Black Holes BV 

**FOR EADP**


# Report on legal parameters for an asteroid deflection demonstration mission as part of the EADP

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**F.G. von der Dunk**

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# Abbreviations & acronyms

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| ADRC | = Asteroid Deflection Research Center (Iowa State University) |
| AST | = (Office of the) Associate Administrator for Space Transportation (FAA) |
| COPUOS | = Committee on the Peaceful Uses of Outer Space (UN) |
| DSN | = Deep Space Network (NASA) |
| EADP | = Emergency Asteroid Deflection Project |
| FAA | = Federal Aviation Administration (US) |
| FCC | = Federal Communication Commission (US) |
| HAIV | = Hypervelocity Asteroid Intercept Vehicle |
| IADC | = Inter-Agency Debris Coordination committee |
| ITU | = International Telecommunication Union |
| JPL | = Jet Propulsion Laboratory (NASA) |
| MPL | = Maximum Probable Loss |
| NASA | = National Aeronautics and Space Administration (US) |
| NED | = Nuclear Explosive Device |
| NGO | = Non-Governmental Organisation |
| NIAC | = NASA Innovative Advanced Concept |
| NPS | = Nuclear Power Source |
| TT&C | = Telemetry, Tracking & Control |
| ULA | = United Launch Alliance |
| UN | = United Nations |
| US | = United States |

## Executive Summary

1. The fact of launching EADP demonstration missions into outer space as envisaged in itself does not present any show-stoppers under international space law, but merely results in a number of requirements all or most of which would be likely transformed into licensing obligations under the US licensing system that would not represent major obstacles either – and actually, in some respects, even contribute to further legitimacy and justifiability of such missions.

2. In view of the envisaged use for of a private launch service provider for the EADP mission requiring a US license under the Commercial Space Launch Act, the EADP would, either directly (as far as the payload review process is concerned and as far as it will be subject to the cross-waiver of liability) or indirectly through the launch service provider's license application process (in particular where it concerns the general assessment of the mission to be launched and licensed, and the third-party liability and related insurance issues), be confronted with the licensing requirements imposed under US law as per the Commercial Space Launch Act.

3. In view of the rather unique character of the EADP, the above should preferably cause the EADP to:

(1) Seek early consultations with the FAA AST on payload review issues, to avoid unhappy surprises later in the applications process;
(2) Determine early on its policy on insurance for property damage, and/or any negotiation position with the launch service provider regarding contractual agreements mitigating the risks emanating from the obligatory cross-waiver of liability;
(3) Seek early consultations with the envisaged launch service provider on the positions to be asserted *vis-à-vis* the FAA AST regarding the policy and safety approvals, in particular when it comes to the specific public benefits to be generated by the EADP demonstration mission; and
(4) Determine early on its policy on the third-party liability and related insurance requirements under the US regulations, and the resulting negotiation position *vis-à-vis* the envisaged launch service provider as to how such requirements are to be distributed over or shared between itself and such a launch service provider.

5. In view of the envisaged use of US governmental launch facilities for the EADP mission triggering certain clauses of the Commercial Space Launch Act, the EADP would, presumably indirectly through the launch service provider's license application process, be confronted with the licensing requirements imposed under US law as per the Commercial Space Launch Act specifically related to the use by the launch service provider of US government launch facilities.

6. In view of the rather unique character of the EADP, the above should preferably cause the EADP to determine early on its policy on insurance for property damage and any negotiation position with the launch service provider regarding contractual agreements mitigating the risks emanating from the obligatory cross-waiver of liability as well as its policy on the liability and related insurance requirements which continue to apply under the US regulations, and the resulting negotiation position *vis-à-vis* the envisaged launch service provider as to how such requirements are to be distributed over or shared between itself and such a launch service provider.

7. Whilst the intended usage of NASA's Deep Space Network in itself does not present any show-stoppers for an EADP demonstration mission, the EADP's specific use of radio frequencies for that purpose would raise some legal and regulatory issues, in regard of which the EADP would do well to consult in advance with NASA and the FCC as appropriate whether such use would meet with any problems in this respect.

8. The intended kinetic impact which an EADP demonstration mission is to effect raises several major legal issues which are not insurmountable but require substantive *a priori* attention by the EADP in order to be properly resolved. Notably, this concerns:

(1) The need to avoid any perception that by (aiming to) impact(ing) with an asteroid actual 'appropriation' is to be sought or achieved;
(2) The need to ensure that any potential liability for damage caused by the asteroid or its fragments post-impact is properly taken care of, in consultation with the FAA AST; and
(3) The need to properly address the possible risk that an EADP mission may contribute to the generation of 'space debris', again in close consultation with the FAA AST.

9. As long as the actual missions carrying NEDs would not result in stationing or orbiting the spacecraft in outer space, the Outer Space Treaty does not put fundamental obstacles in the way of such missions. Only the risk of 'political fall-out' may need to be carefully addressed also in this legal context. This conclusion also largely applies to some general customary international law principles which could, in theory, be claimed as legal obstacles to such missions.

10. In addition, it may be advisable for the EADP to briefly assess in due time whether the NPS Principles would contain any relevance for missions using nuclear reactors, in particular in consultation with the FAA AST to the extent the latter might consider including elements thereof in its safety approval.

11. Thus, the main potential show-stopper for any EADP-like mission carrying NEDs in conformity with the HAIV model – whether in the end to be undertaken by a state or a private operator – would be the fundamental prohibition provided by the Partial Test Ban Treaty of *any* nuclear explosion in outer space. There would, in principle, be three possible ways out of this conundrum, each however with their own drawbacks:

(1) To amend the Treaty as required. This may take a long time however, and not necessarily bring all states parties to the Treaty on board – not to mention non-parties;
(2) To withdraw from the Treaty once required. While the timeframe of three months may not present major problems, such withdrawal requires justification narrowly with reference to 'the supreme interests' of the state concerned, and may also result in undesirable 'political fall-out' – or even a cascade of other withdrawals; and
(3) To re-interpret the relevant clause as required, it being 'manifestly absurd or unreasonable' to define as illegal an action intended to save mankind or a major part thereof from disaster. Also here, however, undesirable 'political fall-out' with undesirable legal consequences may threaten.

12. Resulting from the above, in order to maximise accommodation of its intended missions, demonstration as well as actual, within the legal parameters sketched above, it would in particular be recommended for the EADP to:

- Address from an early stage onwards and in a continuing fashion the risk of 'political fall-out' outside the United States which EADP missions might give rise to, in particular as regards any possible future use of NEDs in actual threat mitigation missions, by way of information of and appropriate consultation with the other states of the world, the United Nations and the global scientific community and by stressing the clear benefits for and interests of all mankind and all states in the EADP missions. This should notably involve the US Department of Foreign Affairs as being the representative of the United States in international fora such as COPUOS and responsible for defending US interests and rights in the international community.
- Determine early on its risk mitigation strategy and policy, in particular with a view to the cross waiver of liability under US law and contractual liabilities *vis-à-vis* the launch service providers, including insurance options.
- Consult at an early stage with the FAA AST on the various key aspects of the mission with a view to licensing, in particular concerning general mission assessment, payload review, third-party liability, liability towards the US government for the use of federal launch sites, space debris mitigation strategy and the involvement of NEDs.
- Consult at an early stage with the envisaged launch service providers on the positions to be asserted vis-à-vis the FAA AST with respect to the above points.
- Consult at an early stage with NASA and the FCC on the use of the DSN for EADP missions with a view to guaranteeing interference-free usage of radio frequencies for that purpose.

# 1. Introduction

Further to e-mails between Mr. Henrik Skaksen Jacobsen (Emergency Asteroid Defence Project) and Mr. Frans von der Dunk (Black Holes) in the course of February 2015 a contract between the EADP and Black Holes was signed on 18 February 2015.

Under this contract Black Holes would produce a Report detailing and analysing the legal parameters under international and related US national law applicable to, and potential legal obstacles arising under the same legal regimes for, preparing and undertaking an asteroid deflection demonstration mission as part of the Emergency Asteroid Deflection Project (EADP) using the Hypervelocity Asteroid Intercept Vehicle (HAIV) model developed by Iowa State University's ADRC.[1]

Thus, the aim of the present Report is to offer the EADP insights into

> what we can and cannot do in regards to national and international law and 'good morals' in relation to our concept. Whether or not there's a legal way of using the HAIV for the use of protecting the planet against an asteroid impact on a short notice. If there's a way of it being legal, we need to know how. We need a report that can be viewed by the public, as part of our first funding will be brought home by a crowdfunding campaign and we regard transparency as very important in this matter.[2]

Consequently, the EADP would be entitled to publish each and all of the sections of the present Report as considered appropriate for that purpose. This notably includes the issue of use of kinetic impactors and nuclear devices as part of an asteroid deflection mission, issues of international responsibility and liability and resulting licensing requirements, as well as the need for communication capabilities.

The present Report thus first summarizes in the following chapter the deflection missions envisaged under the EADP in terms of their legal relevance. The result of this summary analysis will indicate six different legally relevant aspects and elements of a mission following the model, which will each be analysed in turn. The final chapter will then provide some overarching conclusions and recommendations.

[1] Further details were provided by the aforementioned e-mail correspondence and two documents provided to Black Holes; the article 'Conceptual design of a flight validation mission for a Hypervelocity Asteroid Intercept Vehicle' (hereafter Conceptual design HAIV mission), by B.W. Barbee, B. Wie, M. Steiner & K. Getzandanner, *Acta Astronautica* 106 (2015), 139-159; and the 'NAIC Phase 2 Final Report: Executive Summary' of 9 December 2014 (hereafter NAIC Phase 2 Final Report), by B. Wie & B.W. Barbee.

[2] E-mail Henrik Skaksen Jacobsen to Frans von der Dunk, 16 February 2015.

## 2. Deflection missions under the EADP using the HAIV model

From a legal perspective it is important to note that the HAIV model as contemplated by the EADP in the context of the EADP currently differentiates between a first demonstration mission and later actual missions to be undertaken once real asteroid threats would materialize.

The *demonstration mission* itself currently envisaged comprises five main aspects and elements from the perspective of legal analysis and evaluation:

1. A launch is envisaged of a spacecraft, consisting of two parts, into outer space.[3]
2. The launch is to be conducted – as far as currently foreseen – by a US private launch service provider, presumably a ULA Atlas vehicle, as opposed to either the US government (for example through NASA) or a non-US launch service provider.[4]
3. The launch is to take place from a US government launch facility, as opposed to either a private US launch facility or a non-US launch facility.[5]
4. The spacecraft will aim for a target asteroid in a very precise manner, calling amongst others for continuous and interference-free radio communication with the spacecraft by way of NASA's Deep Space Network as close to real-time as possible.[6]
5. The first part of the spacecraft, closely followed by the second part, will crash into the asteroid, creating a crater in the asteroid by ejecting matter, possibly fragmenting the asteroid and likely sending any fragmented parts of it into orbits different from the original one of the asteroid.[7]

These elements will be dealt with each in turn in Chapters 3 through 7 below.

The HAIV model also involves all five elements listed above, but adds one more key element. Whilst this is to be omitted for the demonstration mission (at least for the first one currently envisaged), ultimately this is to be brought back for any *actual missions*, whether state or private, as it represents the most important part of the impact strategy: is to render the asteroid harmless from the point of view of earth:

6. The second part of the spacecraft will contain a nuclear device, a NED, which is to detonate in the crater created by the first part, and thus create more ejected matter and likely cause still more fragmented parts to be sent into orbits different from the original one of the asteroid.[8]

In view of the special legal nature of this sixth element and the fact that it is currently only foreseen for actual missions, it will be dealt with separately in Chapter 8.

Chapter 9 will finally provide some overarching conclusions as well as recommendations, taking into account the differentiation between a demonstration mission as envisaged and an actual mission as foreseen in case of a real asteroid threat.

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[3] See *e.g.* Conceptual design HAIV mission, 139-40, 146, 148; NIAC Phase 2 Final Report, 5, 7-8.
[4] See *e.g.* Conceptual design HAIV mission, 148-9; NIAC Phase 2 Final Report, 7-8, 12-3.
[5] See *e.g.* Conceptual design HAIV mission, 148; NIAC Phase 2 Final Report, 13.
[6] See *e.g.* Conceptual design HAIV mission, 143, 156-7; NIAC Phase 2 Final Report, 17.
[7] See *e.g.* Conceptual design HAIV mission, 139-40, 145, 148; NIAC Phase 2 Final Report, 5-10.
[8] See *e.g.* Conceptual design HAIV mission, 139-40, 145; NIAC Phase 2 Final Report, 1-4.

# 3. Legal parameters for launching into outer space

## *3.1. Introduction*

As soon as a man-made object – such as a spacecraft on an EADP demonstration mission – is (attempted to be) launched into outer space, space law starts to apply and a range of relevant legal obligations consequently come into play. Most important for the current report are those resulting from the 1967 Outer Space Treaty[9], the 1972 Liability Convention[10] and the 1975 Registration Convention[11]. The United States is a party to all three treaties, together with all other major space-faring nations.

## *3.2. Structural obligations under international space law*

Most fundamentally, the fact that outer space constitutes a 'global commons' means that no single state can determine the legal regime in that realm, and that the baseline is the freedom of activity which can only be curtailed either by international agreement amongst all relevant states, or by individual states – but then only as far as their own subjects are concerned.[12]

Whilst the lower boundary of outer space (in other words, where vertically speaking the airspaces subject to sovereignty of the underlying states give way to the global commons of outer space) has never been authoritatively determined, actual discussions have usually focused on altitudes between 50 and 120 km above the earth's surface.

It is clear therefore that any launch vehicle to be used for EADP and/or HAIV missions by virtue of their targeted altitudes being well above any of the aforementioned altitudes would comprehensively fall within the scope of space law, and the default freedom of activity also applies to their operations in that area.

As a mirror-side to that default freedom of activity in outer space, a principled and comprehensive accountability of states for space activities presents the main channel for imposing legal limitations (also) upon non-governmental actors. This accountability takes two main forms.

First, states are going to be held internationally responsible for any potential violation of international law resulting from space activities also if conducted by private entities. Further to such international responsibility, the 'appropriate state' would then be actually required to ensure "authorisation and continuing supervision" of such

[9] Treaty on Principles Governing the Activities of States in, the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (hereafter Outer Space Treaty), London/Moscow/Washington, done 27 January 1967, entered into force 10 October 1967; 610 UNTS 205; TIAS 6347; 18 UST 2410; UKTS 1968 No. 10; Cmnd. 3198; ATS 1967 No. 24; 6 ILM 386 (1967).
[10] Convention on International Liability for Damage Caused by Space Objects (hereafter Liability Convention), London/Moscow/Washington, done 29 March 1972, entered into force 1 September 1972; 961 UNTS 187; TIAS 7762; 24 UST 2389; UKTS 1974 No. 16; Cmnd. 5068; ATS 1975 No. 5; 10 ILM 965 (1971).
[11] Convention on Registration of Objects Launched into Outer Space (hereafter Registration Convention), New York, done 14 January 1975, entered into force 15 September 1976; 1023 UNTS 15; TIAS 8480; 28 UST 695; UKTS 1978 No. 70; Cmnd. 6256; ATS 1986 No. 5; 14 ILM 43 (1975).
[12] Cf. Art. II, Outer Space Treaty.

activities, which would be realised most effectively by establishing national space law including a licensing system for space activities.[13]

Second, states are also going to be held internationally liable for damage caused by space objects for which they would qualify as a 'launching state'.[14] Thus, such a state would have a strong incentive to ensure that any space activity allowed in conformity with its exercise of authorisation and continuing supervision would amongst others be required to partially or fully reimburse the state for such international claims and to take out insurance covering such events.

It is *inter alia* as a consequence of these obligations that the United States (like a number of other states) has developed national legislation; which would presently apply also to EADP demonstration or actual space missions. Most importantly, the Commercial Space Launch Act in its current reiteration would apply, and would require a license which would only be granted following compliance with an extended set of obligations.[15]

### *3.3. Substantive obligations under international space law*

Beyond resulting in such fundamental 'structural' requirements for a state concerned – in this case the United States – to ensure the proper application of national law and regulation, the applicability of the space treaties to EADP demonstration and other missions in outer space results in several further relevant, more 'substantive' international, obligations which will likely find their way also into the licensing requirements.

Thus, the United States would have register the mission both nationally and internationally, including as to the latter providing details on basic orbital parameters, including nodal period, inclination, apogee, perigee and general function of the space object.[16] It will thus require such data to be provided by any licensee or payload operator as appropriate; read as for the latter presumably by the EADP.

Also, the United States would carry international state liability in accordance with the Liability Convention, which calls for absolute liability for damage caused in earth or to aircraft in flight, for fault liability for damage caused to other space objects, for compensation of the damage in principle without limits, for the possibility to sue in a private capacity in national courts as well as for the possibility to install a Claims Commission to determine liability and the extent of compensation due.[17]

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[13] See Art. VI, Outer Space Treaty. The provisions of this clause refer to 'national' activities in outer space of the entity concerned. This phrase has never been defined beyond doubt, but in view of the 'nationality' of the EADP as a non-profit NGO registered in Denmark, that country would most likely qualify; whilst as a consequence of the set-up of the EADP missions as these are to be conducted from the United States, the United States would also qualify as such. In the present case, noting that Denmark does not have a national law on space activities whilst the United States does, and that the EADP-related activities are clearly focused in the latter country, the United States would be the appropriate state to exercise such authorisation and continuing supervision.

[14] See Art. VII, Outer Space Treaty; Arts. I-III, Liability Convention. The legal status of 'launching state' would result from being the state that launches, that procures the launch, or whose territory or launch facility is used for the launch. Under these criteria, the United States would be the only state which qualifies as such in the case of missions envisaged under the EADP.

[15] The Commercial Space Launch Act is now codified as 51 U.S.C. Ch. 509. See further *infra*, Chapters 4 and 5, for the licensing requirements other than those referenced in the present Chapter.

[16] See Arts. II-IV, Registration Convention.

[17] See, resp., Arts. II, III, XII, XI & XIV-XX, Liability Convention.

Missions in outer space furthermore are to be conducted with due regard for the activities of other states in outer space and without unduly interfering with them[18], should be for the benefit of all mankind[19] and should serve the interests of science[20]. These requirements would not only likely be met easily by EADP missions, but actually serve to further contribute to the legitimacy and justifiability of such missions.

Finally, missions in space should not orbit weapons of mass-destruction or station them in outer space in any other manner.[21] For EADP demonstration missions, which will not yet involve nuclear technology, this is of no concern; the relevance for actual missions following the HAIV model involving such technology will be addressed later.[22]

This clause presents the only fundamental direct limitation of states' usage of outer space for military purposes under the Outer Space Treaty. Therefore, as long as not clearly threatening "international peace and security" or undermining "international cooperation and understanding"[23], alternatively amount to stationing or orbiting of such NED-equipped spacecraft, such EADP demonstration missions would not run counter to the letter of Outer Space Treaty – even if, for example, military launch vehicles were to be used.

International law hardly provides for binding obligations in the realm of space debris prevention or mitigation. On the other hand, the IADC Guidelines[24] and the more succinct COPUOS Guidelines[25], both as such providing for non-binding sets of (strong) recommendations, may nevertheless be turned into binding obligations for launch service providers and payload operators and under the US licensing system.

### 3.4. Conclusion

***In sum, the fact of launching EADP demonstration missions into outer space as envisaged in itself does not present any show-stoppers under international space law, but merely results in a number of requirements all or most of which would be likely transformed into licensing obligations under the US licensing system that would not represent major obstacles either – and actually, in some respects, even contribute to further legitimacy and justifiability of such missions.***

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[18] See Art. IX, Outer Space Treaty. For EADP missions this would require appropriate planning, *a priori*-analysis of the potential to harmfully interfere with other legitimate space activities, and possibly international consultation as appropriate, in conformity with Art. XI.

[19] See Art. I, Outer Space Treaty. This does not necessarily mean that each and every state would have to benefit, as long as the 'net benefits' to mankind would unequivocally exist. EADP missions, targeted at ultimately enhancing the capabilities to defend earth against asteroids, would obviously fit these requirements very well unless major risks of interference, damage or illegitimacy of its activities would somehow have become part of the mission.

[20] *Cf.* Arts. I, XI, Outer Space Treaty. As long as EADP missions would share scientific results with the rest of the scientific community and the UN Secretary General, these requirements would be easily met.

[21] See Art. IV, Outer Space Treaty. 'Weapons of mass destruction' are generally defined as including nuclear, biological and chemical weapons.

[22] See further *infra*, § 8.2.

[23] Art. III, Outer Space Treaty.

[24] IADC Space Debris Mitigation Guidelines (hereafter IADC Guidelines); A/AC.105/C.1/L.260.

[25] Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space (hereafter COPUOS Guidelines), UN OOSA (2010), ST/SPACE/49.

# 4. Legal parameters for a launch by a private US launch service provider

## *4.1. Introduction*

The launch options discussed in the context of the EADP all crucially involve a private US launch provider. Consequently, each such launch of an EADP mission, including demonstration missions, will indeed require a license under the US Commercial Space Launch Act.[26]

In order to obtain such a license, the launch provider needs to comply with a set of requirements, which most notably involve a general assessment of the mission to be licensed (which includes what is referred to as a 'policy review'), a payload review and liability-related arrangements, including mandatory insurance.

## *4.2. General assessment of the mission*

As to the general assessment, a license will only be granted if the applicant's mission will be "[c]onsistent with the public health and safety, safety of property, and national security and foreign policy interests of the United States".[27] Such 'foreign policy interests' include the various obligations of the United States under international space law as summarized above.[28] This is essentially achieved by means of the policy and safety approvals which are required.[29]

It may be noted specifically with a view to the EADP, that the AST "may waive a requirement, including the requirement to obtain a license, for an individual applicant if the [AST] decides that the waiver *is in the public interest* and will not jeopardize the public health and safety, safety of property, and national security and foreign policy interests of the United States".[30]

Though the license application will be conducted by the launch service provider, the EADP might do well to assist it in that process for example in order to ensure that the obvious 'public interest' of a demonstration mission such as envisaged under the EADP would be properly taken into account in the determination of the license requirements.

## *4.3. Payload review*

As to the payload review, its main aim is to ensure that US international obligations such as those summarized above[31] would be complied with not only by the launch service provider but also by the payload provider more specifically with regard to the payload – as opposed to the launch operations broadly speaking.

Thus, the payload review has "to determine whether (…) launch [of the payload] would jeopardize public health and safety, safety of property, U.S. national security or

[26] Formally, the authority to approve or deny licenses lies with the Secretary of Transport, but it has been delegated to the FAA's Office of the Associate Administrator for Space Transportation (AST). See also 14 C.F.R. §§ 401.1, 401.3.
[27] 51 U.S.C. 50905(a)(1).
[28] See *supra*, §§ 3.2, 3.3.
[29] See 14 C.F.R. §§ 415 resp. 414.
[30] 51 U.S.C. 50905(b)(3); emphasis added.
[31] See *supra*, §§ 3.2, 3.3.

foreign policy interests, or international obligations of the United States".[32] It is clear, therefore, that normally through the US licensing process the international obligations resting upon the United States as summarized above[33] would at least partially be transferred to the customers of launch service providers, such as in this case the EADP.

More in detail, the payload provider should identify to the AST:

> (1) Payload name;
> (2) Payload class;
> (3) Physical dimensions and weight of the payload;
> (4) Payload owner and operator, if different from the person requesting payload review;
> (5) Orbital parameters for parking, transfer and final orbits;
> (6) Hazardous materials, as defined in § 401.5[34] of this chapter, and radioactive materials, and the amounts of each;
> (7) Intended payload operations during the life of the payload; and
> (8) Delivery point in flight at which the payload will no longer be under the licensee's control.[35]

### *4.4. Liability-related obligations*

As for the liability-related arrangements, these should ensure that any damage caused by the launch with the EADP demonstration mission would be properly dealt with in the context *inter alia* of the international liability of the United States under international law as discussed above.[36]

First, the EADP would be required to accept – as an obligation under the Commercial Space Launch Act[37] – a cross-waiver of liability *vis-à-vis* the launch service provider and all its contractors and subcontractors. This means that for any damage which the launch service provider in the cause of the preparation and the execution of the launch may cause to the payload compensation cannot be claimed by the payload customer – as well as *vice versa*.[38]

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[32] 14 C.F.R. § 415.51. For purposes of this review, the FAA AST will notably consult with the Departments of Defense, Department of State and any other appropriate federal agencies such as NASA; see § 415.57.
[33] See *supra*, §§ 3.2, 3.3.
[34] 14 C.F.R. § 401.5, refers to 49 C.F.R. § 172.101, which contains a detailed list of materials considered hazardous, which include toxins, flammable materials, explosives, corrosive materials, self-reactive materials, organic peroxides and radioactive materials. In due time, the EADP may be well advised to have a closer look at those clauses in order to determine any possible applicability to the envisaged missions – especially of course those actual missions that are to include NEDs.
[35] 14 C.F.R. § 415.59. This refers usually to the moment of payload separation and taking control of the payload by the payload operator, as opposed to the launch service provider. Likely – but not automatically – under the launch contract this would also be where the launch service provider would hand over responsibilities and liabilities for the payload to the payload operator, presumably the EADP.
[36] See *supra*, § 3.3.
[37] See 51 U.S.C. 50914(b)(1).
[38] Throughout history, a few attempts have been made to avoid comprehensive application of this cross-waiver by arguing that it could not be held to apply in case of gross negligence or wilful misconduct, but those were by and large unsuccessful, noting also that the clause makes no reference to gross negligence and/or wilful misconduct, where *e.g.* the latter has been referenced specifically in 51 U.S.C. 50914(e). In any event, in practice the need for a claimant to prove wilful misconduct or even gross negligence would represent a very high threshold. Many launch service contracts would furthermore instead provide for specific remedies in case of a major failure by the launch service

If the EADP would not wish to accept such risks, the main solution available would be to take out property insurance covering the appropriate risks that during launch preparation or execution damage would be caused to the EADP payload. (Likewise, of course, the EADP would be at liberty to seek insurance coverage for the payload or its successful functioning also beyond the launch phase properly speaking.)

Second, the launch service operator would be required to take out third-party liability insurance, in other words: insurance against the possibility that either the launch vehicle or the payload would cause damage to third-parties. This in turn is meant to ensure that the operator would actually be able to pay out compensation for such damage, which may after all amount to major, even catastrophic losses. This would notably include cases of compensating the US government for claims the latter would have had to compensate under its international liability as discussed above.[39]

The amount of the insurance coverage will be specified in the license, and will be the lowest of: (1) the maximum probable loss (MPL) that could be caused by the space object's launch and further operations;[40] (2) the highest amount for which coverage is available in the global insurance market against reasonable rates (as determined by the licensing authorities); and (3) an absolute maximum of 500,000,000 US$[41].[42]

In case the third-party damage would rise above the insurance coverage required by the license (the chance of which by definition would be 1 in 10,000,000 or less), the licensing authorities promise to request US Congress for taking care of such a second tier of liability, which in any case however cannot be more than 1.5 billion US$ in 1989 rates – close to 3.0 billion US$ in today's rates.[43]

Whilst such liability-related requirements are going to be imposed on the licensed launch service operator, likely efforts will be undertaken in the contract between that operator and the EADP as the payload provider to shift the burden of some of those requirements to the EADP. Notably, this will concern the obligatory subscription by the EADP to the inter-party waiver of liability as discussed above and the burden of any third-party liability for damage caused by the payload, in particular after separation from the launch vehicle.

## 4.5. Conclusion

***In sum, the EADP would, either directly (as far as the payload review process is concerned and as far as it will be subject to the cross-waiver of liability) or indirectly through the launch service provider's license application process (in particular where it concerns the general assessment of the mission to be launched and licensed, and the third-party liability and related insurance issues), be confronted with the licensing requirements imposed under US law as per the Commercial Space Launch Act.***

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provider to perform the contract, such as a 'free' re-launch. This however is essentially a matter of contractual freedom read negotiations, not imposed as such by the law.

[39] See *supra*, § 3.3.

[40] The MPL is the result of a theoretical statistical analysis of the risks that the launch and further operation of the space object might cause damage to third parties; the size of the damage which has a chance of occurring of 1 in 10,000,000 constitutes the MPL.

[41] In actual fact, so far under the Commercial Space Launch Act limits have been quoted in licenses varying from a few million US$ for a sub-orbital test launch to more than 250 million US$ for launches of large satellites into geo-stationary orbit.

[42] See 51 U.S.C. 50914(a).

[43] See 51 U.S.C. 50915(a)(1).

***In view of the rather unique character of the EADP, the above should preferably cause the EADP to:***

***(1) Seek early consultations with the FAA AST on payload review issues, to avoid unhappy surprises later in the applications process;***

***(2) Determine early on its policy on insurance for property damage, and/or any negotiation position with the launch service provider regarding contractual agreements mitigating the risks emanating from the obligatory cross-waiver of liability;***

***(3) Seek early consultations with the envisaged launch service provider on the positions to be asserted* vis-à-vis *the FAA AST regarding the policy and safety approvals, in particular when it comes to the specific public benefits to be generated by the EADP demonstration mission; and***

***(4) Determine early on its policy on the third-party liability and related insurance requirements under the US regulations, and the resulting negotiation position* vis-à-vis *the envisaged launch service provider as to how such requirements are to be distributed over or shared between itself and such a launch service provider.***

# 5. Legal parameters for a launch from a US government launch facility

## 5.1. Introduction

Apart from the licensing process addressing launch service providers summarized above, the Commercial Space Launch Act also handles two basic options for using launch facilities within the United States.

On the one hand, any space launch could in principle be conducted from a private launch facility. The operator of such a launch facility also requires a license in order to properly operate it.[44] Since the few launch service providers currently considered for EADP missions, however, would all operate their services from federal launch facilities, this issue need not be further explored here.

On the other hand, while US federal launch facilities do not as such require a license for operations (*inter alia* since there could be no question whatsoever as to US international responsibility and liability for activities conducted therefrom[45]), the Commercial Space Launch Act nevertheless defines certain legal parameters for undertaking private launch services from such governmental launch facilities.

## 5.2. Liability-related obligations

Most notably, this concerns the inter-party liability as between the launch service provider and the governmental agency operating the launch facilities. This issue would also regard a launch customer such as the EADP by proxy, as it might give rise to certain further legal consequences in the launch service contract, at least as suggested, proposed or urged by the launch service provider.

First, the launch licensee using governmental launch facilities would, along the same lines as with third-party liability as discussed above[46], have to accept liability for damage caused to the government's facility and commensurately would need to ensure insurance coverage up to an amount which will be the lowest of: (1) the maximum probable loss (MPL) that could be caused by the space object's launch and further operations to the launch facility; (2) the highest amount for which coverage is available in the global insurance market against reasonable rates (as determined by the licensing authorities); and (3) an absolute maximum of 100,000,000 US$[47].[48]

Second, above the amount thus included in the license a cross-waiver of liability similar to that already discussed above between any launch service provider and its customers[49] is applied as between

> the [US] Government, executive agencies of the Government involved in launch services or reentry services, and contractors and subcontractors involved in launch services or reentry services, [and] the licensee or transferee, contractors, subcontractors, crew, space flight participants, and customers of the licensee or

[44] See e.g. 51 U.S.C. 50904(a), for the baseline obligation to obtain a license under the Act.
[45] *Cf.* the discussion *supra*, § 3.2, of state responsibility and liability under the space treaties.
[46] See *supra*, § 4.4.
[47] So far under the Commercial Space Launch Act limits have been quoted in licenses up to the maximum of 100 million US$.
[48] See 51 U.S.C. 50914(a).
[49] See *supra*, § 4.4.

transferee, and contractors and subcontractors of the customers.[50]

Thus, similarly to the third-party liability arrangements discussed above[51], the EADP might become involved in discussions, presumably primarily with the launch service provider, on the extent to which in particular payload-related activities at the launch facilities might give rise to risk- and liability-sharing arrangements in the launch contract with regard to such liabilities *vis-à-vis* the US government.

## 5.3. Conclusion

***In sum, the EADP would, presumably indirectly through the launch service provider's license application process, be confronted with the licensing requirements imposed under US law as per the Commercial Space Launch Act specifically related to the use by the launch service provider of US government launch facilities.***

***In view of the rather unique character of the EADP, the above should preferably cause the EADP to determine early on its policy on insurance for property damage and any negotiation position with the launch service provider regarding contractual agreements mitigating the risks emanating from the obligatory cross-waiver of liability as well as its policy on the liability and related insurance requirements which continue to apply under the US regulations, and the resulting negotiation position* vis-à-vis *the envisaged launch service provider as to how such requirements are to be distributed over or shared between itself and such a launch service provider.***

[50] 51 U.S.C. 50914(b)(2).
[51] See *supra*, § 4.4.

# 6. Legal parameters for radio-communications via the Deep Space Network

## 6.1. Introduction

The EADP demonstration mission intends to use the Deep Space Network for radio-communications with the spacecraft, in other words to transmit and receive TT&C and other key data from the spacecraft on its operation and the progress of the mission. Such radio communications require the maximum possible protection against radio interference in order to maximise the chances of success of the mission.

The Deep Space Network (DSN) has been described as "NASA's international array of giant radio antennas that supports interplanetary spacecraft missions, plus a few that orbit Earth."[52] It is operated by NASA's Jet Propulsion Laboratory (JPL), and consists of three facilities at Goldstone, near Barstow, California; near Madrid, Spain; and near Canberra, Australia.

## 6.2. The use of radio frequencies

The use of radio frequencies in an international realm, such as envisaged by the EADP demonstration mission's intended usage of the DSN, has to fit within the international regime developed under the auspices of the International Telecommunication Union (ITU), in particular if such a mission cannot afford to suffer from radio interference coming from other sources.

Although NASA, as the US agency responsible for the operation of the DSN, would – with the help of the US FCC – ensure the proper operation of the DSN in this context, it would be appropriate for the EADP to appreciate how that context works, in order to allow the EADP missions to proceed with as little obstruction as possible.

The first step in the overall process of internationally managing frequency usage in the ITU context is the 'allocation', read the 'reservation' at the international level of frequency *bands* to *categories* of services using radio waves.[53] As of today, 42 different specific services are recognized for this purpose, of which exactly half are space services.[54]

Thus, any specific use by the EADP of DSN frequencies for radio communication with the EADP spacecraft would have to fit in with the allocation to that kind of service as per the ITU regime in order to obtain international recognition of the right to use hat frequency without interference from other international users. The EADP consequently would be well advised to discuss with NASA what service allocations its intended use of the DSN for EADP missions would fit into, read which particular frequency bands could be targeted for the purpose.

The second step then, as far as the EADP scenario is concerned, is the 'assignment' to a specific governmental user (in this case NASA) of specific *frequencies* to the specific *service(s)* it intends to use those frequencies for, as following from the formal 'allotment' to (in this case) the United States.[55]

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[52] At http://deepspace.jpl.nasa.gov/about/#; last accessed 2 March 2015.
[53] See Art. 1(16), Radio Regulations Articles (hereafter Radio Regulations), Edition of 2012.
[54] See Art. 1(19)-(60), Radio Regulations.
[55] See Arts. 1(18), resp. 1(17), Radio Regulations.

While, as said, NASA would take responsibility (in conjunction with the FCC) to ensure that any use of the DSN would comply with the international requirements under the ITU regime – as well as with any domestic regulations imposed by the FCC – it would thus be advisable for the EADP to discuss with NASA/JPL the frequencies it intends to use for the EADP, to ensure proper compliance with the above regime and, if necessary, to allow NASA to take the necessary further steps to achieve international legal protection against radio interference with the EADP demonstration mission.

Also, it may be noted that as part of the FCC authority, any payload to be launched into outer space requires an FCC license for the use of appropriate frequencies.[56] It is advisable for the EADP to enter into consultations with both NASA and the FCC to address in that context the scenario envisaged for the EADP demonstration mission. Either such requirements would be pre-empted by NASA's involvement and its contributing offer to allow access to the DSN or, in case the mission is in spite of NASA's involvement still seen as a private one, the EADP itself would be tasked to ensure proper compliance with the FCC's regulations in this regard.

## 6.3. Conclusion

***Whilst the intended usage of NASA's Deep Space Network in itself does not present any show-stoppers for an EADP demonstration mission, the EADP's specific use of radio frequencies for that purpose would raise some legal and regulatory issues, in regard of which the EADP would do well to consult in advance with NASA and the FCC as appropriate whether such use would meet with any problems in this respect.***

[56] See Sec. 301, Communications Act, 19 June 1934; 47 U.S.C. 151 (1988); 48 Stat. 1064; cf. also 14 C.F.R. § 415.53(a).

# 7. Legal parameters for impacting with an asteroid

## 7.1. Introduction

The key element of the EADP demonstration mission (as well as any actual missions to follow) is the aim of kinetically impacting with asteroids, in order to properly change their orbits and (perhaps, either advertently or inadvertently) 'damage' or even fragment them in the course of doing so.

As such, there is no prohibition whatsoever regarding kinetically impacting with a celestial body. Still, from the perspective of international space law this leaves four main legal issues to be discussed, which likely may also become part of the licensing process, for example as part of the policy approvals and/or payload reviews as discussed above.[57]

## 7.2. The 'appropriation' issue

First, there is the general prohibition for states to appropriate any part of outer space, whether "by claim of sovereignty, by means of use or occupation, or *by any other means*".[58] In theory, in view of the aim of this clause to be as all-encompassing as possible, it might be argued that crashing into an asteroid, especially if taking place without consultation or at least information of the world community[59], suggests that such an asteroid is considered as national 'property'.

Such arguments would be easily refuted as long as not only the international consultation and provision of information referred to is properly undertaken by the EADP but the mission's aim would clearly be to benefit all of mankind, by developing technologies and strategies to mitigate asteroid threats to the earth.

Only once, as part of a venture such as envisaged in the future by the EADP, possibilities to harvest any valuable resources from an asteroid to be kinetically impacted would arise and come to be seriously discussed, this might change.

Even as the mere extraction of such resources for exploratory and/or scientific purposes in itself is unequivocally allowed, extraction of such resources for exploitation purposes is at worst considerably disapproved of by a number of states and at best lacking clear legal guidance, which may lead to a protracted discussion regarding whether the non-appropriation provision of Article II of the Outer Space Treaty is duly honoured. Such discussions should not be allowed to give rise to international disputes potentially disrupting or obstructing an EADP mission.

## 7.3. Damage caused by an asteroid or its fragments

Second, the change of orbit or even fragmentation of an asteroid resulting from a kinetic impact may result in damage being caused, either by the asteroid or its fragments to a spacecraft, or by any of those to states, persons or property on earth. The regime developed following Article VII of the Outer Space Treaty by the Liability Convention[60] was not developed for such scenarios, but it cannot be fully excluded that it could nevertheless become applicable to certain instances.

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[57] See *supra*, esp. §§ 4.2, 4.3.
[58] Art. II, Outer Space Treaty; emphasis added.
[59] Note also the obligation under Arts. IX & XI, Outer Space Treaty, to inform and consult as relevant with other space-faring states and the UN Secretary-General, as briefly discussed *supra*, § 3.3.
[60] See further *supra*, § 3.3.

The regime by the Liability Convention as briefly sketched above is triggered by damage caused '*by*' an object launched into outer space from earth, which by definition then also is a man-made object.[61] Damage in the aforementioned scenarios, however, is literally speaking caused by the asteroid or its fragment(s), not by the spacecraft itself. Compensable damage, moreover, is defined by the Liability Convention as being limited to "loss of life, personal injury or other impairment of health; or loss of or damage to property of States or of persons, natural or juridical, or property of international intergovernmental organizations".[62]

This has generally been interpreted as being limited to *direct* damage, focusing on the direct and proximate cause of the damage, which would rule out liability under this regime for the indirect chain of causation moving from the spacecraft through the asteroid (or fragments thereof) to a damaged other space object or damaged state, person or property on earth.

On the other hand, repeatedly arguments have been advanced to extend the liability to such cases, for example where the chain of events giving rise to the damage has unequivocally started with the kinetic impact by the space object, and interpret the word 'by' in a broad sense, as anything inevitably resulting from an activity of the space object.[63] Since, in the scenario at issue, the damage would not have taken place without prior kinetic impact by the EADP spacecraft, this would give rise to liability under the Liability Convention.

In the last resort, until either an authoritative international document would provide an unequivocal interpretation of the extent to which the liability under Liability Convention would apply to such a scenario or a major legal dispute would result in a corresponding authoritative judgement, no legal certainty could be provided as to whether in an actual case involving an EADP mission liability would be claimed – and, more importantly, whether such claims would (have to) be honoured.

For the EADP demonstration mission this would then actually boil down to the question regarding which interpretation the FAA AST would apply in the context of its licensing process as summarized above[64], and, pursuant to that, the launch contract of the EADP with the launch service provider to be licensed for the launch of the demonstration mission. In any event, the EADP would do well to consult with the FAA AST on its position in this regard, and how this would consequently transpire in the licensing process.

Of course, the intended kinetic impact with the asteroid may also result in a damaged, in the worst case even uncontrollable and/or fragmented spacecraft, which gives rise to two further legal issues.

### *7.4. The space debris issue*

Third, though at the international level there is no clear-cut prohibition to knowingly and willingly create any space debris, or even to avoid substantial risks that such space debris might result from one's activities, as discussed before the strong recommendations existing at the international level under the IADC and COPUOS

[61] See Arts. I-III, Liability Convention.
[62] Art. I(a), Liability Convention.
[63] Efforts have, for example, also been made to claim liability in scenarios where damage would result from an aircraft crash which in turn would have been caused by flawed navigation information originating with positioning and navigation satellites.
[64] See *supra*, Chapter 4.

guidelines can be transformed into binding obligations for licensees under (for instance) the US licensing regime.[65]

As these guidelines *inter alia* disapprove of intentional destruction of a space object and activities undertaken with a very serious chance that destruction of a space object will result, it would be necessary for an EADP demonstration mission to ensure that the US launching authorities would make an exception to any prohibition to do so to the extent necessary for the demonstration mission to succeed.

Beyond that, the EADP as envisaged payload operator would (likely) be required in the course of the licensing process's payload review to inform the FAA AST on its end-of-life procedures and strategy, sufficiently so as to convince the latter that the threats of creating space debris are minimised as much as feasible.

Thus, any effort to use launch vehicles and spacecraft capable of surviving prolonged space travel and equipped with extreme resilience against the environmental conditions of outer space, would present a positive factor for consideration in the launch licensing process.

## 7.5. Damage caused directly by the EADP spacecraft

Fourth, once such an EADP spacecraft or its fragments causes damage, the liability for such damage is without any doubt covered by the Liability Convention. Consequently, it would give rise to US liability under the Liability Convention, with the resulting obligation to fully compensate any damage caused outside of the United States, a liability which might well feed into the licensee's requirements to take out third-party liability insurance discussed above[66].

## 7.6. Conclusion

***The intended kinetic impact which an EADP demonstration mission is to effect raises several major legal issues which are not insurmountable but require substantive* a priori *attention by the EADP in order to be properly resolved. Notably, this concerns:***

1. ***The need to avoid any perception that by (aiming to) impact(ing) with an asteroid actual 'appropriation' is to be sought or achieved;***
2. ***The need to ensure that any potential liability for damage caused by the asteroid or its fragments post-impact is properly taken care of, in consultation with the FAA AST; and***
3. ***The need to properly address the possible risk that an EADP mission may contribute to the generation of 'space debris', again in close consultation with the FAA AST.***

[65] See *supra*, §§ 4.2, 4.3.
[66] See *supra*, § 3.3 & § 4.4.

# 8. Legal parameters for using a nuclear device in outer space

## *8.1. Introduction*

Chapters 3 through 7 above have addressed five main sets of legal issues and parameters which need to be addressed, or at least taken into account, for an EADP demonstration mission as envisaged in the Conceptual design of the HAIV mission and the NIAC Phase 2 Final Report.[67]

All these would equally apply to future follow-up missions actually intended to impact with an asteroid threatening the earth, even if sometimes to a slightly different extent. For example, the fact that in such scenarios the threat to earth to be countered is imminent and real, as opposed to general, abstract and far-off, would make the benefit of all mankind of such a mission commensurately larger. This in turn would make it much more likely also in a legal sense to make the accompanying risks of partial or complete failures acceptable – although at the same time fears and panics may also result in suspicions which otherwise might not have arisen.

In addition, there is of course one thing that would make an actual asteroid threat mitigation mission stand out as against a demonstration mission as envisaged: the use of a NED, a nuclear explosive device as crucial part of the effort to change the orbital characteristics of the asteroid and/or fragment it, whether on a state or a private mission. Such usage of a nuclear explosive device raises a handful of major issues under international (space) law, which would no doubt also – at least largely – find their way into the US licensing process as summarily described above.[68]

## *8.2. The Outer Space Treaty*

First, the Outer Space Treaty itself (merely) prohibits states to "place in orbit around the Earth any objects carrying nuclear weapons (…), install such weapons on celestial bodies, or station such weapons in outer space in any other manner".[69] One should note that an explosive nuclear device would generally be subsumed under the concept of 'weapons of mass destruction', also if – in the present case – clearly to be used for peaceful purposes or, even better, for averting disaster for mankind or a substantial part thereof.

Thus, this clause would only present an obstacle to an EADP mission with a nuclear explosive device on board in case the strategy would be to send such a spacecraft in orbit or in another semi-permanent holding position, so as to 'wait' for an asteroid threat to materialize – years, perhaps decades after launch. As this does not form part of the current EADP approach, this clause indeed would not stand in the way of an EADP asteroid threat mitigation mission.[70]

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[67] See further *supra*, Chapter 2.
[68] See further *supra*, Chapter 4.
[69] Art. IV, Outer Space Treaty.
[70] Even if, at some point in the future, a strategy of 'parking' an asteroid threat mitigation spacecraft somewhere in outer space would be contemplated – for example, to allow swifter responses once an actual asteroid threat would be detected – the general principle that literal interpretation of a treaty text should be ignored if leading to patently absurd results might come into play, as discussed in further detail *infra* at § 8.4.

In any event, from a wider perspective the use of nuclear devices for explosive purposes in outer space may raise some *political* 'fall-out', which in the context of the Outer Space Treaty could at some point be considered or claimed to run counter to the obligation to act "in the interest of maintaining international peace and security and promoting international cooperation and understanding"[71]. A proper level of publicity and transparency however hopefully should be able to ensure that such a legal conclusion would not be (widely) drawn.

However, the Outer Space Treaty does not represent the last and final word on this issue: an additional international document of space law specifically addresses the use of nuclear reactors in outer space, whereas by virtue of Article III of the Outer Space Treaty both another, more general treaty of international law and rules of customary international law also come into play.[72]

### 8.3. The Nuclear Power Source Principles

Thus, second, the Nuclear Power Source Principles should be briefly addressed.[73] These provide for "a set of principles containing goals and guidelines to ensure the safe use of nuclear power sources in outer space", and "applies to nuclear power sources in outer space devoted to the generation of electric power on board space objects for non-propulsive purposes".[74]

These principles were never intended to address nuclear power sources *not* devoted to 'the generation of electric power' but, as is the case with EADP missions using the HAIV model with its NEDs, rather to the creation of an explosion and thus, also following the letter of the clause, would not be applicable here. Moreover, the principles being in the form of a Resolution of the UN General Assembly, the text thereof does not as such constitute binding (treaty) law.

However, the general idea behind the principles was to provide guidelines for the safe launch and further movement in particular in near-earth space of nuclear power sources.[75] The use of NPS for propulsive purposes was to be excepted as it was understood that particularly in this area "for some missions in outer space nuclear power sources are particularly suited or even essential owing to their compactness, long life and other attributes"[76] and, moreover, such usages would emanate from within a state's sovereign realm over which international law cannot simply exert its influence.

The 'negative' formulation of the scope – 'non-propulsive purposes' – of the Principles, in conjunction with the general principle that "the use of nuclear power sources in outer space shall be restricted to those space missions which cannot be operated by non-nuclear energy sources in a reasonable way"[77], might therefore still give rise to application also to the novel concept of nuclear-device-usage for

[71] Art. III, Outer Space Treaty.
[72] Art. III, Outer Space Treaty, provides: "States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the Moon and other celestial bodies, in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international cooperation and understanding."
[73] Principles Relevant to the Use of Nuclear Power Sources in Outer Space (hereafter NPS Principles), UNGA Res. 47/68, of 14 December 1992; UN Doc. A/AC.105/572/Rev.1, at 47.
[74] Preamble, NPS Principles.
[75] Cf. e.g. Princs. 3, 'Guidelines and criteria for safe use', & 4, 'Safety assessment', NPS Principles.
[76] Preamble, NPS Principles.
[77] Princ. 3, NPS Principles.

explosive purposes, in particular as part of the domestic US licensing regime, which after all needs to ensure any nuclear reactor would be launched as safely as feasible.

To ensure clarity on this, the EADP would be recommended to consult in due time with the FAA AST with a view to the payload review to be conducted as discussed earlier.[78] In this respect, again it may be noted that building a major level of resilience with respect to the operational environment of outer space into the mission presents a positive factor for consideration in this context.

### *8.4. The Partial Test Ban Treaty*

Third, the 1963 Partial Test Ban Treaty[79], which counts the United States amongst its parties, needs to be addressed. Drafted in order to counter the threats of nuclear conflicts by trying to take away the risks of escalation from nuclear explosions which might be viewed with suspicion by the opposing power in the Cold War context, it basically requires states

> to prohibit, to prevent, and not to carry out any nuclear weapon test explosion, or *any other nuclear explosion*, at any place under its jurisdiction or control:
> (a) in the atmosphere; beyond its limits, *including outer space*; (…); or
> (b) in any other environment if such explosion causes radioactive debris to be present outside the territorial limits of the State under whose jurisdiction or control such explosion is conducted.[80]

In addition:

> Each of the Parties to this Treaty undertakes furthermore to refrain from causing, encouraging, or in any way participating in, the carrying out of any nuclear weapon test explosion, or any other nuclear explosion, anywhere which would take place in any of the environments described, or have the effect referred to, in paragraph 1 of this Article.[81]

These clauses thus in first instance provide for a very fundamental obligation for the United States, which will result in an equally fundamental prohibition also to use nuclear explosions as envisaged by the EADP. There are, however, three escape options which could be explored for purposes of the EADP.

By way of a first escape route, the Treaty provides that amendments to the Treaty may be proposed (for instance) by the United States.[82] Such an amendment should, logically, carve out from the comprehensive prohibition cases where the nuclear explosion would clearly be meant to counter an asteroid threat to mankind or a substantial part thereof.

Amending a treaty, however, takes a considerable amount of time, and any amendment would only become implemented upon agreement by a majority of states

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[78] See *supra*, § 4.3.
[79] Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water (hereafter Partial Test Ban Treaty), Moscow, done 5 August 1963, entered into force 10 October 1963; 480 UNTS 43; TIAS No. 5433; 14 UST 1313; UKTS 1964 No. 3; ATS 1963 No. 26. Meanwhile, also a Comprehensive Test Ban Treaty has been concluded, but as this treaty has not entered into force yet and in addition is not underwritten by the United States, it would not be relevant presently; see Comprehensive Test Ban Treaty, New York, done 24 September 1996, not yet entered into force; Cm. 3665; 35 ILM 1439 (1996); S. Treaty Doc. No. 105-28 (1997).
[80] Art. I(1), Partial Test Ban Treaty; emphasis added.
[81] Art. I(2), Partial Test Ban Treaty.
[82] See Art. II(1), Partial Test Ban Treaty.

party to the Treaty (currently totalling 125[83]) as well as by all of the "Original Parties"[84]. In view of the political sensitivities surrounding the use of nuclear explosions in outer space, further complicated by the existence of the 1996 Comprehensive Test Ban Treaty (even if that treaty has not entered into force yet), this might not seem a very feasible option therefore.

A second escape route is provided by the Treaty which states:

> Each Party shall in exercising its national sovereignty have the right to withdraw from the Treaty if it decides that extraordinary events, related to the subject matter of this Treaty, have jeopardized the supreme interests of its country. It shall give notice of such withdrawal to all other Parties to the Treaty three months in advance.[85]

There would be no doubt that a threat by an asteroid could 'jeopardize the supreme interests of' a country if the asteroid would somehow be heading for that country, if it would somehow head for open waters adjacent to that country threatening to cause a tsunami, or if it would be so big as to cause global economic disruption and/or a substantive change in the global climate.

In such cases, all depends on whether the withdrawal notice term of three months would in itself not present a safety risk, in other words: whether the asteroid threat allows for such a delay in achieving the formal legality of the mission. As far as can be judged presently, however, considering the normal lead times for initiating a mission like this, this relatively brief delay should not present major problems.

The main potential issue with this solution would thus be a case where the asteroid threat would not somehow directly 'jeopardize the supreme interests of', in this case, the United States as the country formally responsible and liable for the mission.[86] If there would be no 'jeopardy' to any country at all, there would be no justification for withdrawal from the treaty either – but at the same time: neither would, for precisely the same reason, most likely any real justification for the mission arise. If there would be 'jeopardy' only to (an)other country/ies, the scenario would effectively be similar to that of the third escape route.

This third escape route, which could also be used in cases where the three months' notice of withdrawal would cause unacceptable delays or where, for instance for general political reasons, it would not be deemed feasible to withdraw from the Treaty, essentially bases itself on the core principle of international law, that other interpretations of a treaty clause than a literal one should be used if the latter "leads to a result which is *manifestly absurd or unreasonable*".[87]

Objectively speaking it would clearly be 'manifestly absurd or unreasonable' to read a clause prohibiting any nuclear explosions, drafted to mitigate threats of nuclear conflict in a different era, as indeed prohibiting such explosions if these would be unequivocally intended to save mankind or a substantial part thereof from impending disaster.

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[83] See http://en.wikipedia.org/wiki/List_of_parties_to_the_Partial_Nuclear_Test_Ban_Treaty; last accessed 5 March 2015.
[84] Art. II(2), Partial Test Ban Treaty.
[85] Art. IV, Partial Test Ban Treaty.
[86] *Cf.* further *supra*, § 3.2.
[87] Art. 32(b), Vienna Convention on the Law of Treaties, Vienna, done 23 May 1969, entered into force 27 January 1980; 1155 UNTS 331; UKTS 1980 No. 58; Cmnd. 4818; ATS 1974 No. 2; 8 ILM 679 (1969); emphasis added.

However, in view of the geo-political sensitivities of the use of nuclear devices in outer space, *politically* speaking the above conclusion may not turn out to be that generally acceptable. If the United States, as the state presumably licensing a future EADP mission countering an actual asteroid threat, would agree to the conclusion, obtaining a license would not be an insurmountable obstacle to that extent; nevertheless, the FAA AST and/or the EADP would do well to at least inform the international community in a transparent fashion, preferably through the United Nations,[88] of its plans, in order to try and mitigate any 'political fall-out' as far as possible.

## 8.5. Customary international law

Fourth, further to the specific Partial Test Ban Treaty, general customary international law principles could also be invoked to support the interpretation that it would be manifestly absurd and unreasonable to invoke any specific rule, drafted for rather different purposes, as a legal obstacle to an asteroid threat mitigation mission intended to save humanity or a substantial part thereof.

Such customary international law principles refer to a right to self-defence, a right to use force generally – in spite of otherwise existing prohibitions to use force – to protect a certain population from disaster, or even to contribute towards a sustainable environment on earth – which might be threatened by a major-size asteroid. Also, there is the – albeit hotly disputed – legal principle adhered to by a number of countries and experts that the use of nuclear weapons is basically to be outlawed.

However, in the normal terrestrial contexts where these principles have so far been applied, they had to be balanced (usually) with the respect due to the sovereignty and rights of other states and the threats of escalating conflicts, and hence were often considerably premised on compliance with such other fundamental principles, viewed with suspicion, or even forthwith dispensed as legally relevant principles.

Since those terrestrial concerns would be largely absent in cases of 'self-defence', 'use of force' or even use of *nuclear* force against an asteroid, in principle such legal opposition would be much less legitimate than on earth.

Nevertheless, again, in view of the geo-political sensitivities, a substantial effort should be made to convince the international community, in particular through the United Nations, that any such mission would indeed *only* be undertaken to counter such a threat, and would take maximum care to avoid any political as well as other fall-out.

## 8.6. Conclusion

***As long as the actual missions carrying NEDs would not result in stationing or orbiting the spacecraft in outer space, the Outer Space Treaty does not put fundamental obstacles in the way of such missions. Only the risk of 'political fall-out' may need to be carefully addressed also in this legal context. This conclusion***

[88] *Cf.* also Art. XI, Outer Space Treaty, providing: "States Parties to the Treaty conducting activities in outer space, including the Moon and other celestial bodies, agree to inform the Secretary-General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, of the nature, conduct, locations and results of such activities. On receiving the said information, the Secretary-General of the United Nations should be prepared to disseminate it immediately and effectively."

*also largely applies to some general customary international law principles which could, in theory, be claimed as legal obstacles to such missions.*

*Next, it may be advisable for the EADP to briefly assess in due time whether the NPS Principles would contain any relevance for missions using nuclear reactors, in particular in consultation with the FAA AST to the extent the latter might consider including elements thereof in its safety approval.*

*Thus, the main potential show-stopper for any EADP-like mission carrying NEDs in conformity with the HAIV model – whether in the end to be undertaken by a state or a private operator – would be the fundamental prohibition provided by the Partial Test Ban Treaty of* **any** *nuclear explosion in outer space. There would, in principle, be three possible ways out of this conundrum, each however with their own drawbacks:*

*(1) To amend the Treaty as required. This may take a long time however, and not necessarily bring all states parties to the Treaty on board – not to mention non-parties;*
*(2) To withdraw from the Treaty once required. While the timeframe of three months may not present major problems, such withdrawal requires justification narrowly with reference to 'the supreme interests' of the state concerned, and may also result in undesirable 'political fall-out' – or even a cascade of other withdrawals; and*
*(3) To re-interpret the relevant clause as required, it being 'manifestly absurd or unreasonable' to define as illegal an action intended to save mankind or a major part thereof from disaster. Also here, however, undesirable 'political fall-out' with undesirable legal consequences may threaten.*

## 9. Concluding remarks and recommendations

Analysis of the main legal aspects of an EADP demonstration mission give rise to the clear conclusion that such a mission would basically be in compliance with existing international space law, existing international responsibilities and liabilities of the United States (as the state under whose *aegis* such a mission will take place) and existing US domestic space law, as long as certain parameters would be duly respected.

The launch into outer space and the missions conducted there would thus principally benefit from the default freedom of activity, as long as for example not amounting to the stationing or orbiting of NEDs but contributing to the maintenance of international peace and security and accompanied by appropriate consultation with and information of the international community, as long as the United States' international responsibility and liability for the mission would be duly taken care of through US domestic law, and as long as the risks of generation of space debris are also properly addressed.

Existing domestic US law indeed would currently be able to take care of full compliance of an EADP demonstration mission under the current scenario with these international legal parameters, basically through the licensing system under the Commercial Space Launch Act and general assessment of the mission by the FAA AST, payload review and liability-related arrangements, including waivers of liability and insurance requirements.

Also the use of NASA's Deep Space Network for indispensable interference-free usage of radio communication with the EADP spacecraft would avert the risk of non-compliance with relevant existing international law, as the existing ITU regime allows NASA in conjunction with the US FCC appropriate opportunities to arrange for such usage for the benefit of the mission.

Actually, in a number of respects such a mission would be encouraged especially under international space law, as long as it is clearly and unequivocally aimed at serving the benefit and interest of mankind and all countries in contributing to the development of technologies and strategies to protect mankind or a major part thereof against asteroid threats.

Thus, it is essentially only for follow-up EADP actual missions using NEDs along the lines of the HAIV model, that a major legal obstacle would arise: the Partial Test Ban Treaty, to which also the United States is a party, prohibits any nuclear explosion in outer space – which, in principle, also includes NED operations for asteroid threat mitigation purposes.

The Treaty, however, was never meant to address 'extra-terrestrial' threats, but to minimize the outbreak of nuclear conflict on earth in particular in a Cold War context and the risk of escalation following suspicions regarding another party's nuclear testing, by prohibiting any nuclear explosion which could after all be seen as a veiled nuclear test or even threat, no matter what the official label would be.

Apart therefore from the options to amend the treaty or to withdraw unilaterally from it, the ultimate conclusion should be that arguing this provision to prohibit the use of a NED in an emergency situation where a large-size asteroid would threaten mankind or a major part thereof would be absurd and unreasonable, and should legally be discarded.

This is not to say, however, that in the present geo-political reality such a legal analysis would be globally shared, and efforts should be undertaken at the international level to minimise the potential for any 'political fall-out' that might result from the intended use of NEDs in outer space in such emergency scenarios, preferably by way of open and transparent information of, and as necessary consultation with, the other states of the world, the United Nations and the global scientific community.

In order to maximise accommodation of its intended missions, demonstration as well as actual, within the legal parameters sketched above, it would be recommended for the EADP to:

- Address from an early stage onwards and in a continuing fashion the risk of 'political fall-out' outside the United States which EADP missions might give rise to, in particular as regards the use of NEDs in actual threat mitigation missions, by way of information of and appropriate consultation with the other states of the world, the United Nations and the global scientific community and by stressing the clear benefits for and interests of all mankind and all states in the EADP missions. This should notably involve the US Department of Foreign Affairs as being the representative of the United States in international fora such as COPUOS and responsible for defending US interests and rights in the international community.
- Determine early on its risk mitigation strategy and policy, in particular with a view to the cross waiver of liability under US law and contractual liabilities *vis-à-vis* the launch service providers, including insurance options.
- Consult at an early stage with the FAA AST on the various key aspects of the mission with a view to licensing, in particular concerning general mission assessment, payload review, third-party liability, liability towards the US government for the use of federal launch sites, space debris mitigation strategy and the involvement of NEDs.
- Consult at an early stage with the envisaged launch service providers on the positions to be asserted vis-à-vis the FAA AST with respect to the above points.
- Consult at an early stage with NASA and the FCC on the use of the DSN for EADP missions with a view to guaranteeing interference-free usage of radio frequencies for that purpose.