Legal Aspects of Solar Power Satellites

FINAL REPORT

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SCOPE OF THE FINAL REPORT

The purpose of the following report is to assess the legal provisions that shall be applicable to SPS in their different phases (development and operation). These provisions are therefore presented according to the various applicable branches of law that have been identified in WP1 Report. In addition, their concrete impact on every SPS development phase has been underlined through the Executive summary.

The Final Report proposes an organisational scheme in its second part for respectively developing and then operating SPS, given the legal constraints that have been identified in its first part, as well as the inherently global nature of SPS.

PART I. LEGAL PROVISIONS ASSESSMENT

The first part of this report assesses the relevant provisions of law applicable to SPS. Space law (1), telecommunications law (2), environmental and health law (3), and disarmament law (4) are subsequently reviewed.

1. SPACE LAW

The term "space law" is generally referred to as the laws and principles governing outer space at international level. These principles have been mainly developed by the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) from the 1960's, in order to regulate the activities of States and their nationals conducted in outer space. To date 2003, the COPUOS has adopted five multilateral treaties and five main resolutions.

The five multilateral treaties are:

- The 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (hereafter: the Outer Space Treaty)[2];
- The 1968 Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (hereafter: the Rescue agreement)[3];
- The 1972 Convention on International Liability for Damage Caused by Space Objects (hereafter: the Liability Convention)[4];
- The 1975 Convention on Registration of Objects Launched into Outer Space (hereafter: the Registration Convention)[5];
- The 1979 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (hereafter: the Moon Agreement)[6].

These texts constitute treaties as defined by the 1969 Vienna Convention on the law of treaties and shall as such be regarded as fully binding upon States having ratified them (the so-called States Parties). In addition, non-States parties may also be bound by some of the principles contained in these treaties, as soon as they have customary force. Custom, which can be defined as an international practice accepted as law by the international community, constitutes a source of law. Most of space law principles proclaimed by the Outer Space Treaty have a customary value.

The five main resolutions are:

- The 1963 Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space (resolution 1962 (XVIII));

[2] 610 *UNTS* 205
[3] 672 *UNTS* 119
[4] 961 *UNTS* 187
[5] 1023 *UNTS* 15
[5] 1363 *UNTS* 3.

- The 1982 Principles Governing the Use by States of Artificial Earth Satellites for International Direct Television Broadcasting (resolution 37/92);
- The 1986 Principles Relating to Remote Sensing of the Earth from Outer Space (resolution 41/65);
- The 1992 Principles Relevant to the Use of Nuclear Power Sources in Outer Space (resolution 47/68);
- The 1996 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).

Contrary to what was mentioned concerning space treaties, these texts do not constitute binding law as such, since they have been adopted through recommendations adopted by an international intergovernmental organization. They may nevertheless contain principles that shall be regarded as binding on a customary basis, which will also be mentioned as well.

Space law applicability to SPS will first be analysed (1.1). Then, the relevant rules dealing with the status of outer space will be reviewed (1.2). The rules dealing with the uses of outer space (1.3) and with the liability regime applicable to space activities (1.4) will finally be examined.

1.1 Space Law Applicability

1.1.1 Application of Space Law to SPS

The applicability of space law to SPS must firstly be noted. Space law provisions generally apply to the exploration and use of outer space. According to the *travaux préparatoires* of the space treaties, the term “exploration” refers to scientific activities in outer space whereas the term “use” refers to commercial activities in outer space". SPS projects, they shall be subject to the relevant provisions of space law during the development phase as well as during the exploitation phase. It can be added at this point that Article 1 of the Moon Agreement states that: "The provisions of this Agreement relating to the Moon shall also apply to other celestial bodies within the solar system, other than the Earth […]". Consequently, not only the Moon but also the Sun, fall under the provisions of this agreement.

According to the various technical/legal documents that were taken as reference for the needs of this study, most of SPS concepts are expected to transmit energy, via either microwaves beam or laser beam, to Earth. This will notably result in the transmission of energy through airspace. According to Article 1 of the 1944 Chicago Convention on international civil aviation[7], "Every State has complete and exclusive sovereignty over the airspace above its territory". To that extent, the question whether power transmission through airspace could violate the sovereign rights of the State concerned might appear. This issue shall nevertheless be avoided since SPS constitute a space activity, governed by the principle of freedom of use of outer space and falling under the provisions of international space law. The fact that SPS signals will pass through airspace shall therefore not be considered as a reason for denying space law applicability to SPS. While the debate existing around space law sphere of applicability is not closed yet[8], it is clear that SPS shall be regarded as subject to space law to the extent that they can be qualified as a use of outer space. Air law applicability shall consequently be rejected, and space law preferably applied.

[7] Chicago Convention on International Civil Aviation, December 7, 1944, *ICAOTC* Doc.7300.
[8] The main question revolves around the criterion of such applicability. Whereas some States consider that a geographical criterion should be retained - geographical approach, some other States consider that every space activity shall be subject to space law - functionalist approach.

For these reasons, the provisions of space law that shall be applied to SPS concepts/architectures have been assessed thereafter.

1.1.2. Application of Space Law to activities conducted by ESA

According to Article XIII of the Outer Space Treaty, the provisions of the treaty shall apply to activities of States in outer space, whether such activities are carried on by a single State party to the Treaty or jointly with other States, including cases where they are carried on within the framework of international intergovernmental organisation. As such an international organisation, ESA shall be subject to the Outer Space Treaty when carrying out SPS projects.

Concerning the other space treaties, they shall be regarded as applicable to ESA When ESA has made declarations of acceptance of such treaties, such declaration acceptance being foreseen in the provisions of the concerned treaties, which is the case concerning the Rescue agreement, the Liability convention and the Registration convention.

1.2. Rules dealing with status of outer space

1.2.1. Non-appropriation

According to the Outer Space Treaty, Article II: “Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means”. This principle clearly excludes any possibility of national appropriation of any element of outer space.

According to Article 11 par. 2 and 3 of the Moon agreement:

" 2. The Moon is not subject to national appropriation by any claim of sovereignty, by means of use or occupation, or by any other means.

3. Neither the surface nor the subsurface of the Moon, nor any part thereof or natural resources in place, shall become property of any State, international intergovernmental or non-governmental organization, national organization or non-governmental entity or of any natural person. The placement of personnel, space vehicles, equipment, facilities, stations and installations on or below the surface of the Moon, including structures connected with its surface or subsurface, shall not create a right of ownership over the surface or the subsurface of the Moon or any areas thereof […]".

In the context of the cold war, the non-appropriation of the Moon represented the main justification for the adoption of the Outer Space Treaty. The non-appropriation rule constitutes the fundamental difference between outer space and airspace, which is characterised by the complete and exclusive sovereignty of State over the airspace above its territory proclaimed by the Article 1 of the 1944 Chicago Convention. The principle of non-appropriation is applicable to all judicial entity or natural person including international intergovernmental organizations and private companies.

Consequences for SPS. As far as SPS are concerned, this may have two kinds of consequences: first, should they involve specific lunar and/or orbital stationing, this cannot be subject to appropriation by operating States. Second, solar energy and lunar resources used for SPS might be envisaged as part of outer space, falling under the non-appropriation principle. In fact, exploitation of outer space deals with the freedom of outer space principle and not with the rule of non-appropriation. As it will be

underlined, freedom of outer space, stated by Article I of the Outer Space, Treaty protects space resources exploitation trough the principle of freedom of use. However, Article II of the Outer Space Treaty as well as Article 11 of the Moon Agreement clearly state that there shall be no use that leads to appropriation of outer space, the Moon or other celestial bodies. Legally speaking, the notion of ''Appropriation'' is generally accepted as being constituted of the three following elements:

- the "*usus*", which refers to the ability to use a resource,
- the "*fructus*", which refers to the ability to harvest its fruits,
- the "*abusus*", which refers to the ability to destroy, to give and to sell it.

Concerning SPS, one distinction has to be made between systems using solar energy and systems using lunar resources. The use of solar energy that appears to be an unlimited and renewable source of energy cannot be considered as an appropriation since it does not conduct to destroy, to give or to sell sun resources themselves. Such use does not exclude the ability for other States to use solar energy as well. Then the *abusus* part is missing. This statement can in addition be enhanced by the fact that States are already using solar energy through other satellites systems equipped with solar panels, and no claim has been registered on the basis of the non-appropriation principle. On the contrary, the use of lunar resources may be regarded as an appropriation of space resources since the *abusus* element is obvious.

Then, such use of lunar resources should be regarded as violating space law, and the non-appropriation principle in particular. Two different solutions may nevertheless be distinguished in order to get around this problem. The first solution would be to argue that such use of outer space is conducted for experimental purpose, during the development phase, in particular. Such experimental use would indeed be covered by the freedom of scientific research in outer space principle. Objections may nevertheless arise from other States as soon as this use appears to loose its experimental nature. States might therefore prefer the second solution, which would consist in reaching an international agreement organising the common exploitation of lunar resources. Such a solution has for instance been adopted with the Convention on the Regulation of Antarctic Mineral Resource Activities done at Wellington 2 June 1988[9], which authorises under certain conditions the exploitation of to exploit the Antartic resources, the Antartic having previously been designated as an "international zone" by the Washington Treaty on Antartic of 1st December 1959[10].

Should this second solution be chosen, concerned States could adopt national legislations applicable during the transition phase during the time preceding the adoption of an international agreement. The USA, the United Kingdom, Germany and France notably adopted such practice during the transition phase preceding the conclusion of the 1982 Montego Bay Convention on the law of the sea[11], in order to organise deep sea bed exploitation at national level during this period preceding the convention adoption. Such practice however implies that a convention concerning lunar exploitation is under adoption at international level.

1.2.2. Non-militarization

Article IV par. 1 of the Outer Space Treaty deals with partial non-militarization of earth orbits and states: "States Parties to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner".

[9] 27 *ILM* (1988) 859.
[10] 402 *UNTS* 71.
[11] Doc. A/CONF.62/122 and Corr.1 to 11.

Consequences for SPS. Since SPS may use laser technology, Article IV par. 1 that prohibits the placement of weapons of mass destruction on Earth orbits will have to be respected. However, even if space lasers used for SPS can be considered as weapons, they can definitely not be assimilated to a weapon of mass destruction. International law traditionally recognizes three categories of weapons of mass destruction: nuclear, chemical and biological weapons[12]. This list is not exhaustible, and States could possibly add to it arms equipped with laser equipments in the future, as soon as such arms could be considered as having the equivalent destruction capacity as massive destruction arms. The current technical evolutions do however not lead to envisage seriously such possibility.

Article IV par. 2 deals with non-militarisation of the Moon and the other celestial bodies and proclaims the obligation to use the Moon and other celestial bodies "exclusively for peaceful purposes".

Consequences for SPS. Applied to SPS, which are expected to use celestial bodies resources, namely solar energy and/or lunar materials, this will probably mean that they shall not be legally entitled to provide energy for non-peaceful activities on Earth or in outer space. In the light of States practice, non-peaceful means non-aggressive.

1.2.3. Common heritage of mankind

Article 11 par. 1 of the Moon Agreement states that: "The moon and its natural resources are the common heritage of mankind". In fact, this text was the first treaty giving effect in international law to the concept of the common heritage of mankind, despite the fact that the former USSR was against this principle because of its lack of legal definition and the vagueness of the obligations being deduced. Article 11 par. 5 represents the cornerstone of the common heritage principle by requiring from the States Parties to the Agreement to "establish an international regime, including appropriate procedures, to govern the exploitation of the natural resources of the moon as such exploitation is about to become feasible". Article 11 par. 7 deals with the content of this international regime by specifying that it shall include especially "An equitable sharing by all States Parties in the benefits derived from those resources, whereby the interests and needs of the developing countries, as well as the efforts of those countries which have contributed either directly or indirectly to the exploration of the moon, shall be given special consideration". Such an international regime has not yet been adopted.

Consequences for SPS. This principle shall however not be regarded as causing strong legal constraints for lunar-based SPS, since the Moon agreement has been ratified by a very limited number of States, and shall therefore be exclusively binding upon these States. The customary force of Article 11 par. 7 must also be rejected since no practice or international consensus has been reached for implementing this principle. Nevertheless, and as previously indicated, the possibility remains for States to reach a special international agreement organising the common exploitation of lunar resources, apart from the application of the Moon Agreement.

1.3. Rules dealing with the uses of outer space

1.3.1 Freedom of outer space

According to Outer Space Treaty, Article I, "Outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis

[12] B. MENON, *Disarmament – a basic guide*, New York, Geneva, United Nations, 2001, p. 13.

of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies". Whereas the freedom of exploration principle protects scientific activities, the freedom of use principle protects commercial activities. The freedom of outer space principle has vocation to apply to every States, including non-space faring nations, international organisations, and to non-governmental entities as soon as they have obtained authorisation from the appropriated State(s).

The freedom of outer space includes the freedom of access, the freedom of exploration and the freedom of use. International intergovernmental organisations may also invoke this freedom thanks to Article XIII of the Outer Space Treaty that extends the provisions of the Outer Space Treaty to activities carried on within the framework of international intergovernmental organisations. Private entities can also invoke the freedom of outer space since article VI indirectly expands this rule to non-governmental entities authorised and continuing supervised by the appropriate State Party to the treaty

Consequences for SPS. SPS development and exploitation benefit from the freedom of use principle. States as well as international organisations such as ESA can develop SPS for scientific and/or commercial purpose. Under Article I of the Outer Space Treaty, this activity is thus protected from orbital experimental test to the exploitation phase.

The freedom of outer space is counterbalanced by the "common interest principle" stated in the Article I, according to which: the "exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind".

Consequences for SPS. Since most of SPS systems concepts and architectures are expected to involve orbital positions, radiofrequencies, and to exploit solar energy and/or lunar materials, they shall fall under the application of this so-called "common interest" principle as a "use of outer space" involving celestial bodies, namely: the Sun and/or the Moon. This shall nevertheless not be regarded as a major problem for developing SPS, due to their inherently global nature and to the fact that they potentially represent a great interest for all countries. In addition, this principle is not self-executing since it is formulated in a very broad sense in the OST. Therefore it shall not be regarded as stating strong obligations for State parties, as long as it is not completed by concrete provisions under international law, which is not the case so far. The 1996 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 tried to implement the "Common interest principle". However, the text only recalled the principle of freedom of cooperation giving thus more weight to the commercial activities developed by space faring nations.

1.3.2. Principles regarding astronauts

Outer Space Treaty, Article V, provides the legal status of astronauts and obligations of States regarding these astronauts. They shall be regarded as "envoys of mankind in outer space", and States shall render to them special assistance. The Rescue Agreement completes the legal regime applicable to activities of astronauts by obliging States in particular to take all possible steps to rescue and assist astronauts in distress and promptly return them to the launching State.

Consequences for SPS. Several SPS systems could imply human intervention in outer space. To that extent, the dispositions of the Rescue Agreement shall be applicable to SPS development and operation. This will mean in particular, for States operating SPS systems, the right to be assisted by other States in case of astronaut distress.

1.3.3. Jurisdiction and control

Article VIII of the Outer space treaty states that a State "on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body". Therefore, national law of the State of registry has to be applied to space objects as well as to activities and individuals in spacecrafts. Article VIII also specifies that "Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth".

Consequences for SPS. These principles apply to SPS as "objects launched into outer space". National laws of the State of registry shall therefore apply to SPS and over any personnel thereof. SPS may however be composed of different parts, registered in different States. Should it be so, each State shall retain jurisdiction and control over the part of SPS it has registered. States might however conclude special agreement in order to simplify the competence issues.

1.3.4 Planetary protection

According to OST, Article IX, States shall notably conduct exploration of outer space “so as to avoid [its] harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter”.

Consequences for SPS. Combined with the relevant dispositions of environmental law as developed hereinafter, this principle shall bring States operating SPS to pay particular attention to their potential impact on Earth environment. Article IX constitutes a binding legal basis for such principle of harmful contamination of Earth avoidance. States responsibility and liability may therefore be engaged according to the general principles of international law in case of harmful contamination of the Earth caused by SPS activities.

1.3.5. Application of international law

Article III of the Outer Space Treaty states that space activities have to be carried on in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international co-operation and understanding. This article underlines that space law is part of international law. According to Article 38 paragraph 1 of the Statute of the International Court of Justice annexed to the Charter of United Nations adopted in 1945[13] sources of international law include: treaties, international customs, general principles of law implemented by case law and scholars.

Consequences for SPS. All SPS legal issues not regulated by space law have to be analysed in the light of general international law among which telecommunications law, environmental law, health law and law of war.

[13] 961 *UNTS* 183.

1.4. Rules dealing with responsibility and liability

1.4.1. Responsibility

According to the Outer Space Treaty, Article VI: “States Parties to the Treaty shall bear international responsibility for national activities in outer space […] whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty”. Article VI adds that when spaces activities are carried on by an international organisation, "responsibility for compliance with this Treaty shall be borne both by the international organisation and by the States Parties to the Treaty participating in such organisation".

Consequences for SPS. States launching, developing and operating SPS will then appear internationally responsible as such, whether the activities are carried on by governmental or by private entities legally placed under their jurisdiction. Their international responsibility shall therefore be directly and automatically engaged for every violation of the Outer Space Treaty by their nationals, even private companies, during SPS development and operating phases. Furthermore, in case of violation of the Outer Space Treaty due to SPS activity carried on by the European Space Agency, the Agency as well as its Member States will be directly responsible.

That is notably why Article VI of the convention states that "The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require authorisation and continuing supervision by the appropriate State Party to the Treaty".

Consequences for SPS. States have to ensure effective control on SPS operators, notably through the delivery of licences for SPS activities.

1.4.2. Liability

1.4.2.1. Liability for damage caused by the space object

According to Article VII of the Outer Space Treaty: “Each State Party to the Treaty that launches or procures the launching of an object into outer space […] and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air or in outer space […]. This liability regime is completed by the 1972 Liability Convention.

This victim-oriented convention organises the liability of the launching State. According to Article I, (c), of the Liability Convention, the launching State is the State that launches or procures the launching of a space object, or the State from whose territory or facility a space object is launched. Two regimes of liability are established. According to Article II, in case of damage caused on the surface of the Earth or to aircraft flight, “the launching State shall be absolutely liable to pay compensation. Therefore, the victim does not have to prove the fault of the launching State. According to Article III, in case of damage caused elsewhere than on the surface of the Earth, the launching State “shall be liable only if the damage is due to its fault or the fault of persons for whom it is responsible”.

Consequences for SPS. SPS systems involve various platforms, satellites and other installations in outer space, that constitute “space objects” as defined by the 1972 Liability convention. They shall be

regarded as falling under the Liability Convention regime in case of damage caused on Earth, in airspace or in outer space, as soon as this damage is directly and physically caused by one of these components (in case of collision, for instance). States operating SPS may therefore be liable and subject to the Liability convention for such damage. Whereas such direct and physical damage clearly fall under the application of the Liability convention, the issue is still remaining concerning damage caused by the service provided by the space object. This issue has not found clear solutions yet, under the current legal and doctrinal knowledge. Two possibilities must therefore be exposed. On the first hand, the Liability convention might be regarded as not applicable for a damage caused by the beam projected by the SPS system. Such damage would then be excluded from the scope of the Liability convention, and would consequently find solution in the general principles of international law in terms of liability. On the other hand, the Liability convention might be considered as applicable to such damage, and damage caused due to the beam projected by the SPS would therefore find solution according to the principles proclaimed in the Liability convention: a fault-based liability regime for damage occurring in outer space, and an absolute liability regime for all damage occurring elsewhere other than in outer space. This latter solution would present important legal risks for States operating SPS. The doubt remaining on this issue must therefore be strongly underlined, and taken into particular account by the concerned States.

1.4.2.2. Liability for damage caused by the space service

Liability for damage caused by space services falls under the general liability regime. The general liability regime is composed by general principles of law not yet codified by any treaty. Five conditions have to be fulfilled to declare a subject of law – State or international intergovernmental organisation – liable:

- a violation of an international obligation
- attributable to a subject of international law
- causing a damage
- to another subject of international law
- with a direct connection between the violation of law and the damage

A subject of law declared liable has the international obligation to repair the damages resulting from the violation of its international obligations.

Consequences for SPS. The general international liability regime may apply to a damage caused by SPS signal, but only in the case that the above-mentioned conditions are met. First, this damage will have to result from a violation of international law, which could be the case for instance if the damage results from the fact that the State operating SPS has not respected the environmental law requirements described below. Second, this damage shall be attributable to a subject of law, notably a State or an international organisation such as ESA, but this requirement will always be met as far as space activities are concerned due to the combined effect of Articles VI and XIII of the Outer Space Treaty. Third, the concerned damage shall effectively exist (which excludes potential damage caused by SPS), and be caused to another subject of international law. Last, a direct connection will have to be established between the damage caused and the violation of international law by the entity operating SPS.

1.4.3. Registration

The Registration Convention has been adopted in order to implement the Liability convention by establishing a central register of objects launched into outer space and by providing for States Parties additional means and procedures to assist in the identification of space objects.

Consequences for SPS. Under Registration Convention, States launching objects in outer space, as it will be the case for States developing SPS projects, are subject to particular obligations in term of registration of the space objects they launched. The launching State shall notably register SPS by means of an entry in a national registry (Article II). To that extent, States of registry having launched SPS shall, for every launched object, notably furnish the following information to the Secretary-General of the United Nations under Article IV of Registration Convention:

- name of launching State or States,
- an appropriate designator of the space object or its registration number,
- date and territory or location of launch,
- basic orbital parameters, including: nodal period, inclination, apogee, and perigee,
- general function of the space object.

2. TELECOMMUNICATIONS LAW / FREQUENCY ISSUES

Telecommunications law includes rules dealing with uses of telecommunications resources, equipments and services. At the international level, telecommunications law is mainly elaborated under the auspices of the International Telecommunications Union (hereafter: ITU).

After having stated the legal status of ITU regulation (2.1), its applicability to SPS will be examined (2.2). Legal provisions deriving from ITU regulation will then be assessed (2.3), as well as legal provisions applicable in terms of electromagnetic compatibility (2.4).

2.1 Legal status of ITU regulation

Before entering into the content of ITU rules, as applicable to SPS in particular, one must be very aware of these rules.

First, ITU constitution and convention do constitute treaties according to the definition given in the Vienna convention on the law of treaties: "an international agreement concluded between States in written form and governed by international law, whether embodied in a single instrument or in two or more related instruments and whatever its particular designation"[14]. They are therefore binding.

The Radio regulations, second, is also binding on all ITU members according to ITU Constitution, Article 4, 31.3 which states: “The provisions of both this Constitution and the Convention are further complemented by those of the Administrative regulations, enumerated below, which regulate the use of telecommunications and shall be binding on all Members:

- International Telecommunication Regulations,
- Radio regulations”.

[14] Vienna convention on the law of treaties, 22 May 1969, 1155 *UNTS* 331, Article 2, 1, (a).

2.2. ITU regulation applicability to SPS

A distinction must be made according to the concept envisaged for SPS: the applicability shall not be the same for concepts involving power transmission via microwaves as for concepts involving power transmission via laser.

2.2.1. SPS via radio waves

According to ITU Constitution[15], Article 1, the purposes of the Union are only related to telecommunications. The issue of ITU competence for regulating the transmission of solar energy may therefore appear quite sensitive, even if such transmission implies to the use of the radiofrequency spectrum.

For the purpose of this constitution, the term "telecommunication" is defined in the Constitution annex as "any transmission, emission or reception of signs, signals, writing, images and sounds or intelligence of any nature by wire, radio, optical or other electromagnetic systems". As it was underlined by S. GOROVE[16], the competence of ITU to regulate SPS therefore depends on "whether the use of microwaves for power transmission involves such transmission of signs, signals, writing, images and sounds of intelligence"[17]. Should it be so, we will not enter into these considerations since there are, from our point of view, some other sound reasons to consider that ITU is competent to regulate SPS. These reasons are the followings:

First, SPS will have to use telecommunications between ground stations and the satellites in order to operate these satellites. Constituting a telecommunication service, such activity is undoubtedly regulated by the ITU, as a "space operation service", defined by the Radio Regulations as: "a radiocommunication service concerned exclusively with the operation of spacecraft, in particular space tracking, space telemetry and space telecommand" (No 1.23).

Second, it must be underlined that for the purposes assigned in its Constitution, the Union shall in particular: "effect allocation of bands of the radio-frequency spectrum, the allotment of radio frequencies and registration of radio-frequency assignments and any associated orbital positions in the geostationary-satellite orbit in order to avoid harmful interference between radio stations of different countries" (ITU Constitution, Article 1, 11(a)). The fact is that according to this article, any harmful interference[18], even if not caused by a telecommunications service, as it might be the case for SPS services if they are not considered as constituting telecommunication services, fall under ITU's competence[19]. Since it could possibly result in such harmful interference with radiocommunication services, the transmission of power via microwaves must therefore be regarded as a legitimate concern of the Union. This point of view has in addition been confirmed by the 1979 World Administrative Radiocommunication Conference (WARC) that took place in Geneva, and during which the possibility of developing and operating SPS in the future was expressly taken into account, due to the fact that such activity may have an impact on radiocommunication services[20].

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[15] Constitution of the International Telecommunication Union, 1992, 36 *ILM* 369.
[16] S. GOROVE, "Solar power satellites and the ITU: some U.S. policy options", *Annals of air and space law*, Vol. IV, 1979, pp. 505-517.
[17] *Ibid*, p. 511.
[18] According to Article 1 of the RR, Article 1.169, "harmful interference" means: "Interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with Radio Regulations".
[19] See in this sense: S. GOROVE, "Solar power satellites and the ITU: some U.S. policy options", *ibid*, pp. 512-513.
[20] Recommendation N°3, REC3-1, *Actes finals de la conférence mondiale des radiocommunications*, 1979, french version, p. 851.

For both reasons, ITU regulation must be regarded as applicable to SPS, and the Union fully competent to regulate the transmission of power through radio frequencies.

2.2.2. SPS via laser beams

It must however be added that on the other hand, ITU shall not be regarded as competent for the transmission of energy via laser. The issue of such competence has been postponed at the present time before ITU. ITU is not competent for luminous waves use, since the regulation of such waves has been considered too difficult to implement. SPS concepts that may be based on laser transmission shall therefore not fall under ITU competence, except for the space operation services they may involve.

2.3 Assessment of legal provisions applicable to SPS

After having assessed the legal provisions applicable to the use of frequency bands by SPS, the issue of orbital position allocation will be addressed.

2.3.1. Frequency bands use

In order to assess the legal provisions of ITU regulation that apply to SPS, a distinction must be made between the space operation services that will be necessary in order to operate SPS, and the transmission of energy itself. Whereas the space operation services undoubtedly fall under ITU current regulation as stated by the Radio regulation, and shall therefore use the frequencies allocated for this purpose as every other space activities, the issue of energy transmission appears to be more sensitive. Two different possibilities are foreseeable: on the first hand, SPS could use the frequency bands that are currently used for the so-called ISM services. On the other hand, frequency bands specially dedicated to the transmission of energy could be required before ITU.

2.3.1.1. Use of ISM bands

Definition & scope

The industrial, scientific and medical (ISM) applications (of radio frequency energy) are defined by Article 1.15 of the Radio Regulations as "Operation of equipment or appliances designed to generate and use locally radio frequency energy for industrial, scientific, medical, domestic or similar purposes, excluding applications in the field of telecommunications". Whereas SPS could be considered as such industrial use of the radio frequency spectrum, the problem for entering this category of ISM may come from the "local" characteristic that ISM are supposed to present. SPS beams are indeed supposed to be received on very large Earth ground stations.

Nevertheless it must be underlined that energy transfer, via satellite in particular, has been considered as belonging to the list of current ISM applications in the ITU-R SM. 1056 Recommendation on ISM of 1994[21]. There are therefore strong assumptions that SPS shall be regarded as ISM by the ITU, thus falling under the following regime.

ISM regime

[21] See Annex, French version only.

The term "unregulated frequencies" is commonly used for designating ISM, since according to Article 5.150 of the Radio Regulations, “radiocommunication services operating in ISM bands must accept harmful interference which may be caused by ISM applications”. These bands may therefore present themselves as viably advantageous for SPS.

The corresponding bands are stated by Articles 5.138 and 5.150 of the Radio Regulations, as follows:

"**5.138** The following bands:

6 765-6 795 kHz	(centre frequency 6 780 kHz),
433.05-434.79 MHz	(centre frequency 433.92 MHz) in Region 1 except in the countries mentioned in No. **5.280**,
61-61.5 GHz	(centre frequency 61.25 GHz),
122-123 GHz	(centre frequency 122.5 GHz), and
244-246 GHz	(centre frequency 245 GHz)

are designated for industrial, scientific and medical (ISM) applications. The use of these frequency bands for ISM applications shall be subject to special authorization by the administration concerned, in agreement with other administrations whose radiocommunication services might be affected. In applying this provision, administrations shall have due regard to the latest relevant ITU-R Recommendations.

5.150 The following bands:

13 553-13 567 kHz	(centre frequency 13 560 kHz),
26 957-27 283 kHz	(centre frequency 27 120 kHz),
40.66-40.70 MHz	(centre frequency 40.68 MHz),
902-928 MHz	in Region 2 (centre frequency 915 MHz),
2 400-2 500 MHz	(centre frequency 2 450 MHz),
5 725-5 875 MHz	(centre frequency 5 800 MHz), and
24-24.25 GHz	(centre frequency 24.125 GHz)

are also designated for industrial, scientific and medical (ISM) applications. Radiocommunication services operating within these bands must accept harmful interference which may be caused by these applications. ISM equipment operating in these bands is subject to the provisions of No. **15.13**."

Article 15.13 of the Radio Regulations tends to maintain minimum control of the competent authorities on ISM:

"**15.13** § 9 Administrations shall take all practicable and necessary steps to ensure that radiation from equipment used for industrial, scientific and medical applications is minimal and that, outside the bands designated for use by this equipment, radiation from such equipment is at a level that does not cause harmful interference to a radiocommunication service and, in particular, to a radionavigation or any other safety service operating in accordance with the provisions of these Regulations".

It must finally be added that ISM applications are bound by radiation standards as stated below, like every other services.

2.3.1.2 Allocation of bands specially dedicated to energy transmission

Another solution may be to require the allocation of frequency bands especially dedicated to SPS before the ITU. The procedure that shall then be followed is described hereafter:

Frequency Allocation is defined by RR, Article 1.16, as: "Entry in the Table of Frequency Allocations of a given frequency band for the purpose of its use by one or more terrestrial or space radiocommunication services or the radio astronomy service under specified conditions. This term shall also be applied to the frequency band concerned".

One or several frequency bands or part of thereof may be reserved for the use of SPS.

In order to get an official answer to the question whether SPS should use ISM bands or get special allocated bands in order to be operated, this question should be presented before a ITU World Administrative Radio Conference (WARC), notably during one of the WARC preparatory conferences. This implies to address national administrations that will present the question via the European Conference on Post and Telecommunications before ITU. This however constitutes a lengthy process, which may produce positive developments but not before WRC 2010.

2.3.2 Orbital position allocation for SPS

According to the various projects architectures described in the reference technical documents, most of SPS are expected to include satellites/platforms placed in GEO, whereas a few of them only involve LEO and/or MEO satellites/platforms. It has to be underlined that the following developments concerning the use of orbits do only refer to GEO, since only the use of this particular orbit has been and remains regulated through ITU rules. The use of LEO and MEO is therefore not regulated by any special rules, except those deriving from the other branches of law, as described in the present study.

In the case they are (even partly) placed into GEO, SPS will have to conform to ITU regulation governing the use of this orbit. To that extend, ITU Constitution, Article 44.2, provides that, for the purpose of using GEO:

"Members shall bear in mind that radio frequencies and the geostationary-satellite orbit are limited natural resources and that they must be used rationally, efficiently and economically, in conformity with the provisions of the Radio Regulations, so that the countries or groups of countries may have equitable access to both, taking into account the special needs of the developing countries and the geographical situation of particular countries."

This provision has been periodically reaffirmed by ITU Radio Regulations (see ITU Radio Regulations, 2000, 0.3). As far as SPS are concerned, this notably means that the use of GEO for such activities will have to prove efficiency in order to get the required orbital position before the ITU. This general principle is however implemented through the frequency allocation process, as stated by the ITU Radio Regulations. The question of SPS efficiency will therefore not directly appear, but only indirectly through the issue of frequency allocation, as described before.

2.4 Electromagnetic compatibility

The EU Directive on electromagnetic compatibility[22] gives instructions to EU Member States in order to insure that apparatus liable to cause electromagnetic disturbance are so constructed that the electromagnetic disturbance generated does not exceed a level allowing radio and telecommunications equipment and other apparatus to operate as intended. This directive is of course only applicable to Earth-based apparatus. Since no element in the definition of the apparatus concerned by the directive permits to exclude SPS ground stations from its application field, SPS constructors will have to take this constraint into account while constructing every electrical and electronic elements (space and ground elements) needed for operating SPS ground stations.

3. ENVIRONMENTAL AND HEALTH LAW

After having reviewed the relevant provisions applicable to SPS (3.1), namely the prevention and precautionary principles (3.2), as well as their legal status, an overview of existing radiation limits will be given (3.3).

3.1 Relevant provisions : Prevention & Precautionary principles

3.1.1. At international level

The International Court of Justice mentioned in 1997 the absolute need to prevent environmental damage, due to their possibly irreversible effects[23]. The so-called "prevention principle" gives birth to a certain number of general obligations for States, that are notably implemented through the precautionary principle. Three international texts must be noted as far as these principles are concerned:

The 1972 Declaration of the United Nations Conference on the Human Environment[24] was adopted in Stockholm in order to take into account the "need for a common outlook and for common principles to inspire and guide the peoples of the world in the preservation and enhancement of the human environment". According to its Principle 21, "States have […] the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction".

Principle 2 of the Rio Declaration[25] strictly reproduces in similar wording the above-mentioned Principle 21 of the Stockholm Declaration. For the above-mentioned purpose of preventing damage caused to the environment of other States (…), Principle 15 of the Rio Declaration has for the first time explicitly recognised the Precautionary Principle: "In order to protect the environment, the precautionary approach should be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation".

According to Article 1, the Draft articles on prevention of transboundary harm from hazardous activities[26] apply to activities not prohibited by international law, which involve a risk of causing

[22] Council Directive 89/336/EEC of 3 May 1989 on the laws of the Member States relating to electromagnetic compatibility, as amended, *Official Journal* L 139, 23.05.89.
[23] ICJ, 25 September 1997, *Gabcikovo-Nagimaros Project*, par. 140.
[24] Declaration of the United Nations Conference on the Human Environment, June 16, 1972, 11 *I.L.M* 1416 (1972).
[25] Declaration of the United Nations Conference on Environment and Development, August 12, 1992, A/CONF.151/26 Vol.I, Principle 15.
[26] Draft articles on prevention of transboundary harm from hazardous activities, Report of the International Law Commission on the work of its 53rd session, *Official records of the General Assembly, 56th session, Supplement N°10 (A/56/10), chp.V.E.1,* November 2001, pp.370-377.

significant transboundary harms through their physical consequences[27]. It must be emphasised that even if these draft articles are related to hazardous activities, they shall be regarded as applying to ultra-hazardous activities as well, by inference, as soon as these activities involve such a risk. The harm may be caused to persons, property or the environment. Assuming that SPS are not prohibited by international law, they shall be regarded as constituting such activities, thus falling under the application of principles contained in the Draft Articles, as described thereafter. First and as far as the prevention principle is concerned, "the State of origin shall take appropriate measures to prevent significant transboundary harm or at any event to minimise the risk thereof"[28]. In application of the precautionary principle, it shall therefore require its prior authorisation for any activity within the scope of the draft articles carried out in its territory or otherwise under its jurisdiction or control[29]. It is also mentioned that such authorisation shall "be based on an assessment of the possible transboundary harm caused by [the] activity, including any environmental impact assessment"[30]. Some consultation and notification processes are foreseen, in order to "achieve an equitable balance of interest"[31] between concerned States. They shall also "provide the public likely to be affected […] with relevant information relating to [the concerned] activity, the risk involved and the harm which might result "[32]. All these measures are addressed to States and shall not as such affect directly the situation of the entity operating SPS. States shall nevertheless implement them through "the necessary legislative, administrative or other action including the establishment of suitable monitoring mechanisms to implement the provisions of the [draft articles]"[33]. The SPS operating entity will therefore have to refer to the relevant provisions of national law that may have been adopted for implementing the draft articles, by the State within the jurisdiction of which they fall.

3.1.2 At European level

In the case that EU Member States should develop SPS, precautionary principle as implemented at Community level shall also be respected. This would concretely mean that the following legal sources should be taken into account:

Article 174,2 of the EC Treaty explicitly refers to the precautionary principle in the field of environment policy, stating that EC Environment policy shall be grounded on this principle, as stated hereafter: "Community policy on the environment shall aim at a high level of protection [and] shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay […]". As potential polluters, EU Member States operating SPS, or whose nationals operate SPS, shall therefore pay particular attention to this principle. The precise scope of this principle shall be found both in the Communication from the Commission of 2000[34] on the precautionary principle and in the Community case law.

The European Commission has communicated guidelines to EC member States in order to apply the precautionary principle as contained in the EC Treaty. First, these guidelines identify the factors triggering recourse to the precautionary principle, namely: identification of potentially negative effects, scientific evaluation and scientific uncertainty, which must be all three met in order to have recourse to the precautionary principle. Second, the guidelines identify three principles that shall guide this recourse: it shall be grounded on scientific evaluation, preceded of a risk assessment, and give the possibility to all interested parties to express their opinion on possible action. Last, the guidelines remain the general principles of application: proportionality, non-discrimination, consistency, examination of the benefits and costs of action and lack of action, and examination of scientific developments.

According to European case law (EC Court of Justice, May 5, 1998, C-157/96, C-180/96): "Where there is uncertainty as to the existence or extent of risks to human health, the institutions may take

[27] *Ibid*, Article 2.
[28] *Ibid*, Article 3.
[29] *Ibid*, Article 6.
[30] *Ibid*, Article 7.
[31] *Ibid*, Article 9.2.
[32] *Ibid*, Article 13.
[33] *Ibid*, Artcle 5.
[34] Communication from the Commission on the precautionary principle, 2 February 2000, COM(2000) 1 final.

protective measures without having to wait until the reality and seriousness of those risks become fully apparent. […] That approach is borne out by Article 130r(1) of the EC Treaty, according to which Community policy on the environment is to pursue the objective inter alia of protecting human health. Article 130r(2) provides that that policy is to aim at a high level of protection and is to be based in particular on the principles that preventive action should be taken and that environmental protection requirements must be integrated into the definition and implementation of other Community policies." According to this statement, SPS projects should be compromised by EC protective measures in the case they may, or even might be a risk to human health.

The European Court of First Instance (Court of First Instance, President Order, June 30, 1999, T-70/99), has added that "requirements linked to the protection of public health should undoubtedly be given greater weight that economic considerations". European operators shall therefore notice that, by application of the precautionary principle, the potential economic benefit deriving from SPS concepts would not be sufficient to sustain their projects, for instance in getting Community/EC Member States licences of exploitation, in the case these projects might involve a risk to human health.

3.2 Legal status

The Stockholm and Rio declarations have the status of non-binding agreements, also commonly referred to as *gentlemen's agreements*, and have as such no binding force. Nevertheless, they may contain some principles that are binding on a customary basis. The prevention principle in particular, as stated both in Principle 21 of the Stockholm Declaration and in Principle 2 of the Rio Declaration, shall be regarded as a customary one, that is also binding for States as a general principle of law.

The International Law Commission Draft Articles have no legal value but contain some general principles of international law and some customary principles. The prevention principle, as contained in Article 3, shall be regarded as one of these (binding) customary principles. The principles contained in the draft articles concerning cooperation, prior authorisation, assessment of risk, and information to the public, shall also be considered as binding on a customary basis or as general principles of law. The national implementation measures subsequently adopted by States shall as well be regarded as binding within the jurisdiction of States concerned.

The Commission communication does not constitute binding law. There are nevertheless strong assumptions that EC Member States shall apply the contained guidelines when they have recourse to the precautionary principle, and in particular when regulating SPS activities. In addition, the principles contained in EC case law undoubtedly constitute binding law for EC member States, that will therefore apply them as well when regulating SPS activities.

Consequences for SPS. The entity developing and/or operating SPS will fall under the jurisdiction of one or several States. Since States shall comply with the prevention principle, they will have to ensure that this entity does not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction, through preventive measures such as licences delivery (depending on the national instruments that are commonly used). These preventive measures, regrouped in the so-called precautionary principle, may be grounded on EC legislation and case law if these States are EC member States. The entity developing and/or operating SPS shall therefore question national authorities in order to conduct its activity in accordance with national environmental regulation.

3.3 Radiation limits

As most of SPS concepts and architectures are expected to transmit energy on Earth or in space via microwave beams, they shall be bound by applicable radiation limits. The current limits have consequently been reproduced hereafter, subsequently taking into account international, European and most concerned States national regulations.

3.3.1 Relevant provisions

As requested for the needs of the present study, the frequency range that has been taken into reference lies from 2.45 to 100 GHz.

International standards

Radiation standards for electro-magnetic fields are set up, at international level, by the International Commission on Non-Ionizing Radiation Protection - ICNIRP, which has adopted some "Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)". The corresponding standards are stated below for the frequency range from 2.45 to 100 GHz.

Two kinds of distinction are made by the ICNIRP, according one first hand to the exposure characteristics and on the other hand to the type of restriction. Two different standards are therefore applicable, depending on the fact that either occupational or general public exposure is involved. In addition, it is distinguished between:

- **basic restrictions**, that are based on scientifically proved effects on human health,
- **reference levels**, which are obtained from the basic restrictions by mathematical modeling by extrapolation from the results of laboratory investigations at specific frequencies.

It must finally be specified that for scientific reasons, different scientific bases are used - current density, SAR, or power density, in the development of basic exposure restrictions, according to the various frequency ranges concerned.

Exposure characteristics	**Frequency range (GHz)**	**Current density for head & trunk ($mA.m^{-2}$) (rms)**	**Whole body average SAR ($W.kg^{-1}$)**	**Localised SAR (head & trunk) ($W.kg^{-1}$)**	**Localised SAR (limbs) ($W.kg^{-1}$)**	**Power density ($W.m^{-2}$)**
Occupational exposure	▪ From 2.45 to 10	-	0.4	10	20	-
	▪ From 10 to 100	-	-	-	-	50
General public exposure	▪ From 2.45 to 10	-	0.08	2	4	-
	▪ From 10 to 100	-	-	-	-	10

Table 1. Basic restrictions for time varying electric, magnetic fields and for power density for frequencies from 2.45 to 100 GHz.

Exposure characteristics	**E-field strength ($V.m^{-1}$)**	**H-field strength ($A.m^{-1}$)**	**B-field (μT)**	**Equivalent plane wave power density Seq ($W.m^{-2}$)**
Occupational exposure	137	0.36	0.45	50

General public exposure	61	0.16	0.20	10

Table 2. Reference levels for exposure to time-varying electric and magnetic fields (unperturbed values) for frequencies from 2.45 to 100 GHz.

(Source: ICNIRP Guidelines)

European standards

At EU level, the Council has adopted a recommendation concerning general public exposure to electromagnetic fields. The Council Recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz)[35] is based on ICNNIRP Guidelines. The corresponding standards, which only apply to general public exposure, are reproduced below.

Frequency range (GHz)	**Current density for head & trunk ($mA.m^{-2}$) (rms)**	**Whole body average SAR ($W.kg^{-1}$)**	**Localised SAR (head & trunk) ($W.kg^{-1}$)**	**Localised SAR (limbs) ($W.kg^{-1}$)**	**Power density ($W.m^{-2}$)**
▪ From 2.45 to 10	-	0.08	2	4	-
▪ From 10 to 100	-	-	-	-	10

Table 3. Basic restrictions for general public exposure to time varying electric, magnetic fields and for power density for frequencies from 2.45 to 100 GHz.

E-field strength ($V.m^{-1}$)	**H-field strength ($A.m^{-1}$)**	**B-field (μT)**	**Equivalent plane wave power density Seq ($W.m^{-2}$)**
61	0.16	0.20	10

Table 4. Reference levels for general public exposure to time-varying electric and magnetic fields (unperturbed values) for frequencies from 2.45 to 100 GHz.

(Source: EC Recommendation 1999/519)

National standards

The national regulation of EU Member States and most concerned States are reproduced in annex of this report.

3.3.2 Legal status

ICNIRP Guidelines

It must be underlined that ICNIRP Guidelines by themselves do not constitute a text of binding law, but only a recommendation stating radiation standards for Electro-magnetic fields. The corresponding

[35] Council Recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz), 1999/519/EC, *Official Journal L 199*, 30/07/1999 p.0059-0070.

standards have nevertheless been subsequently integrated in national (binding) regulations of numerous States.

European Recommendation

In the same way, the Council Recommendation on the limitation of exposure of the general public to electromagnetic fields do not have binding force as such for EC member states, unless they have explicitly or tacitly accepted it. This acceptation may take the form of the introduction into national regulation of the corresponding standards.

National laws

The binding force of national standards depends on the binding force of the text by which they have been integrated into national law. It will therefore have to be determined for each concerned State on a case-by-case basis, according to the binding or non-binding force generally recognised to the type of regulation that has been used for introducing the standards.

3.3.3 Recommended approach

Consequences for SPS. The relevant provisions of law for operating SPS will be the law(s) of the State(s) where the ground station(s) is/are located. Should they not contain any (national) limitation in terms of exposure to electromagnetic fields, the relevant (ICNIRP & EC) recommendations may however be applicable in the case they have been tacitly accepted by the concerned State(s).

Additional remarks

It shall be mentioned that a universal harmonisation process of existing standards has been launched at WHO level, through the so-called EMF International Project[36].

4. Humanitarian Law

Since some SPS concepts are based on power transmission via laser, space-to-Earth or space-to-space, their utilisation may fall under the applicable provisions of disarmament treaties dealing with lasers. This actually depends on the technical characteristics of laser power transmission. Indeed, the 1995 Additional Protocol on Blinding laser Weapons (Protocol IV) to the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons[37] which may be deemed to be Excessively Injurious or to have indiscriminate effects, forbids the use of "blinding" lasers.

Since, according to the technical documents taken as a reference for this report, SPS concepts are not expected to enter such categories of "blinding" lasers, defined by the Protocol as "Laser weapons specially designed, as their sole combat function, or as one of their combat functions, to cause permanent blindness to unenhanced vision […]", they shall not be regarded as falling under the regime of this Protocol. As long as this condition is met, SPS shall therefore not be compromised under international disarmament law.

[36] http://www.who.int/peh-emf/project/en/
[37] Additional Protocol to the convention on prohibitions and restrictions on the use of certain conventional weapons which may be deemed to be excessively injurious or to have indiscriminate effects, Vienna, 12.10.95, CCW/CONF.I/7.

PART II. POSSIBLE ORGANISATIONAL STRUCTURE FOR SPS OPERATING PHASE

According to ESA Convention, Article II, the purpose of the agency: "shall be to provide for and to promote, for exclusively peaceful purposes, co-operation among European States in space research and technology and their space applications, with a view to their being used for scientific purposes and for operational space applications systems"[38]. Operating a SPS system will therefore have to be undertaken by an entity separate from ESA itself.

Given the inherently continental or global dimension of SPS concepts, the organisational structure adopted for operating SPS will furthermore have to be included into an international partnership, already existing or specially created for this purpose, organising the concerned States cooperation.

After having reviewed foreseeable solutions for setting an international partnership up (1), an organisational scheme for operational phase will be envisaged (2).

1. INTERNATIONAL PARTNERSHIP

We will first examine the purpose of such an international partnership (1.1). Then, the different solutions will be described: the treaty solution (1.2), the gentlement agreements solution (1.3), as well as their respective advantages and drawbacks (1.4).

1.1 Purpose

There are three different reasons for establishing such an international partnership at the head of the SPS organisational structure

- The construction, development and deployment of SPS concepts involve significant financial investments as well as a high level of risk in terms of technical feasibility (as with every other space activities). Such risks and investments can only be made by the public sphere, or at least involve strong public support,
- The need to maintain a public control on the entity operating SPS, given the obligations deriving from the fact that it is a space activity, which must therefore implement space law principles (non-discrimination, common benefit, etc.),
- The continental or even global dimension of SPS concepts.

Two different institutional solutions are therefore foreseeable as far as an international partnership dedicated to organise States cooperation around SPS operation is concerned. The first one would be to conclude a treaty - bilateral or multilateral - between concerned States. The second solution, less constraining from a legal point of view, would be to conclude one or several cooperation agreements (also called: *gentlemen agreements*) as and when required by the development of SPS operations. The most significant difference existing between these two solutions lies in their binding or non-binding effect. Their main characteristics are described below.

[38] Convention for the Establishment of a European Space Agency, 30 May 1975, 14 *ILM* 864, Article II.

1.2 Treaty solution

According to the Vienna convention on the law of treaties[39], a treaty can be defined as "an international agreement concluded between States in written form and governed by international law, whether embodied in a single instrument or in two or more related instruments and whatever its particular designation"[40]. Such a treaty will always fall under the provisions of the Vienna Convention, and particularly under the *pacta sunt servanda* rule, as contained in Article 26 of the convention: "*Every treaty in force is binding upon the parties to it and must be performed by them in good faith*"[41]. Treaties are also considered as a source of law according to Article 38 of the Rules of the International Court of Justice. As a consequence, States may be regarded as responsible and liable before an international jurisdiction for having failed to apply such treaties.

1.3 Gentlemen's agreements

Political agreements, also commonly referred to as *gentlemen's agreements*, are concluded between subjects of international law as well, through people or organisms entitled to negotiate on behalf of States, but do not fall under the *pacta sunt servanda* rule. They constitute political agreements only, and shall therefore not be regarded as binding between the contracting parties. In the same way, States do not engage their responsibility under international law by failing to apply such agreements.

1.4 Advantages & drawbacks

The treaty solution presents the advantage to establish strong obligations between State parties, that they will be bound to respect. This solution may however encounter difficulties, given the weight of treaty elaboration procedure as well as the lack of political consensus that may appear between negotiating States. Solutions may therefore be searched for in soft law (e.g. non-binding law), especially in some more flexible cooperation agreement solution.

The gentlemen agreement solution presents at least one advantage, compared to the treaty solution: it may be easier to reach an agreement between concerned States since only soft law would be elaborated, thus solving the fear of being bound for States.

Nevertheless, gentlemen agreements, non taking into consideration the form they might take (MoU, etc.) have no legal value and only constitute manifestations of a political will to cooperate in one given field. They should therefore not actually been regarded as a legal basis for developing a SPS project, but only as a political one. It shall nevertheless be added that States are supposed to conclude and apply these gentlemen agreements in good faith, and that they might constitute a political basis for subsequently concluding a treaty.

2. ORGANISATIONAL SCHEME FOR OPERATIONAL PHASE (PPP)

Two possible organisational schemes will be reviewed, namely the international organisation solution (2.1) and the private entity solution (2.2), as well as the consequences of both approaches in terms of energy policy (2.3).

[39] Vienna Convention on the law of treaties, 23 May 1969, 155 *UNTS* 331.
[40] *Ibid*, Article 2, 1(a).
[41] *Ibid*, Article 26.

2.1 The international organization

For the purposes that have been mentioned above (need of public support, public control and global dimension), the INTELSAT pattern could be applied to SPS. This pattern would permit to make a distinction between the development and operation phases of the SPS project, thus giving the public sphere the possibility to bring financial support for the R&D phase, and then to keep a control on the entity in charge of the operational phase.

2.1.1 Public support in R&D phase

Given the financial investments required for developing space projects, and SPS in particular, a bilateral or multilateral treaty between concerned and/or interested States may be an appropriate solution for developing SPS. The main purpose of this treaty would be to organise the conditions of States cooperation around the project from an institutional and financial point of view.

Applying INTELSAT pattern, this treaty could establish an international organisation for the purpose of carrying forward the development, construction, and establishment of the space segment of the SPS project[42].

Considering the obligations deriving from international business law, as stated by WTO in particular, the SPS services may on the contrary have to be provided through a commercial private entity (see below for a proposed PPP structure). The established international organisation shall however keep a political control on this operating entity. The convention could consequently foresee that the international organisation remains responsible for controlling that the operating entity complies with its public service obligations.

2.1.2. Political government control in operation phase

The objective of the international organisation in charge of the SPS project development, as defined by the convention, will have to contain the general principles of international law (including space law) that States parties either intend, or are bound to respect. As in the case of INTELSAT, the convention may therefore include a provision stating that SPS services will have to be provided on a non-discriminatory basis to all areas of the world. In addition, the relations between the international organisation and the entity operating SPS will have to be organised in the convention so as to maintain a governmental control of the one over the activities of the other. A provision may be included into the convention, according to which the international organisation keeps full competence to control the compliance of the operating entity with the principles contained in the convention, during the operation phase.

2.2 The private entity operating SPS

A private entity may be designated for operating SPS, in the conditions mentioned above (public control maintained). To that extend, the reference may be made to the concession scheme that is being set up for operation phase of the GALILEO program.

[42] See Agreement relating to the International Telecommunications Satellite Organisation "INTELSAT", 1971, Article II, (a).

GALILEO development and deployment phases have been attributed to a joint undertaking, whose form is foreseen by Article 171 of the EC treaty, and notably shared between ESA and the European Union. When this task is completed, the joint undertaking will designate a private entity in order to carry on the operation phase, under the public sphere control, through a call to tender. Such a concession scheme may be used for developing and operating SPS, being specified that:

- The special joint undertaking form that is foreseen in the EC treaty implies that every State participating in the SPS project belongs to the European Community. An *ad hoc* joint undertaking may however been established through special treaty to avoid this problem.
- The financial feasibility and profitability of the whole project will have to be demonstrated before launching a concession program, so that the private sphere would find an interest to invest in such a project.

Should this conditions been met, the concession solution presents both advantages to provide an institutional solution for operating SPS, and to give to the public sphere the desired control over the operation phase. The operating entity will however fall under the regulation applicable in terms of energy policy in the State where it has been registered. Assuming that this State will belong to the European Community, the main characteristics of the European regulation have consequently been reproduced hereafter

3. CONSEQUENCES IN TERMS OF ENERGY POLICY

For the purpose of this report, we assume that the entity operating SPS will be established in one of the member states of the European Union. Its activity shall therefore be subject to European laws, regulation and policies in terms of energy producing and transporting. The main characteristics of EC regulation are consequently mentioned hereafter.

According to the Green Paper on the security of energy supply of November 2000[43], the main objective of the energy policy in the European Union is to ensure a supply of energy to all consumers at an affordable price in the respect of environment and of the promotion of healthy competition on the European energy market. Constituting energy sources, SPS shall tend to reach this goal. The operating entity shall therefore take this requirement into account, in accordance with the applicable national law they are submitted to, since the Green paper does not constitute binding law directly applicable to companies established in the European Union.

In addition, the energy market has been progressively opened to competition. In March 2001, the European Commission adopted measures in order to have gas and electricity markets fully opened by 2005. Among these measures, one can mention the Communication from the Commission of 13 March 2001, "Completing the internal energy market"[44], a Proposal for a Directive amending Directives 96/92/EC and 98/30/EC concerning common rules for the internal market in electricity and natural gas[45] and a Proposal for a Regulation on conditions for access to the network for cross-border exchanges in electricity[46]. These texts, which are applicable to SPS concepts, provide for an accelerated timetable, the strengthening of conditions in favour of genuine and fair competition and the implementation of a single market which offers guarantees to the public, protects the environment and ensures a safe and affordable supply of energy.

[43] Green Paper of 29 November 2000 towards a European strategy for the security of energy supply.
[44] Communication from the Commission to the Council and the European Parliament of 13 March 2001, "Completing the internal energy market",
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Taking these competition goals into account, the energy policy and regulation that will be applied to SPS operator will be the ones of the State in which it will be established.

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ANNEX I. LIST OF APPLICABLE LEGAL TEXTS

SPACE LAW

TREATIES

Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, January 27, 1967, 610 *UNTS* 205.

Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, April 22, 1968, 672 *UNTS* 119.

Convention on International Liability for Damage Caused by Space Objects, March 29, 1972, 961 *UNTS* 187.

Convention on Registration of Objects Launched into Outer Space, November 12, 1974, 1023 *UNTS* 15.

Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, December 18, 1979, 1363 *UNTS* 3.

DECLARATIONS OF LEGAL PRINCIPLES

Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space, adopted on 13 December 1963, *RES 1962 (XVII)*.

Principles Relevant to the Use of Nuclear Power Sources in Outer Space, adopted on 14 December 1992, *A/RES/47/68*.

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, adopted on 13 December 1996, *A/RES/51/122*.

AIR LAW

Convention on International Civil Aviation, December 7, 1944, *ICAOTC* Doc.7300.

ITU RULES

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ENVIRONMENTAL LAW / HEALTH LAW

International texts

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Regional texts

Resolution on combating the harmful effects of non-ionizing radiation, *Official Journal* C 205, 25/07/1994 p. 0439.

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National texts

See Annex II, III.

HUMANITARIAN LAW

Additional Protocol to the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects, 12 October 1995, Doc. CCW/CONF.I/16 (Part I).

ANNEX II. TABLES OF RADIATION LIMITS

AT INTERNATIONAL LEVEL

Table 1. Basic restrictions for time varying electric, magnetic fields and for power density for frequencies from 2.45 to 100 GHz.

Exposure characteristics	Frequency range (GHz)	Current density for head & trunk ($mA.m^{-2}$) (rms)	Whole body average SAR ($W.kg^{-1}$)	Localised SAR (head & trunk) ($W.kg^{-1}$)	Localised SAR (limbs) ($W.kg^{-1}$)	Power density ($W.m^{-2}$)
Occupational exposure	▪ From 2.45 to 10	-	0.4	10	20	-
	▪ From 10 to 100	-	-	-	-	50
General public exposure	▪ From 2.45 to 10	-	0.08	2	4	-
	▪ From 10 to 100	-	-	-	-	10

(Source: ICNIRP Guidelines)

Table 2. Reference levels for exposure to time-varying electric and magnetic fields (unperturbed values) for frequencies from 2.45 to 100 GHz.

Exposure characteristics	E-field strength ($V.m^{-1}$)	H-field strength ($A.m^{-1}$)	B-field (μT)	Equivalent plane wave power density Seq ($W.m^{-2}$)
Occupational exposure	137	0.36	0.45	50
General public exposure	61	0.16	0.20	10

(Source: ICNIRP Guidelines)

AT EUROPEAN LEVEL

Table 3. Basic restrictions for general public exposure to time varying electric, magnetic fields and for power density for frequencies from 2.45 to 100 GHz.

Frequency range (GHz)	Current density for head & trunk ($mA.m^{-2}$) (rms)	Whole body average SAR ($W.kg^{-1}$)	Localised SAR (head & trunk) ($W.kg^{-1}$)	Localised SAR (limbs) ($W.kg^{-1}$)	Power density ($W.m^{-2}$)
▪ From 2.45 to 10	-	0.08	2	4	-
▪ From 10 to 100	-	-	-	-	10

(Source: EC Recommandation 1999/519)

Table 4. Reference levels for general public exposure to time-varying electric and magnetic fields (unperturbed values) for frequencies from 2.45 to 100 GHz.

E-field strength ($V.m^{-1}$)	H-field strength ($A.m^{-1}$)	B-field (μT)	Equivalent plane wave power density Seq ($W.m^{-2}$)
61	0.16	0.20	10

(Source: EC Recommandation 1999/519)

AT NATIONAL LEVEL

THE LIMITS IN EU MEMBER STATES

See tables enclosed.

THE LIMITS IN OTHER MAJOR STATES

See tables enclosed.

Table 5. Restrictions for time varying electric, magnetic fields and for power density for frequencies from 2.45 to 100 GHz in EU Member States.

Country	Type of instrument	Title of instrument	Issued when?	Are the limits based on ICNIRP guidelines?	Compliance	Group protected
Austria	Standard	ÖNORM(Vornorm) S1120	January, 1994	Limits close to ICNIRP, full harmonisation intended by current revision	No legal binding, meeting the limits required as state of the art	Public and occupational
Belgium	Decision	ab- Arrêté ministériel c- Arrêté royal	a- May 7th, 1987 b- April 20th, 1988 c- April 20th, 2001 (revised in December 2001)	No	Mandatory	Public
Denmark	No legally binding measures or recommendations	/	/	When evaluating exposure, Labour Inspectorate of Denmark follows ICNIRP recommendations.	/	/
Finland	ac- Decision b- Act d- Regulation ef- Instruction	a- Decision on high-frequency equipment and control thereof (473/85) b- Radiation protection act (592/91) c- Decision on limiting exposure to non-ionising radiation (1474/91) d- Regulation/decree on non-ionising radiation control (1306/93) e- Instruction 9.2: Pulse radar safety f- Instruction 9.3: Safe practices when working on frequency modulation and television masts	a- 1985 b- 1991 c- 1991 d- 1993 e- 1991 f- 1993	a- No b- N/A c- No d- No e- N/A f- N/A	a-d- Mandatory e-f- Voluntary	a- Occupational b- Public and occupational c- Occupational d- Public e- N/A f- N/A
France	Ordinance and Decree	a- Authorization of exploitation of public areas in respect to health environment protection b- Definite limit values of telecommunications	a- July 25th, 2001 b- November 14th, 2001	Yes - EC 1999/519	Mandatory	Public

		equipment				
Germany	Ordinance	a- 26th BImSchV (pollution control order) b- BMPT order 306/97	a- December 16th, 1996 b- 1997	Yes	Mandatory	Public
Greece	Act	Act 1105/Vol. II/6.9.2000 "Measures to protect the general public from the operation of ground antenna installations"	September 6th, 2000	Based on EC Recommendation with additional safety parameters (0.8 of reference level values)	Mandatory	Public
Ireland	Act	Planning and Development Act	November 2001	Yes	Mandatory	Public
Italy	a- Law b- Decree	a- Law n°22 "Framework la on protection against exposures to electric, magnetic and electromagnetic fields" b- Decree n°381 "Regulations on the definition of ceiling value of radiofrequency fields compatible with human health"	a- February 22nd, 2001 b- September 10th, 1998	a- No b- No, completely different approach	Mandatory	a- Public and occupational b- Public
Luxembourg	a- Standard b- Recommendation	a- Standards regarding non-ionising radiation due to cellular mobile telephony b- ITM-CL 179-2	?	a- No b- Yes, to conform EC Recommendation	a- Mandatory b- No. Voluntary	Public
Netherlands (The)	No legally binding measures or recommendations	/	/	Yes, to conform EC Recommendation	/	/
Portugal	A draft joint order by Ministry of Social Infrastructure and Ministry of Health	/	/	Yes, to conform EC Recommendation	/	/
Spain	Royal Decree	a- Radioelectric public domain protection b- 1451/2000	a- September 28th, 2001 b- July 28th, 2000	a- Yes	Mandatory	a- Public b- Public and occupational
Sweden	Ordinance	a- Announcement of the Swedish Work Environment Authority with regulations or high frequency electromagnetic fields b- The Swedish Radiation Protection Institute's regulations on drying with microwaves	a- 1987 b- 1995	a- No, based on EHC 16 (1981) and NCRP n°86 b- Yes	Mandatory	a- Occupational b- Public

United Kingdom	Guideline, but used to establish compliance with law	Board statement on restrictions on human exposure to static and time varying electromagnetic fields and radiation	1993	No	Mandatory for occupational exposures and exposures of the public arising from occupational activities. Legal duties are to control risks. If Guidelines are followed, Government Agencies (eg Health & Safety Inspectors) accept that (EMF) risks are controlled adequately.	Public and occupational

(Source : WHO/EMF)

Table 6. Restrictions for time varying electric, magnetic fields and for power density for frequencies from 2.45 to 100 GHz in major states outside Europe

Country	Type of instrument	Title of instrument	Issued when?	Are the limits based on ICNIRP guidelines?	Compliance	Group protected
Australia	/	/	/	/	/	/
Canada	Guidelines	Safety code 6	1999	No	Mandatory	Public and occupational
China	Unknown	/	/	/	/	/
Japan	Law	Radio-radiation protection guidelines for human exposure to EMF	1997	Yes	Voluntary. But mandatory standards notably for base stations since 1999 and for hand-held devices since 2001	Public and occupational
Russia	a- Law (N/A) b- Standards (BNS) cde- Sanitary regulations and norms (SanPiNs) [d et e : N/A]	a- Federal law "The sanitary-epidemiological welfare of the population" no. 52–FZ b- GOST 12.1.006–84 Occupational safety standards system. Electromagnetic fields of radio frequencies. Permissible levels at work-places and requirements for control c- SanPiN 2.2.4/2.1.8.055–96 Radiofrequency electromagnetic radiation (RF EMR) d- MSanPiN 001–96 Sanitary norms of permissible levels for physical factors during use of domestic articles e- SanPiN 2.1.2.1002–00 Sanitary-epidemiological requirements for living buildings and locations	a- March 30th, 1999 b- 1984 c- 1996 d- 1996 e- 2000	No	Mandatory	a- Public b- Occupational c- Occupational d- Public e- Public
United States	Law	Radiofrequency radiation exposure limits	1996	No	Mandatory for FCC-licensees and grantees only	Public and occupational

(Source : WHO/EMF)

Table 7. Restrictions for time varying electric, magnetic fields and for power density for frequencies from 2.45 to 100 GHz in EU Member States

Country	Type of instrument	Title of instrument	Issued when?	Are the limits based on ICNIRP guidelines?	Compliance	Group protected
Australia	/	/	/	/	/	/
Canada	Guidelines	Safety code 6	1999	No	Mandatory	Public and occupational
China	Unknown	/	/	/	/	/
Japan	Law	Radio-radiation protection guidelines for human exposure to EMF	1997	Yes	Voluntary. But mandatory standards notably for base stations since 1999 and for hand-held devices since 2001	Public and occupational
Russia	c- Law (N/A) d- Standards (BNS) cde- Sanitary regulations and norms (SanPiNs) [d and e : N/A]	f- Federal law "The sanitary-epidemiological welfare of the population" no. 52–FZ g- GOST 12.1.006–84 Occupational safety standards system. Electromagnetic fields of radio frequencies. Permissible levels at work-places and requirements for control h- SanPiN 2.2.4/2.1.8.055–96 Radiofrequency electromagnetic radiation (RF EMR) i- MSanPiN 001–96 Sanitary norms of permissible levels for physical factors during use of domestic articles j- SanPiN 2.1.2.1002–00 Sanitary-epidemiological requirements for living buildings and locations	f- March 30th, 1999 g- 1984 h- 1996 i- 1996 j- 2000	No	Mandatory	f- Public g- Occupational h- Occupational i- Public j- Public
United States	Law	Radiofrequency radiation exposure limits	1996	No	Mandatory for FCC-licensees and grantees only	Public and occupational

(Source : WHO/EMF)

APPENDIX - Radiation limits specific to some States

- **Belgium**

BASIC RESTRICTIONS FOR TIME VARYING ELECTRIC AND MAGNETIC FIELDS UP TO 300 GHz						
Exposure category	Frequency range	Current density for head and trunk (mA/m^2)	Whole-body average SAR (W/kg)	Spatial peak SAR in the head & trunk (W/kg)	Spatial peak SAR in limbs (W/kg)	Power density (W/m2)
Occupational						
General public			0.02			
REFERENCE LEVELS FOR TIME VARYING ELECTRIC AND MAGNETIC FIELDS UP TO 300 GHz						
(unperturbed rms values)						
Arrêté Ministériel - a. 07.05.87, b. 20.04.88						
measurements at 1,5 m from the ground						
1: below 5 kV/m in urban area						
2: below 7 kV/m over roads						
3: below 10 kV/m in other area						
c. Arrêté Royal 29.04.01						
Exposure category	Frequency range	E-field strength (V/m)	H-field strength (A/m)	B-field (mT)	Equivalent plane wave power density (W/m^2)	
Occupational						
General public	10 MHz - 400 MHz	13.7			0.5	
	0,4 - 2 GHz	0,686f0,5			f/800	
	2 GHz - 10 GHz	30.7			2.5	
For composed field:						
10 GHz Σ(Ei/Eiref) <= 1 10 MHz						
Note: For ELF indicate whether limit is a 'ceiling limit', 'short-term' or 'work-day' exposure						

(Source: WHO/EMF)

- **Canada**

BASIC RESTRICTIONS FOR STATIC ELECTRIC AND MAGNETIC FIELDS						
Exposure category	E-field strength (kV/m)	B-field (mT)				
Occupational	N/A	N/A				
General public	N/A	N/A				

BASIC RESTRICTIONS FOR TIME VARYING ELECTRIC AND MAGNETIC FIELDS UP TO 300 GHz						
Exposure category	Frequency range	Current density for head and trunk (mA/m2)	Whole-body average SAR (W/kg)	Spatial peak SAR in the head & trunk (W/kg)	Spatial peak SAR in limbs (W/kg)	Power density (W/m2)
Occupational	100 kHz - 10 GHz		0.4	8	20	
	10 GHz - 150 GHz					50
	150 GHz - 300 GHz					3.33 x 10-4*f*
General public	100 kHz - 10 GHz		0.08	1.6	4	
	10 GHz - 150 GHz					10
	150 GHz - 300 GHz					6.67 x 10-5*f*
Note: Frequency, *f*, is frequency in MHz						

REFERENCE LEVELS FOR TIME VARYING ELECTRIC AND MAGNETIC FIELDS UP TO 300 GHz						
		(unperturbed rms values)				
Exposure category	Frequency range	E-field strength (kV/m)	H-field strength (A/m)	B-field (mT)	Equivalent plane wave power density (W/m2)	Averaging time (min)
Occupational	0.003 - 1	600	4.9			6
	1.0 - 10.0	600/*f*	4.9/*f*			6
	10.0 - 30.0	60	4.9/*f*			6
	30 - 300	60	0.163		10*	6
	300 - 1500	3.54*f*0.5	0.0094*f*0.5		*f*/30	6
	1500 - 15000	137	0.364		50	6
	15000 - 150000	137	0.364		50	616000/*f*1.2
	150000 - 300000	0.354*f*0.5	9.4 x 10-4*f*0.5		3.33 x 10-4*f*	616000/*f*1.2
General public	0.003 - 1	280	2.19			6
	1.0 - 10.0	280/*f*	2.19/*f*			6
	10.0 - 30.0	28	2.19/*f*			6
	30 - 300	28	0.073		2*	6
	300 - 1500	1.585*f*0.5	0.0042*f*0.5		*f*/150	6
	1500 - 15000	61.4	0.163		10	6
	15000 - 150000	61.4	0.163		10	616000/*f*1.2
	150000 - 300000	0.158*f*0.5	4.21 x 10-4*f*0.5		6.67 x 10-5*f*	616000/*f*1.2

*Power density limit is applicable at frequencies greater than 100 MHz						
Notes: 1. Frequency, *f*, is frequency in MHz						
2. A magnetic field strength of 1 A/m corresponds to 1.257 x 10-3 mT						
REFERENCE LEVELS FOR INSTANTANEOUS CONTACT CURRENTS FROM POINT CONTACT WITH CONDUCTIVE OBJECTS						
Exposure category	**Frequency range**	**Maximum contact current (mA rms)**	**Averaging time**			
Occupational	0.003 - 0.1	1000*f*	1 s			
	0.1 - 110	100	6 min			
General public	0.003 - 0.1	450*f*	1 s			
	0.1 - 110	45	6 min			
Note: Frequency, *f*, is frequency in MHz						
REFERENCE LEVELS FOR TIME AVERAGED CURRENT INDUCED IN ANY LIMB						
Exposure category	**Frequency range**	**Current through both feet (mA rms)**	**Current through each foot (mA rms)**	**Averaging time**		
Occupational	0.003 - 0.1	2000*f*	1000*f*	1 s		
	0.1 - 110	200	100	6 min		
General public	0.003 - 0.1	900*f*	450*f*	1 s		
	0.1 - 110	90	45	6 min		
Note: Frequency, *f*, is frequency in MHz						

(Source: WHO/EMF)

- **Japan**

BASIC RESTRICTIONS FOR STATIC ELECTRIC AND MAGNETIC FIELDS						
Exposure category	**E-field strength (kV/m)**	**B-field (mT)**				
Occupational	**-**	**-**				
General public	**-**	**-**				

BASIC RESTRICTIONS FOR TIME VARYING ELECTRIC AND MAGNETIC FIELDS UP TO 300 GHz						
Exposure category	**Frequency range**	**Current density for head and trunk (mA/m2)**	**Whole-body average SAR (W/kg)**	**Spatial peak SAR in the head & trunk (W/kg)**	**Spatial peak SAR in limbs (W/kg)**	**Power density (W/m2)**
Occupational	**100kHz-3GHz**		**0.4**	**10 (10 g ave.)**	**20 (10 g ave.)**	
General public	**100kHz-3GHz**		**0.08**	**2 (10 g ave.)**	**4 (10 g ave.)**	

REFERENCE LEVELS FOR TIME VARYING ELECTRIC AND MAGNETIC FIELDS UP TO 300 GHz						
(unperturbed rms values)						
Exposure category	**Frequency range**	**E-field strength (kV/m)**	**H-field strength (A/m)**	**B-field (mT)**	**Equivalent plane wave power density (W/m2)**	
Occupational	**50 Hz / 60 Hz**	**3**	**-**	**-**	**-**	
	10 kHz - 30 kHz	**0.614**	**163**	**-**	**-**	
	30 kHz - 3 MHz	**0.614**	**4.9/f**	**-**	**-**	
	3 MHz - 30 MHz	**1.842/f**	**4.9/f**	**-**	**-**	
	30 MHz - 300MHz	**0.0614**	**0.163**	**-**	**10**	
	300 MHz - 1.5 GHz	**0.00354f1/2**	**f1/2/106**	**-**	**f/30**	
	1.5 GHz - 300 GHz	**0.137**	**0.365**	**-**	**50**	
		*** f [MHz]**	*** f [MHz]**		*** f [MHz]**	
General public	50 Hz / 60 Hz	3	-	-	-	
	10 kHz - 30 kHz	0.275	72.8	-	-	
	30 kHz - 3 MHz	0.275	2.18/f	-	-	
	3 MHz - 30 MHz	0.824/f	2.18/f	-	-	
	30 MHz - 300MHz	0.0275	0.0728	-	2	

	300 MHz - 1.5 GHz	0.001585f1/2	f1/2/237.8	-	f/150	
	1.5 GHz - 300 GHz	0.0614	0.163	-	10	
		* f [MHz]	* f [MHz]		* f [MHz]	
Note: For ELF indicate whether limit is a 'ceiling limit', 'short-term' or 'work-day' exposure						

REFERENCE LEVELS FOR INSTANTANEOUS CONTACT CURRENTS FROM POINT CONTACT WITH CONDUCTIVE OBJECTS

Exposure category	**Frequency range**	**Maximum contact current (mA rms)**				
Occupational	10 kHz - 100 kHz	0.001f	Average time < 1 s			
	100 kHz - 15 MHz	below 100 * f [Hz]	Average time < 1 s			
General public	10 kHz - 100 kHz	0.00045f	Average time: 6 min			
	100 kHz - 15 MHz	below 45 * f [Hz]	Average time: 6 min			

REFERENCE LEVELS FOR TIME AVERAGED CURRENT INDUCED IN ANY LIMB

Exposure category	Frequency range	Current (mA rms)	
Occupational	3 MHz - 300 MHz	below 100	Average time: 6 min
General public	3 MHz - 300 MHz	below 45	Average time: 6 min

(Source: WHO/EMF)

- **Russia**

REFERENCE LEVELS FOR STATIC ELECTRIC AND MAGNETIC FIELDS

Exposure category	E-field strength (kV/m)	B-field (mT)	B-field, ceiling (mT)	B-field, pacemekers (mT)			
Occupational	25	60	2000	1,0			
General public							

BASIC RESTRICTIONS FOR TIME VARYING ELECTRIC AND MAGNETIC FIELDS UP TO 300 GHz

Exposure category	Frequency range	Current density for head and trunk (mA/m2)	SAR (W/kg)	Power density (W/m2)	WE = E².T [V²/m².h]	WH = H².T [A²/m².h]	WS = S.T [□W/cm².h]
Occupational	30 kHz-3 MHz	N/A	N/A	N/A	20000	200	
	3 MHz-30 MHz				7000	-	
	30 MHz-50 MHz				800	0.72	
	50 MHz-300 MHz				800	-	
	300 MHz-300 GHz						200
General public							

* For rotating and scanning antennae 10 times higher values of the WE are allowed.

** For rotating and scanning antennae 10 times higher values of the WS are allowed.

*** On the basis of the energetic loading limits the maximal permissible times (in hours) of exposure are being calculated, as follows:

REFERENCE LEVELS FOR TIME VARYING ELECTRIC AND MAGNETIC FIELDS UP TO 300 GHz

(unperturbed rms values)

Exposure category	Frequency range	E-field strength (V/m)	H-field strength (A/m)	B-field (mT)	Equivalent plane wave power density (W/m2)		
Occupational	>0 Hz-100 Hz	25,000*		60/f			
	100 Hz-4kHz	2.5x106/f		60/f			
	4 kHz-60 kHz	625		60/f			
	60 kHz-3 MHz	500	50,0				
	3 MHz-10 MHz	300	-				
	10 MHz-30 MHz	300	-				
	30MHz-300 MHz	80	-				
	300MHz -300GHz				10,0**		
General public	30 - 300 kHz	25					
	0.3 - 3 MHz	15					
	3 - 30 MHz	10					
	30 - 300 MHz	3					
	0.3 - 30 GHz				0,10		

Note: For ELF indicate whether limit is a 'ceiling limit', 'short-term' or 'work-day' exposure

* For 50 Hz this is the ceiling limit; the work day limit (8 hours) is 5 kV/m. The time limitations between 5 and 25 kV/m are the following: up to 180 min for 5-10 kV/m; up to 90 min for 10-15

kV/m; up to 30 min for 15-20 kV/m, and up to 10 min for 20-25

** In the presence of ionizing radiation and/or high temperatures (above 28 C) maximal permissible exposure should be not more than 1 W/m2

*** Assessment of simultaneous exposure to different sources (more than one in the same place) of EMR or both to electric and magnetic fields is determined by the following relations:

where WE,i; WH,i; WE, WH are the measured dosimetric values; WElim,i, WHlim,I are the limits for dosimetric values for the corresponding frequency ranges.

****Exposure assessment of microwaves in case of multidirectional exposure is determined by summing the dosimetric values of the separate exposures.

REFERENCE LEVELS FOR INSTANTANEOUS CONTACT CURRENTS FROM POINT CONTACT WITH CONDUCTIVE OBJECTS

Exposure category	Frequency range	Maximum contact current (mA rms)					
Occupational		No					
General public		No					

REFERENCE LEVELS FOR TIME AVERAGED CURRENT INDUCED IN ANY LIMB

Exposure category	Frequency range	Current (mA rms)	
Occupational		No	
General public		No	

(Source: WHO/EMF)

- **United States**

BASIC RESTRICTIONS FOR STATIC ELECTRIC AND MAGNETIC FIELDS					
	Exposure category	E-field strength (kV/m)	B-field (mT)		
Occupational					
General public					

BASIC RESTRICTIONS FOR TIME VARYING ELECTRIC AND MAGNETIC FIELDS UP TO 300 GHz						
Exposure category	Frequency range	Current density for head and trunk (mA/m2)	Whole-body average SAR (W/kg)	Spatial peak SAR in the head & trunk (W/kg)	Spatial peak SAR in limbs (W/kg)	Power density (W/m2)
Occupational	0.3MHz-6GHz	N/A	0.4	8	20	
General public	0.3MHz-6GHz	N/A	0.08	1.6	4	

REFERENCE LEVELS FOR TIME VARYING ELECTRIC AND MAGNETIC FIELDS UP TO 300 GHz						
(unperturbed rms values)						
Exposure category	Frequency range	E-field strength (kV/m)	H-field strength (A/m)	B-field (mT)	Equivalent plane wave power density (W/m2)	AVG time (min)
Occupational						
	0.3-3.0 MHz	0.614	1.63		1000	6
	3.0-30 MHz	1.842/f	4.89/f		9000/f*2	6
	30-300 MHz	0.0614	0.163		10	6
	300-1500 MHz	n/a	n/a		f/30	6
	1.5-100 GHz	n/a	n/a		50	6
General public						
	0.3-1.34 MHz	0.614	1.63		1000	30
	1.34-30 MHz	0.824/f	2.19/f		1800/f*2	30
	30-300 MHz	0.0275	0.073		2	30
	300-1500 MHz	n/a	n/a		f/150	30
	1.5-100 GHz	n/a	n/a		10	30
NOTE: f = frequency in MHz						
Note: For ELF indicate whether limit is a 'ceiling limit', 'short-term' or 'work-day' exposure						

REFERENCE LEVELS FOR INSTANTANEOUS CONTACT CURRENTS FROM POINT CONTACT WITH CONDUCTIVE OBJECTS		
Exposure category	Frequency range	Maximum contact current (mA rms)
Occupational	n/a	

General public	n/a	
REFERENCE LEVELS FOR TIME AVERAGED CURRENT INDUCED IN ANY LIMB		
Exposure category	Frequency range	Current (mA rms)
Occupational	n/a	
General public	n/a	

(Source: WHO/EMF)

ANNEX III. ITU ISM REGULATION

RECOMMANDATION UIT-R SM.1056

LIMITATION DES RAYONNEMENTS PROVENANT DES APPAREILS INDUSTRIELS, SCIENTIFIQUES ET MÉDICAUX (ISM)

(Question UIT-R 70/1)

(1994)

L'Assemblée des radiocommunications de l'UIT,

considérant

a) que la Disposition N° 16 du Règlement des radiocommunications (RR) définit les utilisations ISM (de l'énergie radioélectrique) comme étant la mise en œuvre d'appareils ou d'installations conçus pour produire et utiliser, dans un espace réduit, de l'énergie radioélectrique à des fins industrielles, scientifiques, médicales, domestiques ou analogues, à l'exclusion de tout usage de télécommunication;

b) que les appareils ISM sont susceptibles de causer dans tout le spectre un brouillage préjudiciable aux services et équipements de radiocommunication;

c) que pour assurer l'utilisation optimale du spectre des fréquences, il convient de limiter les rayonnements provenant des appareils ISM fonctionnant hors des bandes qui leur sont désignées;

d) que la Conférence administrative mondiale des radiocommunications (Genève, 1979) (CAMR-79) dans sa Résolution N° 63, a invité l'UIT-R à spécifier, en collaboration avec la Commission électrotechnique internationale/le Comité international spécial des perturbations radioélectriques (CEI/CISPR), les limites à imposer au rayonnement des appareils ISM à l'intérieur et à l'extérieur des bandes qui leur sont désignées dans le RR;

– que des limites doivent être spécifiées dans toute la partie du spectre des fréquences radioélectriques attribuée aux services de radiocommunication;

– que le degré de protection nécessaire varie en fonction du service de radiocommunication concerné et qu'il convient de tenir compte, en matière de protection, des exigences particulières des services de sécurité et des communications relatives à la sécurité;

– que l'utilisation de l'énergie radioélectrique à des fins industrielles, scientifiques, médicales et domestiques profite à l'économie et aux consommateurs et qu'elle est dans certains cas indispensable;

e) qu'en raison des différents environnements dans lesquels les appareils ISM sont utilisés et des caractéristiques de ces appareils, il convient d'établir plusieurs catégories de limites;

f) que les services de radiocommunication fonctionnant dans les bandes désignées pour l'utilisation des appareils ISM avant la CAMR-79 doivent accepter les brouillages préjudiciables et qu'il convient de limiter le rayonnement dans toutes les autres bandes pour protéger les services de radiocommunication;

g) que l'élimination des rayonnements émis par les appareils ISM risque d'être coûteuse et techniquement difficile à réaliser, et que par conséquent, l'établissement d'exigences en la matière doit se faire en prenant en considération, pour éviter les mesures inutilement restrictives, les contraintes physiques, techniques, économiques, d'exploitation et de sécurité;

h) que les appareils qui respectent les limites imposées au rayonnement, qui sont le résultat d'un compromis, peuvent dans certains cas causer des brouillages préjudiciables, et qu'il convient d'envisager de prendre des mesures pour les réduire ou les éliminer au cas par cas;

j) que les règlements et les dispositions administratives varient d'un pays à l'autre et que par conséquent, chaque administration a ses propres modalités d'application des limites et de contrôle de leur respect;

k) que le CISPR a fixé des limites au rayonnement et a tenu compte des principes énoncés aux § f) et g) et des prescriptions en la matière pour harmoniser les procédures de contrôle des brouillages afin d'éliminer les obstacles techniques aux échanges;

l) que les risques de brouillage dépendent de l'endroit où l'appareil ISM est placé chez l'utilisateur et qu'il faut tenir compte, dans les mesures effectuées sur place, de la distance de mesure et de la position du point de référence;

m) que l'établissement, par différents organismes internationaux, de limites différentes pour la même catégorie d'appareils pourrait poser de graves problèmes, notant

1. que l'Annexe 1 indique les fréquences normalement utilisées par les appareils ISM correspondant aux diverses applications, ainsi que certaines des utilisations ISM actuelles et futures;

2. que l'UIT a désigné certaines bandes de fréquences pour les utilisations ISM, mais que d'autres fréquences sont également utilisées lorsque des contraintes d'ordre pratique ne permettent pas d'utiliser les bandes désignées;

3. que la Publication 23 du CISPR («Calcul des valeurs limites du matériel industriel, scientifique et médical») fournit des précisions sur les méthodes d'établissement des valeurs limites;

4. que les appareils de traitement de l'information (ATI) et les dispositifs d'éclairage qui fonctionnent aux fréquences radioélectriques ne sont pas assimilés par le CISPR à des appareils ISM et que les Publications 15 et 22 du CISPR contiennent un guide à utiliser pour l'application des limites et des méthodes de mesure,

recommande

1. aux administrations de s'inspirer de la dernière version de la Publication 11 du CISPR et de ses modifications, pour ce qui est des limites et des méthodes de mesure dans le cadre de la réglementation applicable aux appareils ISM destinée à protéger les services de radiocommunication;

2. de poursuivre la collaboration avec le CISPR pour faire en sorte que les besoins des services de radiocommunication soient pleinement pris en considération.

ANNEXE 1

Utilisations industrielles, scientifiques et médicales (ISM)

1. Introduction

On trouvera dans la présente Annexe la définition que l'UIT donne des utilisations ISM, une liste des fréquences normalement utilisées par les appareils ISM et une description de quelques-unes des utilisations ISM actuelles et futures.

2. Utilisations ISM

Aux termes du numéro 16 du RR, les utilisations ISM sont définies comme étant la mise en œuvre d'appareils ou d'installations conçus pour produire et utiliser, dans un espace réduit, de l'énergie radioélectrique à des fins industrielles, scientifiques, médicales, domestiques ou analogues, à l'exclusion de tout usage de télécommunication.

On trouvera ci-dessous une liste non exhaustive des utilisations et appareils ISM:

Appareils de chauffage par induction
(fréquences inférieures à 1 MHz)

- cuisson domestique par induction
- fusion des métaux
- réchauffage des billettes
- soudage de tubes
- soudure et brasage
- réchauffage des composants

- soudage par points
- traitement thermique sélectif de surface de pièces métalliques
- croissance et purification des cristaux semi-conducteurs
- collage par joints d'éléments de carrosserie automobile
- soudage des emballages
- réchauffage de feuillards d'acier pour la galvanisation, le recuit et le séchage des peintures

Appareils à chauffage diélectrique RF (1-100 MHz)

séchage des placages et du bois d'œuvre

séchage des textiles

séchage des fibres de verre

séchage du papier et des revêtements en papier

préchauffage des plastiques

soudage et moulage des plastiques

post-cuisson et séchage des denrées alimentaires

décongélation des viandes et des poissons

séchage à cœur en fonderie

séchage des colles

séchage des couches minces

polymérisation des adhésifs

préchauffage des matériaux

Appareils médicaux

appareils de diathermie et d'hyperthermie à ondes décamétriques et à ondes hyperfréquences

appareils chirurgicaux électriques

imagerie par résonance magnétique

imagerie par ultrasons

Appareils à hyperfréquences (900 MHz et plus)

fours à micro-ondes domestiques et commerciaux

réchauffage, décongélation et cuisson des aliments

durcissage des peintures et revêtements

vulcanisation du caoutchouc

produits pharmaceutiques

Appareils divers

appareils de soudure à l'arc à RF

appareils d'étincelage

Matériels de laboratoire et matériels scientifiques

générateurs de signaux

récepteurs de mesure

fréquencemètres

débitmètres

analyseurs de spectre

appareils de pesage

appareils d'analyse chimique

microscopes électroniques

alimentations à découpage (non incorporées à un appareil)

2.1 Utilisations actuelles

Les fréquences actuellement utilisées pour les applications ISM et autres applications hors du domaine des télécommunications couvrent une très large partie du spectre, et notamment des fréquences qui ne sont pas désignées par le RR. Certains appareils ISM fonctionnent à des fréquences avec une tolérance et une stabilité qui ne sont pas définies et d'autres utilisent des fréquences attribuées aux services de sécurité et aux services de radionavigation. On trouvera au Tableau 1 une liste non exhaustive d'appareils ISM utilisés dans certaines bandes de fréquences.

2.2 Utilisations futures

Les recherches sur l'utilisation de l'énergie électromagnétique pour les applications autres que les télécommunications destinées à améliorer les procédés industriels se développent de façon spectaculaire à travers le monde. Ces recherches ne sont pas limitées aux bandes de fréquences attribuées aux appareils ISM. Le choix de la fréquence sur laquelle va fonctionner un appareil donné tient compte de nombreux facteurs, entre autres:

- l'existence d'une source de puissance appropriée,
- le risque de brouillage radiofréquence et le coût de l'isolation électromagnétique,
- la sécurité,
- l'existence d'une fréquence ISM bien adaptée,
- l'optimisation de la fréquence en fonction de l'utilisation voulue.

Un certain nombre d'utilisations nouvelles sont porteuses, à la différence d'autres procédés, d'importants progrès économiques et sociaux, et aussi d'importantes économies en termes d'énergie et d'environnement.

TABLEAU 1

Appareils ISM utilisés actuellement

Fréquence (MHz)	Utilisations principales	Puissance RF (valeur type)	Nombre d'appareils en service (estimation)
Inférieure à 0,15	Chauffage industriel par induction (soudage et fusion des métaux) Nettoyage aux ultrasons (15-30 kHz) Applications médicales (imagerie par ultrasons)	10 kW-10 MW 20-1 000 W 100-1 000 W	□ 100 000 □ 100 000 □ 10 000
0,15-1	Chauffage par induction (traitement thermique, soudage des emballages, soudage et fusion des métaux) Diagnostics médicaux aux ultrasons	1 kW-1 MW 10-1 000 W	□ 100 000 □ 100 000
1-10	Diathermie chirurgicale (oscillateur à ondes amorties 1-10 MHz) Collage du bois et traitement du bois (3,2 et 6,5 MHz) Générateurs d'induction à tubes électroniques Production de matériaux semi-conducteurs Soudage stabilisé à l'arc à fréquences radioélectriques (oscillateur à ondes amorties 1-10 MHz)	100-1 000 W 10 kW-1,5 MW 1-200 kW 2-10 kW	□ 100 000 □ 1 000 □ 10 000
10-100	Chauffage diélectrique (la majorité des appareils fonctionnent dans les bandes désignées pour les appareils ISM (13,56, 27,12 et 40,68 MHz), mais nombre d'entre eux fonctionnent également sur les fréquences situées à l'extérieur de ces bandes) – Céramiques – Séchage à coeur en fonderie – Séchage des textiles – Produits industriels (livres, papier, collage et séchage) – Denrées alimentaires (post-cuisson, décongélation des viandes et des poissons) – Séchage aux solvants – Séchage et collage des bois (séchage des placages et du bois d'œuvre) – Séchage diélectrique général – Chauffage des plastiques (soudage en coquille et formage des plastiques) Applications médicales – Diathermie médicale (27 MHz) – Résonance magnétique (10-100 MHz dans de vastes locaux blindés)	 15-300 kW 15-300 kW 15-200 kW 5-25 kW 10-100 kW 5-400 kW 5-1 000 kW 1-50 kW (en général □ 5 kW) 100-1 000 W	 □ 1 000 □ 1 000 □ 1 000 □ 1 000 □ 1 000 □ 10 000 □ 100 000 □ 10 000 □ 1 000
100-1 000	Traitement des denrées alimentaires (915 MHz) Applications médicales (433 MHz) Générateurs de plasma RF Vulcanisation du caoutchouc (915 MHz)	□ 200 kW	□ 1 000 □ 1 000
Supérieure à 1 000	Générateurs de plasma RF Fours à micro-ondes domestiques (2 450 MHz) Fours à micro-ondes commerciaux (2 450 MHz) Vulcanisation du caoutchouc (2 450 MHz) Polymérisation aux ultraviolets à fréquences radioélectriques	 600-1 500 W 1,5-200 kW 6-100 kW	 □ 200 millions □ 1 000

Ces recherches portent sur les domaines suivants.

2.2.1 Chauffage par induction

Sans constituer une nouveauté, l'expérience acquise dans le domaine des générateurs à induction à haut flux peut être mise à profit pour la mise au point de certains procédés tels que:

l'affinage de matériaux semi-conducteurs à très haute pureté,

la fusion des métaux, notamment la fusion sous vide pour l'aérospatiale et l'automobile.

2.2.2 Chimie plasmatique

Les bandes des 27, des 915 et des 2 450 MHz utilisées par les appareils ISM, ainsi que d'autres fréquences, font l'objet de recherches dans les domaines suivants:

- croissance de cristaux,
- traitement et frittage des céramiques,
- traitement des matières premières.

2.2.3 Médecine

Des recherches sont en cours dans les domaines suivants:

- analyse chimique accélérée (2 450 MHz),
- traitement des cancers par irradiations locales (fréquences inférieures à 400 MHz (hyperthermie)),
- fixation des tissus,
- résonance magnétique (entre 10 et 100 MHz, salles spécialement protégées),
- traitement de l'hyperthermie.

2.2.4 Traitement des matériaux et des denrées alimentaires

- réchauffage de l'espace environnant (5 800 MHz),
- récupération de l'huile de schiste (fréquences inférieures à 10 MHz),
- destruction des déchets dangereux (hyperfréquences, par exemple 2 450 MHz),
- décongélation et cuisson industrielle (915, 2 450 et 5 800 MHz),
- séchage du linge (2 450 MHz),
- traitement des sols,
- stérilisation des déchets médicaux,
- pasteurisation et stérilisation des denrées alimentaires,
- traitement des déchets (13,56 et 2 450 MHz).

2.2.5 Transfert d'énergie.

La plupart des expériences relatives au transfert d'énergie se font aux hyperfréquences (par exemple 2 450, 5 800 MHz et plus):

- des expériences concernant les satellites de production d'énergie à partir de l'énergie solaire sont en cours (2 450 MHz et 35 GHz);
- transfert d'énergie vers un aéronef (2 450 MHz);
- chaussées «électrifiées»: stations de transfert d'énergie placées dans le revêtement de la chaussée permettant de recharger les batteries d'accumulateur des véhicules qui circulent au-dessus (915 et 2 450 MHz);
- systèmes de propulsion électromagnétique (fréquences inférieures à 1 MHz).

3. Niveaux de rayonnement dans les bandes désignées pour les utilisations ISM

3.1 Exposé des motifs

L'établissement de limites à l'intérieur des bandes utilisées par les appareils ISM permettra d'atteindre au moins cinq objectifs:

- maîtriser les effets biologiques;
- limiter les rayonnements hors bande afin de protéger les services de radiocommunication;

- limiter les rayonnements dans la bande afin de protéger les services de radiocommunication fonctionnant dans les bandes désignées pour les appareils ISM;
- limiter les rayonnements radioélectriques afin de protéger les services de radiocommunication fonctionnant dans les bandes adjacentes;
- limiter les rayonnements radioélectriques afin de protéger les services électroniques ou de radiocommunication fonctionnant au voisinage immédiat d'appareils ISM.

La fixation des valeurs limites et des méthodes de mesure, ainsi que des méthodes de contrôle du respect des limites relatives aux effets biologiques, ne relève pas de la compétence de l'UIT ni de celle du CISPR, et par conséquent, il n'a pas été possible de prendre en considération les effets biologiques pour fixer les limites à l'intérieur des bandes. Cependant, on a relevé que, dans de nombreux cas, le respect des limites imposées en matière d'effets biologiques n'a pas fait baisser de façon substantielle les niveaux de rayonnement aux distances de mesure du CISPR.

On notera que la réduction des rayonnements dans la bande n'a pas nécessairement pour effet d'abaisser les rayonnements hors bande qui peuvent même augmenter si l'on élimine les signaux dans la bande.

Les limites imposées pour les rayonnements dans la bande afin de protéger les services de radiocommunication fonctionnant à l'intérieur des bandes n'ont pas été prises en compte car les services à protéger n'ont pas été spécifiés. En outre, l'établissement de limites restrictives fera perdre une partie de leur utilité aux bandes ISM utilisées à des fins industrielles, ce qui aurait pour effet d'encourager l'utilisation d'appareils ISM dans les gammes de fréquences convenant mieux à leur fonctionnement, mais aussi de nuire au bon fonctionnement des services de radiocommunication.

La question de l'imposition, à l'intérieur des bandes, de limites destinées à protéger les services de radiocommunication fonctionnant dans des bandes adjacentes à celles désignées pour les appareils ISM, ou à protéger les équipements électroniques ou de radiocommunication situés dans le voisinage d'appareils ISM, peut être traitée de manière plus appropriée si on la considère sous l'angle de l'immunité des appareils. La meilleure solution consisterait à prévoir une distance suffisante de séparation ou à donner aux équipements concernés des caractéristiques d'immunité appropriées. Cependant, on ne peut calculer ni mettre en œuvre de telles caractéristiques que si l'on connaît les champs de force auxquels on aura affaire dans la pratique. A cette fin, on trouvera ci-dessous un tableau contenant les niveaux de rayonnement mesurés, établi à partir des données fournies par les différents pays.

3.2 Bandes désignées par l'UIT pour les appareils ISM et niveaux mesurés

On a mesuré, dans différents pays et en différents lieux, les niveaux de rayonnement produits par les appareils ISM dans les bandes qui leur ont été désignées (voir le Tableau 2).

TABLEAU 2

Niveaux des champs de force produits par les appareils ISM fonctionnant dans les bandes de fréquences qui leur ont été désignées par l'UIT

Bande de fréquences	Fréquence centrale	N° de la note de bas de page correspondante dans le Tableau des attributions de fréquences du RR de l'UIT	Fourchette des champs de force mesurés (dB(μV/m))(1)
6,765-6,795 MHz	6,78 MHz	524	80-100
13,553-13,567 MHz	13,567 MHz	534	80-120
26,957-27,283 MHz	27,12 MHz	546	70-120
40,66-40,70 MHz	40,68 MHz	548	60-120
433,05-434,79 MHz	433,92 MHz	661, 622 (Région 1)	60-120
902-928 MHz(2)	915 MHz	707 (Région 2)	60-120
2 400-2 500 MHz	2 450 MHz	752	30-120
5,725-5,825 GHz	5,8 GHz	806	Pas d'information
24,00-24,25 GHz	24,125 GHz	881	Pas d'information
61,00-61,50 GHz	61,25 GHz	911	Pas d'information

122-123 GHz	122,5 GHz	916	Pas d'information
244-246 GHz	245 GHz	922	Pas d'information

(1) Le champ considéré est celui qui est mesuré à 30 m de la plus proche façade du bâtiment dans lequel se trouve l'appareil ISM. On ne connaît donc pas la distance effective qui sépare l'appareil du point où la mesure est effectuée.

(2) 896 MHz au Royaume-Uni.