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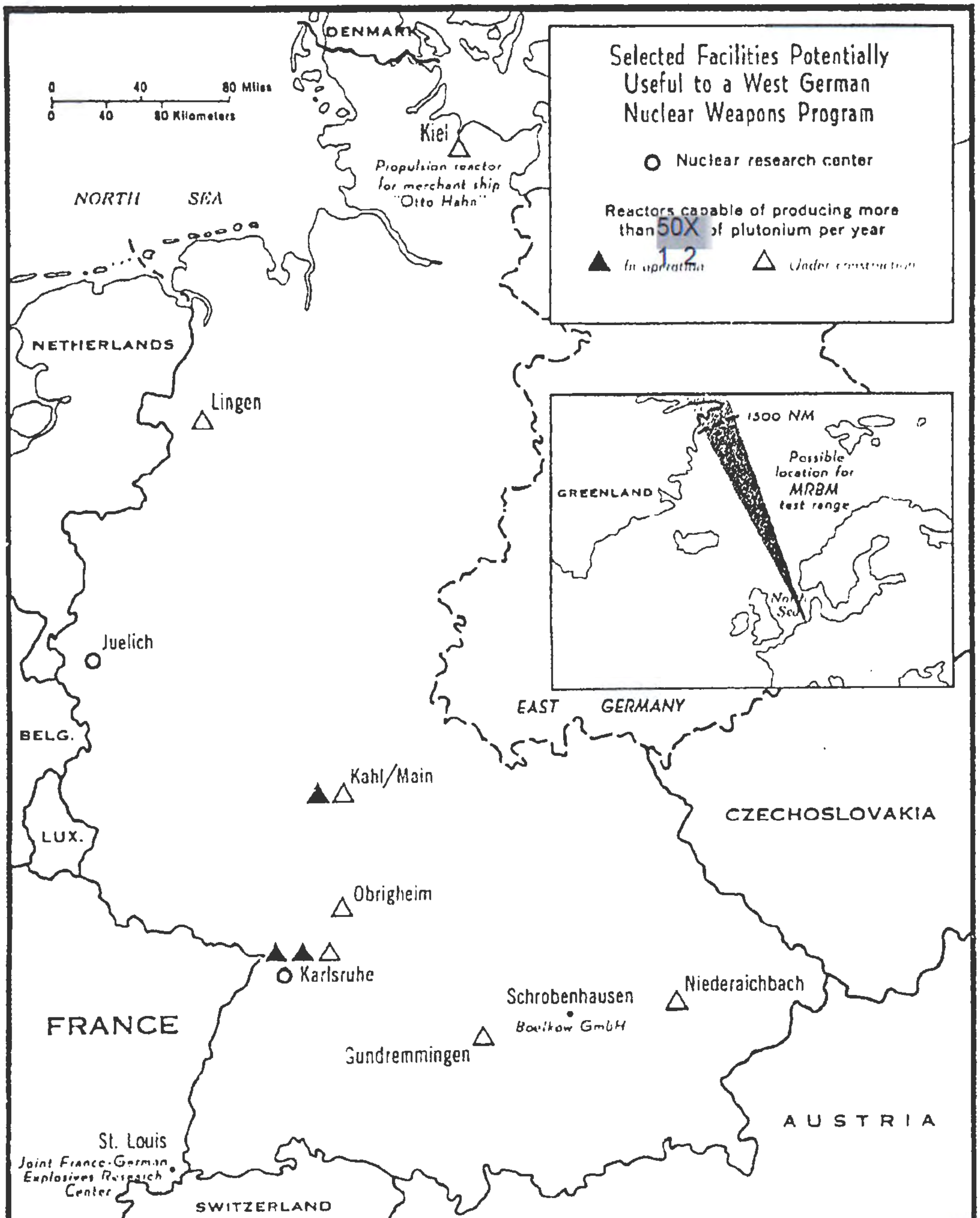

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WEST GERMAN CAPABILITIES AND INTENTIONS TO PRODUCE AND DEPLOY NUCLEAR WEAPONS

CONCLUSIONS

A. West Germany could, if it violated its agreements, have a first nuclear device in two years using domestically produced fissionable material, or in one year if it used fissionable material already supplied for peaceful purposes by the US or Great Britain. (*Para. 12*)

B. West Germany could not deploy a domestically designed missile or supersonic aircraft delivery system able to reach targets in the Western USSR until the early 1970s. (*Paras. 15-16, 19*)

C. For the next several years, West Germany almost certainly will not take the political decision to begin a national nuclear weapons program. Thereafter, the inhibitions on such a program will probably remain strong. However, the future evolution of Europe appears uncertain to German leaders, and they will probably try to keep open any options which might eventually enable them to produce nuclear weapons. (*Paras. 35-41*)

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DISCUSSION

1. West Germany unquestionably has the technical and economic capability to produce nuclear weapons. The likelihood of a political decision to do so is discussed in Section VI. We first examine the questions of how large a nuclear weapons program West German capabilities could support; what kinds of delivery systems West Germany might want and could obtain; and how quickly it could acquire both the weapons and the delivery systems.

I. CAPABILITIES TO PRODUCE NUCLEAR DEVICES

2. West Germany has a larger nuclear research and power program than any other country not already possessing nuclear weapons. The country has in operation or under construction over 20 research reactors, 9 sizable power reactors, and one ship propulsion reactor.[1] The government and industry, convinced that nuclear power soon will become competitive with conventional power, are bending every effort to make Germany a leading world supplier of reactor and nuclear power technology. By the end of 1965 West Germany had spent about $1,000 million on its nuclear program, which began in 1956. Current annual expenditures total about $200 million to $250 million and are rising, with industry accounting for a large part of the increase. Large, well-equipped nuclear research centers, capable of providing excellent training in nuclear and reactor physics, have been established at Karlsruhe and at Juelich. These facilities, plus others at various German universities, would be ample to train personnel for a nuclear weapons program.

A. Natural Uranium Reserves

3. Proven uranium reserves containing about 3,000 tons of uranium metal are located in West Germany. Most of these reserves are fairly low grade ore which cannot be economically processed at the present world market price of uranium. However, they could be used in a weapons program in which cost was not an overriding factor. Three thousand tons of uranium metal could be converted into sufficient plutonium or uranium enriched in U-235 for at least several hundred fission weapons of nominal yield.

4. West Germany probably could import additional uranium, ostensibly for peaceful purposes, without submitting to strict safeguards. Spain, Argentina, and South Africa have in the past sold small quantities of uranium to various countries without safeguards. They, and Brazil, Portugal, and possibly the Congo, might be willing to do so in the future. Canada and Australia have substantial reserves of uranium but probably will continue to insist upon stringent safeguards on any exports. West Germany almost certainly would encounter

[1] See Annex for a list and brief description of all West German reactors in operation or under construction. See also Map for selected West German nuclear facilities.

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major difficulties in importing uranium for an openly acknowledged weapons program.

B. Fissionable Materials

5. *Plutonium.* West Germany could produce plutonium much more easily than uranium enriched in U-235 as fissionable material for a weapons program. We estimate that by 1970 West Germany will have reactors in operation which if operated in a manner to maximize plutonium production could produce about 1,000 kg. per year, enough to produce well over 100 weapons. Table I shows the cumulative amounts of plutonium which West German reactors—other than the small research models—could produce through 1972. Even under a crash program, of course, not all these reactors would be devoted to the maximum production of plutonium for weapons; and the use of any of them in a weapon program would be a violation of safeguards and treaty provisions.

TABLE I

POTENTIAL PLUTONIUM PRODUCTION
OF WEST GERMAN REACTORS
(Existing and under construction)
(Approximate end-of-year cumulative totals in kilograms)[a]

NAME AND LOCATION OF REACTOR	PLUTONIUM AVAILABILITY AT END OF YEAR						
	1966	1967	1968	1969	1970	1971	1972
FR-2 Reactor, Karlsruhe	50X1, 2, 6 [redacted]						
VAK Reactor, Kahl/Main							
MZFR Reactor, Karlsruhe							
KRB Reactor, Gundremmingen							
FDR "Otto Hahn" Ship Propulsion Reactor, Kiel							
HDR Reactor, Kahl/Main							
KBWP Reactor, Obrigheim							
KWL Reactor, Lingen/Ems							
AKB Reactor, Niederaichbach							
KNK Reactor, Karlsruhe							
Potential Total Cumulative Output (kg.)							

[a] These figures take account of the six months for cooling and chemical processing required to make the plutonium available for weapons use.
[b] Includes cumulative production of earlier years.

6. West Germany would need facilities for extracting the plutonium from irradiated fuel elements. 50X1, 2, 6 [redacted] German plans for such facilities call for a small plant at Karlsruhe capable of extracting 50X1, 2, 6 [redacted] of plutonium a year. This plant is scheduled for completion by late 1968 or early 1969. The six Euratom countries are planning to build another plutonium separation plant at Karlsruhe, but this facility will also be fairly small and will be under the joint control of all six nations. Although West Germany has no facilities for converting the plutonium salts which are produced in a separation plant into

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the plutonium metal needed for a weapons program, it could build such facilities in six months or so.

7. There are about 300 kg. of plutonium physically located in West Germany which would not require further processing in a separation plant before being used for weapons. Most of this plutonium has been supplied by the US to Euratom, which in turn has provided it to Germany subject to Euratom safeguards; the remainder has been provided bilaterally by either the US or Britain and comes under safeguards administered by those countries. In view of the great importance which Germany attaches to the Western Alliance, West Germany would not use this plutonium for military purposes.

8. *U-235.* West Germany has done some research on various methods to produce uranium enriched in U-235, which is used as fuel for almost all the reactors in Germany and is also the other main fissionable material used in nuclear weapons. The only method which has progressed beyond preliminary research is the gas ultracentrifuge process. Most ultracentrifuge research has been concentrated at Juelich. In 1960 the German government at US request classified its work on ultracentrifuges; foreign access, including that of the US, has been restricted since that time. 50X1, 2, 6 [redacted] 50X1, 2, 6 [redacted] 50X1, 6 [redacted] Unless much larger funds and a much higher priority are devoted to this project, Germany will probably not be able to construct ultracentrifuge facilities of significant size before 1970. 50X1, 6 [redacted] 50X1, 6 [redacted]

9. West Germany presently has about 1,400 kg. of US-supplied U-235, but only a small portion of this is sufficiently enriched to be suitable for weapons without further processing. The UK has provided smaller amounts of uranium enriched in U-235 as fuel for several West German reactors. As in the case of US and British plutonium, all of this U-235 is under US, Euratom, or UK safeguards.

C. Design and Fabrication

10. If Germany decided to use fissionable material it had obtained from abroad or which was produced in its reactors, it could design and fabricate nuclear devices fairly quickly. The plutonium research facilities at Karlsruhe are among the best in the Western world. Research there is devoted to the development of fast breeder reactors, but German scientists are gaining experience in all phases of plutonium technology. Germany also has the necessary facilities for machining plutonium. 50X1, 6 [redacted] 50X1, 6 [redacted]

50X1, 6 [redacted] 50X1, 6 [redacted] Information on radiation effects would be of value to the basic research and development of a weapons program.

11. One of West Germany's largest aerospace and military hardware firms, Boelkow, GmbH, would probably participate in any national production of nuclear warheads as well as delivery systems. Boelkow now is owned one-third by the Boeing Aircraft Corporation, one-third by the Nord Aviation company of France, and one-third by West German interests. The Schrobenhausen plant of Boelkow, near Munich, is 50X1, 6 [redacted] 50X1, 6 [redacted] This plant is largely funded by, and works on projects for, the research and development division of the defense ministry. The management of the Schrobenhausen Works has an extensive knowledge of implosion techniques. Schrobenhausen is known to have many but not all of the facilities necessary to develop the conventional components of nuclear weapons, and probably could obtain the others without difficulty. 50X1, 6 [redacted] 50X1, 6 [redacted]

D. The Time Required

12. Ignoring safeguards and other political restrictions, West Germany could probably have a first device ready for test in about one year if it used US or British plutonium or U-235 now in Germany. If domestically produced plutonium were used, we do not believe that a first device could be ready for testing in less than two years. The small plutonium separation plant to be built at Karlsruhe could probably be completed—on a crash basis—by early 1968, almost a year sooner than now planned. 50X1, 2, 6 [redacted] 50X1, 2, 6 [redacted] and the first device fabricated by mid-1968, assuming that the weapons development work had been carried out concurrently with construction of the plutonium separation plant. To produce more than a few weapons a year, West Germany would need larger plutonium separation facilities. Construction of a larger plant could probably not be started before early 1967; a plant capable of separating enough plutonium for about 30 weapons a year would take almost three years to complete.

13. West Germany is a signatory to the Partial Test Ban Treaty. Furthermore, there is no area in West Germany where atmospheric tests of nuclear devices could be held safely. However there are sparsely populated regions where underground tests could be conducted. Preparation of a site for an underground test might take longer than fabrication of the device itself, but work on the site could be started concurrently with construction of the plutonium separation plant.

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II. DELIVERY SYSTEMS

A. MRBMs

14. The major emphasis in a West German national nuclear weapons program would probably be on the acquisition of a weapons system with a range of about 1,500 n.m.—great enough to reach targets in the western USSR. West German military doctrine is focused on the Soviet threat to central Europe and is aimed at preventing any prolonged war on German territory. West German planners believe that the best way to prevent such a war is to make sure there is a credible threat of rapid retaliation against Soviet territory itself. In this context, their principal worry is that they do not share in making decisions on the use of long-range weapons systems which could attack the USSR directly.[3]

15. Assuming that a national nuclear weapons program were undertaken, we believe that West German planners would recommend the acquisition of some 60 to 100 MRBMs with nuclear warheads. These would be targeted against major population centers in the European USSR. They could be emplaced in hard and dispersed sites, or some form of land-mobile system might be employed, but West Germany would probably want ultimately to deploy the majority at sea on surface ships or submarines because of the limited depth of its own territory.

16. We estimate that it would take five to six years for West Germany to deploy an effective liquid fuel MRBM. If a solid fuel missile were chosen in order to improve mobility, development and production would take about a year longer, and deployment on submarines would require several more years. Little research and development has been done to date in West Germany on long-range military missile systems, although German firms have done some work on space boosters. US firms have bought into several German aerospace companies, and these companies are participating with US industry in missile-associated programs. They are obtaining access to technology which could reduce the research and development time of a future national missile program.

17. West Germany would encounter substantial but not insurmountable difficulties in establishing a test range for MRBMs. The only way to test such missiles to a 1,500 n.m. range from German territory would be to fire from the North Sea coast in a northwesterly direction to an ocean impact area east of Greenland. This range would pass over the very active North Sea shipping lanes, however, and weather in the Sea of Greenland would probably limit use of the range to summer months. West Germany's only alternative would

50X1, 6
50X1, 6
[redacted] Germany supports a strategy of "forward defense" along its eastern border, under which any necessary means would be used to prevent the loss of even small portions of West German territory. West German planners are concerned that a non-nuclear response to a Soviet incursion into Western Europe would mean the loss of part of their territory. They are equally concerned that a partial escalation to tactical nuclear weapons would result in massive destruction to Germany both East and West.

be to ask some other country for permission to use an existing missile range or set up a new one.

18. We estimate that West Germany could develop a compatible 1,000-1,500 pound fission warhead well within the five or six years needed to deploy an MRBM.

B. Bomber Aircraft

19. A less likely possibility would be the development or acquisition of bombers which could reach targets in the western USSR. The West German aircraft industry has produced, under license from the US, supersonic short-range aircraft such as the F-104G, but the industry has seen little growth and has not done much original design or development in the last decade. West Germany probably would want a bomber with a 1,000-1,500 n.m. combat radius and a mach 2.0 supersonic dash capability, which could carry a bomb 30 inches in diameter and 2,000 pounds in weight. If the West Germans obtained a license to build a foreign-designed aircraft of these specifications, series production could probably begin in two or three years. Native design and production of a bomber with a mach 2.0 supersonic dash capability would take about as long as an MRBM system; production probably could not get underway before the early 1970s. West Germany could produce compatible fission bombs several years before such an aircraft of domestic design could be available.

C. Tactical or Battlefield Systems

20. West Germany already owns a number of short-range nuclear delivery systems provided by the US. The nuclear components for these systems are under strict US control. The West Germans would not go nuclear just to produce their own warheads for these short-range systems, but they might want such warheads as an adjunct to a strategic system. Table II lists the delivery systems which have been provided to West Germany by the US.

TABLE II

PRESENT NUCLEAR DELIVERY SYSTEMS PROVIDED TO WEST GERMANY BY THE US

Delivery System	Range or Combat Radius	Approximate Warhead Weight or Bomb Load
MISSILES:		
Honest John, surface-to-surface rocket	14 n.m. range	1,500 lb. warhead
Sergeant, surface-to-surface missile	75 n.m. range	1,500 lb. warhead
Pershing, surface-to-surface missile	400 n.m. range	800 lb. warhead
Nike-Hercules, surface-to-air missile (can also be used surface-to-surface)	100 n.m. surface-to-surface range	1,000 lb. warhead
AIRCRAFT:		
F-104G, Fighter-Bomber	540 n.m. combat radius	2,000 lb. bomb
ARTILLERY:		
8-Inch Howitzer	8 n.m. range	250 lb. warhead

21. West Germany probably could, if it started now, produce by 1969 or 1970 a fission weapon suitable for the F-104G fighter bomber. By 1971 or 1972 it could probably produce warheads for most of the other weapons listed above, and it would need still more time to produce warheads of less than 1,000 pounds.

FRD [redacted]

D. Atomic Demolition Munitions (ADMs)

22. West German military planners have considered the usefulness of atomic demolition munitions to deter invasion from the East. They have concluded that while certain areas would be suitable for the use of such munitions, these weapons would have to be of very small yield in order to avoid unacceptable risks to West German troops and population. It would take Germany many years to develop such small munitions and we do not believe that the Germans would attempt to produce weapons of such limited use at any early stage of a national program.

E. Other Possible Delivery Systems

23. Later in this decade and in the next, the West Germans intend to purchase or produce new tactical aircraft and short-range surface-to-surface missile systems such as the US Lance, and they may be interested in the French MD-620 or Pluton missiles. Germany has also been working on the development of a tactical air-to-surface missile, originally with France, but now apparently alone. If West Germany acquires such weapons and should want to produce its own nuclear warheads for them, it could eventually do so—the time in each case depending on the weight and yield desired for the respective warhead.

III. COSTS AND ECONOMIC BURDEN

24. A program to produce 30 plutonium fission weapons per year would probably cost about $200 million up to the testing of an initial device. We estimate that thereafter expenses would run about $100 million annually, including $35 to $45 million per year on the research and testing necessary for increasingly sophisticated devices. The cost of developing an MRBM system with 60 to 100 missiles and support equipment would be on the order of $1,000 million to $2,000 million for deployment in hard and dispersed sites, mobile deployment on land, or at sea on surface ships. Deployment on submarines would cost some $600 million to $1,000 million more, depending on whether the submarines were conventionally or nuclear powered. If West Germany decided to develop a bomber force of 75 to 100 aircraft instead of MRBMs, the cost would be about $1,000 million. Operating costs of either the missiles or the bombers after deployment might total $100-$150 million annually. Germany has already paid for its various short-range nuclear delivery systems, and plans to allocate funds for other short-range systems in the future. These costs would not be an additional expense arising from a decision to develop national nuclear weapons.

25. West German defense expenditures now are running about $4,500 million a year, or nearly five percent of the country's gross national product. In order to meet present military goals, a rise in the absolute level of defense spending will be necessary through the mid-1970s. The country's economy will probably grow about four percent a year in this period, however, and defense expenditures—without the addition of a national nuclear force—could be held to five percent of GNP without difficulty. Costs in the early years of an independent nuclear weapons program could even be absorbed in this figure. But thereafter expenses would rise rapidly and would cause either an increase in the proportion of GNP devoted to defense, or sacrifices in other military programs. An increase in defense expenditures to seven percent of GNP would be sufficient to cover the incremental costs of building and operating a nuclear force of the size postulated without diverting funds from other military programs.[3]

26. Such a rise in defense spending would cause minor dislocations of manpower and of research and development activities in non-military sectors of the German economy, which is already operating at full employment. The government would also probably have to change tax rates and monetary policies, or accept a degree of inflation. But there is no question that West Germany could fairly easily afford a national nuclear weapons program.

IV. SAFEGUARDS AND TREATY RESTRICTIONS

27. All known fissionable materials, reactors, ultracentrifuge facilities, and other nuclear research installations in West Germany are covered by either US, Euratom, or British safeguards.[4] Under all three safeguard systems, West Germany has specifically promised not to use these facilities and materials to develop or produce nuclear weapons. Euratom inspectors are allowed to inspect all known West German nuclear installations at times of their own choosing, to check all records and books and to make sample tests of materials. In addition, US or British inspectors have the same rights regarding materials and facilities which are also under bilateral US or UK safeguards. We believe that these safeguards are generally effective in fulfilling their limited function; i.e., they are likely to detect any significant diversion of materials or equipment from the uses intended by the supplier. However, safeguards are concerned more with detection than prevention and, like other international agreements, could be abrogated or violated. The sanctions which would be imposed on West Ger-

[3] Both Great Britain and France now spend about seven percent of their GNP for military purposes. France, with a smaller economy than that of West Germany, has cut back conventional forces considerably in recent years, in part to prevent total defense expenditures from rising more rapidly than GNP.

[4] Most of the larger West German reactors, the plutonium research center at Karlsruhe, the ultracentrifuge facilities at Juelich, and over half of the US-supplied fissionable material in Germany are under Euratom rather than US safeguards. 50X1, 6 [redacted] 50X1, 6 50X1, 6 [redacted] We believe that Euratom safeguards are as good and are administered as effectively as US safeguards.

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many for any violation would depend ultimately on the amount of political, economic, or military pressure which other countries were willing to bring to bear.

28. 50X1, 6
50X1, 6 [redacted]

29. As more reactors are built and the amount of plutonium available in Germany rises, the chance that West Germany could successfully divert small amounts of plutonium will also increase. However, the likelihood that Germany could successfully divert larger amounts—of a kilogram or more—will not increase markedly. Under US, Euratom, and British safeguards the frequency of inspections increases when there is more fissionable material available at a given facility. In addition, under US safeguards, any facility whose inventory or production of material exceeds 60 kg. per year must allow a resident inspector if the US wishes.

30. In addition to safeguards, there are formal treaty restrictions on West German production of both nuclear weapons and delivery systems. Under the West European Union (WEU) Treaty of October 1954, West Germany agreed not to manufacture atomic, biological, and chemical weapons on West German territory. Under the treaty at present, West Germany also cannot manufacture on its territory guided missiles with a range of over 30 kilometers (18.75 miles), submarines of over 1,000 tons displacement, and surface warships of over 6,000 tons displacement. The treaty imposes no restrictions on West German procurement of armaments from outside sources. This treaty was part of the complex of Western postwar agreements in 1954 and 1955 which enabled West Germany to rearm and join NATO and allowed the US, Britain, and France to maintain troops in Germany under NATO auspices rather than as occupying forces. To the extent that future changes in NATO modify any of these arrangements, West Germany could, if it desired, argue that other aspects of the interlocking agreements should no longer apply.

31. Both safeguards and the WEU treaty are major inhibitions on any West German national nuclear weapons program. We do not believe, however, that these inhibitions would prevent Germany from embarking on such a program if it ever decided that vital national interests required it to do so.

V. 50X1, 6
50X1, 6 [redacted]

50X1, 6

[redacted]

VI. THE GERMAN DECISION

35. We think it highly unlikely that the West German Government would embark on a covert nuclear weapons program with any expectation of preserving secrecy. Bonn would almost certainly calculate that several activities involved in developing nuclear weapons and delivery systems would give rise to Allied and Soviet suspicions at an early date, that its intentions would be revealed well

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before it could deploy a strategic weapon system and that the penalties for being caught would be stiff. This being so, the German choice is essentially whether or not to throw off present restrictions and proceed in open defiance.

36. We believe that West Germany almost certainly will not do this during the next several years. A German government could embark on this course only as part and parcel of a fundamental and dramatic change of the country's international orientation. This change would involve the sacrifice of postwar respectability, the loss of US favor and a high risk of forfeiting US protection, strong Soviet hostility and possible retaliation, and the alienation of all the European states. In essence, Germany would be playing a lone hand against the world. Domestic opinion is almost universally opposed to such a course, and it is difficult to believe that, over the next few years, any government would regard Germany's interests as well served by it.

37. In the meantime, however, Bonn will probably want to keep open what options it can for the eventual production of nuclear weapons. Non-weapons programs will continue to increase the country's nuclear resources and improve its technology. The government is likely to carry on research applicable to nuclear weapons, but without committing itself to a weapons program. In all this, West Germany will be seeking to hedge against the uncertainties of its own and Europe's future.

38. In the longer run, a decision to proceed on a nuclear weapons program would be the result of some major frustration of key German interests. It is possible that during the next five years, sentiment for reunification, which appears to be rising, will so change domestic politics as to incline the Germans in this direction. A breaking of West European unity which left Germany isolated and facing an actively hostile France could have a similar effect. Most important of all will be the German estimate of US intentions on two key points: whether the US security guarantee remains valid, and whether the US would in the end acquiesce in an independent German weapons program.

39. We do not believe that West German sentiment in favor of a national nuclear weapons program will be significantly strengthened if Bonn fails to obtain a "hardware" solution to the problem of nuclear sharing in the Alliance. In coming years, the broader trends of European politics will have a much greater impact than any sharing arrangements on German attitudes toward nuclear weapons. If national rivalries in Europe or frustrations over reunification do encourage West Germany to seek such weapons, it will not long be satisfied with arrangements which leave the final decision on use in other hands. If Europe moves in other directions—toward an agreement with the USSR on the German problem and on European security acceptable to the Federal Republic, or toward West European unity, or both—Germany will not have the desire for national weapons which the ANF/MLF or similar proposals are meant to allay.

40. Less important factors will be the experience of present nuclear powers with such weapons and the pace of further proliferation. If British and French

possession of nuclear weapons appears to be bringing London and Paris increased political benefits, Bonn's desires to emulate these neighbors could be stimulated. The use of nuclear weapons in hostilities anywhere in the world would also encourage West Germany (and other countries as well) to desire nuclear weapons. If countries such as India or Israel developed nuclear weapons, West Germany would probably be encouraged to do likewise, but only marginally. If Japan—another previously defeated country now bound in close alliance to the US—were to develop nuclear weapons and get away with it, pressures in West Germany to do likewise might mount appreciably.

41. On balance, we believe that, even five years hence, West Germany will not have committed itself to a national nuclear weapons program. We base this estimate primarily on our view that major changes in the European order, and in German domestic politics, will come about relatively slowly. Even if the pace is quick, and the changes strengthen the arguments for a national program, we believe that the Germans would still want to sound out US reactions and that these would carry considerable weight in their decision.

ANNEX

COMPLETE LIST OF REACTORS IN OPERATION OR UNDER CONSTRUCTION IN WEST GERMANY

I. RESEARCH REACTORS

1. *The AEG-PR-10 Reactor, Grosswelzheim:* A small Argonaut type reactor of 100 watts power: Fueled with 6.4 kg. of U-235 at 20 percent enrichment: Went critical on 27 January 1961: US and Euratom safeguards on both fuel and reactor. Reactor was built by the US and is used for research and materials testing. [redacted]

2. *The BER Reactor, Berlin:* A small 50 KW homogeneous type research reactor, operated by the Free and Technical Universities of Berlin: Fueled with 1.4 kg. of U-235 at 20 percent enrichment: Went critical on 24 July 1958: US and Euratom safeguards on both fuel and reactor: [redacted]

3. *The FR-2 Reactor, Karlsruhe:* A tank type 12 MW (thermal) reactor fueled with 5,100 kg. of natural uranium: Went critical on 3 July 1961: US safeguards on fuel and heavy water, Euratom safeguards on the reactor. [redacted]

4. *The FRF Reactor, Frankfurt:* A small homogeneous type 50 KW reactor: Fueled with 1.4 kg. of U-235 at 20 percent enrichment: Went critical on 10 January 1958: US and Euratom safeguards on both fuel and reactor: [redacted]

5. *The FRG-1 Reactor, Geesthacht:* A swimming pool type heavy water reactor of 2 MW (thermal) power: Fueled with 5.4 kg. of U-235 at 20 percent enrichment: Went critical on 23 October 1958: US and Euratom safeguards on fuel, reactor, and heavy water: Used for research in ship propulsion. [redacted]

6. *The FRG-2 Reactor, Geesthacht:* A swimming pool type heavy water reactor of 2 MW (thermal) power: Fueled with 3.0 kg. of U-235 at 90 percent enrichment: Went critical on 15 March 1963: US and Euratom safeguards on the fuel, reactor, and the heavy water: Installed in same pool as FRG-1: Modifications are expected to raise total combined power to 10-15 MW (thermal). [redacted]

[redacted]

7. *The FRJ-1 (Merlin) Reactor, Juelich:* A swimming pool type reactor of 5 MW (thermal) power: Present fuel loading is 4.5 kg. of U-235 at 80 percent enrichment: Provided by the British: A second fuel loading of U-235 enriched to 90 percent provided by the US is in storage: Reactor went critical on 23 February 1962: Both UK and Euratom safeguards on present fuel and reactor; US safeguards on next fuel loading. 50X1, 2 [redacted] 50X1, 2

8. *The FRJ-2 (Dido) Reactor, Juelich:* A heavy water tank type reactor of 10 MW (thermal) power: Fueled with 2.8 kg. of U-235 at 93 percent enrichment: Went critical on 14 November 1962: UK and Euratom safeguards on fuel and reactor: US safeguards on the heavy water: 50X1, 2 [redacted] 50X1, 2

9. *The FRM Reactor, Munich:* A pool type reactor originally of 1 MW (thermal) power, to be raised to 4 MW (thermal) power in 1966: Fueled with 4.3 kg. of U-235 at 90 percent enrichment: Went critical 31 October 1957: US and Euratom safeguards on both fuel and reactor: 50X1, 2 [redacted] 50X1, 2

10. *The FRMZ Reactor, Mainz:* A Triga Mark II type reactor of 100 KW power pulsed to 250 MW (thermal): Fueled with 213 kg. of U-235 at 20 percent enrichment: Went critical on 3 August 1965: US and Euratom safeguards on both fuel and reactor: 50X1, 2 [redacted]

11. *The PTB Reactor, Braunschweig:* A tank type reactor of 1.0 MW (thermal) power: Core A fueled with 3.2 kg. of U-235 at 90 percent enrichment; core B fueled with twice 2.9 kg. of U-235 at 90 percent enrichment: Will probably go critical in 1966: Euratom safeguards: 50X1, 2 [redacted] 50X1, 2

12. *The SAR-1 Reactor, Munich:* A small Argonaut type reactor of 1 KW power: Fueled with 5.7 kg. of U-235 at 20 percent enrichment: Went critical on 23 June 1959: US and Euratom safeguards on both fuel and reactor: 50X1, 2 [redacted]

13. *The SNEAK Fast Critical Assembly, Karlsruhe:* Zero power: Fueled with 0.3 tons of plutonium and 0.5 tons of natural uranium: Will probably go critical some time in 1966: Both US and Euratom safeguards: To be used for fast breeder reactor research: 50X1, 2 [redacted] 50X1, 2

14. *The STARK Reactor, Karlsruhe:* A two zone Argonaut type reactor of zero power: Fueled with 5.6 kg. of U-235 at 20 percent enrichment in the slow zone, and with 90 kg. of U-235 at 20 percent enrichment in the fast zone: First zone went critical 11 January 1963 and second zone went critical on 24 June 1964: US and Euratom safeguards: 50X1, 2 [redacted] 50X1, 2

15. *The SUR-100 Reactor, Aachen:*

16. *The SUR-100 Reactor, Berlin:*

17. *The SUR-100 Reactor, Bremen:*

18. *The SUR-100 Reactor, Darmstadt:*

19. *The SUR-100 Reactor, Munich:*

20. *The SUR-100 Reactor, Hamburg:*

21. *The SUR-100 Reactor, Kiel:*

22. *The SUR-100 Reactor, Stuttgart:*

23. *The SUR-100 Reactor, Ulm:*

These are all small homogeneous reactors of low power—0.1 watt: Fueled with 700 grams of U-235 at 20 percent enrichment: Most are completed but several are still under construction: All are under both US and Euratom safeguards: All are used for minor research and teaching: Built by Siemens, they are German versions of the Argonaut reactors: [redacted] 50X1, 2 50X1, 2

II. POWER REACTORS

1. *The AKB Reactor, Niederaichbach:* A pressure tube type reactor of 400 MW (thermal) power and 100 MW (electric) power: Fuel will be U-235 of low enrichment or natural uranium: Will probably go critical in 1968 or 1969: Euratom safeguards: [redacted] 50X1, 2 50X1, 2

2. *The AVR Reactor, Juelich:* A pebble bed reactor of 50 MW (thermal) power and 15 MW (electric) power: Fueled with 17 kg. of U-235 at 93 [redacted] 50X1, 2 enrichment: Will probably go critical in 1966: Euratom safeguards: [redacted] 50X1, 2 50X1, 2

3. *The HDR Reactor, Kahl/Main:* A boiling water reactor with nuclear superheating: Has a power rating of 100 MW (thermal) and 25 MW (electric): Will be fueled with 260 kg. of U-235 at 2.5 percent enrichment (to be delivered in 1967): Will probably go critical in 1968: Both US and Euratom safeguards will be applicable: [redacted] 50X1, 2

4. *The KBWP Reactor, Obrigheim:* A pressurized water reactor of 900 MW (thermal) power and 280 MW (electric) power: Will be fueled with 668 kg. of U-235 at 2.5 percent enrichment (fuel to be delivered in 1968): Reactor will probably be completed and go critical in 1968. Euratom safeguards: [redacted] 50X1, 2 50X1, 2

5. *The KNK Reactor, Karlsruhe:* An experimental power reactor rated at 60 MW (thermal) and 20 MW (electric): Fueled with 112 kg. of U-235 at 6.8 percent enrichment: Will probably go critical in 1968 or 1969: Euratom safeguards: [redacted] 50X1, 2

6. *The KRB Reactor, Gundremmingen:* A boiling water reactor of 800 MW (thermal) and 240 (electric) power: To be fueled with 1,088 kg. of U-235 at 2.5 percent enrichment (to be delivered some time in 1966): Should be completed and go critical some time in 1966: Euratom safeguards: [redacted]

7. *The KWL Reactor, Lingen:* A boiling water reactor with conventional superheat: Rated at 520 MW (thermal) and 250 MW (electric): To be fueled with 878 kg. of U-235 at 2.3 percent enrichment: Fuel to be delivered in 1968: Reactor will probably go critical in 1968: Euratom safeguards: [redacted]

8. *The MZFR Reactor, Karlsruhe:* A pressurized boiling heavy water reactor of 200 MW (thermal) power and 50 MW (electric) power: Fueled with 13.5 tons of natural uranium: Went critical on 29 September 1965: Euratom safeguards plus US safeguards limited to the heavy water: [redacted]

9. *The VAK Reactor, Kahl/Main:* A boiling water reactor of 60 MW (thermal) power and 15 MW (electric) power: Fueled with 127 kg. of U-235 contained in 5.56 tons of uranium dioxide enriched to 2.6 percent: Went critical on 13 November 1960: Both US and Euratom safeguards on fuel and reactor: [redacted]

III. SHIP PROPULSION REACTOR

1. *The FDR Reactor:* A reactor now being installed in the merchant ship "Otto Hahn" at Kiel: Power rating to be 40 MW (thermal): To be fueled with 2.95 tons of uranium dioxide enriched to 4.02 percent: To be completed and go critical some time in 1966: Euratom safeguards: [redacted]

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