body or mind and for being in a dangerous situation and in need of help.[137] Read in the context of the full paragraph which focuses strongly on obligations of offering aid, the context favours the latter of the two understandings.

A dangerous situation can be similar to the life-threatening events that were found to be

[137] The legal instruments and their preparatory documents remain clear on the obligation of rendering assistance as a fundamental humanitarian duty, see *supra* note 41, UN Doc A/AC.105/C.2/SR.17 , but refrains from offering definitions of events of accident or distress. As such, the ordinary meaning of the terms within the frames set by art. 31 of the 1969 Vienna Convention on the Law of Treaties must be applied. See for instance Cambridge University Press, "Distress" (Accessed 12 June 2020, last visit 6 August 2020) Online: *Cambridge Dictionary* <https://dictionary.cambridge.org/dictionary/english/distress> and Merriam-Webster, "Distress" (accessed 12 June 2020, last visit 6 August 2020) Online: *Merriam-Webster.com* Dictionary <https://www.merriam-webster.com/dictionary/distress>. Both online dictionaries also refer to a "law" definition of "distress" which concerns distrain but this definition was hardly intended by the drafters. It makes little sense to think of "astronauts" in the procedure of distressing goods.

covered by “accident” but the choice to apply both terms indicates that they were intended to cover different situations. One such difference is the matter of intent. A dangerous situation can arise from someone’s intent, an accident cannot. Another difference is time. A dangerous situation can arise before, during, after or completely unrelated to an accident. The harm resulting from a dangerous situation can also be different from that of an accident, in that the situation can harm a person psychologically merely from being in a situation of distress. Expanding the context analysis to include complimenting bodies of law, the description in the 1968 Rescue and Return Agreement of “conditions of distress” supports a broader application of “distress”.[138]

Resulting from this interpretation, accidents under the Outer Space Treaty art. V include accidents that create high risks for the lives of spacecraft personnel, and thus accidents which create the most severe risks for their physiological health. Distress reaches further, covering dangerous situations that can negatively affect both the physical and mental health of personnel members.

Asking then what is covered by ‘all possible assistance’, the ordinary meaning hereof is broad. An online search will show that the term is commonly used in political documents and correspondence, as well as legal texts. However, the specifics of the present use of the phrase are contained in the 1968 Rescue and Return Agreement. The Agreement details obligations of *notification* to the launching authority of the UN Secretary-General presumably for the purpose of having the launching authority act on the identified accident, distress, or emergency landing, of *rendering all necessary assistance*, by the State that the landing has occurred in the jurisdictional territory of, of *extending assistance,* if necessary where the landing occurred in a territory

[138] *Supra* note 25, see art. 1 of the 1968 Rescue and Return Agreement.

under no jurisdiction, and of *safe and prompt return*.[139] Other than the notification obligation, the assistance obligation is focused on rescue activities and thus *lifesaving* rather than health and wellbeing maintenance. The notification obligation leaves any further action to be taken to the launching authority. Any health focused measures are left to policy decisions.

In regards to whether rendering assistance is limited to being rendered on Earth, while it is clear that assistance will be given on Earth, it is unclear if assistance *from* Earth is also to be rendered.[140] The problem originates from the wording *"(...) in the event of accident, distress, or emergency landing on the territory of another State Party or on the high seas(...)".* Is "on the territory of another State Party or the High Seas" also the location on which the accident or event of distress must take place before all possible assistance can be demanded? The sentence seems to suggest so on the surface, not indicating that the territory requirement was only intended to relate to emergency landing.[141] But in using the word *or*, in opposition to *and*, there seems to be no requirement that the accident or distress is related to an emergency landing, or any landing at all.

When the second paragraph states that "astronauts" have an obligation to assist each other "*in carrying on activities in outer space and on celestial bodies*", it could indeed be read as meaning that when in space, astronauts can only rely on the assistance of other astronauts and not assistance from Earth. But another way of reading the paragraph proposes that it is an obligation on "astronauts" in addition to the obligation already placed on States in the first para-

[139] *Supra* note 25, Articles 1-4 of the 1968 Rescue and Return Agreement.
[140] Francis Lyall, "Who is an astronaut? The inadequacy of current international law" (2010) 66 Acta Astronautica 1613 at 1615.
[141] For an analysis of accident, distress and emergency landing under art. V of the 1967 Outer Space Treaty that supports this reading, and which does not extend its analysis to the contents of the 1968 Rescue and Return Agreement, see Stephan Hobe et al., ed, "*Cologne Commentary on Space Law – Outer Space Treaty*" 2nd Edition (Berlin, Berliner Wissenschafts-Verlag, 2017) at 366-369.

graph, and not in replacement of. Looking again to the 1968 Rescue and Return Agreement for additional legal context, art. 1 of the Agreement discerns between "*suffered [an] accident or (…) conditions of distress or have made an emergency landing*."[142] This article clearly distinguishes between three different situations and the following articles 2 to 4 contribute to this interpretation by making it clear that the most onerous assistance obligations, those of a State offering all necessary assistance to spacecraft personnel that have landed in territory under the jurisdiction of that State, only activates when there has been a landing due to accident, distress, emergency or otherwise unintended landing.[143] This additional landing requirement is also present in art. 3, with the softer obligation of extending assistance if necessary and, if in a position to do so, in situations of spacecraft personnel alighting on the high seas or other non-jurisdiction territory, and in art. 4 where the obligation of prompt and safe return can only be activated following a landing in territory under the jurisdiction of a State Party. What assistance thus remains for situations of accident or distress that do not involve or result in an emergency landing or other type of landing is the notification obligation in art. 1 of the Agreement, and the aid to be offered between "astronauts" per the 1967 Outer Space Treaty art. V.

[142] The reading of art. 1 of the 1968 Rescue and Return Agreement as differing between three situations; accident, distress, and emergency landing, rather than as a cumulative situation of an event of accident, distress or other emergency leading to or involving an unintended landing is supported by the travaux préparatoires. Initial revised drafts by the USSR explicitly differ between accident and emergency landing, see articles 2 and 3 which concern "(…) the crew of a spaceship of another Contracting State has met with an accident(…)" and "(…) the event of astronauts (…) making an emergency landing,(…)" in UNCOPUOSOR, *Report of the Legal Sub-Committee on the Work of its Second Session (16 April - 2 October 1963) To the Committee on the Peaceful Uses of Outer Space*, UNCOPUOS, 1963, UN Doc A/AC.105/12, at Annex I, p. 3. The American revision contains a similar distinction, see art. 1 in Annex I, p. 5. Through years of negotiation the wording changed into the single "accident, distress or emergency landing" sentence that is found in the 1968 Agreement. The intent of applying the assistance obligation to both situations of accident or distress ending in emergency landing, and such situations not ending in emergency landing, remains clear. See articles 1(1) and 2(1) in Annex I p. 4 of UNCOPUOSOR, *Report of the Legal Sub-Committee on the Work of its Sixth Session (19 June – 14 July 1967) to the Committee on the Peaceful Uses of Outer Space*, UNCOPUOS, 1967, UN Doc A/AC.105/37 in which the single sentence appears but distinction is made between "assist" or "rescue" as not all situations of accident or distress would call for a rescue, as there would have been no emergency landing required.

[143] *Supra* note 25, the 1968 Rescue and Return Agreement, art. 2.

What this means for health risks and available countermeasures is that, while in orbit, the spacecraft personnel will have to rely extensively on the help they can provide for themselves and others, together with whatever specific measures the relevant "launching authority" (that has been duly notified under art. 1 of the Agreement) have in place. This ties in with the application of national law under articles VIII and II of the 1967 Outer Space Treaty and the 1975 Registration Convention, respectively, where such national law contains health rights and services or delegates the creation of such for spacecraft personnel specifically to the space agencies. Both of these will be studied closer in section 1.3 of this present Chapter.

The third paragraph of art. V of the Treaty focuses on phenomena in outer space that can constitute a danger to the life and health of astronauts. A phenomenon is commonly understood to be a fact or event that *exists*, i.e. that is known through the senses, and has a wide scope of application.[144] The understanding of a 'dangerous phenomenon' and the application of the term is left to the individual States, in good faith.[145] A crucial element of the evaluation to be made by States under this paragraph is also what "life or health" means. Life is the easier of the two, clearly involving life-threatening situations, whereas the mention of health is the first and only mention in the entire Agreement. It is clear from the recurring focus on protection of lives that physical health must be included. Whether mental health is included is more doubtful and requires a broad rather than narrow interpretation of the paragraph. Ultimately, the decision on when a phenomenon constitutes a danger to health in a manner that would activate the information obligation under this paragraph comes down to State discretion. Historically, consider-

[144] See Cambridge University Press, "Phenomenon" (Accessed 17 June 2020, last visit 9 August 2020) Online: *Cambridge Dictionary* <https://dictionary.cambridge.org/dictionary/english/phenomenon> which gives examples of phenomena such as gravity, weather, and child abuse, and Merriam-Webster, "Phenomenon" (Accessed 17 June 2020, last visit 9 August 2020) Online: *Merriam-Webster.com Dictionary* <https://www.merriam-webster.com/dictionary/phenomenon#examples> where examples include trends and cultural developments.

[145] *Supra* note 141 at 369-370.

ing mental health as an important factor in space exploration has not been the universal approach. The Soviet space medicine programmes gave mental health some importance early on, while the American programmes gave it less so.[146] This paragraph thus neither confirms nor rejects that mental health implications from exposure to dangerous phenomena trigger the information obligation, but it is surely triggered by dangers to physical health. As a result, it further promotes the interpretation of art. V as focused on more than simply life-threatening events.

The concluding remark on the presence and availability of health protection under international space law must, in light of the analysis above, be that the 1967 Outer Space Treaty contains no express health protective means, other than life-saving measures. However, the lack of an express regulation creates room for additional regulation on the matter through other means, and especially the obligations of the Treaty that demand "all possible assistance" to be rendered by States, and assistance to be rendered between "astronauts", both of which, when read in the context of the 1968 Rescue and Return Agreement, urges the application of protective measures in the event of accident or distress, outside of such situations leading to or involving emergency landing or unintended landing, including countermeasures to the protection of personnel health, but subject to the contents of national legislation and policy.

6.1.2 The right to health under public international law

The right to health appears in many international instruments, including art. 12.1 of the International Covenant on Economic, Social and Cultural Rights. It is this instrument that contributed the most comprehensive presentation of the right, expressly stating that "*The States*

[146] *Supra* note 85 at 1 and 7. See also *supra* note 11 at 368.

Parties to the present Covenant recognize the right of everyone to the enjoyment of the highest attainable standard of physical and mental health". The drafting history of art. 12 shows that this statement includes underlying determinants of health, including safe and healthy working conditions.[147] The UN Committee on Economic, Social and Cultural Rights has published a general commentary on the contents of art. 12 of the Covenant which includes many freedoms, rights and, in contrast, obligations that the right to health leads into. Of particular relevance for spacecraft personnel are the rights of and to availability of functioning health-care facilities and services within the jurisdiction of States Parties.[148]

As States retain jurisdiction over personnel and modules contributed to the ISS and registered under that State[149], the question can be raised whether States Parties that are also part of the ISS project must provide such facilities and services for their personnel members either to or on the space station. If so, the right to healthy workplace environments under the Covenant would require that States Parties to both the Covenant and the ISS project establish preventive measures for occupational accidents and diseases as well as ensure the prevention and reduction of exposure to harmful substances, including radiation and other environmental conditions that impact upon human health.[150] This includes an obligation of minimizing, "*as far as reasonably practicable*", the causes of health hazards that are inherent in the working environment.[151] That the minimization of health hazard causes can only be required "*as far as reasonably practicable*" leaves some flexibility for the States to make preventive measures for health

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[147] Committee on Economic, Social and Cultural Rights, *Substantive Issues Arising in the Implementation of the International Covenant on Economic, Social and Cultural Rights, General Comment No. 14(2000), The right to the highest attainable standard of health (article 12 of the International Covenant on Economic, Social and Cultural Rights)*, UNICESCR, 2000, UN Doc E/C.12/2000/4, at para. 4 and 11.
[148] *Supra* note 147 at para. 12(a) and 12(b). Art. 12.2(d) includes mental health services under the right to health facilities, goods and services, see para 18.
[149] *Supra* note 118, Art. 5 of the 1998 IGA.
[150] *Supra* note 147 at para 15.
[151] *Ibid*.

hazards on the space station. They are not obligated to make it as safe as perhaps a regular office workplace, and there is an acceptance of the fact that some working environments are inherently hazardous. Space is undoubtedly a such environment. But at the same time, spacecraft personnel are ensured a fundamental right to having as healthy a working environment as reasonably practicable. The countermeasures necessary for the protection against radiation as identified in Chapter 4 must be covered by this provision. But a facility such as the gym, that works to minimize the negative effects on bone- and muscle loss, may more easily be compromised upon when looking to "reasonable practicable". Would additional gym facilities and tools require changes to the Station or creation of new equipment that would exceed what could be considered "reasonable practicable"? It must be noted here that the Covenant only reaches as far as it has been ratified. The United States, as the State of registry for Node 3[152], where the gym facilities are, are only signatories to the Covenant and have not ratified the instrument despite having signed the Covenant in 1977. Considering the massive power that the U.S. holds over the ISS project, and the U.S. being a recurring provider of spacecraft personnel on the Station, the application of the Covenant becomes questionable. It grants rights to some crew members, if their States have ratified the instrument, but for States to be able to exercise their obligations under the Covenant may thus not be fully possible.

6.2 Health rights under the ISS framework

The ISS framework consists of the 1998 IGA, the four MoUs between NASA and ESA, the Canadian Space Agency (CSA), the Russian Space Agency (RSA), and the Government of

[152] Committee on the Peaceful Uses of Outer Space, Note verbale dated 14 February 2011 from the Permanent Mission of the United States of America to the United Nations (Vienna) addressed to the Secretary General, UN Doc ST/SG/SER.E/614 at 3.

Japan, respectively, implementing agreements of the MoUs, and the Code of Conduct. This is also the order of the hierarchy of the instruments that make up the framework.

6.2.1 *Under the 1998 Intergovernmental Agreement*

The prime objective of the 1998 IGA, as set forth in its art. 1, is to establish a "*long-term international cooperative framework (...) for the detailed design, development, operation and utilization*" of the ISS. The joint efforts towards this goal will be under the leading role of the U.S. for over-all management and coordination, as per art. 2. As for the on-board operation, crew matters are only dealt with in art. 11, which provides for the creation of the Code of Conduct and policies, while health specifically is only mentioned in connection with the cross-waiver of liability clause in art. 16. Despite being the leading agreement between the parties, the IGA is not of much further use for the analysis of crew and health regulations. Attention must therefore be turned to the second ranking sources, the MoUs.

6.2.2 *Under The Memoranda of Understanding*

Two of the core objectives of the MoUs are, in part, to establish the partnership's management structure in order to ensure effective planning and coordination in carrying out the design, development, operation and utilization of the space station, and, in part, to provide a basis for partnership cooperation that *i)* maximises the capability of the space station in order to accommodate user needs, and *ii)* that ensures that operation of the station occurs in a manner safe, efficient, and effective for both users and operators of the station.[153] The MoUs between NASA

[153] The National Aeronautics and Space Administration of the United States of America and the Canadian Space Agency, "Memorandum of Understanding Between the National Aeronautics and Space Administration of the United States of America and the Canadian Space Agency Concerning Cooperation on the Civil International Space Station" (29 January 1998) [*1998 MoU between NASA and CSA]* art. 1.2; The National Aeronautics and Space Administration of the United States of America and the European Space Agency, "Memorandum of Understanding Between the National Aeronautics and Space Administration of the United States of America and

and CSA, RSA and the Government of Japan contain provisions concerning the creation of health policies both during the design and development activities and the utilization and operation activities.[154] The provisions are worded in the same manner, stating that the parties together will develop "*crew health and medical care policies and procedures in accordance with Article 11*". The MoU between NASA and ESA only requires the creation and adherence to such policies during utilization and operation activities.[155] That this MoU does not call for health policies and procedures to be established during design and development activities could be unproblematic if the "everyday" activities of the spacecraft personnel on the ISS at present are categorized as utilization and operation activities, but this makes little sense when the provision was thought necessary for design and development activities for the CSA, RSA and the Government of Japan. All three of these space agencies were to provide both on-orbit and ground-based elements to the ISS, but so were ESA.[156] As the space station has an evolutionary character[157] the lack of such policy creation and adherence for the NASA and ESA partnership becomes problematic as design and development activities could take place on board the station, for example when attaching a new module or element.

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the European Space Agency Concerning Cooperation on the Civil International Space Station" (29 January 1998) [*1998 MoU between NASA and ESA]* art 1.2; The National Aeronautics and Space Administration of the United States of America and the Government of Japan, "Memorandum of Understanding Between the National Aeronautics and Space Administration of the United States of America and the Government of Japan Concerning Cooperation on the Civil International Space Station" (24 February 1998) [*1998 MoU between NASA and the Government of Japan]* art 1.3; The National Aeronautics and Space Administration of the United States of America and the Russian Space Agency, "Memorandum of Understanding Between the National Aeronautics and Space Administration of the United States of America and the Russian Space Agency Concerning Cooperation on the Civil International Space Station" (29 January 1998) [*1998 MoU between NASA and RSA]* art. 1.2.

[154] *Supra* note 153, 1998 MoU between NASA and CSA, art. 6.1.a(22), 6.1.b(8), 6.2.a(21), 6.2.b(8); 1998 MoU between NASA and RSA, arts. 6.1.a(24), 6.1.b(8), 6.2.a(24), 6.2.b(8); 1998 MoU between NASA and the Government of Japan, arts. 6.1.a(22), 6.1.b(8), 6.2.a(21), 6.2.b(8).

[155] *Supra* note 153, 1998 MoU between NASA and ESA, arts. 6.1.b(13), 6.2.b(7).

[156] *Supra* note 153, see art. 3 of the 1998 MoU between NASA and CSA, 1998 MoU between NASA and the Government of Japan, 1998 MoU between NASA and RSA, for ESA specifically 3.3 and 3.5.b of the 1998 MoU between NASA and ESA.

[157] *Supra* note 118, The 1998 IGA, art. 1.4.

In addition to ensuring the right for each partner to provide personnel to the crew and allocating crew opportunities, article 11 contains the foundation for the establishment of a *Multilateral Crew Operations Panel* as a forum for all crew matters, including processes, standards, selection criteria, certification, assignment and training coordination on a top-level.[158] Working together through this panel makes it easier for the partners to create selection criteria and training standards that are highly uniform though training is undertaken by the individual space agencies. The importance of a uniform understanding of the impact of crew selection and composition was one of the key findings in Chapter 4 on countermeasures to negative psychological effects of long-term space travel, in the form of inter-crew disputes as well as disputes between crew members and non-crew members. By being equally informed about the abilities, mindsets, and traits of the selected crew members, the agencies will be more capable of creating complete crews with healthy individual and group dynamics that can negate the development of tension or groupthink.[159] Shared standards and training coordination supports the crew composition measure by making it possible for the agencies to educate their selected personnel prospects on a variety of vital skills, including skills in both physiological and psychological care for others and themselves.

In addition to the crew operations panel, art. 11 also has an explicit health and safety focus and provides for the creation of a *Multilateral Medical Policy Board*, to ensure coordination and oversight of crew health issue and to develop a common system for medical support. The

158 *Supra* note 153, art. 11.3.of the 1998 MoU between NASA and CSA, 1998 MoU between NASA and ESA, 1998 MoU between NASA and the Government of Japan, 1998 MoU between NASA and RSA.

159 See the Multilateral Crew Operations Panel, "Principles Regarding Processes and Criteria for Selection, Assignment, Training and Certification of ISS (Expedition and Visiting) Crewmembers, 2001, Revision A" (Accessed 24 June 2020, last visit 9 August 2020) Online, pdf: The *European Space Agency* <https://esamultimedia.esa.int/docs/isscrewcriteria.pdf> at 5-6, by which agencies are obligated to undertake background reviews of crewmember candidates, to vet candidates for past and present conduct or misconduct, and to assess the candidates' behavioral suitability to ascertain whether the candidate is fit for crewmember functions.

board is supported by a *Multilateral Space Medicine Board* and a *Multilateral Medical Operation Panel* which functions on a principle of consensus and attends to matters including clinical care, medical standards, preventative medicine, and environmental monitoring, by creating medical standards, certification, care requirements covering pre-flight, in-flight and post-flight phases, as well as operational procedures and recommendations, to be presented to and finally approved by the crew operations panel and the medical policy board.[160]

The creation of these boards and panels signifies that it was important for the partnering agencies to address crew health issues early on and to continuously monitor and improve the living experiences of the crew members. By having agreed that each agency is able to appoint one point of contact under the medical policy board for the resolution of issues related to a common system for medical support for crew members, and that decisions of the space medicine board and the medical operations panel are made by consensus, in opposition to majority voting,[161] the agencies dedicated themselves to a common, considerate and humanitarian approach to space travel, acknowledging the hardships of the ISS environment and that merely living in that environment can constitute human experimentation research.[162]

The artificial *0-g* environment on the ISS severely impacts the physiology of crewmembers and the research based on these changes and the impact on human health makes crewmembers *de facto* experiment subjects. The exercise facilities and mandatory exercise plans are two examples of how health issues caused by the space environment have been identified and acted

[160] *Supra* note 153, art. 11.4 of the 1998 MoU between NASA and CSA, 1998 MoU between NASA and ESA, 1998 MoU between NASA and the Government of Japan, 1998 MoU between NASA and RSA.
[161] *Ibid*.
[162] *Supra* note 153, art. 11.5 of the 1998 MoU between NASA and CSA, 1998 MoU between NASA and ESA, 1998 MoU between NASA and the Government of Japan, 1998 MoU between NASA and RSA, which establishes a *Human Research Multilateral Review Board* for monitoring human research protocols and the health, safety, and well-being of human research subjects on the ISS.

upon by the agencies taking measures to counter the effects on muscle and bone mass. Another of the necessary countermeasures identified earlier, in Chapter 4, underlined the importance of creating mission-appropriate procedures for emergency situations to take the stress of emergency decision-making away from the crew members. The medical operation panel is the perfect forum for drafting and promoting such procedures, and for creating policies on fundamental health and mental health care service access, to be finalized by the space medicine board and medical policy board.

As to the dangers of the increased radiation exposure, art. 10 of the MoUs sets out a responsibility for the partnering space agencies to establish and continuously develop upon over-all space station safety requirements and plans for the design and development and operations and utilization phases.[163] Whilst each partner can create their own plans and requirements for the modules and elements they provide to the Station, hereby implied that the safety requirements and plans focus on hardware, software and technology or other equipment, the different agencies' plans must all comply with shared requirements and safety plans that outline the minimum level of equipment safety.[164] The most powerful countermeasure against radiation exposure is the use of appropriate shielding materials. Anti-radiation measures should be included in the minimum safety requirements that apply to all ISS partners.

The MoUs are the strongest foundation for the development of space health measures. They create an obligatory focus on health issues in addition to providing an organisational structure for the establishment of adequate policies and promote such a system and such policies in an international setting based on consensus, thus resulting in a health focused approach applied

[163] *Supra* note 153, art. 10.1 of the 1998 MoU between NASA and CSA, 1998 MoU between NASA and ESA, 1998 MoU between NASA and the Government of Japan, 1998 MoU between NASA and RSA.

[164] Supra note 153, art. 10.2 of the 1998 MoU between NASA and CSA, 1998 MoU between NASA and ESA, 1998 MoU between NASA and the Government of Japan, 1998 MoU between NASA and RSA.

internationally by virtue of transnational agreement between space agencies and governments. This is a strong foundation indeed, even if the MoUs themselves do not contain specific directions on how to mitigate radiation or *0-g* exposure or other physical health or behavioural implications. The path is clear and it would be too much to expect of the initial documents establishing the ISS that they should contain complete policies at the time of signature. However, the true impact of provisions 10 and 11 will depend on the successful creation of the boards and panels and the continued monitoring of health and safety issues as the station is physically developed upon and the circumstances for the crewmembers change.

6.2.3 Under the Code of Conduct

The Code of Conduct is, unlike the IGA and MoUs, not an international agreement in a legal sense, yet it was important for the partner States to the ISS project to hold each other accountable for compliance with its contents. This resulted in various domestic implementations of the Code in order to ensure uniform compliance and accountability for the crewmembers provided by the different States. As such, the individual crew members are legally bound to comply with its contents.[165]

The final paragraph of art. 11 in the MoUs describes the general contents of the Code of Conduct and makes it binding upon partner States to approve the Code before it provides crewmembers to the space station.[166] By art. 11, the Code will establish a chain of command on-orbit and a clear relationship between ground and on-orbit management, the management hier-

[165] The most common way of implementing the code was to include it in space agency employment agreements. For details see André Farand, “The Code of Conduct for International Space Station Crews” (2001) 105 ESA Bulletin 64 at 67-68.

[166] *Supra* note 153, art. 11.8 of the 1998 MoU between NASA and CSA, 1998 MoU between NASA and ESA, 1998 MoU between NASA and the Government of Japan, and art. 11.9 of the 1998 MoU between NASA and RSA.

archy, standards for work and activities in space and on the ground, responsibilities with respect to elements and equipment, disciplinary regulations, physical and information security guidelines, and provide the space station commander the appropriate authority and responsibility *to enforce safety procedures* and physical and information security procedures and crew rescue procedures. In creating a clear management hierarchy and making it mandatory for all participants to submit to the authority of the space station commander, who in turn submits to the director from ground-control, the Code provides a minimum level of decision-making procedure that removes some stress from crew and especially the commander, as his or hers freedom, and burden, to make important decisions for the entire crew is restricted in advance.

The Code states that all ISS crewmembers must abide by the standards and requirements defined by the crew operations panel, the space medicine board and the medical operations panel throughout the pre-flight, in-flight, and post-flight phases.[167] In this way, the Code almost immediately loops any health policies back to art. 11 of the MoUs and the panels and boards established therein, instead of offering support in any form as to what should be contained in the standards and requirements to be established by the panels and boards. Whilst this ensures that there will be no contradictions between the instruments of the ISS framework, the approach also drowns out the notion that the Code contains any fundamental health or safety principles applicable, at least from the initiation of the ISS project. The closest the Code comes to any such principle is the obligation put on crewmembers to conduct themselves in a manner "*such as to maintain a harmonious and cohesive relationship among the ISS crewmembers and an appropriate level of mutual confidence and respect through an interactive, participative, and*

[167] 14 C.F.R. §1214.403 – Code of Conduct for the International Space Station Crew (U.S), art. I.B

relationship-oriented approach" considerate of the international and multicultural nature of both the crew and the mission.[168]

Although worded in a general manner, this provision supports and seeks to promote a healthy work environment amongst the international crew members as colleagues by setting a standard for the over-all tone between crewmembers and their attitudes toward each other. However, the general nature of this wording is due to the provision being a compromise. The partner States had originally considered a zero-tolerance policy on acts of inter-crew harassment but were unable to agree on a common definition of *harassment*, and so agreed on the *harmonious and cohesive*-phrase in order to be able to establish a sanctioning system for actions of crewmembers that would negatively affect the already extreme and sensitive social environment on the ISS.[169] The general wording regains some of its power by the creation of a sanctioning system, and a such system exists in the form of the Disciplinary Policy for International Space Station Crew, which outlines different levels of disciplinary action that can be taken when applicable, and changes depending on when during the pre-flight, in-flight, or post-flight phases the breach of the Code of Conduct occurs.[170]

In contrast to the broadly worded behavioural standard, the Code also contains a very specific provision on mementos and personal effects, by which crewmembers are allowed to bring smaller items of minor value with them to the ISS, for their private use. This may be a comforting right for the crewmembers, as the possession of something from their home may help them during mental lows and thereby improve their mental health, but the further details of the

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[168] 14 C.F.R. §1214.403 – Code of Conduct for the International Space Station Crew (U.S), art. II.B.
[169] *Supra* note 165 at 66.
[170] See the European Space Agency, "Disciplinary Policy for International Space Station (ISS) Crew" (Accessed 29 June 2020, last visit 10 August 2020) Online, pdf*: Disciplinary Policy for International Space Station (ISS) Crew* <http://download.esa.int/docs/ECSL/ISS_Crew_Disciplinary_Policy.pdf>

provision do not indicate that this was the original intent with the right. The provision specifies that the items are subject to restrictions of manifest limitations, on-orbit stowage allocations and safety considerations, and that they must not later be used as a commercial object.

Whilst it is an obligation on all crewmembers to conduct themselves in harmonious and cohesive ways, it is, in addition, the obligation of the Commander to maintain this social environment.[171] This is just one of the responsibilities derived from the Commander's special position as crew leader. Other responsibilities include, but are not limited to, the responsibility for forming the individual crewmembers into an integrated team, acting as the crew's representative, mission accomplishment, maintaining order, and ensuring crew safety, health, and well-being.[172]

The Commander may use any reasonable and necessary means to fulfil these responsibilities.[173] It is in other words the Commander's responsibility to ensure that the crewmembers act in accordance with orders, work-schedules, and procedures, including procedures for ensuring safety, health, and well-being, such as are created by the space medicine board, medical operations panel and medical policy board. Without the Code containing any detailed crew health and safety measures as such, it does contain an enforcement system of policies passed by the space medicine board, though only the most fundamental pillar of the enforcement system. This pillar is the authority of the Commander to use "*any reasonable and necessary means*" to fulfil his or her responsibilities, including carrying out and ensuring crew compliance with crew health, safety and well-being rules and procedures during the in-flight phase.

[171] 14 C.F.R. §1214.403 – Code of Conduct for the International Space Station Crew (U.S), art. III.A.
[172] 14 C.F.R. §1214.403 – Code of Conduct for the International Space Station Crew (U.S), arts. III.A.1 - III.A.2(a) and (b).
[173] 14 C.F.R. §1214.403 – Code of Conduct for the International Space Station Crew (U.S), art. III.A.2(c).

6.3 Health rights under national law

6.3.1 Example of American law

Spacecraft personnel that have been provided by NASA are, with the exception of personnel provided to NASA by the US military which remain military employees, federal employees and therefore only subject to the Occupational Safety and Health Act of 1970 to the extent that the standards contained in the Act apply to the safety and health standards created by NASA itself. Military employees are fully exempt from the Act.[174] NASA's safety and health standards for spacecraft personnel are contained in NASA Space Flight Human-System Standard Volumes 1 and 2. Potential personnel of a private space station, thus not employed by NASA, are not covered by these standards and would instead be subject to the Occupational Safety and Health Act of 1970, as applicable, unless the private space station company or organization entered into legal relations with NASA, as the Volumes 1 and 2, per their sections 1.2, can be made applicable to external contractors.[175]

6.3.1.1 NASA Space Flight Human-System Standard Volume 1

Volume 1, entitled "*Crew Health*", applies to all NASA space flight programs and supersede any conflicting crew health requirements contained in other NASA standards. The technical requirements only apply to internationally provided systems and contractors if explicitly agreed upon in writing between NASA and the other party.[176] The Volume is highly detailed, beginning with an outline of the six levels of medical care that NASA can provide, ranging from

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[174] Executive Order No. 12196, 3 C.F.R. p. 145 (1980) (U.S)

[175] An example hereof is the B330 inflatable hospitable module currently being developed by Bigelow Aerospace. While the module could, in theory, be sent into orbit as a private venture, Bigelow Aerospace is hoping to partner with NASA in its actual use. See Chris Bergin, "Bigelow's B330 – an autonomous, expandable independent exploration space station" (13 September 2019) Online: *NASAspaceflight.com* <https://www.nasaspaceflight.com/2019/09/bigelows-b330-autonomous-expandable-station/>

[176] NASA Technical Standard, "NASA Space Flight human-System Standard Volume 1, Revision A: Crew Health", Approved 30 July 2014, NASA-STD-3001, VOLUME 1, Revision A w/Change 1, at 8.

care level zero with no perceived threat and thus no planned medical support to care level five with a high level of potential risk to personnel and strong preventive strategies required because of the autonomous nature of the specific mission type, before describing the three types of standards for human performance and acceptable medical risks, including fitness for duty standards, permissible exposure limits standards, and permissible outcome limits standards.

The lowest level of care, Level Zero, applies to certain training situations, includes no special medical support, but a survival kit may be made available. Care Level One, however, concerns situations of missions in LEO and sub-orbital flights, and requires crewmember training in first-aid implementation of follow-on medical support.

In situations where there is a moderate medical risk to personnel, namely missions in low earth orbit with a duration of less than 30 days, Level Two enters into effect, by which preventive strategies must be in place for reduction of risk, interventions strategies shall be in place to reduce risk to an acceptable level, and the crew shall have access to clinical diagnostics, ambulatory care and basic life support. In situations of a moderate to high medical risk, typically missions outside of LEO of less than 30 days duration, Level Three expands the required preventive and intervention strategies to an advanced level including medications and equipment to support advanced life support, trauma care, and limited dental care. In addition, there must be plans for return transport for the serious ill or injured crewmember.

Care Level Four is activated for planetary missions and low earth orbit missions with a duration greater than thirty days and is thus the level applied to NASA employees provided to the ISS. It includes greater use of preventive strategies as the ability to support chronic illness or to return an ill or injured crewmember to earth is readily available. Therefore there will also be more training in intervention strategies, but the scope of medical care will be limited as a result of availability of supplies and consumables. Level Five is used for planetary missions greater than 210 days and builds upon the contents of Level Four, but also includes a requirement of physician level caregiving from a crewmember and recognizes that return to earth is not a viable option for serious illness or injuries.[177]

The rationale for the six levels of care highlights the importance of preventive medicine for missions categorized under Levels Four and Five, for Level Five the rationale specifically describes the effects on available care caused by the conversion from ground-reliant care to autonomous care, and it is underlined that for missions under Level Four and Five any care given to a crewmember as a patient will be measured against the sustainability and survivability of the remaining crewmembers, effectively causing the care to be triaged accordingly.[178] Volume 1 does not describe the exact preventive or intervention strategies that should be applied, but it must follow from the balancing act of the patient's needs versus the needs of the remaining crewmembers combined with the fundamental understanding that some levels of health risk exposure are acceptable, that the strategies must be focused on keeping the space between the upper limit of termination of care due to crew concerns and the lower limit of the acceptable risk exposure as wide as possible by countering the deleterious effects as effectively and for as long as possible.

The lower limit, or the extent of health risk exposure which is acceptable, is set out in the three Standards provided in Volume 1. The Standards are extensive. As an example, the first Standard, "*Fitness for Duty*", lists the aerobic capacity standard for pre-, in- and post-flight down to the minimum acceptable unit[179], orders that standards for sensorimotor function shall

[177] *Supra* note 176 at 15-18.
[178] *Supra* note 176 at 47-48.
[179] *Supra* note 176 at 19.

be guided by the nature of the mission-associated high-risk activities, provides for pre-, in-, and post-flight monitoring of the crewmembers' behavioural health including post-flight transitioning, and lastly includes standards for haematology and immunology levels.

The rationale for the health standards are equally comprehensive, detailing both the reasoning and the science behind the standards. As such, the aerobic capacity standards are intended to counter deconditioning resulting from microgravity, lack of exercise and other such factors, as is the case with the sensorimotor monitoring, and the behavioral health standards are meant to counter sleep disturbances, team cooperation and communication issues, isolation, workload and similar health impacting stressors, while the haematology and immunology standards work to lower immune system changes.[180] Interestingly, the rationale for the behavioral standards is one of the most explanatory, dividing potential strategies into six categories covering a wide span of psychological issues resulting from space travel. This includes the inclusion of behavioral health and performance testing during selection of crew members, training in environmental adaptation and effective stress handling, the availability of in-flight psychological and neurobehavioral support in the form of private conferences, care packages, task scheduling, and individualized countermeasures for long-term missions, continued in-flight monitoring, and even psychological support for crew families and repatriation when nearing return to Earth.[181]

The second standard, "*Space Permissible Exposure Limits"*, concerns radiation exposure and outlines the maximum levels of radiation dosage acceptable for 30-days, for one year, and for an entire career in order to minimize potential cancerous issues.[182] This is in line with the

[180] *Supra* note 176 at 51, 53, 55, 61.
[181] *Supra* note 176 at 56-57.
[182] *Supra* note 176 at 22 and 75.

recommended monitoring-countermeasure suggested in addition to the appropriate radiation shielding. The third and final standard, "*Permissible Outcome Limits"*, extends the physiological protection scope, covering such topics as nutrition, muscle strength, and bone mineral loss, Volume 1 thereby successfully addressing the major physiological risks of space travel as identified previously in this thesis. For all three, a pre-flight standard is defined and must be met, with some flexibility for the individual crewmember. In-flight, the nutrient intake must not go below 90% of the calculated nutrient requirements, the muscle strength must not go below 80% of the pre-flight baseline, and the bone mass shall be maintained at a pre-defined post-flight level. Post-flight, treatment shall be given to return these differing values to their baseline value.

6.3.1.2 NASA Space Flight Human-System Standard Volume 2

Standard Volume 2, entitled "*Human Factors, Habitability, and Environmental Health"*, differs most significantly from Volume 1 by its change in focus from physiological crew health issues to that of the capabilities and limitations of the human physical and cognitive situation in space and what such limitations mean for the design of the human-system integration of the space station or space vehicle.[183] The question at the heart of Volume 1 could be "how does space interact with humans?", while the question for Volume 2 could be "How do humans interact with space?". As such, the Volume contains fewer standards and policies on crew health issues, yet some measures detailed in Volume 2 make for additional support to the measures taken in Volume 1. Examples of such physiology-oriented measures include an obligation to take the decreased muscle mass into consideration when designing systems requiring

[183] NASA Technical Standard, "NASA Spaceflight Human-System Standard Volume 2: Human Factors, Habitability, and Environmental Health", Approved 9 September 2019, NASA-STD-3001, VOLUME 2, REVISION B, at 11.

human strength[184], an obligation to limit noise limits and vibrations for the purpose of improving sleeping conditions[185], the obligation to meet all radiation exposure limitation requirements set out in Volume 1 when creating system design requirements[186], an obligation of providing a food system capable of maintaining food safety and nutrition throughout the mission[187], and an over-all obligation to provide countermeasures to meet crew bone, muscle, sensory-motor, and cardiovascular requirements as defined in Volume 1[188]. Requirements aimed at psychological countermeasures are also included in Volume 2, one example hereof being the obligation to provide individual privacy facilities for missions with a duration exceeding 30 days and the obligation of providing both individual and team-oriented recreational capabilities for the crewmembers.[189]

Though this list of examples is not in any sense an exhaustive list of the standards and requirements set out by NASA, almost all of the here mentioned examples clarify that a large part of their rationale is the protection of crewmembers and vehicle or station systems for the sustainability of the crew and thus, ultimately, the success of the mission. By NASA policies and standards, crew safety is less of a goal in itself and more of a subsidiary goal to achieve mission success.

6.3.2 Example of Russian law

As illustrated previously in this thesis, the national framework for the rights of spacecraft personnel from a Russian perspective is less immediately specialised than the American system. Specialised international agreements do exist, by virtue of the obligation under the MoUs

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[184] *Supra* note 183 at 22.
[185] *Supra* note 183 at 64, 69.
[186] *Supra* note 183 at 70-71.
[187] *Supra* note 183 at 75, 77-78.
[188] *Supra* note 183 at 88.
[189] *Supra* note 183 at 97, 99.

to create medical policies together, but for the potential Russian non-ISS spacecraft personnel, other legal instruments – at a higher level than any inter-agency agreements – will apply.

6.3.2.1 Rights as Russian citizens

The right to health under the International Covenant on Economic, Social and Cultural Rights applies, providing the right to enjoy the highest attainable standard of physical and mental health, and the Russian legal system pays an unusual amount of attention to health in even its most fundamental legal documents, such as its constitution directing the Federation to a national policy of creating conditions in the nation that provide for a worthy life and protects the health of its citizens. As citizens of Russia, spacecraft personnel also have these fundamental health rights. It must be remembered, however, that the right to health under the Covenant is a flexible right, requiring the availability of health services and facilities only as far as reasonably practicable. The issues that this limitation creates for the ISS project have been described earlier, but they remain relevant for purely national missions. Any ideally available health services and facilities will be weighed against the other needs of the mission, which is why the in-flight phase will be the phase in which most health measures are likely to be compromised upon, while the pre- and post-flight phases, where the personnel is back on Earth, will more easily include the necessary services and facilities.

In addition to the services and facility level granted by the Covenant, the Russian health system provides a variety of services available under the mandatory general health insurance system. The services offered under the publicly financed health insurance are determined by state guarantees on an annual basis and thus subject to detail changes, though the purposes of the two parts that make up the mandatory insurance cover everyday health needs of the population, for the basic part, and cover specialized and high-technology medical care, outpatient pharmaceutical costs for certain groups, and emergency core, for the advanced part. Benefits not included in the insurance will be listed expressly in the updated benefits documentation.[190] Facilities are managed on a municipal level.[191] Though the municipal management has resulted in considerable differences in regional health outcomes[192], Russian spacecraft personnel would, in theory, have the right to availability, by virtue of their citizenship, to benefits such as treatment of different types of disease including such relating to the cardiovascular system, bone and muscle, or disease of a neurological nature.[193] This being the case, some medical securities are in place for the 'cosmonauts' upon return to Earth, as any such type of disease developed during and perhaps caused by their stay in space can be sought medical attention for. It does, however, not help the 'cosmonauts' while they are *in* space, as facilities and services made available for the Russian public cannot be expected to extend to specific space exploration activities, and pre-emptive measures are not guaranteed.

6.3.2.2 Rights as federal employees

In Russia, spacecraft personnel are selected and employed by the state-owned Roscosmos, which triggers the application of occupational health regulations in addition to health rights of the Russian public. Occupational health is mainly regulated in the Labour Code of the Russian Federation.[194] By article 11 of the Labour Code, the Code applies to all but a select group of employment situations. This exempted group includes military personnel, employees under

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[190] *Supra* note 134 at XVII.
[191] *Supra* note 134 at 13.
[192] *Supra* note 134 at XXIII.
[193] *Supra* note 134 at 75-76. Note the annual modification of the mandatory health insurance package, and that Popovich's list is from 2011.
[194] International Labour Organization, "Russian Federation – 2015" (Accessed 7 June 2020, last visit 12 August 2020) Online: *International Labour Organization, LEGOSH* <https://www.ilo.org/dyn/legosh/en/f?p=14100:1100:0::NO:1100:P1100_ISO_CODE3,P1100_SUBCODE_CODE,P1100_YEAR:RUS,,2015:NO>

civil law contracts[195], board directors of organisations, and employees explicitly exempted by federal law. None of these include spacecraft personnel, and being a federal employee is not in itself exempted either.[196] Safety regulations can be found in section X of the Labour Code.

A main principle in the Russian Labour Code is to ensure the rights of employees to fair working conditions, including working conditions meeting relevant safety and hygiene requirements and the right to leisure.[197] Section X elaborates comprehensively on this principle by, firstly, establishing basic guidelines for state policy in the field, such as prioritizing the preservation of employees' life and health, and propagating best practices of improving working conditions.[198] Secondly, the Code calls for mandatory labour protection requirements and obligates employers to ensure safe conditions and labour protection by adhering to those mandatory requirements, and to adopt the rules and instructions for workplace safety, as well as organizing continued surveillance and medical examinations of workers.[199] Special requirements are in place for the more vulnerable workers, such as those working in environments with high exposure to ionising radiation, or much vibration and noise.[200] Such safety standards, focusing on the technical aspects of radiation, vibration, noise, and emergency situations, have been developed.[201] This all adds on top of a governmental standard from 1995, the GOST R 50804-95 entitled "Cosmonaut`s habitable environments on board of manned spacecraft. General

[195] In opposition to labour contracts as defined in art. 56 of the Russian Labour Code, *supra* note 130.
[196] The Russian Labour Code applies to employment situations no matter the ownership or structure of the employer. See art. 11 of the Russian Labour Code, .*supra* note 130
[197] S*upra* note 130. Art. 2 of the Russian Labour Code.
[198] S*upra* note 130. Art. 210 of the Russian Labour Code.
[199] S*upra* note 130. Arts. 211-213 of the Russian Labour Code.
[200] *Supra* note 194 at 9.4.
[201] See Olga Zhdanovich, "Russian National Space Safety Standards and Related Laws", in Joseph N. Pelton & Ram S. Jakhu, ed, "*Space Safety Regulations and Standards*", 1st edition New York, (Butterworth-Heinemann, 2011) at 75-77, where several standards relating to radiation protection are listed, as well as standards for lowering vibration and noise levels.

medicotechnical requirements."[202] Thirdly, a highly detailed process for the reporting and investigation of workplace accidents is established leading into liability issues and compensation regulation in the later sections of the Labour Code.[203] When considering this broad scope of the Labour Code and its level of detail it is important to note that the Code only considers events resulting in bodily harm, *i.e*. injuries, as accidents under the Code. In interpreting whether this means *physical* injuries, the examples provided in the Code, which include, but are not limited to, radiation exposure, bites, burns, damage from explosions, electrocution, which supports the reading of bodily harm as requiring physical injury.[204]

The elements that the specific policies add, such as those for radiation workers, and the contents of the GOST R 50804-95, show a similar approach. The GOST, for example, in its eight chapter, requires the provision of technical means of general and physical protection of the crew against radiation, the use of prediction of radiation situations during in-flight phases and the planning of emergency measures to be taken to return the crew to Earth if a situation where the radiation environment becomes dangerous to the life and health of the crew arises. The focus on use of appropriate shielding is evident.[205] Chapter eight of the GOST also manages some preventive measures to the adverse effects of weightlessness, such as letting the duration of the mission be indicative for which measures to apply, to include considerations of these affects during crew selection phases and organizing physical training.[206]

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[202] The GOST R 50804-95 is available in Russian online, see GOSTExpert, "ГОСТ Р 50804-95, Среда обитания космонавта в пилотируемом космическом аппарате. Общие медико-технические требования" (Accessed 14 July 2020, last visit 4 August 2020) Online, pdf: *GOSTExpert.ru* <http://gostexpert.ru/data/files/50804-95/ba0cb87228427f54f1e37c9b8e3e1583.pdf>

[203] *Supra* note 130. Arts. 227 – 231 of the Russian Labour Code.

[204] *Supra* note 130. Art. 227 of the Russian Labour Code.

[205] *Supra* note 202, para. 8.1.6.

[206] *Supra* note 202, paras 8.2.1 – 8.2.7.

When the Law of the Russian Federation on Space Activities entails that the contractual relationship with spacecraft personnel shall follow the laws and other normative legal acts of the Russian Federation and the legislation for the personnel as employees reflects a large scale safety system though with a limited, physical scope of application, it becomes apparent that the immediate physiological dangers are recognized and therefore also to some extent have already been sought countered. As an example, the use of a fixed annual radiation dose average cap has been established both in Russia for radiation exposed workers, including specific standards for space crews, and for the spacecraft personnel employed under other space agencies.[207] But it is just as apparent that there are flaws in the system and that the labour situations regulated for the general public and general labour problems do not transfer in full to the labour situation of spacecraft personnel. Especially the lack of psychologically focused regulation is surprising, when it has previously been discovered that the Soviet space programs were pioneers in the field of space psychology studies, and when the Russian legal system places the health of the federation's citizens at the heart of the system, continuously promoting a fundamental right to health and thus health care services and facilities sufficient for the needs of the general public. It is thus revealing that the most solid regulation of mental health protection for spacecraft personnel shall be found in the GOST, in which sections 7.4.1 and 7.4.3 require that also mental health care concerns must be involved in mission planning procedures, including sensitivity to the crews' schedule, allowing "time off", training crewmembers in self-monitoring, and providing external sources of mental stimulation. As such, the GOST clearly aligns with the countermeasures necessary for sustaining the physical and mental health of spacecraft personnel as proposed in the former chapters of this thesis, but the GOST remains, merely, a governmental standard.

[207] *Supra* note 194 at 9.4.1; *Supra* note 11 at 207.

7. Findings and forward paths

7.1 The status quo of spacecraft personnel health regulation

The initial task of the present thesis was to examine the international and, in specific cases, national regulation of health issues pertaining to spacecraft personnel and health implications of space travel. In undertaking this task, a number of the most immediate implications for both the human physiological and psychological health and the countermeasures necessary to ensure a stable work- and living environment that would result in mission successes were identified.

In regards to personnel physiology, the implications included the highly increased radiation exposure and the eroding effects of the *0-g* environment on the human body's ability to maintain bone strength and build and maintain muscle, also negatively affecting the cardiovascular system. Countermeasures to radiation risks included the appropriate shielding of the space vehicle or station combined with continuous monitoring of potential radiation events, like solar flares, and monitoring of crew individuals, effectively measuring radiation exposure and comparing the radiation levels to a career-level chart to track exposure and terminate the active personnel duty when certain levels were reached. For bone loss, muscle loss, and the cardiovascular issues a common solution was proposed; exercise, and much of it, while in space. The exercise programmes to be followed should, in addition, be tailored to the specific mission, as, for instance, higher strength levels might be necessary for interplanetary flight, while orbital missions required less muscle capacity, and since return to Earth would be more easily facilitated, after which the rehabilitation activities could be initiated to help the personnel individuals reach their pre-mission bone and muscle base levels. As a general point of interest, it was found that long-duration and beyond LEO missions would present the biggest risks to mission crew.

In regards to the psychological risk factors, the dangers identified were many. Proneness to feelings of both physical and social isolation, the high-stress work environment, the inability to “get away” and limited space for privacy, monotony in almost all aspects, the stressors of major exposure to noise and vibration, in addition to the completely changed experience of a day – sixteen sunsets in twenty-four hours – all leading to lack of sleep and poor sleep quality, ultimately creating a “perfect storm” for the development of stress, depression, and exhaustion in crew members individually, presenting one kind of threat, but also another kind of threat as such feelings could negatively affect the group dynamic resulting in either crew-internal or crew-external disputes and a negative social work environment, which in such communication and cooperation-dependant work situations as space exploration missions could result in mission failure as well as more dire consequences on an individual level. Identified countermeasures to these psychological risks included work schedule planning that is mindful of leisure time and not putting additional stress on crew members, the ability to communicate with family, friends and other Earth-based non-mission related people, the availability of stimuli, e.g., supply of new and different foods, items from home, care packages, as well as the availability of private mental health services, such as one-on-one conference with health care professionals, and continuous monitoring of the individual crew-members wellbeing, so that any negative developments may be caught in time for countermeasures to be activated and deter the further derogation of the mental health of that individual. The issue was also raised that for long-term missions venturing beyond the LEO, communication services and supply of new foods or items will become increasingly more difficult to provide. Some significance was granted to suggestions of training crew members in behavioral health aspects and what to expect during missions, so that they would be able to monitor their own well-being and aid each other, should another crew member succumb to any of the stressors and mental triggers inherent to long-term isolation and the physical circumstances of the vehicle or space station.

In summary, provision of the necessary countermeasures for both physiological and psychological well-being needs to be addressed during pre-flight, where vehicle development can include implementation of shielding and exercise facilities and crew members can receive the proper training, during in-flight, where the self- and ground-controlled monitoring of well-being levels can take place and where provision of stimuli services can be provided, and during post-flight rehabilitation and recovery training. What is needed for the necessary protection of spacecraft personnel health, from a legal perspective, is thus, in part, the right of spacecraft personnel to not suffer physiological or psychological implications beyond a reasonable limit, and the obligation on their launching state, authority, or agency in the case of ESA, to provide adequate health services and facilities during pre-, in- and post-flight.[208]

Upon examining the treaties that make up the legal instruments of international space law, it was discovered that the 1967 Outer Space Treaty, even with the clarifications and additions offered by the 1968 Rescue and Return Agreement, contained only some wording on the matter of crew health and safety, though the wording was of high significance in that it promoted an open interpretation of the "astronaut" term, thereby granting States and agencies the powers of detailing "astronaut"-making, including selection and training requirements. Any immediate connection from this to the psychology training suggested above was, however, a stretch. Article V furthermore provided for the obligation on States to render all possible assistance in the event of accident, distress, or emergency landing, which was found to result in merely an in-

[208] The term "reasonable" is applied here due to the acknowledgement that some implications *will* be experienced by the crew members, which is why a right to not experience any implications at all would be without purpose.

formation obligation in events of health-only accident or distress, with distress being the broader term of the two and more inclusive of mental distress events, not triggering any obligations of rescue and return, with the information obligation ultimately leading to the relevant launching authority taking further steps to mitigate the event of accident or distress reported to it. Thus, much was left to the contents of national law and policy, whether specialised or not. As for the obligation of informing other States when phenomena in outer space that could constitute a danger to the life and health of astronauts, the result were much the same. As such, the protectionary measures available directly under the space treaties were very few, and mainly focused on aiding spacecraft personnel during or after an event of accident or distress, with the protection being clearer where such a situation created a life-threatening event.

Another instrument of international law, the International Covenant on Economic, Social and Cultural Rights, which establishes the right to health, was of help only on a case by case basis, as the U.S. has not ratified the Covenant, which is why, in the case of ISS-situations, the right will fall to the national ratification and implementation of the State of which the individual crew member is a national.

The ISS framework provided a much stronger foundation in its MoUs, by virtue of the 1998 IGA, as the MoUs between all parties in almost the exact same wording obligated the parties to create crew health and medical care policies, and to cooperate on standards of selection and training of spacecraft personnel prospects. The MoUs also established a series of panels and boards tasked with the different aspects of monitoring, researching, and improving health and medical care issues, and expressly provided for the creation of technical standards to protect against radiation and other dangers of the space environment. The MoUs were detailed on the organisation of international cooperation on these matters, though the MoUs were equally clear on the ISS project being a project led by the U.S., and the documents being exclusively applicable to the ISS project. In the face of the U.S. withdrawing from the project in the mid 2020's, this exclusive applicability will create issues for future international space exploration, as a new legal framework will need to be built for such missions, and, should national space exploration be boosted, the varied national legal systems will apply, creating a highly varied protective system for crew health issues.

The Code of Conduct for crewmembers was found to successfully create a legally binding acceptance of conform behaviour amongst international crews, created to avoid in-crew disputes, a countermeasure called for by space health experts.

Surprisingly, following analysis of both the national American and Russian legal set-up for health of citizens in general and occupational health specifically, both systems, though very different in mentality and organisation, were found to be highly detailed. The American system nearly completely bypasses the Occupational Safety and Health Act, allowing NASA as a federal agency to create their own policies, which for spacecraft personnel has resulted in the NASA Space Flight Human-System Standard Volumes 1 and 2. Especially Volume 1 contained crucial health protectionary means, allowing for an increased amount of medical training and countermeasures to be available the longer the term and the deeper into space the relevant mission would go, highlighting in part the importance of tailoring needs to individual missions and preparing crews for self-reliance for long term missions and missions beyond the LEO. Volume 2 reiterated the obligations contained in Volume 1 by demanding that the technical requirements necessary for meeting the contents of Volume 1 were met, thereby physically requiring the inclusion of the facilities necessary for those health services to be provided. The Russian system took a both similar and very different approach to the matter, having health concerns for its citizens at the heart of the legal system, based in the constitution, granting Russian citizens access to certain health services, though the provision of such in space travel situation were questioned. Roscosmos, as the state owned employer of cosmonauts, is obligated by the Russian Labour Code to ensure compliance with the code for its employees, which ties into the GOST R 50804-95. The standard contains many detailed sections and manages both physical issues, such as those caused by radiation and microgravity exposure, and mental problems resulting from high stress levels and a lack of mental stimulation, and it continuously provided for the flexibility of mission planning necessary to provide the appropriate services and facilities to sustain over-all health of the personnel members. The single most evident fault of the GOST was that it was a governmental standard rather than legislation or in-house Roscosmos policy.

Using these findings to answer the fundamental question asked with this thesis, whether the current legal framework sufficiently protects the health of spacecraft personnel, the answer is found to be far less straight forward than presumed by the question. On an international treaty level, it is not. On an international multilateral level, it *can* be. On a national level, the answer is the same; it *can* be, but will inevitably be highly varied depending on the specific nation's interests in space exploration.

7.2 Paths, standards, and international agreements

7.2.1 Regulation at a national level

To put it simply, the findings of this thesis, so far, suggest that the most effective approach to ensuring the *de facto* protection of spacecraft personnel health, both physical and mental, has been through detailed and specific national regulation on the relevant space programme or mission. However, the analysis has also shown that where detailed regulation does exist, most commonly in the form of standards or "in-house" policies, they make up only parts of a much larger *mission success* framework, rather than having an elevated position or even a legally binding position.

What the spacecraft personnel do have is a series of very detailed and evolving, and in scope and purpose very varying, policy-based benefits, which are subject to change and with no established lowest common denominator. The American and Russian space agency-focused employee policies successfully address at least the most vital health issues, as demonstrated in the former analysis, and these policies together with numerous other technical standards of these nations were driving sources for the International Organization for Standardization (ISO)'s creation of the ISO 17763:2018 standard on "*Space systems – Human-life activity support systems and equipment integration in space flight*", of which the two-part purpose is to increase crew efficiency and support their health.[209] The ISO standard is a voluntary standard and not a legally binding document. Whilst it thus may help in an international unification of the technical design of space systems in regards to the physiological and behavioral needs of crewmembers[210], it does not guarantee it, and it definitely does not grant the crewmembers any health rights.

It adds further to the questionable reliability of national law that national law on health, occupational health, and space-related health matters varies greatly, as demonstrated by the differences in the American and Russian examples, but surely also in other countries that are less active space explorers, or that have combined their space efforts, such as the State parties

[209] International Organization for Standardization, "ISO 17763:2018(en)" (accessed 13 July 2020, last visit 14 August 2020), Online: *ISO Online Browsing Platform* <https://www.iso.org/obp/ui/#iso:std:iso:17763:ed-1:v1:en>

[210] Jenni Tapio & Alexander Soucek, "National Implementation of Non-Legally Binding Instruments: Managing Uncertainty in Space Law?" (2019) 44:6 Air and Space Law 565 at 568.

to ESA. One example hereof is the German system. Three German nationals have been stationed on the ISS, making Germany the European country with the third most nationals to have visited the ISS.[211] The legal framework that applies to German spacecraft personnel, and other personnel that are nationals of member states of ESA, is complex. Germany has, like Russia, ratified the International Covenant on Economic, Social and Cultural Rights, which includes the right to health. National health legislation applies by virtue of individual nationality and in many instances national law will reflect the law of the European Union. The German healthcare system is based on mandatory health insurance and equal access, is obtained through either public or private insurance, and grants access to a series of benefits, including physician services and mental healthcare.[212] The regulation hereof is set out in the German Social Code ("Sozialgesetzbücher").[213] National *occupational* health regulation will not apply as German nationals that are employed as spacecraft personnel by ESA will not be employees of a German employer, but of ESA as an inter-governmental organization with legal personality, which, as a such organization, does not tie its legal framework to any specific country.[214] Internal organization policies will apply instead, despite the fact that the European Astronaut Centre is located in Cologne, Germany. As such, in countries with more small-scale space industry, national policy cannot be relied upon to properly secure the health of national spacecraft personnel.

The argument that appropriate levels of health and safety of spacecraft personnel should be dealt with on an exclusively national basis is thus rejected. The national basis is important, as

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[211] Italy has provided 5 visitors, France has provided 4. See *supra* note 127.
[212] World Health Organization, "UHC Law in Practice, Legal access rights to health care, Country Profile Germany" (2019) Online, pdf: *World Health Organization* <https://www.who.int/publications/i/item/uhc-law-in-practice-legal-access-rights-to-health-care-country-profile-germany> at 4, 7 and 9.
[213] For provisions on the statutory health care system see The German Social Code, Book V – Statutory Health Insurance (Article 1 of the law mod. 20 December 1988, BGBI I, p. 2477).
[214] See art. XV of the Convention for the Establishment of a European Space Agency, 30 May 1975 (entered into force 30 October 1980).

shown, but the appropriate level of detail in health-focused policy can only be expected of high-level space exploration participants, and there is no common binding standard, which is why the national-based system would eventually result in better health services and facilities available to some space mission crews and not to others as part of international crews. The ISS project successfully avoided this issue by binding the project partners on a multilateral level to create medical policies, by the power of the 1998 IGA and the MoUs. But with the ISS nearing its final years as a mostly non-commercial station, and both the U.S. and Russia wanting to venture deeper into space – to orbit the Moon – the successful legal framework of the ISS will, just as the station itself, be left behind.

7.2.2 Proposing a spacecraft personnel health principle

In a way, this is a favourable position to be in for a legal field. New issues are at hand, and some instruments of the legal field falling behind will make space for new ones. This moment is opportune for suggesting that a new principle should be added to space law.[215] This principle should contain an obligation of the launching authority, per the 1968 Rescue and Return Agreement, or the launching State, per the 1972 Liability Convention, to provide the services and facilities necessary for sustaining the physical and mental health of spacecraft personnel before the spacecraft is launched, while the spacecraft carries personnel, and after the spacecraft personnel has returned to Earth. In keeping the vagueness of its wording similar to that of the 1967 Outer Space Treaty[216], the principle would accomplish two goals. Firstly, it would be manda-

[215] *Supra* note 25. The contents of the 1967 Outer Space Treaty, for instance, whilst they clearly create obligations of States as well as rights, are also, in essence, high-level principles. The name of the Treaty itself suggests as much, being "Treaty on *Principles* Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies". See also *supra* note 210 at 567 where it is argued that the 'incompleteness' of the principles' wording was intentional so that they would be further developed upon as space exploration and use evolved.

[216] *Ibid*.

tory for States parties to develop health regulation or policies, thus establishing a more uniform international approach. Secondly, it would allow for States to implement such spacecraft personnel health regulation or policy at an appropriate level for the individual State, thus making it possible for a State like the U.S. to delegate the powers of policy-making to the national space agency, or for a State not as directly involved with space exploration to either create a national policy for any spacecraft personnel member provided by that State or to enter into negotiations with a multinational organization, such as the ESA, with the negotiations thus including requirements of crewmember health services and facilities, as the State would be bound to ensure the provision of such.

For the proposed principle to successfully meet these two goals, it would, ideally, have to be presented and implemented at treaty-level in order to reach its maximum potential as an international unifier of health protection. In theory, this is not an unimaginable approach. All of the five UN space treaties contain provisions allowing for a State to propose amendments to the treaties and for such to enter into force for each State that accepts the amendment, upon their acceptance by a majority of the States parties to the Treaty.[217] But in practice no new UN space treaty has seen the light of day since 1979, and there have been no successful amendment proposals to any of the treaties. This issue is related to the fact that international law-making requires time, patience, and a multinational interest in international cooperation on the specific subject matter. It is a slow process, which has led to suggestions that most progress within international space law is best made through soft law instruments[218], or, with the prime example of the International Telecommunications Union, through specific delegation on a treaty-level

[217] *Supra* note 25. The 1967 Outer Space Treaty, art. XV; The 1968 Rescue and Return Agreement, art. 8; The 1972 Liability Convention, art. XXV; The 1975 Registration Convention, art. IX; The 1979 Moon Agreement, art. 17.

[218] Jonathan Lim, "The Future of the Outer Space Treaty – Peace and Security in the 21st Century" (2018) 4:2 Global Politics Review 72 at 97-98.

of an area of regulation to expert institutions, due to the highly complex nature of the area subject to regulation.[219]

7.2.3 Present and future solutions; ISS and Artemis

A part of why the legal documents surrounding the ISS project have been so successful at laying the foundation for a sustainable international space exploration project must therefore be that it succeeded at combining the two approaches. The agreements are not at treaty level and their rights and obligations do not spread to non-partners, but they do retain binding legal effects on partners, thereby pushing partners to comply with the contents of the legal framework. It is a multilateral framework that dives into bilateral but interconnected agreements for its specifics. Thus, with this type of framework already tried and tested, the best and most realistic approach for ensuring personnel health rights is to include a principle of access to health services and facilities in future multilateral frameworks for space exploration projects, while allowing for the medical and technical details to be agreed upon on a bilateral scale.

A concrete example of including such a health principle could be made of the Artemis Program currently being developed by NASA. With the initial and fundamental goal to land a man and a woman on the Moon by 2024 and then to initiate more substantial lunar surface exploration activities, NASA is projecting a long-term goal of interplanetary travel and exploration. A naturally multifaceted project, the Artemis program will involve the construction of several new systems necessary to meet these goals. Such systems will include exploration ground systems, space launch systems, new spacecraft for lunar missions, lunar landers and spacesuits created for deep space exploration. The most relevant of these new creations in a spacecraft

[219] Yon Henri et al., ”Regulation of telecommunications by satellites” in Ram S. Jakhu & Paul Stephen Dempsey, ed, ”*Routledge Handbook of Space Law*” 1st Edition (New York, Routledge, 2017)

personnel health perspective, however, is the ‘Gateway’ spacecraft to be launched into orbit around the moon, in effect serving as a lunar outpost.

The ‘Gateway’ spacecraft, referred to as a spaceship rather than a space station[220], will not be an ISS replacement. The intended use and the physical aspects of the ship differ from the station, as ‘Gateway’ is meant to function as a “temporary home and office” for the spacecraft personnel. This means that the spaceship will provide basic life support for the personnel after they arrive, after having launched from Earth, and prepare the crew for their later visit to the Moon’s surface. Whilst ‘Gateway’ will have some equipment and systems usable in the undertaking of scientific analysis and experiments, it is not, as the ISS essentially is, a laboratory.[221] As such, ‘Gateway’ will physically be much smaller than the ISS and it is not planned that the spaceship will host any manned missions with a duration of more than three months.[222] Despite the size differences, ‘Gateway’ is already underway to becoming an international collaboration, with almost all of the parties to the 1998 IGA and the ISS project having agreed to participate in creating the spaceship. Canada has announced intention to participate and a Canadian company has been awarded a robotics contract, Japan has announced interest in contributing habitation components and logistics resupply, and ESA has sought and received authorization to support contributions to the spaceship.[223]

As a natural result of NASA promoting a new and ambitious space program and other States having begun to offer contributions, international legal discussions have followed. The U.S.

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[220] Erin Mahoney, ”Q&A: NASA’s New Spaceship” (13 November 2018) Online: *NASA* <https://www.nasa.gov/archive/feature/questions-nasas-new-spaceship/>

[221] Kelli Mars, “More About Gateway” (accessed 21 July 2020, last visit 21 July 2020) Online: *NASA* <https://www.nasa.gov/johnson/exploration/gateway>; Sandra May, ”What Is the International Space Station?” (7 February 2018) Online: *NASA* <https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-the-iss-58.html>

[222] Supra note 220.

[223] Supra note 221, Mars.

has taken the early steps and has announced the drafting of the Artemis Accords, which shall carry the legal fundamentals of the new space program. The Accords will be inspired by the 1967 Outer Space Treaty and seek to build and expand upon the principles contained in the Treaty. This being the case, and though the Accords are still a work in progress, the most key principles contained in the Accords have been made public. They are as follows; the principle of peaceful purposes, the principle of transparency, the principle of interoperability, the principle of emergency assistance, the principle of registration of space objects, the principle of release of scientific data, the principle of protecting heritage, the principle of space resources, the principle of deconfliction of activities, and the principle of orbital debris and spacecraft disposal.[224] Upon examining the further description of the principles provided by NASA, it becomes clear that some of the principles are presented as reiterations of pre-existing principles, others are familiar but new within space law in a written format, whilst two of them – concerning resources and deconfliction – are almost completely new in essence.[225] The principle of peaceful purposes stems from art. IV of the 1967 Outer Space Treaty, the principle of emergency assistance is contained in both the 1967 Outer Space Treaty and the 1968 Rescue & Return Agreement, the principle of space object registration draws its force from the 1975 Registration Convention, and a principle on releasing scientific data can be traced back to the obligation under art. I of the 1967 Outer Space Treaty to make the benefits of space technology available to all countries. The new yet familiar principles are those concerning transparency, which ties into corporate social responsibility and best practices, and interoperability, which has already been sought through the ISO standards described earlier. The completely new principles concern the protection of heritage sites, the ability to extract and utilize Moon resources,

[224] National Aeronautics and Space Administration, "The Artemis Accords – Principles for a Safe, Peaceful, and Prosperous Future" (Accessed 21 July 2020, last visit 21 July 2020) Online, pdf: *NASA* <https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords_v7_print.pdf> at 3-12.
[225] *Ibid*.

and the introduction of deconfliction through, for instance, the establishment of 'safety zones' surrounding certain moon operations so as to avoid harmful interference by other parties, in effect creating more security for any equipment and facilities in those safety zones.[226] As the Accords are thus not afraid of proposing new principles for the international goals with the Artemis program, and the Accords already list one principle that guards the interest of protecting crew members by calling for the creation of emergency assistance policies, it would not be out of place to propose the inclusion of an additional health-centric principle, or to consider if such a principle could be deduced from the principle of emergency assistance.

The principle on emergency assistance is described as a cornerstone factor of responsible civil space programs. It is a twofold principle, both reaffirming the commitments of NASA and partnering States under the 1968 Rescue and Return Agreement and asking NASA and partnering States to "*commit to taking all reasonable steps possible to render assistance to astronauts in distress*".[227] As such, the principle touches upon the findings also made in this thesis, namely that emergencies and situations of distress entitle spacecraft personnel to certain levels of assistance without a requirement of Earth-landing, intentional or otherwise. One element of the principle, however, gives reason to pause. This element is the presentation of the Accords, and thus these principles, as bilateral agreements, rather than multilateral. For one, what can be considered "reasonable steps" may differ from one State to another. The minimum requirements contained in the 1967 Outer Space Treaty arts. IX and XII, whereby States shall cooperate and "*all stations, installations, equipment and space vehicles on the Moon*" shall be open to representatives of other states upon meeting certain formal requirements are relevant to the

[226] Joey Roulette, "Exclusive: Trump administration drafting 'Artemis Accords' pact for moon mining – sources" (5 May 2020) Online: *Reuters* <https://www.reuters.com/article/us-space-exploration-moon-mining-exclusi/exclusive-trump-administration-drafting-artemis-accords-pact-for-moon-mining-sources-idUSKBN22H2SB>

[227] *Supra* note 224 at 6.

envisioning of emergency or distress assistance, but are likely to require rewording in emergency or distress situations, where requirements of, for example, timely notice of visit to another State's facility may not be possible to give.[228]

For stations, installations, equipment and vehicles to be open to crews from different nations and space agencies, a high level of interoperability must be secured, and in order for the provision to have any real protective effect, the infrastructure must physically be in place on the Moon for crews to use. Such an infrastructure system, it would seem, must also require a multilateral or international rather than a bilateral foundation. The issue has been met with some foresight by the "Accords" proposing State. The Acting Associate Administrator for NASA's Office of International and Interagency Relations, Michael 'Mike' Gold, has clarified that the principle of emergency assistance is connected with the principle of interoperability. In NASA's view, the more interoperable systems are available to the lunar crews, the easier, more effective and safer will it be to render emergency assistance.[229] This appears to be a reiteration of the concerns and needs put forward in the section immediately above, but it has not been clarified how the bilateral agreements will result in the ideal multinational interoperable infrastructure. This presents the strongest rebuttal to the argument that the addition of a principle on protection of health to the 'Artemis Accords' under the emergency assistance principle would bring about an appropriate level of protection of the health of spacecraft personnel in

[228] *Supra* note 25. The 1979 Moon Agreement contains, in its arts. 10(2) and 12(3), much stronger wording and obligations on the safety of Moon-based personnel, such as an obligation to offer shelter to persons in distress on the Moon and the allowance of use of other State's equipment and facilities in emergency situation requiring only "prompt" notification to the UN Secretary-General or the State Party concerned. The U.S. is not party to the Moon Agreement. Compliance with the Moon Agreement for any States party to it, that wish to sign on to the Artemis Accords, must nationally analyse their ability to comply with both.

[229] Mike Gold, "Artemis Accords – Enabling International Partnerships for Lunar Exploration" (15 May 2020) Online: *U.S. Department of State* <https://www.state.gov/briefings-foreign-press-centers/artemis-accords-enabling-international-partnerships-for-lunar-exploration/>

the near future. A principle to ensure the appropriate levels of spacecraft personnel health must therefore be introduced in addition to the pre-existing 'Accords' principles.

The ten fundamental principles are presented by NASA as "*a common set of principles to govern the civil exploration and use of outer space*" and will be described in the Artemis Accords agreements that NASA wishes to sign with potential international partners.[230] These will be signed on a bilateral basis, which will be a diversion from the multilateral framework created for the ISS with the 1998 IGA, which served as a unifying document for the bilateral agreements between NASA and Canada, Japan, ESA, and Russia. By insisting on using a bilateral approach to creating a set of fundamental principles for future manned space exploration, the U.S. risks inflating the significance of those principles as their practical execution may be dragged down by the negotiation specifics and differing interests and resulting obligations that the final and, if the U.S. seeks to engage a larger amount of partners than those contracted with under the ISS framework, numerous 'Accords' may contain.

The legal and political 'safe zones' that the presented principles are intended to establish are thus yet far from being actual safe zones. Russia had originally expressed interest in cooperation on 'Gateway' but now their potential participation may be in jeopardy following disagreement between Russia and the U.S. on the legality of the mining of space resources, which is a topic touched upon in the fundamental principles of the Accords.[231] With Russia having, as of yet, rejected to join the 'Accords', the introduction of a personnel health principle to the 'Accords' would not expand to Russia, thereby cutting short the reach of the principle. This

[230] *Ibid* at 2.
[231] Amanda Miller, "Russian could join US-led Lunar Gateway programme" (21 October 2019) Online: *ROOM* <https://room.eu.com/news/russia-could-join-us-led-lunar-gateway-programme>; *Supra* note 226; Joey Roulette, "U.S.-led moon program rejected by Moscow, but NASA chief says Russia ties 'solid'" (14 July 2020) Online: *Global News* <https://globalnews.ca/news/7178012/nasa-moscow-space-program/>

development indicates another issue with relying too heavily on the 'Artemis Accords' to bring forward a spacecraft personnel principle. The 'Accords' will only ever create common ground between its parties. International common ground *must* come from treaty-level rules. But with the issues pertaining to creating international law at the highest level and the concerns for spacecraft personnel being present as well as near-future concerns, a compromise must be sought until the time when the international community has gathered enough momentum to re-regulate on matters relating to space exploration and exploitation in the twenty-first century.

The proposed compromise is thus; in order for a new health principle to reach its full potential, it must be promoted as a key factor in any and all multinational plans for space exploration cooperation. Including the principle as an additional principle to the 'Artemis Accords' would allow for a meaningful inclusion of spacecraft personnel health matters to the future U.S. led space exploration projects. It would also be a significant inclusion forwards, as the U.S. remains one of the leading space faring nations of the world. Should China and Russia continue their joined lunar orbiter and landing missions talks[232], including a personnel health principle in their discussions would be highly recommended, as the existence of the spacecraft personnel health principle in the plans for future space stations of the U.S., Russia, and China, as three of the most space-faring nations in the world, would not only provide for an appropriate minimum level of availability of crew health services and facilities, but also result in an important boost of the integrity of the principle, propelling it forward and potentially making it almost a 'household-principle' for space program policy and regulation. Consequently, having integrated a health principle for crewmembers into the mentality of space activity regulation, the principle may, in due time, make its way into international regulation.

[232] Andrew Jones, *"China, Russia to cooperate on lunar orbiter, landing missions"* (19 September 2019) Online: *SPACENEWS* <https://spacenews.com/china-russia-to-cooperate-on-lunar-orbiter-landing-missions/>

8. Conclusion

Provoked by the worrying statement of Cosmonaut Ryumin that a physical and social environment equal to that of a manned space station would create the perfect conditions for murder, and by clear projected future of space exploration as going deeper into space and for longer periods of time, this thesis set out to answer the question; acknowledging that astronauts are the envoys of mankind, to what extent is the present international legal framework for astronauts able to regulate and ensure the protection of their mental health? Thus, by first ascertaining that spacecraft personnel, as envoys of mankind as a whole in and to space and the space environment, and the personnel therefore being owed and entitled to certain minimum levels of protection of their life and health in their function as mankind's envoys, the scene was set for an analysis of the status of the current health-focused legal framework applicable to spacecraft personnel. In order for the analysis to compare the current regulation to the current and actual needs of the personnel, a presentation of the most vital dangers of the space environment was given, alongside a presentation of necessary present and future countermeasures to the negative effects of these risks and dangers to the personnel. Accordingly, the analysis was set up to investigate health-focused regulation within three legal frameworks; public international space law, the legal framework of the ISS, and the national regulation of the U.S. and Russia as two major space-faring nations. The findings were surprising. After the review of the 1967 Outer Space Treaty and the 1968 Rescue and Return Agreement in particular, it was clear that the foundations for crew health regulation in the arena of public international space law were very fundamental indeed, and any comparison between the contents of the treaties and the identified health issues and countermeasures was near impossible. The treaties were too generally worded, but contained indication that the specific regulation of health matters may be dealt with separately, and the 1968 Rescue and Return Agreement specifically added to this by opening up for State- or agency specific regulation on non-landing distress situations. As an additional international instrument, the International Covenant on Economic, Social and Cultural Rights provided, although in a State-wise limited fashion, a right of health in the form of "*the right of everyone to the enjoyment of the highest attainable standard of physical and mental health*". The legal framework of the ISS took no notion of the Covenant's contents, but did adhere to the space treaties through the constellation of the 1998 IGA as a multilateral and combining instrument, sorting the latter bilateral agreements between the ISS project parties beneath it, creating a structured framework. It were these bilateral agreements that most strongly demanded health policy creation of and between the parties, with few discrepancies, though the specific contents of those policies were not laid out, and the Code of Conduct contained very little aid hereto. Truly, the most significant finding was to be made in the analysis of the national frameworks. Through different approaches, both the U.S. and Russia had derogated the power to regulate on spacecraft personnel health matters to the respective space agency, both of which have made numerous and richly detailed health-related policies, providing for different services and health-maintenance and training procedures, for both physiological and mental health. These findings called for a deeper discussion of the appropriate way forward, for if the most powerful legal tool to create an international common health protection standard would be through a treaty-level international agreement, but the most efficient and adequately detailed regulation of health matters were better suited for individual, almost exclusively national regulation, how could these two approaches be combined?

The suggested path forward presented a compromise; the drafting and inclusion in future bilateral agreements of a new health-focused principle, that would call for the launching authority or launching state to provide the services and facilities necessary for sustaining physiological and mental health of spacecraft personnel during pre-, in-, and post-flight phases. An example of such inclusion was made of the newly published ‘Artemis Accords’. The ‘Accords’, representing the basics of the legal framework to be made in connection with the NASA led ‘Artemis Program’, were found to be suitable for the inclusion of such a new principle, as the ‘Accords’ are still at a principle-based stage, but that they were also limited in their reach, as no ‘Accords’ have been fully drafted yet, and some countries, like Russia, are already considering alternatives to pursuing another US-led space exploration initiative.[233]

For the suggested path to reach its full potential, it would thus require that the health-focused principle, rooted in the notions in art. V of the 1967 Outer Space Treaty of “all possible assistance” to be rendered by States Parties and assistance rendered between spacecraft personnel, was promoted internationally as a ‘household clause’, in the sense that the international space community would push towards a constant inclusion of the health-focused principle in negotiations of new bilateral or multilateral agreements relating to space exploration endeavours, and in this way create a common minimum standard of service and facility availability to spacecraft personnel, with the hope that such international ‘consensus’ on how to regulate the matter would prove sufficient until international agreement on the highest level could be concluded. In following this approach, a common minimum of available health services and facilities, for both mental and physical health, will become available for spacecraft personnel, as the envoys of mankind, thus effectively granting them the protection they need to carry out their missions, as these missions go deeper into space and for longer periods of time while the international

[233] For an additional legislative proposal see the “Model Implementation Agreement for the Moon Treaty”, as promoted by Dennis O’Brien, “The Artemis Accords: Repeating the Mistakes of the Age of Exploration”, (Accessed 2 August 2020, last visit 2 August 2020) Online, pdf: *Spacetreaty.org* <http://spacetreaty.org/repeating-mistakes.pdf>. The Model Agreement is available at http://spacetreaty.org/modelimplementationagreement.pdf, for commentary on the Model Agreement see Dennis O’Brien, ”The 8th CSA-IASS Conference on Advanced Space Technology, Shanghai, China – The Way Forward: An Implementation Agreement for the Moon Treaty” (Accessed 2 August 2020, last visit 2 August 2020) Online, pdf: *Spacetreaty.org* <http://spacetreaty.org/implementationagreement.pdf>

space community rallies itself to regulate internationally on the new risks posed by the new space age to come.

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