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THE STORY OF "PROJECT AQUARIUM"

Francois Kertesz

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DIRECTORS DIVISION

THE STORY OF "PROJECT AQUARIUM"

Francois Kertesz

AUGUST 1968

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee
operated by
UNION CARBIDE CORPORATION
for the
U.S. ATOMIC ENERGY COMMISSION

Original Core Still Going Strong

First 'Atoms For Peace' Reactor Has 10th Birthday in Switzerland

Marks Tenth Anniversary

ORNL has been lauded for its outstanding work in the design and development of the first nuclear reactor in the international "Atoms For Peace" program.

Praise came by way of cable from the directors of the Swiss Federal Institute For Reactor Recearch in Wuerenlingen. The Institute has been operating the reactor since acquiring it from the United States at the close of the 1955 Geneva Conference on the Peaceful Applications of Atomic Energy.

The cable states: ". . . As you will remember, Saphir (the name given to the reactor by the Swiss) was originally exhibited at the first Geneva Conference by the USAEC as the 'acquarium' reactor. It has since been in operation at a power level of up to 1 Mw, giving every satisfaction. The first core is still going strong so that this fuel has very likely set up a world record. We wish to record our recognition for the excellent work ORNL put in."

The Geneva reactor was officially inaugurated at Wuerenlingen May 17, 1957, and so has just marked its 10th anniversary as a fully operable research reactor.

Saphir was packaged and airshipped to Geneva a few days in advance of the opening of the 1955 conference on August 8. Completely automated, it achieved initial criticality while the conference was in progress. When the international meeting had ended, the reactor was signed over to the Swiss Government, dismantled and shipped to Wuerenlingen.

During the next year and a half, some original design changes were made and Saphir was rebuilt to a considerable extent. It again reached criticality April 30, 1957 and was operating at full power May 17.

Some persons closely associated with design and development of the Geneva reactor are still active ORNL staff members, including T. E. Cole (Reactor Division) and E. P. Epler and J. B. Ruble (Instrumentation and Controls Division).

Cole said it was his belief "Saphir served as a 'catalyst' in the entire program of Atoms For Peace reactors."

Epler said, "the weeks and days immediately preceding the shipment of the reactor were slightly hectic. We were operating on a tight schedule. We knew it (Saphir) would be seen by thousands of very important people, and we were all determined to give them a good show."

The reactor is much like the Oak Ridge Research Reactor (ORR), but smaller. The fuel consists of 20 percent enriched uranium-235 dispersed in aluminum-clad elements and is installed in a rectangular-shaped pool. The Swiss have improved the cooling system to allow the reactor to operate for longer periods at maximum power.

SAPHIR—The United States Exhibit Reactor, designed and constructed at ORNL, was tested prior to being air-shipped to Geneva, Switzerland, for demonstration at the 1955 International Conference on the Peaceful Uses of Atomic Energy. Participating in the test were (L-R) E. P. Epler, Instrumentation and Controls Division; C. W. Ricker (now head of the Albion College Physics Department); and J. B. Ruble, Instrumentation and Controls. The reactor was acquired by the Swiss Federal Institute (Wuerenlingen) at the close of the conference and was later named Saphir.

THE STORY OF "PROJECT AQUARIUM"

We live in an age in which everything -- from military operations to social welfare projects -- is designated by a catchy code name. The Second World War gave us the famous "Operation Overlord"; perhaps the best known of the early postwar atomic tests was "Operation Crossroads". Since then, we are bombarded in the newspapers and magazines by a host of code-word-designated operations or projects. It is not surprising, therefore, that many people in this Laboratory, even those who were closely connected with it, are no longer able to identify the "Project Aquarium".

This descriptive code name designates the design, construction, and the operation of a swimming-pool-type reactor for the First Geneva Conference in 1955. Today, when every Saturday large crowds of high school students and tourists file past our reactors, the full impact of this undertaking is not fully realized. This was to be the first occasion that the general public would glimpse one of those mysterious "atomic furnaces" about which they read so much in the Sunday pages of the newspapers. Those reports were full of superlatives, without giving much true information; they often sounded more as extracts from a science-fiction story. And here we were about to show to the man in the street an "atomic furnace" operated under the water!

For the younger ones among the readers it might be of interest to set the stage. Up to the beginning of our story, the science and technology of atomic energy grew up in secrecy. After its birth, in the midst of war, nuclear science was kept by law from developing like other branches of science. Its practitioners had little contact with their colleagues in the universities and industry. President Eisenhower's famous speech at the United Nations and the subsequent decision to hold the first truly open, international atomic conference was a tremendous change; scientists the world over became hopeful that fruitful personal contacts may be achieved once again.

The overall preparations for the conference were in the hands of an organizing committee that appointed "scientific secretaries" representing most of the scientifically active countries.[1] Each country had its own committee; during the feverish preparations before the conference every nation attempted to marshal the best scientific papers documenting its achievements, and to develop eye-catching exhibits for the scheduled scientific show, in order to attract the attention not only of the scientists but also of lay people and the press.

Obviously, it is quite difficult to prepare a scientific exhibit that is of interest to experts and tickles the curiosity of the public.

[1] Robert Charpie, former ORNL Assistant Director, was one of them.

The American scientists also submitted one proposal after the other. Many of them were accepted and organizers blocked out the necessary space, within the limitations arising from the structure of "Hall Fifteen" assigned to the United States in the Palace of Nations in Geneva. That building, of course, was built as a political meeting arena being completed in 1939, during the dying days of the old League of Nations. It was not suited for operating science exhibits which require high-current outlets, special instruments, etc.

As a whole, the submitted proposals represented excellent technical achievements, but they were definitely not sufficiently spectacular to capture the imagination of the populace. The country where the atomic energy was born was expected to present something never before seen by the public. Therefore, the suggestion forwarded by an ORNL scientist, Tom Cole, was received with great enthusiasm.

Tom was involved in the design of the first swimming pool reactor, the BSR, and at the time of this story was hard at work on the design and construction of the ORNL Research Reactor (the ORR). Being familiar with the features of pool-type reactors, he recognized that they were well suited for public display. First of all, the operation is quite safe, especially at the proposed low-power level. Then, this type of reactor is shielded by a transparent material, water, that makes it possible to observe the spectacular "blue glow", the Cherenkov radiation. Because of the size of the structure, the phenomenon may be observed simultaneously by a large number of people. Presentation of such a reactor would offer an opportunity to demonstrate the reliable operation of automatic control systems, while the reactor itself could be used to carry out a number of neutron-physics experiments. This was considered to be of special interest to scientists from smaller countries who did not have access yet to an operating reactor. The most important feature of the proposal was that the exhibit would allow to demonstrate to the public at large, to the sophisticated international colony living in Geneva, and to the expected large number of tourists, that nuclear energy is something that they can live with; actual observation could alleviate their fears, and would show that the control of nuclear energy is in competent hands.

The legend says that Tom received his insight during a dream, and the next morning he energetically started his rounds to convince his colleagues and superiors. In short order, the idea received the endorsement of the ORNL management; and, at their turn, the AEC officials charged with the preparation of the exhibit adopted it enthusiastically.

However, this was not enough. Although the purpose of the exhibit was to demonstrate the safe operation of a nuclear reactor, the organization committee of the conference first had to be convinced; then, the objections of the Swiss federal and Geneva municipal authorities had to be overcome. These negotiations of more-or-less diplomatic character took time, but they were successfully carried out. Thus, "Project Aquarium" came into official existence.

The word "aquarium" of course describes fairly closely the general idea behind the reactor exhibit. It was a system containing water, and people were supposed to see what was inside. It is of interest that the term "swimming pool reactor" met with general official disapproval before the conference. That term was also quite logical to designate a reactor placed in a water-filled rectangular hole in the ground which, for all purposes, looked like a swimming pool. However, according to the story, the powers that be did not like the term because of its less-than-serious connotations. In any case, the first such reactor, also built at ORNL, was designated as the Bulk Shielding Reactor, a component of the "Bulk Shielding Facility", or BSF. The name was technically correct but definitely not as colorful as the original one. Although the term "swimming pool" was removed by censors from the papers submitted to the Geneva Conference, the newspapermen got hold of it and no official edict could prevent references to the "swimming pool reactor", "réacteur piscine", "Schwimmbadreaktor", etc.

After the United Nations and municipal officials somewhat dubiously approved the project, new problems arose. Obviously, the reactor was too big and too awkward to be placed in the marble halls of the Palace of Nations; therefore, construction of a separate building had to be considered. As the conference was international, every participating country had to have access to the same facilities; therefore, a similar offer was made to the other nations, including the Soviet Union, advising them that they could present an operating reactor if they so desired.

While these diplomatic negotiations were carried out, work was started at the Oak Ridge National Laboratory; the shortage of time did not allow to wait until final approvals were obtained. Of course, nothing was official, but the word leaked out anyway. This was due to the fact that work related to this project was assigned highest priority in the various shops, and technical men learned to their disgust that their requisitions were squeezed out by the new Aquarium Project.

Organization of the work proceeded rapidly while the negotiations were dragging on. There was a vast storehouse of information on this subject at ORNL because our Laboratory pioneered the construction of this type of reactor, and the ORNL metallurgists were among the country's foremost experts in the manufacture of the required fuel elements. As a matter of fact, for a long time, the rolling mill of the Metals and Ceramics Division was the only manufacturer of swimming-pool-type fuel elements until private industry took over the ever-growing requirements.

No difficulties were foreseen -- after all, our backlog of experience was one of the cornerstones of Tom's proposals -- and for a while none were encountered. Construction of the reactor went on with no more than the usual amount of trouble. The reactor was designed at top speed, construction was started, and assembly of the control system was well under way.

Then, like a bolt of lightning out of the blue sky, troubles were encountered in the manufacture of the fuel elements. Actually, this

was more a legal than a technical problem. The MTR-type elements fabricated in our rolling mill were made of a uranium-aluminum alloy placed in an aluminum sandwich. The uranium in the alloy was enriched to a level exceeding 90 percent. Unfortunately, the 1954 Atomic Energy Law prohibited the exportation of uranium containing more than 20 percent of ^{235}U. The lower level of enrichment required an increase of the uranium:aluminum ratio which resulted in a mixture with undesirable mechanical properties. After some unsuccessful tests with such alloys, it was decided to use uranium dioxide mixed with aluminum powder, fashioning the mixture into compacts by powder metallurgy techniques. This method worked well in the laboratory, but a large number of the finished elements had to be rejected in pilot plant operation. Examination of the rejects revealed that the UO_2 reacted with the aluminum powder, forming the compound UAl_4; this crystal continued growing until it ruptured the protective aluminum plate.

This state of affairs created a very delicate situation at the Laboratory. Negotiations were being pursued to overcome the resistance of United Nations and Swiss authorities, assuring them that the reactor operates safely. The AEC people were assured that the ORNL staff knows how to design and build the reactor; they were promised that the whole project can be completed without any further delay, once the official word is given. It was rather awkward to find out at that late stage that we were not quite sure whether the necessary fuel elements could be successfully fabricated. Obviously, an executive who under such conditions sticks his neck out deciding to go ahead, hoping that everything will be ready when needed (meaning within a few weeks at most), instead of calling off the whole project, really earns his pay, although he may have to save some money to treat his ulcers.

At this point, the assistance of the Metals and Ceramics Division's experts was sought; only a short time before, those researchers encountered a similar problem with stainless steel uranium dioxide powder, which exhibited an increased rate of attack. It was first tried to increase the particle size by sintering, but this did not solve the problem satisfactorily, as the agglomerates tended to break down. After some feverish experimentation and several lost weekends for the ceramic laboratory staff, the problem was solved: the large hydrated uranium trioxide ($UO_3.H_2O$) crystals, made by an autoclave technique, were reduced to large-size UO_2 crystals. Incorporation of these crystals yielded satisfactory fuel elements. The particle size was the most important quality-control parameter, and the method was excellent to control the size. The UO_2 grains had the same external shape as their UO_3 parents, but the size was reduced to about two-thirds. However, during the scaling up of operations to the pilot plant stage, it was found that no large production autoclaves were available. Thanks to the ingenuity of the design engineers, a makeshift autoclave was made from a large diameter pipe; quite naturally, it became known as "Genevieve". After some trial runs with Genevieve the large-scale fabrication of fuel elements was started.

By this time, the Soviet Union and the other countries decided that they will not build a full size operating reactor; they probably thought

that nobody can do it during the short period remaining before the Conference.

Let us go back again to Geneva. In view of the bulkiness of the reactor and the large number of auxiliary equipment, it was agreed that a separate building must be constructed; after all, the marble floors of the Palace of Nations could not be broken up, not even for a reactor. The Secretariat was prevailed upon to assign a suitable plot.

The original plan, designed by Union Carbide Corporation's architect, called for a simple house to shelter the reactor. The experience of the architect as chief designer of the Corporation's industrial exhibit program was very helpful in bringing out the spectacular features of this modern machine. The original plan called for an elevated platform, housing the superstructure and reactor tank, to be spotlighted in an otherwise dark room; the glass front of the building, modeled somewhat after a Swiss chalet, was intended to act as a giant show window, allowing passers-by to see the reactor from a distance. Unfortunately, it turned out that it was not possible to find a glass pane of the desired size in Switzerland within the allotted short time; it was therefore replaced by an opaque front carrying the Atoms-for-Peace emblem. Even so, the building attracted considerable attention.

The first location assigned to the reactor was on the land near the lake at a considerable distance from the main building of the Palace of Nations, and was inherited by the United Nations from the now defunct League of Nations. Luckily, this land was too small for the intended purpose; in addition, the City of Geneva needed it. Finally, after much discussion, an exchange was made that satisfied everybody. The city relinquished one of its plots next to the United Nations grounds, in exchange for the lakeside area: Project Acquarium obtained a good location on the Palace grounds, close to the exhibit hall and to the main meeting rooms; and everybody was happy, at least for awhile. However, when construction started, legal experts who checked the old documents discovered that the original deed to the land assigned to the reactor building covered only the surface rights; the question was how many feet of digging into the subsoil would violate this requirement. After some additional diplomatic haggling, this technicality of several centuries-old document was overlooked.

Construction of the building was started in April 1955. A Geneva contracting firm was in charge of the work, under the supervision of an ORNL engineer. You can imagine the problems facing this American engineer, who had to learn foreign practices in a very short time, to supervise a construction project by Swiss workers accustomed to metric units, using American plans, in English units. The construction boss also had to become accustomed to the work habits of European craftsmen. The job called for a combination of talents, ranging from that of a strict task master to that of a suave diplomat. But thanks to the splendid cooperation between Swiss and Americans, the building was finished on schedule. Credit must be also given to the young, English-speaking Swiss foreman who, in no time, closed the gap between the Swiss and the American

Aquarium Project personnel. The son of the manager of the construction company, a young Swiss engineer*, who at that time was a graduate student at MIT (and later became an ORNL employee), was also of considerable assistance in overcoming the cultural differences between the local people and the visitors.

Organization of the work in Geneva was greatly facilitated by the fact that Geneva was the headquarters of Union Carbide Europa, the European office of Union Carbide Corporation. They did an excellent job in locating contractors, smoothing out local difficulties, finding quarters for the Oak Ridge personnel, hiring auxiliary personnel such as interpreters, etc.

While this was going on in Europe, the project was formally organized back in Oak Ridge. Proposals concerning the exhibits to be installed near the reactor and the experiments that could be performed during the scheduled two weeks of operation of the reactor was considered. The physicists and engineers, whose opinion was solicited had interesting ideas but, luckily, their proposals were supervised by the architect whose experience as design specialist for the corporation helped to ensure that each exhibit panel carried a "message". Thus, in view of the fear of the general public on all matters involving radiation, health physics problems were emphasized. One of the chief panels carried the pithy slogan "Radiation <u>is</u> Detected -- Personnel <u>is</u> Protected".

In view of the fact that the Conference was sponsored by the United Nations, everything written in English had to be translated into the three other official languages: French, Spanish and Russian; luckily, they did not insist on translating the material into Chinese also. The translations were made in a great hurry, and there was considerable discussion how to translate terms developed in secrecy into the other languages. Problems were encountered with widely used terms such as "Scram". A request to translate this expression was answered by the French expert by an explanation that this American slang word has no exact equivalent in French. He was obviously not aware of the specific technical meaning of the word. The problems further compounded when it was attempted to translate the text into Russian. Work was progressing also on the preparation of an explanatory brochure.

Continuing the race against time, the construction of the reactor was completed; the assembly went critical at a somewhat lower ^{235}U content than calculated. An open house was held at that time for the Laboratory personnel. The Geneva reactor story became official; LIFE magazine published a photograph of it, as it appeared in the BSF pool.

After the critical experiment, the reactor was disassembled; the crated parts were loaded into two giant Globemaster planes and the reactor started its long trip across the ocean, accompanied by eleven AEC guards.

* Alain Colomb is working again in Switzerland.

During this time, the construction crew in Geneva had its share of problems. As the deep hole was dug for the reactor tank, an old cistern was uncovered in the neighboring area; it probably supplied water to a nearby villa a few hundred years ago. In an old city like Geneva, with a history going back to Roman times, a structure built a few hundred years ago is of relatively little interest. Indeed, the workers took this finding in their stride; the old cistern was simply filled with dirt. However, the story made the rounds and became exaggerated later on. As circulated, the story stated that Roman ruins were found during the excavation and that the Americans were afraid that construction would be stopped to allow the archeologists to study the ruins; therefore, the hole was filled. The story is definitely apocryphal, which is a pity. It would have made a nice headline in a magazine: "The scientific glory of the twentieth century, the atomic reactor, built on the site of a twenty-century-old structure".

Moving the 22-foot-long, 10-foot-wide steel tank to the site through the city streets was quite a complex job. As the tank was lowered carefully into the hole, one of the supporting cables broke, and instead of being placed gently, the tank fell into the hole. Had it been broken it would have been the end of the project, as the time was too short to remove it and to replace it with another one. Luckily, it did not break, but it came to rest in a somewhat inclined position like an inverted tower of Pisa. As it was filled with water, the level reached the edge of the steel cylinder at one point while it was several inches below the edge at the opposite point. Because of the shortage of time, the tank could not be lifted and readjusted; but the problem was solved ingeniously by a tour de force: the top of the tank was sliced off in such a way that the top rim of the tank became horizontal. Of course, the walls were not quite vertical, but nobody noticed it.

By now, the time was early July, several weeks from the start of the First Conference on the Peaceful Uses of Atomic Energy. While the tank was placed in position, the building was constructed around it by another crew, the Oak Ridge engineers unloaded the crated reactor from the two Globemasters, and started the installation of the reactor itself in the still half-finished building. The Globemasters were the largest planes ever to land at the Geneva airport up to that time, and they attracted considerable attention. The local papers devoted long articles to the planes and, in connection with it, to our project, because of the international aviation exhibit then being held in Geneva. This brought publicity to the reactor project.

The next ten days were really hectic ones. The Oak Ridge crew, with the assistance of Swiss craftsmen, uncrated the items and assembled the reactor, while the building was constructed around them. The crew became experienced in climbing up and down on a rickety ladder from the platform to the bottom of the 22-foot-deep tank.

In view of the fact that the reactor was already successfully put together once in the BSF swimming pool, it was expected that the assembly in Geneva would proceed uneventfully; however, this was not to be the

the case. The bottom grid plate was adjusted to an exactly horizontal position before filling the tank with water. However, after filling, the weight of the water caused the bottom to buckle; and the plate had to be readjusted under the water to a horizontal position from the top by means of a socket wrench at the end of a 25-foot-long pole.

While the reactor itself was assembled, the instrumentation engineers were kept busy connecting the thousands of wires of the control system to their proper places. The general construction progressed smoothly but in an unorthodox fashion: as the construction materials were moved from one spot, the gardeners moved in, planted flowers and unrolled the pregrown lawn. At one side of the reactor, workmen were laying the linoleum, while at the other one two janitors were already busy waxing and buffing it energetically. Two motor generator sets were installed in the basement; they provided the American 110-volt, 60-cycle current needed for our equipment in the reactor control room and for the American machine tools. In addition, of course, we had to have the regular Swiss 220-volt, 50-cycle current; in some places, the Swiss 50-cycle current was transformed down to 110 volt. We had to be sure not to use electric clocks or tape recorders on these outlets. The overall result of this hybrid arrangement was somewhat confusing; one had to think over carefully what outlet to use for a given equipment. Luckily, we had excellent Swiss electricians who kept a large supply of fuses to replace the ones blown by the improper use of outlets.

This truly international crew which included Italian laborers started out to work somewhat awkwardly, but within a very short time the feelings became quite friendly. Excellent personal relations prevailed; a strong team spirit developed between the local workmen, the laborers, and the overseas engineers. It was really heartwarming to see the electrician drop his tools to help the carpenter if he needed an extra pair of hands; everybody helped the riggers to move awkward, odd-shaped equipment.

Of course, the local customs differed from those prevailing in Oak Ridge. The Swiss workers started to work at 7:30 a.m.; at about 9 o'clock they disappeared mysteriously. The lunch period was from 12 to 2 and like everywhere in continental Europe, the workers usually went home to their families. In the midafternoon they were again absent for a while. We soon discovered their secret: they had a midmorning and midafternoon wine break, to which they invited some of their American friends. Their hiding place was in a small dark hole in the basement, behind the reactor tank, later dubbed "Bar Atomique". By the time the reactor was operating and the crew had a little bit more free time, they paneled the place with salvaged boards; tables and chairs were built in, and a window was painted on the wall, complete with flowers; even a view of Lake Geneva could be glimpsed through the curtains. Membership in the "Bar Atomique" became a status symbol; the Swiss workers invited only those persons with whom they were especially friendly. During the Conference itself, some of the V.I.P. visitors were also spirited away to this hideaway where the list of refreshments was truly international: Coca-Cola and Swiss

white wine. The bilingual discussions centered on the bouquet, aroma and body of various wines, the standing of the baseball teams, and current reactor problems, depending on the occupants of the room.

The American habit of coffee drinking was not neglected either. At the headquarters of the AEC guard force in the main room of the basement a coffee pot was going all the time. Some of our Swiss friends joined them in coffee drinking while the Americans descended to the depths of the Bar Atomique, thus doing justice to the customs of both countries. Exhausted reactor engineers had their choice in how to relax.

The building was guarded by the Oak Ridge AEC guard force during the day; Marine guards took over the night watch. Although the Marines were in civvies, they could be easily identified by their crew cut, broad shoulders, blue serge suit, bow tie, and straight military bearing.

The reason for this complex arrangement was to guard the reactor against mischief. After all, at the time the original arrangements were made, the "Geneva spirit" that prevaded international relations after the Big Four meeting could not be anticipated; it was theoretically possible that some of the less friendly countries might not mind if our reactor would break down at awkward times. As it turned out, there was no reason for concern, but it was just as well that the relations were friendly because the main electrical panel serving the reactor building was located in the portion of the Palace of Nations assigned to a "less friendly" country. Whenever a fuse was blown, they had to give permission to go through their exhibit to reach the panel. So, if they really wanted to cause us trouble, they could have done it easily, regardless how many guards were watching.

By the time the reactor was assembled, the attention of Geneva, and perhaps of the whole world, was focused on the "Big Four" Conference. Just before that conference began, the first American reactor in Europe went critical on July 18, at 9:47 a.m. The exact time was checked on a wrist watch, because our otherwise magnificient control board did not possess a clock.

Extraordinary safety measures were taken during the Big Four meeting: the city was full of secret service men of the four countries. In addition, the Swiss police and the army in field uniform, with submachine guns in hand, occupied strategic positions near the reactor building, when President Eisenhower came to visit on July 20. The importance of the event was heralded by the arrival of White House staff members and Secret Service men. They were followed by a horde of newspapermen and photographers who set up large flood lights which overloaded the circuit. The electricians were kept busy changing fuses. The newsmen climbed all over the place, standing on the exhibits; and it was a miracle that nobody fell into the pool and that no serious damage was done to the equipment.

A tactless remark of a minor official, who gave loud orders to keep all men in work-clothes out of sight, caused resentment among the Swiss workers. We had to appease our hard working Swiss friends by appointing

the foreman the personal microphone carrier for the President. He rushed home, changed to a dark suit, and was the proudest man, walking right next to the President.

The Presidential visit was a great success: it focused attention on our exhibit and was written up extensively in the local and international press. The President showed great interest in the reactor, which was operating two weeks prior to the opening of the conference; the crew was very proud of this.

There was a slight breathing spell during the period after the visit of the President and before the official opening of the Conference. We did not have to compete for the services of the few available craftsmen, and could relax while the other countries' exhibit staff worked feverishly. As a favor, the reactor was open to special visitors which included U.S. Consulate, Union Carbide Europa employees, and the staff of the U.N. agencies. They were used to provide "field experience" for the girl guides who were carefully trained during the previous weeks. These seven girls were students at the well-known Interpreter's School of the University of Geneva; all of them spoke at least three languages. They ranged in age from 19 to a mature 23; they looked very decorative but they did not have too much background in reactor physics and engineering. Within a very short time they were guiding people around so expertly in a variety of languages, that many visitors complimented us for having selected such goodlooking physics students.

Of course, everybody who worked around the reactor during these early days considered himself an expert when guiding personal friends. As an example, I recall a Marine who was showing a beautiful Swiss girl around, explaining the reactor to her in approximate French. One of the real "experts" was about to offer his services to explain the operation more correctly, but the rapt expression on her face revealed that it did not really matter what he said.

It is very possible that many misconceptions concerning the operation of the reactor have been perpetuated during this informal period when everybody was so free with information. Thus, a group of Swiss customs officials admired the assembled reactor that they had seen in its crated form. A transparent plastic cover had been placed in position just under the water level of the pool, and somebody put a large nail on it in order to bring to the attention of his colleagues the presence of this otherwise invisible sheet. One of the customs inspectors was puzzled; he couldn't understand how that heavy iron nail was floating on water. The electrician explained it to him knowingly: "It's heavy water, you know". "Of course, of course," said the customs man, and went home happily that he had learned some more about the mysteries of the atom.

As the time of the opening of the Conference was drawing close, and as conference delegates appeared on the scene, the originally small Oak Ridge group became larger and larger. This confused the Swiss workers who

could not clearly understand the relative rank of the new arrivals. The first American supervisor on the scene was the ORNL project engineer, W. Morgan; a little later, C. E. Winters, the project director, made his appearance. Things became more involved when Dr. Weinberg, then ORNL research director, Dr. Larson, then the ORNL Laboratory director, arrived, followed by a Union Carbide Corporation vice-president. In addition, Dr. Manov and Dr. Cope, who were in charge of the reactor project for the AEC, also supervised the work every day. Occasionally, Dr. Weyl, the head of all U.S. Exhibits at the Conference appeared at the site. They were, of course, topped by AEC Commissioner Libby, Chairman Strauss, and finally, by President Eisenhower. At that time the Swiss gave up completely and expressed their opinion that apparently everybody from America is a "boss".

In spite of the fact that the reactor was ready weeks before the opening of the Conference, last minute problems kept popping up. The original name of the reactor was "Geneva Conference Reactor", but before the beautiful sign could be put up, the name was changed to "U.S. Research Reactor"; the day before opening, the sign painters hurriedly painted the new name in four languages.

The crew started operations in distinctive coats sent from Oak Ridge, bearing proudly the ORNL insignia. This was vetoed by one of the AEC "bosses"; the men were instructed to cover the badge with their name tag. However, pride in the home base prevailed, and the name tags were put on every day in a slightly different position until the Laboratory's insignia, like an Army division's shoulder patch, was visible in its full glory.

After feverish activity during July, the opening ceremony was somewhat of an anticlimax. The reactor was duly visited by U.N. and American officials; the official host of the conference, President Petitpierre of Switzerland, spent nearly an hour inspecting everything. He arrived in the company of two of his staff members and was guided through the exhibit, which at that time was open to the public. At the end of the tour he looked around, trying to find his staff members; somehow they became separated from him by the crowd, and there wasn't even a police officer in evidence next to the president of the host country. This tour attracted much less attention than the visit of President Eisenhower.

Mrs. Fermi, the widow of Enrico Fermi, was the official historian of the conference; she visited the building several times. Her book "Atoms of the World" contains several references on the reactor project. Many world-famous scientists were among the visitors; their presence presented problems. We wanted to avoid the embarrassment that girl guides might try to explain the principles of the reactor to Nobel-Prize winners or other famous people who contributed themselves to the development of this branch of science. The reactor attracted indeed luminaries such as Professor Bhabha, chairman of the Conference; Professor Hahn, the discoverer of fission; heads of delegations; Professor Perrin, the French High Commissioner of Atomic Energy; and other chairmen and members of

national atomic energy commissions. The scientists were also given an opportunity to operate the reactor. Of course, this was more of a ceremonial activity as the servomechanism took over after the operator pushed a button. President Eisenhower was the first such honorary reactor operator; among the others was also the head of the Russian scientific exhibit, Professor Ryabchikoff, who thus can claim the distinction that he is the first Soviet citizen to operate an American reactor.

The newsmen represented a special class; they differed from the reporters and photographers who descended on the reactor building during the President's visit. Many of them were well-known newspaper-chain or press-agency science writers, including several dignified older persons who spent hours in the building, taking notes and listening to detailed explanations.

The magazine photographers worked more carefully and slowly than the news photographers. A well-known photographer of LIFE magazine wanted to take a series of pictures during the assembly of the reactor and was somewhat disappointed when he found out that the reactor was completed two weeks before his arrival. He still took hundreds of pictures and used up enough film to keep a camera club active for a year. Expecting a big display in the magazine, the reactor crew was disappointed when LIFE printed only a small picture showing the backs of people as they were peering into the reactor tank.

Local dignitaries, and the European ex-royalty required special protocol arrangements. There were so many of them that occasionally a traffic jam of VIP's arose.

The reactor was operating from 9 a.m. til 4 p.m. for the Conference delegates and newsmen; the general public was admitted from 4 until 10 in the evening. We miscalculated the attraction of the reactor: nobody expected that it would draw such a tremendous crowd. People were waiting outside the gate of the Palace of Nations before opening, then rushed to the reactor building, queuing up for hours. During the two weeks of the Conference more than 62,000 visitors passed through the building, receiving explanations in English, French, German, Spanish and Italian. In view of the large crowd, it was attempted to reduce the duration of the tours, but the girl guides were so proud of their newly acquired knowledge that they did not want to leave out anything and fed detailed information to the crowd. Their professional pride rebelled against any shortening of their spiel. It was really interesting how the "blue glow" excited the general public, without any real background in science. We used it to emphasize the theme of international collaboration in science: the basic effect was discovered by an American, Compton; it was applied to this specific case by the Russian scientists Cherenkov and Vavilov and was now being demonstrated for the citizens of Europe and the scholars of the world by American scientists and engineers.

Because of the large crowd of visitors, many of the carefully prepared experiments fell by the wayside; there was simply no time to perform them.

Many television and radio broadcasts were prepared at the reactor site. The crew was interviewed in every possible language, and "The Men in White from Oak Ridge" became well known to European TV viewers and radio listeners.

As the Conference ran its course, the glamorous days of the reactor came also to an end. As the climax negotiations between the AEC and the semigovernmental Swiss group, Reactor Ltd., title to the machine was transferred to the Swiss in a formal ceremony on August 20, becoming effective after the closing of the Conference. Admiral Strauss and Miss Willis, the American Ambassador to Switzerland, signed for the United States; the two directors of Reactor Ltd., Professor Scherrer of the Zurich Polytechnic Institute, and Dr. Boveri, the well-known Swiss industralist, accepted the reactor for Switzerland. Everybody was happy. The Swiss received a "slightly used" reactor, and the American crew was relieved of the worry concerning packing and transporting the now-radioactive components back home. The Swiss also took over the obligation to tear down the building and to replant the trees, as required by our agreement with the United Nations.

Sunday, August 21, the last day of operation, was very quiet. The Conference closed, the delegates were leaving, the other exhibits were shutting up, and the visitors consisted mostly of tourists and townspeople. At seven o'clock the sign was removed from the front of the building; somebody scribbled "Sold", and "Vendu" on it. The doors were closed but reopened an hour later for a party to which everybody who had anything to do with the construction was invited. This was a somewhat sad occasion of farewell; the many people of various background who worked feverishly for months side-by-side, did not expect to meet again.

Next morning the large blue sign was still at the entrance of the Palace of Nations; but on closer inspection it turned out that it was not the old one to which we became accustomed. The efficient Swiss changed the sign overnight and now it announced the beginning of the International Conference on Penology and Prison Management. The First Geneva Conference on the Peaceful Uses of Atomic Energy belonged to the past.

By noon the reactor was dismantled; components and instruments were lying all over; anything that was radioactive was in the pool, which soon was covered and locked, "to be transported" to the Swiss Atomic Center in Wuerenlingen. After having been built and assembled in Oak Ridge, dismantled, crated, flown across the ocean, reassembled in eleven days, shown to scientists, presidents, ex-kings, and tourists, it was officially inaugurated on May 17, 1957, with the new name of SAPHIR, at Wuerenlingen where it continues a second useful, if less, dramatic career.

FOR THE RECORD ...

The project was under the overall supervision of C. E. Winters who coordinated all efforts, both in Oak Ridge and later in Geneva. He was assisted by A. F. Rupp who was in charge of the exhibits in the reactor building. The reactor operations crew included L. B. Holland, J. W. Hill, Jr. and C. D. Cagle while E. P. Epler, T. E. Cole, S. H. Hanauer, C. W. Ricker and J. T. DeLorenzo were in charge of instrumentation and controls. R. L. Clark assumed responsibility for health physics matters and E. P. Blizard, A. C. Stewart, A. L. Boch, and M. E. Ramsey acted as guides. The writer was part of the latter group, having been also responsible for the training of the guides and translation problems.*

D. D. Cowen, together with G. Moynehan of Union Carbide Corporation, took care of public relations matters of the project. W. L. Morgan acted as resident engineer in Geneva and D. Steward of Union Carbide Corporation designed the building and coordinated the preparation of the exhibits.*

In addition to the above individuals, a number of ORNL scientists and engineers collaborated on the development of the fuel elements, overall design and other technical problems. Members of Graphic Arts, Traffic and Travel, Central Shops and many other departments contributed to the success of the Aquarium Project.

The regularly assigned guides were supplemented by the ORNL delegates to the conference who made it possible to handle the large crowds.

D. F. Cope of AEC's Oak Ridge Operations Office was the contract administrator of the project; G. Manov provided liaison with Headquarters. The local AEC office was also responsible for security problems during the transportation of the reactor, up to its transfer to the Swiss. The guard force (twelve men) was supervised by T. Avery and Chief J. P. M. Roach.*

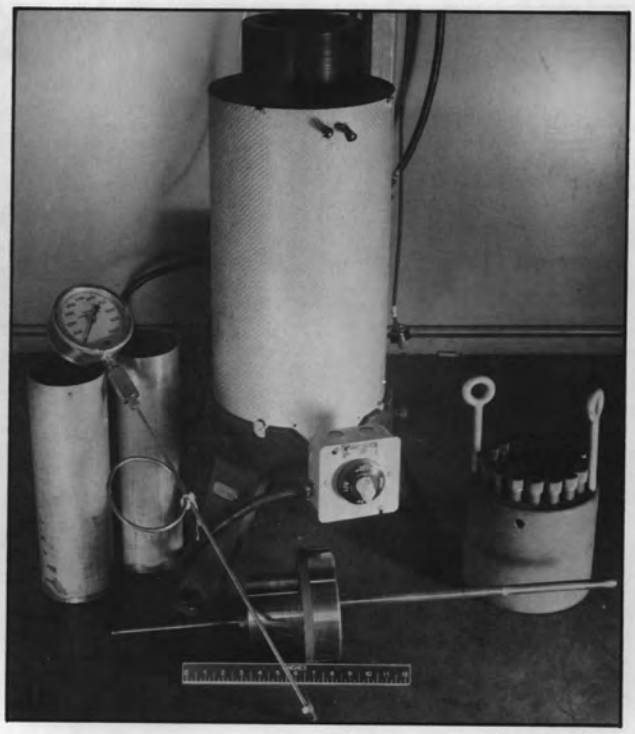
The Laboratory also participated in the main U.S. Exhibit in Hall 15 of the Palace of Nations. These exhibits (HRT Model, Analytical Cave Mock-up, Sampler Mock-up and Solvent Extraction and Ion Exchange) were assembled and manned by T. A. Arehart, W. K. Eister and M. T. Kelley.

** Deceased*

Preparation of the 20%-enriched UO_2–Al fuel

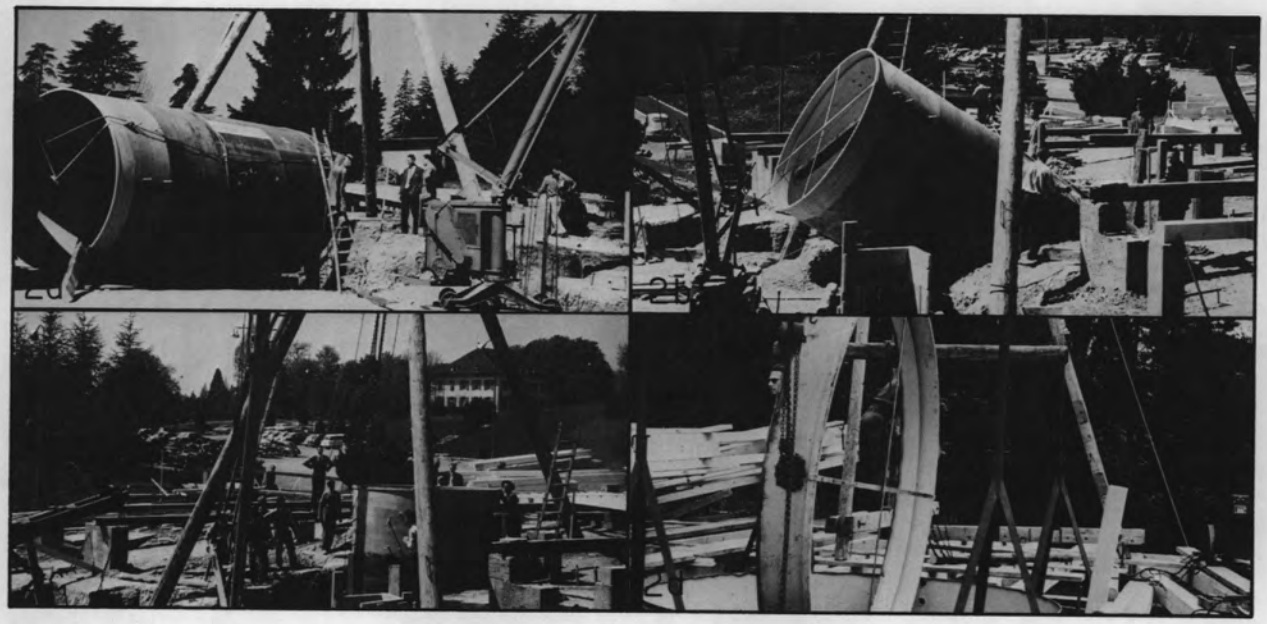
1a (top)
UO_3 parent crystals

1a (bottom)
UO_2 grains



1b. The autoclave "Genevieve"

Placement of the reactor tank



2a. Transportation to the site

2b. Lowering of the tank into the hole

2c. Adjusting the position of the tank

2d. Cutting off the top rim

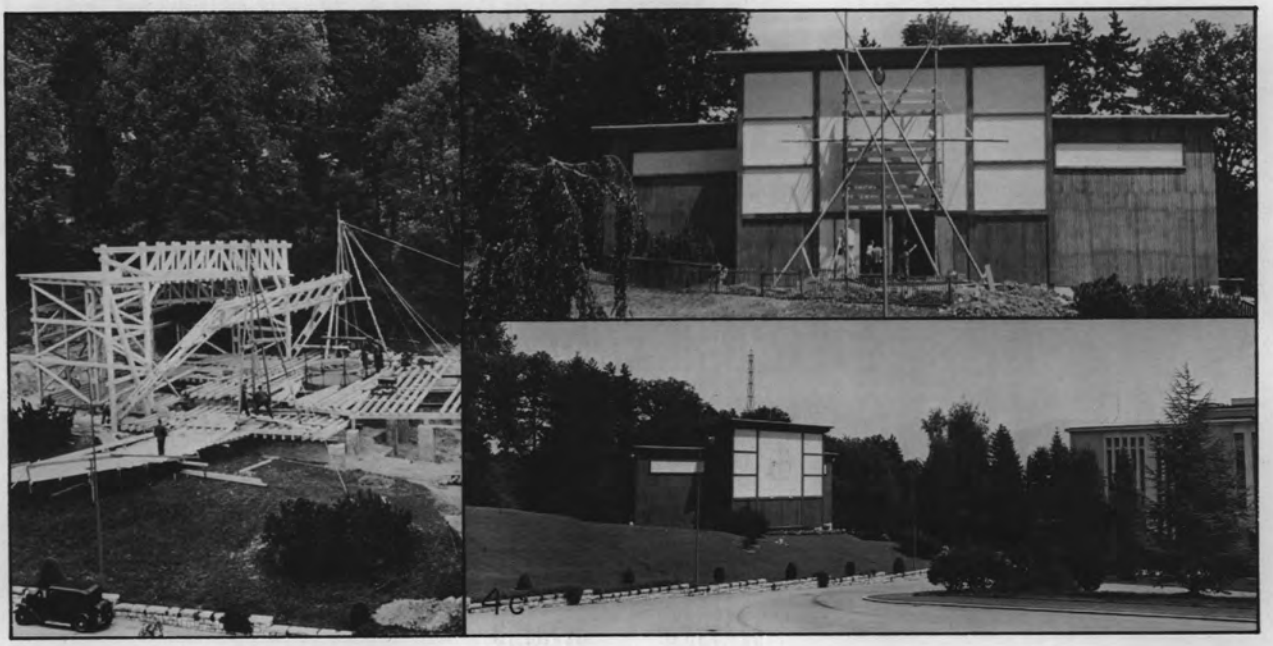
The first transportation of a reactor by air

3a. The Globemaster arrives at the Geneva airport

3b. Unloading of the crates

3c. Careful planning: the back door was just the right size for the crates

Progress of the construction

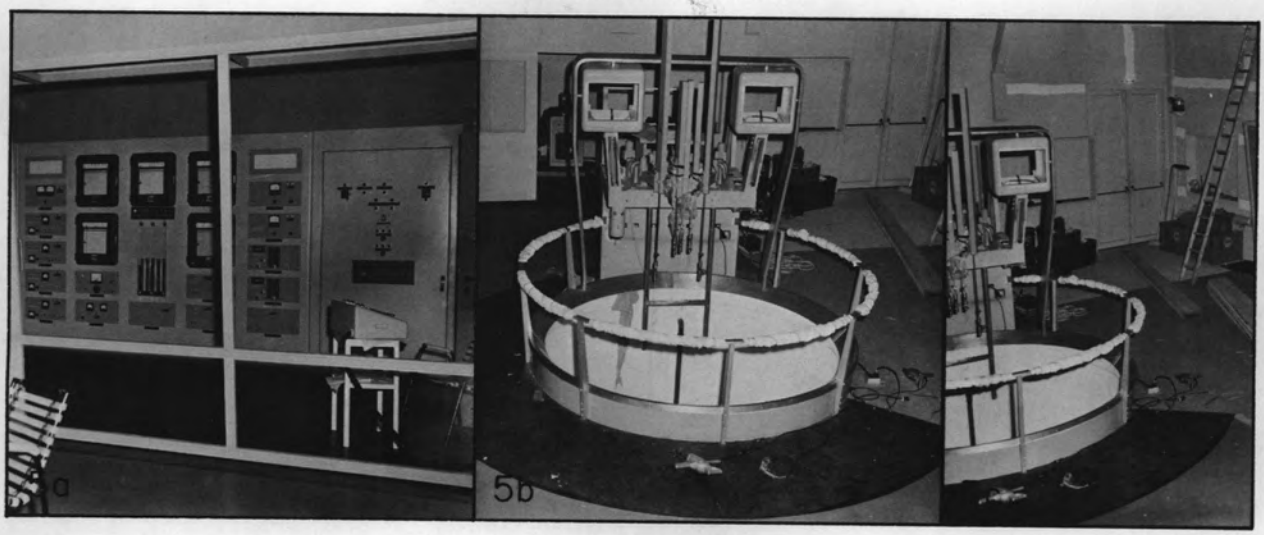


4a. Framework is going up

4b. Finishing touches

4c. The reactor building next to the Palace of Nations

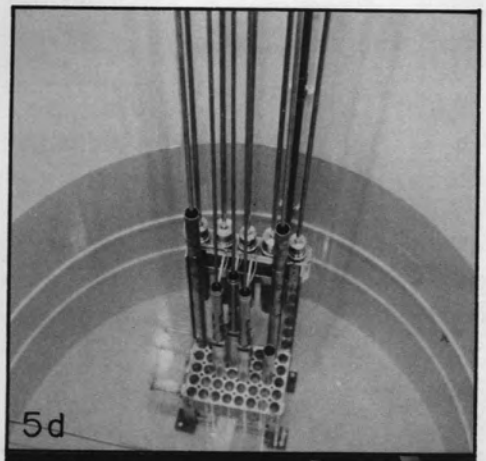
Installation of the reactor

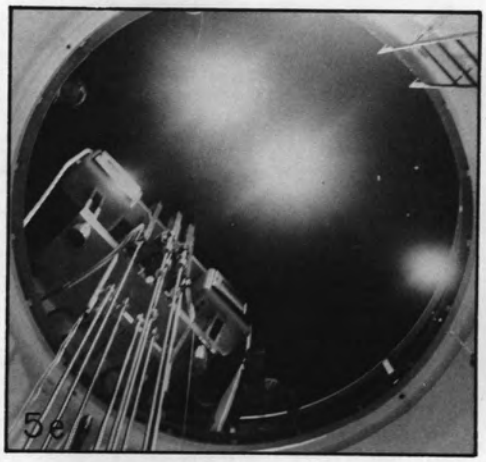


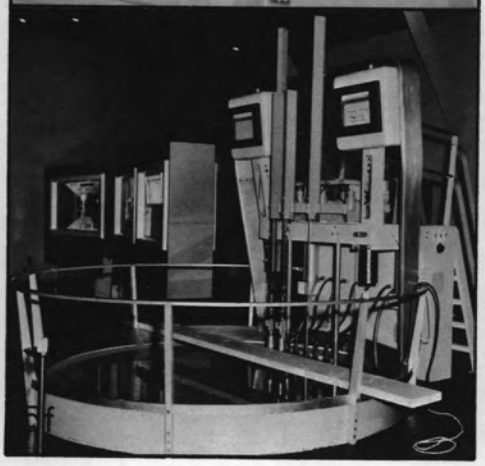
5a. The control room

5b. Progress of the assembly

5c. The linoleum is laid at one side and waxed at the other while the reactor is installed





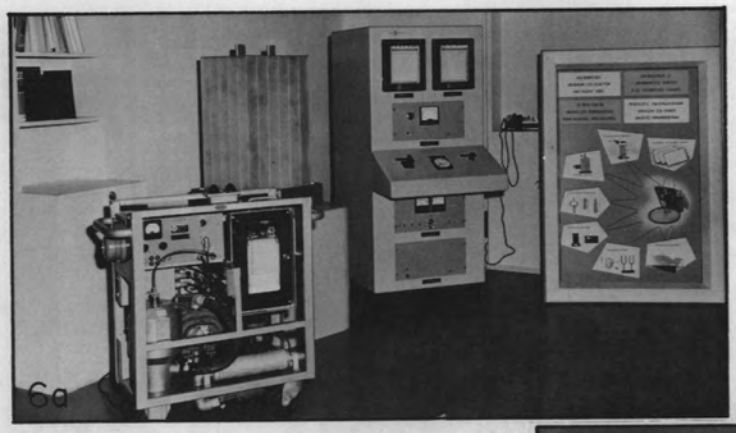


5d. The base plate and control rod assembly

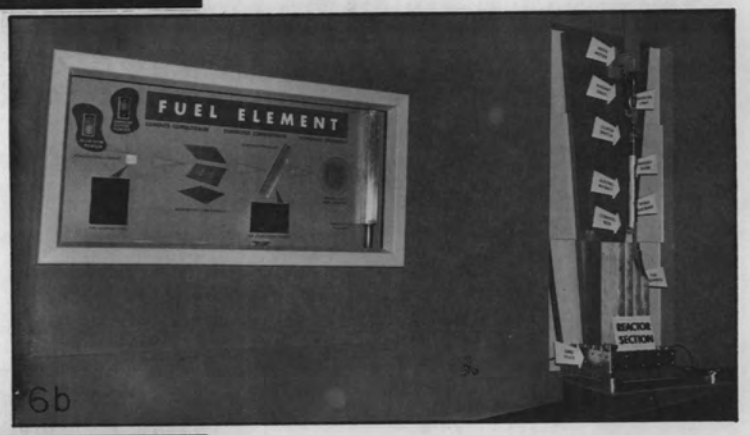
5e. A fish-eye view from the bottom of the tank

5f. The work is nearly finished

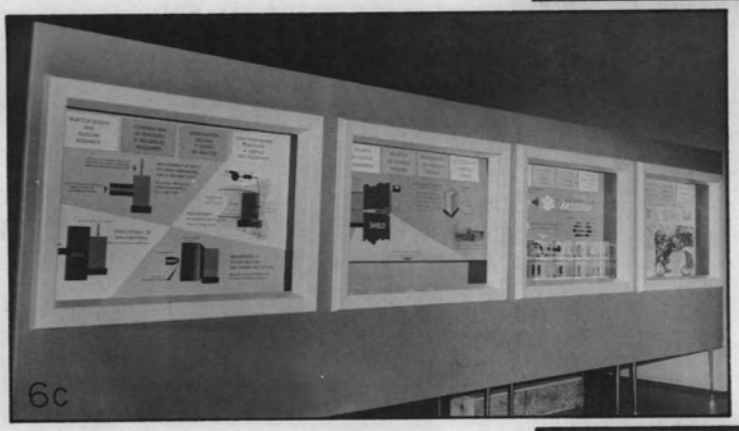
Some of the exhibits around the reactor



6a. The reactor simulator



6b. Fuel elements and control rods



6c. Reactor design and shielding

6d. Radiation effects

The visit of President Dwight D. Eisenhower

7a. The President near the reactor. L. B. Holland provides the explanation. (Now Governor) Nelson Rockfeller at right.

7b. C. E. Winters describes the details to the President

7c. John W. Hill, Sr., in the control room with the President

7d. The President speaking: ". . . I hope that everybody who gets a chance to see this (reactor) will learn that there are really many, many ways in which atomic science can be used for the benefit of mankind and not for destruction."

7e. The news photographers and cameramen getting ready

8a. President Petitpierre of Switzerland with G. Manov and the author

8b. President Petitpierre starts the reactor (in the control room with the author and J. W. Hill, Jr.)

Dignitaries

9a. Dag Hammarskjöld, U.N. Secretary General (with J. E. Cunningham, C. E. Winters, C. E. Larson, and A. F. Rupp)

Scientists at the reactor

10a. Prof. Homi Bhabha, Chairman of the Conference, and Prof. Walter G. Whitman, Conference Secretary-general, with J. W. Hill, Jr.

10b. Prof. Francis Perrin, High Commissioner of the French AEC (later Chairman of the Second Geneva Conference) with J. W. Hill, Jr., and the author

10c. Prof. O. Hahn, co-discoverer of nuclear fission, with Prof. (now AEC Chairman) Glenn T. Seaborg and Prof. E. O. Lawrence

10d. Prof. F. Strassmann, co-discoverer of nuclear fission

10e. Prof. Niels Bohr with C. E. Larson and J. A. Swartout

The curious public

11a. Gates open at 4 P.M.

11b. A few minutes later: the queue formed at the reactor building

11c. Everybody wants to see the blue glow

11d. One of the girl guides explains the Cherenkov radiation

Transfer of the reactor to Switzerland

12a. AEC Chairman Lewis Strauss makes the presentation. In the background: Dr. Boveri, Miss Willis, U. S. Ambassador to Switzerland; Prof. Sherrer and Prof. (then AEC Commissioner) W. F. Libbey

12b. Signing the official transfer papers: The U.S. Research Reactor will become the property of "Reaktor A.G."

Celebrating the end of an exhibit

13a. "Sold" to the Swiss

13b. The girl guides . . .

13c. . . . are glad that it is all over

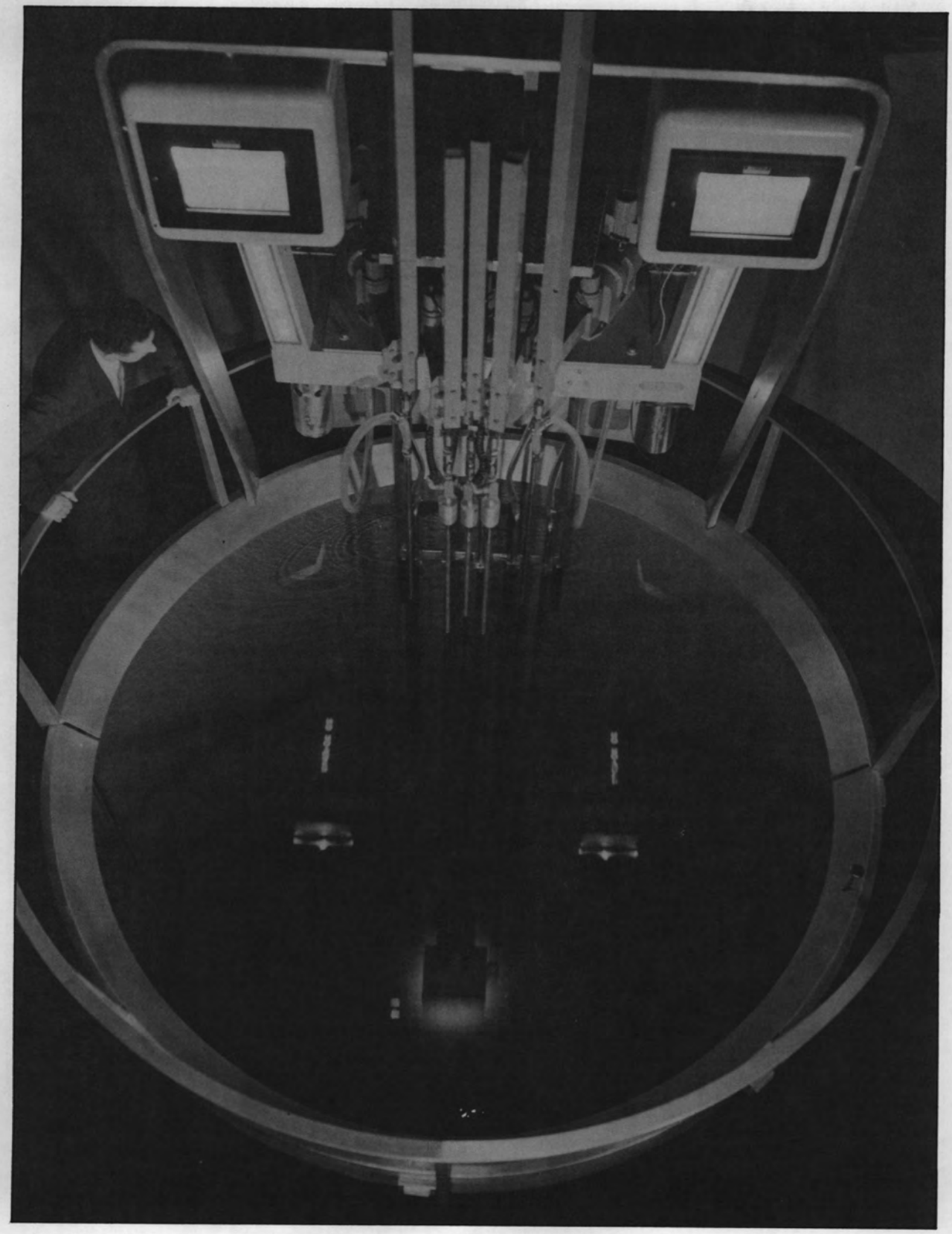
13d. An hour later, uniforms are exchanged for party dresses (the length of the dresses gives away the year)

13e. Everybody is happy – Mr. and Mrs. A. M. Weinberg and Prof. and Mrs. E. P. Wigner

13f. Dr. and Mrs. C. E. Winters with D. F. Cope

13g. Dancing around the reactor

13h. We are all relaxed and happy – G. G. Manov, J. Conway, head of Union Carbide Duropa, the author, and E. P. Epler



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24. J. W. Hill
25. L. B. Holland
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