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TS 190187
3 December 1964

MEMORANDUM

SUBJECT: Nuclear Weapons Programs Around the World

I. Prerequisites for a Nuclear Weapons Program

A nation must take certain steps before it can produce nuclear weapons. First, either a supply of plutonium or U-235 must be obtained. Plutonium is produced by the irradiation of natural uranium fuel rods in a reactor. The reactors used to produce plutonium can also be used to generate electric power. The number of countries possessing these reactors is increasing.

Much of the information needed to construct simple nuclear weapons from plutonium is available in open literature. An industrialized nation could construct a crude weapon after conducting a few tests, perhaps only one.

In an industrialized nation, a nuclear device probably could be exploded after an initial outlay of $140-180 million. More than half of this outlay would be required for basic research and weapons development. The rest would go toward construction of a reactor, development of urnaium resources or purchase of urnaium feed materials, and construction of a plant for separating plutonium from irradiated fuel rods. Once this outlay had been made, a program to produce one or two 20-kiloton weapons per year, [redacted] would cost $20-30 million annually. To produce 15-30 20-kiloton weapons per year an initial outlay of $600-700 million would be required, followed by annual outlays of $70-100 million.

3.3(b)(1), 6.2(a)

Fission weapons can also be made from U-235. U-235 is separated from natural uranium in a gaseous diffusion plant. These plants are expensive and difficult to operate, which might deter some potential nuclear powers from considering U-235 for weapons use. For example, the initial outlay and annual costs for a program to make 30 20-kiloton weapons from U-235, [redacted] could be as much as double the cost of the same program utilizing plutonium.

6.2(a)

Thermonuclear weapons are much more expensive and complex than fission weapons. The US, the USSR, and the UK now possess thermonuclear weapons, and it is likely that France will detonate its first thermonuclear device in the near future. China probably will test its first thermonuclear device before 1975, but it is unlikely that any other country will.

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II. Safeguards Against Proliferation

In nuclear parlance, the term safeguards refers to the control of nuclear materials and facilities to assure that they are used only for peaceful purposes. Safeguard controls are commonly exercised by the US, Canada, the UK, and other Western countries capable of exporting reactors, uranium, heavy water, and other materials needed to initiate a weapons program.

Controls required by the US and other major countries supplying nuclear materials and technology generally include the submission of periodic reports and the right of inspection for on-the-spot verification of peaceful use. The West European atomic agency, EURATOM, applies similar controls to those reactors and materials which Common Market recipients have agreed to place under its jurisdiction. An effort is being made to have such safeguards applied universally and administered by the International Atomic Energy Agency. Specific sanctions for the violation of safeguards range from requiring the return of the assistance to notification of the UN.

While there are no iron-clad controls to prevent a recipient of material from violating its agreement, suppliers could, of course, refuse to provide further material or technical assistance. As the number of nations supplying technology and materials increases, and as competition among them mounts, the present safeguards program probably will become a less and less effective tool toward prohibiting proliferation.

Adherence to the test ban treaty would not greatly inconvenience a country engaged in a fission weapons development program. Underground testing is somewhat more expensive than atmospheric testing, however.

III. Soviet Union

A. Nuclear Weapons Program

The USSR became interested in nuclear weapons development shortly before World War II, about the same time as the US. Little or no work was carried out during the war, but development was pursued on a crash basis immediately thereafter. The first Soviet fission device was detonated in 1949 and the first thermonuclear device in 1953.

Most of the early Soviet nuclear facilities were located in the Urals. Newer plants have been concentrated farther east, in Central Siberia. [redacted]

3.3(b)(1)

3.3(b)(1)

[redacted]

3.3(b)(1)

The three Soviet plutonium plants--Krasnogarsk, Kyshtym, and Tomsk--have a combined annual capacity [redacted] The Tomsk reactor is the only one in the USSR that produces both electric power and plutonium. At the same time that he announced the cutback in U-235 production, Khrushchev stated that the USSR intended to discontinue construction of two big plutonium-producing reactors. We believe that these reactors are located at Tomsk, but that construction has not been halted.

3.3(b)(1), 6.2(a)

We estimate that cumulative Soviet production of U-235 will reach [redacted] kilograms by the end of this year, and almost [redacted] kilograms by the end of 1970. Cumulative Soviet production of plutonium equivalent is estimated at [redacted] kilograms by the end of 1964, and about [redacted] kilograms by the end of [redacted]

In addition to nuclear weapons production facilities, the USSR now has about 25 research reactors available not only for the development of nuclear weapons, but also for the development of nuclear-fueled propulsion systems and electric power plants, for the manufacture of isotopes needed for medical and agricultural research, and for conducting chemical and physical experiments. Among the peaceful uses of atomic energy of interest to the Soviets are the removal of overburden from mineral deposits and the creation of waterways and harbors by means of nuclear detonation. The use of nuclear power to desalinate water is also receiving much attention in the USSR.

The USSR has conducted most of its nuclear tests at two sites, Novaya Zemlya and Semipalatinsk. Since 1949 we have detected more than 190 explosions, with yields ranging from about 2 kilotons to 55 megatons. This includes 5 underground tests at Semipalatinsk that have been detected since the test ban treaty was initiated in 1963.

B. Delivery Systems

3.3(b)(1), 6.2(a)

To deliver its nuclear weapons, the USSR now has about 200 operational ICBMs carrying warheads of [redacted] About one-fourth of these missiles are in hardened silos. About 20 additional ICBM launchers are available at the Tyuratam missile test range. One new missile under development in the USSR may carry a warhead yielding up to [redacted] The Soviets are now stressing missile deployment in dispersed, hardened silos less vulnerable to destruction than the clustered launchers used previously.

3.3(b)(1), 6.2(a)

The Soviets also have deployed about 740 medium range and intermediate range missiles capable of covering all of Europe and most of Asia and the Middle East. These missiles carry [redacted] warheads. Less than 150 are in hardened silos.

3.3(b)(1)

The Soviet ballistic and cruise missile submarine fleet contains about 76 units, 21 of them nuclear powered. One type Soviet submarine utilizes a
3.3(b)(1), 6.2(a) surface-launched ballistic missile with a range of 350 nautical miles. Each missile carries a [redacted] warhead. Enough of this type submarine are operational to launch about 145 missiles.

A second type Soviet submarine launches 700-nautical-mile ballistic missiles from underwater. Only a small number of these submarines are
3.3(b)(1), 6.2(a) operational, however, and each can carry only 2-3 missiles. The missiles carry [redacted] warheads.

The USSR also has over 30 submarines capable of launching some 140 cruise
3.3(b)(1), 6.2(a) missiles. Most of these missiles have a range of 300 nautical miles but a newer version can go as far as 450 miles. The cruise missiles carry warheads with yields [redacted]

In addition, the USSR has available about 190-220 heavy bombers and 850-900 medium bombers. Of these, only 50-75 of the operational medium bombers
3.3(b)(1), 6.2(a) are supersonic. With aerial refueling, the heavy bombers can cover most of the United States. Each heavy bomber can carry a bomb load of up to [redacted] Recent advances in Soviet weaponry may enable these aircraft to carry the [redacted] bombs that the Soviets have bragged about. The medium bombers, which can reach only a small part of the United States outside Alaska, carry a bomb load of up to [redacted]

C. <u>Attitudes Toward Proliferation</u>

With the exception of its exchanges with Communist China between the mid-1950s and mid-1960, Soviet policy has been to discourage the proliferation of nuclear weapons. The USSR has not given nuclear weapons to any of the satellites and it is unlikely that it will. Although some of the satellites--most notably Czechoslovakia--are building power reactors that could produce plutonium, it is very unlikely that these nations will attempt to develop nuclear weapons.

For many years the USSR exploited uranium deposits in the European satellites. During the past few years the Russians have supplied research reactors to most of the East European nations. They probably exercise tight control over the use of these reactors, which have very little plutonium-producing capacity.

The USSR has supplied or is going to build research reactors in Egypt, Ghana, Afghanistan, Iraq, Yugoslavia, and Indonesia. None is capable of producing significant quantities of nuclear materials. The USSR has given no nuclear aid to Japan or any West European countries and it is unlikely that it will.

3.3(b)(1)

IV. China

A. Nuclear Weapons Program

From about 1955 to mid-1960 the Chinese nuclear weapons program received considerable Soviet aid in the form of technical manpower, technology, and equipment. The withdrawal of this aid in 1960 undoubtedly slowed the Chinese weapons program.

3.3(b)(1), 6.2(a)

China has ample uranium ore deposits, from which it can obtain feed materials for plutonium reactors and isotope separation plants. A plutonium production reactor at Paotou probably can produce [redacted] of plutonium a year, [redacted] This reactor differs from Soviet reactors in that it is air-cooled rather than water-cooled. A possible reactor near Yumen may be in operation and has an estimated output about triple that of the Paotou reactor. It is water-cooled and graphite moderated. An even larger reactor under construction at Yumen probably will not be operational until after mid-1967. The Chinese also have three small research or training-type reactors, none of which is capable of producing significant quantities of plutonium.

3.3(b)(1), 6.2(a)

The Chinese gaseous diffusion plant near Lanchou is small--so small, in fact, that recycling would be needed to obtain U-235 suitable for weapons. This is inefficient, but would be a reasonable choice to make if they were short of equipment. They may also have a second isotope separation facility, perhaps electromagnetic, that has escaped detection. Capacity of the Lanchou plant probably would permit production [redacted] At present, however, the Chinese probably do not have a significant stockpile of either U-235 or plutonium.

3.3(b)(1)

[redacted] Heavy water and graphite are the two materials most commonly used as moderators in reactors. For the manufacture of tritium, an ingredient of boosted weapons, heavy water is a much better moderator than graphite. Heavy water is also a raw material for the manufacture of lithium deuteride, a key ingredient of thermonuclear weapons. We expect the Chinese to build a heavy water plant, since failure to assure themselves of a heavy water supply would hinder them in the development of high yield and sophisticated weapons.

3.3(b)(1)

The Chinese nuclear test facility is located at Lop Nor, in Western China. The Chinese nuclear device detonated on 16 October used U-235 as its fissionable material and had a yield [redacted]

3.3(b)(1) [redacted]

3.3(b)(1), 6.2(a) We believe that the Chinese are striving to develop a [redacted] warhead for missile delivery and that they will need a number of tests and 3-4 years to do it. [redacted] The Chinese probably will not have thermonuclear weapons for some years to come.

The first Chinese nuclear explosion undoubtedly raised their prestige throughout the world. The unexpected sophistication of the device has caused our estimate of Chinese scientific capabilities to be upgraded. The Chinese position vis-a-vis the USSR has been strengthened, and its voice in the international Communist movement commands greater respect. Japan has been challenged as the scientific leader of Asia and India's role as political leader of the unaligned countries has been undermined. Even dimmer, now, are Chinese Nationalist hopes of returning to the mainland. We expect the Red Chinese to increase their support of "wars of liberation."

B. Delivery Systems

Chinese weapons delivery capability is marginal, and it is unlikely that the USSR will give China advanced delivery systems. The Chinese have a number of obsolescent subsonic bombers acquired several years ago from the USSR, but are not known to be developing new bombers. They have about 290 jet light bombers capable of carrying a 6,600 pound payload to a radius of 500-800 nautical miles. China has also two jet medium bombers--capable of delivering a 10,000 pound payload to a radius of 1,550 miles or a 3,300 pound payload to a radius of 1,750 miles--and about 10 B-29 type propeller-driven planes that can carry 20,000-pound payloads to ranges to 1,600-1,800 miles.

The Chinese are probably developing a ballistic missile similar to the SS-4s that the Soviets put in Cuba in 1962. The missile probably will be ready for deployment in the late 1960s. The SS-4 can carry a 2,200-pound warhead to a range of 1,020 nautical miles, and a Chinese missile with this range and payload could cover all of Japan, most of Southeast Asia, and much of Asiatic USSR.

Recent photography shows that at Dairen the Chinese have constructed a missile-launching submarine similar to a Soviet submarine that can fire three ballistic missiles to a range of 350 nautical miles. (The missiles can be launched only while the submarine is surfaced and can carry warheads of 1,500-2,500 pounds.) [redacted]

3.3(b)(1)

C. Attitudes Toward Proliferation

We believe that the Chinese are less concerned about proliferation than the US, the UK, and the USSR. However, for many years China will not be in position to export either nuclear technology or nuclear weapons. In time,

3.3(b)(1)

[redacted]

Indonesia would be a logical recipient of Chinese aid. In addition, the fact that a nation as backward and poor as China could develop a nuclear device also will encourage proliferation.

V. United Kingdom

The United Kingdom has a broad-based nuclear program that includes the world's largest atomic power network. At present, installed nuclear-powered generator capacity in the UK is about 2,500 megawatts, which is 60% greater than installed capacity in the US and three times that of the Soviet Union. Capacity in 1968, when plants at 11 locations will be operating, will be about 5,000 megawatts. The British nuclear power program has been spurred by the fact that nuclear power is more attractive in resources-poor Britain than in countries having large coal, gas, and petroleum reserves. The UK atomic program is supported by more than 50 research reactors.

Among the British nuclear power plants are eight dual purpose reactors that produce both plutonium and power. Four of these reactors are located at Calder Hall and the others at Chapelcross. Each of the eight generates 40 megawatts of electric power and can produce about 75 kilograms of plutonium per year. Because Britain's plutonium requirements are small the eight reactors probably are not operating at capacity. [redacted]

3.3(b)(1),(6), 6.2(a)

The UK's gaseous diffusion plant for producing U-235, located at Capenhurst, is on stand-by status because the British find it cheaper to buy enriched uranium from the US. The capacity of this plant is about 1,200 kilograms of U-235 per year.

The UK has one nuclear-powered hunter-killer submarine powered by a US-built reactor and is building two others containing UK-designed reactors. In addition, 4 nuclear-powered Polaris submarines are being designed or are in early stages of construction.

3.3(b)(1),(6), 6.2(a)

[redacted]

The British strongly oppose proliferation and their exports of nuclear technology and materials always are accompanied by safeguards. Its agreement with the US prohibits the UK from exporting weapons technology.

VI. France

The French nuclear program is broad in scope, and France has the raw materials, production and testing facilities, and delivery systems in existence or under development to support this program. France has uranium ore

3.3(b)(1) [redacted]

reserves capable of yielding at least 50,000 tons of natural uranium, enough to support its nuclear weapons program for many years. It also imports uranium ore from Gabon, Malagasy Republic, and elsewhere. From these various sources, the French annually process about 1,600 metric tons of natural uranium.

3.3(b)(1), 6.2(a) [redacted] Near Chinon the French are constructing three reactors that have been designed to produce electric power, [redacted]

3.3(b)(1), 6.2(a) At present the French have about [redacted] of plutonium available for weapons use, [redacted] By 1970 they could have accumulated about [redacted] from Marcoule alone, and about [redacted] kilograms if operation of the Chinon reactors is maximized for plutonium production.

3.3(b)(1), 6.2(a) France is also building a gaseous diffusion plant at Pierrelatte. While partial operation of the plant already has begun, U-235 enriched to over 90% will not be produced until mid-1967. Initial capacity will be about [redacted] of U-235 per year, or enough for [redacted] thermonuclear weapons. Technical improvements after 1970 might permit production to more than triple. By the end of 1970 the French could have accumulated about [redacted] of enriched uranium for weapons use.

The French now import about 20 metric tons of heavy water annually, most of it from Norway. This imported heavy water does not carry safeguards that restrict its use in the French weapons program. A French heavy water plant with a capacity of 20 tons will be completed in 1966 or 1967. It probably will not fill French heavy water needs, however, and imports are likely to continue. The French also are building facilities for the production of lithium-6 and tritium, two feed materials for thermonuclear weapons.

3.3(b)(1)(6) [redacted]

Under its agreement with the Algerian Government, France will give up its Algerian test site in 1967. A more advanced and larger facility in which atmospheric thermonuclear tests can be conducted is under construction in the Tuamotu Archipelago, southeast of Tahiti.

3.3(b)(1)

The [redacted] nuclear weapon that France now possesses is designed for delivery by the Mirage IV jet bomber, which has a range of about 1,100 nautical miles without refueling and 1,500 miles with aerial refueling. In 1968 the French probably will begin to deploy an intermediate range ballistic missile in hardened silos. This missile will have a range of 1,600 nautical miles and carry a thermonuclear warhead [redacted] The French are also developing a submarine-launched missile force consisting of 3-6 nuclear-powered submarines, each carrying 16 missiles with a range of 1,600 nautical miles. Each missile eventually will have a [redacted] warhead. The first submarine may become operational in 1970.

3.3(b)(1), 6.2(a)

At present France is spending somewhat more than one percent of its gross national product for nuclear weapons and delivery systems. Outlays are expected to be about two percent of GNP in the late 1960s. At that time about one third of French military expenditures will go for these weapons.

The French appear to believe that nuclear proliferation is inevitable. They have stated privately that they will not disseminate nuclear weapons and they probably will not. They have, on the other hand, provided Israel with a reactor and are developing a short-range missile for them around which an Israeli weapons program could develop.

VII. Other Potential Nuclear Powers

Among the countries capable of developing nuclear weapons during the next decade, India, Israel, and Sweden deserve the closest attention. All are in position to develop fission weapons from plutonium. None is likely to build gaseous diffusion plants for obtaining U-235 or to develop thermonuclear weapons, however, because of the high cost and technical complexity.

A. India

There is a good chance that India will embark on a weapons program during the next few years, although shortly after the Chinese test the Indian Government reaffirmed its intention not to develop these weapons. We think pressure by political and military leaders is likely to eventually force a reversal of this decisión.

The Indians fear that possession of nuclear weapons will give the Chinese an overwhelming military superiority. They also believe that recognition of China as a nuclear power entitled to a seat at the disarmament negotiations table would be an irreparable blow to Indian political prestige. Finally, they are afriad that underdeveloped nations will attribute India's failure to develop nuclear weapons to scientific and economic backwardness rather than to a moral decision.

3.3(b)(1) [redacted]

India has adequate reserves of uranium, a uranium metals plant, a facility for fabricating fuel rods, and a chemical separation plant. It is building an installation to recover plutonium metal from fuel rods processed in the chemical separation plant. [redacted]

3.3(b)(1), 6.2(a)

3.3(b)(1), 6.2(a)

Using only the Canada-Indian Reactor, India could accumulate enough plutonium for [redacted] The US and Canada are providing technology and equipment for two more power reactors which will become operational in 1968-70. These reactors probably will be safeguarded to prevent their use in a weapons program. The rate of Indian plutonium accumulation could be increased after 1970, however, as other, unsafeguarded reactors become operational. Two small research reactors in India have no plutonium-producing capacity.

India could test a plutonium device one to three years after a decision to do so. Two additional years would be needed to develop a weapon deliverable by jet bombers that India already possesses. Ballistic missile delivery capabilities are beyond India's reach during this decade.

To date, India has spent about $220 million on its nuclear program, which has been directed toward research and development of electric power. To develop, build, and test an initial nuclear device would require an additional $30-40 million.

B. Israel

Israel probably has decided not to build nuclear weapons. However, there would be a better than even chance that Israel would develop such weapons if it felt that it was unable to maintain its military superiority over the Arabs. If the Arabs acquired a nuclear capability, the Israelis almost certainly would initiate a program.

Israel's atomic energy program is less advanced than India's and the manufacture of nuclear weapons would take longer. Like the Indians, the Israelis claim that development of electric power is the primary goal of their program.

3.3(b)(1), 6.2(a)

France has supplied Israel with a reactor capable of producing enough plutonium [redacted] Israel has its own uranium reserves and facilities for manufacturing fuel rods. It also imports uranium from Argentina.

Israel has no plant for separating plutonium from irradiated fuel rods, however. Unless it received plutonium from another country--an unlikely possibility--detonation of Israel's first device would have to await construction of such a plant, which would take about two years.

3.3(b)(1)

[redacted]

An additional two years would be needed to develop a weapon for the only bomber that Israel possesses. Development of a nuclear warhead for the short-range missile that France is designing for Israel would require four years from the time of the initial blast. The present nosecone consists of 1,870 pounds of TNT and steel; it is much larger than needed to contain this weight, however, and could carry a nuclear warhead. This missile has a range of 270 nautical miles and can reach most of the important urban centers of Egypt, Syria, and Jordan.

3.3(b)(1), 6.2(a)

To convert their present nuclear program to a weapons program producing [redacted] would require expenditure of 1 to 1.5 percent of Israel's gross national product annually for about three years.

C. Sweden

The chances are better than even that Sweden will not initiate a weapons program during this decade. There is strong public sentiment against nuclear weapons development, although Swedish military leaders argue that a nuclear capability is essential to an effective defense posture.

Sweden has a highly advanced nuclear research and power program. It has all the facilities necessary for producing plutonium weapons except a plant for separating plutonium from irradiated fuel rods. Sweden could explode a device about two years after deciding to build such a plant. Development of a fairly sophisticated plutonium weapon would take an additional two or three years.

D. Other Countries

Germany, Italy, and Japan have well-developed nuclear research and power programs. All three countries lack significant domestic supplies of uranium, however, and the materials used in reactors in these countries are carefully safeguarded. Furthermore, in all three countries sentiment against weapons development is very strong. During this decade, it is unlikely that any of the three will begin a weapons program.

Canada, with its well-developed nuclear research and power programs and large uranium resources, has most of the prerequisites for a substantial weapons program. Detonation of a device probably could take place one to two years after a decision to do so. However, the Canadian Government is firmly opposed to development of nuclear weapons, a policy that enjoys strong public support, and we believe it is unlikely that Canada will undertake a weapons program during this decade.