JPRS L/8382

9 April 1979

[redacted]

WEST

EUROPE

[redacted]

FRANCE: NUCLEAR, MISSILE, AND SPACE DEVELOPMENTS

FOUO No. 457

U. S. JOINT PUBLICATIONS RESEARCH SERVICE

[redacted]

NOTE

JPRS publications contain information primarily from foreign newspapers, periodicals and books, but also from news agency transmissions and broadcasts. Materials from foreign-language sources are translated; those from English-language sources are transcribed or reprinted, with the original phrasing and other characteristics retained.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by JPRS. Processing indicators such as [Text] or [Excerpt] in the first line of each item, or following the last line of a brief, indicate how the original information was processed. Where no processing indicator is given, the information was summarized or extracted.

Unfamiliar names rendered phonetically or transliterated are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear in the original but have been supplied as appropriate in context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by source.

The contents of this publication in no way represent the policies, views or attitudes of the U.S. Government.

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000100040018-7

JPRS L/8382

9 April 1979

FRANCE: NUCLEAR, MISSILE, AND SPACE DEVELOPMENTS

FOUO No. 457

CONTENTS PAGE

FRENCH, EUROPEAN SPACE PROGRAMS SEEN ON THE MOVE

Paris LE NOUVEL ECONOMISTE in French 5 Mar 79 pp 44-47

[Article by Philippe Grazier: "Space Industry is in Orbit"]

[Text] Frenchmen and Europeans are firmly determined to no longer let Americans monopolize space. With the Ariane program, they are venturing forth into the industrial world of space, and under favorable conditions.

The space war has indeed begun. It is no longer a question of spectacular landings on the moon, or even of scientific explorations, but of industrial exploitation of space. This Wednesday, Minister of Industry Andre Giraud will brief the full cabinet on France's new space goals as determined in last week's restricted cabinet meeting. These new goals will mean increased effort by both Frenchmen and Europeans in their competition with Americans.

To participate in this new industrial adventure, four requirements have to be met: have a launch vehicle, know how to build operational [commercial] satellites, be able to process and use the data furnished by these satellites, and display political determination. This enterprising adventure is of European dimensions rather than of strictly French dimensions. This means the fourth requirement, political determination or will, applies at all technical and industrial stages.

Launch Vehicle Requirement

If everything goes well, the year 1979 should mark the end of the American monopoly of placing heavy payloads into orbit. Thanks to the Ariane, a conventional launch vehicle quite comparable to NASA's Atlas-Centaur. Ariane capitalizes greatly on the experience acquired by France with its series of Diamant launchers: 10 successful launches out of 12 attempts between 1965 and 1975, initially from the Hammaguir missile base and then, as of 1970, from the space center in Kourou, Guiana.

As explained to LE NOUVEL ECONOMISTE by Yves Sillard, director general of the National Center for Space Studies (CNES), "Ariane's importance rests in the

fact that it enables Europe to become independent in launch matters and freely pursue its own policy with respct to applications satellites." The point is that up to now, the United States has capitalized on its monopoly of launch vehicles to pick and choose the satellites it would accept for launch: at best, NASA has agreed to launch experimental-type satellites.

Hence with Ariane, Europe can now enter, at long last, the era of operational satellites, but at a financial cost of some 4.5 billion current francs, nearly two-thirds of which were furnished by France. Ariane recently received valuable recognition when it was selected by Intelsat [International Telecommunications Satellite Organization]. This agency manages a world-wide communications satellite system. From Early Bird in 1965 to the present-day Intelsat 4's, all of its satellites have been launched by the United States. Yet even before Ariane's first qualification launches--in late 1979 and at various times in 1980--the Intelsat board of governors representing national telephone systems ordered one Ariane launch from the European Space Agency (ESA). Ariane will, therefore, place into orbit, in July 1981, one of the last three satellites of the Intelsat 5 series. The other two will, in principle, be launched by NASA's space shuttle, the huge reusable space vehicle on which the Americans have decided to focus all their effort by finessing on conventional type launchers beyond 1980, and by devoting the fantastic sum of 22.5 billion francs to its development (prome contractor: Rockwell International).

The Intelsat order was approved last December and signed in Paris on 15 February. It was coupled with an option for a second launch. This order has freed the Ariane program from a serious handicap, namely an inordinately exclusive European destiny. It won Ariane international recognition. Roy Gibson, ESA's director general, told us: "Convincing Intelsat was a major objective for us. We have achieved that objective but must now move ahead, increase production of the present series of operational Arianes, of course, and also develop new versions with improved performance characteristics." Versions with an increased payload capability or the capability to launch two satellites simultaneously (the Syla system developed by Aerospatiale, Ariane's industrial architect).

Pierre Usunier, manager of Aerospatiale's space and ballistic systems division, indicated: "Up to now, we have been working at a production rate of two launchers per year. But to meet demand we could double this rate without augmenting our industrial facilities." At the European Propulsion Company (SEP), the prime contractor for Ariane propulsion systems, Pierre Soufflet said it is possible "to multiply Ariane's capabilities by two."

Ariane already has a significant point in its favor. It is more suitable than the space shuttle for lifting a satellite into a geostationary or geosynchronous orbit--the so-called "24-hour orbit--some 36,000 kilometers above the earth. This is important because synchronous-orbiting satellites will represent a very large part of the some 200 nonmilitary satellites expected to be launched over the next 10 years. A good 30 of these will undoubtedly be launched by Europeans themselves, with, in addition, those they will sell to foreign customers through Trans Space [proposed commercial organization to handle Ariane program].

Operational Satellite Requirement

Europe admittedly lags substantially behind the Americans and Soviets in this field. Those two countries have produced dozens of operational satellites, indeed hundreds of them when you count the military satellites which constitute about two-thirds of all satellites currently in operation. With respect to nonmilitary operational satellites alone, Hughes, General Electric, RCA, Ford Aerospace, Fairchild Industries, and Lockheed already have more than 140 to their credit. Nevertheless, Europe need have no inhibitions in this respect. It "can manage." For example, the two Symphonie [communications satellites] are performing satisfactorily. They were developed under a bilateral Franco-German program approved in 1967 and placed in orbit in 1974 and 1975 by American launchers. Furthermore, Ford Aerospace did not hesitate to ask Aerospatiale's space and ballistic systems division and Thomson-CSF to participate in development and production of the Intelsat 5 series of satellites.

To meet European and international needs, two industrial groups were formed: the MESH consortium and the Eurosatellite group, a German chartered corporation.

MESH: established in 1965.

Members: Aeritalia of Italy, British Aerospace of Great Britain, ERNO-VFW-Fokker of the FRG and Netherlands, INTA of Spain, and Matra of France.

Specialties: 500-700 kilogram satellites.

Projects: Telecommunications (ECS for ESA), maritime communications (Marecs for ESA), plus for Matra: SPOT earth observation satellite and, very likely, Telecom 1.

Eurosatellite: established in 1977.

Members: Aerospatiale of France, ETCA of Belgium, and MBB of the Federal Republic of Germany.

Specialties: 1,000-kilogram heavy telecommunications platform.

Projects: studies on direct television broadcasting via satellite; Phebus, H-Sat, and TV-Sat programs.

Capability of Processing, Using Data Furnished by Satellites

Satellites offer practical applications possibilities and attractive market prospects. The principal applications and markets are in the communications field. The first such application was in intercontinental communications: the Intelsat system was established for this purpose. Then came the use of satellites for domestic communications: existing landline and radio relay communications links were supplemented by satellites in Canada in 1973 by Western Union and in the United States in 1974 by RCA and Comsat General Corporation. Indonesia also installed its own system, Palapa. Other countries simply joined the Intelsat club by leasing transponders onboard its satellite.

Algeria was the first to do this and was followed by others. Jean Grenier, Intelsat's French governor, revealed: "New applications for service are on the agenda of every one of our meetings. As a result, Intelsat's gross receipts for 1978 amounted to nearly 800 million francs."

Europeans have become fully aware of the prodigious expansion of the communications satellite market in Europe, a market "destined to become as large, indeed even larger than the North American market before the end of the century." So Europeans decided they too would provide themselves with a regional communications satellite system. The European Space Agency's ECS [European Communications Satellite] will constitute that system. Ariane rockets will lift this series of satellites into orbit beginning in 1981. Eutelsat--a still provisional organization--will operate the system "somewhat in Intelsat fashion, but for intra-European communications," to quote Francois Job, Eutelsat's secretary general. The MESH consortium is producing the ECS. Matra is responsible for the ECS attitude control system and for integrating these satellites in its "clean rooms," those sterilized and pressurized laboratories in which satellites are assembled. Noel Mignot, the manager of Matra's space division, told us: "We have started a capital investment program in Toulouse to give us additional capacity for the assembly of equipment bays for the Ariane, the ECS and also other satellites."

But the function of communications satellites is not solely to handle telephone calls. They also have the capability--constantly being improved--of transmitting messages and images, of remote printing, and of providing teleconference and data-bank services. In other words, these "a la carte satellites" will constitute a privileged instrument for everything Simon Nora and Alain Minc have labeled with the neologism "telematique" [remote-controlled electronic data processing].

As a matter of fact, a new generation of high-powered satellites are under development in the United States. They will be launched within the next 2 years: the Canadian Telesat and three American systems. The most advanced of the latter is the SBS (Satellite Business Systems) whose chief promoter and future user is IBM, the giant of the computer industry.

In this field of "integrated" communications satellite, France has chosen to go it alone with its Telecom 1 project that will benefit, however, from experience gained with the ECS. Telecom 1's promoters claim "it will withstand comparison with the American SBS." The system's definition study was conducted jointly by CNES and the General Telecommunications Directorate (DGT). Total system cost will be nearly 1.5 billion francs to be financed mainly from the Telecommunications budget. Telecom 1 will particularly relieve congestion in existing communications systems within France proper without requiring additional capital spending on these systems. It will also provide communications links with a certain number of overseas departments and territories. Jean Syrota, DGT's director for industrial and international affairs, explained: "An additional benefit to be derived from the Telecom 1 system is that it will win

considerable recognition for our industry, thereby enabling France to carve a place for itself in the export trade." Satelconseil, [a communications satellite counsulting service] formed by CNES and France-Cable-Radio, recently replied to a request for proposals from Columbia.

The second major field for the practical application of satellites is earth observation. Europe has not yet formulated a specific program for such satellites. Consequently, last year France approved its own earth observation satellite, the SPOT project, at a cost of 700 million francs. Will this project eventually be Europeanized as was the Meteosat weather satellite program? The stumbling block here is military opposition to such a move. Military authorities are keenly interested in SPOT as evidenced by the following comment from Pierre Sauliere, an adviser to the minister of defense: "In the near future, our deterrent would be blind without a satellite. Considering its uses, such a satellite can only be military property."

The last highly promising application is one around which Europeans and Japanese are currently "dancing a hesitation waltz." I refer to direct television broadcasting. "A sort of television transmitter installed at an altitude of 36,000 kilometers and capable of beaming several programs," is the way it was described to us by Maurice Remy, general manager of Television Broadcasting of France (TDF). Programs broadcast by such satellites can be picked up directly through small special, individual or community, parabolic antennas. The advantage for countries that are still without any television services is that such a system enables them to dispense with all ground-based radio relay and cable facilities. The advantages for a country like France are the elimination of those infamous "shadow areas" [unreachable by standard TV systems] and relief from the saturation of frequencies in current use. There is one disadvantage, however, for the public--not for manufactureres--whose sets have to be converted to receive satellite telecasts. Recent studies sponsored by Eurospace (European Space Research Industrial Group), among others, indicate that by the late 1980's capital spending for direct TV boradcasting will exceed such investment for conventional TV broadcasting methods. The billions of francs at stake and the anticipated political and cultural influences explain the conspicuous lack of any consensus on the ESA's proposed experimental TV satellite, designated H-Sat. Each country wants to look out for number one, the German TV-Sat project being a particular case in point. Nevertheless, in the absence of a broader consensus, development by two or three countries of a common heavy platform within the Eurosatellite consortium would have the advantage of being more economical than purely national projects. Why, some persons ask, couldn't France and the FRG equip their own satellites with suitable electronic gear--Thomson-CSF or AEG Telefunken--the same way Air France and Lufthansa use similar Airbus transports but each bearing their respective national colors? Such an approach would retain the advantages of cooperation and safeguard Europe's chances in the world market.

Was any headway made on the direct broadcast TV satellite program at the recent Franco-German summit meeting? Unquestionably, but not to the point of being able to make a decision on 7 March [at the cabinet meeting]. A few more months

of studies and talks are necessary. The French Government has still not answered "yes" to the two following questions: Is it in France's interest to provide itself with a direct broadcast TV satellite system? Is such a system a major export item? While a decision on further Ariane development and on initiation of the French Telecom 1 project was imperative, such is not yet the case with the direct TV satellite question. In fact, this attitude was suggested by the "Cannac report" submitted a few weeks ago to Matignon [prime minister's office] and to the Elysee Palace by its author, Yves Cannac, president of Havas.

In space related matters, France must reconcile its deep concern for independence in certain fields with the necessity of European cooperation, while at the same time finding work for its industry and sparing its budget. These are quite a few imperative requirements demanding simultaneous solution.

Key Figures on French Space Effort

Space Budget for 1978: 1.46 billion francs.

Persons employed in space effort: CNES, 1,000; industry, 3,000.

Volume of space-related business by principal industrial firms in 1978 (millions of francs): Aerospatiale, 300*; SEP, 340*; Matra, 295; and Thomson-CSF, 200*.

*approximate

8041
CSO: 3100

PLANNED CONSTRUCTION OF TWO MORE REACTORS REPORTED

Paris LE MONDE in French 8 Feb 79 p 32

[Article by B.D.: "France Will Construct Two Additional Reactors"]

[Text] In a communication to the Council of Ministers on 7 February Mr Giraud should recall the mechanisms according to which petroleum products prices are set: the dollar's rate of exchange in the past two months, the price of unrefined oil and the profit margin of the retailers. The prices, which will be applicable as of 15 February, will be known only a few days in advance, however, and the idea of creating a special "pool" for purchasing oil at the free market price seems to have been abandoned.

A limited council, which met on 6 February at the president's office to examine available French stocks of hydrocarbons, has also decided that two more reactors should be built at the Gravelines site in the north and that the construction of the second reactor at Cattenom in the Lorraine should be speeded up. France is going to accelerate her nuclear program and intensify her efforts to save energy. That was the result of the limited ministerial council held on 6 February at the president's office and presided over by Giscard d'Estaing, which had been convened to examine French supplies of petroleum products over the medium and long term range. "The President of the Republic," announced presidential spokesman Mr Hunt, "has asked that, in view of the uncertain outlook, the national effort now underway to save energy and to pursue the electro-nuclear installations program should continue."

While recent electric power shortages would have suggested the establishment of new installations in the western part of France, Giscard d'Estaing has chosen the sites of Cattenom in the Lorraine and of Gravelines in the north for the installation of equipment as soon as possible. Of course, this is aimed at maintaining employment in two regions that have been particularly hard hit by unemployment.

It was decided to construct two more installations at Gravelines on a site which already numbers four others that will become operational in 1979 and 1980.

At Cattenom, the second 1300 megawatt reactor which should have been started in 1980, will now start at practically the same time as the first during the course of this year. The two reactors will not be put into service before 1986 or 1987. That means that in 1985 the nuclear portion of France's energy supply will hardly exceed 20 percent, about 5 percent less than the goals defined by a planning commission in February 1975.

However, this decision has already generated numerous protests. For instance, Phillipe Saint-Marc, member of the information council on electro-nuclear energy and a Giscardian candidate at the 1978 elections, writes: "The government's decision to speed up the nuclear program significantly is a serious economic and ecological error. Under the mantle of a state secret the nuclear program runs the risk of becoming, on a financial plane, a new Concorde."

The energy saving programs will also be started again. In a communication to the Council of Ministers on 7 February, Minister of Industry Giraud mentions the utilization of the "pool" during the last quarter of 1978. based on fuel prices and which was established thanks to the devaluation of the dollar. The 520 million francs that were thus "collected" have been fully transferred to the Energy Saving Agency. This entity will require 420 million in 1979 to stimulate businessmen to invest in the field of energy savings. It is in fact in the industry sector that this effort has been least effective. Of the 15 million tons of oil or its equivalent, which were to have been saved in 1978 (a figure below the objectives of the planning commission), industry's share represented only 2 million tons of oil or its equivalent. The agency will therefore offer a premium of 400 francs for each ton of oil saved for industrial investments.

The limited council at the president's office has decided, moreover, to diversify the geographical distribution of hydrocarbon supplies and to associate the oil companies with the objectives for commercial exchanges with oil-producing countries and the imperative need for secure supplies.

9291
CSO: 3100

ARIANE LAUNCH PREPARATIONS DESCRIBED

Third Stage Problems Delay Launch

Paris AIR & COSMOS in French 17 Feb 79 pp 33-34

[Article by Pierre Langereux: "Scheduling First Launch for 3 November 1979 Is Calculated Risk"]

[Text] At its 17 January meeting, the Ariane Program Board announced that the first test flight of the Ariane launch vehicle had been postponed from mid-June 1979 to 3 November 1979. This postponement stems directly from the delay in development of the third stage with its cryogenic propulsion system as a result of the explosion on November 1978.

This decision raises the question of why the first launch was postponed "merely" to 3 November 1979, inasmuch as by that date only the first two stages of the rocket will have been regularly test-stand qualified. In other words, why is CNES [National Center for Space Studies] taking the risk of not waiting until completion of the two qualification static firings of the third stage--the most critical--before proceeding with the first launch which is of such tremendous political and psychological importance? Especially after the failure of the Europa 2 rocket, a fiasco still fresh in everyone's memory! What would happen to the Ariane program if its series of test flights were to likewise open with a spectacular failure?

No Delay in Becoming Operational

Frederic d'Allest, CNES Ariane program manager, explained the whys and wherefores to the press at the first unveiling of Ariane in Guiana on 5 February. Allest said technical considerations had prompted the selection of 3 November 1979 as the date for Ariane's first launch. He maintained that CNES had not let itself become involved in any vainglorious timetable rivalry with the American space shuttle whose first flight was likewise recently postponed. In this case to 9 November 1979. This closeness of the two launches is only a fortuitous coincidence--at least as far as the European side is concerned--in that CNES had announced the new Ariane launch date 3 days before NASA made its announcement.

After the accident to the third stage, the first launch obviously could no longer go on in mid-June as planned. One possible alternative would have been to await the third stage's test-stand qualification. But Allest explained this would have meant postponing the first test flight to March 1980, in other words 9 months later than planned. This delay would have used up all of the program's contingency funds and timetable, and as an immediate consequence, Ariane's operational availability would have been deferred to mid-1981 instead of end-1980 as planned. Such a delay would have greatly disadvantaged Ariane in its competition with the space shuttle by disappointing the European launch vehicle's first customers.

Doubts About Third Stage

Consequently CNES and ESA [European Space Agency] preferred taking a calculated risk by substantially deferring the first two Ariane launches but without delaying either completion of the test launch series or the launch vehicle's operational availability. The operation consists in taking maximum precautions to ensure successful initial launches under less than ideal conditions, and in banking on the absence of any serious problem requiring solution during the 12-month flight testing period.

CNES prefers to proceed, without excessive waiting, to launch the first Ariane so as to flight test those elements already qualified--operation of the first and second stages, stage separation, release of the payload firing, guidance and control, etc.--and thus cover a large part of the rocket's flight envelope. Even if this means accepting a third stage malfunction, an incident that could, however, preclude placing a satellite in orbit, that spectacular crowning event of any launch vehicle firing.

It is also possible, however, that everything will run smoothly, even with the upper stage that will previously have undergone numerous pre-flight tests. In fact, CNES has prescribed mandatory tests before the first launch (launch vehicle LO-1). Between now and June, it will have conducted two or three other static firings of the third stage in battleship configuration plus two complete test-bench runs with the new stage in flight configuration, i.e. a stage replacing the one damaged last November.

In addition, a review of the complete launch vehicle's flyability is to be conducted in June. This will allow the SEP [European Propulsion Company] to still make modifications in the third stage—if and as required--in June and July before shipping it to Guiana for the first launch. This final project review of the launch vehicle and launch site will permit confirmation of the launch date and initiation of the pre-launch program.

The stages of the first Ariane rocket (LO-1) are currently being assembled: the first stage in Aerospatiale's Launcher Integration Site (SIL) in Les Mureaux near Paris, the second stage in ERNO's plant in Bremen, Germany.

The LO-1 launcher's third stage is expected to arrive at Les Mureaux about mid-February and assembly of the launcher's "upper part" is scheduled for April. Following integrated electrical testing in April and May, the rocket will be disassembled, placed in its container, and delivered to CNES for shipment to Guiana by freighter sometime between mid-July and mid-August.

The pre-launch program in preparation for the firing of the Ariane LO-1 in Guiana will begin 15 August 1979. It will last 2-1/2 months up to the scheduled 3 November 1979 launch at 1200, plus or minus 3 hours. The operation will be supported by all of the Guiana Space Center's facilities plus the CNES and ESA tracking networks. It will involve some 1,000 persons at the space center and at downrange stations in Brazil and Ascension Island (U. S. satellite tracking center), including approximately 100 payload technicians. The LO-1's payload will consist only of a technological capsule to monitor conditions aboard the launcher. After this first firing, restoration of the Ariane launch pad will take about 2 months and the pre-launch program for launch vehicle LO-2 another 2 months. The LO-2 launch is scheduled for 15 March 1980, unless a serious incident occurs during the LO-1 launch thereby forcing postponement of the second flight.

Qualification of Missile Range

Paris AIR & COSMOS in French 17 Feb 79 pp 35-36

[Article by Pierre Langereux: "Technical and Operational Qualification of Missile Range"]

[Text] Reactivation of the Guiana missile range has been underway since late 1977. This is a twofold task: technical qualification and operational qualification. J. P. Rouzeval, director of Ariane operations in Guiana, told us the objective of the reactivation program is to bring Guiana Space Center facilities back up to acceptable standards and train personnel, most of them new, for the purpose of launching Ariane rockets, including insertion of their payloads into orbit.

Technical qualification of the missile range, specifically the facilities of the CSG [Guiana Space Center] in Kourou and of the three downrange stations, on 1 February 1979.

This technical qualification validated the Infrastructure and Equipment Renovation Plan (PRIE) implemented by CNES to replace or modernize certain CSG facilities--position finding, telemetry, and communications equipment--that had either reached the end of their service life-10 years--or were inadequate to handle the launching of a rocket like Ariane.

For example, under the PRIE the position finding system's electronic data processing equipment--computer, software, and consoles--was renovated and reconfigured differently--"distributed" data processing--for its new mission.

Telemetry equipment was also completely replaced to adapt it to new standards (E-band). Communications facilities have been modernized and expanded.

Operational Qualification in Late April

Operational qualification of the missile range began in January 1979 and is expected to be completed this May, with complete acceptance of the missile range scheduled for late April.

This operational qualification is being conducted in two phases: the first for the CSG alone, the second for all facilities of the Guiana missile range that make up the Ariane Launch Base (BLA). This base includes all CSG facilities in Kourou and the three downrange trajectory measurement stations--at Salinopolis and Natal in Brazil and on Ascension Island--as well as the Ariane Launch Complex (ELA) in Kourou.

The ELA proper includes the launch pad complete with service tower (or gantry), propellant storage tanks, and launch control center, as well as the vehicle assembly building with its checkout facility, and the payload--satellites and apogee motors--preparation building.

'Propellant Mock-Up'

Qualification of the BLA is being conducted with the Ariane "refueling mock-up" (MR), also called "propellant mock-up," erected on its launch pad as the flight vehicles will be. It was this full-scale "propellant mock-up"--similar in all respects to a real rocket--that was unveiled for the first time on 5 February to the press and representatives of the member states of ESA's Ariane Program Board.

The "propellant mock-up" will be used to develop and refine procedures for erecting the rocket in the air conditioned tower, and also procedures for manual and automatic refueling of the launcher's fuel tanks. It is also employed for vibrational and climatic environmental testing of the complete rocket.

The launcher's first refueling test was scheduled for on or about 20 February. As in the case of an actual launch, the test begins with the complete refueling of the third stage--first with liquid oxygen and then with liquid hydrogen--so as to familiarize launch crews with these cryogenic propellants being used for the first time in a European rocket.

This procedure is also followed in filling, last of all, the first and second stages with storable propellants--UDHM and N_2O_4--that irreversibly "contaminate" these tanks because there are no plans to decontaminate fuel tanks in Guiana as is common practice for test-stand runs.

It is planned to fill and drain the third stage five or six times before fueling the lower stages. This is done both automatically (normal procedure) and manually (backup procedure). The backup procedure for draining the third stage--once the fuel supply lines have been disconnected--will also be tested by freely venting the tanks to allow propellants to evaporate in 18-20 hours. All these operations with cryogenic fuels will, of course, be conducted with the tower withdrawn so as to avoid the risk of explosion through hydrogen accumulation. Plans call for three withdrawals of the 900-ton service tower per week; it takes 5 hours to detach the rocket.

Final 5 Minutes

Refueling trials with the propellant mock-up are scheduled to be completed by 15 April. The mockup will then be used for "testing the synchronized launch sequence" which corresponds to the final 5 minutes preceding ignition.

All missile range facilities are involved in these tests. The launch sequence is fully automatic because of the complexity and number of operations and checks to be accomplished at specific times. Some 1,200 parameters have to be continuously monitored on the rocket up to lift-off. If all prescribed conditions are met, the ignition order is issued automatically. The famous "red button" the director of operations used to press not so long ago is now only an accessory. A computer monitors all operations at the speed of light. At the slightest irregularity--a parameter outside prescribed limits--the computer automatically halts the countdown which will then have to "restart from zero," i.e. from 4-8 minutes. And this as long as all parameters are not nominal. CNES is going to practice this procedure during a period of 3 weeks with the objective of successfully going through the entire synchronized launch sequence without incident at least three times.

The Ariane mockup will also be used for simulating countdowns lasting 19 hours! These tests will also be used to train crews to react quickly and correctly in case of an incident and this up to lift-off. The countdown can actually be suspended at any time up to 3 seconds after ignition, that is to say only 4 seconds before lift-off (i.e. when rocket is released from the arms or catches holding it down on the launch pedestal), for example, in case of insufficient thrust from the first stage's four Viking engines (245 tons of thrust).

No decision has yet been made about disposition of the "propellant mockup" after these tests. Since it cannot be launched, it will either be scrapped or sent back to France with the shipping containers. But it will not be exhibited at the Paris Air Show as had once been discussed. A regular mockup will take its place.

Simulation With Aircraft, Sounding Rockets, Satellites

Simulations conducted by the Guiana missile range to represent the rocket's flight conditions employ various means such as wired ("cabled") simulators, magnetic tape recordings, or such mobile means as aircraft, sounding rockets, and satellites.

Two aircraft have been used: the Kourou Aero Club's Piper Cherokee and an Xavante on loan from Brazil. These aircraft were equipped with radar transporders, telemetry and remote control transceivers to enable ground-based antennas and radars to track them and transmit signals.

Four French solid-propellant sounding rockets are also being used for operational qualification of the missile range: one single-stage Dauphin rocket and three two-stage Eridan rockets. These are equipped like the aircraft to specifically test positions finding and safety systems, as well as support facilities. An Eridan sounding rocket was fired on 23 November 1978 to check the CSG's state of readiness. The test was deemed satisfactory. A Dauphin sounding rocket was fired on 7 February 1979: this was the first CSG launch made in the "Ariane configuration." Another Eridan is to be fired in early June to test the missile range's "downgraded configurations"--i.e. configuration allowing mission to be accomplished but with less redundancy--and train crews in action to be taken in case of incident, a radar failure for example. The last Eridan rocket will be fired 30 or 35 days before the Ariane launch, during the LO-1 pre-launch program.

The American GEOS C satellite equipped with two coded radar transponders is also bo be used by CNES to qualify communications links between the CSG and downrange stations in Natal and Ascension Island. This satellite flys over several times per day at a speed of 7,935 meters per second and simulates the Ariane rocket that will have to be tracked by the CSG and downrange stations for 14 minutes (840 seconds) of flight until insertion of the payload into a transfer orbit. The problem is one of getting crews of the different stations thoroughly trained to acquire and lock on to the rocket, and then transfer it from one to the other as quickly as possible: radar operators on Ascension Island will have only 60-80 seconds in which to fix upon the rocket and "parallax" their radars before the Natal radars have finished their task. During tests, station messages are routed by Intelsat satellites via ground stations in the United States and Guiana to the CSG's launch control center.

8041
CSO: 3100

FUTURE MARKET FOR ARIANE ROCKETS NOTED

Paris AIR & COSMOS in French 17 Feb 79 pp 37,39

[Article by Pierre Langereux: "A Market for 40-50 Rockets Over 10-Year Period"]

[Text] A new market research study made by CNES [National Center for Space Studies] and ESA [European Space Agency] with the help of the Eurosat consortium estimates there is a "reasonable" market for some 40 to 50 Ariane launch vehicles in the next decade (1981-1990) on the basis of a worldwide market for at least 200 satellites.

The assumption used for this estimate rest on two main points:

a. The development and launching of space systems in Europe, systems already approved in principle and for which there is a very high probability of obtaining a formal go-ahead during the next 3 years.

b. Export prospects for European space systems in the face of American competition.

European Market for 31-34 Satellites

The European market's share of this estimate is 31-34 satellites. This share is three-fourths or three-fifths of the entire estimated market. It includes 15-17 satellites for ESA, 9-10 for France, and 7 for other European programs.

This market research study assumes the following satellites will be launched during the period 1981-1990:

a. Two or three ESA scientific satellites, the first of which, Exosat [astronomy satellite], is already approved and will be launched in 1981.

b. Three French observation satellites, including the SPOT [Earth Resources Observation Satellite] now under development and scheduled for launch in late 1983-early 1984, and two other satellites of the same type to provide continuous system operation and development.

c. One or two observation satellites for ESA which is currently studying such projects as LASS and COMSS.

d. Three geostationary Meteosat weather satellites to ensure constant coverage throughout the next decade. The first of this series, Meteosat 3, may be launched in 1982.

e. Two technological satellites designed to test techniques and systems for materials processing in space, a field that is likely to expand greatly in the period 1990-2000. France is already preparing such a satellite project with its Minos study.

f. Four geostationary communications satellites: ECS [European Communications Satellite] 1, 2, 3, and 4 to be launched in late 1981, late 1982, 1985, and 1986 respectively by ESA for the "Interim Eutelsat" organization that will operate them commercially.

g. Three MARECS [Maritime Communications Satellite] to be placed in geostationary orbit in mid-1981 (Marecs B), early 1982 (Marecs C), and late 1982 (Marecs D), on condition that Europe reaches an agreement with the United States on joint use of these satellites.

h. Three national communications satellites for the French Telecom 1 project sponsored by CNES and the DGT [General Telecommunications Directorate]. This project is now up for government approval (at a 28 February 1979 cabinet meeting). The first Telecom 1 satellites could be launched into geostationary orbit during the second half of 1982 and in mid-1983.

i. Seven direct television broadcasting satellites for use in three European national television systems, for example, in France, Germany, the Scandinavian countries, etc. These satellites could be launched into geostationary orbit beginning in 1983.

j. Three to four "other applications satellites" that would actually be French military satellites, such as, for example, the SAMRO military observation satellites currently under study. These could be launched beginning in the mid-1980's.

Export prospects for satellites made in Europe and/or launch services for satellites made abroad--mainly in the USA--are based essentially on the market for geostationary point-to-point communications and direct television broadcasting satellites.

Export Market for 11-22 Satellites

The communications satellite market outside Europe and the United States has long been dominated by American industry. It will probably remain such and, therefore, be difficult for Europe to gain a foothold in this market. Nevertheless, French and European authorities estimate they will launch some 5 to

10 geostationary satellites from 1981 to 1983 for the establishment of two to four national or regional communications systems in such countries as Iran, India, the Arab League, and certain South American countries, Columbia notably, and perhaps in Indonesia also.

But the most attractive prospects are probably offered by direct TV broadcasting systems. According to CNES and European manufacturers: "It is certain that the operational demonstration of such a powerful instrument as TV broadcasting via satellite may possibly accelerate existing projects in a large number of countries, projects that currently still have a very indefinite timetable." This could be the case in Europe the moment one country decides to use such a system, but likewise in Middle East countries like Saudi Arabia, in South America and Africa, particularly in those countries where the ground-based infrastructure is still nonexistant or covers only limited territory. The market research study estimates four to eight direct TV broadcasting satellites will be launched for the establishment of two to four direct broadcasting systems in these countries after 1983.

The study also estimates two to four satellites will be launched for such large international organizations using space communications as Intelsat and Inmarsat. Intelsat has already ordered one launch of the Intelsat 5 satellite by the Ariane launch vehicle for April or July 1981 and holds an option on a second launch. Inmarsat will have its own satellites to be launched during the next decade.

A 5.5 to 7.5 Billion Franc Deal

In summary, this market research study lists a total of 42 to 46 satellites to be launched between 1981 and 1990, including 17-25 communications satellites and 11-15 direct TV broadcasting satellites that represent between 70 and 85 percent of the total market! Consequently the market for Ariane launch vehicles definitely lies, as expected, in space communications and launches into geostationary orbit. The rest of the market is divided among three weather satellites, four or five observation satellites, two technological satellites, two or three scientific space research satellites, and three or four military space vehicles.

This market of 42-56 satellites actually represents only 36-46 launches, given Ariane's dual-payload launch capability that will become available in 1983. The market research study estimates there will be approximately 6 to 10 dual-payload launches. But if we add an additional five or six launch vehicles on the basis of a success probability of 90 percent--comparable to the U.S. probability--then we obtain an estimated overall market for some 40 to 50 production series launch vehicles in the 10-year period from 1981 to 1990. Based on an average cost price of 135-150 million francs per launch vehicle in this series, this market of 40-50 vehicles represents a 5.5 to 7.5 billion franc deal for European industry.

8041
CSO: 3100

PREPARATIONS FOR ARIANE LAUNCHING OUTLINED

Paris LE MONDE in French 6 Feb 79 p 17

[Article "Ariane Makes its Appearance in Guiana" by Maurice Arvonny]

[Text] A commercial company would ensure the sale of the European rocket.

Kourou--This Monday 5 February [sic], a white silhouette will be outlined on the flat savannah of the Space Center of Guiana. A just-completed model of the Ariane rocket launcher will move out of its assembly tower. For Kourou, a settlement of 6000 people who live, more or less, on the 80 million francs which the center injects annually into the economy of Guiana, this operation symbolizes the return to a lucky period, punctuated by spectacular launchings, after five years of slumber.

The symbols are misleading: This Ariane that will be seen from afar is only a "mockup model." The rocket body is quite real and so are the tanks, but the engines are of old vintage, used up by the experiments and the entire delicate electronic equipment for navigation of the rocket is missing. The mockup will never fly. It will be subjected to several cycles of filling and emptying the tanks to establish the exact procedures to be followed before launchings; then it will be taken back to the tower and completely disassembled.

The first real rocket launcher most of whose components have already been constructed, will then be assembled. On 3 November, the 187 tons of propergol, which it will contain, should permit it to put a small capsule full of measuring instruments into orbit. This first shot, known as qualification launching, will be a "trial run."

Orders Placed for Nine Models

Three further qualification shots will follow in 1980, with real loads to go into orbit. Then the operational phase of the program will begin: starting in 1981, Kourou should see three or four launchings annually. The European Space Agnecy (ESA) is counting on some 50 possible launchings in the course of the coming decade.

Actually, only nine models of the Ariane have been ordered; four for qualification shots and five for commercial launchings. But the number of satellites actually agreed upon, which Ariane will put into orbit, is higher; it will grow even larger if, on 28 February, the Council of Ministers of the French government should decide on the construction of national satellites for telecommunication and television. A new series of five or six rockets will thus go on order during the current year.

For the preceding examples a unanimous decision of the ESA council composed of representatives of 11 governments was necessary. This procedure, quite normal during the development phase of the program requiring budgetary contributions from all the participating countries, may prove to be excessively burdensome for some of the commercial rocket launchers whose sale will cover the manufacturing cost. The National Center for Space Studies (CNES), which is the prime contractor of the Ariane for the ESA, is thus considering the formation of a commercial company, Transpace, whose shareholders, in addition to the CNES, will be the principal European industrialists constructing the Ariane rocket launcher.

Transpace will relieve the ESA of the tasks of dealing with customers and obtaining bank credits, matters not exactly within the experitse of the ESA as an international body for space development. However, some member nations of the agency seem to have reservations with regard to this suggestion emanating from the French Minister of Industry by way of the CNES. They fear a diminution of the role of the ESA. Such a solution would also pose the problem of the launching pad at Kourou, which belongs to the ESA and is financed by specific contributions from the member countries. The creation of Transpace and the definition of its relations with the ESA, in particular, will require some complicated negotiations. These ought to be terminated quickly so as not to delay future orders for rocket launchers and launching themselves.

9291
CSO. 3100

MATRA'S TOULOUSE SPACE ACTIVITIES OUTLINED

Paris AIR & COSMOS in French 10 Feb 79 p 12

[Article by Pierre Langereux]

[Text] The MATRA Company just announced on 31 January 1979 that this summer it is going to combine the greater portion of its space activities and facilities for programs in progress and those of the future. The new MATRA space center at Toulouse will therefore be directed toward three sectors of activity: telecommunications satellites with the ECS (of the ESA [European Space Agency]) and its derivatives; earth observation satellites with SPOT (of France) and its derivatives; and equipment groups for the European Ariane launches. The space division of MATRA, whose general management remains at Velizy, near Paris, will henceforth include two space centers: Toulouse, to serve as general contractor for programs, and for systems engineering and assembly and Velizy for technology and equipment.

Expansion in Two Stages

The schedule for decentralization contemplates that the SPOT and Ariane project units will be transferred from Velizy to Toulouse this summer. This involves 30 persons, of whom 15 will be new employees.

Construction of the new MATRA center, installed upon 6 hectares in the Montaudran 2 industrial zone, to be added to the existing center, will be effected in two stages:

The first stage, to be opened for service during the second quarter of 1980, comprises three new buildings with floor space of 7,000 square meters, of which 1,000 will be occupied by white rooms and 1,000 by shops. It is planned to begin construction in July 1979. This stage represents an investment of about 40 million francs and creation of 80 new jobs, of which 50 will be filled by local hiring.

[Photo Caption] Claude Gourmy, Chief of the Studies and Integration Section of the Space Division of MATRA, will be the director of MATRA's new space center at Toulouse.

The second stage is contingent upon MATRA's work load for the new programs now in the process of being defined, that is, the derivatives of the SPOT and ECS. It involves the acquisition of another 4 hectares upon which to erect 5,000 square meters of buildings which will include an additional 2,000 square meters of white rooms. Construction should begin in July 1980 in order for completion to be achieved in the second quarter of 1981. This stage represents creation of 100 new jobs, 80 of them to be filled locally.

In total, the staff of the new MATRA space center at Toulouse should number 250 persons by the end of 1981, half of them engineers and management personnel, and the other half technicians and other employees.

Activities in Progress

MATRA was installed, in March 1975, in the Montandran zone, near the CNES [National Center for Space Studies] and the text facilities of SOPOMEA [Specialized Environmental Testing Service Company] at the instigation of DATAR [Delegation for Territorial Development and Regional Action] and the CNES. The initial installation, upon 1.8 hectares, mainly comprised a space assembly center of two buildings (2,500 square meters), including an assembly bay of 650 square meters, 8 meters high, for assembling large satellites. The present crew comprises 35 specialists whose average age is 30 years.

Assembly of the ESA's OTS satellite in 1976-1977 brought together 60 specialists, half of them coming from the European firms participating in the program. In 3 years four OTS satellites (one simulation model, one qualification model, and two flight models) have thus been assembled at Toulouse, representing more than 150,000 man-hours of work. Thereafter, the teams went to the American launching field at Cape Canavaral, Florida, for the three series of firings (May and September 1977, and April-May 1978) which ended with the launching of the OTS 2 satellite on 11 May 1978).

MATRA has now reported its activity in the ECS European operational telecommunications satellite program which includes a series of five flight models, for two of which firm orders have already been received; the order for the other three satellites is expected this year. Assembly of the first flight model, ECS 1, will begin at Toulouse in the middle of 1980; launching by air Ariane rocket is planned for the end of 1981 (see AIR & COSMOS, No 748).

Since 1976 MATRA has also been engaged in assembly of the equipment groups for the Ariane launches. Three groups have thus been completed: one electrical mock-up (PO 1), one qualification model (PO 2), and one

flight model (LO 1) intended for the first rocket which will be launched on 3 November 1979. Three other equipment groups, intended for the three other flight qualification firings (LO 2, LO 3, and LO 4) are in the course of completion and five additional groups have just been ordered for the first series of operational launchers which will be used beginning in 1981. These eight groups will be delivered between now and 1982.

11,706
CSO: 3100

WORKINGS OF PRIVATE NUCLEAR FUEL CYCLE INDUSTRIES

Duesseldorf ATOMWIRTSCHAFT-ATOMTECHNIK in German Feb 79 pp 82-84

[Article by B. Kalthoff: "French Private Industry in the Nuclear Fuel Cycle"]

[Text] Because of the dominant role of the state and its institutions in France, it is often overlooked that private industry has also undertaken significant efforts in the area of nuclear energy. This is most particularly true for the initial stage of the nuclear fuel cycle, which is a domain of private industry from the procuring of uranium ore to the completed fuel element--with the exception of enrichment, which is in the hands of the state. In addition, the technologies of chemistry and processing have put their experience with processes and plants at the service of state activities. France is the only European country which is self-sufficient in the area of the nuclear fuel cycle.

In contrast to the FRG, the French nuclear industry developed out of military research with the direct cooperation of the state, which in 1945 created a commission specially responsible for atomic energy: the Commissariat a l'Energie Atomique (CEA) [Atomic Energy Commission].

The leading position of the CEA--including Cogema--and the no less important role of the national electric company Electricite de France (EDF) make the state often appear to be the sole decisive factor in the French nuclear industry, even in its relations with other countries. But aside from the role of Framatome as a reactor builder, French private industry has a large and important share in the activities in the nuclear fuel cycle (Fig 1). The experience of the different industrial groups in the areas of geology, chemistry and metallurgy has proved indispensible for the development of a nuclear industry which covers all phases of the nuclear fuel cycle from uranium ore to the reintroduction of reprocessed fissionable material into the cycle.

This "nuclear autonomy" is almost a compelling necessity for a country which has neither its own petroleum and natural gas nor any occurrence of coal worth mentioning available to it. Since the 1950's, but more intensively since

1965, French private industry has become strongly involved in the fuel cycle, and today produces all materials specifically for the fuel cycle of the pressurized water reactor (which was introduced in 1969).

In prospecting, mining and treatment of uranium the Compagnie Francais des Petroles (CFP) [French Petrols Company] and Pechiney Ugine Kuhlmann (PUK) have channeled their experiences in prospecting and chemical treatment of ores into a common subsidiary firm, Minatome, which since then has drawn on guaranteed reserves of 30,000 tons of uranium and hopes, on the basis of intensive exploratory activity all over the world, to increase these reserves fourfold within the next 10 years.

The French chemical industry has developed the optimal procudures for the concentration of uranium from the most varied deposits of ore in its own country--the deposit of uranium in France is after all estimated at 125,000 tons of uranium--and abroad, and thus offers itself as a potent partner for interested exploratory or mining companies.

Conversion of uranium concentrates into uranium hexafluoride, the form of uranium that permits enrichment in the gas phase, is performed by Comurhex, which today has a 25-percent share of the world market. In Europe, uranium conversion is carried out only in France and Great Britain, so that French industry, along with that of Britain, provides an important contribution to the processing of uranium for the German electricity business as well. In the process, the standards of both American and Russian enrichment plants are satisfied, as well as the specifications of the centrifuge installations which are a product of cooperation between Germany, Britain and the Netherlands.

For the enrichment facility Eurodif, which is starting up this year under state management, Comurhex offers the advantage of physical proximity--both are within sight of each other in the Rhone valley at Pierrelatte--and therefore minimal transport and simplified administrative expense.

It is also worth mentioning that the uranyl nitrate which is given off in the reprocessing of irradiated uranium is converted to UF_6, which also meets the strict technical standards of American enrichment facilities.

Fuel elements for pressurized water reactors are produced by Franco-Belge de Fabrication de Combustibles (FBFC) [Franco-Belgian Fuel Fabrication] in two plants in Dessel (Belgium) and Romans (France). Even if the capacities created here are primarily intended to satisfy national demand, French industry still has an interest in playing a role in the international market along with the supplying of reactors destined for EdF.

In the production of fuel elements for water pressurized reactors, French industry profits from the fact that by means of the steel producers Ugine Aciers within the PUK group they have built up a complete line for the production of zircaloy. This has all the more weight since zirconium alloys are classified at the moment in the United States as "sensitive materials." The investments

carried out by PUK in the last 2 years and the capacities created in this way are no longer only intended to supply the French market, but also a large part of the rest of the European market, with zircaloy preparatory material for casing tubes.

At this time a production facility is under construction at Paimboeuf (Loire) which is to roll out the preparatory material which is produced in the country in the form of tube balls into the final dimension of the casing tubes, starting from 1980. The capacity of this plant of the firm of Zircotube, founded by PUK (51 percent) and Framatome (49 percent), will be built up to 2,500 km/a by 1982.

Thus apart from the areas of enrichment and reprocessing, which are under state management, French industry not only offers a comprehensive service to its own national electricity business, but also supplies its European neighbors with part of its capacities.

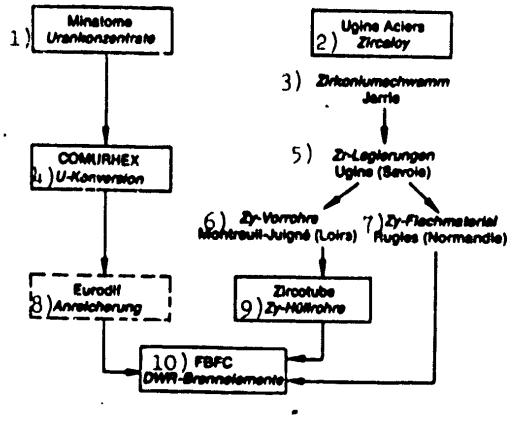

Figure 1: Centers of Private Business Activity in the French Fuel Cycle Industry

Key:

1. Uranium concentrates
2. Zircaloy
3. Zirconium sponge
4. Uranium conversion
5. Zirconium alloys
6. Zircaloy input tubes
7. Zircaloy flat material
8. Enrichment
9. Zircaloy casing tubes
10. Pressurized water fuels

Kernreaktoren – 1978 erstmals kritisch

Name 1)	2) Land	3) Standort	4) Typ	5) Leistung brutto	6) Eigentümer bzw. Betreiber	7) Konstrukteur oder Lieferant	8) erstmals kritisch
			9) Leistungs- und Versuchsreaktoren				
KKU	10) BR Deutschland	Essenshamm/Weser	Druckwasser (11)	1300 MWe	12) Kernkraftwerk Unterweser GmbH	KWU	16. 9. 78
Nord-3	13) DDR	Lubmin/Greifswald	Druckwasser	440 MWe	—	—	15. 5. 78*)
TVO-1	14) Finnland	Olkiluoto	15) Siedewasser	691 MWe	Teollisuuden Voima Oy (TVO)	ASEA-Atom	21. 7. 78
Bugey-2	16) Frankreich	Saint-Vulbas	Druckwasser	957 MWe	EDF	Framatome/ Creusot-Loire	20. 4. 78
Bugey-3	Frankreich	Saint-Vulbas	Druckwasser	957 MWe	EDF	Framatome/ Creusot-Loire	31. 8. 78
Caorso	17) Italien	Mezzanone di Caorso	Siedewasser	840 MWe	ENEL	Ansaldo Meccanico GETSCO (USA)	31. 12. 77
Ohi-1	Japan	Ohi	Druckwasser	1175 MWe	Kansai Electric Power Co.	Westinghouse (USA)	2. 12. 77
Fugen (ATR)	Japan	Tsuruga	D_2O-H_2O Siedewasser	165 MWe	JAEC	PNC	30. 3. 78
Tokai-2	Japan	Tokai	Siedewasser	1100 MWe	JAPCO	General Electric (USA)	18. 1. 78
Fukushima-I-4	Japan	Okuma-Futaba	Siedewasser	784 MWe	Tokyo Electric Power Co.	Hitachi	26. 1. 78
Hamaoka-2	Japan	Hamamatsu	Siedewasser	840 MWe	Chubu Electric Power Co.	Toshiba	26. 3. 78
Ohi-2	Japan	Ohi	Druckwasser	1175 MWe	Kansai Electric Power Co.	Westinghouse (USA)	14. 9 78
Bruce-3	18) Kanada	Tiverton, Ont.	CANDU-D_2O	788 MWe	Ontario Hydro	AECL	26. 11. 77
Bruce-4	Kanada	Tiverton, Ont.	CANDU-D_2O	788 MWe	Ontario Hydro	AECL	10. 12. 78
Taipower-2	Taiwan	Taipeh	Siedewasser	636 MWe	Taiwan Power Co.	General Electric (USA)	19. 12. 78*)
Bohunice-1	19) Tschechoslowakei	Trnava	Druckwasser	413 MWe	Slowak. Elektr. Behörde	Atomenergo-export (UdSSR)	26. 11. 78
Davis Besse-1	USA	Oak Harbor, Ohio	Druckwasser	960 MWe	Toledo Edison Co. Cleveland Electric	Babcock & Wilcox	12. 8. 77
Donald C. Cook-2	USA	Bridgman, Michigan	Druckwasser	1000 MWe	Indiana & Michigan Co.	Westinghouse	10. 3. 78
Three Mile Island-2	USA	Goldsborough, Pennsyl.	Druckwasser	960 MWe	Metropolitan Edison	Babcock & Wilcox	9. 3. 78
North Anna-1	USA	Mineral, Virginia	Druckwasser	947 MWe	Virginia Electric Co.	Stone & Webster/ Westinghouse	5. 4. 78
Hatch-2	USA	Baxley, Georgia	Siedewasser	822 MWe	Georgia Power Co.	General Electric	4. 7. 78
Arkansas Nuclear One-2	USA	Russelville	Druckwasser	958 MWe	Arkansas Power & Light Co.	Combustion Engineering	5. 12. 78
			20) Forschungsreaktoren, Nullenergiereaktoren und kritische Experimente				
HD-II	10) BR Deutschland	Heidelberg	Triga Mark I	250 kWth	21) Krebsforschungs-zentrum	General Atomic (USA)	26. 2 78
TU Dresden	13) DDR	Dresden	22) Forschungs- u. Ausbildungs-reaktor	—	23) Techn. Universität Dresden	—	Okt. 78**)
Phébus	16) Frankreich	Cadarache	11) Druckwasser	—	CEA	CEA	9. 8. 78
Lima	Peru	Lima	24) Forschungs-reaktor	—	25) Institut für Kernenergie	26) Argentinien)	Juli 78**)
NRAD	USA	Idaho	27) Radiografie-reaktor	—	INEL	—	12. 10. 77
LOFT	USA	Idaho Falls, Idaho	Druckwasser	55 MWth	NRC	—	5. 2. 78
ACRR	USA	Sandia Lab., Albuquerque	28) Sicherheits-forschung	—	NRC/DOE	—	Okt. 78***)

*) Zum Dauerbetrieb freigegeben.
**) Eingeweiht.
***) Volle Leistung.
29) Erste Stromerzeugung.

Anmerkung: „Kernreaktoren – 1978 erstmals kritisch" schließt zeitlich an die entsprechende Liste für 1977 an. Soweit in der neuen Aufstellung Reaktoren aufgeführt sind, die bereits vor dem 31. 12. 77 kritisch wurden, sind sie (wegen verspäteten Eingangs der Information) in der Vorjahrsliste noch nicht enthalten.

Table 1: Nuclear Reactors Which Became Critical in 1978
(Key on following page)

Note: "Nuclear Reactors Which Became Critical in 1978" follows chronologically from the 1977 list. To the extent that reactors are included in the new chart that became critical before 31 December 1977, they were not yet included in the previous year's list (because of a delay in receiving the information).

Key:

1. Name
2. Country
3. Location
4. Type
5. Capacity (Gross)
6. Owner or manager
7. Constructor or supplier
8. First became critical
9. Capacity and experimental reactors
10. FRG
11. Pressurized water
12. Nuclear Power Plant
13. GDR
14. Finland
15. Boiling water
16. France
17. Italy
18. Canada
19. Czechoslovakia
20. Research reactors, zero energy reactors and critical experiments
21. Cancer Research Center
22. Research and development reactor
23. Technical University, Dresden
24. Research reactor
25. Institute for Nuclear Energy
26. (Argentina)
27. Radiography reactor
28. Safety research
29. *) Released for continuous production
    **) Dedicated
    ***) Full capacity
    °) First production of current

Kernreaktoren – 1978 stillgelegt

Name 1)	2) Land	3) Standort	4) Typ	5) Leistung	6) Eigentümer bzw. Betreiber	7) Konstrukteur oder Lieferant	8) Inbetriebnahme (1. Kritikalität)	(9) Stillegung
IRL	USA	Plainsboro, N.J.	10) Schwimmbad	5000 kW	Industrial Reactor Lab.	AMF	Januar 1959	(1977)

84

atomwirtschaft, Februar 1979

Table 2: Nuclear Reactors Shut Down in 1978

Key:

1. Name
2. Country
3. Location
4. Type
5. Capacity
6. Owner or manager
7. Constructor or supplier
8. Start of operation (first criticality)
9. Shutdown
10. Swimming pool

9337
CSO: 3103

END