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PROLIFERATION OF MISSILE DELIVERY SYSTEMS FOR NUCLEAR WEAPONS

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INTRODUCTION

It is sometimes assumed that any nation with a moderate scientific and technical base can develop ballistic missile weapons systems* without great difficulty. The only nations that have developed ballistic missile systems using essentially native resources have been World War II Germany, the USSR, and the United States, and both of the latter initially made extensive use of German equipment, personnel, and experience in their programs. Since World War II, five other nations have established serious programs to acquire missile delivery systems capable of carrying nuclear payloads. These are Communist China, France, Israel, Egypt, and the UK. Despite a great investment of time and effort, together with a considerable amount of foreign assistance, none of these countries has yet successfully deployed a military missile system. The Chinese program, although now struggling for self-sufficiency, originally was primarily dependent on Soviet assistance and direction. The UK, which received substantial assistance from the US, has terminated its development efforts in favor of purchasing a US system. The Egyptian program, which had European assistance, has all but ended in failure. Both France and Israel have benefited from substantial US assistance.

The US Government has not provided major components or subsystems of actual missiles to any of these native development programs. However, US industry has been supplying considerable assistance. One form of this assistance has been general end-use items such as umbilical connectors, accelerometers, gyroscopes, tracking equipment, telemetry equipment, and computers, which play an important but secondary role in missile development. A second form of assistance has been component and subsystem production by foreign subsidiaries or licensees in the country concerned. These agreements usually provide for US technical personnel to assist in this production by means of training programs, both design and production assistance, and on-the-spot trouble shooting.

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*In this paper, surface-to-surface ballistic missile systems have been defined in terms of their ranges as follows (in nautical miles): SRBM (short-range ballistic missile)--up to 600; MRBM (medium-range ballistic missile)--600 to 1,500; IRBM (intermediate-range ballistic missile)--1,500 to 3,000; and ICBM (intercontinental ballistic missile)--over 3,000.

A third category of assistance is the US export of equipment for use in fabricating and testing missile components. Many times these machines are general purpose; sometimes they are unique items.

There have been few if any instances in which the items or assistance provided by the US, if withheld, would be critical to the foreign missile development program. In each case, it is likely that the country concerned could acquire a substitute or develop a replacement for any US-supplied item by paying a penalty in time, money, and possibly a degradation in performance. However, when this assistance is taken in total it is clear that the cost of these foreign missile development programs and the time required for their fulfillment would increase markedly if access to US markets were denied. This denial would certainly cause a major policy review of the programs and might prompt cancellation altogether in certain cases. The time periods estimated in the following text assume that access to the US aerospace market remains unchanged.

Except for the Communist Chinese, the Soviets have never assisted any foreign country in the development of a strategic missile capability. Their sales of surface-to-surface missiles have been limited to tactical missiles.

In the country-by-country breakdown that follows, France and the United Kingdom have been treated first because they are the best potential sources of missiles or missile technology other than the US. The remaining nations considered have been discussed in a generally descending order of importance.

FRANCE

French activity in the ballistic missile development field is of special importance for two reasons. First, it is the only country other than the US, the USSR, and Communist China that is developing ballistic missile systems up through IRBM and possibly ICBM classes. Secondly, it is the only country other than the US that is supplying a missile system of strategic value to a foreign country, and it appears that it might be persuaded to supply missiles to other countries within the next ten years.

A considerable number of different ballistic missile systems with ranges in excess of 200 nautical miles are being

developed or are under study by the French. The system of most immediate concern is the short-range MD-620 surface-to-surface missile, being developed by Avions Marcel Dassault for the Israeli Government. It is estimated that this system could become operational about mid-1970 at the earliest. The terms of the agreement between the French and Israeli Governments are largely unknown but they may permit the sale of the MD-620 to other countries as well.

Of greater strategic interest is the SSBS system (sol-sol balistique stratégique or surface-to-surface ballistic missile) being developed for silo launch. This system is expected to carry a reentry vehicle of 1,500 pounds to a maximum range of about 1,600 nautical miles with a CEP of one to two nautical miles. The missile should be operational sometime in 1970. There is no indication, however, that the French are considering the sale of this IRBM system to any foreign country. If it were to become available, the most likely customers probably would be India and Japan, and perhaps West Germany.

The French also are developing a Polaris-type missile system called the MSBS (mer-sol balistique stratégique or sea-to-surface ballistic missile), which will be operational about 1971. The missile may be able to deliver a 1,500-pound reentry vehicle to a maximum range of about 1,500 nautical miles or a 3,000 pound RV to about 1,000 n.m. It does not appear, however, that other countries will be greatly interested in this system, with the possible exceptions of West Germany and Italy.

In addition to these three systems, the French have another, the Saphir, which could be easily adapted for an operational ballistic missile. The two-stage Saphir originally was designed as a possible ballistic missile and as an experimental test vehicle. Twelve launches of the Saphir were conducted from Hammaguir, Algeria, to test the SSBS reentry vehicle and guidance system. Development of the Saphir, therefore, as a ballistic missile system essentially is complete and would require only a few more flight tests and the design and construction of the necessary ground support equipment to bring the system to a deployable stage.

The French also are studying three-stage missiles in the ICBM class and have static tested a booster capable of being used as the first stage.

In the event that one of the less-advanced countries elects to develop its own missile system, France probably would be one of the countries approached for missile technology. Although their technology is not comparable with that of the US, the French have sufficient knowledge and experience to be of great assistance in providing technicians, critical technology, and components to any such country. A considerable portion of the French capability was acquired from the US, and most of the US components being produced under license are under at least some restrictions for sale to other countries. It is believed that the French will honor these agreements. US-designed components modified by the French, though, probably will be considered free of restriction and in some cases might be sold to foreign countries.

Competent in most of the fields involved in missile development, the French have an excellent capability for the development of both large composite solid and storable liquid propellant boosters. They still are having difficulty in producing satisfactory components for inertial guidance systems, but because of work presently underway, these problems should be solved in the next year or two. The French could be of most assistance to a less-developed country in the fields of booster development and guidance technology.

UNITED KINGDOM

The United Kingdom occupies a somewhat unique position with respect to the missile proliferation problem in that it has one of the best capabilities to develop and produce sophisticated ballistic missile systems, but has chosen to put this capability to use mainly in native and multinational space research programs. However, the country's high level of competence in most facets of missile technology makes it a very likely source of technical assistance and components for other countries wishing to develop a ballistic missile system.

Except for a few weaknesses, the British have a good to excellent capability for the development of ballistic missiles. They surpass France and the other countries discussed in the design, development, and production of sophisticated inertial guidance platforms and navigational systems. They have an excellent capability for the development of large liquid-propellant boosters as a result of their Blue Streak and the Black Knight programs. Their development capability in

reentry vehicles is also high, primarily because of a cooperative test program with the US and access to US technology. They have a good capability for developing solid-propellant boosters and high-energy stages (e.g., liquid oxygen/liquid hydrogen). However, this capability is inferior to that of the French who are receiving considerable assistance from the US. In most other aspects of missile development, the British are generally quite competent--equal to the French and superior to other Western European countries.

Despite the size of the UK aerospace industry, there are no current native ballistic missile development programs, although there are a number of tactical missiles being developed or in production. The British strategic missile program is based on the purchase of the US A-3 Polaris system with the Mark 2 reentry vehicle, less warhead.

The native British rocket-motor program consists of the development and production of a very few types of sounding rockets, the first stage of the ELDO satellite launch vehicle, and a native satellite-launch vehicle. Their first successful space research vehicle was the solid-propellant Skylark sounding rocket.

The largest vehicle under development is the liquid-propellant Blue Streak which originally was conceived in 1955 as an IRBM but concelled in 1960. Subsequently, it was taken over by European Launcher Development Organization (ELDO) and successful flight tests have been conducted at Woomera in Australia. Another liquid-propellant vehicle, the single-stage Black Knight, was developed (by Westland Aircraft, Ltd., in collaboration with the Royal Aircraft Establishment) as a reentry test vehicle for nose cone and warhead development for the Blue Streak IRBM. A two-stage version with a solid-propellant second stage has been used for reentry experiments. The British also are developing a three-stage satellite launch vehicle, the Black Arrow, which will have a performance similar to the US Scout.

Even though the UK has no native ballistic missile effort, its high level of technology in most facets of missile development makes it a very likely source for missile technology and components for a lesser developed country wishing to develop a ballistic missile system. The British could be of greatest assistance in the guidance field, which is the most critical factor in the development of such a system. Some of the key

components (e.g., gyros) used in their most advanced systems are being produced under license from several US firms and probably would not be available for export. However, cheaper, less sophisticated, but adequate components of British design would not have this restriction, and a less inexpensive inertial guidance system could be developed based on such components. Although such a system would undoubtedly be less accurate than systems using US-developed components (i.e., probably one to two nautical miles versus less than one nautical mile at a range of 200 nautical miles), it would be adequate for a ballistic missile being developed by a lesser developed country. The British also could be of great assistance in the field of reentry technology for longer range ballistic missiles, probably the next most difficult problem after guidance. The British might export guidance technology and components, but they would not be likely to release reentry technology.

In the less critical fields of missile technology, the British could be of considerable assistance. They are largely free of licensing restrictions. Very little ballistic-missile-related technology or components has been exported as far as is known. Although the British Government may have a policy against exporting such assistance, it is possible that very little has been requested because such assistance was available until recently from the US. It is believed, though, that if a country such as India decided to develop its own ballistic missile system, a considerable amount of aid could be obtained from the UK.

INDIA

India has had an active research rocket launch program for several years. An adequate, though modest, launch facility designated the Thumba Equatorial Rocket Launching Station has been in operation since late 1963. The facility, which is one of the few sites located near the geomagnetic equator, has been accorded UN sponsorship as an international rocket range. Thus far, only US and French-supplied sounding rockets have been launched from Thumba, in many cases carrying Indian-designed and produced scientific payloads for study of upper atmosphere phenomena. The Indian range personnel have for the most part received training in the US or France and have acquired considerable experience in the launching of sounding rockets. Nevertheless, the available information

indicates the launch operations are still conducted in a rather unprofessional and uncoordinated fashion.

The geographical location of the Thumba facility near the southern tip of the Indian subcontinent would give it excellent access to ocean impact areas up to at least IRBM range should a strategic missile program be undertaken.

In addition to the firing of foreign-supplied sounding rockets at Thumba, India probably has begun the production of two-stage solid-propellant Centaure research rockets under a French license. The manufacturing probably involved the use of some imported components and materials, including the special steels for the motor cases and the motor nozzles. The rocket motor cases are to be fabricated at the Atomic Energy Commission's workshop facilities near Bombay. The propellant for the Centaure apparently will be produced at a plant presently under construction near the Thumba rangehead. It will add to the Indian's basic knowledge in the area of rocket technology. However, as in the K-13 program, it will not have any direct military application.

A space science and technology center is now under construction near the Thumba rangehead. Some facilities have already been completed, including static test stands for small solid-propellant rocket motors. The Indians are attempting to develop a native-designed sounding rocket at this facility for use in meteorological research. Some limited development work has already been conducted, apparently with little success. It appears that the project has a low priority and that there is little interface with the Centaure or other programs.

An attempt by India to acquire nuclear-capable missile delivery systems would undoubtedly be in direct response to progress shown in this area by Communist China or Pakistan. The detonations of China's nuclear devices have already led to serious discussion within India on the advisability of developing nuclear weapons. Such a course of action would be even more likely should Pakistan somehow obtain strategic missiles.

It is presumed that Communist China and Pakistan would be the only countries against which Indian nuclear-capable missile systems might be targeted. In the case of Pakistan,

a relatively short-range system with a range capability on the order of about 400 nautical miles would suffice. The Indians might look to foreign sources for such a system rather than attempt to develop it within the country. For example, the French MD-620, under development for Israel, would fill the Indian requirement if it were fitted with a reentry vehicle weighing about 2,000 pounds. It is conceivable that this system, or one similar to it, could become available for sale to India at some future time.

India would, however, require a missile delivery system in the IRBM category for use against major targets in Communist China. A system in this category could conceivably be purchased abroad, although such an agreement would obviously be much more difficult and costly to arrange than for a short-range system. France is presently testing a ballistic missile with a range of about 1,600 nautical miles. A few weeks after the Communist Chinese detonated their first nuclear device (October 1964), a high-level Indian delegation reportedly arrived in Paris to discuss the purchase of an offensive missile system, and additional discussions may have taken place since that time.

In sharp contrast to its achievements in the field of nuclear energy, India has thus far demonstrated a rather limited capability in those scientific, technical, and industrial areas that would be required to support a basically indigenous strategic missile development program. This is particularly applicable to the chemical, electronic, and aeronautical industries. In light of these deficiencies and the general lack of directly usable missile experience to date, India would probably be forced to seek considerable external assistance should it decide to develop and produce such missiles domestically. This would include the systematic exploitation of large quantities of available open technical literature in the field, the purchase of large numbers of specialized missile components and missile test equipment, and probably the hiring of at least some key foreign missile engineers and technicians. Such a program, if begun in the near future, would probably take at least ten years to produce a successful system, and, even then, one which would probably be quite unsophisticated, even by current Western and Soviet standards.

If the possibility of such aid coming from the US, UK, or USSR is excluded, the most likely source of assistance would be France. Although the Japanese have demonstrated a significant degree of proficiency in the development of

large sounding rockets and are currently developing satellite launch vehicles, they have done relatively little work in the development of guidance systems or reentry vehicles which would be suitable for strategic missiles.

ISRAEL

Israel has chosen to purchase a powerful strategic deterrent in the form of a short-range, nuclear-capable, land-based ballistic missile force. In an attempt to obtain a deployed system in the shortest time and at minimum cost, the Israeli Government contracted with the French to design, test, and produce for them the nuclear-capable MD-620 system. Other factors leading to the foreign purchase undoubtedly were their limited scientific and technical resources and shallow industrial base.

The complete Israeli missile system is being developed under a contract with the French firm Avions Marcel Dassault. The missile itself is about 45 feet long, 31.6 inches in diameter, and has a range of about 260 nautical miles with a 2,200 pound warhead. It is currently being flight tested at the French Ile du Levant Missile Test Range. Initial operational capability (IOC) of the system is estimated to be about mid-1970 at the earliest. It is believed that the Israelis have obtained some missiles as well as ground support and maintenance equipment for systems familiarization and training purposes. The number of missiles to be purchased is not known, and it is possible that the figure has not yet been fixed. The contract with Dassault reportedly included 25 test missiles.

It has become evident over the past few years that the Israeli Government is developing a native missile research and development capability. This effort in anticipation of native production of the MD-620 appears to include literally all aspects of missile technology, from basic fuels and aerodynamics to flight-test instrumentation systems.

Israel is engaged in several other native missile programs, including a short range ship-to-ship or shore-to-ship missile system as well as an air-to-air system and an unguided tactical surface-to-surface rocket. The country has a very competent though small corps of scientists and technicians to carry out these domestic efforts, but relies on outside purchase of

components and technology. It is apparent that Israel prefers to buy what it cannot easily produce.

Some research and/or purchasing activity is being conducted by Israel in almost every field that could have application to missiles--rocket engines, propellants, airframes, guidance, and range instrumentation. The research is carried on probably by a small group of competent scientists and technicians who have been assisted by a wide variety of Western (especially US) technology and hardware. The Israelis are procuring, wherever possible, applicable foreign missile technology and key components, obviously in order to bypass expensive and time-consuming native research. Over the past several years, Israeli Government representatives have approached (with varying degrees of success) many US and Western European missile system component manufacturers, mainly in the fields of guidance, range instrumentation, solid-propellant technology, exhaust nozzle materials, and ordnance hardware for ignition and stage separation. Their approaches have taken the form of outright purchases, requests for quotations and/or technical information, and personal plant visits and tours. In several instances the Israelis, with apparently little or no intention of purchasing the item, obtained a few samples or drawings, apparently from which to produce native copies in Israel. In this way, they probably have gained a significant amount of basic design and engineering data. In addition, there is a distinct association of certain Israeli university research programs and applications in the field of missiles.

The Israelis would encounter little difficulty, other than the expense, of establishing or obtaining access to a missile test range. There are indications that they plan to construct a strategic missile launching area for the MD-620 missile. These sites could also house flight-test facilities for the native-designed missile system, using the Mediterranean Sea for impact.

Israel has no space program of note which might be used as a cover for a military program or from which significant technology could be obtained. A sounding rocket program was begun about 1958 but probably was canceled about 1962.

JAPAN

It appears that Communist China is the only country

against which Japan might want to deploy strategic missiles during the next ten years. The areas of heaviest Chinese population, industry and agriculture are concentrated within 1,500 nautical miles of Japan. Thus, a relatively small force of Japanese MRBM's could do very substantial damage in China, and could provide an effective deterrent.

Japan possesses a considerable portion of the scientific and technical competence required to develop nuclear-capable missile delivery systems. The level of technology in areas directly related to efforts of this kind, e.g., aeronautics, propellants, metallurgy, and electronics is more than adequate to sustain such a program.

Of particular significance and applicability are the advances made in recent years by the Japanese in the field of space research and the development of launch vehicles. These achievements have brought Japan near to being the fourth nation to orbit a satellite with a native-developed booster. The experience gained in the development, testing, and production of the hardware associated with these programs would be of considerable value in any ballistic missile development effort.

The Japanese have so far not produced any missile systems capable of delivering a nuclear warhead. Purely domestic missile efforts have thus far been limited to R&D and some production of defensive systems such as air-to-air, surface-to-air, and short-range tactical missiles. In addition, the Japanese are producing or will produce US Hawk and Nike surface-to-air missiles and the Sidewinder air-to-air missile under license.

A "Type 30" unguided rocket, similar in many respects to the US Little John artillery rocket, was in the final stages of development and testing in 1967. The Type 30 rocket will reportedly carry a conventional warhead weighing about 330 pounds to a maximum range of 15 nautical miles.

As indicated above, any Japanese development of a nuclear-capable missile delivery system would undoubtedly rely heavily on the sounding rocket and satellite programs

already in existence. It is considered very likely that the most advanced of the launch vehicles currently under development, the four-stage, solid-propellant Mu, would form the basis for the development of a strategic missile system.

It is clear that the Mu has a definite potential, at least from the propulsion standpoint, of being converted into a nuclear-capable missile delivery system, and it is believed that the Japanese would view such a conversion as the quickest and most feasible means of obtaining such a weapon. The pacing factor in the conversion of the Mu to a military missile system would appear to be the acquisition of the guidance system. In its present satellite launch role, the Mu vehicle has only a relatively simple attitude control system, and the Japanese have placed relatively little emphasis on guidance until recently. Consequently, this area represents the weakest area in their missile-related technology. Moreover, the basic components for the attitude control system to be used with both the Lambda IV and Mu satellite launchers were acquired from the US.

Based on the current estimated Japanese state- of-the-art in the field, it is likely that it would take at least three years to develop a satisfactory missile guidance system without further external aid. Development of a fully inertial system would take somewhat longer. In both cases, these times could be reduced if a complete guidance package, or at least the major components thereof, were acquired from foreign sources. Some assistance for the development of a guidance package for the Mu could be obtained through existing channels between Japanese and US aerospace firms, but a major assistance program would require a change in US policy. In the next decade, however, assistance might be obtainable from the UK and France. In fact, there was some indication that the Japanese approached the French Government shortly after the detonation of China's first nuclear device in October 1964 to discuss the acquisition of a nuclear-capable missile delivery system, presumably the French IRBM under development.

Aside from the technical problems already discussed, there would probably be few other, if any, serious barriers to the modification of the Mu to a strategic missile role. It is estimated that the Japanese would require a minimum of four years to develop a nuclear-capable missile delivery system based on the Mu satellite launch vehicle.

Japan has the capability to provide other nations with technology which could be used in developing ballistic missile systems. As indicated above, Japan is quite advanced in many areas associated with the development of military missiles, with the exception of guidance systems. However, even this deficiency will undoubtedly be overcome to a large extent in the coming decade. Japan has already provided Yugoslavia and Indonesia with sounding rocket plans, components, and technology (Kappa Series) and has negotiated with a number of other countries requesting similar assistance. However, this type of aid has practically no directly related military applicability. Japan will almost certainly continue to sell such services to lesser developed nations in the future and will probably attempt to expand these efforts.

Communist China has found Japan to be a vital source of supply for large quantities of scientific, technical, and industrial equipment, instruments and associated technology. Although the final end-use of this trade in most cases cannot be demonstrated with any certainty, China's advanced weapons programs have undoubtedly been major benefactors. The flow of this trade will probably not be significantly reduced until such time as the threat posed to Japanese national security by China is clearly greater than the advantages derived from the commercial relationships between the two countries.

SWEDEN

Sweden has expended a substantial portion of its national income for defense to preserve its traditional neutrality. Sweden's policy has been to exclude from its defense any delivery system that could be construed as offensive or that might be incompatible with Swedish neutrality, and to limit its military commitment to tactical defensive systems. All long-term proposals of the Swedish defense establishment indicate that this policy will continue unchanged.

Sweden's principal defense concern, and the one which might induce her to acquire a nuclear weapons delivery capability, is the possibility of invasion by the USSR. A Swedish nuclear weapons program would most likely rely upon the Draken and Viggen aircraft as nuclear carriers. Sweden is not expected to attempt to acquire offensive missiles.

UNITED ARAB REPUBLIC

In 1960 the Egyptians began a native program to develop two short-range ballistic missiles. In about mid-1967 one of these missiles, the Victor, was cancelled and work on the other, the Conqueror, was suspended because of technical and financial difficulties. In so far as is known the Conqueror program has not been resumed. It originally was designed to be as cheap and simple as possible, however, modifications in the system in the hope of making it work increased both the complexity and cost of the system thereby making the missile less desirable to the Egyptians and probably contributed to its suspension. Technical problems in the missile's propulsion system probably could be solved provided adequate resources were applied, but at least five years would be required to develop a satisfactory system.

WEST GERMANY

West Germany has a fairly good native missile development capability and a high level of technology and could develop missile systems through ICBM ranges without additional outside assistance. There exists a very good capability for the development of storable liquid-propulsion systems, a limited capability for the production of larger solid-propellant rocket motors, and only limited experience with inertial guidance systems.

As a result of their role in the production of the US Hawk system and in the maintenance of the US Sergeant and Pershing tactical nuclear missile systems, the highly developed German industrial base already has some familiarity with modern production methods for missiles and test equipment.

Work is currently being performed at three locations in West Germany that is capable of being converted to liquid-propellant medium- or intermediate-range missile development.

There is also some solid-propellant research and development underway in West Germany for use in meteorological and military tactical rockets. This technology is of sufficient quality so that solid-propellant boosters for medium- and intermediate-range missiles are within the

capabilities of the West Germans, although new production and test facilities would have to be constructed. The leading firm in the solid propellant field is Nitrochemie, Liebenau. Composite US solid-propellant technology is available to Nitrochemie through its part ownership of Aerochemie, the Italian producer of solid motors for licensed production of the US Hawk surface-to-air missile.

If future political and military circumstances provide an important stimulus for a purely native ballistic missile program, the German approach probably would be based on many aspects of the space program. As the German efforts focus on the development of launch vehicles for ELDO and national space programs, there is a growing technical, engineering, and industrial capability in West Germany that could be applied to military missiles if the funds were provided. These space systems are rather advanced in concept and their development is providing the Germans with a capability in propulsion, fabrication, and guidance. With these abilities and the knowledge obtained from working with France and the UK, which are building the first and second ELDO stages, a purely native program to develop MRBM's could be of relatively short duration.

Should the West Germans elect to develop strategic missiles, they would probably choose a system with a range of about 2,500 nautical miles. Such a system could reach most of the population centers of the USSR. At the present level of technology, the West Germans probably would require at least five years after a decision to commence a program to deploy such a system. There is evidence that they already may have initiated a limited study of such missiles. In some few instances this has taken the form of studies to determine the feasibility of converting certain vehicles and components developed for both national and international space programs to military hardware.

As implied above, the limiting factor in the development of such long-range systems would be the lack of guidance technology. If they could obtain a license for the production of the basic components of a guidance system consisting of gyros, accelerometers, and a computer, the development time for a missile could be shortened by perhaps a year. The controlling factor, however, probably still would be the length of time it would take to get a satisfactory system into production. Only if they were able to purchase a considerable number of entire guidance systems, which seems unlikely, would

guidance cease to be the limiting factor.

Some US technology is already available to the Germans in the Sergeant and Pershing systems. Through detailed analysis of the Pershing system a reduction of about 25 percent in the development time of a native system might be accomplished. Other technology in the guidance field also has been obtained, but this is not considered critical. The Litton P-330 guidance platform was obtained for use in the German-developed ELDO satellite launch vehicle their stage, and an inertial navigation system for the F-104 Starfighter is being produced under license by Platt-Litton in Hamburg.

There is some probability that additional guidance technology could be obtained from UK firms. At present, however, it seems somewhat unlikely that the West Germans could obtain significant assistance in this field from other countries. They probably would not require foreign assistance in any of the other aspects of a missile program.

As mentioned earlier, the West German participation in ELDO has yielded some possible contribution to the development of a missile system. Most benefit has resulted in the establishment of storable-liquid-propellant rocket-engine technology. Lesser benefit has resulted from guidance and control technology. The project also has provided additional experience, such as systems management, staging, servo amplifiers and mechanisms, and rocket-engine testing techniques and evaluation. West German participation in ESRO (European Space Research Organization) is not believed to have contributed significantly to the potential for the development of a missile system.

AUSTRALIA

Australia possesses a small but competent aerospace industry which could provide some skilled technical personnel and industrial facilities for a missile program. However, it has only a limited over-all capability to produce a surface-to-surface ballistic missile system for delivery of a nuclear warhead. Should it be seriously threatened by Communist China and no longer willing to place confidence in guarantees of protection from the US and the UK, Australia would attempt to purchase a ballistic missile delivery system from the US before it would undertake a native development.

However, it appears unlikely that the Australians will attempt to acquire any system in the next ten years.

EASTERN EUROPEAN COUNTRIES

No bloc country now has the capability to develop a nuclear-capable ballistic missile delivery system. East Germany and Czechoslovakia might eventually be capable of developing such a program; however, under present and foreseeable circumstances, the USSR will not permit them to engage in such a program.

ITALY

Italy now has a limited capability in the missile and aerospace fields and probably could develop a satisfactory short-range ballistic missile within four to five years without significant outside help. An IRBM or ICBM system, on the other hand, probably would require considerable foreign technology.

In 1958, Italy showed an intent to acquire a nuclear-capable delivery system employing the US Polaris missile, launched from surface ships. The cruiser Garibaldi was equipped with four missile launch tubes, from which the first of several dummy missiles was ejected successfully in December 1961 by means of a hot-gas system. This project largely resulted from a belief that the US would supply Polaris missiles, but it was shelved in 1962 after the Italians learned that such weapons would not be made available to them. No further efforts to obtain a ballistic missile system have been noted, but the Italians were interested in acquiring the Polaris as shown by the inclusion of four launch tubes in the cruiser Vittorio Veneto, launched in early 1967.

NATIONALIST CHINA

Despite Nationalist China's obvious concern with Communist China's burgeoning progress in the nuclear and missile fields, it has neither the scientific, technological, or industrial resources to develop ballistic missile delivery systems and would probably be unable to obtain assistance in this area from foreign sources.

PAKISTAN

Pakistan would probably consider attempting to acquire nuclear-capable missile delivery systems only if India made some effort in this direction. Pakistan presently has no indigenous ability to develop such systems and almost certainly will not acquire such a capability during the next decade. It would, therefore, be forced to look to foreign sources for assistance in this area. Missile delivery systems capable of ranges in the 300 to 1,200 nautical miles category would be required to cover all important Indian targets. Difficulties in purchasing such vehicles probably would force Pakistan to consider the use of aircraft for a nuclear delivery role.