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Tort Aspects of Space Technology

Rathuel L. McCollum*

Introduction

Since man first observed the vastness of the universe, he has dreamed of exploring outer space. Directly involved in the use of missiles, rockets and man-made earth satellites is an enormous group of relevant legal problems.

A recent newspaper headline exemplifies a matter that has been of some concern to many persons. It reads:

Reveals Scores Died in Soviet Sputnik Tests

The story gave details supplied by a former Soviet corporal who claimed to be an eye witness to the disasters.

The purpose of this article is to examine the tort problems connected with space activities.

Basic Principles

To launch a satellite in an orbit around the earth it is necessary to supply the satellite with a tremendous amount of energy in order to attain the necessary height and velocity. This can be done by means of a rocket-driven vehicle but not by an air-breathing engine because the air necessary to sustain the ordinary engine does not extend to the heights to which a satellite must rise in order to be established in orbit.

A rocket vehicle consists of a motor housed in a fuselage, a container of propellant fuel and some kind of payload. The fuel undergoes a chemical reaction after being pumped into the motor. The gas produced in the combustion chamber of the motor is at a high pressure and temperature. As it expands through a nozzle and is forced out of the rear of the rocket at a high velocity the rocket is pushed at the same time in the opposite direction. The force (thrust) giving the rocket its propul-

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The opinions expressed in this article are those of the author and are not to be construed as the views of the National Aeronautics and Space Administration.

sive power is proportional to the velocity of the gas leaving the nozzle and the mass of gas ejected per unit time. In contradistinction to other types of vehicles, a rocket does not maintain a constant velocity. On the contrary, it is propelled by a burst of power in which the greatest possible speed is built up and then the rocket coasts in a ballistic trajectory or orbit. This is how a single stage rocket operates. However, rocket engineers have found it to be necessary to use multi-stage rockets in order to launch a satellite most efficiently. These stages can be separated in flight, so that as each one burns out it is dropped and the empty mass need not be lifted by the remaining ones. The final velocity of each stage becomes the starting velocity for the next one and hence the satellite can be boosted to the necessary height to go into orbit.

Launching the Rocket and Satellite

There is far more involved in launching a rocket and satellite than the suspenseful countdown, the climactic firing of the engines and the dramatic take-off of the vehicle. The assembly of a multi-stage rocket is a very complex and precise engineering job.

The over-all reliability of a complex system is a product of the reliability of the individual components. Each component reduces the over-all reliability by its own reliability factor. For example, a missile system which is composed of 100 components each having 99 per cent reliability would have an over-all reliability of only 36.5 per cent.

It is reported that rocket engineers agree that the most difficult thing about the operation of a rocket motor is reliable ignition. Propellant mixtures with high reaction rates are readily ignited with a normal spark plug by controlling the flow of fuel but too long an ignition delay can result in an accumulation of a large amount of unburned fuel in the combustion chamber causing a violent explosion which may result in loss of human life. Thus, it became necessary to find means of avoiding this explosive hazard and at the same time insure reliable ignition.

3 Lusser, supra, note 2.
4 Redding, Getting Missiles Off to a Good Start, 3 Astronautics 30 (April 1958).
5 Redding, supra, note 4.
While the preceding statements assumed the use of liquid propellants, the problems associated with the use of solid propellants also deserve considerable attention. It is now said that a solid propellant, which normally will not detonate, might become detonated when a certain size is exceeded. The conclusion is that the transition from burning to detonation is a physical condition rather than the chemical make-up of the propellant. Thus, as in the case of liquid propellants, the standards of care in the use of solid propellants must be extremely high in order to avoid both the costly loss of equipment and danger to the lives of those involved.

After the individual components have been checked and then assembled the missile is ready for firing. However, the technical and legal problems are still many and varied. Weather conditions must be checked thoroughly not only for the area of the launching site but also at the higher altitudes where the satellite-bearing missile will travel. If the wind velocity is too high, launching will be postponed.

A dangerous fuel leak could also halt the launching. It is also possible that the rocket may become ignited prematurely with the result that one or more stages may take off and explode nearby starting brush fires, or it may blow itself apart in flight due to the malfunction of a component such as the control system or the fuel system or other unknown causes. Furthermore, it may be necessary for a safety official to destroy the missile in flight if it veers off course. In each of these instances the protection of lives and property must be a prime consideration.

A successful launching of a satellite-bearing missile proceeds somewhat as follows: After a vertical take-off, the first stage of the rocket will accelerate the vehicle to a height of about 50 miles and a velocity of about 4000 miles per hour during which time the guidance system has tilted the missile so that it points generally in the direction of the orbit.

7 Von Braun, The Story Behind the 'Explorers,' This Week Magazine, April 13, 1958, p. 8.
8 Von Braun, supra, note 7.
9 Cleveland Plain Dealer, October 16, 1958, p. 1.
10 3 Astronautics 5 (March 1958).
11 4 Missiles and Rockets 157 (June 1958).
12 Cleveland Plain Dealer, October 9, 1958, p. 1.
13 Cleveland News, November 5, 1958, p. 18.
When the propellants in the first stage are consumed and burn-out occurs a device is actuated which separates the first and second stages. The first stage falls back toward earth and may land as far as 300 miles from the launching site. The second stage will then be fired and accelerate the remainder of the vehicle to a velocity of about 10,000 - 12,000 miles per hour and almost to orbital height from which it will coast farther upwards. During this time the guidance system has been used to put the vehicle on the proper course. Then the second stage is separated and it will fall towards earth. From this height of about 500 miles the velocity of the second stage may be so high that it will burn up due to friction. The third stage of the rocket is fired and pushes the satellite into orbit. The separation of the rocket from the satellite is made and also that of the satellite from its nose cone, if it has not been done before. It is worth noting here that the satellite and rocket both will orbit since they have obtained sufficient velocity and height. Even more important is the question of whether or not the nose cone of the satellite is separated before it attains orbital status. If it is not separated from the satellite before the orbit is reached then it also becomes a satellite. However, if it is separated before that time and begins to fall towards earth there should be nothing to prevent its successful descent through the atmosphere. After all its duty is to protect the satellite during its ascent. Therefore it is reasonable that a nose cone that is constructed to withstand the frictional heat of a climb through the air should make the return trip in the same manner. Thus it would be possible to make the descent safely several hundred miles from the launching site with all of the attendant legal consequences.

The Satellite in Orbit

Once a satellite is established in orbit the question arises as to jurisdictional authority of sovereign states over which it passes. This particular issue is the source of scores of legal articles, in fact it seems that more has been written on "space law" jurisdiction than all of the other associated problems combined.

14 Flight Magazine, October 18, 1957, p. 611.
The central theme in all of these views seems to be a necessity for drawing an imaginary line below which each nation will exercise sovereignty. There are differences as to where the line should be drawn. However, this writer believes it to be far more practical to define jurisdiction in terms of activity. For example: An air vehicle can be guided in certain paths and hence observe jurisdictional lines. But an unmanned, uncontrolled satellite is entirely oblivious of any question of jurisdiction and simply follows its orbit. Until the time arrives when satellites can be controlled it is futile to attempt to establish arbitrary jurisdictional areas. While the passage of a satellite over another nation without its permission may be a trespass, no nation has yet protested such actions even though it was well known that attempts would be made to launch earth satellites during the International Geophysical Year. 16

One of these legal problems is that involved in the use of radio frequencies for communications with a space vehicle. Haley 17 has given the matter considerable attention. He points out that at present, no radio frequencies are set aside solely for the use of space vehicles or point-to-point communications between earth and positions in space.

Nevertheless, the Soviet Union has used the frequencies 20.005 megacycles and 40.002 megacycles for the Sputniks, ignoring the fact that they have been set aside for specific uses by international agreement. A threat to safety of property and life could be the result of improper use of these frequencies inasmuch as they are used for calibration and aeronautical services. It has been pointed out that the United States has specifically "cleared" the use of two frequencies, 108 megacycles and 137 megacycles, with the nations of the world. Thus the American Rocket Society takes the position that the current use of any part of the spectrum for space flight communications "is not primary or exclusive, or indeed in some instances lawful." 18

Satellite tracking teams have become concerned about the need for additional frequencies for space flight missions. A satellite carrying a transmitter powered by solar batteries could tie up one frequency for many years. 19

In the present state of space activities one problem con-

18 Haley, supra note 17.
19 3 Astronautics 6 (June 1958).
cerning the satellite in orbit has had very little attention. The probability of satellite collisions must be faced sooner or later. This means that some type of control of orbiting satellites needs to be had especially if manned satellites are to be used. Human reactions are far too slow to allow anyone aboard to attempt the guiding of a vehicle traveling at 18,000 miles per hour. It would be gross negligence to depend on this type of guidance. Thus, the use of electronic guidance mechanisms (i.e. remote control) is almost assuredly a step in the right direction.20 In fact before human lives are risked in a satellite, means must be found to control the movements of the unmanned satellite.

Satellite Reentry into the Atmosphere

The recovery of artificial satellites is far more difficult to achieve than launching and orbiting them. This is due to the intense aerodynamic heating that occurs as a satellite reenters the earth's atmosphere. As of this writing every space vehicle that has fallen from orbit into the heavy air blanket surrounding the earth has become a fiery mass and was destroyed. Sputnik II was reported to have been seen in flames over the West Indies and probably came to its end in the jungles of Brazil.21 There was no report of any damage in the jungle but it could just as well have fallen in a densely populated area causing considerable damage to property and injury to persons. A satellite falling through the earth's atmosphere may be likened to a meteorite and the probabilities of striking an object on earth compared.22

Northrup Aircraft Inc. has announced plans for launching into orbit a recoverable manned satellite laboratory.23 The vehicle would be a bullet-shaped capsule. While still orbiting the vehicle would be turned by a control mechanism so that its blunt end faced forward. This would cause a slowing down due to high drag and reverse-thrust rockets (retro-rockets) would cause further reduction in velocity. Then reentry into the earth's atmosphere would be made at a shallow angle keeping the rate of

21 Cleveland News, March 14, 1958, p. 4.
23 4 Missiles and Rockets 200 (June 1958).
heating and deceleration at desirable levels. A parachute would open at a lower altitude for a gentle landing of the vehicle.

As commendable as this ambitious plan is, at present we are still confronted with the problem of meteor-like satellites falling earthward.

**General Discussion**

The need for international agreement on the legal problems posed by space technology cannot be overemphasized. Satellites orbiting the earth have ushered in what has been called the Age of Space.\(^2\) The scientists and engineers have left the international lawyers far behind in this respect. The conservatism of the law may have its good points in numerous instances, but when new situations arise that have no reasonable analogy to any other, conservatism should not become an excuse for failing to keep up with the times. By its very nature space technology is an international affair and specific international law is required to meet the problems involved. Otherwise chaos and confusion may result from a multiplicity of national interpretations of just what the law is. Attempts to reason by analogy from other bodies of law such as admiralty law or aviation law are doomed to failure because the problems are not the same. If aviation is so different from land movement that a new body of law was deemed necessary, then certainly satellite movement is so different from that of aircraft that new law is necessary for this type of activity.

Space technology encompasses every facet of science and engineering necessary for the successful flight through space. It includes man, aircraft, space vehicles, missiles, launching sites and all of the associated equipment required for the exploration of the universe. Problems unlike those within previous experience must be solved. In carrying on his space activities, man must deal with the basic laws of nature. Since a space vehicle must first leave earth before reaching space it seems only reasonable to consider the aerodynamic forces that act upon it during its flight. Not even Solomon with all of his wisdom could say exactly where the earth's atmosphere ends and space begins. There is no definite line of demarcation between aeronautics and astronautics. It is certain, though, that before earth-man can become an astronaut he must first become an aeronaut. Should a system of law covering

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space technology be less inclusive than the subject matter? It
would be futile indeed to attempt to compartmentalize an issue
that is as vast as the universe.

A rule of torts is that an actor is liable if his actions were
the proximate cause of the loss suffered, i.e., if such loss was the
result of consequences which follow in a sequence from the effect
of the act upon conditions existing and forces already in operation
at the time, without the intervention of any external forces
which come into active operation later.25

The leading case involving the doctrine of strict liability or
liability without fault for abnormal activities is Rylands v.
Fletcher.26 Water from the defendants' reservoir flooded into the
plaintiff's adjoining mine. In holding the defendants liable for
the damage, Lord Cairns used the principle of "non-natural use"
of land. Lord Cranworth, concurring, stated, "In considering
whether a defendant is liable to a plaintiff for damage which the
plaintiff may have sustained, the question in general is not
whether the defendant has acted with due care and caution, but
whether his acts have occasioned the damage."27 Furthermore,
one in possession of land is required to exercise reasonable care
with regard to any activities that he carries on so as to protect
those outside his premises.28 This brings the question of damage
by a satellite into sharp focus. Launching a space vehicle, per se,
involves an activity which cannot be held within the close of the
possessor of the land. Thus the matter of where the satellite
lands upon its return to earth is extremely important. If it falls
on the property of another person and causes damage, that tort
problem must be faced either on an international basis or on a
domestic basis. The problems involved in the two instances are
alike in some respects and quite different in others.

Claims Against a Foreign Power

Consider the unfortunate person who is injured or whose
property is damaged by a falling satellite, which was launched by
a country other than his own. What is his measure of recovery,

26 L. R. 3 H. L. 330 (1868).
27 Rylands v. Fletcher, supra note 26, at 341. See Oleck, Damages to Persons
and Property, (1957 revision) and Oleck, Negligence Forms of Pleading,
(1957 revision).
28 Prosser, supra note 25, at 428.
if anything? Suppose that the tort-feasor refuses to waive its sovereign immunity to permit the claimant to sue. Without an international agreement on space technology covering the subject of damages, much grief can come to innocent parties. It seems to this writer that the answer to this problem should be embodied in a code of international law of space technology. Justice demands that an injured claimant should have a remedy for his loss and it would be manifestly unconscionable that he should be made to suffer simply because of the lack of a procedure to litigate the claim.

Claims Against the United States

A person in the United States who suffers personal injuries or property damage as a result of our space activities has a choice of remedies against the Federal Government.

Judicial Remedy

In 1946 the United States waived its sovereign immunity to lawsuit by means of the Federal Tort Claims Act. This consent to be sued is embodied in Section 1346 (b) of the Act as follows:

Subject to the provisions of chapter 171 of this title, the district courts, together with the District Court for the territory of Alaska, the United States District Court for the District of the Canal Zone and the District Court of the Virgin Islands, shall have exclusive jurisdiction of civil actions on claims against the United States, for money damages, accruing on or after January 1, 1945, for injury or loss of property, or personal injury or death caused by the negligent or wrongful act or omission of any employee of the Government while acting within the scope of his office or employment, under circumstances where the United States, if a private person, would be liable in accordance with the law of the place where the act or omission occurred.

This Act makes the United States liable for negligent acts or omissions under local law where the acts or omissions occur and not where the injury or damage occurs. Thus, it is important to look to the law of the places where space technology facilities are located. The following such jurisdictions have approved the principle of strict liability as enunciated in Rylands v. Fletcher:

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California,\textsuperscript{30} the District of Columbia,\textsuperscript{31} Maryland,\textsuperscript{32} Ohio\textsuperscript{33} and the Second Circuit of the United States Court of Appeals.\textsuperscript{34}

The fact that certain jurisdictions approve the doctrine of \textit{Rylands v. Fletcher} does not mean that the United States will be held strictly liable for damages as a result of government activity in said jurisdictions.

In the leading case, involving the Texas City Disaster,\textsuperscript{35} a suit was filed against the United States, under the Federal Tort Claims Act, for damages resulting from the explosion of some ammonium nitrate fertilizer. The material was manufactured for and under the direction of the Government and the accident occurred while it was being loaded for export. In a four to three decision, with two justices not participating, the Supreme Court ruled that liability does not arise by virtue either of United States ownership of an "inherently dangerous commodity" or property, or of engaging in an "extra hazardous" activity and since the Act requires some brand of misfeasance or malfeasance it could not extend to liability without fault.\textsuperscript{36}

Justice Jackson, joined by Justices Black and Frankfurter, dissented. He wrote:

The government, as landowner, as manufacturer, as shipper, as warehouseman, as shipowner and operator, is carrying on activities indistinguishable from those performed by private persons. In this area, there is no good reason to stretch the legislative intent to immunize the Government or its officers from responsibility for their acts, if done without appropriate care for the safety of others. . . . Surely a statute so long debated was meant to embrace more than traffic accidents. If not, the ancient and discredited doctrine that "The King can do no wrong" has not been uprooted; it has merely been amended to read "The King can do only little wrongs."\textsuperscript{37}

\textsuperscript{30} Kall v. Carruthers, 59 Cal. App. 555, 211 Pac. 43 (1922).
\textsuperscript{34} Norfolk and Western R. R. Co. v. Amicon Fruit Co., 269 F. 559 (4 Cir. 1920).
\textsuperscript{35} Dalehite v. United States, 346 U. S. 15, 73 S. Ct. 956, 97 L. Ed. 1427 (1953).
\textsuperscript{36} Id., 346 U. S. at 45, 73 S. Ct. at 972, 97 L. Ed. at 1445 (1953).
\textsuperscript{37} Id., 346 U. S. at 60, 73 S. Ct. at 980, 97 L. Ed. at 1453-54 (1953).
It is apparent then, that the proof required to sustain a claim against the United States under the F. T. C. A. must show negligence on the part of some employee of the Government. A litigant claiming damages from a space vehicle may be faced with an extremely difficult task in showing specific negligence. That would require extensive knowledge in the fields of rocket engineering and astronautics. The resort to *res ipsa loquitur* could be overcome by the defense simply proving with scientific evidence that due care was exercised during all phases of the satellite preparations. At the present stage of the art, a plaintiff would indeed have a formidable obstacle to overcome in order to show the contrary.

Still another problem is that of liability for the negligence of an independent contractor who does work on space projects for the Government. Can a plaintiff prevail under the Federal Tort Claims Act in a suit for damages as a result of such negligence? In a recent case action was brought against the United States for the death of an employee of a private corporation operating an ammunition depot for the Government under a cost-plus arrangement. The plaintiff pleaded that the work was "inherently dangerous" and that the Government could not escape liability by delegating the work to an independent contractor. However, the court rejected this contention, stating:

The Supreme Court has interpreted the Tort Claims Act "to require a clear relinquishment of sovereign immunity to give jurisdiction for tort actions." By its terms the Act is specifically limited to claims based upon negligent or wrongful acts or omissions of "any employee of the Government," and there is nothing in the Act to indicate that Congress intended to extend liability of the United States to actions founded upon negligent or wrongful acts or omissions of employees of independent contractors. . . . Therefore, liability under the Act cannot be predicated upon the alleged negligence of an independent contractor and employees are not employees of the United States.

It follows that before the United States can be held liable under the Act, the plaintiff must show that the negligent or wrongful act or omission was committed by one whose relation to the Government is that of a servant. If the master-servant

relationship does not exist the United States does not consent to be liable.\textsuperscript{41}

\textit{Non-Judicial Remedies}

The Federal Tort Claims Act provides for administrative settlement of claims against the United States amounting to $1,000 or less.\textsuperscript{42} Still, the claim must be based on negligence or wrongful act or omission of a Government employee.

A remedy touching directly on space technology is found in the \textit{National Aeronautics and Space Act of 1958},\textsuperscript{43} which created the National Aeronautics and Space Administration (NASA). It provides:

In the performance of its functions the Administration is authorized—to consider, ascertain, adjust, determine, settle, and pay, on behalf of the United States, in full satisfaction thereof, any claim for $5,000 or less against the United States for bodily injury, death, or damage to or loss of real or personal property resulting from the conduct of the Administration's functions as specified in subsection (a) of this section, where such claim is presented to the Administration in writing within two years after the accident or incident out of which the claim arises; and if the Administration considers that a claim in excess of $5,000 is meritorious and would otherwise be covered by this paragraph, to report the facts and circumstances thereof to the Congress for its consideration.\textsuperscript{44}

This provision does not require a claimant to plead any negligence on the part of anyone. The Congress, in writing the Space Act was cognizant of the substantial questions of international and local law raised by astronautics.\textsuperscript{45}

\textbf{The International Outlook}

As this is being written, the American Bar Association's Committee of World Peace through Law is concluding the first of a series of regional meetings.\textsuperscript{46} The goal of this group is a world conference of lawyers to formulate an international code of law.

\textsuperscript{42} 28 U. S. C. A., Sec. 2672.
\textsuperscript{43} 72 Stat. 426.
\textsuperscript{44} 72 Stat. 429-431.
\textsuperscript{46} Cleveland Plain Dealer, March 28, 1959, p. 15.
It is encouraging to note that they are placing emphasis on the interrelation of law and science.

Conclusions

The only practical approach to the solution of legal problems raised by space technology is by international agreement. The exigencies of the matter make it necessary that agreement be reached pro re nata. Continued delay could make it more difficult to resolve the various different national views.

Any effective system of space law must include all of the phases of space technology, not just those of flight. These principles of law must consider (a) the status of launching sites, be they fixed or mobile, (b) the status of satellites wherever they may be and (c) question of control of satellite movements. The prime considerations should be the scientific and engineering principles involved rather than legal theory based on past experience. The problems raised are prima impressionis and must be dealt with as such.

Participation of the nations of the world in the International Geophysical Year program and failure of any nation to object in advance to the passage of man-made satellites over its territory indicates that they have assented to such peaceful flights.

Only national governments (through their authorized agencies) should be permitted to engage in launching space vehicles. The very nature of space technology involves international relations.

Liability for damage caused by a satellite should attach to the nation launching it irrespective of the identity of the party suffering the loss, the place where such loss occurs, or the elapsed time between the launching of the vehicle and the ensuing damage.