



Preliminary Cosmic Study Report  
of Study Group 3.18

## Study of possible Inter-Agency Protocol to handle crisis/emergency of astronauts in Low Earth Orbit

### STUDY GROUP

**S. Ramakrishnan** ●  
ISRO, India

**Prof. Irmgard Marboe** ●  
University of Vienna, Austria

**W. Michael Hawes** ●  
Lockheed Martin, USA

**Bernhard Hufenbach** ●  
ESA / ESTEC, The Netherlands

**Zhang Shu** ●  
CALT, China

**Dr. Unnikrishnan Nair S** ●  
ISRO, India



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## Executive Summary

Low Earth Orbit (LEO) is the first step in accessing space to perform any Earth bound missions such as building a Space station and also to embark upon voyages to other distant destinations viz. the Moon, Mars etc. As such, human activities in LEO are bound to increase and in-fact, for more than a decade, there is continuous human presence in LEO. Commercial cargo shipment to space by Private agencies is a reality today and it is expected that private human transportation to LEO to service the space station will happen in the near future. While the possibility of Astronauts getting lost in space in a crippled spacecraft has been a subject of concern and discussions, the recent Columbia accident once again brought this subject into focus as a very credible scenario requiring urgent attention. The entry of private operators and advent of space tourism is expected to expose more and more common people to such risks and requirements, methodologies and inter-agency protocol for rescue of human life from Low Earth Orbit has become an imperative. While the UN convention for safety of Life at Sea (SOLAS) may serve as a model for such international rules on rescue from space, there are several complex and unique issues specific to space rescue.

Having been drafted in the early days of the space age, the existing legal framework for the rescue and return of astronauts, consisting mainly of Article V of the UN Outer Space Treaty (OST) and the 'Agreement on the Rescue and Return of Astronauts and the Return of Space Objects' (ARRA), mainly focuses on events such as emergency/unplanned landing of astronauts occurring within the national territory of a state or on the high seas or any other place not under the jurisdiction of any state, there are no explicitly obligations with respect to rescue operations involving accident/emergency in Low Earth Orbit (LEO). This makes clarification and further development of existing international rules desirable, addressing for instance when an obligation to render assistance/rescue arises, who would be obliged to render assistance/rescue, what kind of assistance would be required, who would liable, and who would bear the cost. Such issues could be addressed in a set of rules or guidelines laid down in an Inter-Agency protocol regulating assistance for Astronauts in distress in LEO.

The possible crisis situations for Astronauts in LEO encompasses a multitude of scenario viz. crippled spacecraft with loss of de-orbit capability, compromised spacecraft integrity, limitations on the resources/life support system to sustain crew on board, crew injury/incapacitation etc. All such contingencies requiring external intervention and assistance for saving the life of crew will be governed by this new protocol. Of course, the variety and complexity of possible contingencies and scenario do pose several challenges in effecting such rescue. The response time to mount a rescue effort, the choice of robotic vs crewed rescue with associated risks etc. are few of the many such daunting issues to be debated and resolved. The key enabling factor to attempt such intervention to a crippled spacecraft is obviously the adaptation of common engineering standards such as docking

interfaces and other hardware technical protocol. The Apollo-Soyuz docking experiment and the building up of ISS with multi-national modules provide us with practical models to accomplish this basic compatibility. Having said that, it is the geopolitical consensus on the essentiality of such a rescue mechanism governed by international legal framework which will drive this initiative on crew rescue from LEO.

Formulation of such a rescue protocol will have to address following specific issues:

- (i) Definition of situations demanding an international obligation to mount such rescue effort.
- (ii) Identification of States having wherewithal to render such assistance and role of other States in this international effort.
- (iii) The role, responsibility and liability of State(s) which own the crippled spacecraft, the State which performed the launch and the liability for damages due to an unsuccessful rescue effort.
- (iv) The resources required to maintain such international rescue mechanism and the sharing of expenses among member States.
- (v) The role of private players and non-governmental space faring entities in implementing this rescue protocol.
- (vi) Possible physical and technical limitations in overall rescue efforts.

As a way forward, the immediate action will be the recognition and in-principle acceptance of a need for such a protocol for crew rescue from space by all space faring nations through a declaration/resolution by the Heads of Space Agencies. This should lead to setting up of an inter-agency committee to evolve the basic framework for such a rescue mechanism and the governing rules including the funding. On the technical front, the first action will be to develop and define international standards for manned space vehicles specifically addressing the crew safety and survival requirements and mandatory interfaces to enable access and rescue of crew in contingencies. This can be effectively handled by team of technical experts from space faring nations.

In conclusion, with the increase in human presence in space, specifically with the recent spurt in private operators venturing into space transportation as well as growing public response to space tourism opportunities, the spectre of incidents/accidents leading to humans stranded in space in near earth orbit is real. In the current information age, the response of the media and the public at large to such unfortunate happenings is something unfathomable. The public outrage and emotional impact of allowing loss of human life without any positive attempt to rescue them will have a lasting effect on

the future of all space endeavours. This makes this whole issue of Astronaut rescue from Space Protocol urgent and imminent.

# Chapter 1

## Prologue

### 1.1 Introduction

It is expected that human activities in Low Earth Orbit (LEO) would be on the rise in the future due to missions around the Earth and to other destinations including interplanetary manned missions to Mars, Near Earth Objects, etc. As the potential for more commercial human spaceflight increases in the near future, space missions will no longer be solely government ventures and the applicability of Space treaties and Protocols to such scenarios is under debate. Many of the studies and existing treaties have focused on assisting crew after the landing phase of the mission. Most studies were carried out when only the United States and Russia conducted human launch and re-entry activities. Much has changed in the human spaceflight environment over the past decade. These changing situations include the advent of China as an independent human space-faring nation, the completion of the International Space Station with more than a decade of continuous human presence, the Columbia Shuttle accident and the retirement of the Space Shuttle itself. Individually all these have major influence on the global scope of human spaceflight. Together they present enormous change in the perspective of human spaceflight. In addition, public private partnerships have allowed cargo service flights to be initiated to the ISS. NASA has funded a significant portion of the development cost and is paying for the services of cargo flights, yet has accomplished this in a very different methodology than past space developments. New requirements, methodologies and regulations for crew rescue are therefore likely to become a significant factor in the future, in particular, if one assumes that private operators of crew spacecraft will succeed in developing a market for private human access to space.

With more and more human missions, the probability of crew having significant issues in space increases and there is a strong case for having in place adequate international legal mechanisms to deal with such situations and provide aide to crews, irrespective of their nationality or other geopolitical considerations of the disabled craft. In this context, it is imperative to have early consultations among space-faring nations, to identify the issues involved in rescuing a crew in distress from LEO, and if possible, work towards a set of agreements with participation of all nations. This will eventually pave the way to put in place an international mechanism to aide and possibly rescue the crews in distress in LEO.

Rescuing from orbit is a critical operation and may actually subject another set of crew engaged in rescue to operational hazards. Therefore the design of space vehicles must consider conceivable failure modes and make the space vehicle reliable to the extent possible. In the extremely unlikely event of such crisis/emergencies, the space vehicle design should be capable enough to remove the crew from immediate danger without any external assistance. If this is not viable, external assistance to save the lives of stranded crew must be considered.

The Human Spaceflight Coordinating Group (HSFCG) has been established to define and monitor the implementation of the projects related to the priorities in the field of Human Spaceflight, selected by the IAA and the National Space Agencies. This Group is composed of experts from all over the world. The projects, proposed by the HSFCG and approved by the IAA Board of Trustees, shall present summaries of their findings on the occasion of the Head of Space Agency Summit dedicated to Robotics and Human Space Exploration planned in January 2014 at Washington. This report is the outcome of the Study group 3.18 on “Feasibility study of possible inter-agency protocol to handle crisis/emergency of astronauts in LEO” to address this matter.

## **1.2 Scope/Objectives of study**

The scope of the study is to support human space exploration in low earth orbit by paving the way for consideration of international design standards and protocols to treat crisis/emergency situations of astronauts in LEO. At this point the scope is limited to address the feasibility of a protocol discussing rescuing crew from LEO and the study is not considering Moon, trans-lunar, Mars or other interplanetary or Near Earth Object missions. Rescue in the context of this study is considered to be those cases where external assistance is mandatory to save the lives of the crew.

The crew in the context of the study is defined as any person who travels to LEO in a space vehicle and belongs to any nation or state inclusive of astronauts, cosmonauts, taikonauts etc

The objectives of the study are outlined below.

- To identify the possible crisis situations/emergency scenario of crew in LEO
- To discuss the various crew rescue methodologies that are available to bring back crew under emergency/crisis
- To study the current international treaties/protocol in the area of outer space & space travel/space systems, their implementation status and limitations
- To bring out the various impediments/hurdles foreseen in evolving an inter-agency protocol on crew rescue from space and the approach to overcome them.
- To make recommendations, as outcomes of the study, and propose possible ways forward to evolve such a protocol to handle such crisis/emergency of astronauts

The Study group report has six chapters with the first chapter as a prologue along with the scope and objectives of the study. The possible crisis situations that are likely to encounter in LEO and the possible rescue methodologies are briefed in chapter 2. Chapter 3 discusses the current international treaties/protocols, implementation status along and their limitations. The various impediments or hurdles that can emerge during discussions on an inter-agency protocol to handle crisis/emergency along with possible mitigation strategies are discussed in chapter 4. Finally, chapter 5 provides the



recommendations of the Study group and chapter 6 discusses the way forward on this very important topic related to future human space missions.

## **Chapter 2**

### **Possible crisis situations/emergency scenario of Crew in LEO and Crew rescue methodologies**

Many studies have considered the potential scenarios and possible issues associated with providing assistance to crew in low Earth Orbit [1,2,3,4]. Studies such as Tedeman and Wright 1992 [5] and Bartoe 1989 [6] discuss a variety of scenarios including incapacitation of the crew, failure of the spacecraft de-orbit system and other hardware failures which would compromise the ability of the crew to return safely to the earth.

During the Columbia accident investigation the board tasked a small group of NASA engineers to develop a rescue scenario that might have enabled a transfer of crew from a suspected damaged ship to a new spacecraft. While the scenario developed for the Columbia Accident Investigation Board (CAIB) [7] had to make many large assumptions the exercise served to drive new thinking and perspectives on on-orbit rescue possibilities.

#### **2.1 Possible Failure Scenarios**

Failure scenarios such as described by Tedeman and Wright must consider issues of both spacecraft systems and the crew themselves. In the past crew medical emergency cases have been the primary driving requirements for the design of assured crew rescue vehicles [8] and in the development of operational procedures. Much of this discussion has centered on operations of the ISS (International Space Station). Current operational practice is to maintain emergency crew return capability for all crew on board the ISS at all times. The Russian Soyuz vehicles currently provide this function. In fact that emergency return function is one of the limiting factors on crew size. Two Soyuz vehicles allow for a maximum crew of six at any given time in ISS. It is necessary to reduce crew periodically to three as the Soyuz vehicles refresh ISS with new crew. If a crew health emergency occurred it would require that all three crewmembers assigned to that Soyuz vehicle would depart the ISS. As other vehicles are developed to take crew to the ISS the potential exists for the crew size to increase to seven to match the other system design limits.

The ISS can also serve as an emergency safe haven for crews operating in that same orbit. During nearly all the Shuttle missions after the Columbia accident, the ability of the ISS to support a larger crew as part of a safe haven in case of a damaged Shuttle became a mission readiness parameter. In this scenario NASA accepted the risk that the ISS would not maintain emergency return capability for the visiting Shuttle crew that was stranded due to a damaged Orbiter. The Shuttle flights were planned such that the supplies onboard the ISS would meet or exceed the time required for readying and launching a rescue Shuttle.

Many individual system failures can be envisioned which would lead to in space rescue of crew. These possible scenarios highlight the many possible causes and many likely obstacles. The variety of

possible failures also presents an almost limitless number of scenarios. By grouping failures into end result scenarios we can identify salient issues and response scenarios as discussed below.

### **2.1.1 Stable spacecraft but loss of de-orbit capability**

In this scenario the crew is healthy, most of the spacecraft systems are healthy and the only significant issue is loss of deorbit capability. On orbit rescues by another spacecraft or use of safe haven capability are the only real approaches that might be considered for this scenario. If another free flying spacecraft could be made available that spacecraft would still have to have several common interfaces to successfully conclude an on orbit rescue. A common docking system would greatly facilitate a rescue operation. The possibility to equalize pressure and share power would also be useful attributes.

The rescue scenario considered by the CAIB was essentially this case. While the use of ISS as a safe haven was the favored response for most missions, the rescue Shuttle was prepared for the Hubble Space Telescope repair mission. In this scenario, the Shuttle could not dock with but utilized the robotic arm to grapple the disabled vehicle. The crew will utilize the limited available spacesuits to transfer to the good Orbiter. This situation was really only possible due to the existence of airlocks on both vehicles so that the crew could transfer and then send spacesuits back to the other crewmembers. Here the limitations on spacewalk capability arise as a very clear obstacle.

### **2.1.2 Crew is healthy but spacecraft has lost integrity**

In this situation, other systems may have failed. This might include slow loss of cabin pressure, loss of communications, degrading control capability, slow loss of propulsion, etc. In this case the crew would face a decision to either reach a safe haven, if possible or conduct an emergency de-orbit into an unplanned landing scenario. This issue has been the subject of past discussion and agreements as countries have agreed to provide assistance to crewmembers of other states.

Moving to the safe haven option presents a number of issues including commonality of docking systems, communications, limited crew supplies, limited crew return capability etc. Currently only the ISS and the Chinese space station, Tiangong, could be considered as safe haven possibilities. Eventually commercial orbital habitats may also provide some capability.

### **2.1.3 Crew is incapacitated but the spacecraft is functioning well**

This scenario presents many of the challenges already described but has the added challenge of dealing with an incapacitated crew. What form of system failure has incapacitated the crew is a critical piece of information. How long can the crew survive in the remaining spacecraft environment? Are the conditions also potentially harmful to any rescuing crewmembers? The techniques described

earlier to dock with or grapple a spacecraft are also key aspects of this scenario. The ability to transfer the crippled crew in an environment that they can survive (i.e. avoiding spacewalk) is also critical.

#### **2.1.4 Crew is incapacitated and the spacecraft is not under control**

This final scenario is perhaps the most complex and has all the issues of the first three but also adds the challenge of a possible uncooperative object for the rescue spacecraft to approach. Rotation rates, natural venting, rotation axes are now more critical attributes to understand. The docking/berthing and crew transfer issues are very similar to the earlier cases but the rescue crew must now also deal with finding a way to rendezvous with and grapple an uncontrolled spacecraft to access inside to reach and rescue the crew.

#### **2.1.5 Rescue crew or robotic rescue**

We also need to consider that an uncrewed vehicle like a space tug could resolve some of these scenarios and could, for example, ensure delivery of a stranded spacecraft to a safe haven. In this type of scenario some issues are simplified while others are dramatically increased.

### **2.2 Current human launch capability**

As of October 2013 only two human launch systems are in operation; the Russian Soyuz and the Chinese Shenzhou. Within the next few years additional vehicles are expected both as government developments such as Orion and multiple commercial launch service providers reach maturity. The current limitation makes rescue a very unlikely event. The addition of a number of new human flight systems may enhance the possibility of future rescue.

### **2.3 Orbital inclination**

The most expensive maneuver in terms of energy/propellant requirement is a significant change in the orbital plane or inclination of the spacecraft. At this time, anticipating a rescue spacecraft might be launched into an appropriate inclination but it would be unlikely that any spacecraft already on orbit would have the capacity to significantly change inclination. A robotic tug spacecraft may have more flexibility in a limited set of scenarios.

The role of future man-tended infrastructure being able to act as a safe haven may have a strong influence on the orbital inclination and therefore the overall traffic model for future crewed missions. Pre-deploying safe havens in orbit inclinations of interest may therefore be the most effective means for addressing crew rescue requirements.

## **2.4 Rendezvous & Docking/berthing systems**

The ISS partners have completed the definition of a common docking system that could be applied to future situations [9]. Utilization of a system with common attributes might simplify several of the scenarios that we discussed in this section. The lack of a docking system interface presents extreme difficulties in safely accomplishing crew transfer for rescue.

Several current systems, such as the HTV, Dragon and Cygnus utilize berthing techniques to service the ISS. In this scenario the spacecraft approach the ISS and station keep close enough to be grappled by the robotic Canadarm and then berth to a common berthing mechanism on the ISS. In this case the common berthing mechanism provides that common interface without the more complex docking adapter.

Docking to a target with low inertia, as could be the case in a rescue scenario, poses specific requirements on the docking system and in particular the ability of soft docking. Docking systems in operation today do not have this capability, but developments are underway for soft docking (such as the International Docking and Berthing Mechanism developed by ESA)

Furthermore, crew rescue contingencies will require the ability to rendezvous and dock with varying degree of non-cooperative targets. This capability has only been demonstrated on small robotic missions in limited situations such as the US Air Force XSS-11 mission [10]. Agencies are currently investing in technology associated with rendezvous and docking with uncooperative targets in the context of assessing future options for servicing or actively removing space debris, opening opportunities to exploit them for future development of rescue capabilities.

## **2.5 Internal pressure level**

Once docked or berthed the human spacecraft would need to be capable of equalizing the internal pressure to allow for safe crew transfer. Future international standardization efforts should therefore also address this area.

## **2.6 Communications**

Utilization of specific frequencies is closely regulated through the World Radio Conference and various coordination groups. The communications community may need to consider a general emergency frequency that could be easily utilized across different systems.

## **2.7 Power**

Most scenarios would not require a direct transfer of power. It is a certainly a potential resource that requires capability to share.

## **2.8 Future exploration missions and destinations**

The expansion of human spaceflight will present new issues and new opportunities. Missions beyond earth orbit will present new destinations, new challenges and obstacles and new capabilities. The complexity of possible crew rescue will certainly increase dramatically. It is likely that “safe havens in space and on the surface of Moon/ Mars” will play an essential role for expanding human presence into space. The Global Exploration Roadmap developed by the International Space Exploration Coordination (ISECG) suggest e.g. the deployment of a evolvable deep space habitat in cis-lunar space which would not only allow to extended duration missions in cis-lunar space, but also could function as a staging post for human-lunar surface missions at a later stage. One key function of thus evolvable deep space habitat would be to act as a safe haven in case of failure scenarios in cis-lunar space and/ or on the lunar surface.

It is also important to note that space agencies are already discussing the need for standardization to enhance opportunities for international cooperation in advancing common space exploration goals. These standardization efforts will address many of the aspects discussed above. Future space exploration missions may act as a facilitator for enabling future international space rescue operations in Low Earth Orbit.

## **Chapter 3**

### **Current International Treaties/Protocol in the area of Outer Space & Space Travel/Space systems and their implementation status**

The current corpus *iurisspatialis* was elaborated in the 1960s and the 1970s, when spaceflight in general was still in its infancy. The Declaration on Legal Principles of 1963, the Outer Space Treaty (OST) of 1967 and the Agreement on the Rescue and Return of Astronauts and the Return of Space Objects (Rescue and Return Agreement, ARRA) of 1968 were elaborated during the first years following Yuri Gagarin's flight in 1961. It is therefore not surprising that important issues and questions which emerged only in the course of subsequent space flight experience were not sufficiently regulated. In particular, the involvement of private actors, either as participants in space flights or as facilitators/ operators of such activities, has not been envisaged.

The current project aiming at the elaboration of a draft set of principles to handle crisis/emergency of astronauts in Low Earth Orbit (LEO) intends to identify the gaps in the regulation to rescue of crew from LEO. Various emergency scenarios are possible, as elaborated in Chapter 2. They include technical problems of the spacecraft like, for instance, loss of de-orbit capability, integrity or control, as well as other problems endangering the health of the crew, necessitating their rescue.

In the following section, an overview is given on the current legal obligations under international law regarding the rescue of astronauts. As will be shown, the relevant documents concentrate on situations where astronauts have landed on Earth, be it in the territory of a country or in a place outside the jurisdiction of any State. However, several general duties regarding the assistance of astronauts or of humans in general are also relevant and can be used to clarify the role of States in this respect. It has to be remembered that the existing body of space law addresses only the rights and obligations of States and not those of private actors. However, the particularity of space law that States bear international responsibility for national activities in outer space carried out by non-governmental entities (Article VI OST) establishes a link between the activities of private actors and the State. The existing corpus *iurisspatialis* provides a framework that is general enough to avoid that newly developed space activities are taking place in a legal vacuum. Nevertheless, certain aspects with regard to the rescue of astronauts – in particular in LEO – are not regulated and would benefit from a better definition of terms and a clearer formulation of rules.

#### **3.1 Current instruments relevant in the context of space travel**

##### ***3.1.1 Declaration of Legal Principles Governing the Activities of States in the Exploration of Outer Space***

The “**Declaration of Legal Principles Governing the Activities of States in the Exploration and Uses of Outer Space**”(Declaration of Legal Principles) was discussed and elaborated in the Legal

Subcommittee during 1962 and 1963. It was then submitted to the General Assembly which incorporated the text in Resolution 1962 (XVIII). The Declaration was approved unanimously on December 13, 1963[11] and is regarded as customary international law today [12]. It consists of nine operative principles. **Principle 9** deals with the assistance to astronauts in distress and provides that

“States shall regard astronauts as envoys of mankind in outer space, and shall render to them 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 this case, astronauts shall be safely and promptly returned to the State of registry of the space object.

### **3.1.2 Outer Space Treaty**

#### *3.1.2.1 The duty to rescue astronauts*

Principle 9 of the Declaration of Legal Principles has been confirmed in the **Outer Space Treaty (OST)**[13]. As of 1 January 2013, the OST has 102 State parties and 26 signatories. The main space nations, among them China, India, the Russian Federation and the United States have ratified the treaty.

The presence of humans in outer space is addressed in **Article V OST** which provides:

“States Parties to the Treaty shall regard astronauts as envoys of mankind in outer space and shall render to them all possible assistance in the event of accident, distress, or emergency landing on the territory of another State Party or on the high seas. When astronauts make such a landing, they shall be safely and promptly returned to the State of registry of their space vehicle.

In carrying on activities in outer space and on celestial bodies, the astronauts of one State Party shall render all possible assistance to the astronauts of other States Parties.

State Parties to the Treaty shall immediately inform the other States Parties to the Treaty or the Secretary-General of the United Nations of any phenomena they discover in outer space, including the Moon and other celestial bodies, which could constitute a danger to the life or health of astronauts”.

The OST was the first multilateral treaty that used the term “astronaut” without, however, defining it. It is therefore unclear who exactly falls under this term, in particular, whether private spaceflight participants or private researchers in outer space are included [14]. The duty to assist contained in Article V OST is based on the idea that astronauts shall be regarded as “envoys of mankind” deserving a special status and special protection [15]. However, in view of the predominant humanitarian motivation reflected in the provision, the special designation of “envoys of mankind” does not have



any significant meaning. Today, the prevailing view is not to differentiate between the public or private nature of the space activity and not distinguish personnel and passengers of a spacecraft as regards their rescue and return [16]. Article V thus can be seen as a general duty to rescue and assist based on considerations of humanity.

Article V, paragraph 1, reiterates principle 9 of the Declaration on Legal Principle and establishes the obligation to rescue astronauts if they are found in the territory of another State or on the high seas. The obligation to rescue arises in the event of an “accident”, “distress” or an “emergency landing” [17]. These terms have to be interpreted according to the general rules on treaty interpretation according to which the treaty has to be interpreted “in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose” [18].

The “ordinary meaning” of the word “accident” can be described as an “unfortunate incident that happens unexpectedly and unintentionally, typically resulting in damage or injury” [19]. It could cover the situation where there exists a malfunctioning caused by an external factor (e.g. space debris) or by a functional disorder of the spacecraft itself.

“Distress” is a broader term and refers, for example, to “the state of a ship or aircraft when in danger or difficulty and needing help” [20]. In the Law of the Sea, “distress” is interpreted as the facing of an imminent danger of losing the vehicle and its cargo, or a threat to the lives of the crew, and can also arise following situations on board, like equipment failure [21]. With regard to the object and purpose of the OST, which is amongst others the promotion of international cooperation, the term “distress” has to be interpreted in a broad manner [22]. Thus, distress of astronauts should include cases where they, without having suffered yet an accident, are nevertheless in trouble and an accident may be close or at least cannot be excluded [23].

Paragraph 2, in contrast, is not limited to situations of “accident”, “distress” or “emergency landing”. It demands from astronauts of one State Party, while carrying on activities in outer space or on celestial bodies, to render “all possible assistance” to astronauts of other States Parties [24]. This duty refers to situations in which astronauts face danger while in orbit and is therefore of utmost relevance in the context of the present study.

The extent of “all possible assistance” in this provision is unclear. Some authors point out that the duty to assist is supposed to fulfill the underlying humanitarian approach of the Article, namely to ensure assistance to humans in outer space in threatening circumstances [25]. Consequently, the obligation has to be regarded as comprehensive demanding to render all possible assistance in any case [26].

Others, however, argue that such an interpretation would stretch the point, as any activity in outer space remains costly and risky and it would be disproportional to require States to render assistance without an emergency situation [27]. This critique refers to so-called “trivial” assistance which means

assistance in non-threatening situations, for instance helping the personnel of another spacecraft to install a solar panel. In this regard, States should in principle remain free to decide whether to cooperate with others in situation not amounting to distress or emergency. The obligation and standard of care to provide assistance could therefore be interpreted in accordance with general principles of law like liability for failing to rescue in certain cases, the Good Samaritan principle, equity, reciprocity and good faith [28].

In particular, the Good Samaritan principle which is known in several legal systems could provide certain guidance in this context. It addresses the situation in which an individual helps another individual in a situation of danger without being obliged to do so. The main questions discussed in this context are whether a fee or reward should be awarded to the Samaritan and whether the Samaritan himself is liable in the case he causes damage to the aided person [29]. The Good Samaritan principle has also been discussed in the Final Report on “Legal Aspects of NEO Threat Response and Related Institutional Issues” [30] in the context of damage caused during response actions against Near Earth Objects, such as asteroids. As regards the costs of the rescue operation, the OST does not provide any regulation. In view of the humanitarian underpinning of the obligation to rescue, the general principle is deemed to prevail according to which the rescuer does not receive any money. This has later been confirmed by the ARRA according to which the costs for the return of a *space object* have to be reimbursed but not those of the rescue and return of an *astronaut*. This similarly applies to the duty of astronauts to help other astronauts. In view of the costs connected to rescue operations, it is advisable for States to establish a mechanism or fund to defray the costs emerging in these situations [28].

### *3.1.2.2 The international responsibility of States for space activities*

According to Article VI OST, States bear international responsibility for activities carried out in outer space, whether such activities are carried out by governmental agencies or non-governmental entities. In the arena of public international law, this creates a rather unusual link between private activities and the State. The State consequently is obliged to authorize and continuously supervise the activities of non-governmental entities in outer space. Usually, this is done through an authorization or licensing procedure. In the conditions of authorization or licensing, a State can establish certain obligations which it otherwise would not have. These may include, for example, the duty to rescue astronauts in distress. In this way, the international obligation of the States may be transformed into a legal obligation of the private operator. Legal regimes governing many aspects of commercial flight have not yet been developed.

### **3.1.3 Rescue Agreement**

Article V OST was the basis for the elaboration of the **Agreement on the Rescue and Return of Astronauts and the Return of Space Objects (Rescue and Return Agreement, ARRA)** [31]. As of 1 January 2013, it has 92 State parties and 24 signatories, the major space faring nations having ratified

or acceded to it [32].The preamble states the desire “to develop and give further concrete expression” to the duties already contained in the OST.

The ARRA specifies the range of obligations of State parties concerning assistance to astronauts. Its objective is to set out more clearly who has to do what in cases of accidents involving astronauts and space objects. It reflects one of the basic principles of outer space law, namely, the promotion of international cooperation in the peaceful exploration and use of outer space. As the Preamble states, the Agreement is prompted by sentiments of humanity [61].However, except from the full title and the Preamble of the ARRA, the term “**personnel of a spacecraft**” is used instead of “astronauts”. The term “personnel of a spacecraft” might be regarded as encompassing the whole crew of the spacecraft, i.e. being broader than the term “astronaut” [62]. However, also the opposite conclusion is possible. In air law, the crew – the “personnel” – of the aircraft has other rights and duties than the passengers. It follows that the professional crew of a spacecraft should or could also be distinguished from private spacecraft passengers [33].

**Articles 2 and 3** deal with **practical measures** aimed at rescuing and helping the personnel of a spacecraft when they land on the territory of a contracting party or on the high seas or in any other place not under the jurisdiction of any State. Article 2 focuses on events occurring **within the national territory of a State party** and recognises the dominant position of this State. Article 3 applies when astronauts **landed on high sea or any other place not under the jurisdiction of any State**. Only few surfaces on the Earth qualify as places not under the jurisdiction of any State, for example Antarctica [36].The Moon and other celestial bodies can also be regarded as falling within the scope of this provision [37].States that are in a position (from a geographical and technological point of view) to do so **must extend assistance** in search and rescue operations to assure the rescue of the affected personnel, if necessary [38].

As regards the **reimbursement of costs** incurred in the rescue of personnel of a spacecraft, the ARRA is silent. In contrast to the obligation to pay the costs of recovery of a space object the same has not been established with regard to humans being saved. After long discussion in the negotiation process, the view finally prevailed that the duty to rescue is a humanitarian duty and could or should not to be financially rewarded. With regard to space objects, Article in Article 5 (5) provides:

Expenses incurred in fulfilling obligations to recover and return a space object or its component parts under paragraphs 2 and 3 of this article shall be borne by the launching authority.

This focus on “**emergency landings**” of the Articles of the ARRA mentioned above leads to the conclusion that situations of distress without a “landing” are not covered by its scope of application. This includes, for example, cases of emergency in outer space where the spacecraft is still in flight and the rescue of personnel stranded in orbit or deep space [39].However, based on declaration given by

delegates, some authors argue that the gap created by the use of the term “alighted” was not intentional [40].

It is not entirely clear whether in that case the more general obligation contained in Article V OST, paragraph 2, would come in. Generally, according to the *lexspecialis* and *lex posterior* rules, the more specialized prevails over the more general norm and the younger prevails over the older norm. This could mean that the ARRA prevails over the two older and more general instruments and that in case of accidents in LEO, thus not involving a “landing”, there are no obligations for States to rescue. On the other hand, it does not seem to be the purpose of the Rescue and Return Agreement to limit and restrict the duty to rescue astronauts but, on the contrary, to determine the respective obligation of States more clearly. A future protocol or other instrument could try to find a solution to this apparent contradiction of the OST and the ARRA as regards the duty of States to rescue astronauts in LEO.

### **3.1.4 Relevant provisions in the regime of the Law of the Sea**

As the legal regimes of the Law of the Sea and Space law are similar in many respects, principles or rules contained in the former may sometimes serve as a source of inspiration for solving issues not regulated appropriately by the latter. In the following, concepts and provisions of the United Nations Convention on the Law of the Sea (UNCLOS) [41] of 1982, the Convention for the Safety of Life at Sea (SOLAS) [42] of 1974, and the International Convention on Salvage (Salvage Convention) [43] of 1989 will briefly be introduced as a stimulus for the discussion of the duty to rescue of astronauts in LEO.

**Article 98 UNCLOS** in Part VII ( High Seas)deals with the duty to render assistance persons in danger or distress on the high seas, thus in an area outside the jurisdiction of any State as it is the case with Outer Space. Article 98 confirms the general humanitarian duty to rescue persons in distress. More specifically, it obliges the respective State parties to prescribe certain obligations concerning the rendering of assistance to masters of ships under their jurisdiction:

The **SOLAS Convention** of 1974has already regulated earlier the duties of the master of a ship in situations of distress. The main focus of the voluminous **SOLAS Convention** is, however, the prevention of accidents and distress situations. The Convention, in extensive and detailed provisions, deals with the specification of standards for the construction, equipment and operation of ships. The individual chapters of the Convention regulate technical details concerning the construction of ships, including the design of subdivision and stability, machinery, electrical installations, fire protection, lifesaving appliances, radio communications etc. Flag States have to ensure that the vessels flying under their flag comply with the requirements contained in the Convention. According to the Convention’s approach, the standardization of the technical equipment is crucial for the benefit of safety of human life in dangerous environments. The SOLAS Convention thus can serve as a source of inspiration in the endeavor of standardization of outer space technology in the area of manned space flight.

The **Salvage Convention of 1989** aims at determining uniform international rules regarding salvage operations and to ensure that **adequate incentives** are available to those who undertake salvage operations. The duty to render assistance is contained in Article 10 (1) and (2). Article 10 defines the obligation of the master but also the obligation of the State Parties to ensure that this obligation can be effectively enforced. The rescuer must carry out the salvage operations with due care, and the owner of the property in danger must co-operative fully with him. An incentive to undertake salvage operation is the right of the rescuer to obtain a reward as provided in Article 12. However, in the case of salvage of persons, no remuneration shall be paid. This reflects, as in the UN outer space treaties, the humanitarian nature of rescue operations.

The incentive to obtain a reward for salvage operations can be considered as a model for situations in outer space as well. In view of the high risks and costs of rescue operations in outer space, in contrast to the Salvage Convention, the possibility of reimbursement of costs and/or remuneration for the salvage of persons should not be ruled out entirely.

### ***3.1.5 ISS Crew Code of Conduct***

The Code of Conduct was agreed upon in 2000 and covers the conduct of astronauts onboard the International Space Station (ISS) [44]. The Code of Conduct is applicable to an astronaut from the time of his or her designation as an ISS expedition crew member until completion of post-flight activities. It also applies to visiting crew members in order to ensure that all persons on board are covered by the same legal prescriptions [45]. The Code was accepted by all ISS partners and has to be signed by all ISS crewmembers[46].

It establishes a clear chain of command and relationship between ground and on-orbit management, standards for work and responsibilities, disciplinary regulations and security guidelines, defines the ISS Commander's authority and responsibility **to enforce safety procedures** as well as physical and information security procedures and **crew rescue procedures**. The ISS Code of Conduct could be a useful model for determining the obligations of crew members of spacecraft in situations of distress or emergency occurring in LEO.

## Chapter 4

### **Impediments in considering an interagency protocol on Crew rescue from space and possible mitigations**

The previous chapters have discussed the possible crisis situations/emergency scenario that could happen in LEO manned missions, the current space treaties and its limitations in dealing with present and future rescue situations. Though the concepts of rescuing from space is as old as space age itself, the technical and financial factors of rescue of distressed astronauts in space have prevented a full rescue capability from being developed [7,47]. The existing international legal regime has not kept pace with much of the remarkable technological and commercial progress made in the space arena especially with emerging private space transportation activities [48]. Unlike other similar fields such as civil aviation and commercial shipping, there has been no universal law binding all the parties to certain degrees of observance to enhance crew safety and rescue characteristics. It is imperative to understand the limitations that would impact the spread of technologies that will allow the early integration of different nation's space faring systems. The very fact that there is not a single comprehensive law on crew rescue, even after half a century of manned spaceflight, speaks volumes about the influences of impediments, which make such legislation difficult. The nature and extent of obstacles may be very diverse and include technical, managerial, political and economic issues. Identification of these possible stumbling blocks and addressing them successfully will facilitate the development of a satisfactory and effective inter-agency protocol on crew rescue.

#### **4.1 Impediments/hurdles foreseen**

Some of the major possible impediments and the approach to overcome them are discussed below.

##### ***4.1.1 International Standardization of manned space vehicle systems***

Historically, manned spaceflight standards have evolved independently by leading national space agencies. Through the lessons learned and safety analysis conducted, applicable requirements to reduce and control safety risk were derived. In order to successfully establish an international crew rescue capability, common design and operational standards will have to be developed and implemented in each nation's manned space systems. A primary focus maybe on standardisation of systems essential for crew rescue, such as the interfaces for docking/berthing, environmental control and life support systems (ECLSS), interfaces of flight suit/spacesuit, communication systems etc . Capabilities and procedures should be understood and in place so that when the need arises, possible crew rescue can be assessed quickly. This will call for a good understanding of existing human spaceflight systems and related technologies. The countries with human mission capability may not agree to alter their well-proven existing systems. Due to export control limitations countries may not be able to fully share engineering data. Modification of existing systems with enormous flight heritage can also have an adverse impact on overall reliability of the system. Developed countries may be

reluctant or prohibited from transferring their technology without adequate financial compensation. The disparity in “the state of the art” of technology among participating nations may also be an impediment. All the above translates into additional cost, time and effort, which can be resented by many of the participants.

**Mitigation:** The importance of standardization vis-à-vis the usage of existing proven system as well as ‘which’ is the standard to be followed is to be deliberated and agreed upon by the participating countries. The experience of ISS IGAs and MOUs, which took years to develop, may be a good model to consider.

#### **4.1.2 Sharing of cost in rescue mission**

A primary issue with space rescue missions is the potential expense and the apportionment associated with it. This question assumes significance, as we consider scenarios with astronauts of different nationalities than the country of launch place or the country providing the rescue capability.

The cost of a typical rescue mission has many elements.

- Cost of development of rescue system
- Launch cost to the LEO or as required by the mission
- Operational cost; which involves :
  - Maintenance of rescue system in orbit
  - Ground support systems like launch/mission control
  - Maintenance of recovery team for rescue vehicle recovery
- Use of space station if it is used as an intermediate safe haven.
- Compensation to various agencies, whose regular activities were affected due to resource diversion to the rescue mission

The factors associated with the spending of funds for rescue is more likely to be heavily influenced by the political relations between countries, frequency with which a nation uses this facility, the formula for apportioning the cost of rescue, existence of available agreements, if any, etc. Obviously the cost of rescue is going to be quite high. Anticipation of cost, estimation based on realistic rescue scenarios and arriving at logical and acceptable mode of cost sharing is going to be a challenge, while discussing any protocol related to space rescue.

**Mitigation:** A mechanism has to be in place to have a realistic estimate of the actual cost involved on a real-time basis and a proper economic model should be developed. This should take into account the

effort and contribution of each agency in a possible rescue operation, and should be flexible enough to accommodate all the possible variations and uncertainties

#### ***4.1.3 Rescue scenario and response time***

One of the primary choices, within the present constraints of technology, for rescuing a distressed crew in orbit is by sending a rescue spacecraft. This demands an optimal rescue vehicle that can be rapidly prepared for launch.

Due to limitation in launch vehicle payload capacity from a given launch point and constraints with respect to launch stations, rescue spacecraft may not be able to reach the orbit of the stranded vehicle, in all cases. The number of launch opportunities to perform a rescue will be further reduced by orbital mechanics related constraints. All these would severely hamper the rescue attempt. Under such situations, the rescue methodology needs to be expanded by allowing the spacecraft in distress to dock with another vehicle /Space station/crew life stations that can provide ad hoc life support while the main rescue vehicle is on its way.

***Mitigation:*** Every crisis scenario, its consequences and suggested rescue methodology has to be studied well in advance so that in the event of an actual rescue, a clear procedure to be followed and hierarchy of command exist. This will speed up the rescue operation and streamline the co-ordination between the various agencies involved.

#### ***4.1.4 Crew Size for future missions***

The acceptable crew size for rescue is dictated by the accommodation capacity of the space capsule available at that point of time.

At present, the Russian Soyuz-TMA and Chinese Shenzhou are the only manned spacecraft and can only transport a crew of three. The Russian Soyuz is versatile enough to carry out missions to ISS or perform autonomous missions of its own. The United States is in the process of renewing their human spaceflight capability through new generation modules, viz. Dragon, CST-100, Dreamchaser and Orion for beyond earth orbit.. The Russians have also considered developing bigger modules, which could carry more cosmonauts than Soyuz.

The number of crew to be rescued vis-a-vis the carrying capacity of the rescue vehicle will be serious techno-managerial impediment, which has to be thoroughly debated and resolved. The major points of concern are mission to mission variation of crew size, type of mission; its purpose and orbital parameters, capability of the rescue vehicle with respect to the number of crew, which it can safely evacuate at a time, ; immediate requirement or longer term need and nature of rescue vehicle; Piloted or Autonomous.



The crew rescue options are limited by the current technology and choice of available spacecraft. Depending on the type of crisis and the number of travelers to be rescued, the crew can either be brought back to earth or to the safety of a space station. This is an impediment as most crises scenarios demand the evacuation of larger number of astronauts. In the present scenario, rescue of more than two astronauts, means launch or deployment of multiple rescue spacecraft.

**Mitigation:** The crew size for any particular mission is driven by the requirements of that specific mission. Crew rescue may be a consideration but will be traded against the design and reliability of the space craft itself.

#### ***4.1.5 Limitations on technology transfer***

Any crew rescue situation may imply sharing and transferring of technology among the signatories, to successfully address various rescue scenarios. Even if the development of universal safety systems and standards do not intrude on the proprietary or technology transfer realms of the design of space transportation systems, it can still be assumed that objections to technology transfer would be a major deterrent for international cooperation. The concerns include possible dual use of technology, violation of Intellectual Property Rights and disparity in technology readiness or varied maturity level among participating countries. The prevailing socio-political and technology transfer policies of countries, can also act as hindrance to the knowledge sharing.

The Apollo-Soyuz Test Project that materialised (in the 1970s) during the height of the cold war, is often quoted as an example of successful technology transfer between two major space powers. In the years that have followed Apollo-Soyuz, the ISS has demonstrated an ability to share engineering design and technology on a level far greater than past missions. These models should be considered for practical limitations on technology transfer.

**Mitigation:** The difference of technology maturity level among participating nations should be accepted as a fact and realistic methodology for technology transfer has to be evolved based on past experience like the Apollo-Soyuz test project and the ISS. Focusing design considerations on critical interfaces rather than detailed system knowledge may mitigate much of this concern.

#### ***4.1.6 Geopolitical considerations***

In the US, emergence of private players in human space flights is being encouraged and private parties have come forward to invest in space. The 21st century witnessed rapid strides made by China in manned space flights and on-orbit construction activities. Their achievements in human spaceflights have triggered many new global partnerships, especially with European countries, resulting in various collaborative ventures. This has greatly altered the dynamics of international space co-operation. Today, what we have is certainly a multi-polar world, as far as space is concerned, with many stake holders in the fray. Obviously, this creates more challenges to arrive at consensual protocols and

treaties in space, satisfying the interest of all. It is highly likely that countries might put forward unacceptable conditions for acceding to future treaties and protocols, like lifting of arms/trade embargo, underplaying of human rights violations, encouraging clandestine nuclear activities, interference in regional political skirmishes etc. It may be difficult to insulate space and related ventures from the overtures of geopolitical considerations.

**Mitigation:** It is quite possible that only a handful of countries will be providing human spaceflight capability, at least, in the foreseeable many years. The success of ISS has demonstrated even larger multinational space operations for many years. Though the geo-political issues are reality, it can be well managed through appropriate consultations at different levels.

#### ***4.1.7 Gaps of existing legal framework***

Today, there exists no single all-encompassing legal mechanism to deal with or direct the necessary global technological efforts required to tackle the challenges of successful crew rescue. At present, rescue operations or commitments are not mandatory and hence are not governed or regulated by the present treaties. Another inadequacy is that most of the treaties/agreements are between nations or national agencies and they exclude private agencies. This is a serious handicap, in the present scenario, as many private agencies have manned mission capabilities of their own or on the verge of acquiring it. Attempt to forge a single legal framework, which is binding to all space faring nations and capable private parties, can have severe impediments and conflicts with existing national, regional and provisional laws and practices. This can clash with internal goals set by national agencies, national ambitions and agency specific unique technical standards and processes. During evolution of the legal framework, definition of parameters can change and policies that are not made explicit at the beginning of co-operative efforts, can lead to conflicting interpretations, at a later stage. All existing laws are primarily on the use of space for peaceful purposes, on usage of satellite slots and broad guidelines on utilization of resources. They do not address the modalities on policy, management, systems engineering and operation with respect to a realistic crew rescue scenario from Low Earth Orbit.

**Mitigation:** The nations should not only overcome the gaps in the existing legal framework, but also delineate new ones, wherever necessary, on a priority basis. A clear process should be outlined to make decisions and settle disputes. The line of authority and responsibility should be well defined and the role of each agency should be explicit. The evolved legal framework should also address the funding methodology, resource allocation and the financial commitment needed to undertake the task of crew rescue.

#### ***4.1.8 Satisfying diverse interest of stake holders/consensus among member countries***

The achievements of pioneering nations in human spaceflight arena are acquired through significant economic commitments and technological development. There can be varying priorities about sharing

such achievements with agencies, which are not state backed, as it could be utilized for their respective commercial interests. Arriving at a global consensus on any treaty could well be thwarted by regional challenges which depend on the geographic setting and mutually shared economic and political interests. A powerful regional space faring nation could seek to dictate supplementary objectives of their choice in addition to co-operative space rescue, in a regional space co-operation organization. This advantage, in addition to consolidating that country's position in space, can also result in gains in other commercial space ventures, over its regional partners. In such cases, those countries, which do not have a strong political/economic stature in the region, could lose out on opportunities to establish themselves as future leaders on space activities. Therefore, if issues related to space rescue are discussed at a regional level, stake holders should take into account the existence of multiple regional space bodies and its influence.

**Mitigation:** The success of ISS can be cited as an example in bringing together many nations for a common cause. Emphasis should be given in promoting mutual commercial and technological interests in the region and provision for international consensus on various aspects of space rescue should be inscribed in the protocol. At the same time ISS has allowed for individual agency priorities to also be included.

#### **4.1.9 Technology obsolescence**

Obsolescence is a significant cost driver and can have impact at all stages of the development and operational phases. Components, methodologies as well as approaches have to be selected keeping this in mind. Thorough and periodic reviews have to be carried out to avoid systems becoming unacceptably outmoded, which is difficult from a technical management point of view. A robust obsolescence management strategy has to be considered involving all the concerned parties and manufacturers to ensure uninterrupted supply. Although electronics are most likely to be affected by the onslaught of new technology, obsolescence of non-electronic and commercial off-the-shelf (COTS) items also poses a problem in the long run.

**Mitigation:** A clear obsolescence management strategy, which is both practical and effective, should be considered in the development of the protocol. The strategy should address the concerns of participating countries and should encompass all aspects including advances in technology, costs involved and support from participating countries. Useful guidelines shall be evolved with mutual consent of all the agencies involved.

## **Chapter 5**

### **Considerations towards evolving an Inter-Agency protocol to handle crisis/emergency of astronauts in LEO**

As the current legal framework of activities in outer space, most prominently the Declaration of Legal Principles Governing the Activities of States in the Exploration of Outer Space (Declaration of Legal Principles), the Outer Space Treaty (OST) and the Agreement on Rescue and Return of Astronauts (ARRA), do not specifically address crisis or emergency situations of astronauts in LEO, there is a need for clarification and further development of the existing international rules. Some general principles are applicable and give some guidance but several questions remain open. The open questions concern, in particular, (1) the definition of situations which would trigger the obligations to rescue, (2) the identification of who would be obliged to render assistance and/or carry out salvage operations, and (3) what kind of assistance and/or salvage operations would be required. In addition, (4) matters of liability and (5) cost bearing should be addressed.

The following considerations need to be taken into account in the development of a future consensus protocol to put in place an international mechanism to aide and possibly rescue the crews in distress.

#### **5.1 Situations that trigger an obligation to assistance and/or rescue**

Different scenarios are possible which could lead to an emergency situation in LEO. As shown in Chapter 2, these can be technical problems of the spacecraft or further problems endangering the health of the crew. All of these situations become life-threatening at one point, either in orbit or when the spacecraft tries to re-enter the Earth atmosphere.

The current legal framework already stipulates obligations of States in respect of assistance and rescue of astronauts. Principle 9 of the Declaration of Legal Principles and Article V (1) OST establishes that States “shall regard astronauts as envoys of mankind in outer space and shall render to them all possible assistance”. However, the language of the provision appears to limit the scope of this obligation to events of “accident, distress or an emergency landing on the territory of another State Party or on the high seas.” Yet, it is generally accepted that this obligation has a predominantly humanitarian underpinning. It should thus be interpreted in a way that includes events of “accident, distress or emergency” occurring in outer space. A “landing” on a territory or on the high seas should not be required to trigger the obligation to assist.

This would fill the gap between Article V (1) in relation to (2) which already establishes the duty of astronauts to assist astronauts of other States when carrying on activities **in outer space**.

Such an interpretation would also confirm the general principle that anyone in a position to do so must help other persons in an emergency situation. Even if the extent of the duty to assist or rescue

varies from country to country, it exists in numerous national jurisdictions. This duty may therefore be regarded as a general principle of law which is also binding upon States. It is generally limited by the helper's capabilities and by the exclusion that he or she must not endanger his or her own life or that of others while conducting the rescue.

Similar obligations are already well established in the Law of the Sea (see Article 98 UNCLOS, Regulation 10 of Chapter V of the SOLAS Convention 1974, and Article 10 of the Salvage Convention 1989 (as quoted above).

It may be concluded that situations triggering the obligation of States "to render all possible assistance to astronauts" should be "accident, distress or emergency situations occurring in LEO." The term "astronaut" in this context should also encompass private spaceflight participants and private researchers.

## **5.2 Obligation to provide assistance and rescue**

Principle 9 and Article V OST simply refer to "States" being obliged to provide assistance. However, a differentiation may be appropriate depending on the capability of the State and its involvement in the concrete mission. Only relatively few States are actually carrying out space activities and have the necessary infrastructure. Their duties must be different from those which do not have any space faring capability.

With respect to the issue of astronauts in emergency situations in LEO, it appears to be appropriate to differentiate between three different types of States: (1) States which are involved in the mission, either as a launching State or as a responsible State; (2) States which have space faring capabilities, in particular with respect to manned space flight; and (3) all other States.

Group (1) may have the most far-reaching obligations in the case of emergency in LEO as they have the relevant know-how concerning the planning and procedure of the mission.

Other space faring nations not involved in the respective mission (Group 2) may also have certain duties with respect to astronauts in distress in LEO. The reason is that they potentially have the capability to conduct rescue missions. In this respect, Article 3 of the ARRA provides some guidance. It provides that States which are in a position to do so from a geographical and technological point of view are obliged to extend assistance in rescue operations. The obligations of States not having space faring capabilities at all (3) will be more limited due to the lack of technologies. However, due to humanitarian considerations, all States have general obligations to assist them in case of necessity. Article V paragraph 3 OST already requires State parties to provide information on any phenomena they discover in outer space that could constitute a danger to the life or health of astronauts to other State parties or the UN Secretary General.

**Astronauts** themselves are obliged to provide assistance to other astronauts while in orbit according to Article V paragraph 2 OST. A similar obligation is also known in the Law of the Sea. Various conventions (UNCLOS, SOLAS, Salvage Convention) provide for the duty of the master of a ship to render assistance and to rescue persons in distress at sea.

### 5.3 Providing assistance and rescue

Principle 9 of the Declaration of Principles and Article V OST do not set parameters for required assistance other than it being “possible”. In general, the extent of obligation to assist or rescue depends on the concrete circumstances of both the crew/ spacecraft in danger and the rescuing crew.

In the Law of the Sea it is accepted that “all possible assistance” does not place an unlimited duty to provide assistance on the assistor, but is guided by the technological or financial capability and a general geographical proximity. In outer space, the situation is even more sensible as any activity, including rescue activity, is hazardous, putting into risk also the rescuing crew. Also in other highly dangerous environments, such as Antarctica or extreme sports adventures, there exists a legal obligation to help and assist only in situations which are life threatening to other participants and only if the rescue does not entail a large risk for the rescuer himself.

The type of measures constituting “possible assistance” in outer space depends on the capabilities of the rescuing crew and the concrete circumstances of the emergency situation. Most importantly, the safety of the rescuing crew should always be crucial in the evaluation of measures to be taken.

Several measures aiming at assisting and rescuing astronauts in LEO can be distinguished:

- Measures to prevent emergency situations from occurring (*a priori*, long before the respective mission is launched)
- Measures to assist astronauts in distress (assist phase). This includes both ground based and in-space components of assistance. For example, providing emergency communication
- Measures to rescue astronauts in distress (evacuation phase)

Measures to prevent emergency situations have to begin well in advance and may include standardization procedures of manned space vehicle systems. In this respect, reference can be made to the SOLAS Convention of 1974 which specifies minimum safety standards in construction, equipment and operation of ships in order to ensure their safety.

Measures to assist are measures aimed at helping the crew in distress to manage the crisis by itself until its members are rescued or can return to safe haven. Such measures could include allowing the crew in danger dock at a space station in order to get oxygen or other supplies needed.

The evacuation phase includes evacuation and transport of the crew to a safe place in orbit or on the Earth.

When deciding which measures should be taken in the concrete case, the limitations attached to the duty to rescue as a general principle of law could provide guidance. In a number of jurisdictions due care is required from the rescuer, which is established according to his personal skills and knowledge. Due care is also relevant in the context of the Good Samaritan principle and is reflected in Article 8 of the Salvage Convention of 1989.

#### **5.4 Liability for damages occurring during the rescue operation**

An issue to be addressed is whether liability could be triggered for damage occurring during rescue operations, such as damage on the spacecraft in emergency, the rescue space vehicle, death or injury of persons, damage to the environment (like, for instance, emergence of space debris).

The current legal regime for outer space establishes State liability for damages caused by space objects under the OST as well as the Liability Convention. A waiver of liability should be considered for damage caused by, or in the course of an effort to rescue astronauts. In this context general principles of law could provide useful guidance and the Good Samaritan principle, the liability of the rescuer in emergency situations is more limited than usual.

As long as the rescuer acts with due care in a reasonable manner, he/she should not be liable for the failure of the rescue attempt or for damages that might arise as a consequence. The liability in this case should be limited to grossly negligent or reckless behavior. In addition, there should be no liability for contributory negligence, if he or she acted reasonably.

The necessity of due care is also reflected in Article 8 of the Salvage Convention and could be applied for situations of rescue attempts in orbit.

The Good Samaritan principle was included in the Recommendations enshrined in the Final Report on “Legal Aspects of NEO Threat Response and Related Institutional Issues”, According to Recommendation No 3, if damage occurs “(...) as a consequence of such mission being not (completely) successful, the state(s) responsible for such mission should not be held liable for such damage as long as the mission was undertaken within the parameters set by a proper mandate by the international community”.

#### **5.5 Bearing the costs of rescue mission**

Assistance and rescue operations in orbit involve very high costs. It is therefore of utmost importance to define how the costs for such operations should be born. In view of humanitarian considerations upon which Principle 9 of the Declaration of Legal Principles and Article V OST are based, costs of

measures taken to save human life should not be reimbursed. This contrasts with the costs for the return of a space object and its regulation in the ARRA (Article 5 (5) ARRA). The same distinction between objects and human life is made in the Law of the Sea (Article 12, 13 and 16 of the Salvage Convention of 1989).

However, in view of the costs of rescue operations in outer space which are not comparable to costs emerging in similar legal regimes, it seems to be unfair to ask the “capable” States with all the financial burden of rescue operations.

In order to create an incentive for developing and employing rescue operations and measures, reimbursement or remuneration mechanisms could be introduced. These could be financed by an international fund. In addition, launch providers could ask for appropriate insurance to cover such costs.



## **Chapter 6**

### **Conclusions and Way forward**

#### **1. Summary of Study**

1. The ability to provide assistance in on-orbit scenarios is fundamentally driven by the physical parameters of the spacecraft position in space and the state of the spacecraft and the crew. While many systems failures can be envisioned to cause situations leading to distress events those situations can be organized into a smaller set of scenario outcomes. Several of the scenarios highlight the desirability of common standards and interface definition.
2. The current legal framework was elaborated in a period when space activities were conducted only by States, were reflecting the technological capabilities of the time and were conducted in front of a particular political background. Thus, in addition to humanitarian considerations, the duties of States to rescue and return astronauts were very much drafted to safeguard the interests of the then space faring nations. The current legal frame work does not cover all types of space activities carried out by a number of different space actors, including emerging space faring nations and private operators. The obligations of States in cases of distress or emergency situations occurring in LEO are not clear. The respective provisions on the rescue of astronauts have a slightly different scope in the Principles Declaration, the OST and the ARRA. A protocol or another instrument for interpretation could be beneficial for the clarification of the outstanding questions.
3. The various impediments that can come up in formulating an inter-agency protocol on crew rescue from LEO are identified along with the approaches to overcome them. There are technical as well as geopolitical issues that need to be tackled.
4. A set of discussion points, as given below, have been identified by the study group addressing questions related to the development of a possible consensus protocol to handle crisis/emergency of crew in LEO.
  1. Defining the situations that trigger an obligation to assist and/or rescue and the persons who should benefit.
  2. Identifying the States which should have a duty to render assistance to astronauts in outer space, depending on their respective capabilities, particularly in the area of manned space flight and other space activities.
  3. Describing the extent of the duty to render assistance, possibly distinguishing between measures aiming at assisting and rescuing astronauts which consist of measures to prevent,

measures to assist, and measures to rescue. Measures to assist and rescue astronauts shall be carried out with due care. Considering that, when the circumstances so require, assistance from other States and non-governmental entities should/could be sought.

4. Defining the extent of liability for damages caused by an assistance or rescue operation. Such liability could be limited to cases of gross negligence, intention or recklessness.
5. Considering the establishment of an international fund for the coverage of the costs for assistance and rescue operations for astronauts in distress or emergency situations in outer space.
6. Considering whether non-governmental entities carrying out space activities should be encouraged to take out insurance to cover the costs for assistance and rescue operations for astronauts in distress or emergency situations in outer space.
7. Paying due regard to the ISS International Docking System Standard as a great start in the development of compatible interface systems for human spaceflight, several other systems can be considered for studies leading to similar standards.
8. Developing a list of primary systems to be considered for definition of standards. That list could then be shared and considered in international for a. Synergies with international coordination efforts driven by the intent of space agencies to cooperate for advancing common space exploration goals could be identified and exploited. Space agencies could also give due considerations to crew rescue requirements as they plan future human spaceflight missions and define the associated architecture, infrastructure and Design Reference Missions.
9. Acknowledging the physical limitations of various orbital scenarios in the legal considerations for assistance.
10. Considering an international crew rescue organization, in line with the International Maritime Organisation (IMO), with participation from many countries, possibly under the aegis of the United Nations, to formulate, oversee and implement the standardization process.

## **2. Recommendations of SG3.18 for immediate consideration**

From above, the following recommendations are put forward for immediate consideration while discussing the feasibility study of possible interagency protocol to handle crisis or emergency of astronauts in LEO.

**2.1 Need for protocol:** Considering the gaps in the existing space laws and the changed scenario of human spaceflight world-wide, there is a need to bring out a protocol on crew rescue in low earth

orbit missions. The various impediments that are likely to crop up while discussing a consensual protocol are brought out along with the mitigation plan. Space faring nations with human spaceflight capability may take the initiative in arriving at a consensual protocol on this.

- 2.2 **Developing international standards in vehicle systems:** Developing a list of primary systems to be considered for definition of standards. Synergies with international coordination efforts driven by the intent of space agencies to cooperate for advancing common space exploration goals could be identified and exploited. Space agencies could also give due considerations to crew rescue requirements as they plan future human spaceflight missions and define the associated architecture, infrastructure and Design Reference Missions. Paying due regard to the ISS International Docking System Standard as a great start in the development of compatible interface systems for human spaceflight, several other systems can be considered for studies leading to similar standards.
- 2.3 **Defining preferred orbital corridors for manned flights:** Acknowledging the physical limitations of rescue of crew in danger from various orbital scenarios, the feasibility of defining few orbital corridors with defined orbital inclinations may be considered for human spaceflight activities and construction of space stations.
- 2.4 **Setting up of an international mechanism:** Considering setting up an international body, preferably under the aegis of the United Nations, in line with the International Maritime Organisation (IMO), to formulate, oversee and implement crew rescue from LEO along with addressing associated issues like cost sharing.

## **Annexure**

### **International Agreements and other documents**

#### **Treaties**

1. The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies of 27 January 1967
2. The Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space of 22 April 1968
3. The Convention on International Liability for Damage Caused by Space Objects of 29 March 1972
4. Vienna Convention on the Law of Treaties of 23 May 1969
5. International Convention on Maritime Search and Rescue, of 27 April 1979
6. United Nations Convention on the Law of the Sea of 10 December 1982, see [http://www.un.org/depts/los/convention\\_agreements/texts/unclos/closindx.htm](http://www.un.org/depts/los/convention_agreements/texts/unclos/closindx.htm)
7. International Convention for the Safety of Life at Sea 1 November 1974, see <http://treaties.un.org/doc/Publication/UNTS/Volume%201184/volume-1184-I-18961-English.pdf>
8. International Convention On Salvage of 28 April 1989
9. Intergovernmental Agreement on the International Space Station of 29 January 1998

#### **Non-binding international instruments**

1. The Declaration of Legal Principles Governing the Activities of States in the Exploration and Uses of Outer Space (General Assembly resolution 1962 (XVIII) of 13 December 1963);
2. The Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries (resolution 51/122 of 13 December 1996)
3. Memoranda of Understandings (MOUs) between NASA and each of the four cooperating agencies of Russian Federation, Canada, Europe, and Japan, signed on 29 January 1998 (and 24 February 1998 for Japan)
4. Code of Conduct for the International Space Station Crew, 14 CFR 1214.403, last update of 1 January 2012

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