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Atomic Energy and World Trade

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ATOMIC ENERGY AND WORLD TRADE

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INTRODUCTION

A few basic facts will determine the pattern of world trade and investment in atomic energy over the next decade. These facts pertain on the one hand to the nature of atomic energy itself and on the other to the environment in which atomic development is taking place. Other facts having to do with the atom and its environment will decide the significant problems, both lay and legal, with which international atomic trade and development will have to contend during this period. Necessarily treatment of such a broad topic as world atomic trade must be cursory in the extreme, and some rough and ready paring of the subject to match the limitations of space is required. Accordingly, there is no attempt here to discuss trade in raw materials or by-product materials. And there is no discussion of the important trade in research, test, or special purpose reactors. Attention is focused exclusively on nuclear reactors for power, which is the heart of the matter. Moreover, most of the discussion is limited to trade between the United States on the one hand and Western Europe and Japan on the other. Other areas, such as Brazil and India, which are on the threshold of industrialization, have acute needs for energy and may be expected to need significant amounts of atomic goods and services in the future. It is not to belittle these prospects to observe that they are not for the time being significant compared with the needs of Western Europe and Japan. I have not ignored, but have deliberately disregarded potential trade between the U.S.S.R. and its satellites, or between the Soviet bloc and other areas. It is too early to talk intelligently about such possibilities.

In what follows an attempt is made first to arrive at an estimate of the pattern and the volume of trade in atomic equipment and services in the areas and for the period under discussion (1960-1970); and then a brief survey is attempted of the principal problems affecting this trade. Most of what is discussed is not the usual stuff of a legal periodical. But it will be apparent that a great deal of it has important implications for lawyers and lawyering. In any case one may be forgiven, perhaps, for trying to describe in skeletal form the context in which a large volume of important legal transactions of interest to lawyers in the atomic field will take place during the next decade.

THE NATURE OF THE DEMAND FOR NUCLEAR POWER

The Need for Energy: The primordial fact shaping the form of international atomic trade is the burgeoning increase in demand for energy

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all over the world, brought about by a worldwide exploding population growth and a marked trend everywhere towards increased industrialization. There have been estimates that half as much energy in all forms was consumed in the century ending in 1950 as had previously been consumed in all previous centuries, and that between 1950 and 2000 A.D. the world would need as much again as in preceding eras.[1] An over-all rate of growth in need for energy of approximately three per cent a year has been estimated for the world as a whole. This would mean a doubling of requirements by 1975 and a four to five-fold increase by the year 2000.[2]

In already heavily industrialized areas such as the United States, Western Europe and Japan the increase in demand for electrical energy, as distinct from other forms, is even more remarkable. A commonly accepted rule of thumb holds that in these areas demands for electricity are presently doubling every ten years.[3] It is estimated that the consumption of electricity in Western Europe will be 982 billion kilowatt-hours (982 twh)[4] by 1970, requiring installed electrical generating capacity of about 246 million kilowatts (246 gw).[5] This compares with a current United States production of 631 twh and generating capacity of 135 gw.[6]

The Uses of Nuclear Power: A second basic fact shaping world atomic trade, but one often overlooked, is that the atom, regarded as a source of energy, is at present almost exclusively suited for the production of base load electricity in large central power stations. The consequence of this fact is that nuclear power cannot in the next few decades play much of a role in meeting the energy needs of underdeveloped areas, but will be chiefly used to fill the growing "energy gap" in industrial areas such as Western Europe and Japan.[7]

1. PUTNAM, ENERGY IN THE FUTURE 231 (1953).

2. Mason, *Energy Requirements and Economic growth,* 5 NATIONAL PLANNING ASS'N (1955).

3. ORGANIZATION FOR EUROPEAN ECONOMIC COOPERATION [OEEC], SOME ASPECTS OF THE EUROPEAN ENERGY PROBLEM 14 (1955), a report prepared for the OEEC by Mr. Louis Armand.

4. A terawatt hour represents about the annual output of one 150,000 watt power station with a load factor of about 80%.

5. OEEC, THE ELECTRICITY SUPPLY INDUSTRY IN EUROPE 1957-1975 34 (1958), a study of the Electricity Committee of the OEEC. By Western Europe is meant the area of the Seventeen member countries of the Organization for European Economic Cooperation, which includes the United Kingdom but does not include Spain. The seventeen countries are: Austria, Belgium, Denmark, France, Western Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland, Turkey, United Kingdom.

6. Figures supplied by the Edison Electric Institute, 750 Third Avenue, New York, N. Y.

7. Opening address of Francis Perrin, French High Commissioner for Atomic Energy, before the International Conference on Atomic Energy held at Geneva, Switzerland, in September, 1958. See NETSCHERT & SCHURR, RESOURCES FOR THE FUTURE 54-56 (1957); Mason, *supra* note 2, at 21.

The reasons for this are not hard to see. First of all, nuclear power stations have got to be large to be economical. This is because the inherently expensive nature of many of the elements of a reactor (*e.g.*, the pressure vessel, control equipment) requires that costs be spread over as many kilowatts of capacity as possible. Secondly the establishment of large power stations of any kind requires considerable capital. Capital costs of nuclear power stations are presently estimated at around $300-$350 per kilowatt of installed capacity, or roughly twice the capital required for modern conventional stations.[8] A 100 mw nuclear power station, which is not overly large by modern standards, would therefore cost $30-$35 million. Even if fuel is produced locally, several million dollars of additional capital will be required to cover fuel production. Moreover, there is a sizeable foreign exchange component in almost any power installation, at least for all but heavily industrialized areas. The experience of the World Bank has been that anywhere from 35 to 70 per cent of the total capital required for installation of conventional power stations in underdeveloped areas must be imported.[9] Furthermore if fuel must be imported rather than produced locally, as will be the case in underdeveloped areas for nuclear stations as well as thermal stations fueled with coal or oil, the continuing foreign exchange requirements will be substantial.

Since underdeveloped areas are almost by definition areas which lack capital and foreign exchange, it can be seen that the construction of large power stations, and especially nuclear power installations, will be a difficult matter for them. These difficulties are enhanced by another frequently overlooked implication of the high capital cost of nuclear power stations. This is simply that nuclear stations must be run with as high a degree of continuity as possible in order for the kilowatt cost to fall within the range of costs of electricity generated at conventional stations. In the jargon of the electrical world, nuclear power stations must operate at a much higher load factor than conventional stations to be economical. Since demand for electricity is by nature fluctuating, nuclear stations are best suited to the production of electricity to meet that steady demand, called the base load, which continues night and day throughout the year. For the large central power station for which nuclear stations are suited this requires the established electrical power grid of a highly industrialized area. Except in special cases it is impractical to employ nuclear reactors at independent power stations with a necessarily fluctuating load.

8. For discussions of latest cost estimates of nuclear plants under construction in the United States, see *The Proceedings of a Conference Sponsored by the Atomic Industrial Forum and the National Industrial Conference Board,* MANAGEMENT AND ATOMIC ENERGY 348-63 (1958).

9. Mason, *supra* note 2, at 25.

We find ourselves therefore in a situation today where the principal demand for nuclear power is bound to come from those industrialized areas of the world where there is a scarcity of conventional fuels. And this comes down pretty much to Europe and Japan. Both the United States and the Soviet Union are plentifully supplied with cheap resources of coal, oil and falling water and do not have a pressing need for power from nuclear fuels at this time. Europe and Japan on the other hand face an acute shortage of electrical energy, at least at reasonable prices, unless they take extraordinary measures pretty soon.[10] The current costs of producing electricity in Western Europe from new conventional stations are estimated at around 11 to 12 mills per kwh, and these costs will gradually increase.[11] The equivalent range for Japan is about 10 to 12 mills per kwh.[12] Since electricity from nuclear reactors can undoubtedly be produced right now in the range of 10 to 14 mills per kwh,[13] and since we may be confident that these costs will steadily decrease, it is clear that nuclear power will soon be competitive in Europe and Japan with the most modern thermal facilities of conventional type. It is worth calling attention here to another fact peculiar to atomic power: whereas in a particular conventional power station generating costs may be expected gradually to increase with the age of the system, in a nuclear station lower costs may be anticipated with time as new improved cores are substituted for old.

Furthermore, in both Europe and Japan, coal is only available at ever-increasing cost and indigenous resources of oil are limited,[14] so that increasing reliance now has to be placed upon imported fuels, at the price of an increasing strain upon external balance of payments. Since the unique promise of nuclear technology is minimal fuel cost, the promise of reducing fuel imports is in itself a powerful incentive toward the exploitation of nuclear energy in Europe and Japan.

10. For Europe, see OEEC, SOME ASPECTS OF THE EUROPEAN ENERGY PROBLEM (1955). See also OEEC, EUROPE'S GROWING NEEDS FOR ENERGY—HOW CAN THEY BE MET? (1956); Armand, Etzel and Giordani, *A Target for Euratom,* a report submitted in 1957 at the request of the governments of Belgium, France, German Federal Republic, Italy, Luxembourg, and The Netherlands. Not published. For content of the report, see N. Y. Times, May 8, 1957, p. 1, col. 1. For Japan, see Sapir and Van Hynning, *The Outlook for Nuclear Power in Japan,* 6 NATIONAL PLANNING ASSOCIATION (1956). See also *Proceedings of Conference on Peaceful Uses of Atomic Energy, Japan and U. S. Atomic Industrial Forums* (1957).

11. *Target for Euratom, ibid.*

12. Sapir and Van Hynning, *The Outlook for Nuclear Power in Japan,* NATIONAL PLANNING ASSOCIATION 6 (1956).

13. See *Proceedings, AIF-NICB* Conference, *supra* note 8, at 348; *Proceedings of Conference on Peaceful Uses of Atomic Energy, Japan and U. S. Industrial Forums* (1957).

14. OEEC, EUROPE'S GROWING NEED FOR ENERGY (1956); Sapir and Van Hynning, *The Outlook for Nuclear Power in Japan,* 6 NATIONAL PLANNING ASSOCIATION (1956); Japan and U. S. Industrial Forum, *op. cit. supra* note 13.

Finally the experience of Suez has driven home to the Europeans their precarious dependence upon oil from the Middle East, and this lesson has certainly not been lost upon the Japanese.

In recognition of their acute need to exploit fully the potential of nuclear power the Western European nations have already undertaken joint efforts to assure atomic development. A European Nuclear Energy Agency has been formed under the auspices of the Organization for European Economic Cooperation (OEEC). Among other things this agency is charged with encouraging collective efforts to establish nuclear facilities in the OEEC area.[15] The six nations of France, Germany, Italy, and the Benelux countries have formed the European Atomic Energy Community (Euratom), a "supranational" organization possessing many attributes of sovereignty. As recounted elsewhere in this symposium, Euratom, established in January 1958, has already entered into arrangements with the United States Government for a major joint research and development program and a joint program for the construction of approximately six large nuclear power stations having a total capacity of 1,000,000 kilowatts (1 gw), the entire lot to be completed by 1963, or at the latest 1965.[16] This joint reactor program is considered to be only a forerunner to a more comprehensive joint program to be undertaken later.

Military Significance of the Atom: Another significant fact determining the pattern of world trade in atomic energy is the military significance of the atom. This has a number of consequences, the chief of which lies in the past. The military importance of the atom led to tremendous atomic development programs in the United States and later in the United Kingdom. The United States spent over $13.8 billion between 1940 and 1956 in the development of atomic energy for military and peaceful purposes.[17] The consequence is that the United States and Great Britain are the principal reservoirs of trained manpower and technological know-how in the atomic field today, at least in the western world. For a time therefore those countries that require atomic power will have to obtain atomic equipment and services and technological knowledge from the United States and the United Kingdom. At the same time, energy needs being as fundamental as they are in modern societies, there is a natural propensity on the part of the energy deficient areas to strive for self-sufficiency as soon as possible. It is therefore to be expected that the technological advan-

15. OEEC, FIRST REPORT OF THE STEERING COMMITTEE FOR NUCLEAR ENERGY, Annex IV (1958); TREATY ESTABLISHING THE EUROPEAN ATOMIC ENERGY COMMUNITY, March 25, 1957.

16. Euratom Cooperation Act of 1958, 72 Stat. 1084 (1958). See also *Proposed Agreement for Cooperation Between the United States and Euratom,* H. R. Doc. No. 441, 85th Cong., 2d Sess. (1958).

17. AEC SEMIANN. REP. [Financial] (1956).

tage of the United States and the United Kingdom will be shortlived. This likelihood is enhanced by the declared readiness of the United States under its Atoms-for-Peace program to share its atomic technology freely with other friendly nations.[18]

THE NATURE AND EXTENT OF ATOMIC TRADE

In the light of the facts outlined above it is possible to predict that over the decade 1960-1970 the primary current of world atomic trade will flow from the United States and the United Kingdom into Europe, and that there will be a secondary, but smaller volume from these same countries to Japan. This trade will probably reach a peak during the latter half of the decade and thereafter rapidly wane as Europe and Japan develop their own technology and resources.

The Quantity of Trade

In the following pages an attempt will be made to quantify roughly the extent of the exports of atomic equipment, materials and services that will move from the United States to Western Europe and Japan between now and 1970.

It was noted above that Western Europe will probably have about 246 gw of electrical generating capacity of all forms by 1970.[19] In order to reach this level about 88 gw of new thermal plant will need to be installed, including replacement of obsolete facilities.[20] It is unlikely that more than a minimum amount of electricity will be generated in Western Europe from nuclear fuels before 1962, but after that they will replace thermal fired stations to a greater and greater extent. The OEEC has estimated that some 25 gw in nuclear capacity will have been established in the OEEC area by 1970, and that from that point on virtually all power installations will be nuclear.[21]

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18. Address of the President of the United States before the General Assembly of the United Nations, December 1953. See also Atomic Energy Act §§ 123, 124, 68 Stat. 919 (1954), 42 U.S.C. §§ 2153, 2154 (Supp. V, 1958).

19. OEEC, SOME ASPECTS OF THE EUROPEAN ENERGY PROBLEM 34 (1955). A good part of this plant will be in the form of thermal facilities fired by coal, oil or nuclear fuels. It is estimated that a total capacity of about 166 gw in thermal plant will be reached by 1970. To reach this level obsolete units will have to be replaced to the extent of about 10% of new units laid down, besides net additions to plant.

20. *Id.* at 37.

21. *Id.* at 39. The estimate of 25 gw of nuclear plant by 1970 may fall short of what is in fact achieved. The so-called Three Wise Men, appointed in 1953 to consider the nuclear power program of the about-to-be established European Atomic Energy Community, set 15 gw as a target by 1967 for the six countries of Euratom alone. See *A Target for Euratom*, *op. cit. supra* note 10. Under this assumption one might obtain for all the OEEC countries an installed nuclear capacity of 15 gw by 1965 and 40 gw more by 1970. Most people regard the achievement of this Euratom target as hardly possible, however, and even Mr. Armand, one of the Three Wise Men and since appointed President of the Euratom Commission, has conceded that achievement

The British have laid down a target of 6 gw of nuclear plant by 1965,[22] and it is reasonable to suppose that half the nuclear plants established in the OEEC area by 1970 will be in the United Kingdom. This is important since it is assumed for purposes of this discussion that essentially no goods or services from the United States will go into the nuclear power program of the United Kingdom. On the estimates made above, therefore, about 12.5 gw would be laid down in continental Europe by 1970. Of this by far the largest part would be established in the Euratom area—in all likelihood about 11 gw of the total. In any case these figures will be assumed in estimating the dollar magnitude of the atomic equipment, materials, and services that will be provided from the United States to Europe in the next ten to twelve years.

In all likelihood the European market will be shared during the next decade or so by the following main types of proven reactors: the light water cooled, the organic moderated (in both of which the United States is pre-eminent), and the gas cooled, which is the mainstay of United Kingdom technology and of many European programs. Other concepts including the heavy water moderated and, to a much lesser extent, the sodium cooled systems, will probably be included in the latter part of this period.[23] It is assumed for the purposes of the following estimates that none of the goods and services used in the installation of gas cooled reactors will be supplied from the United States. The components and services which will have to be imported in order to construct water cooled reactors will be imported exclusively from the United States and in the case of heavy water systems, to the extent of about 60 per cent from the United States.

Under these assumptions, it is estimated that the "reactor-mix" which will be established in Western Europe by 1970 will be as follows:

Light water & organic moderated	5 gw
Gas cooled	5 gw
Heavy water	2 gw
Other	.5 gw

This gives about 6.5 gw of plant capacity for which American concerns would supply the import requirements.[24]

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of the Euratom 15 gw target by 1967 is unlikely. See ATOMIC INDUSTRIAL FORUM, INC., FORUM MEMO (June 1958).

22. Statement by Minister of Power, Lord Mills, in the House of Lords, United Kingdom, March 5, 1957. See ATOMIC INDUSTRIAL FORUM, INC., FORUM MEMO 22 (April 1957).

23. What follows draws heavily on a comprehensive survey of the market for atomic power products in the next decade prepared by Pickard-Warren-Lowe Associates for the Atomic Industrial Forum. ATOMIC INDUSTRIAL FORUM, INC., A GROWTH SURVEY OF THE ATOMIC INDUSTRY 1958-1968 (1958).

24. The *Growth Survey* estimates a much higher proportion of heavy water

Equipment and related services

In general the items which would be ordered from United States suppliers would be special fuel handling and control apparatus, and fuel cores and core supports, for the United States designed systems. Other items such as pressure vessels, heat exchangers and main circulation pumps might be supplied at perhaps 40 to 60 per cent of the total required. In addition architect-engineer services should be in demand from American suppliers for United States designed plants.[25]

On the basis of the above assumptions it can be estimated that from $0.5-1 billion of equipment and services will be exported from the United States to Western Europe to build United States type reactors by 1970. About 1/10 of this, or from $50-100 million can be estimated for Japan.[26]

It should be remembered that the rough estimates outlined above are based on the assumption that approximately equal amounts of goods will be exported from the United Kingdom to continental Europe and Japan during the same period of time. Naturally there will be keen competition among United States and United Kingdom manufacturers for a larger share of this trade and much will depend on how the United States light water type stands up against the British gas cooled systems in actual operation. If one proves much better than the other the shares of the United States and the United Kingdom in the total volume of trade could change substantially.

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reactors and does not mention the organic moderated. *Id.* at 56. Recent events, however, most especially the discussions of the joint U.S.-Euratom reactor program, seem to indicate that the organic moderated reactor will play an immediate part in the European programs, whereas the heavy water reactor system will not come along for some time. Of course these estimates are "guesstimates."

25. *Ibid.*

26. Pickard-Warren-Lowe estimate that the equipment and services to be supplied from the U. S. will range between about $40 to $100 per electrical kilowatt (ekw), of the total dollars of capital investment per ekw for plants based on U. S. designs, and the resulting estimate of U. S. equipment and services for the assumed 6.5 gw U. S. designed reactors would range from $260 million to $650 million by 1970 or roughly ¼ to ¾ of a billion dollars. This would appear to be a conservative estimate. Another estimate could be arrived at in a slightly different manner. In the proposed U. S.-Euratom reactor program $135 million out of a total of $350 million of capital investment will probably be supplied in the form of goods and services from the U. S. This is a proportion of approximately 40%. If one assumes an average capital cost of $300 ekw (which is less than the $350 assumed for the Euratom program) then a total capital investment of $1.95 billion of goods and services would be required for the 6.5 gw of American designed plants estimated to be constructed in Europe by 1970. Forty per cent of this would give $780 million. Even assuming that only 25% would have to be supplied from the U. S., a volume of about ½ billion dollars in equipment and related services required for reactor construction would flow from the U. S. to Europe during the decade 1960-1970. A similar process of reasoning leads to an estimate of about 1/10 of this requirement for Japan for this same period of time or a total of around $50-$75 million in atomic equipment and services traded between the U. S. and Japan.

Fuel Materials and Related Services

The above estimates do not take into account fuel needs for the United States designed reactors. The United States Government is at present the only source of supply for enriched fuel required by American type reactors.[27] It is therefore estimated that the total fuel requirements for these enriched fuel reactors will be supplied from the United States. The materials and services relating to the supply of fuel will be supplied partly from the United States Government and partly from private industry.

Materials and Services from the United States Government: Under present law in this country enriched uranium, whatever its chemical form, is owned by the United States Government,[28] but under the United States bilateral agreements program and under the proposed agreement with Euratom, these materials will be sold and title passed to foreign governments, including the Euratom Commission.[29] The United States stands ready to repossess spent fuel, to reprocess this fuel for the same price charged United States citizens, and to purchase any remaining enriched uranium and any plutonium found in the spent fuel.[30] Based on the assumptions made above, the total value of the materials and services relating to fuel supply which will have to be purchased by Western Europe from the United States Government can be estimated at approximately $350 million, and about 1/10 of this amount or $35 million by Japan.[31]

Materials and Services from Private Firms in the United States: The job of converting UF_6, the material that comes from United

27. The U. K., France, and the U. S. S. R. have facilities for enriching uranium in its fissionable isotope U-235, but so far as is known none of these countries have offered enriched material for export.

28. Atomic Energy Act of 1954 §§ 51, 52, 68 Stat. 919 (1954), 42 U.S.C. §§ 2071, 2072 (Supp. V, 1958).

29. The usual AEC power bilateral provides that "the United States Commission will sell or lease, as may be agreed, to the Government of ..... uranium enriched up to 20 per cent in the isotope U-235. . . ." See, for example, Article VII of the Proposed Agreement for Cooperation between the U. S. and Japan, initiated June 16, 1958. But "in general, special nuclear material distributed abroad under . . . power agreements will be sold." See *Summary of General Terms and Conditions Governing International Transactions in Special Nuclear Materials,* CCH ATOMIC ENERGY L. REP. ¶ 8204 (1956).

30. See statement of Louis L. Strauss, Chairman, U. S. Atomic Energy Commission, and accompanying statements appearing in CCH ATOMIC ENERGY L. REP. § 8204 (1956).

31. The calculation is made in the following manner: We have assumed that 5.75 gw of the American designed reactors (all but heavy water) to be established in Western Europe by 1970 will use enriched fuel. Assuming these are brought on line at a gradually increasing rate it can be roughly calculated that by 1970 approximately 19.75 gw/years of electricity will have been produced. This works out at 118 billion 500 million kilowatt hours at a 70% load factor. The Pickard-Warren-Lowe *Growth Survey* estimates, *supra* note 23, at 63, that costs for slightly enriched large water type reactors for inventory, burn-up (with $12 plutonium credit), reprocessing and transportation, and losses, amount to between 2.8 and 4 mills per kwh. Assuming an aver-

States isotopic separation facilities, into uranium metal or oxide to be used as reactor fuel, will probably be done largely by private chemical processing firms. And the job of fabricating the final fuel elements will also be done by private manufacturers. Again, based on the assumptions outlined in preceding pages, it can be estimated that the total value of such services that will need to be purchased from the United States by Europe over the decade 1960-1970 will be around $250 million. Again the figure for Japan ought to be about 1/10, or $25 million.[32]

In conclusion, and with due insistence on the extreme roughness of the calculations, one may expect somewhere around a billion to a billion and a half dollars of goods and services to be supplied by the United States to Europe, and between $110-160 million to Japan, over the next ten years. Of this most would move in private trade, the greater part in aid of reactor construction, and the rest to supply the finished reactors with fuel. It should also be emphasized that while the figures are rough and ready, they are also conservative.

THE PROBLEMS OF ATOMIC TRADE

Atomic trade between the United States on the one hand, and Europe and Japan on the other, during the period 1960-1970 will encounter a number of serious problems. Only some of these are essentially legal in nature though all have a number of elements for which lawyers' services will be required. Among the non-legal ones, the problems of finding adequate foreign exchange and capital are fundamental.

The Foreign Exchange Problem

The estimates given above of the potential export trade from the United States to Western Europe and Japan are by the same token a measure of the foreign exchange problem which Europe and Japan will have in purchasing the goods and services needed from the United States. In short, Europe will have to meet a dollar exchange burden of a billion to a billion and a half dollars, and Japan $100-$150 million, to finance nuclear power generation.

age of 3 mills per kwh over the whole decade 1960-1970, and multiplying this by the total estimated kilowatt-hours to be produced in this period gives a total of about $350 million.

32. The calculation can be made as in the earlier case. It can be estimated that a total of 19.75 gw years of electricity will be produced by the 5.75 U. S. type enriched fuel reactors by 1970. At a 70% load factor this works out to 118 billion 500 million kw hours. Pickard-Warren-Lowe estimate that the fabrication and conversion charges presently run between 2.6 and 4.4 mills per kwh. Taking a low of 3 mills as the average cost over the 10-year period would give a total value of these services of about $350 million. Another $35 million in services might be required for U. S. designed heavy water reactors giving a total of approximately $400 million. Since fuel manufacturing facilities will undoubtedly be established in Europe as soon as possible it is estimated that only about $250 million of this would be supplied from the U. S. over the whole decade.

Alongside total annual European imports of over $20 billion, of which some $2.5 billion is for coal and oil, an average amount of $150 million a year does not at first glance appear too serious.[33] Nevertheless Europe and Japan have had to struggle greatly with the problem of external trade balances in the past, and the dollar gap, the deficit on current trade account with the dollar area, has been especially serious for both since World War II. Recent years have brought a marked resurgence of the deficit on current account between Europe and the dollar area. Although in 1953 this deficit had been reduced to almost zero, it has since been steadily widening until it has reached a current level of over $2 billion a year.[34] Furthermore, the dollar exchange required for atomic trade is an unusual charge and one that must be set on top of current normal charges on reserves of foreign exchange.

It was stated above that one of the primary incentives for the establishment of nuclear power stations in Europe and Japan was to save on scarce foreign exchange and that this would result from the relative cheapness of nuclear fuels compared to coal and oil for thermal stations. Over the long run this will certainly be true, but it is doubtful whether this will markedly affect the situation in the next decade, the principal saving during that time being on transport.[35] Fuel costs are still a major part of the cost of nuclear

33. OEEC, EUROPE'S GROWING NEEDS FOR ENERGY—HOW THEY CAN BE MET 24, 42 (1956).

34. OEEC, A DECADE OF COOPERATION 70, 71 (1958).

35. Almost no one now estimates that nuclear fuel costs for enriched fuel reactors will be reduced to below 3 to 5 mills per kwh during the next decade. See GROWTH SURVEY, *supra* note 23, at 63. This may be compared with conventional fuel costs, using hard coal as the basis for comparison, as follows: It is a generally accepted conversion factor that 0.4 kg of coal is needed to produce 1 kwh of electricity in an up-to-date power plant. OEEC, EUROPE'S GROWING NEEDS FOR ENERGY—HOW THEY CAN BE MET 17 (1956). Assuming an f.o.b. price for coal of $10 a metric ton, *id.* at 45, this gives a coal cost of 4 mills per kwh, or about the same as the nuclear fuel cost to be expected. The savings from the use of nuclear fuels in Europe over the next decade will therefore probably be primarily in the cost of transporting conventional fuels. This is by no means small. Transport costs generally are set by what the traffic will bear, and have varied from a high of $14 to a low of $5 per ton of coal from the United States during the last decade. *Ibid.* The cost of transporting oil is somewhat less and has been more stable. It would be fair to assume an average of around $5 a ton, figuring oil at its hard coal equivalent value. This was used by the Euratom Three Wise Men. See *Target for Euratom, op. cit. supra,* note 10. Assuming that about 25% of total movements would be in American bottoms, OEEC, EUROPE'S GROWING NEEDS FOR ENERGY—HOW THEY CAN BE MET 43 (1956), we have a net foreign exchange burden of $1.25 per ton (hard coal equivalent) for coal and oil imports which would be saved by a substitution of nuclear power. We have assumed above that the United States-designed enriched fuel reactors will produce about 118 billion 500 thousand kwh by 1970 and that U. S. heavy water reactors might bring this up to about 125 billion kwh. This would represent a savings in coal of about 50 million tons and a saving of transportation costs of around $65 million. While this is substantial it is not significant in comparison with the estimated dollar exchange burden of over $1.5 billion which has been conservatively estimated above for construction and operation of United States type reactors in Europe by 1970.

power and will constitute a heavy part of the total dollar requirement of establishing United States type reactors in Europe and Japan between now and 1970. Accordingly, reliance will have to be placed for a time on special measures for obtaining the necessary dollar exchange.

Eximbank Loans

One solution to the exchange problem will no doubt come in the form of major loans from the United States Export-Import Bank (Eximbank). A feature of the joint United States-Euratom reactor program is a long term, low interest rate Eximbank loan to Euratom of $135 million, the estimated dollar exchange segment of the total capital investment required for the program.[36] And quite aside from the Euratom program, the Eximbank last year stated in a public release issued jointly with the United States Atomic Energy Commission that it is "prepared to consider loans to privately owned utility companies as well as to governments on appropriate terms to finance the construction of atomic power plants abroad . . . ."[37] We may expect therefore that Eximbank loans will be available to ease the immediate burden of dollar exchange cost involved in the construction of United States designed atomic power stations overseas. This should be an especially effective measure since, after 1970, savings on imports of coal and oil will free substantial amounts of foreign exchange to pay off the loans while in the meantime the special dollar exchange burden will have been eased.

Deferred Fuel Payments

The Atomic Energy Commission may well act to ease this burden by deferring the obligation of payment for enriched fuel purchased from the United States Government. An important feature of the joint United States-Euratom program is deferrals of payment of the purchase price of initial inventories of enriched fuels for a period of ten years.[38] It would seem likely that similar deferrals will be offered for fuel inventory needs of future increments of Euratom reactor construction and that the same privilege will be granted to other cooperating governments in Europe and Japan.

Atoms-for-Peace Grants

It is at least conceivable that the Atoms-for-Peace section of the

36. *Proposed Agreement for Cooperation Between the United States and Euratom,* H.R. Doc. No. 441, 85th Cong., 2d Sess. 6 (1958).

37. *Joint Statement by the Chairman of the Atomic Energy Commission and the Chairman of the Export-Import Bank,* CCH ATOMIC ENERGY L. REP. ¶ 8209 (1956).

38. *Proposed Agreements for Cooperation Between the United States and Euratom,* H.R. Doc. No. 441, 85th Cong., 2d Sess. 7, 31 (1958).

Mutual Security legislation will be extended to cover power reactors.[39] At the present time the Mutual Security Act provides for grants to other nations to enable them to construct research reactors but not power reactors. This law might be amended to provide for grant type assistance in connection with power reactor construction.

The Problem of Capital

Quite aside from the problem of finding necessary foreign exchange, Western Europe and Japan will face a major problem in raising the necessary capital to construct nuclear power plants in the next decade. As can be seen from the much higher prevailing rates of interest in these countries, capital is a relatively scarcer commodity in these areas than in the U. S.[40] Moreover the money market is reported to become increasingly tight.[41]

The problem will be aggravated by the competition for funds from non-nuclear stations. It has been estimated that a total investment of approximately $70 billion will be required for power installations alone in the OEEC area by 1970.[42] It is expected nevertheless that European utilities planning to construct nuclear facilities will be able to raise through normal channels the capital necessary to finance at least that portion of the investment that would be required to construct conventional stations of the same magnitude. Since nuclear stations cost about twice what conventional thermal installations cost this would leave half the necessary capital (roughly $3.0 billion for Continental Europe) to be obtained by special means.

The Dollar Component

Eximbank loans and deferred fuel payments will assist in meeting part of this need by covering much of the foreign exchange component of the total capital required.[43]

As mentioned above in connection with foreign exchange, it is conceivable that the United States Atoms for Peace program will be

39. Mutual Security Act of 1956 § 12, 70 Stat. 565 (1956), 22 U.S.C. 1939 (Supp. IV, 1937), as amended by the Mutual Security Act of 1957 § 8(n), 71 Stat. 362 (1957), 22 U.S.C. § 1939 (Supp. V, 1958).

40. OEEC, THE SUPPLY OF CAPITAL FUNDS FOR INDUSTRIAL DEVELOPMENT IN EUROPE (1957).

41. OEEC, THE ELECTRICITY SUPPLY INDUSTRY IN EUROPE 1957-1975, 24 (1958).

42. *Id.* at 43.

43. The Eximbank loan to Euratom calls for an interest rate of 4½%. This will be relent in turn by Euratom to private and government utilities in Europe proposing to construct nuclear installations, and while the Euratom loans will probably be at a higher rate they will probably for incentive purposes be substantially below the prevailing interest rate in the money market. This should make this part of the capital costs more freely available than on the regular money market. See *Proposed Agreements for Cooperation Between the United States and Euratom,* H.R. Doc. No. 441, 85th Cong., 2d Sess. 47 (1958).

expanded to include assistance for the construction of nuclear power installations, and this too would make capital available.

The European Investment Bank

A European Investment Bank was created by the treaty establishing a European Common Market and charged with the duty of helping to finance projects of interest to two or more of the Euratom nations which cannot be financed through normal channels.[44] The European Investment Bank has already assured the Euratom Commission and the United States that the bank will arrange for a sizeable part of the necessary capital for the joint United States—Euratom program, and presumably its facilities will be available for future increments of construction of nuclear facilities in the Euratom area.[45]

Joint Projects

Another possibility for raising capital is by means of joint projects, for which both the OEEC and Euratom have special provision. The Euratom treaty provides that "undertakings of outstanding importance to the development of the nuclear industry in the Euratom community may be constituted as joint enterprises." Approved joint enterprises may provide for capital participation by outside countries and their nationals and by international organizations.[46] Presumably this capital could take the form of equity as well as debt capital. Similarly the charter of the OEEC European Nuclear Energy Agency provides for the formation of "joint undertakings" by groups of member countries.[47] The form of these undertakings is not prescribed, but it seems clear that a preferred form is an international joint stock company established under an international convention and providing for ownership of capital shares by governments and their nationals.[48]

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44. TREATY ESTABLISHING THE EUROPEAN ECONOMIC COMMUNITY, pt. 3, Title IV, March 25, 1957.

45. *Id.* at 65. See also *Hearings Before the Joint Committee on Atomic Energy on the Proposed Euratom Agreements,* 85th Cong., 2d Sess., pt. 1, at 111 (1958).

46. TREATY ESTABLISHING THE EUROPEAN ATOMIC ENERGY COMMUNITY, March 25, 1957.

47. OEEC, FIRST REPORT OF THE STEERING COMMITTEE FOR NUCLEAR ENERGY, Annex IV, art. V, at 128 (1958).

48. *Ibid.* OEEC countries have already set up a joint undertaking to erect a chemical reprocessing plant at Mol, Belgium under a convention establishing a European commercial company called Eurochemic. This precedent will probably set the pattern of future joint undertakings of a similar kind. The statute of this company provides for capital shares initially purchased by the subscribing governments but transferable with the approval of the governing Board of the company to nationals of a member country. Since these joint undertakings will have special privileges and assistance from the member governments, the establishment of such joint companies opens up the possibility of attracting equity capital to the construction of power stations in the OEEC area.

Special Government Programs

Finally a number of the Euratom nations apparently intend to adopt special measures to provide capital for the establishment of nuclear facilities within their borders, including special governmental subsidies or long-term loans at low interest.[49]

The Tariff Problem

As considered here the tariff problem is simply whether and to what extent United States suppliers will be at a competitive disadvantage in foreign markets as against suppliers from other countries. In practically all areas protective tariffs confer some competitive advantage upon local citizens as against nationals of foreign countries. This is a condition that one would expect to hold in the atomic field as well as others, as long as free trade is not an internationally accepted policy. It is to be hoped, however, that (a) this competitive advantage will not be so large as to virtually exclude United States suppliers from important nuclear markets abroad, and that (b) no market area grants discriminatory advantages as among nuclear products of different countries.

Over-Protection of Local Manufacturers

The natural desire of countries who are pressed for foreign exchange to become independent of foreign sources of supply in the nuclear field has already been noted. At the present time such countries are probably more anxious to obtain United States nuclear products than to exclude them, in order to meet their immediate pressing needs for nuclear power and to limit their imports of conventional fuel. But in time we may expect the countries of Western Europe and Japan to prefer to protect their infant atomic industries by a protective tariff policy. If United States negotiators wait until that time arrives to seek protection for United States nationals, their present strong bargaining position will have been dissipated. It would seem that now would be the time to negotiate long-term agreements to prevent exclusion of United States products by high tariffs or quotas.

In the case of Euratom, the proposed Agreement for Cooperation does provide that Euratom will take steps to minimize the impact of customs duties.[50] Since one effect of the Euratom treaty is to establish a customs union in nuclear materials[51] with a common tariff as to goods from outside the Community, whatever tariff Euratom

49. *Hearings Before the Joint Committee on Atomic Energy on the Proposed Euratom Agreements,* 85th Cong., 2d Sess., pt. 1, at 111 (1958).

50. Article X of *Proposed Agreement for Cooperation Between the United States and Euratom,* H.R. Doc. No. 441, 85th Cong., 2d Sess. 25 (1958).

51. TREATY ESTABLISHING THE EUROPEAN ATOMIC ENERGY COMMUNITY, tit. 2, ch. 2, March 25, 1957.

adopts will apply to all the six nations of the Community. The level of this common tariff, both at the beginning and as it may subsequently be amended, will be of vital importance to United States suppliers.[52]

Tariff Discrimination

At the present time Most-Favored-Nation agreements protect United States products in most markets from discrimination as against products from other outside areas.[53] As far as Japan is concerned, this will probably continue to be as effective protection as can be demanded. However, the situation may well be different in Europe. The competition which United States suppliers have most to fear is British. If the United States were placed at a tariff disadvantage vis-à-vis the British it could seriously prejudice the United States position in the European market. At present the United States and the United Kingdom probably stand on the same footing. In the Euratom area they will both be subject to a common tariff barrier erected by the Community. In other countries of Western Europe they are presumably equally protected by Most-Favored-Nation agreements. But there are presently under way in Europe, under the aegis of the OEEC, serious negotiations to establish a European-wide free trade area, including the United Kingdom.[54] When and if this is established, United Kingdom suppliers will no longer be subject to trade barriers of any kind in respect of transactions with the continental European area, including Euratom, whereas United States suppliers will still be subject to the usual national and Euratom barriers. United Kingdom suppliers would then possess a competitive advantage to the extent of the tariffs or quotas in force in Europe. Naturally this is a problem for all United States suppliers to Europe, not just suppliers of nuclear products. Moreover there are powerful agruments why the economic well-being of the Western world may depend upon a certain measure of discrimination against American products in the European market for a time. But equally powerful free trade arguments are at hand, and in the case of nuclear products there is an added argument to the effect that it is vitally important for Europe

52. Apparently the Euratom common tariff on source and special nuclear materials will be virtually nil. But the more important group of nuclear products as far as U. S. suppliers are concerned, are those items of equipment that have special application in the nuclear field, including reactors and their components. The common Euratom tariff on these items will be set in the next few months. See EURATOM COMM'N, FIRST GENERAL REPORT ON THE ACTION OF THE COMMUNITY 50 (1958).

53. Treaty and Protocol between the United States of America and Japan, art. XIV, April 2, 1953. "Each Party shall accord most-favored-nation treatment to products of the other Party, from whatever place and by whatever type of carrier arriving . . . with respect to customs duties and charges of any kind . . . ."

54. See *Bulletin from European Community* (May-June 1958), published by the information constultant to the European Community for Coal and Steel, Washington, D.C.

to establish the most efficient and economical power generation system, and that this can only be done by permitting technological competition among reactor systems on an equal, non-discriminatory basis. (Although the European Free Trade Area talks have apparently collapsed just as this symposium goes to press, there are indications that separate discussions have been held, and may well continue, looking toward the establishment of a special free trade zone for nuclear products.)

The Nuclear Liability Problem

The problem which will most bedevil atomic trade between the United States and other countries in the near future is the problem of nuclear liability. As this term is commonly used it refers to the legal and financial, as opposed to the physical, consequences of a serious atomic accident, especially that resulting from claims of injured members of the public. While it is generally conceded that the risk of such an accident is almost vanishingly small, the magnitude of the damage that might be done is unprecedently large. And the public liability that might ensue from such an accident might well be beyond the financial resources of even the largest corporation. Under the circumstances it is no wonder that most American companies are reluctant to engage extensively in the shipment of nuclear supplies abroad without reliable financial protection against the nuclear liability hazard. The problem is the international counterpart of the one which led the Congress in 1957 to enact the Price-Anderson Act,[55] under which the federal government is bound to indemnify any parties held liable for a nuclear incident beyond the amount of insurance or other financial protection available from private sources. The underlying legal problem reduces itself to the question of who shall bear, or share, the risk of nuclear liability as among suppliers of nuclear equipment, operators of nuclear facilities, governments under whose jurisdiction the nuclear facilities are operated, or the public.

Our concern in what follows is principally with the problem as it affects American suppliers of nuclear equipment and services to reactor installations abroad. Both the nature of the liability that is risked and the forms of protection against this hazard are a matter of fundamental and anxious concern to United States organizations interested in atomic trade with other countries.[56]

The Rules of Liability

It seems clear that United States suppliers will be accessible to

55. Atomic Energy Act of 1954 § 170, as amended 71 Stat. 576 (1957), 42 U.S.C. § 2210 (Supp. V, 1958).

56. In what follows I have cribbed shamelessly from FINANCIAL PROTECTION AGAINST ATOMIC HAZARDS: THE INTERNATIONAL ASPECTS, A PRELIMINARY REPORT (1958), the interim report of a study under the auspices of the Harvard Law

suit by foreign claimants either by way of direct suit in the United States or by way of enforcement in American courts of judgments obtained in foreign courts.[57] As a general rule, however, it is unlikely that either American or foreign courts will impose liability upon suppliers in the absence of proof of fault, whereas it seems rather more clear that strict liability will be imposed upon operators of nuclear facilities in foreign jurisdictions than in the United States.[58] Under the circumstances one may expect injured parties abroad normally to proceed against the operator of the nuclear facility, at least in the first instance. Nevertheless, claimants may well seek to recover from American suppliers in the courts of the United States or in their own local courts, either because of simple expectation of a larger recovery or, in the event of a major incident, because of insolvency or other limitations upon recovery from a facility operator. In view of the possible scope of damage resulting from a nuclear incident this is a possibility that United States suppliers would ignore at their peril, and the risk must be avoided or mitigated if business is to be done abroad without risk of financial disaster.

Private Measures to Avoid Nuclear Liability

Contractual Arrangements: The most obvious means by which a United States atomic supplier can protect himself in some measure from nuclear liability consists of contractual indemnities or "hold harmless" arrangements with the purchaser—that is, in the usual case, the reactor operator. This will at least afford protection against direct suits by the operator to recover over from the supplier for third party claims enforced against the operator.[59] But it goes without saying that an agreement with a purchaser cannot bar independent claims of injured third parties brought directly against a supplier. In such cases the supplier would be left with the probably sterile right of a suit to recover from the reactor operator under the contractual arrangement. In any case the extent of protection afforded by contractual arrangements at best is limited to the assets of the purchaser. In the event if a major incident, this would be less than complete protection. Moreover, in European courts contractual "hold harmless" arrangements may well not be enforced in the face of a plea of "dolus," a concept of European law roughly equivalent in modern application to our concept of wanton or wilful negligence.[60] Since a disregard

School and the Atomic Industrial Forum, Inc. The director of the study is Robert Eicholz and the assistant director is Peider Konz. A final report will be published by the Atomic Industrial Forum, Inc., in January 1959.

57. HARVARD PRELIMINARY REPORT, *op. cit. supra* note 56, at 12.

58. *Id.* at 35.

59. The problem of the supplier in protecting himself against claims of the operator growing out of damage to the reactor property or breach of warranty of products supplied is beyond the scope of this discussion.

60. HARVARD PRELIMINARY REPORT, *op. cit. supra* note 56, at 33.

of applicable safety regulations, intentional or unwitting, might well be considered to be an instance of "dolus," it is readily seen that this is a major infirmity.[61] In some cases the strength of contractual indemnity arrangements might be improved by backing of the local government, but in most countries this kind of obligation would probably require specific parliamentary approval to be certain of enforcement.[62]

Subsidiaries and Affiliates: Additional protection may be afforded United States suppliers by operation through foreign subsidiaries, affiliates, or joint enterprises. Under appropriate circumstances the parent company may thus insulate itself from liability. In order to be effective, however, the affiliate will probably have to be an actual operating company, not a mere sales agent for the parent. Otherwise the parent may be considered to be "present" in the foreign jurisdiction for purposes of suit on the spot and for enforcement of judgments in the United States. Moreover, there is always the possibility that courts may "pierce the corporate veil" where it appears that the subsidiary or affiliate was established merely to avoid liability, especially if it is undercapitalized. In case of a major incident causing extensive injury to the public local courts will have a strong incentive to look through corporate veils where possible.[63]

Licensing: Even limiting one's participation in overseas markets to simple licensing of patents and manufacturing know-how will not guarantee immunity against liability, although it will pretty clearly be more difficult to prove fault on the part of a licensor than of a direct supplier of equipment or services.[64]

Insurance: Ordinarily the most satisfactory means of financial protection against risks of liability is insurance. Eventually this may be true of risks from participation by United States suppliers in overseas markets. But for the time being insurance does not provide adequate protection. As a practical matter it is not yet even clear what insurance is available. The United States nuclear liability insurance syndicates, Nelia and Maelu, are reportedly willing to consider applications by United States suppliers for insurance against product liability on exported articles, but so far they have announced no clear policy as to the availability of such insurance. Foreign nuclear insurance syndicates have been established, but it is not at all clear in what amounts or on what terms insurance will be available from them.[65]

61. *Ibid.*
62. *Id.* at 36.
63. *Id.* at 27.
64. *Id.* at 30, 31.
65. Austria-Verband der Versicherungsanstalten Oesterreichs, Schwarzen-

Even in theory insurance is not a complete answer to the problem of third party liability unless coupled with a firm statutory limitation of liability or a provision for governmental indemnification beyond the amount of private insurance available. The unique feature of nuclear liability is the overwhelming size of the total liability in the event of a major incident. Even in the United States, where the insurance pools are prepared to make available up to $60 million of insurance for a single installation, far larger than any coverage hitherto assembled, government indemnification beyond this amount was thought to be necessary. Present indications are that only a fraction of this amount of insurance will be available to cover foreign risks, unless a major program for reinsurance of pools in other areas is subsequently undertaken by United States and United Kingdom insurers.[66] Once it becomes available, insurance will be of immense practical importance, and United States suppliers will be well-advised to keep up to date on nuclear insurance developments in Japan and Europe. Meanwhile the measures that will be taken by governments to limit liability or to afford government indemnification are of special importance.

Governmental Measures

In all likelihood governmental action of some sort will be required, either in the form of national legislative action or intergovernmental agreement, to provide a satisfactory solution to the nuclear liability problem, both as it affects United States suppliers and as it affects the atomic industry and the public of other countries. There are several distinct possibilities.

Action by the United States Government: Congress might extend

bergplatz 7, Vienna III; Belgium—Union Professionnelle des Entreprises d'Assurances Belges et Etrangères opérant en Belgique, 7 rue Guimard, Brussels; Denmark—Assurandr Societetet, Tordenskjoldsgade 10, Copenhagen; Federal Republic of Germany—Gesamtverband der Versicherungswirtschaft e.V., Eberplatz 1, Cologne; Finland—Suomen Vakuutusyhtiöiden Keskusliiton, Bulevardi 28, Helsingfors; France—Fédération Fraincaise des Sociétés d'Assurances, 3, rue de la Chaussée d'Antin, Paris 9e; Great Britain—British Insurance Companies European Co-operation Committee, 65/66 Watling Street, London E.C. 4; Greece—Fédération Hellénique d'Assurances, 10 rue Sina, Athens; Union des Assureurs de Grèce, 6 rue Sophocleous, Athens; Ireland—Irish Insurance Association, 46/49 Dame Street, Dublin; Italy—Associazione Nazionale fra le Imprese Assicuratrici, Piazza S. Babila, Milan; Luxembourg—Association des Compagnies d'Assurances agréés au Grand-Duché de Luxembourg, 6 rue de Bragance; The Netherlands—Nederlandse Unie van Schadeverzekeraars, 163 Riouwstraat, The Hague; Norway—Norske Forsikringsselskapers Forbund, Tollbodgate 17, Oslo; Portugal—Gremio dos Seguradores, 16 Largo Rafael Bordalo Pinheiro, Lisbon; Spain-Sindicato Nacional del Seguro, 4 Avenida Calvo Sotelo, Madrid; Sweden—Svenska Försäkringsbolags Riksförbund, Strandvägen 5 B, Stockholm; Switzerland—Association des Compagnies Suisses d'Assurances, 43 Gotthardstrasse, Zurich; Turkey—Turkije Sigorta ve Reassurans Sirketleri Birligi, Unyon Han 73/74, Galata-Istanbul.

66. *Hearings Before the Joint Committee on Atomic Energy on the Proposed Euratom Agreements,* 85th Cong., 2d Sess., pt. 1, at 33 (1958).

the coverage of the Price-Anderson Act to foreign nuclear incidents. This would make available $500 million in United States Government funds to indemnify any United States supplier held liable for damage caused by a nuclear incident, on top of any private insurance available. So far the Joint Committee on Atomic Energy has not been receptive to the notion of extending the coverage of the act in this fashion.[67]

Another proposal that has been made is for the United States to insist as a condition of bilateral agreements for cooperation with other countries for the foreign government to hold United States suppliers harmless.[68] This has been questioned on the grounds that it would put United States suppliers at a competitive disadvantage with suppliers from other countries that do not make a similar demand, notably the United Kingdom. Moreover, it is defective in that a supplier may have assets or even domicile in a third country, and suit might be brought there, outside the scope of the defence made possible by the bilateral agreement.

Other proposals have been to limit the amount recoverable by foreign claimants in United States courts from American suppliers or to limit access to the courts in some fashion. Either of these raises serious constitutional problems, at least in the absence of treaty.

Action by Foreign Governments: It is possible that other governments will find it advisable to adopt legislation to protect their publics from nuclear liability which will at the same time protect United States suppliers. In several countries of Europe legislation of this sort is under serious study. United Kingdom legislation is considered in Highton, "The Legal Aspects of Atomic Energy in the United Kingdom," *infra,* p. 223.

In Germany the principal draft under consideration provides for (a) strict liability of the owner of a nuclear installation, or possessor of fissionable material, (b) compulsory insurance or other financial protection against public liability, (c) government payment of third party claims not covered by the required financial protection up to a maximum of 500 million Deutsche Marks (about $125 million) less the amount of the claims covered by financial protection, and (d) allocation of liability as among parties jointly liable in proportion to their responsibility.[69] Liability to any injured or deceased person is limited in amount and a double limitation period on claims is prescribed:

67. *Hearings Before the Joint Committee on Atomic Energy on Operation of AEC Indemnity Act,* 85th Cong., 2d Sess. 35, 36 (1958).

68. Suggestion of Congressman Sterling Cole. *Hearings Before the Joint Committee on Atomic Energy on Governmental Indemnity and Reactor Safety,* 85th Cong., 1st Sess. 206 (1957).

69. Proposed Act on the Peaceful Use of Nuclear Energy and on Protection Against Its Hazards. Document Number 244/58 of the Bundesrat of the German Federal Republic.

"Two years after the time at which the party entitled to compensation became aware of the injury and . . . thirty years after the damaging event took place."

In Switzerland legislation is being considered that would (a) make operators of nuclear installations strictly liable (b) compel them to carry insurance or equivalent security in the amount of 20 million Swiss francs ($4.7 million) covering not only themselves but any party in contractual relation with them who might be held jointly liable, and (c) authorize compensation to injured parties by the Swiss Confederation beyond the insurance available. An alternative version would additionally (d) limit the over-all liability of the operator and persons jointly liable with him to the amount of the compulsory insurance, and (e) provide that the Swiss confederation "shall make good the damage not covered . . . ."[70]

In Japan no draft legislation has yet appeared, but the Japan Atomic Industrial Forum has undertaken a careful investigation of the nuclear liability problem. The preliminary report on this study states that "a special legislative enactment is advisable in order to furnish solutions to the problem of tort liability arising out of atomic hazards. Points involved will be strict liability imposed on owners of nuclear facilities and limitations placed on such liability in view of the enormous size of damage. No solution, however, will be possible without . . . state indemnity."[71] This report will undoubtedly influence legislation proposed in Japan.[72]

Similar measures are under consideration in other countries. They are good so far as they go, but those that have appeared are subject to certain major objections from the point of view of United States suppliers. To the extent that they provide for rather low limits on the liability of the operator without either providing for government indemnification or clearly barring recourse against suppliers, they may create a positive incentive for claimants to pursue suppliers, including United States concerns, once the limit on an operator's liability has been reached. Neither the German nor the Swiss legislative proposals clearly bars independent action against suppliers or actions by a facil-

70. The draft referred to is the result of the work of a special Commission composed of representatives of the federal ministries and of certain private agencies and thereafter distributed widely for comment by the Swiss Federal Council, the cabinet or executive arm of the Confederation. The alternative version referred to consist of variants of certain of the articles suggested by private groups, in particular insurance circles. The draft is at present with the Federal Council which will probably pass it on this year to the two chambers of the Swiss Federal Assembly, the National Council and the Council of States.

71. Preliminary Report of a Committee for Studies on Atomic Hazards Indemnity of the Japan Atomic Industrial Forum, Inc., entitled *Financial Protection Against Atomic Hazards* (June, 1958).

72. Private conversation with Mr. Yoshio Kanazawa, Chairman of the Japan Forun Atomic Indemnity Committee.

ity operator to recover from a supplier for claims he has had to pay. The Swiss draft reserves the Confederation's right "to claim indemnity from the person liable and from any person jointly and severally liable" where it is called on to compensate injured parties.

Intergovernmental Agreements: In view of the international participation in nuclear projects and the probability that the effects of any major nuclear incident will be felt beyond the borders of a single country, an international convention is probably the only means by which a comprehensive solution to the nuclear liability problem will be achieved.[73] It is pretty clear that the International Agency is interested in sponsoring a general convention treating of this problem. It is equally clear that this will take a long time, and that so far the Agency has taken no concrete steps in this direction.

The OEEC, however, has for many months had under study by a group of experts the question of a regional convention or treaty on third party liability, and has hopes of having a draft convention ready for initialing by member governments within a matter of months. Although the results of the group's deliberations are still confidential, it is understood that any proposal will at least subscribe to the following, among other, principles: (1) that the liability of the facility operator shall be strict, exclusive, and limited, (2) that up to the limit of his liability, the operator must maintain insurance or some other suitable form of financial protection to protect all parties potentially liable for a nuclear incident, (3) that no party other than the operator shall be liable and recourse actions by the operator against suppliers or other third parties will not lie. The treaty does not itself provide for governmental, or state, compensation of claimants beyond the limit on liability, but does require that any state making national arrangements for additional compensation shall not discriminate against foreigners. A convention adhering to these principles would protect United States suppliers in large measure against claims of third parties. However, to the extent that the ceiling on the operator's liability is set too low—and it may have to be in view of the present limited capacity of the European insurance market—an open inducement will exist to bring direct suits in the courts of the United States by injured parties who cannot recover fully from the operator. It is at least open to question whether United States courts in such an event would apply the OEEC convention to bar the action. Since the current draft of the convention provides for a limit of only $15 million, with participating countries having the option to set different limits as low as $5 million, it can be

73. Address of Sterling Cole, Director of the International Atomic Energy Agency before the Geneva International Conference on Atomic Energy in September 1958. See also conclusion of HARVARD PRELIMINARY REPORT, *op. cit. supra* note 56.

readly seen that the apprehension is not an idle one: in the event of a major incident pressures to get around the convention would be strong.

It is not yet clear what Euratom will do about this problem. The draft agreement of cooperation between the United States and Euratom recognizes the vital importance to the joint reactor program of finding a solution to the problem,[74] but so far there is no clear indication what action will be taken. The Euratom nations are members of the OEEC and there are indications that Euratom's first step will be to bring the OEEC convention promptly into force in the Euratom area if it can. There is some possibility that Euratom may initiate action by its members to set up a Euratom indemnification fund, out of which parties injured by a nuclear incident would be indemnified for liability beyond the limit on private liability set pursuant to the OEEC convention.[75]

What form the eventual solution of this formidable problem will take is problematic. A single comprehensive treaty sponsored by the International Agency may be adopted. More likely an overlapping series of acts including national legislation, bilateral agreements, regional conventions, and a final international treaty covering what is not otherwise treated, will gradually circumscribe and eventually erase the problem. Meanwhile it is a major barrier to international atomic development.

The Patents Problem

All the signs indicate that Western Europe and Japan will bend every effort to establish strong indigenous nuclear industries, and that these areas will not for long continue to be open markets for American nuclear exports. As time goes on continued participation by the United States atomic industry in these market areas will therefore probably come to depend more and more upon licensing arrange-

74. *Proposed Agreement for Cooperation Between United States and Euratom* art. IX, H.R. Doc. No. 441, 85th Cong., 2d Sess. 25 (1958).

"The Government of the United States of America and the Community recognize that adequate measures to protect equipment manufacturers and other suppliers as well as the participating utilities against now uninsurable risks are necessary to the implementation of the going program. The Euratom Commission will seek to develop and to secure the adoption, by the earliest practicable date, of suitable measures which will provide adequate financial protection against third party liability. Such measures could involve suitable indemnification guarantees, national legislation, international convention, or a combination of such measures."

75. Euratom would appear to be invested with only limited powers, namely those expressly set out in the Treaty. Consequently effective action on the liability problem, including the establishment of an indemnification fund, may depend upon reference back to Member States for formal action. However, Article 161 of the Euratom Treaty does confer on the Euratom Commission broad power to "adopt regulations and directives," binding upon Member States. If liberally construed this authority might be employed by the Commission to prescribe measures for dealing with the liability problem by mandate.

ments or upon the establishment of operating subsidiaries, affiliates, or joint enterprises abroad. This will in turn enhance the importance of patent rights on nuclear technology, both as a basis for licensing and cross-licensing arrangements and as a bargaining counter in the negotiations leading to the formation of joint enterprises with European and Japanese companies. Considerable importance therefore attaches to a strong patent position for United States technology in Western Europe and Japan.

Atomic Energy Commission Policy

In part this is a private and in part a governmental problem. Because so much of the atomic development program in the United States has been carried on under government contract or other arrangement with the Atomic Energy Commission, a wide range of the resulting technology is subject to patent rights vested in the United States Government, and obtaining foreign patent rights on this technology is a matter of government prerogative.[76] A solid patent position for United States technology in foreign areas therefore depends in large degree upon the extent of AEC efforts in filing for patent rights abroad. AEC ownership of foreign patent rights does not of course confer a privileged position on any particular United States manufacturer, but it does have the beneficial effect of preventing United States atomic industry from being blocked by competing patents obtained by foreign governments or their nationals from practicing abroad inventions growing out of the United States atomic energy program. The AEC has recently come in for some criticism on the grounds that it has not been sufficiently active in seeking foreign patent rights on inventions owned by it.

It is understood that it is AEC policy to permit a contractor who has made an invention in the nuclear field to seek foreign patents at its own expense wherever the AEC decides not to file for foreign rights itself.[77] What is not so clear, however, is whether the Commission's policy requires transfer of title in the resulting foreign patent to the AEC or simply assignment to it of a royalty-free, non-exclusive license for governmental purposes. The difference is important.

76. The Atomic Energy Act of 1954 § 152, 68 Stat. 919 (1954), 42 U.S.C. § 2182 (Supp. V, 1958), provides in part:

"Any invention or discovery, useful in the production or utilization of special nuclear material or atomic energy, made or conceived under any contract, subcontract, arrangement, or other relationship with the Commission, regardless of whether the contract or arrangement involved the expenditure of funds by the Commission, shall be deemed to have been made or conceived by the Commission, except that the Commission may waive its claim to any such invention or discovery if made or conceived by any person at or in connection with any laboratory under the jurisdiction of the Commission as provided in section 33, or under such other circumstances as the Commission may deem appropriate."

77. See Address of Bennett Boskey before the Atomic Industrial Forum Symposium on International Problems of the Atomic Industry, April 25, 1957.

(a) To the extent AEC takes the title to patents obtained by its contractors the principal benefit to United States industry is that it will not be blocked by competing patents obtained by others.

(b) If on the other hand title to the foreign rights is vested in the United States concern that goes to the trouble and expense of obtaining them, subject only to a license to the AEC to use the invention for governmental purposes, then United States concerns have the incentive to establish a preferential position in foreign markets by seeking the foreign patent rights on inventions they conceive pursuant to contract with the AEC. It would improve the situation if the AEC policy were known more clearly.

Except for secrecy restrictions there is no special barrier to the filing of applications on nuclear patents in countries abroad by United States inventors who have conceived their inventions independently of any arrangement with the government. Presumably United States nationals may file for nuclear patents on the same basis as patents may be sought on items of conventional subject matter. United States applicants thus are subject to the various requirements of national patent laws, as well as to any special provisions of local atomic energy laws respecting patents. They are protected from discrimination in the issuance of patents, however, by United States treaties of friendship, commerce, and navigation. These customarily provide that United States nationals and companies will be accorded "national treatment and most-favored-nation treatment with respect to obtaining and maintaining patents of invention . . . ."[78] The usual atomic energy agreement for cooperation, however, is silent on the matter of patent rights.[79] It is at least open to question whether these agreements should not contain standard provisions on patents, not only to give assurance of the non-discriminatory application of local patent laws, but perhaps also to provide that, within the limitations of local law, patents would be routinely granted on atomic energy inventions certified to one party by the other. Moreover, if it is United States government policy to grant royalty-free licenses to foreign nationals to practice nuclear inventions owned by the United States—and there are some signs that this is the policy—it would seem that United States nationals should have assurance of reciprocal treatment by other governments wherever possible.

78. Treaty with Japan, *op. cit. supra* note 51 at art. X.

79. Bilaterals concerning the exchange of Restricted Data do contain patent provisions providing for the sharing of patent rights embodying classified information which grow out of the exchange of classified information under the agreement, and the agreements made with Canada and the U. K. have similar patent provisions that are applicable to exchanges of unclassified information as well. But these provisions are not relevant to the rights of private inventors to establish valid patent rights.

The Euratom Agreement

The proposed agreement for cooperation between the United States and Euratom has a special section on patents that will importantly affect the position of United States atomic industry in the Euratom area.[80] The section has two main parts, one respecting inventions "made or conceived in the course of or under the joint program of research and development," and the second relating to any other inventions "used in the work of the joint program."

The first part is reasonably straightforward. It provides that inventions made under the research program shall be shared: the United States will get the patent rights in its area, and Euratom the rights in its area. Third country rights will depend on where or under whose contracts the invention was made. Each party agrees to grant the other royalty-free licenses for all purposes and assures non-discriminatory treatment to nationals of the other party in licensing its inventions. Since the main focus of the research program is to be fuel technology, a matter of the keenest interest to the United States as well as Euratom, both sides stand to gain from sharing their discoveries in this field.[81]

The other part of the patent section raises more questions. It provides that any "patents used in the work of the joint program," other than patents conceived under the research program, which the United States owns or has the right to license, will be licensed both to "Member States" of Euratom and to their "industries" subject only to the states agreeing to grant similar rights to the United States Government and United States industry.

A number of troublesome points arise. First, it is not precisely clear what is meant by "patents used in the work of the joint program." Does this embrace patents outside the nuclear field, *i.e.*, electronic patents involved in reactor control and instrumentation systems? Secondly, it is provided that licenses granted shall cover "use either in or outside the joint program." This would appear to mean that any kind of patent owned or subject to license by the United States which has even incidental use in the joint program will be available for use by Euratom industrial concerns for any purpose, anywhere, so long as the Euratom states grant the United States similar rights on inventions owned by them. This seems to go far beyond atomic development and to raise fundamental questions of national patent policy.

It is especially not clear whether the provision places the Com-

80. *Proposed Agreement for Cooperation Between the United States and Euratom,* art. VII, H.R. Doc. No. 441, 85th Cong., 2d Sess. 24, 25 (1958).

81. *Hearings Before the Joint Committee on Atomic Energy on the Proposed Euratom Agreements,* 85th Cong., 2d Sess., pt. 1, at 113 (1958).

mission under a special burden not to grant waivers of governmental rights to inventions made pursuant to arrangement with the Commission—waivers which in the absence of the Euratom agreement the Commission might ordinarily be disposed to grant. This has special pertinence in connection with inventions relating to fuel elements. Under the Euratom agreement the AEC agrees to provide guaranties of the price and performance of fuel elements made by United States manufacturers. These guaranties will be provided for the benefit of Euratom utilities but apparently will be made by arrangement between the AEC and the United States manufacturer. If so, a basis exists for the AEC to assert government ownership of inventions made during the course of manufacturing fuel elements covered by the guaranty.

The AEC has stated, however, that it has not yet decided whether it has the legal right to inventions made under the fuel guaranty contracts, but that if it does the Commission will by waiver limit its claims to the use of such inventions by the U. S. Government "with respect to construction and operation of government owned reactors."[82] Apparently therefore the AEC does not construe the Euratom agreement to inhibit the waiver of claims on inventions made under the joint program. But the fuel guaranty arrangements may be a special case, and it is not clear what the effect of the agreement will be on the AEC waiver policy pursuant to other arrangements between the AEC and U.S. industry with regard to the joint program.

The Euratom Treaty

The rights of United States inventors in the Euratom area must of course also be considered in the light of the treaty establishing Euratom. The treaty raises some complicated questions, most of which are beyond the scope of this article, but a few observations may be made. First of all, the treaty appears to leave things pretty much as they are as far as the issuance of patents on nuclear inventions is concerned, including the issuance of patent rights to foreign nationals. The treaty does not set up a single Euratom patent system but leaves the issuance of patent rights on nuclear inventions, as on other inventions, to the member states.[83]

But the treaty does contain provisions that will affect the practice of inventions in the Euratom area, chiefly by providing for the com-

82. *Id.* at 230. The Euratom Cooperation Act (P.L. 85-846), section 4(e) provides, however, that "The Commission shall obtain a royalty-free, nonexclusive, irrevocable license for governmental purposes to any patents on inventions or discoveries made or conceived by the manufacturer in the course of development or fabrication of fuel elements during the period covered by the Commission guarantee."

83. TREATY ESTABLISHING THE EUROPEAN ATOMIC ENERGY COMMUNITY, art. 16, March 25, 1957.

pulsory licensing of patents.[84] The compulsory licensing provision is cast in two parts. One grants to the Euratom Community itself and to Joint Enterprises established by it, the right to non-exclusive licenses to use inventions "directly connected with nuclear research," including the right to authorize third parties to use the inventions in carrying out work for Euratom or its joint enterprises. The second part authorizes Euratom to grant non-exclusive licenses to persons or enterprises which use patents "relating to inventions directly connected with and essential to the development of nuclear power in the Community." This is very broad. Under it, Euratom would appear to have authority to compel the use by European industry of any patents owned by United States industry within its area that the Euratom Commission regards as essential to atomic energy development.

But certain protections exist for the American inventor. First of all, unless the patent relates to a "specially nuclear subject" Euratom may not compel the issuance of a license until four years after the patent was applied for. Secondly, the license to be issued is non-exclusive and an owner of the patent is entitled to "full compensation" for its use. Where the patent owner cannot obtain what he regards as adequate compensation by agreement with the licensee he may put the case before a special Arbitration Committee. The decisions of the Arbitration Committee are in turn appealable to the Euratom Court of Justice.

Finally United States organizations planning to carry on nuclear activities within the Euratom Community appear to have reciprocal rights under the treaty to claim the use of nuclear inventions owned by Euratom nationals, although it is of course always up to Euratom to decide whether licensing a United States concern is "essential to the development of nuclear energy within the Community." United States nationals would also appear to stand on an equal footing with Euratom nationals under the treaty in obtaining licenses to use patents owned by Euratom itself. Under the treaty persons in a position to effectively exploit such inventions are entitled to nonexclusive licenses on demand, and no distinction is made among persons on the basis of nationality.[85] It could be argued nevertheless that the position of United States industry would be improved by a formal agreement under which United States nationals would be entitled to non-discriminatory treatment under the Euratom treaty.

CONCLUSION

The above discussion barely skates the surface of the problems, legal and other, that will affect world trade in atomic energy. All the

84. *Id.* at art. 17 to 23.
85. *Id.* at art. 12.

normal problems of doing business internationally and in foreign areas will have to be contended with by United States organizations exporting nuclear products to foreign areas or attempting to establish operations abroad. Currency, tax, and antitrust problems will affect nuclear activities as well as others. Moreover, there are a number of special problems relating to nuclear activities that will have to be wrestled with, such as licensing under the Atomic Energy Act, health and safety regulations and security controls established by national governments or international agreement, and a host of other problems of doing business in the atomic energy field. It is hoped, however, that the above has served at least to highlight several of the more basic problems that will affect world trade in the atom, and are bound to occupy the attention of lawyers in the atomic industry for some time to come.