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CHERNOBYL AND THE FUTURE OF NUCLEAR ENERGY IN THE EAST

by

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Summary of the Meeting

Exactly ten years ago, a nuclear reactor exploded in Chernobyl. The incident has already been discussed more than enough in the media, but here the facts are put forward according to an engineer's viewpoint. Although the accident revealed the extraordinary ability of the Red Army to mobilize its forces, it also allowed for an assessment of the weaknesses of the safety conditions in numerous plants in operation in the Eastern countries. The site, still contaminated, threatens to contaminate the ground water in the long run. This prospect is frustrating plans for redevelopment of nuclear grounds in Western countries. Therefore, they are preparing to finance the elimination of this risk. But the technical uncertainties, the difficult coordination of the donors, and the socio-political reactions of the Ukraine are acting as so many brakes to this undertaking.

PRESENTATION

Following a career as an engineer in large engineering and public works groups, I am now in charge of the international activities of SGN, a subsidiary created by Cogema in 1976 to externalize its engineering function. This company employs six thousand people and devotes itself in part to the follow-up and management of industrial installation operations, with the other part being dedicated to engineering, particularly in the field of nuclear energy. It is an international corporation that is firmly established in the Czech Republic and in Brazil, and present in Asia and in the Eastern countries as well. I've personally taken on the supervision of the Chernobyl project.

CHERNOBYL, INTERNATIONAL STAKES

The entire nuclear energy industry plans to renew its nuclear plants between 2010 and 2015, both in France and in the U.S. If nothing is done in Chernobyl, the situation will only get worse, and it will be very difficult to justify these site renovations in the eyes of the public. Thus, we have fifteen years to take action. I'm going to attempt to resituate the problem according to an engineer's viewpoint and to set out some possible solutions to the difficult problems that have arisen, both on a technical level, as well as on the management level of such a project, in the context of an international audience.

THE RMBK TECHNOLOGY

Every reactor in Chernobyl is of the RMBK-type. The reactor is non-confined, meaning exposed to the outside air: it is simply isolated by an inert radiobiological armour-plate that has no other structural function. The reactor has only one high-pressure water circuit and uses pressure tubes and graphite as a regulator, demonstrating fairly ancient military technology. The cold water comes from below and goes up through the tubes where the nuclear fuel components are located. The steam that gathers is directly turbined, then condensed and recycled. Control rods are arranged in between the tubes : according to how far they are driven into the graphite, the reaction is more or less powerful.

The advantages of this type of reactor are :
- its simplicity: they are very easy to assemble
- its non-stop operation: the nuclear fuel can be changed without shutting the reactor down

Their faults are now well-known :
- the absence of a confining enclosure: if there is an explosion, the environment is contaminated
- the reactor's instability: at a certain operational speed, the reactor can fly out of control, which requires an exceptional vigilance.

This last point deserves some explanation. When the pressure is lowered, the circulation of water all along the combustible slows down, and therefore the production of instantaneous steam increases. Since the nuclear fuel is hot, the nuclear reaction accelerates. As a result, the temperature of the fuel rises even higher, but beyond a certain threshold, the hotter the fuel is, the fewer neutrons it makes and the slower the reaction is. These two effects balance each other out, and in standard reactors, the "reactivity coefficient" is maintained at a negative value. In other words, the reactor is kept under control. Yet within a certain range of power[1], an RMBK reactor has a positive reactivity coefficient, which is to say it becomes uncontrollable.

[1] 20% of the maximal power

THE ACCIDENT

Before the accident, there are four reactors in operation in Chernobyl. These reactors are paired up, with a common turbine system. Each reactor, just as each turbine system, is sheltered in a "block", meaning a separate building. On April 26, 1986, "Block 4" exploded.

A catastrophic test

There are regular inertia tests run on the RMBK reactors: after complete shutdown, the reactor is checked to make sure that it is still producing enough electricity to keep all the essential safety features working. Such a test was programmed for April 25th during the day, but it needed to be postponed until 1:20 in the morning, a really bad time. For technological reasons, and following poor handling, the operator lost control of the machine. The power began to oscillate more and more and the machine finished by exploding.

Mistakes

What mistakes were made ? The circulation networks of emergency water were partially closed; in order to cut down the power at any cost, the control bars were lifted up beyond the authorized norm; the test took too much time, which partially poisoned the reactor with xenon and iodine; all control was lost. The operators weren't fully trained ; furthermore, they didn't have access to all the information needed to make the right decisions at the right time.

The immediate consequences

We aren't talking about a nuclear explosion, but rather about an explosion of steam, whose instantaneous power was more than one hundred times greater than that of the reactor, that is to say, concentrated in a single stream, the same force produced by the whole of the American nuclear grounds for the production of electricity ! It was immediately followed by a second explosion, probably of hydrogen, formed as a result of the high temperatures. Huge quantities of debris were ejected, the biological plate covering the whole complex - two thousand two hundred tons! - toppled over, the whole building was destroyed, and the graphite caught on fire. This fire was the source of the greatest difficulties: extremely hot and difficult to manage - it took ten days of heroism to put it out - it carried particles and nuclear materials to very high altitudes, thereby forming the most significant source of contamination.

THE SOVIET REACTION

Mr. Gorbatchev was informed in the early morning. In accordance with the customary reactions of the sytem, two decisions were made : to conceal the seriousness of the accident and to create an investigative commission. It was to be an operational commission that would immediately take those measures imperative at the site, in particular the most obvious, the shutting down of the adjoining Reactor 3. Late afternoon the next day, Reactors 1 and 2 were shut down in turn; in three hours, the evacuation of the forty-nine thousand inhabitants of the neighbouring city was decided on and effected! The cloud of radiation was detected at the Swedish plant of Fosmark, whereas the Russians still hadn't announced anything. The list of immediate victims among the operators and firemen: two hundred thirty-seven radiated, of which one hundred and twenty-nine were evacuated to Moscow and thirty-one died, one person of a heart attack, another left buried under the collapsed armour-plate, and twenty-nine as a result of radiation. A second evacuation of ninety thousand others took place five days later.

RESCUE OPERATIONS

Exceptional rescue operations were implemented.

Slowing down the nuclear reaction

Once the graphite fire had been put out, it was necessary to slow down the nuclear reaction : helicopters dumped lead, clay, bronze, and dolomite on the ruins. The contaminated debris, scattered all about - an enormous amount - was collected by bulldozer, and walls were built to contain and conceal it. The roofs of the adjacent buildings also needed to be cleaned up: for fifteen days, the Russians tried to use robots, but the intensity of the radiation put them out of order. So they mobilized three thousand five hundred soldiers, each one for ninety seconds of intervention, that's to say the equivalent of five years of exposure for someone who works with nuclear energy. What would we do in France, confronted with such a problem ?

Cooling off the subsoil

The molten reactor started to sink - the equivalent of one floor every nine days. To avoid the Chinese syndrome, four hundred miners from the Donetz dug a tunnel in fifteen days so that a cooling loop could be placed underneath of Block 4, an operation that is difficult and fairly unknown.

Building a confining enclosure

At the same time, the sarcophagus, a structure composed of cement and steel, was beginning to be built, partially using the reactor's damaged structures. It's an ingenious piece of work that was completed in six months under horrible conditions of radiation.

AN EXCEPTIONAL ABILITY TO REACT

The Russians were able to mobilize, for quite awhile, a total of six hundred fifty thousand people over a six-month period.

I'm not a specialist of the Slavic or Russian worlds; however, I believe I can remark on the supremacy of science, the very large separation of knowledge and therefore of power that exists there, as well as on their crisis management ability - you would think you were in Moscow in 1942 - but also on their courage, their ability to take action and their efficient resourcefulness.

This is their Verdun ! In remembrance of that which they consider to be a great performance and an act of heroism, they wear the Chernobyl medal: "Safety culture - Effectiveness - Social progress".

THE POTENTIAL VICTIMS

We can expect an increase in the number of cancers among the exposed populations. Here are the most likely estimates : a 10 % surplus of cancers among the population of the one thousand people who intervened in the first few days; a 2 % to 2.5 % surplus of cancers among the liquidators and the adults of the region. On the other hand, the surplus of cancer of the thyroid - 2000 % ! - threatens a million children in Belorussia, southeast Russia, and the Ukraine.

It will be difficult to explain to a liquidator suffering from cancer that he belongs more likely to the ninety thousand statistically normal cases than to the two thousand victims expected ! On the other hand, there will be two hundred to five hundred cases of cancer

of the thyroid that will break out among children, while the "norm" is between ten and fifty. Therefore, almost all the affected children will be very real victims.

INTERNATIONAL CONTEST

Silence will once again fall on Chernobyl, whose three unscathed reactors were started up again. In 1991, the Ukraine became independent; invited by the Ukrainian Academy of Science, the first Western experts were allowed to visit the site. They judged the situation catastrophic in more ways than one: lack of money, lack of skills as a result of the Russians leaving, and possible breakdown of the sarcophagus. The public was alerted.

In 1992, Bouygues suggested the first sarcophagus project. The Ukrainians started an international contest for "making Reactor 4 ecologically safe". Notice that that doesn't necessarily imply the construction of a new sarcophagus. Moreover, to solve the problem, the Russians suggested that they inject two million m^3 of cement into the sarcophagus already in place. Three hundred eighty-four organisms responded to the contest! First prize was the right to build a new sarcophagus, second prize was five thousand dollars, and third prize was two thousand five hundred dollars. First prize wasn't awarded ; out of the six finalists[2] only one was awarded a prize: the French group Campenon Bernard SGE, who gave the five thousand dollars to the Association of the Children of Chernobyl. As a matter of fact, nothing had been solved.

TACIS AND ALLIANCE

The TACIS program for aid to Eastern countries gradually took over: in 1991, seven hundred thousand ecus were unfrozen, in 1992, six million ecus, and in 1993, eight million ecus; these sums only being available at two-year intervals. TACIS launched a genuine discussion for the dismantling of the reactor or for the construction of the sarcophagus, should it prove necessary. Among the six contest winners, five formed the group ALLIANCE[3], piloted by Campenon Bernard SGE. The study, more serious this time - three million ecus - took place in 1994-1995.

To dismantle or to stockpile ?

ALLIANCE studied what could eventually be done : was it necessary to dismantle everything ? The answer was affirmative, because it was out of the question to leave one hundred and seventy tons of nuclear fuel permanently in storage in the area, where the waste runs the long-term risk of seeping into the ground water. However, to safely dismantle the ruins of Reactor 4, salvage the melted fuel components and the highly active remains, a confined workshop equipped with all the essential means of lifting, sorting, waste stabilization, conditioning and decontaminating is needed. As the present sarcophagus cannot fulfill this function, a big building needs to be built over top in order to guarantee confinement. An arch is the ideal shape for minimizing the volumes that need to be treated in terms of nuclear ventilation, and it allows for prefabrication: thus, large precast elements equipped with automatic cranes would be assembled on the site. Next, all the means of resumption would need to be put into place, and lastly, litlle by little, the dismantling could begin.

Treatment of the waste

The TACIS studies tackled the shutdown of the reactors in operation as well as the problem of waste. There are a million tons of waste on the site, divided up in eight hundred warehouses: helicopters, trucks, and various unclassified scraps. However, it is

[2] Two Frenchmen, an Englishman, a German, a Russian, and a Ukrainian. Note the absence of the Americans.

[3] The Germans did not want to take part.

impossible to go solely by surveys or statistics : the treatment would be radically different depending on if, among the refuse, there are nuclear fuel components or not.

THE WEAKNESSES OF TACIS

The aid program that took place from 1993 to 1996 was highly criticized; that said, I think it was an excellent way for Western businesses to do some training and learning. But seeking a consensus at any price presents difficulties. The commission felt very uncomfortable when faced with the controversies of which the ALLIANCE project had been the object. We had to explain ourselves in front of all of our competitors ! The TACIS method is not operational: very biased and variable approaches - the commission wants to please everyone - twenty-five firms interfered in the study, hugely scattered expertise, an inefficient public relations policy, etc. There is, of course, a local contractual entity - who is also one of the sub-contractors -who would do well to get 10% to 20 % of the contract, but the biggest deficiency is that there is no client, no one to make the decisions.

FIRST DECISIONS

Following numerous incidents, the Ottawa Agreement - a memorandum which allowed for the work to begin - was signed. It foresees shutting down the nuclear plants in the year 2000, making the active reactors safe to a certain extent, and carrying out complementary studies on Reactor 4. During the Moscow summit in April 1996, the financial means anticipated in the memorandum were reinforced, and the shutting down of a first section was confirmed.

For the general public all is well if we close the plant, and of course that's an incentive for politicians to demand the shutdown. As for the Ukrainians, they want to confirm the shutdown of a first plant for more technical reasons: under radiation, graphite expands, and after fifteen years, the pipes have to be changed, and the Ukrainians don't have the money to change them. But the shutdown encompasses a number of activities beyond simply stopping everything. There are many people who don't understand that dismantling is more difficult than construction, especially in the field of nuclear energy, because the presence of nuclear matter is very restrictive. It requires what are called "utilities" and very strict coordination to constantly maintain safety. Lastly, we mustn't forget the eight hundred sites where waste is being stored that has to be taken care of. To insure their complete elimination, it will be necessary to build a very large facility and keep it operating for twenty years.

THE NEED TO IDENTIFY THE CLIENT

Thus, we are on the threshold of the genuine launching of the first operations and there's still no client, nor project organisation. The G7 countries officially asked the Ukraine to designate the client who, I think, should be backed for his own operational expenses in order for him to have three key elements at his disposal: skill, income, and legitimacy. It's all the more important because there exists the fundamental problem of nuclear responsibility as well as of civil responsibility.

COORDINATION REQUIRED

There are numerous donors; everyone has put in his million dollar bit. Today, the donors need to sit down around a table and decide on the creation of financial structures managed in a coherent manner.

Mrs. Lepage, our Minister of the Environment, announced, with her German counterpart, the creation of a scientific center ; the Americans did exactly that six months ago. So is it the same scientific center, or are we talking about two different centers ?

A PROJECT UNLIKE THE OTHERS

A project with unique characteristics needs to be organized. In a standard project, data is gathered, the client sets his goals, a course of action is chosen, and things progress from there. If there are problems along the way, they're tackled by putting in place skills equal to the task. Unfortunately, in a project like Chernobyl, not all the basic facts are known and the goals are unavoidably vague and adjustable. Is it necessary to make an exhaustive inventory of the facts ? No, because that would require not only a considerable investment, but also, if we attempted to acquire all the data on the site, the safety conditions would likely be compromised.

Therefore, we recommend that a professional and focussed organization be created, separate from the suppliers, that would, first of all, draw up a comprehensive plan using the basic, most reasonably accessible data. Next, for the duration of the project, since the situation remains partly unspecified as of yet, the evolution of a model - an instrument for evaluation and reevaluation - will need to be constantly checked on in order to make the best decisions possible according to the criteria imposed by the donors as a whole, as well as by the client. The project's leadership organization must be especially strong since the keywords are: vagueness, reason, and flexibility. This implies, paradoxically, great rigor when putting the tools, methods, and procedures into place, as well as in the precision of the evaluations, experiments, and feedback. This is not what TACIS is doing today: it's plain to see that their method is a complete scattering of knowledge!

We are quite willing to lead such a team, and this direction seems to suit everyone. The team's first mission would be to gather together the literature that is very scattered at present : for example, ALLIANCE has original documents available - contaminated, for that matter - of which no copies exist; nobody knows that we have them. After putting this enormous file in order, it will have to be validated and supplemented with tests and evaluations. This operation could require a year's work.

HOW MUCH WILL ALL OF THIS COST ?

Three Mile Island cost several billion dollars. For Chernobyl, we must talk in terms of yearly effort, that is to say, four hundred million dollars per year for more than ten years. This sum would represent only three thousandths of the worth at cost price of the production of electricity of nuclear origin in the world. The only problem is that it would be a question of a long-term committment. What is difficult to evaluate is the Ukraine's ability to participate and at what price.

CONCLUSION

I've tried to distance myself from the events here, but Chernobyl remains a tragedy. We must solve this problem equipped with an organization and the means adapted to the situation, working with people who are very sound, both morally and intellectually. It would be an even greater tragedy to fail in this undertaking! Admittedly, the costs and the stakes are high, but we must be resolute. All we have to do now is begin.

DEBATE
Living conditions

Contributor : *How do the people who operate all that live ?*

Xavier Gorge : In Chernobyl, salaries are higher, housing is free, and living conditions are very comfortable. Of course, there still exists a no-entry area on account of the radiation, but it would be possible to live there if we accepted that the inhabitants live just as exposed as nuclear energy workers in France.

The levels of radioactivity on the site have become perfectly acceptable outside of the marked hot spots.

Contributor : *The amount of natural and artificial contamination in Chernobyl is less than the amount of natural contamination in France and well below the average in Finland*[4]*. Moreover, outside of the production ofelectricity, industrial tourism is Chernobyl's main activity: last year, two hundred and thirty groups of Westerners, including children, visited Chernobyl. It reaps a genuine fortune; the hotels charge international market prices.*

The consequences of neglect

Contributor : *What would happen if we didn't do anything ?*

X. G. : Two setbacks could occur :
- the partial collapse of the sarcophagus on account of its decay, with emission of the contaminated particles presently hanging in the air inside the enclosure. The consequences would be local and, objectively speaking, not too serious.
- the contamination of the water by the eight hundred warehouses; nobody knows how long it would take for the contamination to reach the ground water, but this will definitely occur. Even though the radioactivity in the waterways[5] fed by the northern Chernobyl forests have returned to normal, it's a major risk: nothing more can be done when the water's been contaminated !

That said, the surrounding soil is also contaminated; it would be absurd to contemplate dealing with fifty thousand km2 of terrain. The only conceivable option is to equip wood incinerators with filters in order to try and gradually retrieve the nuclear substances.

Unreliable information

Contributor : *For ten years, it's been impossible to gather consistent and reliable information - can the lack of information, the disinformation, or the lies on the subject of Chernobyl be explained ? - and yet it would be in the interest of all of the nuclear property administrators to be able to take this experience into account.*

Contributor : *The point of reference is the accident at Three Mile Island : it was the object of an extraordinary worldwide appropriation. Chernobyl reveals more what happens in the CIS : safety training still hasn't been perfected. A very serious incident occurred once again a few months ago, and such facilities are numerous in the East. The WANO*[6]*, a federation of nuclear operators, was in fact created so they could form a genuine solidarity.*

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[4] Information given during the recent conference in Vienna on Chernobyl.
[5] The Dniepr and the Pripyat river.
[6] World Association of Nuclear Operators.

Contributor : *It can also be said that the politico-administrative organization of the Western countries, inevitably involved in the salvation of Chernobyl, wasn't very outstanding either, particularly regarding the organization of a single command. It would really be nice to avoid accumulating the perverse effects of the Russian system and those of the Western system !*

Contributor : *Everyone's pulling in his own direction, the community has its bilateral problems, the Americans weren't very concerned, too much money was given to Western industry and not enough to Russian industry, even though the latter was in a better position to act. Who are you going to choose in the end and how ?*

X. G. : It is inconceivable to exclude the local means ! And yet that's exactly where the BERD's international invitations to tender "with immediate entry" could lead ! The implementation of a joint project organization, with the partnership of the great Russian institutes and probably of Kiep (Kiev Energo Projekt), an Ukrainian engineering firm that has a sound knowledge of the local industry aims to do just that, i.e. to place the maximum services in the hands of the Ukrainians and the Russians. But they will need to be taught the basics of economics and the cost price notion, which seems possible to me.

Safety

Contributor : *Twenty years ago, we were saying that the most essential safety principle was to conceive of an intrinsically stable reactor. However, the RMBK reactors were the opposite in design, and it was well-known that they were susceptible to dangerous fluctuation phenomena. In 1975-76, some thought that the absence of a confining enclosure would be more economical and more practical for inspections and operation. The Three Mile Island accident put those thoughts back where they belong. Although it's not the answer to every scenario - we can conceive of the enclosures exploding - it's an added safety precaution.*

Contributor : *The power stations that continue to operate are still the biggest danger for the West.*

X. G. : There are other plants with RMBK reactors, and unfortunately, they won't close down tomorrow, especially those that supply St. Petersburg.

Contributor : *The RMBK plants have been improved, to the point where practically all risk of a similar accident has been eliminated. There is still the fear of the simultaneous rupture of several pressure tubes... But design is not the only potential cause of an accident, there is also the manner in which one operates the machine. If we regard science as perfect and underestimate the need for safety inspections, we end up increasing the risks remarkably. The WANO must see to it that there are finally people accountable for safety whose authority is both genuine and recognized in the Eastern countries.*

Contributor : *We shouldn't fool ourselves into thinking that safety training exists everywhere in the West : there remains a lot to do in this area, and for the first time, we feel the need to manage a crisis that is no longer local but international; on the other hand, we are not at all ready to master the unique management of such a global crisis. How do we consider the question of crisis management on an international level ?*

X. G. : Indeed, although ALLIANCE's approach, which consists of slotting itself in as adviser to those in charge may seem ambiguous in certain respects, it is actually quite clear. It really is a question of building, at the most fair cost, the most reasonable facilities possible, and only if they're necessary.

What if it were in France ?

Contributor : *What would happen if a catastrophe like Chernobyl occurred in our country ? Could we send the Marcoule firemen out to take the same risks ? I hear people say that that will never happen, but the probability must exist. What is the degree of probability ?*

X. G. : That question is more for the administration of the nuclear facilities' safety office or for the French Electricity Board. The risk of a major explosion that would contaminate half of France is ruled out though, because the reactors are confined and their design is safer. That said, measures have been taken for a worst-case scenario in spite of everything. Could we come up with the same human resources as in Chernobyl to take action immediately after such an explosion ? I'm not so sure !

Contributor : *The Americans have demonstrated their ability to take action. Certainly the Three Mile Island accident was less tragic, precisely because there was a confining enclosure in place. But a few hours after having taken note of the effects of handling errors - their seriousness was as of yet unknown - the construction teams were on site and were able to very quickly take the emergency technical measures. They also launched very large-scale operations, and there were heart attacks. If it were necessary to find heroes in democracies they would be found on the basis of voluntary service.*

It kills

Contributor : *With Chernobyl, we came to see that civil nuclear technology kills as well. Isn't it time to stop playing the sorcerer's apprentice ?*

X. G. : We need to recall other catastrophes in other industries : Minamata : one thousand dead, ten thousand handicapped ; Mexico in 1984: five hundred dead, four thousand two hundred and forty-eight wounded ; Bhopal that same year: two thousand eight hundred and fifty dead, two hundred thousand wounded, and in 1979, the bursting of the Mervi dam in India : fifteen thousand dead. Nuclear energy isn't the only source of industrial accidents. In actual fact, the chemical risk is the most serious, because it is very spread out and more lethal. That said, safety is a genuine obsession in the field of nuclear energy.

No boss ?

Contributor : *It seems to me that the authority of a recognized leader is missing in this whole matter.*

X. G. : It's true that we're not talking about a military operation with an omnipotent commander : this is a project that must be carried through to a successful conclusion. But the more complex a project is, the more rigourous one has to be, and the more reliable the organization must be, with the means to act in the long run. We need to stop all the visits to Kiev, checkbook in hand ; they're flashy, short-lived, and useless in the end.

Is the uktaine the client ?

Contributor : *According to you, we need to satisfy three conditions : a competent client who disposes of the financial means - it's difficult to give them to him - donors who can sit down and come to an agreement - a dream - and a committee that reasons completely differently - that seems very utopic. So is all that nothing but a wishful thinking ?*

X. G. : It's an awkward set-up but the people are intelligent. The TACIS team realizes that it must implement an efficient project structure in order to obtain a domino effect : it will be necessary for the countries to approve of it and to gather the income together. As there will be no command after the standard European fashion, we'll have to practise a highly developed assistance to the project owner. In the end, an Ukrainian representative will have to sign his name to it.

Contributor : *To me, the client isn't only the one who pays; he's also responsible for the result, he's got a stake in the outcome. So really, the Ukrainians are the principal clients.*

Contributor : *You're saying that the Ukraine is the client, but after listening to you, I'd think it was Framatome or Western industry, which have to renew their nuclear stations. Perhaps if it had the income, the best thing for the Ukraine would be simply to avoid water pollution. But that wouldn't suit the French at all, since they want to equip their nuclear plants. If I were Ukrainian, I'd obviously bank on that.*

Contributor : *When the client has a stake in the result and he's not the one paying, he can also raise the bidding...*

Contributor : *That's what they're doing, since they're saying : "If you want us to shut down our plant, you'll have to pay us, because we'll be without electricity as well !"*

X. G. : There are two ways to approach this : either we give the Ukrainians a check and they sort it out themselves, or we get the West to do it, we deliver, and we leave : that's what the BERD is suggesting. But there's a middle road : the donors and the Ukrainian authorities define the goals in a public debate.

A socio-political phenomenon

Contributor : *I would also like to evoke the sociological and political components of Chernobyl. The destructuring sociological impact sticks out a mile : it is absolutely abominable to be the mother of a ten year old child in Kiev right now. The slightest cold causes extraordinary concern. For a woman who is between twenty-five and thirty years old, having a baby is a question of a much different dimension after Chernobyl. It must also be said that after the explosion, in the ensuing panic, there was a great tendency to abort the foetus. These are things that deeply scarred the population.*
Politically speaking, I hear a lot about Russia, but the Ukraine exists as well, and Chernobyl helped to found its identity. The country is comparable to France, located in the center of Europe. 60 % of the population lives as in a country settled by the Russians ; all information on the Ukraine took shape within the context of Soviet discussion about the Ukraine. Over there, all pollution is experienced as a political phenomenon, it is Soviet. The Ukrainian people fought against it. It's a country with enormous potential. For the moment, however, it's been reduced to the mere role of final signatory. But through all of this humming and hawing, regarded disdainfully by

the West as though it were a sort of blackmail, there is something much more important at hand. Chernobyl is not only an economic or industrial phenomenon, it is also the birth of a new sovereign State.

Contributor : *Is it a good idea, then, to make the Russians a partner in this project ?*

X. G. : They're happy to come if the Ukrainians ask them to. But they've announced they won't put a single dollar into the project. Their skills are essential.

Contributor : *The psychological component is extremely important, and Chernobyl is an unfortunate combination of a major catastrophe with a country that was itself undergoing a very difficult transformation. There were differences of opinion among Ukrainians : some were members of an independence movement and others weren't, some in favor of the Germans and others against, the Parliament voted to shut down the reactors, then withdrew its decision. Whatever the case may be, it seems inevitable to me that the Ukrainians be the ones who decide and it is in our interest that they solve this problem : all those who have nuclear plants in the West, including the Americans, would do well to finance it, but we would need to find a financing organization, which, in my opinion, is not TACIS. As well, the Ukrainian government needs to assume its responsibilities and agree to the schedule of conditions by promising to solve the problem with the money it will receive. But aren't the Western engineers pushing for solutions that are too costly ? For countries that are lacking in every way, it wouldn't be logical to spend the money extravagantly in order to solve this problem.*

Contributor : *The Ukrainians are saying : "In Lugansk, the pollution caused by heavy metals is appalling : the entire Donetsk basin is completely polluted by garbage stockpiled on the ground. That's concrete pollution, and it's worse than Chernobyl." Furthermore, it's impossible for the Ukrainians to obtain thyroxin, which would allow for the treatment of children without surgery. The Ukrainians are trying to emphasize this type of imbalance : "You're alarmed about Chernobyl, but here it's more complicated than that !"*

Difficult negotiations

Contributor : *The advantage for the West has been clearly identified, but that of the Ukrainian representative hasn't. In order to obtain their signature, you will need to negotiate heavily with this world imbued with the Orthodox religion and very difficult for a lay-person to understand. We noticed this same negotiation problem between the Westerners and the Serbs in Bosnia.*

X. G. : We're getting to know our Ukrainian partners better, and that's also why the objectives remain vague : with them, we must cooperate in discussion and feedback so that we are able to complete the project, under conditions that they may indeed find very restricting.

Contributor : *But how are we to have them work according to Western methods while at the same time safeguarding their honor ?*

X. G. : There's only one way, that is to work together in an atmosphere of continuous dicussion and negotiation.

Contributor : *What language do you use ?*

X. G. : We speak to them in English, but they only speak Russian ! We'll have to speak in Ukrainian and Russian : all documents are in Russian, and it's the working language.

Leadership of an unclear project

Contributor : *Is there not in fact great ambiguity in this project management, because deep down we don't really know where we're starting from, nor really where we want to go. What are the differences, in organizational terms, when it comes to managing a project that's unclear ?*

X. G. : The project structure needs to be given true scientific skills, and technological skills need to be integrated into the very heart of the management - some decisions are based on purely technical advances. Very powerful tools are needed, which would, in particular, allow us to simulate the impact of the decisions being considered on the level of safety. What we really need is a model, that is to say, a representation of the project situation accessible to all those involved, that will maybe materialize thanks to data processing tools, but which will allow for a very constant and rigourous review of the situation.

Tacis

Contributor : *It's often been said, and with good reason, that TACIS served to finance many research organizations whose efficiency in the field proved to be worthless. There are said to have been many mistakes.*

X. G. : I didn't hide that fact. A standard TACIS program costs three thousand ecus and lasts six months: three months to try and find out what the issue is, one month to find references in Europe to enable them to complete a file, and two months to write it up. The risk is high that the output will be of no interest for the beneficiary. But in TACIS there are still some reliable studies done.

The scientists

Contributor : *I'm just as confused by this debate as by all that's been said about mad cow disease. Scientists give such conflicting opinions that one has to wonder what's really at stake. What is their position in the end ?*

X. G. : As far as technical and scientific analysis is concerned, this is a first, and scientists are still at the research stage with a certain number of subjects. Furthermore, it is impossible to conduct an exhaustive study of every aspect of the problem : the field is too vast, and are dealing with slowly evolving mechanisms. In order to know more, we'll have to wait ! The key is to immediately take those measures that logically have priority, and to expect to have to take others later, which are not yet obvious today. That's the technique that we have to implement.

A magic wand or a shovel ?

Contributor *: In all of this business, we are more in the presence of magical behavior than scientific behavior. So everyone gives a wave of his magic wand, yours being traditional project management. The Russians wanted to simply inject thousands of tons of cement inside to protect the ground water; you quickly dismissed that solution, but if there are no others, why not go with theirs ?*

X. G. : You're waving your magic wand too ! But I disagree with you when you say that project management is also like magic. The problem needs to be solved from the inside, because there'll be no miraculous solution from the outside. We need to head off problems with reason, skill, and gauging implements so that we're not completely lost, and then we'll take a shovel and clear away the debris. That comes about through raw courage, organization, and action.