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# Worldwide Report

NUCLEAR DEVELOPMENT AND PROLIFERATION

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PEOPLE'S REPUBLIC OF CHINA

PRC JOINS INTERNATIONAL ATOMIC ENERGY AGENCY

OW111330 Beijing XINHUA in English 1252 GMT 11 Oct 83

[Text] Vienna, 11 Oct (XINHUA)--China was admitted to the International Atomic Energy Agency (IAEA) today.

According to a resolution adopted at the 27th IAEA conference here today, China has become the 113th member state of the agency which was founded in 1957 as one of the 15 special agencies under the United Nations to promote world peace and the peaceful uses of atomic energy.

Speaking at the conference, head of the Chinese delegation Wang Shu thanked the other member states for supporting China's membership in the agency.

On behalf of the Chinese Government, he elaborated China's stand on the issue of the peaceful uses of nuclear energy. He said, "We rely, in the main, on our own efforts, but at the same time we are sincerely looking forward to cooperating extensively with other countries on the basis of mutual respect for sovereignty, equality and mutual benefit and non-interference in internal affairs."

He said that China will accept the statute of the agency and fulfil her obligations. But China's membership in the agency does not imply any change in her position with regard to the "Treaty on the Non-proliferation of Nuclear Weapons," and China remains critical of the discriminatory nature of that treaty, he said.

"We respect the desire of a great many non-nuclear weapon states not to test, use, manufacture, produce and acquire nuclear weapons," he said.

China neither stands for nor encourages the proliferation of nuclear weapons, he declared.

"The international cooperation in the peaceful uses of nuclear energy involves some delicate issues which should be dealt with cautiously. China has all along taken a conscientious and responsible attitude towards this cooperation and will continue to take such an attitude after becoming a member of the agency," he said.

"We cannot go along with any attempt at arbitrary and unilateral widening of the scope of restrictions and controls in the name of strengthening the non-proliferation regime," he said. "We believe this practice would not be conducive to the development and world-wide peaceful uses of nuclear energy, to the economic and scientific development of various countries as well as to the peace and security of the world."

"The authorities in Taiwan became a member of the agency and signed the non-proliferation treaty by usurping the name of China after the founding of New China. As is known to all, Taiwan is an integral part of the People's Republic of China, those actions by the authorities in Taiwan are absolutely illegal and null and void," he said.

He noted that the resolution entitled "Representation of China in the Agency" adopted by the board of governors of the agency on December 9, 1971 explicitly "recognizes that the Government of the People's Republic of China is the only government which has the right to represent China in the International Atomic Energy Agency" and "requests the chairmen and the director general to take all the actions resulting from this resolution."

"China believes that the agency will respect the above-mentioned resolution and the consistent principled stand of China and take practical actions to rearrange its safeguard relationship with Taiwan in such a way as to make it non-governmental," he said.

Delegates from many countries congratulated Wang Shu on China's membership in the agency.

CSO: 5100/4101

PROBLEMS IN DUKOVANY NUCLEAR PLANT CONSTRUCTION DISCUSSED

Prague HOSPODARSKE NOVINY in Czech 26 Aug 83 pp 8-9

[Interview with Eng Jiri Szanto, manager of the branch building enterprise of Industrial Construction Projects, Brno, for construction of the Dukovany nuclear power plant, by Jaroslava Markova: "Experience With Management and Organization of Large Construction Projects"; date and place not given]

[Text] Management and work organization on large construction projects is a largely unresearched field. There is always a renewed search for new methods and ways of managing to complete capital construction projects successfully and within the prescribed deadline, a feat that not always succeeds. This "search" is occasioned not only by the fact that each construction project is unique, having its own specific features and, as such, cannot be built as if cast from the same "mold," but also by the fact that each is usually built by a different enterprise, by other managerial personnel, and its investment and planning preparation differs. Nevertheless, due to the fact that even entirely different construction projects can have many things in common, and because many errors and mistakes can serve as lessons elsewhere, confronting the misgivings of others with one's own opinions and experience, we have already published in HOSPODARSKE NOVINY No 38/1982 an interview relating to construction and renovation of the National Theater and in HOSPODARSKE NOVINY No 2/1983 a discussion relating to construction of a railroad track relay between Usti and the Elbe River and Teplice. An identical objective follows also today's interview with the manager of the branch building enterprise of the Industrial Construction Projects, Brno, for construction of the nuclear power plant in Dukovany. And, even though builders of nuclear power plants are not generally equated with success in the public consciousness--construction progress is lagging, papers write of shortfalls--Eng Jiri Szanto has not only a lot to say that could provide instructive incentives for other builders of

future nuclear power plants, but has also something to boast about. Last year the construction personnel in Dukovany met the plan at 100.1 percent and a volume of operations in the amount of Kcs 1,075 billion, thus creating a new record: At no construction project in our country was there ever achieved such a value of construction operations in a single year. The fact that this does not involve merely volumes, which can be used to hide many things, is also pointed out in our interview.

[Question] When did you come to the construction site?

[Answer] In May 1981, when a branch enterprise was established at the site. It turned out that the manner of management by the staff of the project's general contractor proved to be unsuitable. The project was actually managed by generals without troops--they had no capacities of their own to whom they could issue instructions and demand from them that they be met. From the overall concept and the specified deadlines they did know the direction in which the construction project should be heading, but since they had no authorization to issue direct orders they could not influence the actual progress of the construction project.

For example, Industrial Construction Projects Brno were always marked by having a truly well-worked out organizational manual, almost exemplary one could say, but it could not be used for this particular power plant. Each manager directed his own plant perfectly and nobody could tell him what and how to do, no matter at which construction site. That led to a sort of war. It turned out that the only man who can tell what is to be done and how must be the manager responsible for the building part of this construction project, that being the manager of the branch enterprise.

[Question] Did you have any experience with construction, if not nuclear, at least power plants in general?

[Answer] I did not. I worked in the Engineering and Industrial Construction Projects Prague's branch in Brno. We were simply laying out utilities in Prague at Jizni Mesto: engineering networks, communications.

[Question] So that it was your leap into the unknown...

[Answer] Literally. This construction project, as we very soon found out, considerably differed in its character from conventional construction projects. A great number of strictly machining type deliveries are included in building delivery and our plants, specifically the Installation Operations Enterprise and others, were forced to reorient their efforts toward production, with which they had no previous experience.

We got onto a train that was already gathering speed and at the same time it became necessary immediately to devise a system for managing a tremendous volume of operations, a huge number of personnel and various participating enterprises. Not only from the Industrial Construction Projects Brno,

but the entire VHJ [economic production unit] Industrial Construction and other enterprises of the sector.

[Question] And did you actually manage to come up with a system for managing other building contractors as well?

[Answer] That is the problem. We did not manage to apply it to the full extent. In my opinion, for management of such a construction project it is absolutely necessary that the construction manager or the manager of its building part have such an authority over all participating enterprises of the construction sector. The way I see it, it is not enough to manage other plants and enterprises merely from the viewpoint of agreed-upon modes of operation, supply and demand relations and quarterly plans, namely volumes, without the possibility for directing those enterprises from the viewpoint of the matter-of-fact concerns.

[Question] Could you cite a specific example?

[Answer] Certainly. It happens, e.g., that one of the installations shows a lag in construction and we have to reach its contractor through normal channels via our enterprise manager and their enterprise manager, or even via general managers. Such a runaround is tedious and, as can be expected, takes up too much time.

[Question] You say "normal channels." But expedient and effective decisionmaking right on the spot would certainly be much more normal. Why does the Ministry of Construction not intervene in this matter?

[Answer] This involves not only organizations under the jurisdiction of the CSR Ministry of Construction. It must take the form of a post of an authorized representative of the minister and it is turning out at the present time that through him we shall be able to deal with this aspect directly.

[Question] And what about allocations, project completion bonuses for met deadlines? After all, this should enable you to influence many matters and, though perhaps indirectly, you still could achieve completion of tasks wherever you need?

[Answer] Within the Industrial Construction Projects Brno we do promise rewards, but for other enterprises this must go through their VHJ, some things directly through the authorized representative.

[Question] In looking for a system of management, did you not seek to find inspiration at other construction projects? Eng J. Snejdar, CSc, manager of renovation of the National Theater and formerly the head engineer of the plant for construction of the Palace of Culture, told me in an interview which we published in our paper that you made use of some of their methods of management.

[Answer] We understandably tried to make use of experiences from similar large construction projects, even though we know that there is not a single truly comparable project in the entire republic for the time being. We also attempted to apply the system used in the management of construction of the Palace of Culture, specifically daily dispatching.

[Question] Are you using dispatching to this day?

[Answer] Yes. However, that is a very demanding affair. Not only for those who participate in it, because their performance is controlled every day, but particularly for the deputy for production, who heads dispatching. He must chair meetings every day, even though he has many other tasks to attend to. If you consider that dispatching starts at 7:30 in the morning and lasts, let us say, until 10 o'clock and the next morning the same man must again be there, know about everything, control the meeting of daily tasks and has for his other work, management and control, practically only the afternoon and night, then it becomes clear to you that he must work day and night, Saturdays and Sundays.

[Question] But you do not direct the construction project only by dispatching.

[Answer] Certainly. The system of management must be adapted to the progress of the construction project. In the first part, when the builder has the upper hand, when participation by the technologist is minimal, practically everything can be managed by daily dispatching. Later on it is not enough. Then the managing cannot be done by us but by the investor. The project is managed by a system based on a network graph. The mode of operation includes over 1,000 activities, and those are only the main central points. The system is transformed into quarterly plans which are defined in greater detail in monthly operational plans. The daily operational schedule, e.g., daily dispatching, regulates all deviations from factual completion of tasks. Factual completion is emphasized as decisive, because if I complete tasks factually, then I should also automatically meet the financial volume. We have these things verified. Therefore, factual tasks are allocated for key activities per day in vertical breakdown for cooperating plants.

[Question] How do you coordinate your management of the project with management by the investor?

[Answer] Today, at the stage of advanced installation of systems by the general contractor of technology, coordination and management of the entire project itself, as well as that of linkages, is taken over by the investor; he cannot avoid management that to a certain extent has to follow two lines. He manages under a mode of operations that is not conducive to scrutiny of routine operations, details; he takes into account meeting of tasks in key areas, deviations from the mode of operations, their effects on contractual relations, stimulation, keeping a record of deviations and of the progress of construction. On the other hand, the managing staff and its operational group already deal with specific technical problems of

construction under the leadership of a representative of the investor. Further, at important typified installations there were established operational coordination groups headed by the investor's representative as coordinator, the same applying to the technologist and the builder. In our case it involves for the most part the building site foreman of a given installation. Work groups meet as needed, e.g., at the reactor plant proper they meet daily at 6:30, when tasks are assigned to individual partners. That means: you prepare this and that for the technologist at such and such time, he will turn it back to you the next day and you continue.

This is a very important experience for future power plants, where the builder should have in his ranks at least a technologist or, better yet, a start-up technician. We as builders are not familiar with the system of how a power plant is started up, what is needed, in what time sequence, what is more important. Sometimes the investor himself is not overly familiar with it either. Thus, our lack of knowledge leads to errors, delays.

[Question] You seem to refrain from saying right out that your lack of knowledge is being taken advantage of...Nevertheless, lack of knowledge, as is well known, is no excuse.

[Answer] That is precisely why I emphasize that builders should have among them specialists in the technology of power plant operation. For example, the entire system of turning over cubicles was based on a horizontal system, meaning that they were turned over story by story. But now the technologist came complaining that it does not help him a bit, because all lines proceed vertically. That meant a complete disaster for us, we simply were trying to turn over a story and for him it meant absolutely nothing--the pipeline progressed from some point to another vertically; in other words, he had no point for establishing a connection and no way for continuation.

[Question] That is an acute problem. RUDE PRAVO already stated in an article entitled "What is Delaying the Construction of Dukovany?", published on 23 March, that individual technological contractors carefully keep an eye on every shortcoming caused by builders, so that they can readily justify to them why their own performance cannot be any better. Protecting of one's own rear end--says the article--takes up more energy than solving some acute technical or production difficulties. The article brands lack of confidence between partners as a more serious retarding factor than delayed completion of some key point.

[Answer] Exactly so. In my opinion, all of this is due to lack of experience with the construction of nuclear power plants and the attendant problems--nobody wants to bear the blame by himself. Industrial Construction Projects never built a power plant; the investor, while he was familiar with conventional power plants, was, of course, not familiar with nuclear power plants. Even the technologist--the Skoda plant, which does have specialists and made use of certain findings made in the construction of the atomic

power plant V-1 in Jaslovske Bohunice--is plagued in dealing with its subcontractors by even greater difficulties than we are, because they come under the jurisdiction of various ministerial departments. Our key finishing contractors are enterprises from our sector, so that many matters can be dealt with more expediently in the form of orders.

A very wise decision was the adoption of the system of finishing contractors, i.e., meaning that some installations, e.g., administrative operational buildings, are supplied by, e.g., Overland Structures, engineering networks and water management installations Ingstav, finished to turn-key state. Thus, we do not have to provide for deliveries from their subcontractors which, in the tremendous extent of this construction project, I deem impossible. We have enough difficulties with providing deliveries from subcontractors by ourselves.

[Question] To be sure, what is this year's volume of operations on the project?

[Answer] Roughly about Kcs 1 billion. Approximately Kcs 550 million worth is carried out by us as the general building contractor, i.e., Industrial Construction Projects Brno, and the rest accrues to other finishing contractors plus some machine building plants, such as, e.g., Sigma, which provides for us operations included in the building contract.

[Question] Those are impressive numbers. Nevertheless, factual completions at 100 percent would generate more respect. And this is where we start running into certain problems. Even so, I must admit that the situation has been improving as of late and that you did turn over the reactor hall of the first block in the deadline called for by the operational work schedule.

[Answer] The unfortunate feature of this construction project is constituted by the fact, and that should prove instructive for all others, that--if I may put it figuratively--it is being built from the roof down. Layout documentation for engineering networks and thus, understandably, for the entire communications system, came in last and this made overland installations parallel with engineering networks, resulting in great complications. We have difficulties with transportation of material and with freedom of motion at the site in general.

I am of the opinion that the planner, who possibly may not have had the right documentation, because the concept of the project underwent changes (originally it was to have two blocks, later changed to four blocks), should have kept some reserves for the envisioned engineering networks. That would have eliminated today's problems. In Jaslovske Bohunice, and with the V-1 that had identical problems, they learned some lessons in the case of the V-2 and today the situation has improved considerably.

[Question] Planning problems probably involved more than just the engineering networks.

[Answer] Indeed. Development is constantly making progress, nuclear safety conditions are stricter now and that accounts for a huge amount of supplements and changes. Yet, it is also a fact that a variety of matters can use nuclear safety as a hiding place, e.g., various errors, omissions, etc.

[Question] How many supplements were there?

[Answer] Over a thousand and they keep pouring in. They are of two types. On the one hand in areas where operations were not carried out as yet, which is still feasible, because it does not call for additional tearing down of structures, but it naturally translates into ordering of additional material and various elements, and getting hold of them outside of terms for reporting requirements is difficult.

Quite different are the supplements involving structures that had already been completed, which means tearing them down, and that is always a demanding undertaking, but it also has a certain demoralizing effect on personnel--they do their utmost to meet a deadline, succeed in doing so and then comes a supplement and half of a finished structure may have to be torn down. What is more, it complicates matters also for the technology contractor who may have to interrupt an already started installation to let us implement the additional changes. For that reason the so-called modification proceedings system, wherein the necessity of supplements undergoes strict assessment was devised. But that is a difficult proposition. The planner himself may be blameless at times, because it is understandable that in the course of production many products undergo innovation, they reach the project in a version that may be improved, but definitely with different dimensional configuration, system of suspension, etc., and the planner must adapt to all this.

[Question] Nevertheless, research and development is progressing rapidly today and it must be envisioned that we will never return to the times when a project would be started, the construction would last for 6 years and nothing would change during that time. Is our building industry not lagging somewhat in that it cannot manage to adapt itself to such increased demands?

[Answer] I think that the building industry can manage to adapt itself, but none of our regulations, particularly economic ones, manage to adapt themselves. For example, take the standardization base. The norms for laying concrete are not in keeping with the size of this project. Many operations--because the norms were devised before World War II or soon thereafter, when nobody envisioned construction of nuclear power plants in our country--cannot be carried out in accordance with those norms.

And now you are faced with two possibilities. Either you commit an infraction against the norm without detrimentally affecting the operation at hand, leaving yourself open to the danger that any control official will assess sanctions against you, or you are required to apply for an exemption. Of course, the time needed for affirmative processing of an exemption is a horror in itself.

[Question] Is there no possibility for requesting a change of the norm?

[Answer] That is essentially equally time-consuming.

[Question] You also said that it is economic regulations in particular that do not manage to adapt themselves.

[Answer] True. They just take the construction project in the form it was planned in a given year and assign some sort of deadline for it. They do not take into consideration additional changes and the attendant delays. Then there occur problems with financing, with penalization and all those things. When the investor places an order and then changes it, he should modify conditions for the contractor. But that is not being done. For that reason builders, even though they do understand the problem, resist doing something else.

You are entirely correct in stating that gone forever are the times when one could say: the factory will look like this and that was the way it turned out. However, it is hard for us to make any headway in this respect with organs of the economic and financial sphere. For them, once the project had been approved, it is in the form in which it was originally planned. There came the introduction of modified methods of planning, modified methods of construction, but there is no modified method of financing and remuneration.

This gets us into huge economic problems whose impact understandably extends all the way to the personnel, because today the Set of Measures applies to us as well. Our enterprise was awarded the government's Red Banner, we completed all monitored construction projects, not only Dukovany, but also the transit gas pipeline, crude oil pipelines, etc., and yet we are insolvent.

[Question] But why are you insolvent? That is not due to penalties alone, is it?

[Answer] Of course not. That involves also inventories on hand. Let us say that a supplier of reinforced blocks runs a certain type in a series. These blocks are repeated for the first, second, third, and fourth reactor. A part of them is needed immediately, but part of them only 14 months later. Those are lying around here. In this way we understandably generate inventories in excess of the norm and the SBCS [Czechoslovak State Bank] metes out punitive sanctions against us, a higher interest rate. In this manner the general contractor of a project such as this one, which we say is the first of its kind in the republic, is actually winding up in an economic crisis.

[Question] And what else is the cause in addition to inventories?

[Answer] The reason is that the carried out operations are not of the typical price-list variety, specifically in the case of plants like the Installation Operations Enterprise, the Engineering Constructions Enterprise,

which installs reinforced cages through a special technology. All of these are operations that are atypical of the price-list, i.e., for all of them the so-called R-items must be processed. There are hundreds of them, their processing presupposes the availability of huge personnel staffs and it is the contractor's duty to provide documentation for everything and submit it to the planner; at the same time, there is a shortage of good cost accountants and estimators. The only approach, which we are today following jointly with Jaslovske Bohunice, is developing a price-list for nuclear power plants.

[Question] What are its practical implications? Does it delay billing?

[Answer] It does. While we complete a certain operation in a given month, we are unable to make billing for it for a year, because we may not know the costs of deliveries from other enterprises, we do not know the costs situation. We cannot put together the actual analysis of an item until after the entire operation had been completed. We carry out operations, incur costs in the usual way, pay out wages, but we do not do any billing.

[Question] I do believe that all of this is a source of great complications for you, but in spite of it all it seems to me that not all the problems having to do with construction delays can be blamed only on regulations...

[Answer] I do not want to "pin the blame" on others, but there is a need for being objective. To differentiate between what was our fault and what goes beyond us, over which we have no control. But not to talk only about regulations--which could be influenced by somebody else to improve matters--let me cite an example from another area which also complicates operations for us. The structural system of these power plants, I have in mind the 440 type, is based on a high degree of prefabrication. And the latter is absolutely unsuitable from the viewpoint of changes. Any change actually makes a prefabricated unit unusable, it cannot be adapted. And that starts the usual merry-go-round--the change must be quickly discussed with the enterprise which supplies the prefabricated units, and all depends on the latter's attitude. It can react formally, i.e. require a term of "X" months prior to the quarter of the year for reporting requirements, etc., or it can try to accommodate us immediately.

I had the opportunity to visit power plants in Switzerland and in France; they are based on an explicitly monolithic construction system, where changes can be implemented very simply, for all practical purposes through a minor operation by a carpenter or iron worker in the course of 1 or 2 days without incurring any losses in time.

This construction project is not affected to any significant degree by, let us say, the builders being momentarily short of 10 or 20 carpenters; here the worst slippages occur due to the fact that dealing with changes, seemingly small in extent, takes entirely too long. The general contractor assigns individual parts to design and planning institutes all over the republic and the actual negotiation of a change, i.e., with Kosice, takes a minimum of 14 days. Some changes, inasfar as they involve the Soviet

projects itself, go through Leningrad, etc. The change may be small, on the order of Kcs 5,000 to Kcs 15,000, but it postpones high volumes of subsequent operations.

[Question] Could you cite a specific example? I have heard of the huge amount of openings that have to be drilled into finished cubicles.

[Answer] Yes. At the present time we are faced, e.g., with the requirement of drilling 400 additional openings into cubicles, ranging in diameter from 10 to 60 cm, into ferroconcrete structures of 60, 100 and 150 cm thickness.

[Question] What are all those cubicles anyway? They are written and talked about everywhere, but probably only very few people can visualize something under that term.

[Answer] A cubicle is a very minute, or a very huge room with strong concrete walls into which lead protective hermetically sealed doors measuring something like 1 square meter. There is no ventilation, no illumination, nothing. They are rooms in a tract 100 m deep, somewhere at a depth of minus 6 meters, or also plus 50 m high. One cubicle can measure 10 meters square with a cubature of 40 cubic meters, and there are also cubicles with a volume of 50,000 cubic meters. Comparing one cubicle to another is like comparing a class in kindergarten to the faculty of an institution of higher learning. These are tremendous differences. For example, for start-up of the first reactor we need 575 cubicles.

[Question] And what are those additional openings into them for?

[Answer] That is hard for us to judge. For the major part they are needed by the general contractor for technology who requests these changes.

[Question] How is it possible? Did he not see the planning documentation before?

[Answer] The problem consists in the fact that modification of the Soviet project in areas where we supply Czechoslovak equipment causes delays. On the other hand, some Soviet deliveries must be adapted to the Czechoslovak norm, e.g., distributors. This is how changes must be undertaken.

While it is true that the adaptation proceedings do take into consideration how much a given change will cost, how it will effect the construction time and concurrent deadlines, the deadline stipulated by the government had already been specified and that means for us that we will have to shorten subsequent operation.

[Question] What delay, e.g., is constituted specifically by those openings, how many people does it take, how much does it cost?

[Answer] In practical terms it means buying the requisite equipment for drilling, which in most cases means importation from capitalist countries--there are no such drills in our country. Another point is the high labor-intensive nature of this operation. Drilling of a single opening of a

smaller diameter takes 1<sup>1</sup>/<sub>2</sub>-2 hours. Of course, drilling is not the only part, the drilled-out material must be removed from the cubicle, which is a very complicated affair. Then there occurs during drilling some damage to the highly demanding surface finish of the cubicle. The cubicles are encased by black rust-resistant sheet metal or are provided by coatings consisting of up to nine layers. One coating can be applied in 24 hours, i.e., a nine-layer coating takes 9 days. And all of this must be done practically from scratch with strict compliance to quality. That means great delays for us.

[Question] Can it be unequivocally pointed out who is to blame for this change?

[Answer] Everybody is learning and, inevitably, errors occur. It is the price we pay for lack of experience.

[Question] You say that this is a new, unique construction project. But, after all, there is Jaslovske Bohunice!

[Answer] We managed to push through the idea that changes in Jaslovske Bohunice should be applied relatively quickly at our site. We are immediately notified of them directly from Hydrostav; they have considerably greater experience than we do--they are actually building the third nuclear power plant already. Our mutual relations are excellent, technicians and teams--brigades of socialist labor--keep going there to gain experience.

[Question] What makes the construction of a nuclear power plant so complicated? It is certainly their novelty and size, but could it not be said that it is, let us say, a larger version of some smaller construction project?

[Answer] When someone speaks of a construction project, everybody sees some floors, windows, doors; I can enter anywhere and take out some material. That is not the case here. Here, if something that belongs in a room is not put there during construction, nobody will ever get it in there again. That constitutes great demands on operational scheduling, daily dispatching. If a design change at a conventional construction site takes 14 days to implement, it does not mean much. Here, that is an emergency. We must realize that approximately Kcs 6 million per day are spent here on construction and it is not just the tremendous cubature involved, but Kcs 6 million worth of demanding labor of the highest quality. That is why it is not just a larger version of a smaller construction project.

[Question] Several times already we have briefly touched on the problem of quality. You used the designation "highest quality"...

[Answer] Justifiably so. Quality cannot be compared here with anything else. For instance, the floor in one room, e.g., in 501, contains 10,000 m of welded joints--I am not even talking about welded structures. And among all these welded joints there is not a single centimeter that would not have undergone testing, there must be a verification certificate for

everything. Until everything has been tested as perfect, repaired, it cannot be turned over and work cannot continue.

Or take the cubicles. Their nine-layer coatings are of different colors so that they can be controlled. But control does not involve only the number, but also the thickness of coatings. That is a complex matter, complicated by the fact that after blasting the surfaces must be coated within hours. When it comes to normal construction projects, I send out several auxiliary workers who brush or scrub it and painters will go to coat it a week later, or whenever they can find the time. Here, within 6 hours after blasting the painter must start coating, even if it is on a Saturday at 3 am. Similar linkages that cannot be bypassed abound here.

In the case of any other construction project any breakdown in future operations does represent a delay in production, but it can nevertheless be always eliminated. But here, in the hermetically sealed zone, there is nothing that you can fix. No living soul will ever enter some areas again. For that reason high quality is a sine qua non.

[Question] So that it is some kind of a school for builders. Do you think I would be justified in silently uttering: If only everywhere construction would be done with such quality...?

[Answer] I keep saying that, with regard to technicians, whoever succeeds at the nuclear power plant can build any structure in the whole country. When, e.g., I compare reactors no. 3 and 4 with reactors no. 1 and 2, we are building 3 and 4 with substantially higher labor productivity than we did the first two and, for all practical purposes, without any problems. We use a flow-type system of construction and, for the most part, errors committed in the construction of the first reactor are not repeated. We established a sort of a databank of errors and we are careful not to repeat them. It is a fact that technicians working on the third and fourth reactor often go to have a look at the first and second reactors, it is a sort of a textbook for them. Today we accomplish things in substantially shorter time, with a substantially lower number of personnel. Those are differences on the order of one or more.

[Question] How many people are there actually at the site today?

[Answer] There are 5,700 builders, with a prevalent composition of high qualifications. The overall number of personnel, including the general contractor of technology, the future user and investor, is around 8,500 and it is envisioned that this number will increase to approximately 10,000-11,000 in the near future.

[Question] According to you, the builders, is that enough or too little? And how is it with structural operations? At one time you were looking for welders all over the country.

[Answer] We do have some problems with structural operations. The trades needed at this site have traditionally been in short supply in building,

so we are availing ourselves of the help we can get within the sector and we manage to find an adequate number of them. We did not go looking for welders. They were sent here to help out from other VHJ of the sector on the basis of instructions issued by the CSR minister of construction. There are 400 of them at the site today, many of them "stainless steel men," i.e., of the highest qualification.

[Question] So, in essence, you have enough people. But could they not be used more effectively, such as by introducing operation in three shifts?

[Answer] The conventional three-shift operation cannot be organized at this site. The building trade is not some serial operation, in its own way it is a creative effort. When I build, I must adapt to changing conditions. In each factory a welder may have his own shop where he can weld day and night under conditions that do not change. At night he gets perfect illumination, he is provided with heating, reaching to his right he picks up his snack, reaching to his left he picks up his beverage. When five welders have to weld in one room, they provide illumination against each others' eyes. They work on one floor for 4 hours and then they transfer to another cubicle. And for the latter you again have to provide ventilation, suction, heating, illumination. We keep people constantly moving around and everytime there is something that must be provided for them so that they can work at all. Moreover, a factory welder after he leaves his shift comes home to his wife and a warm supper. In our case he comes to the dormitory.

I know that there is need for multiple shift operation. But consider this: for 30 years we have been talking about the need for increasing the use of multiple shift work in the industry. And the result? At the same time, the conditions in industry are ideal in comparison to what we have. If you are to ensure that people can work lying down or kneeling during 20-degree freezing weather in winter, that is really a problem.

Nevertheless, in spite of all the problems, we are naturally endeavoring to improve the utilization of personnel and improve the use of shift work. If we take into consideration also Saturday and Sunday shifts, then together with operation in second and third shifts we are attaining an index of 1.21; if we also include extended shifts, then the index amounts to 1.3, which in comparison with other construction projects and with the industry certainly is not bad.

However, the pressure we are developing is sometimes thwarted when something does not click in the area of social services. An entirely all-too-usual example: on Saturday morning, during a shift we persuaded people to come to, the canteen sells franks. But somebody forgot to order salt-sticks. Those guys want to eat and they will tell you right out what they think of it. And I need not emphasize that something like this will come home to roost during the next session of persuading them.

[Question] And who provides these and other services at the site?

[Answer] They are provided by the general contractor through its subcontractor--the Association which has 400 people here. We, as a branch enterprise, have an additional 300 personnel for this purpose. My opinion is that there should be established an independent enterprise for providing services which will be assigned the requisite economic indicators and, understandably, will be evaluated accordingly.

[Question] The backup provided for builders of Dukovany is written and talked about quite often. And none of it is really flattering. Why can the situation not be improved?

[Answer] The fact remains that expenses for amenities at the same site and for social services for personnel (while a smaller number of personnel was envisioned) were cut by more than one-third. At the same time today, in a situation where the talk is about increasing the budgetary expenses for the project by an order of one or more, pushing through an additional 20-30 million for site amenities creates tremendous difficulties. A shortcoming was also constituted by the fact that in a period where complete project documentation was not available and the project had a slow start, time was not spent on at least supplementing the site amenities. That is being done only now, when it is too late, aside from the fact that it just causes delays by interfering with our work in the power plant installations.

[Question] As can be seen, many of today's difficulties have their roots in the past, in underestimating preparations for construction. We probably should draw a lesson from it for future construction projects. People's demands are justifiably high, and if we are to provide an adequate number of personnel for construction projects, we cannot but provide for them perfect billeting and boarding at the very least.

[Answer] You are right. We cannot maintain any illusions that all of them came here fired with enthusiasm. There are here also those who came just for the higher earnings. Acquisition of technical cadres for the project was complicated enough. And I will say outright that initially we went rather for quantity, just to be able to assign personnel to the individual units and sectors. Lately we have been upgrading the quality of the technical and administrative personnel cadre. But we already have many personnel, particularly in the technical group, who are at a high level, specifically in production and preproduction preparation.

[Question] Consequently, you have by now developed specialists who should be utilized in the construction of future nuclear power plants. Will some of them go on to build Mochovce and Temelin?

[Answer] It would be a pity not to make use of them. We are of the opinion that we could be of help to future builders, particularly at Temelin. I do not speak of Mochovce, because building over there will be done by the enterprise which is building Jaslovské Bohunice. Even though I have a high regard for technicians of the Waterworks enterprise, which will be building Temelin, because their quality is evident in the subway construction in

Prague, still, as a builder, I regret that they have not shown any interest in our experiences so far. The only thing that is going on are consultations on social problems.

[Question] And did you not try to take the initiative and offer cooperation?

[Answer] We did try. You know, I do not think that our preparation specialists should be doing production preparations for the Waterworks enterprise. I repeat: I have a high regard for them, they operate at a high technical level and certainly are capable of coming up with a different concept, maybe they have it figured out in a different way, to coincide with their conditions. But our people could definitely make a contribution if through nothing else then at least by a confrontation of opinions. That is always a good thing.

[Question] And how about you, did you people go to Jaslovske Bohunice to learn? Now you are cooperating, we already mentioned that. But prior to the start of construction?

[Answer] In some things we did learn from them. But I must admit that nobody was there previously, such as on temporary assignment. And that is a pity. And at the same time, for an enterprise of our size, with 7,000 people, it should be no problem to send 2-3 technicians on a temporary assignment for half a year.

If, for instance, one technician from the Waterworks enterprise were with us on temporary duty in the technical sector, one in production, and would not do anything else but come to dispatching in the morning, so that they could see what is talked about there, what is dealt with, they certainly would not introduce the system that we abandoned a long time ago. For half a year such an employee might not deliver any output, but it would be made up in the future. Even if all he did was to go all over the site with his eyes open. A sensible, smart man does not need anything more.

[Question] Anyway, why should it not be you who goes to build Temelin? I do not mean you personally, but your enterprise?

[Answer] It is envisioned within the sector that we shall take over construction of some installations in Temelin, but the Waterworks enterprise is appointed as general contractor.

It is a matter of utilizing production capacities in the sector and in territorial distribution. It took our enterprise practically 3-4 years before it managed to put together capacities of the requisite composition and quality. A specialist of such caliber cannot be just packed into a suitcase and sent somewhere with a visiting card. It calls for solving his family problems, supplementing his education for a certain profession, on-the-job training. But the concept of construction of power plants in our country automatically leads to relatively long intervals between follow-up operations or operations of an identical nature at various power plants.

We have already had occasion to verify it once. When work was completed on the transit gas pipeline, when our welding capacity was at a high level, we were unable to provide for our people the same kind of work with comparable earnings. And so we lost the capacity that took us great effort to develop.

[Question] But that, after all, is tremendous waste. We take the efforts to invest in someone, he will learn how to perform some complex operation, a lot of mistakes must be paid for in the process, and when he becomes proficient in something we let him do something else and start completely from scratch with someone else.

[Answer] Regretfully, that is how things are. But the fault does not lie with us. We are willing to go to another power plant. We have the requisite capacity for doing so. The problem lies in that certain intermediate period when, as I already mentioned, there is a lack of linkage between operations, which creates the danger that these highly qualified trades will again disappear from the enterprise, that many a machine building enterprise will immediately reach out for, e.g., the "stainless steel" welders and provide them with conditions similar to those they had at our site.

[Question] Space in the newspaper is at a premium, so let us return in conclusion to Dukovany. There are shortfalls in construction, deadlines are tight. What is your opinion--are the deadlines realistic? When will the first block be launched into operation?

[Answer] The work schedules worked out for the first block provide a deadline of 31 August 1984. Today, or rather since 1981, the builders have been meeting and shortening intermediate deadlines, even though it became impossible to erase the shortfalls of previous years. Intermediate deadlines for installations of technology also became substantially shorter. The prerequisite for meeting the deadline for start-up of the first reactor is perfect coordination on the part of the investor between the technologist, the builder and the planner. Under these conditions the deadline can be met.

[Question] You are calling for coordination with other partners. They, in turn, call for coordination with you. Is there any guarantee that all of you will come to terms and that one will not blame shortcomings on the other? Do you, builders, give your word of honor that you guarantee your work?

[Answer] We call for coordination on the part of the investor, because by now the relative importance in the sequence of operations by us or by the technologist must be decided solely by him. We have the requisite capacity at hand. We also should have no serious problems with material, so I am of the opinion that we can offer such a guarantee on our part.

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NUCLEAR PHYSICS SITUATION, DEVELOPMENT ASSESSED

Nuclear Research Prospects

Warsaw NAUKA POLSKA in Polish No 1-2, Jan-Feb 83 pp 3-21

[Article by Zdzislaw Wilhelmi: "Situation of Nuclear Physics in Poland and Prospects for Its Development"]\*

[Text]

1. Introduction

The goal of this presentation is to help the Physics Committee evaluate the situation in one of the major areas of physical research in Poland--nuclear physics.

I believe that this is the right moment for doing such an evaluation on the basis of a broad discussion in such a competent and representative body as the Physics Committee of the PAN, because major organizational changes are under way in nuclear physics in Poland. Recently, the Institute of Nuclear Research, the largest in the nation, has fallen apart, and a new institute is being created.

Each major organizational change carries with it an opportunity for substantial improvement, on the one hand, but there also exist the possibilities for error, especially because of the dismantling of valuable structures. For this reason, such changes should be undertaken with the broadest consultation with specialists, and listening carefully to the opinion of the community these changes affect.

The Physics Committee represents that community. I hope this presentation will give rise to a discussion and that the results of this discussion will have a positive effect on the direction of the current changes and development of a constructive science policy, and, further, that this will not only

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\*The text of a paper presented at the plenary session of the Physics Committee of the Polish Academy of Sciences, Jan 26, 1983. For recommendations of the meeting, see NAUKA POLSKA, No 1-2, p 181, 1983.

occur in nuclear physics, because I think many of the difficulties that we as nuclear physicists have to deal with are not unlike obstacles confronted by our colleagues in other fields of physics.

In this article, I speak solely of so-called basic research in high- and low-energy physics, but not about matters of technical nuclear physics, such as nuclear reactors or accelerators. Also, we leave aside all applications of nuclear physics in research in other fields, especially solid state physics and technical and medical problems. These aspects may be discussed separately at some other time.

Here, we will not dwell on the past, but mention it only to the extent that is necessary for showing the general trend of change. We focus on today and the future years.

I had little time to prepare this presentation (just a few weeks), yet I was able to find the necessary data from major nuclear research centers in Poland and to obtain opinions concerning the subjects under discussion from more than a dozen professors and assistant professors from those centers.<sup>1</sup>

To begin with, a small historical retrospective (without any name-calling). Nuclear physics has a long tradition in Poland, which stretches back over half a century. A couple of years before World War II, Ludwig Wertenstein in Warsaw started studies of natural and induced radioactivity and Andrzej Soltan began his work on nuclear reactions.

Immediately after the war, the Krakow Academy of Mining and Metallurgy [AGH] instituted studies of space radiation, and Lodz Polytechnic, under the direction of Soltan, conducted work on a project to construct a cyclotron and isotope

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<sup>1</sup>My kind respondents were: Professor A. Bialas (Jagellon University [UJ]), Professor G. Bialkowski (Warsaw University [UW]), Professor Z. Bochnacki (Institute of Nuclear Physics [IFJ]), Professor A. Budzanowski (IFJ), Assistant Professor T. Goworek (Marie Curie-Skłodowska University [IMCS]), Assistant Professor M. Jaskolka (Institute of Nuclear Research [IBJ]), Assistant Professor A. Jurewicz (IBJ), Assistant Professor K. Pomorski (UCMS), Assistant Professor M. Przytula (Lodz University [UL]), Assistant Professor W. Ratynski (IBJ), Assistant Professor S. Rohozinski (UW), Professor K. Rybicki (IFJ), Professor J. Rzewuski (Wroclaw University [UWr]), Professor A. Sobiczewski (IBJ), Professor A. Strzalkowski (UJ), Assistant Professor M. Szeptycka (IBJ), Assistant Professor W. Tybor (UL), Professor J. Wdowczyk (IBJ-Lodz), Professor J. Zakrzewski (UW), Assistant Professor W. Zych (Warsaw Polytechnic [PW]), and Professor Z. Zylicz (UW).

I also used consultations with Professor R. Sosnowski in high-energy physics.

I thank all my respondents for their help. A week ago, this paper was presented at a meeting of the Nuclear Section of the Physics Committee of the PAN, and some of the comments made during the discussion have been incorporated into this version.

separator. At Warsaw University, research in atomic nuclei was begun on a wider scale in 1948.

Two years later, a Cockcroft-Walton accelerator of 1 MV was put into operation there and studies in fast neutron physics were started. In 1952, research in high-energy nuclear physics was initiated at Warsaw University by the major discovery of the hypernucleus. About the same time, nuclear research was begun in Krakow, where H. Niewodniczanski undertook the construction of a small cyclotron.

All these endeavors in Warsaw and Krakow were conducted with modest resources.

A drastic change came in 1955, when, by government decision, the Institute of Nuclear Research was created, and in a few months, the Office of Government Minister for Matters of the Use of Nuclear Energy was established.

Direct impetus to creation of these institutions came from the offer of assistance by the Soviet Union in nuclear research given to Poland and other socialist nations. In order to make use of this assistance--which mainly consisted of supply of cyclotron and research reactor to Poland--efficiently and rapidly, a research program was to be worked out, staff had to be trained and the appropriate laboratories built.

These tasks were undertaken by the IBJ, which was created on the basis of the existing three PAN institutes--namely, the Institute of Radioactive Isotopes (Warsaw), Institute of Nuclear Physics (Krakow) and Institute of Physics of Nuclear Particles (Warsaw), created back in 1954 for the specific purpose of developing a project and building a Polish experimental reactor.

It was then decided that a U-120 cyclotron, purchased in the USSR, would be placed in the hands of Krakow physicists, and the reactor would be built at the Warsaw center. This decision largely influenced the subsequent destinies of nuclear physics in Warsaw and Krakow, because it placed Krakow physicists in a favorable situation. It is well known that a reactor is a less valuable tool of nuclear physics research than a cyclotron. Warsaw physicists immediately had to move to construct their own accelerators necessary for research. In 1961, a three-megavolt Van de Graaf generator was built in Warsaw, and in 1970 a linear proton accelerator.

After about two years of the existence of the IBJ, the so-called Institute II separated from it, which was located in Krakow; it started its own career as the Institute of Nuclear Physics (IFJ). These two institutes--the IBJ and IFJ--played a major role in nuclear research in the broad sense in Poland. They had influence on the formation of new research centers in Lodz, Lublin and Katowice. Under IBJ's auspices, a laboratory for isotope separation was created in Lublin by Wl. Zuk and soon began studies in nuclear spectroscopy.

In Lodz during the 1940's, studies in space radiation and nuclear effects of highest energies were begun in cooperation with a group of physicists from the AGH and, later, the IFJ.

A great contribution to the progress of Polish high- and low-energy nuclear physics research, both theoretical and experimental, was made by the Joint Institute of Nuclear Studies [ZIBJ] at Dubna, especially for the first ten or more years after its creation in 1956. Currently, the importance of the Dubna Institute has diminished somewhat, but at that time it was an important partner for all of us.

After this brief historical overview, I return to the subject of my presentation. At the beginning, I will describe the scientific manpower situation in a geographic and subject breakdown, then speak of the major research subjects in individual areas of nuclear physics in the broad sense. Subsequent sections will be concerned with the situation with research facilities, international cooperation and financing. After that, I will touch on matters of organization of nuclear research and training of research staff. Finally, we will take a look into the future. We will speak of the research subjects that deserve elaboration and the conditions crucial for making our plans and forecasts reality.

The tasks are numerous, and to be able to fit them into the available time frame I will not speak about scientific accomplishments, because, after all, this audience consists of physicists who can be spared such promotional elaborations, especially since most earlier reviews of Polish physics were, precisely, concerned with those accomplishments.

## 2. Research Staff

Nuclear physics can be subdivided into low-energy physics (i.e., the so-called physics of atomic nucleus) and high-energy physics (i.e., physics of high energies and elementary particles). Basically, these are the two major independent subject fields of physical science which have small overlapping areas and probably would be better discussed in separate papers.

As can be seen from Table 1 and Figure 1, some 100 professors and assistant professors and about 400 auxiliary research workers are employed in nuclear physics in Poland. They are assisted directly by about 240 engineers and technicians employed by physics institutes, not counting technical personnel at central technical laboratories of institutes or educational institutions.

What is the breakdown of these numbers between the physics of the atomic nucleus and high-energy and particle physics? Disregarding technical personnel, the ratio between these two areas will be about 1.5.

In nuclear physics (both low- and high-energy), the number of theoreticians is about a quarter of that for experimental scientists. Another curiosity is that nine members of the PAN are counted among high-energy physicists, while low-energy physics can claim only two.

The breakdown by ministerial subordination of nuclear research is illustrated in Figure 2. Over 30 percent more nuclear physicists work in higher schools than at institutes of the Atomics Ministry.

(1) ZATRUDNIENIE FIZYKÓW JĄDROWYCH  
W UCZELNIACH I W INSTYTUTACH  
RESORTU ATOMISTYKI

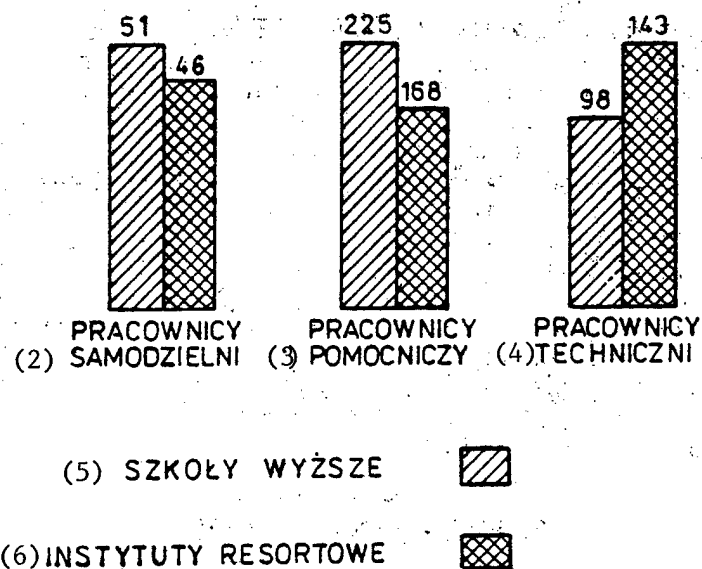


Figure 1. Low- and high-energy physicists:  
Experimentalists and theoreticians.

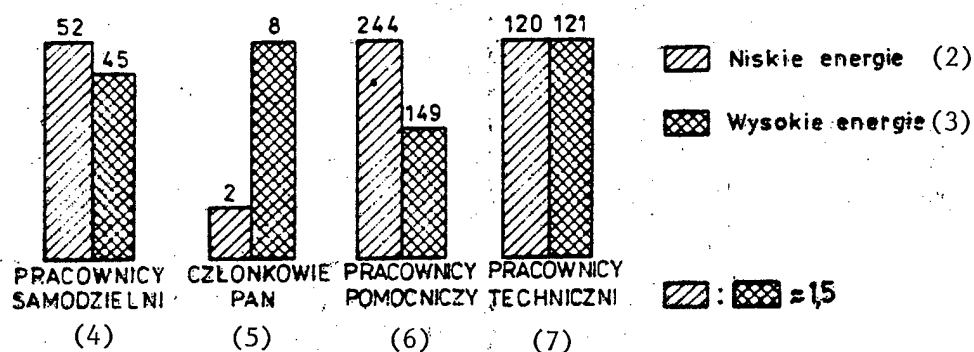
Key:

1. Employment of nuclear physicists at higher schools and the institutes of the Ministry of Atomics
2. Independent investigators
3. Auxiliary research staff
4. Technicians
5. Higher schools
6. Ministerial institutes

Table 1. Distribution of Manpower in Nuclear Physics

| Category                            | Center |        |      |        |         |          |        | Total |
|-------------------------------------|--------|--------|------|--------|---------|----------|--------|-------|
|                                     | Warsaw | Krakow | Lodz | Lublin | Wroclaw | Katowice | Kielce |       |
| Professors and assistant professors | 43     | 33     | 6    | 5      | 7       | 1        | 2      | 97    |
| Auxiliary research staff            | 144    | 153    | 42   | 23     | 13      | 10       | 8      | 393   |
| Research staff subtotal             | 187    | 186    | 48   | 28     | 20      | 11       | 10     | 490   |
| Technicians                         | 111    | 90     | 23   | 6      | -       | 6        | 5      | 241   |
| Total                               | 298    | 276    | 71   | 34     | 20      | 17       | 15     | 731   |
| Total (percent)                     | 41     | 38     | 10   | 5      | 3       | 2        | 2      | 100   |

(1) FIZYCY JĄDROWI NISKICH I WYSOKICH ENERGII



(8) FIZYCY JĄDROWI; DOŚWIADCZALNICY I TEORETYCY

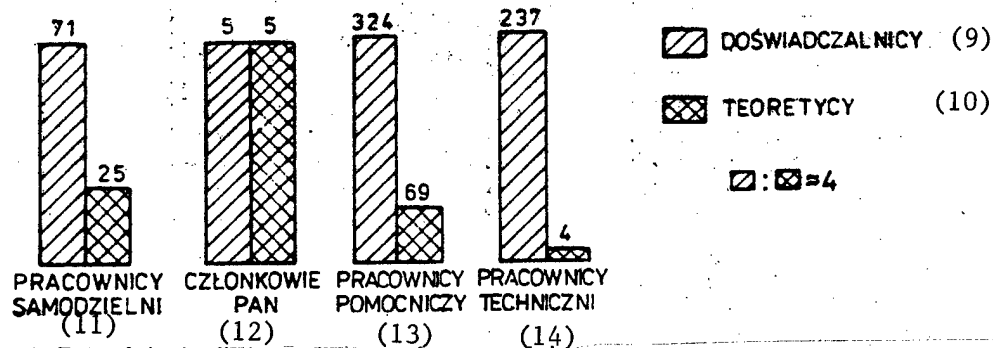


Figure 2. Employment of nuclear physicists at higher schools and the institutes of the Ministry of Atomics.

Key:

- |                                    |                                                           |
|------------------------------------|-----------------------------------------------------------|
| 1. Low- and high-energy physicists | 8. Nuclear physicists: experimentalists and theoreticians |
| 2. Low energy                      | 9. Experimentalists                                       |
| 3. High energy                     | 10. Theoreticians                                         |
| 4. Independent investigators       | 11. Independent investigators                             |
| 5. Members of the PAN              | 12. Members of the PAN                                    |
| 6. Auxiliary staff                 | 13. Auxiliary staff                                       |
| 7. Technicians                     | 14. Technicians                                           |

Table 1 shows the geographical distribution of manpower. A glance at the table demonstrates that there are approximately as many nuclear physicists in Warsaw as in Krakow (187 and 186). Lodz holds third place (48 persons), followed by Lublin (28) and then Wroclaw, Katowice and Kielce (20, 11 and 10, respectively). Eighty percent of all nuclear physicists work in Warsaw and Krakow. Let us now look at the numerical strength of nuclear physics in relation to other sections of the physical sciences (Table 2).

Nuclear physicists hold second place, led only by solid state physicists and followed by applied physics, biophysics and optics.

Now that we have established how many of us are in Poland, let us proceed to the question: What are we doing?

### 3. Major Research Areas

The answer to this question consists of two parts. First, let us define the subject areas in the physics of the atomic nucleus. This is a fairly coherent area, concentrating around crucial issues. In both major centers, Krakow and Warsaw, studies are conducted on the structure of atomic nuclei and mechanisms of nuclear reactions.

Traditional problems to which Polish experimental and theoretical physicists in Krakow and Warsaw (and, to a lesser extent, in Lublin) have contributed include the structure of nuclei, especially nuclei in transitional highly excited nuclear states with a great spin, the deformation of atomic nuclei and collective excitations (this last subject is also being investigated by Wroclaw theoreticians).

The Krakow center has long been concerned with interactions of alpha particles with atomic nuclei and has been developing an optical model. In Warsaw, traditional areas of research include reactions induced by fast neutrons and statistical models of nuclear reactions that have been under development for over 30 years. Much effort has been invested over the years into the study of nucleon capture reactions and giant resonance (UW).

The reaction of single- and multinucleonic transfer are studied experimentally and theoretically at both leading centers; the Warsaw center, in particular, concentrated on sub-Coulombian transfer (UW), and the Krakow center on multinucleon transfer (UJ, IFJ).

For over 20 years now at the IBJ, and recently also at PW, experimental research has been going on into the process of fission of heavy nuclei and for the past few years the problem has also aroused interest of Warsaw and Lublin theoreticians.

Increasingly, more space in programs of almost all Polish nuclear centers is being dedicated to the physics of heavy ions. This involves both the structure of nuclei produced in interactions with heavy ions (Krakow, Warsaw and Lublin), mainly nuclei far from stability (UW), and the mechanisms of heavy ionic reactions (Warsaw, Krakow and Katowice).

Table 2. Specialty Structure of Physics Research  
in Poland

| Specialty              | Percent of<br>participants |
|------------------------|----------------------------|
| Solid state physics    | 37                         |
| Low-energy physics     | 11                         |
| High-energy physics    | 7                          |
| Applied physics        | 7                          |
| Biophysics             | 6                          |
| Optics                 | 6                          |
| Acoustics              | 5                          |
| Geophysics             | 3                          |
| Other physics sections | 18                         |
| Total                  | 100%                       |

In Warsaw and also in Katowice, attention is given to the reaction of heavy ionic multinucleon transport with the study of two-stage processes.

Theoretical nuclear physicists are also concerned with nuclear and hyper-nuclear matter (Warsaw), as well as exotic atoms.

In all the foregoing areas and in many others (not mentioned here due to a shortage of space), interesting results have been obtained placing Polish low-energy nuclear physics in a conspicuous place within the scope of world science. Here are just a few examples of major achievements in the past few years:

1. determination of abnormal backscattering of alpha particles in the region of  $A = 40$  (UH);
2. discovery of nuclear superdeformation, i.e., states with ellipsoid axis ratios of 2:1 (IFJ);
3. development of a new method of measurement of nuclear level density (UW);
4. participation in the discovery of a great number (about 40) new isotopes, including  $^{147}\text{Tm}$ --basic state proton emitter (UW);
5. discovery of the polar emission of charged particles during fission (IBJ);
6. elucidation of the problem of permanent octopolar deformation of nuclei in a surrounding of radium and thorium (IBJ, UMCS and UW);
7. demonstration of strong effects of two-particle interactions on collision parameters of heavy ions (IFJ); and
8. measurement of dipolar magnetic moments of nuclei in excited states (UL).

Now for high-energy physics. Warsaw particle physicists are mainly concerned with the behavior of strange particles and hadron-hadron and also lepton-hadron effects, as well as annihilation of positrons and electrons of great energy, while those working in high-energy nuclear physics investigate collisions of hadrons and nuclei of high-energy with nuclei.

Theoreticians at IBJ and UW dedicate a particularly great amount of time to the description of strong effects based on the theory of field with characterization and especially on quantum chromodynamics, and also theoretical physics of "intermediate energies."

Experimental research at the Krakow center is conducted at IFJ and AGH, and theoretical studies at IFJ and UJ. The traditional subject fields of IFJ include hadron-lepton and nucleus-nucleus interactions. Experimental studies are also conducted of  $e^+e^-$  effects, and work is done in spectroscopy of mesons built of both light and heavy quarks and the study of nucleus-nucleus interactions in a broad energy range from a few to a few hundred GeV/nucleon. Theoreticians at UJ are studying the production of particles in high-energy collisions and various aspects of strong interactions.

Studies of space radiation have a long tradition in Poland. Now they are conducted at UL and Lodz laboratories of IBJ, as well as in Krakow at IFJ. In Lodz, these studies have been focused for over 30 years on large space radiation beams with special emphasis on analysis of effects of extremely high energies. These aspects have been recently moved to the foreground in conjunction with the Collider  $p$ - $p^-$  put into operation at CERN. Energies obtained in that experiment ( $1.5 \times 10^5$  GeV) are already close to large-beam energy ranges ( $E > 10^6$  GeV).

To wrap up this overview of subjects of studies under way in Poland, it should be mentioned that Wroclaw theoreticians are working on theory of supersymmetry and supersymmetric models of the theory of elementary particles.

For a lack of space we can say just a few words about the results of these studies, although they constitute a major worldwide acknowledged contribution to science.

I will mention just a few examples of results from the past few years:

1. observations of meson generation with charm quantum number in proton-proton interaction (IBJ);
2. determination of the characteristics of high-multiplicity effects, particularly as regards multiplicity decay (UW);
3. determination of the parameters of interaction of low-energy kaons and protons (UW);
4. determination of numeric parameters of meson resonances from rho (770) to gamma-prime (10020) (IFJ);
5. development of a model of particle generation in collisions of super-high-energy ions (UJ); and
6. discovery of relatively rapid growth of multiplicities of secondary particles produced in superhigh-energy hadron interactions (UL, IBJ-Lodz).

#### 4. Equipment Situation

I would like now to discuss for a few minutes the technical conditions under which physical research is conducted in Poland. Generally, it can be described as very difficult, especially as regards accelerators and computers. Obviously, we are not complaining that in our country we do not have large accelerators necessary for studies of high-energy and elementary particle physics, because only very wealthy nations can afford to have them. But most keenly we feel the shortage of medium-energy accelerators, which are an indispensable and irreplaceable tool of everyday work for most researchers working in the physics of the atomic nucleus, as well as the shortage of main-frame computers, which are necessary for all work based on the use of foreign accelerators. Even nations that are not wealthy are equipped with such facilities far better than we are.

In this respect, the situation is particularly difficult for atomic nuclear physicists in Warsaw, where the main tool is a three-megavolt Van de Graaf generator built 22 years ago by physicists of UW and IBJ themselves. This facility is inadequate to the needs of the center, while the linear proton accelerator with a "hard" energy of 10 MeV put into operation in 1970 does not provide any substantial relief.

In this situation, a large proportion of our experimentation has to be conducted with the use of accelerators at foreign centers. This is costly and impedes progress for nuclear physics in Poland.

Efforts to provide the Warsaw center with a "real" medium-sized accelerator have been going on for 20 years. Thus far, they have failed to produce positive results. In the past, government decisions were adopted and called off, which included: (1) construction of a large Van de Graaf generator, (2) purchase of a Soviet tandem unit EGP 10, (3) purchase (under extremely favorable conditions) of an American EN tandem, and, finally, (4) the decision to build--based on partial import from the USSR--an isochronic cyclotron on heavy U-200 ions. The project was started in 1978, and despite various obstacles made progress (some 80 percent of elements of the machine have been completed, and about 30 percent of planned allocations received), but because of the crisis the construction has again been put on hold.

The struggle for almost a quarter of a century by physicists to obtain government decisions and their implementation is having extreme effects on the morale of the scientific community, the productivity of work, the influx of new physicists and the base of research. The center of gravity of experimental work of individual physical institutes at UW and IBJ is gradually shifting abroad towards centers in Western Europe and the United States, with cooperation becoming increasingly indispensable. This phenomenon is at the root of a certain disintegration of the Warsaw community and probably a somewhat blurred subject orientation.

Similar things can be said of the Krakow center as well. Here, too, the situation is difficult as regards accelerators. Classical and obsolete, two cyclotrons are operative here: one, constructed "by home means," is the small C48 cyclotron which accelerates alpha particles to 5 MeV, and the other, a U-120 which produces alpha particles with an energy of 29 MeV. Incidentally, this accelerator, acquired in 1958, is the only large research facility (not counting the EWA reactor) for which Polish nuclear physicists have received funds during the past 25 years. Currently, two more accelerators are being built in Krakow based on "self-sufficiency" economic principles. These are: a Van de Graaf accelerator at UJ and an AIC isotronic cyclotron at IFJ. As with Warsaw's U-200, the construction of these facilities is stumbling against all sorts of obstacles.

The effects of these problems with accelerators are obvious in Krakow no less than in Warsaw. A major portion of experimental research is conducted abroad.

To complete the description of the situation with accelerators, we must add that the institutes have several fast neutron generators. These are facilities of the Cockroft-Walton type for voltages not exceeding 300 keV. One of them operates at UL, and the others at IBJ and IFJ.

As regards "auxiliary equipment," the situation is less gloomy. These include all types of spectrometers and nuclear radiation detectors, as well as isotope separators and scattering chambers. Physicists have built many of these units through their own efforts, and a large number of designs constructed in nuclear physics laboratories served as prototypes for nuclear equipment mass-produced by Polish industry.

Yet here, too, a deterioration is in evidence. The long period of accelerator shortages and migration of experimental research to foreign centers weakens motivation for constructing auxiliary equipment in the country, because these facilities are easily accessible at foreign centers.

In high-energy physics, the laboratory equipment situation is somewhat better. As I have mentioned, it does not suffer because of a shortage of accelerators due to the fact that this work is wholly based on foreign accelerators. Bubble chamber films from Dubna, Geneva or Batavia are processed at IJF, IBJ or UW with the aid of semiautomatic measurement devices attached to minicomputers. For ten years, groups in Warsaw and Krakow have been using an alternative technology--namely, electron detectors, mostly multiwire chambers. Such chambers are made in both centers and constitute a major Polish contribution to experiments conducted in the framework of international programs.

The Lodz center, where space radiation of an energy above  $10^{15}$  eV is investigated, has a unique hodoscopic assembly (IBJ) and microdensitometer for analysis of materials from emulsion chambers (UL).

I now want to speak of a painful shortage that is equally felt by high-energy and atomic nuclear physics, by theoreticians and experimentalists: computers. Low- or high-energy physics is impossible today without uninterrupted easy access to digital computers. They are indispensable for the process of experimentation (on line) for analysis of its results and theoretic and model calculations.

Materials with raw data of experiments conducted abroad at accelerator centers and brought by Polish physicists to Poland for further processing and interpretation are currently so complicated that they cannot be analyzed without large mainframe computers. After all, analysis is the main contribution of Polish nuclear physicists to international experiments.

The situation in this respect in Warsaw today is difficult. The CDC 72 computer at Swierk, which serves nuclear research units of UW and IBJ, and operates in the Cyfronet service system, is overtaxed and frequently breaks down. It badly needs modernization and enlargement. Putting into operation the RYAD-60 university computer has been regularly postponed.

The state of affairs with minicomputers is slightly better for activation of data, because IBJ and UW have PDP 11 and SM 4 machines.

In Krakow, the situation is now better. Besides access to the CDC 72 at Krakow Cyfronet service, Krakow physicists use only the services of university computing center equipped with RYAD and ODRA 11304 computers. In addition, low-energy physicists at IFJ have three SM 4 minicomputers and one PDP 11/10, and high-energy physicists PDP 15 and PDP 9 minicomputers. This computer fleet, however, is already insufficient, and IFJ is working to bring into operation an IBM 370/155.

In Lublin and Lodz, physicists are in a similar plight. While Lublin physicists have access to university RYAD-32, they are not equipped with their own terminals. In Lodz, physicists only have access to an ODRA 1305 and a Mera 400 minicomputer.

## 5. International Cooperation

If Polish nuclear physics of low and high energies, despite the shortage of technical facilities, holds an important place in world science, this is largely due to our strong ramified international contacts and their skillful exploitation.

These contacts did not arise yesterday, but have been painstakingly developed over the years. A large part in this process of development and maintenance of international cooperation was played by the traditional "summer institutes" held by Warsaw atomic nuclear physicists every day for over a dozen years at Mazury and winter and summer institutes organized by Krakow physicists at Zakopane and international high-energy physics symposia at Kazimierz. These events have gained worldwide recognition and have helped us acquire many friends and partners in useful joint ventures.

It is impossible to overestimate the importance of broad international cooperation in view of our current problems with equipment. It alone allows us today to carry on research at the front line of science.

For shortage of time, I will not read a long list of foreign centers with which our institutes cooperate. In all, nuclear physicists have joint projects with over a hundred research centers in 17 countries. Most numerous contacts are with institutes of the FRG (31), France (25), and next come American centers (17), ZIBJ in Dubna (16), Soviet institutes (12), and others.

This large number of centers with which we have cooperative projects, however, is slightly disconcerting, because does it not indicate a fragmentation of our subject orientations--already existing or likely to happen in the future? Our apprehension is especially acute because we know the causes of this situation and understand that they cannot be eliminated soon. One of them, as mentioned, is a shortage of accelerators. The other cause is low, insufficient salaries of scientists, for whom a trip abroad is a tempting occasion for improvement of personal finances.

## 6. Financial Situation in Research

The existing system of science financing was basically introduced 11 years ago, that is, in 1971. A new system of planning and coordination of research and development covering the entire field of science was introduced at that time. A comprehensive system of nodal interministerial and ministerial-branch problems was introduced then. The highest priority was ascribed to nodal problems, as specified by the Ministry of Higher Education, Science and Technology, and approved by the Political Bureau and the Government Presidium. Altogether there are 60 such problems, but physics is included in only a few of them.

Most projects in nuclear physics are included in the scope of problem 0.43, "Studies of Nuclear Processes and Applications of Nuclear Technology in Socio-economic Development of the Nation." Until now, it was coordinated by IBJ.

In 1981, a total of 400 million zlotys (see Fig. 3) was allocated to this entire problem; of this amount, low- and high-energy nuclear physics were allotted about 137 million zlotys, i.e., about 34.2 percent. This amounted to two-thirds of the total allocations for basic research in nuclear physics. Of this total budget, about 81 million zlotys, i.e., 22.2 percent, went into studies of atomic nuclei, and about 54 million zlotys, i.e., 14 percent, into high-energy physics.

For comparison, we list some other recipients of this nodal nuclear research problem:

|                                                     |       |
|-----------------------------------------------------|-------|
| Studies of condensated<br>phases by nuclear methods | 12.0% |
| Acceleration physics and<br>technology              | 10.2  |
| Gas and semiconductor detectors                     | 4.5   |
| Hot plasma physics                                  | 3.7   |

A large proportion of basic physical studies are conducted in the framework of interministerial problems. Altogether, 58 such problems are distinguished in Poland's science program, of which only 6 are in the field of physics. The largest of these is problem MRI.5, "Processes of Interaction of Radiation and Matter." The coordinator of this research is the IFD at UW. Finances come from the nuclear budget, but only into projects connected with the physics of heavy ions.

Nuclear physicists also receive support from allocations to problem MRI.7.

Seven selected problems of particular importance to the national economy have been raised to the rank of so-called government problems. Nuclear physics receives funds from only two of those: PR6 and PR8.

(1) ROZDZIAŁ DOTACJI  
 PROBLEMU WĘZŁOWEGO 0.43  
 "BADANIE PROCESÓW JĄDROWYCH,  
 WYKORZYSTANIE TECHNIK JĄDROWYCH"  
 W 1981 ROKU  
 (ŁĄCZNIE 400 MILIONÓW ZŁ)

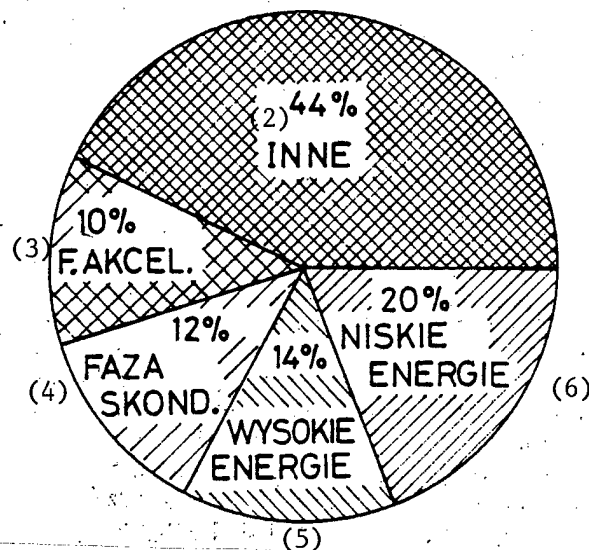


Figure 3. Allocation of funds under nodal problem 0.43, "Studies of Nuclear Processes, Applications of Nuclear Technology," in 1981 (total, 400 million zlotys).

Key:

1. Distribution of subsidies under nodal problem 0.43, "Studies of Nuclear Processes, Application of Nuclear Technology," in 1981 (total, 400 million zlotys)
2. Others, 44%
3. Acceleration physics, 10%
4. Condensed phase research, 12%
5. High energy, 14%
6. Low energy, 20%

The general picture of spending is given in Figure 4. Before discussing these data, it should be pointed out that for ministerial institutes, i.e., for IFJ and IBJ, the "problems" are almost the sole source of finances since even wage funds come from this source, as well as administrative costs and auxiliary services. In higher schools, nuclear physics is managed differently. It is also partially financed from the school's budget. From that source, nuclear physics in 1981 received about 38 million zlotys, not counting the salaries of workers not shown in Figure 4.

As seen from this comparison, the total for Poland in 1981 for nuclear physics was about 214 million zlotys, of which 71 percent came from nodal and government problems, 18 percent from the budget and the rest (i.e., 11 percent) from interministerial problems.

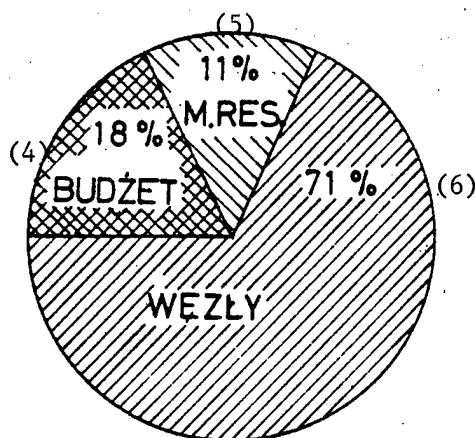
How was this money divided among individual institutes? The larger consumers in 1981 were institutes managed by Atomics Agency, i.e., IFJ, which used 42 percent of spending on basic research in nuclear physics, and IBJ, which "ate up" 30 percent. Next come UW (14 percent), UJ (6 percent), UL (5 percent), etc. Thus, IFJ and IBJ spend 72 percent on nuclear physics and universities 28 percent. This does not include wages for university personnel. Considering that in 1981 some 128,000 zlotys were spent on salaries and overhead per one research worker at UW, and assuming that approximately the same spending level was observed at other universities as well, we obtain that one nuclear physicist in higher education costs an average of 430,000 zlotys, while about 700,000 zlotys were spent per one physicist at IBJ and IFJ.

## 7. Organizational Matters

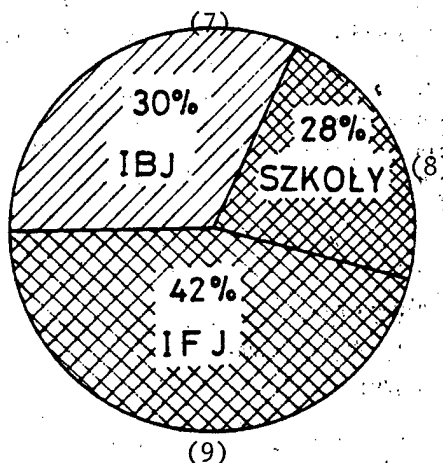
As I have mentioned on several occasions, studies in nuclear physics are conducted by two ministerial agencies: the Ministry of Higher Education, Science and Technology and Polish Atomics Agency [PAA] with the number of scientists engaged in this research being almost the same in the two spheres.

The conditions of the work, however, are different. The privilege and duty of university physicists is education. It takes a portion of their time and energy but ensures valuable daily contact with young people and the continuing influx of talented young physicists into laboratory research. As a result, the aging of science personnel at universities is slower than at ministerial institutes. Another difference--but in this case to the disadvantage of schools--is the less stable financing of research in the framework of the Ministry of Higher Education. As mentioned, two-thirds of allocations to this research comes from problem 0.43, coordinated by IBJ and IFJ. As soon as financial difficulties confronted coordinators, they had a drastic effect on the amounts allocated to universities. In 1979-81, the subsidies varied from year to year as follows: 22, 41 and 10 million zlotys. This fluctuation does not promote a proper atmosphere for work and has fatal effects on productivity. In the future, it should be eliminated.

(1) FINANSOWANIE BADAŃ PODSTAWOWYCH  
W FIZYCE JĄDROWEJ  
W ROKU 1981



(2) ŹRÓDŁA FINANSOWANIA  
(ŁĄCZNIE 214 MILIONÓW ZŁ)



(3) ROZDZIAŁ DOTACJI (214 MILIONÓW ZŁ)

Figure 4. Financing of basic research in nuclear physics in 1981:  
sources of financing and allocation.

Key:

- |                                                           |                          |
|-----------------------------------------------------------|--------------------------|
| 1. Financing of basic research in nuclear physics in 1981 | 4. Budget, 18%           |
| 2. Sources of financing (total, 214 million zlotys)       | 5. Interministerial, 11% |
| 3. Allocation of subsidies (214 million zlotys)           | 6. Nodal problems, 71%   |
|                                                           | 7. IBJ, 30%              |
|                                                           | 8. Higher schools, 28%   |
|                                                           | 9. IFJ, 42%              |

Talking about the differences of conditions in the two spheres of Polish nuclear physics, one should also mention their similarities.

Both suffer from the same scarcity of technical facilities and paralyzing effects of the shortage of the basic tools of science--medium-energy accelerators and large computers.

What is worse, there are no long-term specific--even modest but realistic--plans for improving this situation, that is, investment plans that could be consistently implemented despite the existing economic situation in the country.

A better coordination of activities and interests of agencies is necessary not only in this basic area but also in view of the fact that we need a nationwide coordination of nuclear physics research.

These "interministerial" issues require a uniform long-term policy based on large-scale consultation with the community of physicists--first of all, I would mention the following issues:

1. a program of major investment in nuclear physics;
2. interministerial cooperation--better use of bilateral and multilateral agreements than what has been practiced until now and use of Poland's membership in such organizations as ZIBJ, UNESCO, the International Atomic Energy Agency and others;
3. long-term program of scientific and technical manpower development for future progress in nuclear energetics; and
4. current financing of research--here one could think of obligatory consultative meetings of coordinators of "problems" with the education minister and PAA chairman.

Once we realize that a better coordination of nuclear physics on a national scale is required, we will answer the question as to what kind of agency should provide this coordination or tying in.

Personally, I believe that a collegial body of a consultative-informational type should be instituted. It could be composed of the following members:

1. members of high levels for both ministries concerned (e.g., Deputy Minister of Higher Education and Vice Chairman of the PAA);
2. chairmen of scientific boards of IFJ and IBJ and members of nuclear physics faculties of universities: UJ, UW, UMCS and UL; and
3. representatives of the nuclear section of the Physics Committee of the PAN.

For this last member, I would visualize a specific role of the learned secretary of this body, because he would be the only member of the committee who would be impartial as a representative of the entire community of nuclear physicists in Poland.

The purpose of the meetings of such a body (let us call it a "consultative committee") would be, among other things:

1. exchange of information between member institutions concerning the main organizational plans that might interfere with the activities of other members;
2. consultations on major investments as planned and implemented; and
3. information on new lines of research being undertaken.

An example of matters which would certainly be liable to interministerial consultation, as well as consultations with the physicist community, would be the latest organizational changes at the largest of Polish nuclear institutes, IBJ. These changes affect the situation in the entire country and influence a number of vital interests of other institutions cooperating with the former IBJ. It will be recalled that IBJ was, for instance for UW, the principal contractor performing design and development projects on cyclotron U-200, while Cyfronet was the main provider of computing services. The fate of their colleagues--theoreticians from the IBJ--is not indifferent to other Polish physicists, because, as we know, there is a threat of partitioning or subordination to a different ministry to oversee this institute (VII). The future of physicists from institute II is also uncertain. Physicists throughout Poland are keenly concerned about the future profile and structure of the newly created institute IPJ, that will be a successor in nuclear physics to the former IBJ, which was linked by numerous and strong contacts of cooperation with nuclear physics laboratories of higher schools. One should not forget, also, the existing financial connections, such as joint use of research facilities.

I would like to dwell a while on the Nuclear Physics Section of the Physics Committee of the PAN. It could assume one more function: convening various standing or ad hoc commissions or working groups to identify various problems or resolve matters important for the entire field of nuclear physics in Poland, such as recognizing the current situation in computers for physical research or the matters of educational programs for nuclear physicists. Findings of such commissions would be discussed at meetings of the section and, subsequently, submitted to the Consultative Committee and then directly to leaders of ministries concerned, with comments or suggestions as to appropriate practical steps.

Such commissions and working groups could be created with participation of the Polish Physics Society and thus have a wider social resonance.

A further possible function for the nuclear physics section is worth noting. The secretariat of the section could function as a "minibureau" of information on nuclear physics in Poland. Currently, we do not have in the nation an institution where one can obtain an overall data compilation on nuclear physics in Poland. I have had occasion to realize that in preparing the present report.

## 8. Training Physicists

I believe that this problem deserves a special broad discussion, probably at a session of the Nuclear Physics Section. Today I will only mention the issues of training of research personnel without mentioning studies at the level of the master's degree.

Because of a shortage of time, I will describe the situation in general, because it is largely similar to what is seen in other areas of physics and is well known to the audience. I will only mention the main "sores":

1. Poor motivation towards research work as a nuclear physicist because of a lack of prospects for stabilization of nuclear research in our nation and very low salaries of scientists. How can this be remedied? A national plan for renovation of the material bases of nuclear research and the earliest possible straightening out of wage rates.

2. Another problem is the difficulty with influx of graduates to ministerial institutes (and other places). We suggest: (a) introducing the principle of hiring graduates, not just for "probation" but for a longer period, say three years, as assistant researchers; (b) maintaining post-graduate studies towards the doctoral degree at universities and ministerial institutes. These should be extended one year (initially), that is, up to four years.

3. Young scientists have difficulties in making fast progress, particularly at small centers. This is largely because of an absence of live contacts with major centers. In this connection, we suggest intensifying the practice of: apprenticeship at national centers, broader use of the practice of delegating scientists to doctoral studies with an obligation to return to the parent institution upon awarding of the degree. Or, probably, one could introduce differentiated time terms of "rotation," adapting them to the specific needs of the research field (for instance, giving a longer time to those doing experimental work at smaller and scantily equipped facilities).

4. The scarcity of equipment is the biggest stumbling block to the training of research personnel. For proper training, the trainee must take part in research intensely conducted at the laboratory here at home, rather than just at foreign laboratories on trips to accelerator centers. It is only then that young people will develop broad experimental skills and master technologies and thus boost the research potential of their parent institutions. The only remedy here is to provide to our institutes what is due and necessary for their normal development.

## 10. [as published, no section 9] Future Prospects

It is hard today to look to remote horizons, and, in a questionnaire that I distributed among my colleagues who assisted with the preparation of this review, I chose a fairly close time frame: the year 1990. The following

picture of the scope of scientific subjects to be pursued in Poland by that time was compiled from their responses.

Let us begin again from the physics of the atomic nucleus. At the Krakow center, as well as at UJ and IFJ, studies of heavy ions will remain in the focus, done in increasingly high-energy fields, based on Polish accelerators, if completed, or on foreign facilities. Physicists at UJ also plan to investigate polarization effects in nuclear reactions and do work in nuclear spectroscopy, especially of radioactive materials.

At the Warsaw center, at the university, heavy ions will also be emphasized, especially the mechanism of heavy ionic reactions and nuclei remote from beta-stability. Research in giant resonance will also be continued here, as well as theoretical and experimental work on states of transition nuclei. Based on cooperation with foreign centers, the mechanism of reactions induced by polarized particles will also be studied.

At the Institute of Nuclear Problems, the successor to the Institute of Nuclear Research, low-energy physicists plan to continue working on nuclear reactions caused by fast neutrons and charged particles; measurements and evaluations of nuclear constants and development of experimental methods of nuclear measurements will also be continued. Studies of polarization phenomena are also envisaged.

The Lublin center will continue to use the equipment facilities of the ZIBJ, where (on line) studies of short-lived nucleids are to be conducted by this center. Lublin theoreticians will continue their work on the theory of collective movements.

At UL, the current projects done in cooperation with the Dubna center will be continued as regards the characteristics of excited resonance states. They will also go on with their study of the mechanism of reaction with fast neutrons.

To sum up, the low-energy physicists do not plan any major subject changes and will continue their work on reactions with heavy ions (UJ, IFJ and UW), fast neutrons (IBJ and UL), structure of nuclei, particularly transition nuclei and those far from beta-stability (UW). There will be an increased interest in polarization effects (UJ, UW and IFJ).

In high-energy physics, the Krakow center does not foresee any major changes in programs for the coming several years, but studies of  $e^+e^-$  interactions, new quarks and quark and gluon fluxes will be at the focus of their work. This is in coordination with the planned participation in the DELPHI experiment to be started in 1986. Projects concerned with hadron interaction and the hadron-nucleus collision studies traditional for Krakow will be continued (IFJ).

Theoreticians at UJ will proceed with their investigation of various aspects of strong interactions, but they also plan to investigate the phenomenology of weak interactions as well.

In Warsaw, the existing list of subjects will be mainly continued, with an emphasis on annihilation of electrons and positrons and lepton interactions, which are tied in with the launch of CERN of  $e^+e^-$  collider, the so-called Lep.

Warsaw theoreticians will not change their scope of interest drastically, but they will place stress on quantum chromodynamics and theoretical physics of intermediate energies, as justified by the growing amounts of experimental data from "meson factories."

In studies of space radiation at Lodz, projects for detailed analysis of the evolution of large beams through the all-around study of their structure, and especially time structure, are planned.

Theoreticians at UL will work on unification of interactions.

Another word on Wroclaw theoreticians. They, too, will continue the existing subject nomenclature in studies of the geometry of elementary particles and supersymmetric particle models.

All these plans proceed from the assumption that the situation in nuclear physics in the coming few years will not deteriorate as compared to the period before 1982. A crucial condition on which these plans are predicated in the coming decade is maintaining our contacts with foreign centers, at least at the existing level, and especially the possibility of uninterrupted, unhampered foreign travel; continuing our international summer and winter institutes and symposia is also crucial.

An indispensable condition, if stagnation in low-energy physics is to be surmounted, is a speedy completion of the building of the U-200 cyclotron in Warsaw and the AIC 144 cyclotron in Krakow. A similarly important need for high-energy physics is a radical improvement of mainframe computer availability. Financing the current scientific activity at a higher level than we have today (adjusting for inflation) is mandatory. A constant foreign currency quota, even a modest one, is also necessary. Probably, introducing more flexible procedures that would allow the institutes to tap the funds coming in from taxation of individuals working under contracts with foreign nations could be helpful. The regularity of research financing, which today is very uneven, should be improved. Creating a "Fund for Research Initiatives" to render fast financial aid to interesting and unpreplanned experiments and theoretical work proposed by research groups and positively assessed by a special commission appointed by, for example, the Nuclear Physics Section, is desirable. Such a fund could be managed by the Atomic Council being created now. I also believe that, for the growth of nuclear physics in Poland, a competent representative body of nuclear physics should be given a substantial role in the drafting of major governmental decisions affecting organization of nuclear research and its material supplies. The Nuclear Physics Section of the Physics Committee of the PAN and the Consultative Committee could function as such a body.

## 11. Conclusions

Such is the picture of the current situation of nuclear physics in Poland. Painted mostly in dark colors (because it was not intended as a celebration address), it, however, leaves room for a certain amount of optimism. It shows, indeed, that over the past 38 years since the end of the war, which left Polish science in a shambles, a new important field of science has been built up in Poland, where currently a large group of people is working-- 100 full and assistant professors and about 500 of their co-workers. Ample scientific fruits have been cultivated in this field, including several major discoveries. These results place Polish nuclear science in high and low energy fields in a conspicuous place worldwide.

Although this was not discussed in the paper, Polish nuclear physics laboratories are conducting basic research in this field of science and have developed and improved numerous experimental techniques, designed diverse research equipment used not only in research but also in industry and medicine. In these laboratories, new fields of technical physics, not previously existing in Poland, were born: reactor physics, hot plasma physics, accelerator physics and nuclear geophysics. We have developed in our laboratories and are broadly using in various fields of science and technology all sorts of nuclear methods--neutron activation, Mössbauer techniques, etc.

This major scientific and technical contribution of nuclear physicists obtained by hard work under difficult conditions of financial squeezes speaks positively of their talent and stamina and give the hope that Polish nuclear physics will emerge unvanquished from the difficult years of the current crisis.

### Resolution on Nuclear Research Development

Warsaw NAUKA POLSKA in Polish No 1-2, Jan-Feb 83 pp 181-182

[Resolution of the Physics Committee, Polish Academy of Sciences, on Organization and Trends of Research in Nuclear Physics]

[Text]

The Resolution of the Physics Committee of the PAN  
on the Situation of Nuclear Physics in Poland and  
the Prospects for Its Development

The Physics Committee of the PAN, at its plenary sessions on 26 Jan 1983, heard a report on the state of nuclear physics in Poland presented by Professor Z. Wilhelm and evaluated the general situation in this field of research and prospects for its further development.

The committee believes that Polish nuclear physics of low and high energies has attained a high development level and is holding a good position in world science. In nuclear physics laboratories, sections of technical

physics have been born which did not previously exist in our country, such as reactor physics and nuclear geophysics, and many of the experimental methods created there were adopted by other fields of science, industry and medicine.

We must state, however, that the technical conditions in which nuclear research has been conducted in Poland have been unfavorable for a very long time. Most acutely felt is the disastrous absence of accelerators, which are indispensable tools for research in low-energy physics, as well the shortage of large mainframe digital computers. These shortages threaten the further progress of nuclear physics. The Physics Committee believes that the following requirements should be met to save this area of research from stagnation:

1. Completing shortly the construction of the U200 cyclotron in Warsaw and the AIC 144 cyclotron in Krakow.
2. Modernizing and developing existing computer centers, especially the subscriber networks Cyfronet-Warsaw and Cyfronet-Krakow, and speedy commissioning of the computer center at UW.
3. Financing the current research activities in nuclear physics better than has been done until now. This includes, among other things, allocations of foreign exchange.
4. Ensuring for the Physics Committee the role of a counsel in all government decisions concerning the organization of nuclear research and its material support.
5. Providing to nuclear research institutes opportunities for maintaining and developing proper scientific contacts with foreign centers--simplifying the administrative procedures for scientists' foreign trips, effectively supporting the convening of international symposia and other scientific meetings in Poland.
6. Increasing the salaries of research staff at ministerial institutes and higher schools.

The Physics Committee also supports the organizational proposals set forth in the report submitted by Professor Z. Wilhelmi.

9922

CSO: 5100/3401

# INSTALLATION OF REACTOR AT IPEN SCORED

Sao Paulo O ESTADO DE SAO PAULO in Portuguese 4 Oct 83 p 10

[Excerpt] Nuclear expert Virgilio Tambernini Neto charged yesterday that a critical unit reactor is being installed at the Energy Research Institute (IPEN) for the production of fissionable elements as, for example, plutonium; and an atomic fuel reprocessing plant which, in case of accident, could affect an area of 25 to 50 kilometers around University City. According to him, the two units represent a "potentially greater danger than that presented by the Angra dos Reis nuclear plants."

Indicating the sites where the future installations are being built--the first, in front of the university hospital and the second near the prefecture of the University of Sao Paulo (USP)--the expert declared the most serious thing is that these units belong to the National Nuclear Energy Commission (CNEM), an agency which, "as an objective, should normalize and supervise the sector and, in the meantime, is preparing to produce plutonium, a substance used for nuclear explosions for peaceful and non-peaceful purposes."

Virgilio Tamberini said that the critical unit reactor is being built with "semi-national" technology, while the fuel reprocessing plant is part of the "package" of the nuclear agreement concluded between Brazil and Germany. Owing to the seriousness of the problem, he is thinking of taking a report to the Municipal Chamber, an organ he considers authorized to pursue the charge. Virgilio Tamberini Neto explained also that while the Angra dos Reis plants are going to operate with material enriched with 3.5 percent uranium, the IPEN plant will work with an enrichment of 20 percent.

Several physicists asked to comment on the charge denied that they knew anything about the matter, as for example, the president of the Sao Paulo Electric Power Stations (CESP), Jose Goldemberg, who considered the language used by the nuclear expert to be that of a "layman." Saying that he only knew about the existence of the old reactor used by the USP since 1956, Goldemberg warned against the danger of disseminating this type of information.

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CSO: 5100/2002

WORLD ENERGY CONFERENCE ADDRESSED BY IAEA OFFICIAL

New Delhi PATRIOT in English 23 Sep 83 p 5

[Text] About 1,500 million dollars is being spent each year by major industrialised countries as part of scientific efforts to put up a test nuclear fusion reactor at least by early next century, the World Energy Conference was told, reports PTI.

Scientific progress in the field of controlled nuclear fusion of a long-term source of energy has been "very encouraging," according to Dr R. S. Pease, chairman of the International Fusion Research Council of the International Atomic Energy Agency (IAEA).

A majority of the research work in the US, the USSR and Japan is concerned with the scientific development of the high temperature systems of the order of 100 million degree C, which is needed for the controlled thermo-nuclear reactions, he said.

The United States has the largest research programme worth about 50 million dollars each year.

A rapid expansion to about 220 million dollars has taken place in Japan in the field and an increment in investment to about 10 million dollars per annum is under way in countries who work together in a collaborative programme.

Smaller fusion research efforts are also being carried out in a number of other countries throughout the world, he said.

The main achievements to date reveal that fusion experiments had temperatures and densities approach those needed in a reactor and the conditions were even sustained for several seconds. So far, thermo-nuclear energy has been relaxed on controlled conditions on a scale of a few tens of joules only.

"Enough has been done to indicate that the developments in the field so far will turn out to be technically feasible. The task ahead will call for a sustained and dedicated investment before many problems are resolved," Dr Pease said.

In order to bridge the gap between experiments conducted so far and what is needed in a reactor, large-scale experiments are now being completed. The first of these experiments is expected to be completed by the end of this year.

Though controlled nuclear fusion is still in the research stage, it seems from the steady progress made in the experiments to date the containment and control of a self-sustained thermonuclear reaction needed in a reactor will be achieved.

Controlled fusion uses abundant and cheap fuel, Dr Pease said.

The amount of radioactivity produced has been compared with that for another major long-term source of energy, the fast breeder reactor.

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## ANALYST SEES NO PROSPECT FOR EARLY SUPPLY OF SPARE PARTS FOR TARAPUR

Madras THE HINDU in English 9 Sep 83 p 1

[Article by G. K. Reddy]

[Text] New Delhi, Sept. 8--There is no prospect of an early supply by the United States of the residuary spare parts for Tarapur that cannot be obtained from other Western sources, despite the assurance given by the Secretary of State, Mr. George Shultz, during his recent visit to Delhi.

After a careful consideration of its obligations as a member of the London suppliers group which has prescribed stricter safeguards for the sale of any item on the so-called trigger list, West Germany has informed India of the categories of spare parts that it can provide on the basis of a general assurance that these would be used only at Tarapur for specified purposes within the framework of the 1963 Indo-U.S. agreement.

The general assurance sought by Bonn neatly skirts to some extent the sensitive question of additional safeguards, but it leaves the key issue of continued applicability of these constraints even after the expiry in 1993 of this agreement wide open for the present. The West German Government had earlier indicated that it would be quite content with the kind of understanding arrived at for the supply of enriched uranium fuel for Tarapur which also left this crucial point to be settled later during the life of the 1963 agreement.

The Italian Government also has yet to inform India which of the spare parts it would be able to supply and under what conditions. But Indian officials who have had detailed discussions with both West Germany and Italy are of the view that the more important parts will have to be obtained from the United States.

Though the U.S. is supposed to be still awaiting an official communication from India specifying the parts that cannot be procured elsewhere, the informal exchanges that have taken place on the subject make it pretty clear that Washington will insist on some additional assurances. Apart from insisting on a fresh undertaking that there will be no reprocessing without joint determination, the U.S. is also trying to extract a promise that India will not go in for any more nuclear explosions.

The issue of these spare parts was raised by the Indian Ambassador, Mr. K. R. Narayanan, during his recent meeting with the U.S. Secretary of State, Mr. Shultz, but there was no detailed discussion as such pending the submission of a list by India of the items that cannot be had from Western Europe. There was no indication of what action the U.S. President, Mr. Reagan, proposed to take to fulfil his commitment to supply these critical items.

It is considered highly unlikely that he would ignore the mounting opposition from some Congressional circles in a pre-election year merely to abide by an assurance that had been given to India without some compensatory assurances. In this situation, it is becoming increasingly difficult for India to make up its mind whether it should press for an early decision even at the risk of a negative response or keep the issue in abeyance for the time being in the hope that at some point Mr. Reagan may be able to tackle the issue in his own way by mollifying Congressional opposition.

The continued uncertainty about the supply of these critical items by the U.S. poses a challenge to the political will of the Government to resist pressures and the technical capacity of India's nuclear scientists to improvise and run the Tarapur plant. At some point, India will have to think seriously of the other alternative of closing down the plant as a safety measure if these generic spares are going to be withheld by the U.S. under whatever pretext.

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# KOEBERG TO BENEFIT DOMESTIC INDUSTRY

Johannesburg RAND DAILY MAIL in English 29 Sep 83 p 14

[Text]

ESCOM is trying to ensure that domestic industry benefits — through extra demand, jobs and imported expertise — from the placement of the Koeberg maintenance contracts.

The commission is to include in the contracts the requirement that the winning company must train local people and appoint a sub-contractor.

Implicit in these stipulations is the long-range goal of establishing enough relevant expertise in South Africa to make dependence on overseas contractors unnecessary.

This goal fits in with the authorities' current objective of making all "strategic" industries independent of foreign materials and know-how.

The contracts are for the provision of technical and maintenance services essential to the start-up, scheduled for January, of the Koeberg One reactor, 26km north of Cape Town.

Foreign reports have put the value of the contracts at R55-million, and have named seven US firms — among

them Westinghouse Corporation, Bechtel and Fluor — as tenderers for the contracts.

Some Congressmen have objected bitterly to the State Department's decision to allow US companies to participate in the Koeberg project.

The State Department gave the go-ahead because, it said, no sensitive or classified technology was involved and German or French companies stood to win the contracts if US companies were barred from tendering.

An Escom spokesman said yesterday it was the commission's policy not to disclose the identity of tenderers. The value of the contracts could not be disclosed either because the final price was still under negotiation.

The contracts would initially have a duration of three years, but would include options to extend them. Their value, the commission spokesman said, would therefore depend on their duration.

The commission confirmed that several firms in several countries had been invited to submit tenders before July 15 this year.

Escom will have to award the contracts before the end of the year because the tenders are valid only until December 31.

The services provided by the contracts would have to come on stream in the first quarter of 1985.

## POLL CONFIRMS CONTINUED RISE IN OPPOSITION TO NUCLEAR POWER

Copenhagen BERLINGSKE TIDENDE in Danish 2 Oct 83 p 11

[Article by Asger Schultz]

[Text] The nuclear power accident on the Three-Mile Island in March of 1979 apparently signified a turning point in the long run. After having partly overcome the after-effects of the accident, the opposition has increased anew and has now stabilized at a level which is even higher than immediately after the accident.

And this development is primarily due to a very sharp increase in the opposition among women. This appears from the most recent poll carried through by the Gallup Institute in a series of polls on nuclear power.

The said poll was carried through in September of last year, and a representative section of the population, comprising approximately 1,000 respondents, was asked the following question:

"The Folketing has postponed its decision to build nuclear power plants in Denmark until a sufficiently safe method for storing nuclear waste has been developed. If and when the Folketing, at some point, finds that this problem has been solved and decides to build nuclear power plants, a popular vote may be taken on the issue. Will you advocate nuclear power or will you oppose nuclear power in such a popular vote?"

The answers were as follows compared with previous polls:

|                             | 78  | 79  | 79  | 79  | 80  | 80  | 81  | 82  | 82  | 83  |
|-----------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                             | %   | %   | %   | %   | %   | %   | %   | %   | %   | %   |
| Will advocate nuclear power | 39  | 30  | 32  | 36  | 37  | 37  | 39  | 32  | 31  | 30  |
| Will oppose nuclear power   | 38  | 54  | 51  | 46  | 44  | 41  | 47  | 51  | 56  | 57  |
| No opinion                  | 23  | 16  | 17  | 18  | 19  | 22  | 14  | 17  | 13  | 13  |
| Total .....                 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

There is no great difference from the last poll, and it appears that the public opinion is stabilizing at a level--among the respondents--of two-thirds opposing nuclear power, as compared with 50 percent advocating nuclear power and 50 percent opposing nuclear power immediately prior to the accident at Harrisburg.

This marked change has got nothing to do with party-policy positions; the voters of the Social Democratic Party and those to the left of that party have been opposed to nuclear power all the time, but it is due to changes in the positions among women.

Whereas more or less equally many men now advocate and oppose nuclear power, more than two-thirds of women (68 percent) oppose nuclear power, and only 17 percent advocates nuclear power. Thus a very marked opposition to nuclear power.

On this issue, women clearly hold strong left-wing views.

Reprinting subject to indication of BERLINGSKE TIDENDE and the Gallup Institute as sources.

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SPAIN

BRIEFS

GASTEIZ ANTINUCLEAR COMMUNIQUE--Gasteiz--In view of the British government's confirmation of having dumped highly radioactive wastes along the Galician coast, the Antinuclear and Ecological Committees of Gasteiz have issued a communique to sensitize public opinion to the very serious danger to the ecosystem of the Galician coast, which the European governments have converted into a nuclear cemetery, at the same time that they feel solidarity with all the nations that may be partners of that nationality. The Antinuclear and Ecological Committees have declared that for the British Government, "neither the recommendations of conferences nor the prohibitions of international laws on highly radioactive wastes are of any value. Only the joint and solidary mobilization of the European peoples can put an end to their plans, and therefore we call on the people of Gasteiz to be attentive to the upcoming mobilizations."

[Text] [Guipuzcoa EGIN in Spanish 19 Sep 83 p 6] 9746

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