CHERNOBYL

SOME LESSONS AND IMPLICATIONS FOR LOWER QUALITY ELECTRIC UTILITIES

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CHERNOBYL: Some Implications for U.S. Electric Utilities

Introduction and General Overview

This package of research reports speculates about some lessons U.S. electric utilities and their investors should learn from the Chernobyl nuclear power plant accident.

When considering these comments it is very important to recognize that tremendous gaps continue to exist in everyone's knowledge and understanding of fundamental facts and issues related to the Soviet disaster. On 5/14/86, in a nationally televised address to the Russian people regarding the Chernobyl accident, Mikhail Gorbachev said:

> "It is yet early to pass final judgement on the causes of the accident. All aspects of the problem -- design, prbjecting, operation and technical -- are under the close scrutiny of the Government commission."

Key questions remain unanswered, for example: what initiating event triggered the accident? How much warning, if any, did the operators have that something was going wrong? What were the maximum radiation levels monitored in the region around the plant? Where did the radioactive plume touch ground, and what groundlevel dosages were measured in that vicinity? How many members of the genera? public have been exposed to harmful dosages of radiation? What size land area has been rendered uninhabitable? The list of important unanswered questions with potential relevance to our own nuclear power program goes on.

What is clear, however, is that a large offsite release of radioactive material resulting from an accident at a nuclear power plant no longer is merely an abstract concept. The proverbial "low probabi 1itylhigh consequence" accident now has happened at Chernobyl , and we would argue that the world has been changed as a result.

-About 30 people have died and perhaps several dozen others are in danger from radiation sickness caused by a nuclear power plant accident -- it is widely believed that these are the first such civilian nuclear power fatalaties.

-In addition to these early deaths, a far larger number of individuals have probably been exposed to radiation dosages of sufficient size to cause thyroid problems, immune system breakdowns, latent cancers and other adverse health effects.

-By Soviet reports, over 90,000 people have been evacuated out to a distance of about 20 miles from the Chernobyl site due to high radiation levels in the area -- it is not clear when, if ever, it will be sufficently safe for all of these people to return to their homes.

-Beyond the Soviet Union, the effects of the Chernobyl accident touched the daily lives of hundreds of millions of private citizens--

The point of listing these developments is to illustrate that Chernobyl is an accident with global dimensions.

-The great distances over which radiation from Chernobyl traveled will create a new and lasting impression for many people about the far-reaching consequences that can result from a large accident at a nuclear plant.

-The international community is shocked and outraged that the Soviets provided no warning that the accident was spilling large amounts of radioactive material into the environment and across national boundries.

-The Polish government warned its citizens to avoid drinking milk because of contamination by radioactive iodine from Chernobyl. Also, Polish children were given potassium iodide to block absorption of radioactive iodine by the thyroid.

-West Germany was hit hard by the radioactive plume from Chernobyl -- expecially in the southern parts of the country. There was political fallout as well, when Chancelor Kohl (who was perceived by the voters as too pro-nuclear) just squeaked by in an election in Lower Saxony.

-Great Britain banned the importation of lamb from farm areas hit by radioactive rain.

-The Italian government banned the sale of leafy vegetables and advised that children should not be allowed to drink fresh milk in order to reduce the risk of health hazards.

-European Community countries agreed to ban imports of fresh food products from Eastern European countries in order to avoid dangers from radioactive contamination from Chernobyl.

-While the lives of Ukrainians living near the reactor have been in danger in the days following the start of the accident, thousands of their relatives watched on their living room TV sets in the U.S. Fallout from the accident was measured in trace amounts in U.S. rainwater.

-Throughout the world, plans for expansion of nuclear power have been put on hold, and may be abandoned in some cases due to increased public concerns about nuclear safety following Chernobyl.

We expect many more details about the accident will come *out* in the months and years ahead. Based upon what we know today, however, our assessment is that the worldwide nuclear enterprise will be permanently scarred. We hope that the abundance of misinformation and confusion that have characterized the circumstances surrounding the Chuernobyl accident will give way to a clearer understanding of the lessons to be learned from this tragedy. If insufficient effort is made by the U.S. nuclear industry, its regulators and others to learn these lessons, we would argue that an opportunity will have been lost to reduce both the likelihood and severity of future accidents.

The remainder of this report contains a series of discussions pertaining to Chernobyl and some lessons that apply to U.S. electric uti1ities.

Lessons from Chernobyl: Reactor Containments

This is intended to clarify and interpret erroneous, conflicting, and currently incomplete information about two issues related to containment structures around reactor vessels:

1) The Chernobyl 4 reactor appears to have some containment features, NRC Commissioner Asselstine has testIfied before Congress that the cement wall around the Soviet reactor essentially was a containment structure that was stronger than those surrounding some **U.S.** nuclear plants. This **is** in direct conflict with widely reported accounts of the accident.

-For example, a 5/12/86 Time Ma azine cover story stated that the Chernobyl " c a t a s t r o p e a g i n a b l y worse than the 1979 partial meltdown at Three Mile Island, where a containment building kept most radioactive material from escaping out of the plant. The Chernobyl unit, **by** contrast, lacked such a protective structure." (emphasis added)

-Appended to this Research Note **is** a copy of the NRC staff response to the Commission question "what do we know about Russian practice regarding safety features such as containment vs. confinement?" The **NRC** staff response includes three schematic drawings showjng evidence of Containment features around the Chernobyl reactor core.

--NRC and other federal agency staff were subsequently instructed not to talk about the accident. A memo to NRC staff was distributed to convey this instruction.

2) There seems to be a general perception that containments around **U.S.** commercial reactors are designed to withstand large accidents including core meltdowns and steam explosions. This simply **is** not true **--** the containment design basis assumes that the emergency core cooling system will effectively cool the radioactive fuel following a loss of coolant accident. In other words, there exists a widely held view that containment structures provide a greater margin of safety than is probably the case.

Following is a more detailed discussion of Chernobyl and **U.S.** Reactor containments prepared with the assistance of Dr. Victor Gilinsky, a consultant to DLJ on nuclear matters. Dr. Gilinsky was a two-term commissioner of the **NRC,** and former head of the Physical Science Department of the Rand Corporation.

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The Chernobyl accident has focused attention on a salient difference between U.S. commercial nuclear power plants and those in the Sovjet Union: U.S. reactors are enclosed in "containment" structures designed to prevent release of radioactivity. This is frequently cited as the reason why "it can't happen here". Closer examination shows that while the containments around U.S. power reactors are very valuable safety features, some are much better than others, and it is unclear whether all of them would remain intact in the worst types of accidents -- say, roughly comparable to the one at Chernobyl. The containments are not designed to cope with such accidents.

The NRC requires that the containments be designed to hold in the event a large pipe rupture, releasing and vaporizing the tens of thousands of gallons of water in the reactor cooling system. The resultant steam pressure determines the required size and strength of the containment. It is also required to be reasonably leak-tight over a long period of time. In reviewing how the containment would perform in an accident, however, the NRC assumes that the emergency cooling system works properly and prevents significant fuel damage. This means the containment is not required to cope with emergency cooling failure and consequent fuel overheating and melting.

No one really knows what would happen in these circumstances. Nuclear safety studies generally assume that if the roughly 100 tons of fuel melted, it would melt through the steel reactor vessel in about an hour, fall to the containment floor, and probably eat its way through to the ground.in a day or *so.* This is the so-called "China Syndrome". Optimistic studies conclude that even then, in most cases, the radioactivity would not get to the air, but that is not at all clear. Another worry is that the molten fuel falling on the water-covered containment floor might create dangerous splattering -- a "steam explosion" -- which might burst the containment.

The NRC rationalizes the disregard of fuel melt accidents in licensing nuclear power plants on the grounds that these accidents have been calculated to be so improbable that they need not be considered. Actually, containments of early, small power plants were counted on to hold the radioactive products in an accident -- come what may. Then, in the mid-1960'~-the safety advisors to the Atomic Energy Commission (the NRC's predecessors) discovered that containment design had not kept pace with the larger nuclear reactors then being ordered -- a melted fuel inventory from such a reactor would likely breach its containment. After some handwringing, the safety approach was adjusted: more emphasis was put on emergency core cooling and less on containment. And, accidents in which the emergency cooling failed were ruled out of **bounds** for the licensing process. Opposition groups were not permitted to litigate such issues.

It has since come to light that a substantial fraction of the TMI-2 fuel reached melting temperatures, but that has not altered the basic licensing approach toward containment design except in one limited respect. Some protection is now provided against accidents which overheat the fuel rods but stop short of melting the fuel itself. When the overheated TMI-E fuel sheathing (made of zirconium) reacted with steam, several hundred kilograms of hydrogen were formed. This escaped to the containment and ignited, raising the pressure by about 30 pounds per square inch. Fortunately, the relatively large TMI-2 structure, as that of most U.S. pressurized water reactors, was designed for about 50 psi. A number of reactor containments, however, are about half the standard size and designed to only about 15 psi. These include 10 of the Westinghouse "ice condenser" type -- which use buckets of shaved ice to condense accident-produced steam; they also include about an equal number of the General Electric Mark III type -- which use water pools for the same purpose. Had the hydrogen burn taken place in one of these, it is uncertain whether the containment would have held. Moreover, had the hydrogen combustion taken the form of a nearly instantaneous explosion rather than a fast burn, the pressures would have been much higher.

In view of the foregoing, the NRC has required the "ice condenser" plants and the GE Mark III's to install "glow plugs" to burn off hydrogen as it is formed in an accident to prevent accumulation of dangerous quantities. The systems are not automatic -- they have to be activated manually in the event of an accident. These hydrogen problems have been dealt with in the case of the older Mark I and II GE designs by operating those plants with a nitrogen (that is, oxygen-free) environment in the containment.

> -Interestingly, a similar approach was used in the Chernobyl-type reactors: the Soviet reactor was enclosed in a steel jacket filled ,with a helium-nitrogen mixture. Why this failed to provide protection against hydrogen detonation -- if that is what happened at Chernobyl -- is unclear.

What does this add up to? The containments around U.S. plants are valuable protection for all types of accidents. Their functioning in the worst kinds of accidents (as bad as the one at Chernobyl in which large amounts of fuel melts), however, is not assured and not checked as part of the licensing process. It is unclear at this point whether the explosion believed to have taken place at Chernobyl, stated by Mr. Gorbachev to have come from a sudden power surge followed by a hydrogen detonation, would have been contained by a U.S. type of containment. Among the U.S. designs, the standard large pressurized water reactor containments are superior. The others are decidedly weaker.

APPENDIX

Following is the NRC staff response, including several drawings, to the Commission question regarding whether or not Chernobyl had a containment.

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QUESTION C,4. WHAT DO HE KHOH ABOUT RUSSIAN PRACTiCE REGARDING SAFETY FEATURES SUCH AS CONTAINMENT VS. CONF 1NEMENT?

ANSWER.

UNIT 4 AT CHERNOBYL CONTAINS CHARACTERISTICS OF BOTH CONTAINMENT AND CONFINEMENT. THERE ARE TWO REGIONS THAT APPEAR TO BE DESIGNED TO WITHSTAND 27 PSI AND 57 PSI. THESE VOLUMES ARE IN TURN INTERCONNECTED WITH TWO SUPPRESSION POOLS VIA PRESSURE RELIEF VALVES AND DOWNCOMERS. THE REMAINING PORTIONS OF THE PLANT ARE HOUSED WITHIN A CONFINEMENT STRUCTURE. FOR PURPOSES OF THIS DISCUSSION, THE CONFINEHENT BUILDING CAN BE CONSIDERED AS A FILTRATION SYSTEM WITH LITTLE OR NO PRESSURE RETENTION CAPABILITY.

THE FIRST CONTAlNMENT REGION, REFERRED TO AS THE REACTOR VAULT. IS SHOWN IN THE ENCLOSED FIGURES, IT SURROUNDS THE REACTOR AND PORTIONS OF THE INLET AND OUTLET WATER PIPING, THE DESIGN PRESSURE IS ,18 MPA (27 PSI). AT LEAST TWO RELIEF VALVES CONNECT THIS REGION TO THE SUPPRESSION POOL(S). THE SETPOlNT OF THESE VALVES IS .02 MPA (3 PSI). ENCLOSED PIPING CONSISTS OF RELATIVELY SMALL DIAMETER (].E,, 6 INCH DIAMETER) TUBING ?HEREBY ELIMINATING THE NEED FOR A HlGHER DESIGN PRESSURE.

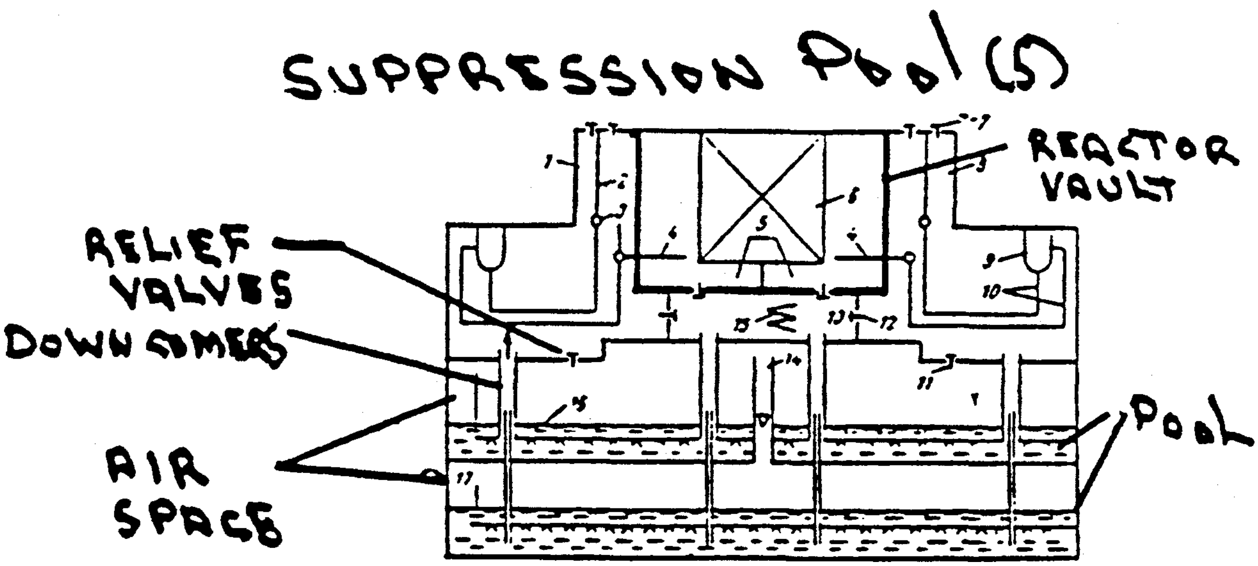
RUSSIAN EVENT/ITT
05/05/86

QUESTION C.4. (CONTINUED) - 2 -

THE SECOND CONTAINMENT REGION ENCLOSES THE MAJOR DIAMETER PIPING AND HEADERS OF THE SYSTEM. THE LARGEST PIPE IN THIS VOLUME IS 90 CM (35 INCH) IN DIAMETER, THE BOUNDARY OF THE ENCLOSED VOLUME IS SHOWN IN THE ATTACHED FIGURE. THIS REGION HAS A DESIGN PRESSURE OF .35 MPA (57 PSI). DOWNCOMERS CONNECT THIS REGION TO THE SUPPRESSION POOLS. THE SUPPRESSION POOLS ARE ARRANGED ONE ON TOP OF THE OTHER, AS SHOWN IN THE ATTACHED FIGURE. EACH POOL REGION IS APPROXIMATELY ElGHT FEET HIGH WITH A POOL DEPTH OF ABOUT 4 FT.

WE ARE NOT AWARE OF ANY OVERHEAD SPRAY SYSTEMS OR DYNAMIC COOLlNG SYSTEMS INSIDE OF THE CONFlNEMENT BUILDING SIMILAR TO THOSE USED IN U.S. LWRs,

RUSSIAN EVENT/ITT
05/05/86



Pig. 1 Schematic diagram of 8ar–tl)ht box: 1, 8—88r–right box (emergent cl aon–emergency balvcr reapecrivrly); 24ovnco~lerlines; 3—colltctorr c MAIN tirtuhtlng p—r; 24ittriburing group collrctort; 5—lwtr water 1: soorpartmar; 6—rerccor; 'I—slfcty valve; WiLI circulating pump; lO—~a: clreuhtixq pmp lines; 11—bypanr valvc; 12—check vdvc panel; 13--1over water line check valve; 14—uvtrflou tube; 15—8urf~cerypc heat cxchangcrr l6—8tum dump lines follovlng main rrfety valve#; 17—bubbler tank

REACTOR VAULT

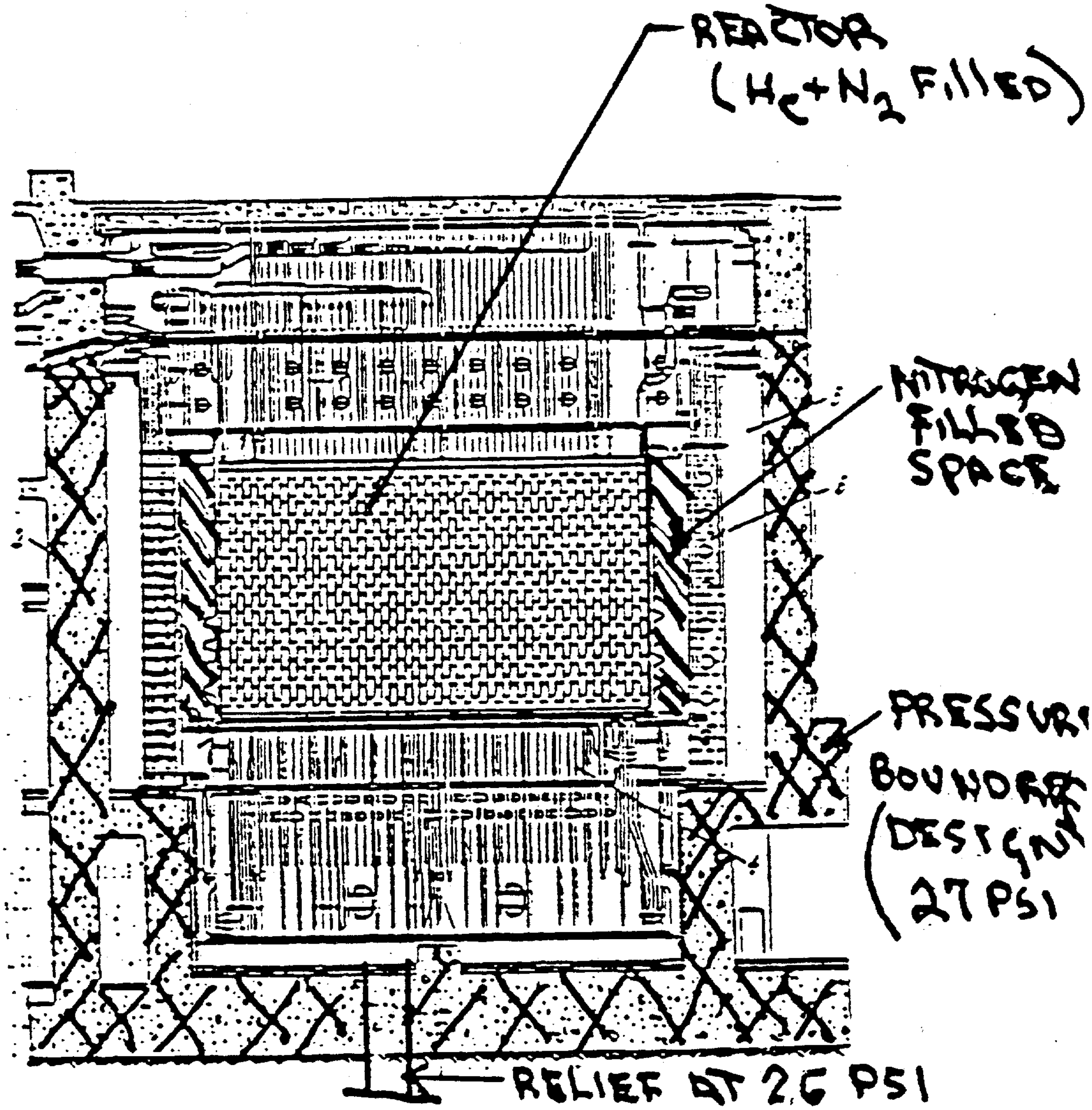


Fig. 3 Cross-sectional view of an RBMK-1000 reactor station building (reactor shaft) 1—steel blocks; 2—ordinary concrete; 3—iron-barium-serpentinite-cement block; 4—serpentinite; 5—sand; 6—water

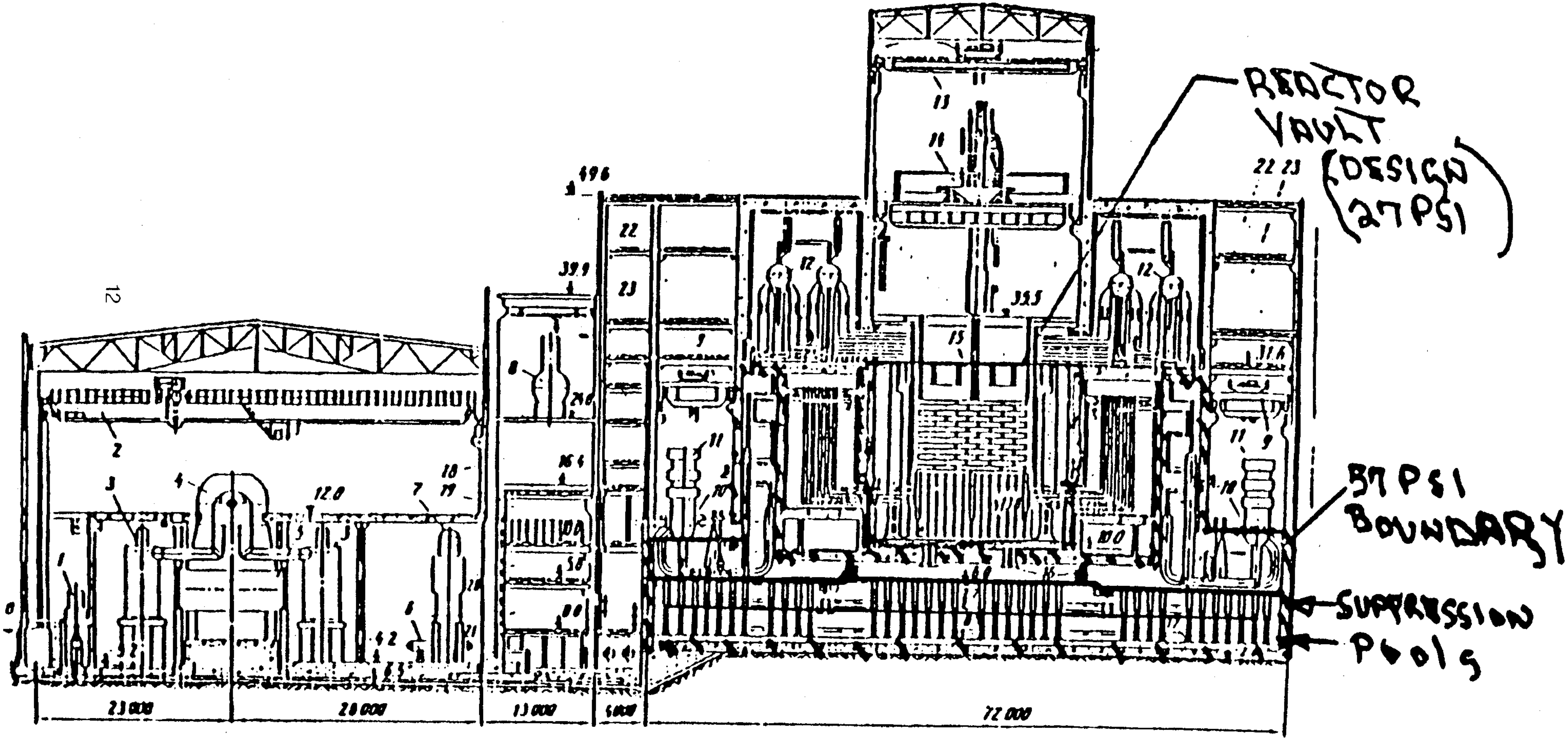


Fig. 2. Cross-sectional view of the main building at Smolensk

1 – first stage condensate pump; 2 — 125/20 t overhead travelling crane; 3 – separator-steam superheater; 4 — K-500-65/3000 steam turbine; 5 – condenser; 6 — additional cooler; 7 — low-pressure heater; 8 – deaerator; 9 – 50/10 t overhead travelling crane; 10 – main circulating pump; 11 — electric motor of main circulating pump; 12 — drum separator; 13 — 50/10 t remotely controlled overhead travelling crane; 14 — refueling mechanism; 15 — RBMK-1000 reactor; 16 — accident containment valves; 17 – bubbler pond; 18 – pipe aisle; 19 – modular control board; 20 – location beneath control board room; 21 – house switchgear locations; 22 – exhaust ventilation plant locations; 23 – plenum ventilation plant locations

The Chernobyl Accident Sequence

(This Research Note was prepared with the assistance of Or. Victor Gilinsky, a consultant to DLJ on nuclear matters. Dr, Gilinsky was a two-term commissioner of the NRC, and former head of the Physical Science Department of the Rand Corporation.)

Here are our best thoughts on the accident scenerio. First: there were indications -- and the Soviets have referred to it -- that experiments were going on at the plant. Odd radioactivity readings were apparently picked up in Finland and Italy a day or two before the accident-affected clouds appeared. These precursors may have had something to do with these experiments. What these were, the Soviets aren't saying. If they had something to do with plutonium production, we are not likely to learn more. In fact, if the Soviets continue to stay mum, we can guess that that is the case, or at least that important reputations are involved. (One senior Soviet official remarked: "physicists should be kept out of reactors.")

Second, there was apparently some manipulation of the control rods going on at the time. There has been some reference to operator error and failure to follow rules. Someone made a comment about an operator putting a control rod too far in, getting an unfavorable neutron flux pattern, and overcompensating. Maybe that drove things haywire.

It is possible that safety systems were disabled in connection with the experiments.

The Chernobyl reactor looks difficult to control. There are alot of things to keep track of in all the fuel channels and we would guess they have to make pretty complicated reactivity calculations every time they make changes in the fuel pattern. The controls appear fairly heavily automated. Perhaps the computers let them down.

The Soviets do not apparently use full scram unless they are absolutely forced to, and rely instead on local control rods. Thls may have figured in, too.

In any case, the Soviets also report, the reactor went from 6% power -- this is thermal power, so it was essentially at hot standby -- to 50% in ten seconds. This is apparently the power surge referred to by Gorbachev. With refueling going on, the refueling machine would have been positioned over the core. One way or another, the rapid increase in power, if it did not itself blow the top of the reactor off, must have burst cooling pipes, wrecked a good deal of equipment and led to the subsequent phases of the accident. Soviet engineers interviewed in the Moscow hospital insist that there was no warning before the first explosion.

-An "automatic control operator" was supposed to be one of the two early deaths.

-The Soviets also let drop the comment that they didn't think they could get into such trouble at low power. They thought the 100%power safety analysis bounded the possibilities.

With pipes bursting, water would flash to steam. We believe the graphite moderator would have been hot enough -- about 600 degrees C -- to combine with steam to form hydrogen. At these temperatures you get:

graphite + steam ---> carbon dioxide + hydrogen

If the cooling was interrupted by the equipment failures tied to the power surge, then the zirconium cladding would heat, interact with steam to form more hydrogen (and releasing energy). At higher temperatures, you also get graphite combining with steam to form hydrogen and carbon monoxide, both combustible.

In order to get a detonation, however, you need oxygen. **How** that enters is not clear. There does not seem to be any oxygen inside the reactor -- it is supposed to be inerted with helium and nitrogen. ***So,*** the first hydrogen explosion probably took place outside the reactor, after a sufficient amount of hydrogen has leaked into the reactor building. (Alternatively, the reactor may not have been inerted during the experiments.)

Here things get fuzzy. The hydrogen explosion in the reactor building could have blown the roof off, but we would be surprised if it also blew the heavy side walls down. This would likely have occurred through an explosion in one of the side compartments (next to the side walls) that form part of the Soviet reactor's containment. Anyway, something knowcked the side walls above the reactor down. The way we know this is that the steam separators can be seen from the air through the hole in the roof, and these would normally be blocked from view by the side wall.

The side walls held up the several hundred ton refueling machine and when the walls failed the refueling machine came crashing down on the reactor cover. If the reactor had not been broken down at this point, then the collapse of the refueling machine would likely have **done** It.

The graphite would then have caught fire. Incidentally, the fire seemed to be concentrated on the periphery **of** the core which suggests that is where the trouble started. The fire in the rest of the reactor building structure would not likely have come from a hydrogen explosion, but if hot metal splattered from the reactor, that could have started fires all over.

We have to say, that the latter part of this scenerio still is not very clear, but its the best we have.

What does it mean for us? We would say this scenerio points to an accident that is tied closely to the particular equipment the Soviets were using -- the special reactivity problems, the graphite, and so on. In a larger sense, Chernobyl is an example of how things can go wrong in power reactors designed and operated by (presumably) competent persons. It has to give us pause. And, just as when you are driving along and see a bad wreck, the prudent thing to do is check your speedometer and seatbelt.

Lessons from Chernobyl: Long-Term Resource Contamination

(This Research Note was prepared with the ass stance of Dr. Victor Gilinsky, a consultant to DLJ on nuclear matters. Dr. Gilinsky was a two-term commissioner of the NRC, and former head of the Physical Science Department of the Rand Corporation.)

Chernobyl is likely to bring to the fore two nuclear safety questions which until now have gotten negligible attention: how large an area around a serious reactor accident is rendered unusable? And, for how long?

Up to now, the issues related to the consequences of a large nuclear power plant accident have been framed in terms of health effects -- how many persons might die immediately and later -- and whether such consequences could be avoided through evacuation. But even if major casualties are avoided, what happens to the surrounding towns and farmland after the radioactive clouds clear away?

The amount of radioactive material that actually falls on the area surrounding the reactor -- as opposed to being dispersed at great distances -- depends sensitively on the details of the accident and weather patterns. It is difficult to say much about this without knowing more except that the fierce fire at Chernobyl would likely have produced a chimney effect and sent radioactive products higher and further away than otherwise. We will just have to wait and see what dropped within, say, a hundred kilometers -- that is, if the Russians will tell us.

In the immediate aftermath of the accident, the most worrisome nuclear component is radioactive iodine. Probably much of the iodine which was in the Chernobyl was released. As the reactor was operating, the inventory could have been in the tens of millions of curies (a standard measure). Such a release -- say, 10 million curies -- wuld be about a million times greater than the radioactive iodine release during the 1979 Three Mile Island accident. To put it another way, imagine depositing that amount uniformly over an area 100 kilometers (60 miles) on a side. This is not very realistic because deposition is likely to be uneven, but it gives us an idea of what could be involved. Persons who remained in that area would receive initially about 1 rem per week, or several hundred times the background level. This would prevent the use of the area for a time. The iodine dose would be cut in half about every 8 days (the half-life of iodine-131) and so would be negligible in a few months.

-A release 1/10 this size -- say, 1 million curies -- similarly affect an area about 30 kilometers on a side (about 20 miles), or roughly 400 square miles.

The long-term situation is less favorable for some other radioactive isotopes. If temperatures in the thousands of degrees were reached at Chernobyl, very likely a significant fraction of the radioactive cesium in the core was released. This could amount to about a million or more curies. The same assumption about depositing this material over an area 100 kilometers on a side results in a ground dose initially about one-tenth of that obtained for iodine -- about 0.1 rems per week. The difference is that the half-life of cesium-137 is about 30 years so that it would persist for decades, which from a practical point of view means indefinitely. A person who lived in the area -- which would cover 10,000 square kilometers or 3,600 square miles --- would receive about 5 rem per year, or the maximum allowed occupational dose for U.S. reactor workers. This is clearly unacceptable for a general population and anything in this range would have to be abandoned. It would be impractical to try to clean up anything of this magnitude.

-As before, a release 1/10 this large -- that is 100,000 curies -- would produce the same effect over a smaller area (hundreds instead of thousands of square. miles). Alternatively, the smaller release would produce a lower dose -- roughly 0.5 rem per year -- over the same area, i.e. over 10,000 square kilometers or 3600 square miles. This would still be equal to the typical occupational dose, which is high for a general population.

It is unclear what would be an acceptable increase to background dosage for. continued habitation and use of agricultural land, but it would clearly be much less than a dosage that directly threatened health. By comparison, the maximum routine doses from the normal operation of power reactors are about 10 millirem per year for someone living right next to a power plant -- 1/50 of the figure for the smaller release referred to abovee. The reality of the Soviets facing the prospect of abandoning land and towns would add a new dimension to the arguments over use of nuclear power plants in the U.S.-

-Imagine Governor Cuomo and other Shoreham opponents speculating about the implications of the forced abandonment of hundreds of square miles on Long Island for a period of years. It probably won't be tong until we start hearing such comments.

To repeat, the examples above are not realistic in that we do not know what fraction of the radionuclides are being deposited in the genera4 area of the Chernobyl accident and any deposition is bound to be nonuniform. Nevertheless, the examples are instructive in that they demonstrate the dimensions of the problem.

Chernobyl: Congressional hearings and State Government Reviews

Congressional hearings scheduled--

--5/30/86, the House Interior Committee announced the scheduling of five hearings on nuclear policy issues. The orientation of the hearings reflects a heightened level of public concern about nuclear safety in the wake of the Chernobyl accident. The Committee's hearing schedule is as follows:

* ***6/5/86*** - a description of the Chernobyl accident and its consequences.

* **6/10** and **6/17/86** - the implications of the Chernobyl accident upon nuclear development in the U.S.

* **6/19** and **6/26/86** - proposals for nuclear legislation including reform of the nuclear licensing process, establishment of a Nuclear Safety Board, conversion of the NRC to an agency directed by a single administrator, and establishment of an Inspector-General's office within the'NRC.

--We expect several other House and Senate committees to convene oversight and legislative hearings in the weeks ahead for the purpose of gathering information about the Chernobyl accident, and considering changes in U.S. nuclear regulatory policy.

State Government Review-

-Massachusetts' Governor Dukakis has chosen Dr. Albert Carnesale of Harvard's Kennedy School as special advisor on the implications of Chernobyl for Seabrook. Recall that following the Soviet reactor accideent, Dukakis suspended the participation of Mass. in Seabrook emergency planning pending a thorough review of the lessons of chernobyl. In **1980,** Carnesale was nominated by President Carter to be an NRC commissioner -- he was never confirmed by the Senate.

--Our expectation is that after some handwringing, Carnesale will find little, or no implications for Seabrook. Dukakis' fact-finding mission, however, is likely to delay initial commercial operation of Seabrook. The Joint Owners will be lucky to have the unit in service before **1988.**

-New York's Governor Cuomo has charged Or. David Axelrod, chairman of the New York State Disaster Preparedness Commission, to "reassess the validity of assumptions which have been the basis for existing requirements... " at nuclear plants.

Lessons from Chernobyl: NRC is being forced to answer questions that might otherwise have been ignored.

5/22/86, during a congressional hearing, and for the first time since 1980, the NRC commissioners were forced to go on record and express their views on the "best" and "worst" commercial reactors now operating in the U.S. The Commission had abandoned the practice of ranking operating performance on a reactor-by-reactor basis in 1980 in large part because it created hassles for them --

--e.g.: questions were raised about whether or not the agency was sufficiently rigorous in regulating the poorer performers; also, the industry vigorously objected to the existance of hit-lists that could be used by anti-nuclear groups as evidence that some reactors might not be sufficiently safe.

It seems likely to us that the Commission would not have agreed to such a listing of the best and worst nuclear units, had it not been for Chernobyl and the resultant refocusing of public and congressional attention on nuclear safety issues. Presumably, the electric utility industry will seek to have the NRC refrain from public disclosure of any future lists -- short of that, the industry will probably point out the flaws inherent in what is admittedly a subjective ranking system. Nevertheless, with the 5/23/86 "New York Times" story, the cat is out of the bag.

At the 5/22/86 hearing before the Subcommittee on Energy Conservation and Power, the commissioners were asked to name the "best" and "worst" reactors among the 101 facilities currently licensed to operate in the U.S. The reactors and licensees named by the commissioners are listed below.

The "Best" Units

REACTOR:	LICENSEE:
-McGuire	-Duke Power Co.
-Oconee	-Duke Power Co.
-Catawba	-Duke Power Co.
-Millstone	-Northeast Utilities
-Farley	-Alabama Power Co.
-Monticello	-Northern States Power Co.
-Prairie Island	-Northern States Power Co.
-Kewaunee	-Wisconsin Electric Power Co.

The "Worst" Units

REACTOR:	LICENSEE:
-Sequoyah 1 & 2	-TVA
-Browns Ferry 1, 2 & 3	-TVA
-Rancho Seco	-Sacramento Muni. Util. District
-Fort St. Vrain	-P. S. Co. of Colorado
-Pilgrim	-Boston Edison Co.
-D. C. Cook 1 & 2	-Indiana & Michigan Electric Co.
-LaSalle 1 & 2	-Commonwealth Edison
-Turkey Point 3 & 4	-Florida Power & Light Co.
-Davis-Besse	-Toledo Edison Co.
-Fermi 2	-Detroit Edison Co.
-Oyster Creek	-Jersey Central Power & Light

We offer the following thoughts pertaining to these lists-

-The rankings above represent the "off-the-cuff" thinking of individual commissioners rather than a Commission view -- as the individual commissioners submit written clarifications of their oral statements, we would expect to see the list modified and the "best" and "worst" distinctions watered down. Nevertheless, the list is a useful first-cut at differentiating between the good and not so good nuclear utilities.

-The fact that Florida Power & Light and Boston Edison are regarded to be among the poorest nuclear operators by the NRC commissioners may be out of line with investors' opinions of the companies -- both are "AA" credits.

-It is somewhat surprising that Commonwealth Edison is included on the "worst" list (for LaSalle 1 & 2) because the Company has more installed nuclear capacity and operating experience than any other nuclear utility which should place CWE further up the learning curve.

-It is troublesome that Rancho Seco, Davis-Besse and Oyster Creek have been included in the "worst" list because the licensees for these units should have been among those who learned the most from the accident at Three Mile Island -- Rancho Seco and Davis-Besse are Babcock & Wilcox reactors of similar design to TMI, and Oyster Creek is operated by General Public Utilities (the operator of TMI).

-The TVA reactors are relatively easy targets for NRC criticism because they are owned by the federal government, and essentially are outcasts from the brotherhood investor-owned electric companies. Fort St. Vrain also is any easy target for the NRC because it is a demonstration reactor (high-temperature gas-cooled) that is not particularly popular with the nuclear industry.

-Inclusion of Fermi 2 on the "worst" list seems a little unfair because the reactor has never operated above 5% power. If NRC is going to rank start-up testing performance, we suspect other units should be mentioned for having below average experiences such as River Bend and Palo Verde.

--It is probably more accurate to characterize Fermi-2 as a project that went through construction quite well, and based upon that background, has had a disappointing start-up testing experience -- which indicates the need for closer scrutiny by NRC than there had been before problems emerged in 7/85.

-Finally, it is important to recognize that any ranking of reactor operator performance is at least somewhat subjective. Prior to the 1979 accident at Three Mile Island, Metropolitan Edison was considered by NRC to be an "average" nuclear utility.

Lessons from Chernobyl: Is the U.S. nuclear industry too smug?

We are concerned by the tone and content of much of the U.S. nuclear industry's reaction to the Chernobyl accident. Public statements by industry officials have included assertions that Soviet technology is so different from commercial reactors in this country that the causes and consequences of the Chernobyl accident have little relevence to the U.S. situation.

-The 4/30/86 "Wall Street Journal," for example, quoted the president of New Hampshire Yankee as saying the Chernobyl facility and Seabrook have very little in common and comparisons shouldn't be made. (NH Yankee is the division of Public Service Co. of New Hampshire responsible for the Seabrook plant).

-Robert Szaley, vice president of the Atomic Industrial Forum told "Newsday" on 4/30/86, "the event that occurred in Russia has little bearing on the probability of an accident in the United States."

-Lilco's vice president for public affairs was quoted in the 5/2/86 edition of "Newsday" saying that given the differences between the Chernobyl and Shoreham designs, the Soviet accident "should have no significant impact" on the licensing of Shoreham.

-The chairman of Southern California Edison wrote the following in a 5/1/86 letter to the Company's employees:

> "Many of you, your family, friends and neighbors are no doubt concerned with the events which have occurred the past few days at the Chernobyl nuclear power plant in Russia. We take comfort in knowing that such an accident could not happen at commercial power plants such as ours at San Onofre or Palo Verde. The Soviet plant has a completely different design from outs, and lacks barriers and 'defense in depth' that we have in our American commercial nuclear units."

There is no question that significant differences exist between U.S. and Soviet power reactor technology and regulation. But, by Mikhail Gorbachev's own admission on 5/14/86, "it is yet early to pass final judgement on the causes of the accident." Premature assertions by the U.S. industry that Chernobyl has little significance for U.S. nuclear plants erodes our confidence that the industry will make a sufficient effort to learn the lessons of the Soviet accident.

Our nuclear industry's motives are easy to understand as it attempts to distance itself from the circumstances surrounding the

Chernobyl accident. Many nuclear utilities in this country are under severe financial strain due to nuclear construction projects that are substantially behind schedule and over budget. There is a natural tendency among these companies to minimize additional delays and costs by highlighting the differences between U.S. and Soviet reactor technology. We would argue, however, this is a short-sighted approach which might waste an opportunity to learn lessons that could help reduce the probability of a large nuclear accident in this country. Keep in mind that NRC-sponsored research indicates there is about a 50% chance of a core-melt accident somewhere in the U.S. during the next 25 years.

The nuclear industry mind-set that the Chernobyl accident "cannot happen here" is troublesome because it seems to ignore a key lesson from Three Mile Island. Perhaps the most fundamental conclusion reached by The President's Commission on the Accident at Three Mile Island (the Kemeny Commission) in its 1979 report to President Carter was:

> "To prevent nuclear accidents as serious as Three Mile Island, fundamental changes will be necessary in the organization, procedures, and practices -- and above all -- in the attitudes of the Nuclear Regulatory Commission and, to the extent that the institutions we investigated are typical, of the nuclear industry."

The Kemeny Commmission found the prevailing attitude within the nuclear utility industry at the time of the TMI accident was that large reactor accidents will not occur and that nuclear power plants are sufficiently safe. This attitude was not acceptable to the TMf investigators, who concluded:

> "The (Kemeny) Commission is convinced that this attitude must be changed to one that says nuclear power is by its very nature potentially dangerous, and, therefore, one must continually question whether the safeguards already in place are sufficient to prevent major accidents."

As the gaps are filled in everyone's knowledge and understanding of fundamental facts and issues related to the Soviet disaster, the implications for the U.S. industry may have relatively little consequence. Today, however, that judgement cannot be reached based upon the incomplete assessment of Chernobyl being conducted by technical experts around the world. By jumping prematurely to conclusions regarding the significance of the Chernobyl accident, the utility industry runs the risk of eroding public confidence in the nuclear enterprise.

In a rush to downplay the importance of Chernobyl, the industry may be missing, or misreading key aspects of the accident. Evidence of this is contained in a 6/2/86 letter to the editors of the "New York Times" entitled "Don't Let Chernobyl Cripple U.S. Nuclear Industry." The letter was written jointly by Linn Draper (president of Gulf States Utilities), Edwin Zebroski (a nuclear scientist with the Electric Power Research Institute), and Richard Wilson (a professor of physics at Harvard). Following is a critique of the letter. The letter is printed as an appendix to this Research Note.

-The Draper/Zebroski/Wilson letter never mentions explosions, which arguably are the chief feature of the Chernobyl accident.

-With regard to reactor containments, the question to ask is whether U.S. containments would have withstood a hydrogen explosion comparable to that which occurred at Chernobyl. As we noted in an earlier section of this report, containments around U.S. reactors are not required to cope with emergency core cooling failure and consequent fuel overheating and melting.

-Incredibly, the letter describes the accident as slow-moving, "which allowed time for an unrehearsed, but orderly evacuation." Even the Soviets have said the accident happened suddenly and have expressed criticism of the delay in evacuation -- in fact, by the Russians' own account, the delay in evacuation was nothing short of scandalous.

-Finally, Draper, Zebroski and Wilson seem to suggest that we ought to be thankful that the dose in Sweden was not alot higher than it was ("than might have been feared"). We wonder if they understand that they are acknowledging that a reactor accident can have significant consequences 800 miles away.

To close this discussion of whether or not the U.S. nuclear is being too smug in its response to the Chernobyl accident, we refer again to the words of the Kemeny Commission in its report on the 1979 accident at Three Mile island.-

> "We have stated that fundamental changes must occur in organizations, procedures, and above all, in the attitudes of people. No amount of technical "fixes" will cure this underlying problem. There have been many previous recommendations for greater safety for nuclear power plants, which have had limited impact. What we consider crucial is whether the proposed improvements are carried out by the same organizations (unchanged), with the same kinds of practices and the same attitudes that were prevalent prior to the accident. As long

> as proposed improvements are carried out in a 'business as usual' atmosphere, the fundamental changes necessitated by the accident at Three Mile Island cannot be realized."

Much of the industry response to date to the Chernobyl accident suggests that one of the most important lessons from TMI has been forgotten, or was never fully learned.

Letter to the Editor of the "New York Times"

TUESDAY, JUNE 3, 1986

Letters

Don't Let Chernobyl Cripple U.S. Nuclear Industry

To the Editor:

With regard to your May 19 front-page report that the Chernobyl nuclear reactor had more safety features and was closer to American design than was assumed immediately after the plant accident, we would like to make it clear that we are *not* among the "experts" who have changed our minds about the structure of the Chernobyl reactor. We have had accurate information and have been attempting to describe it to the public and the press.

The Chernobyl reactor has no containment in the sense we and other safety analysts in the U.S. use the word. In ordinary operation, the core and graphite moderator are confined behind barriers and covered by an inert nitrogen gas; but these barriers can be easily breached as they clearly were on April 26. The difference between confinement under favorable circumstances and containment under unfavorable ones is crucial.

In commercial U.S. reactors, there is a large, strong, tested containment structure designed to withstand the rise in pressure for days in case of accident. It should hold in the event of fire and station blackout, which appeared to be the problem at Chernobyl.

The Chernobyl reactor is of the RMBK 1,000 type, the most easily available drawing of which is for one built at Leningrad. But we recently learned that the accident at unit 4 at Chernobyl took place in a reactor where a pressure-suppression pool had been added under the reactor, as well as strong structure around the steam collectors and headers. This should reduce pressure rise in case one of the water pipes under the reactor breaks — one of the four most obvious accident scenarios. It seems to have played no part in the April 26 accident until cleanup, when the pool was emptied of water. The reactor core was not inside a strong containment, although there is a thick biological shield above the reactor. The building is not filled with inert gas, as are the containments of reactors such as Shoreham.

There are many lessons to be learned from this accident: the importance of containment and the danger of fire, both of which we already knew; the slowness of accident development, which allowed time for an unrehearsed, but orderly evacuation, and that even downwind in Sweden the effects were smaller than might have been feared. We want to find out exactly what happened and further insure that it was not a sequence of events that we have forgotten. We want to learn from the Russians their cleanup procedures, which we hope never to be forced to use firsthand.

It would be ironic if unreasonable fear caused us to cripple our nuclear electric capability as a result of this Russian accident, which caused us no harm and would not have occurred in the U.S.

LINN DRAPER
EDWIN L. ZEBROSKI
RICHARD WILSON
Cambridge, Mass., May 20, 1986

The writers are, respectively, president of Gulf State Utilities; a nuclear scientist with Electric Power Research Institute, and a professor of physics at Harvard University.

Lonq Island Lighting Co.: Shoreham Delays and Ratinq Downgrade

In the aftermath of the Chernobyl accident, we have serious doubts that the credit improvement we had been projecting for Lilco during the next 12 months will be achieved. Our expectations for the Company's credit performance **are** closely linked to the fate of the Shoreham nuclear unit.

Prior to the Chernobyl disaster, there were increasing indications that a majority of the NRC commissioners would soon vote to issue a full power license for Shoreham. Now, however, it is probable that commercial operation of Shoreham will be substantially delayed beyond early 1987. Moreover, there is now an increased likelihood that Shoreham will never be allowed to enter commercial service.

Consequently, we are downgrading Lilco's credit rating from Mid-BB to Low-BB. In addition, as events unfold in the weeks and months ahead there is real potential for further credit erosion.

Summary of Our Arguments

Following is a summary of the arguments supporting our decision to downgrade Lilco's credit rating:

1. There is now a reduced likelihood of credit improvement for Lilco during the next 12 months.

2. As a result of Chernobyl and related events, real credit erosion already has occurred because commercial operation of Shoreham is likely to be, at least, delayed.

3. Events are moving very fast for Lilco, and on balance **look** to be stacking-up against the Company–

–Events moving against the Company include--

--Chernobyl has increased the likelihood of Shoreham licensing delays;

--Also, the odds of the **unit** never entering commercial service have increased;

--There now is a higher probability than before Chernobyl that the **NY** state legislature will act on legislative measures that are harmful to Lilco -- action could come in the next few weeks on state takeover proposals, **"used** and useful" bills, or any other initiative that will prove to their constituents that they are sufficiently anti-Lilco, anti-Shoreham and pro-ratepayer in this election year. Public opinion polls indicate that incumbents must be strong on these issues to win re-election.

--We expect a strong backlash to the **5/14/86** PSC policy decision that would allow Lilco rates to double in the years ahead due to Shoreham.

--Prior to Chernobyl, commercial operation of Shoreham faced an unprecedented amount of state and local political opposition.

--The ability and resolve of Gov. Cuomo, Senators Moynihan and D'Amato, and the Suffolk County Legislature to fight the opening of Shoreham has been galvanized by Chernobyl.

--The FEMA regional director who oversaw the **2/13/86** "drill" of the Shoreham emergency plan resigned saying **he** would rather quit than lie when pressure was put on him to water down criticism of the drill.

--There are indications that the NRC staff has second thoughts about racing forward with Shoreham licensing in the aftermath of Chernobyl -- keep in mind that the agency staff itself is accountable for controversial licensing decisions and can be called before Congress to explain and defend licensing recommendations given to the Commission.

4. Supports for the Company's credit are still out there, but it is too early to tell whether or not they will be sufficient to prevent further credit erosion during the next 12 months–

-Potential supports include--

--Even after Chernobyl, the prevailing attitude of a majority of NRC commissioners seems to be "damn the torpedoes, full speed ahead" -- they would like to license Shoreham on the basis of the FEMA drill (of course, wanting to license, and actually voting to issue a license are two different matters -- as the **TMI-1** restart decision making process clearly demonstrates).

--the NY PSC majority continues to be inclined to provide rate relief safety nets for the Company.

--the recent sale of $525 million in new Lilco debt enabled Lilco to stretch-out payments on over $600 million **of** bank debt that otherwise would have come due this year -- and provided the Company with $125 million in cash which provides the Company with a liquidity cushion.

5. **As** events unfold in the weeks and months ahead, there is increased potential for further credit erosion.

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How did Chenobyl change our perception of the Shoreham situation?

1) Chernobyl demonstrated to the world that nuclear accidents causing large offsite releases of radioactivity can happen -- what previously had been an abstract concept is now a reality to hundreds of millions of people. Public perception of the safety of nuclear power has been damaged. This shifts the burden of the argument and aids Shoreham's opponents.

2) Chernobyl demonstrates that evacuation planning is necessary and important. While the precise details of the accident, and of the Soviets' emergency response remain largely unknown, it is clear that a major evacuation of more than 90,000 residents living within about 20 miles of the facility was requlred to protect human life, and was not carried out promptly enough (by Soviet admission). Inasmuch as the fundamental issue standing in the way of Shoreham's operation is the feasibility of evacuating parts of Long Island, Chernobyl will strengthen the arguments of Governor Cuomo, the Suffolk County Legislature, and others in their fight to keep the unit from going on line. Several substantive issues now seem ripe for reconsideration-

a) The size of the emergency evacuation zone: federal regulations somewhat arbitrarily require a 10-mile emergency evacuation zone around U.S. reactors. There have been efforts underway at NRC to reduce this zone -- this idea now will stay on the shelf. Evacuations around Chernobyl went out to about 20 miles, and significant health effects caused by the accident are expected to be found in people living twice that distance from the plant.

b) The speed of reactor accident progression: relaxation of nuclear regulation in the U.S. increasingly has been predicated on the assumption that if large accidents do occur, they will progress relatively slowly, i.e. hours and perhaps days will pass following the initiating event before large amounts of radioactivity is released into the environment. Under this "leak before break" assumption, ample time is theoretically available to carry out emergency evacuations before the general public is exposed to high levels of radiation. At Cherbonyl, however, the reactor apparently was destroyed by a catastrophic explosion. The lesson for the U.S. nuclear industry and its regulators is that we may not have paid sufficient attention to the possibility of fast moving accident sequences. This also re-emphasizes the degree to which the safety of the surrounding population depend upon honest and accurate warning from the utility.

3) The licensing process for Shoreham will be slowed. Harold Denton, the senior licensing staff official at the NRC, said recently that the agency would be "taking a hard look" at the Shoreham license application in light of the Chernobyl accident. Prior to the accident, we thought the skids were being greased at the NRC for approval of'a full power license before the end **of** the year. We also were hearing that tacit approval was coming from the White House for licensing Shoreham on the basis of the **2/13/86** emergency drill conducted by Lilco, NRC and the Federal Emergency Management Agency. **5/4/86,** however, on "Meet the Press", White House Chief of Staff Donald Regan said he did not believe Long Island could be evacuated. We have little doubt this comment will be reinterpreted. Nevertheless, following, Regan's comments on national **TV,** it will be more difficult for the Administration to support the NRC and FEMA regarding Shoreham. Our view of Lilco as an improving credit was linked to the assumption that Shoreham would more likely than not begin commercial operation, but not before **1987 --** we now believe this assumption is too optimistic.

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Status recap of **NY** State initiatives-

-Sponsors of legislation providing for a public takeover *of* Lilco still intend to bring a bill to a vote in the Assembly prior to the July 4th recess.

-The Sawhill Commission report on the pros and cons of a Lilco takeover was released **6/24/86,** and concluded the replacement of Lilco with a Long Island Power Authority (LIPA) could result in ratepayer savings **in** the the range of **7%** to 9%.

-The "used and useful" bills are still alive in both the Assembly and Senate **--** this is the legislation which would prevent the recovery from ratepayers of investment in a cancelled plant. Initial indications are that action on the takeover bills will come before the Senate and Assembly seek to resolve their differences on the "used and useful" legislation. A key Assembly staffer (who supports the "used and useful" measure) does not believe a statute can be crafted to remove the **$1.8** billion related to Shoreham that already has been reflected in Lilco's rates. His concern is that any such statute would be found to be unconstitutional. On the other hand, Governor Cuomo proposed a bill on **6/16/86** that has the intent **of** removing from rates any cash flows related to Shoreham if the unit fails to begin commercial operation.

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Credit Summary and Investment Recommendations-

-Credit summary-

-We are downgrading Lilco to a Low-BB.

-Prior to the Chernobyl accident, we viewed Lilco as a Mid-BB credit with **good** prospects for credit improvement during the next twelve months. Our expectation for credit improvement was linked closely to the mounting evidence that the Shoreham nuclear unit was increasingly likely to begin commercial operation in early **1987.** We no longer regard this to be the **most** likely course of events during the next year.

-In the aftermath of Chernobyl, **it** now is probable that commercial operation of Shoreham will be substantially delayed beyond early **1987.** Moreover, there is now increased likelihood that Shoreham will never be allowed to enter commercial service. Consequently, we no longer believe there are "good prospects" for Lilco credit improvement during the next 12 months.

-In addition to our backing away from Lilco as an improving credit, we believe the delays and uncertainties now associated with Shoreham licensing and rate recovery have caused erosion of the Company's creditworthiness. Also, as events unfold in the weeks and months ahead, potential exists for further credit erosion.

-Investment recommendation-

-Our research suggests the following--

--we cannot recommend the purchase of Lilco debt securities on an improving or stable credit basis;

--we characterize Lilco as a high yield situation with weakened prospects for fundamental improvement for a sustained period of time;

--the odds of Lilco refunding high coupon securities anytime soon appear to be lower than before Chernobyl; we also do not believe odds favor redemption **of** high coupons at par via the takeover route;

--We believe that there is a significant chance the Company will not reinstate the preferred dividends until the commercial operation of Shoreham; accordingly, preferred dividend reinstatement may not be possible until late 1987, or later. Note that if the Sawhill recommendations are followed, preferred dividend reinstatement may occur at the time a takeover is effected.

--higher coupon bonds should offer continued high yield for a sustained period of time -- in fact, aside from PSNH, Lilco may wind up being the highest yielding utility for the next year or so.

June 27, 1986
Public Service Co./New Hampshire: Seabrook Update

Massachusetts and emergency planning-

In the weeks immediately preceeding the April 26, 1986 accident at Chernobyl, there were increasing indications that Governor Dukakis of Massachusetts was willing to strike a deal that would lead to a full power license for Seabrook. The Governor's key concern regarding the reactor revolved around the potential problems that could result if a major accident were to occurr at Seabrook during the summer necessitating an emergency evacuation of popular beaches within ten miles of the plant site. Prior to Chernobyl, Dukakis seemed inclined to submit a Massachusetts emergency plan to the NRC if the Seabrook Joint Owners would agree not to operate the plant during the summer months.

Following Chernobyl, Dukakis withdrew his proposal regarding the summer shutdown, and indicated he was going to re-evaluate his position as to whether or not Seabrook should ever be allowed to operate commercially. On 6/25/86, Dukakis said he hoped to reach a decision on this matter by the end of August or early September of this year. As we mentioned in an earlier section of this report, Dukakis has enlisted the support of Dr. Albert Carnesale to help in the State's review of the Chernobyl accident and its implications for Massachusetts and Seabrook.

Interest grows in a public takeover of PSNH-

As the public takeover of Lilco gains momentum in New York, we would not be surprised to see a similar effort initiated in New Hampshire aimed at replacing PSNH with a public entity. Many of the ingredients are the same-

-a large controversial nuclear construction project continues to slip behind schedule and exceed cost estimates;

-the principal impediment to commercial operation of the nuclear project (Seabrook) is opposition or reluctance by local and state government to participate in emergency planning;

-grassroots opposition to Seabrook and PSNH (as with Shoreham and Lilco) is broad-based and effective, and has been buoyed by increased levels of public concern about nuclear safety issues following the Chernobyl accident;

-the rate impact on NH consumers once Seabrook goes into service will be high -- the NH PSC projects the need for 15% rate increases in each of the first 5 or 6 years of operation in order to absorb the cost of the unit.

A potentially significant difference between the public takeover debate in New York and one in New Hampshire is that Governor Sununu remains a staunch supporter of PSNH and the Seabrook project. In New York, Governor Cuomo has embraced the concept of public power on Long Island, and initiated the Sawhill panel investigation.

We expect to see discussion of a public takeover of PSNH enter the public debate about the future of the Company and the Seabrook reactor.

Low Power Testing Schedule

Massachusetts' Governor Dukakis has asked PSNH, and the other Seabrook Joint Owners, to defer their current plans to push for low power testing of the reactor later this summer.

Dukakis' argument is that it is premature to test and irradiate the unit at low power levels (up to 5% of full power) until it is determined whether or not the plant will ever be allowed to enter commercial service -- a determination which turns on the question of emergency evacuation planning for the 10-mile zone around Seabrook. Several Massachusetts towns fall within that evacuation zone, and Dukakis has not decided as yet whether the state will participate in emergency planning. In his opinion, the Chernobyl accident has raised new questions about reactor safety and emergency planning which must be answered before he will decide to support or oppose the opening of Seabrook. In an effort to come to grips with these new questions, Dukakis recently began an investigation of the Chernobyl accident with the help of Dr. Albert Carnesale, a nuclear expert from the Kennedy School at Harvard -- this study is not scheduled for completion before the end of the summer.

About a year ago, Governor Cuomo and Suffolk County were making similar arguments to Lilco and the NRC regarding the Shoreham plant. In that case, Lilco and NRC decided to go forward and allow power testing to begin at Shoreham over the objections of the County and Governor Cuomo. Lilco's strategy was to view low power testing as a "foot in the door" that would increase the likelihood of eventual commercial operation of Shoreham. The jury still is out on whether this was a prudent strategy for Lilco to pursue -- opponents viewed Lilco and NRC as arrogant and unresponsive to their concerns. As a result, the opponents intensified the fight to stop Lilco and Shoreham -- and, they may still be successful.

By pushing forward on low power testing over the objections of Governor Dukakis, the Seabrook Joint Owners would run the risk of winning the battle and losing the war.

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While the fate of the Seabrook project may look brighter than it did 12 months ago, there can be little doubt that Chernobyl has created a major new hurdle for the Joint Owners, and particularly for PSNH. We continue to believe the Massachusetts DPU's 4/85 conclusion that Seabrook will not be commercial until 1988, and will cost about $6 billion, is a reasonable basis for investment decisions.

We continue to rate PSNH as a High-B credit with continuing exposure to credit erosion in the months ahead.

A Soviet Preliminary Account of the Chernobyl Accident

In this final section, we are reprinting a 5/21/86 address by the representative of the USSR to the Board of Governors of the International Atomic Energy Agency regarding "information about the accident at Chernobyl, its consequences and measures initiated."

To our knowledge, this statement which has been translated from Russian, has not been distributed in the U.S. We think the presentation is interesting because it provides a preliminary, but detailed accounting of the accident from the Soviet standpoint. In addition, we suspect this statement will represent the most complete Soviet statement on the accident until an international conference is convened late this summer.

We make no representation with regard to the completeness or accuracy of the Soviet statement. We present it here without comment or interpretation for the purpose of reporting an interesting news item.

The Statement follows on the next page.

Translated from Russian

ADDRESS BY THE BEPRESPNTATIVK OF TtlE USSR TO THB BOARD OF GUVPB#ORS OF TH6 IAGA ON THE FIRST ITEfl OF THE AGENDA: "INFORMATION ABOUT THE ACCIDENT AT CHGRNOBYL'. ITS CONSEQUENCES AND HEASUBES INITIATED".

He. Chairman,

First oP all I would like to express our deep gratitude to all those who have shown sympathy and understanding in coanection with the events at the Chernobyl' nuclear power station. We also hi6hly appreciate the coaetructive approach to the accident at the Chernobyl' Lucleat power plant adopted by the IAEA nnd by Dr. Hans Bllx, its Director General.

As we are auare, the rapid progress in acieace and tecbno~o~y brings not only benefits for rankind. Nan'# exploration of the poles end outer space and the harneK8ing oC atomic enorgy muit inevitably involve trqic losses. Ue have been reminded of this once again by the accident at the Chernobyl' nuclear power plant, where for the first tire we have bad to face tho formidable force of nuclear energy when it gets out of control.

In order to make clearer the tecbnicrl detglls which I LU 6oing to tnlk about, it would be useful to recall briefly the rain f.aturer of the Chernobyl' reactors.

The branch o€ nuclear power eogiaeerlng eatailink the use of uronlum-graphite channel (pressure-tube) reactorr cooled with now1 water is a tr.ditioao1 one in our country and has a lon& hirtory. It was iudud tblm type of reactor that was used to the world's first desanutration nuclear power facility tet in operation at Obninsk mote than 30 year8 ago. no dogi&a principles adopted at that tine were retained la tha rubrquont erperl~ntal-indurtrial units of the Byeloyrrrk nuclorr posnr plant, tho long and ruccerrful operation of wbicb coafior*d the vi8bility of tbs chrnnel-type design for uranium-graphite raactors and ude it porSibl6 to wvo on to tbe construction oP reri~~-produced reactors of high pant.

Tho first of tho 80ri.8 of ~ - 1148COOKr~Yas pt into Owr*tL0a at tho LeaiRg,tbd nuclear powr rtatloa la 1973, haace to date we hvo had mor4 than IO yeatr of erpwlonc~in op.rrtln& reactors oC thir tym, Tha RWIC-1000 (uranium-graphite boiling-water high-power **reactor)** has **a** thermal **capacity** of 3200 *WU* and is cooled by boiling water using *8* single circuit **system;** **the** Cue1 **Is** low-enriched *(– 2%)* uranium dioxide and **the moderator is graphite.** **Tha** mean burnup **of** the fuel is 18 *500* W-d/t, **and** the stationary uranium fuel load is 160 t. The water flow rate through the reactor **ir** *37 500* **t/h;** the otean temperatuce at the turbine inlet is *280*^{o}C. and the pressure in *65* **atm.**

The coolant circuit consists of two parallel loops, eich of **which containo** two **drum separrtors,** four circulation **pumps,** • pipe system **(mean** dinmeter *300* **m; mnrimw** diweter **900 111)** and **22** dirtributins sroup **preonure headern,** which feed the reactors' chnonelo. Saturated utea **is** pumped through *8* steampipea **400 m in** diameter to two turbines each with **rn** output **oC** *500* **HU.**

To monitor the power and control the reactor **uno 11 m&de of** lateral ionization chambers, while the **ryntem for** monitoring the **power** density vertically and radially in the reactor employs neutron detectors wunted **io** some **of** the fuel chrnnels **La** well **as in** the chroneln containinn measuring detectors **of** the rerctor control and protection rgoter. The leaktightness *o€* **the** Iuel elements **io** continuously checked by measuring the activity of the ste.nt-water mixture **in** the pipes at the inlet to **tho** separator8 by **maans** of scintillation **6—a** detectors.

The control rad protection rystea contains 180 independent absorbers combined into **sets** with autonomour d~toctorr.

A feature **of thir** particular roactor **is tha rb~onco** of • thick-wrlkod higb-prer8ure **vorrol.** Tho **grrphlte Irronry 11** coata1n.d **in a** thin-wallod leak-tight **casing,** while tho Euol **bss.rblios are** locatod **in chanaole made** of **a** rirconiwr alloy **which** taker the **prerrure.**

In principlo, the **d4riga of** channel reactor8 **1s char&ct*rSrad** by hiah rollability **a8** coaprred with **reactor8** of **tbe** presrute **r4rrel tm, in** which the thick-wallod **bfgh-prarrure vorrol ir one** of the **twrt ccltic d elmntr from the** standpoint **of safety.**

In the chanael coactor disruption **of** tho **inte.(;rLty** *of* **the iadivA4aal Euol channslr doer** not **in** principle **prorant any grrvo dmyer. me** practica **of** replacin16 the **chrnarlr ha. confl—— d** that thlr operation **ip quit9** n0rl.l **in** neture.

The reactor facility possesses an emergency core cooling system, which includes passivo and active eubsystenis with the necessary redundant equipment. The system ensuces reliable cooling of the reactor in tho evant of the meximum design-base accident, which is taken to be an inatantanuous transverse rupture of the pressure header of the main circulation pumps 900 um in diameter.

To atop steaai end fission products escaping in the event that the pipes and working channels of the reactor lose their leaktightness provision la made for the principal componenta of the reactor unit to be contvined in hermetically seeled compartments calculated to withstand an excess pressure oE 4.5 kg/cm^2. These compartments serve the dame function 1s the protective envelope (containment) of PVB reactors. All raleoses during dosign-base accidents are localized in there compartaentn, while the stars condensen in a special pressurizet relief tank connected to the hermeticilly oeiled compartment system.

The passive nuboyatem of the emergency core coolin& aystsm contpins two sets of tanks holding 200 m^3 of water. This regerva 10 guarrntaod to be enough to remove the heat from the core within the first tbrrs minutes from the moment the accident is \n&t\atod.

The actlve ruboyster contaiar five oets of punpa Cor feeding water to tho coco after th4 water tanka have emptird. All tbe active suboyntmn pumps &re QOWerod by backup diesel generator# locrted on sit.. The resefvi)P of water for tho active rubiyutm are adequate to ensure / Pupply of water to tho reactor laatlo& virtually any amount of tlra.

Xt now tranrplrer th8t the accident deva1op.d at tbo pwar station tn the followins manner. At 0123 houri and 40 recondr on 26 4ril en owrgency occurred in tho fourtb unit of the Cheraobyl' nuclear m t station dur\o& tho rchedulod rhutdown of the uolt rrhilo at a pomr lorol of nerea p w cout. The zractor powr suddenly increarod and thoro hgra latoarlv~eraporntion oP tha COOlfng walot 4nd conriderablr forutioa of rteu. Tho anruing reaction betmoa the rteaa and tho zirconium lad to tho forrrrtion of hydrogen wbich then rrploded. The explosion caused a ftru, and tho reactor building tolether with the equipment in it, the reactor itself and tho core were exteasively damaged, causing the release of fission products beyond the site. During the accident the chain reaction ceased.

The fire brigade which arrived soon after succeeded in putting out the fire at the fourth unit and prevented the roof oE the aachine room From catching fire.

The three remaining units were shut down and returned to a sub-critical state; they are now being cooled. Two pereon8 died as a direct result of the explosion, one through burns and the other through injurier nufforod from collapsing otructureo.

The relerse of radioactivity roae to a heisht of approxlootely 1 km. The level of activity in the release wan princip&lly doternloed by short-lived isotopes. The bulk of it uas accounted for by iodine-131 *(50%).*

In the light of the events r Comiarioa win sot up by tho Council of ninlotero of the USSR to take action to eliminate the consequences of the accldent and to rrcertrlo the cruses of it. The C mirrion conrioted oE prominent oc\ent\rtr, admlnirtrators and specialirtr from rinirtrter and deprrtmoatr. Tho Corrrfrrion was herded by B.E. Sbchrrblnr, Dsputp Chrirmrn of tho Council of Hiniiterr of tho USSR. Within literally a wP hours the nreabertr of tho Coarlsrtoa ydcb at tho scone of tha accldeat. ?roo tho very outrot tho Coralrrion ceslirod that its u i o trrk, d t o F rorutlR$ p.ople't rafoty. we8 to c m n c e — rgoncy work on the rorctor so a8 to roduce tho release of radiorctivitx to a rintlrur. In v i w of the exceptional rad dangOCOu8 naturo of the rccidont, • group herbed by Y.I. Rytbkav, Chatrun of tho Council of Minlrtotr of the USSR, w8 ret up wlthio the Poaitburo of the Contra1 Carittoo of tho CPSU to doa1 imdiatoly with tb. pmblam.

In offoct, ~ 1 1ho work 1s betag conductd on • couad-Lb+-clock brrir. The rclentific, technical urd oconoric ro8ource8 of the entire cQUntCl hrvo been btou6,bt into action. Operating In tho ar.4 of tho acoidbat 4cI ot~aniiationsbeloa&in& to rray of the union riairtrler wd a$iacIor uabar tho ruporvirion of minimtor#, pradneot 8clontintm rad ~p.clal~rtr,mtts of tho Sovlot rrmy and doparbontr of tho P(iaintrj of Internal Ufairr.

It is too early yet to draw final conclusions about tha causes of the accident. All aspects of the matter - design. technology and operation - are being clooely scrukinized by the Government Comnieslon. When the investigation into the causes of the accident ha6 been completed, all the necessary conclusions will be drown and me4sures will be taken to pcevent anything of the sort ever happening a~ain.

The main 4im of the earetsency operationo w41, firat, to minimize the releeoe oC fission products fror the teoctor and, second, to cool the cor0 of tho shutdown reactor, in whlch heat had been plerred for a considar~blet h e Oa account of the radioactivity of the fission product#. To doll with the flrst problem a protective coverin6 of saad. clay, boron, dolomite limestone and lend was placed over the core with the aid of haltcopters. The top of the reactor was covered with 4 layer of more than 4000 tons of tblo protective material. By 13 Ury tho reactor had to a11 intents and purposes stopped releasins fission products into the atmosphere. In view of the fact that the bulk of the fuel was inside the reactor, there·war faar of tho core melting on account of tbe residual heat referred to above. It can now b4 said that thi8 problem has been overcome. The coco terperature droppad first to 300-400^{o}C, and thea to 200-250^{o}C. Tbir wa8 made possible. w n g other tbtQ811, by intensive cooling of tho b o t h 8 of the reactor with nltrogea which at the ouee ti— earured an inert atmosphere there.

When tho u i n problems of the flrrt rtagr (caraatioa of thr firrioa product taleare and drop in terporature) had boon dealt with. attention was focused on decontaminating tho torritory and coartructlag A eoncrate containmnt (rrrcopha&ur) for final burial of the reactor. Io guarantee the insulation of the around balow tbe reactor floor, work is to progross to insert additional concroto protection beneath the reactor - uad+r th4 foundations on which it rtandr.

A tunnel is bein6 u d e under the reactor a d will b oqwl to construct uabergrouad wh4t lr la offoct a concrete cooler In tho $4084 that there will be radiators with • suitable coollna r y r t v wouatod into thb copct+t*.

The power station precinct has been banked up and protective adaptations have been made to prevent any rain from washing the radioactive rubstances present on the site itself into the river.

The power station precinct and surrounding areas ure undergoing decoritamination. Virious mathods are being used €or this purpose, including polymer utaterinls. When these are applied to a surface or to the ground they €omp film which bind8 the radioactive substances and prevents them from being washed awry; leter on this film can be rewved and destroyed. Several million square maters of conturinated land have already been tcented io this way. The aost difPLcult part of the work otill ahead io that on the collapsed structures and rubble.

In worldwide prictice, such dlfCicult technical and engineecinj problems a8 those which 8re successfully beins solved by the Soviet ncientists and specialiuts at the Chsraobyl' nuclear power atation have novet before been encountered. The experience gained will be of groat value.

At unit8 1. 2 rad 3 which have been shut down, a perunent watch is being kept by apecialiotr numberlab about 150 altogether. Units L and 2 could be put back into operation 4t any ti—.

'la the situation that followed tbo accident, tho necrrrmy meaoures were taken for the propbr protection of the population. —8s rvrcuatlon was carried out oa 27 Aprll, wOlsn bad children being ovacoat04 Picst. The iohrbitnntr of the power etation rettl — at weto evacuated witbin a fow hours, And then, wben It bocw cl4ar that tbero was e potantid hacard to the health of people in the surroundin6 area, thoy nlso Y.C. moved into rrfe arars. Sevoral 10 A 000rpoop1e wefo evacuated ffm Chernobyl and othvr Qlrco8 within tho 30 h zone Potassium iodtde tablet8 were r&ainirtosed as a prophylactic measur.. 1111 this work requited a rulmm oP rapid, orgcniuQ urd affictent action. The radiation larols io thm pouar 8tatIon Loa* ud the adjacaat aroar, bltbotigh appreciably r.6ucodr @till rmLn hutrsboua W 4— health.

ht tho tiw of tho accident, a~ bar elraady kcro 0614, tlro YE wwe killed. So far, 299 peoplo have booa hoepitrllru! - diofnQBbd Lli ir+ta$ radiation rlcknorr of varying degrees Yiftroa ot thbre hove diud, rad 33 yho received high dosetl of radiation remain in critical condition. The fird brigade personnel suffered most heevily. Nineteen bone-marrow trannplants were carried out. In order to give all possible help, the beet scientific and medlcal people In the country and apecializod hospitals fir Moscow ond other cities were called on to resist. Foreign medical erpertii have been helping alon6sIde the Soviet doctors. Tho patleato who have received doseu hazardoua to their health do oot include any inhabitant8 of the nearby villages, although they were all thoroughly exnminod.

In the area surrounding the rccfdeirt zone, the radiation lovol reached values of 10-15 ailliroentseo per hour. By now the radirtlon levolo have declined ehbrpli. The vduo measured at a neteorolo&ical strtion lbcuted 60 h from the nuclear power station uas 0.17 milliroentgen per hour on 20 Hay. Heasurements carried out at meteorological atations along the Western frontier of the Soviet Union show that the radiation levelr at4 withla normal 'limits. Isotopic analyrir of the composition of the r&dloactivs fallout is bein6 perforned. Sampler froa the Accident are4 contain bsriUr, lanthrnur-140, ruthenium-103 caerlua-131, iodin*-132, telluriua-132, strontium-89 otrontlun-90, and yttrium-91. hr has already bden pointed out, most of tho Pallout ir recounted for by rhort-lived ol.rratr.

Survaya of tho radioactivity leval lo tho water rorenrolr in the Kiev region, which are crrriod out regularly, show that it hAr ror*lned norroll mnd dooo not pora a health barard.

Tho weather setvicor are Leepias the rsdioloslcal rituatlon in tha roil, wrtor and rtwrpbere under conrtant obrorvation.

The current rlturtloa on tb. territory of tho USSR ir 4s follmr: outsido tk 30 h LOR. rtound tho Chernobyl nuclear powr rt*t\gn, the — In radiological factor8 affoctin& tho population of tho Ukranian Oyelorurrim And LLold@rianSoviet Soctallrt Ropublicr a d of the varloa6 fltatctctr Qf the Russian Sorlot Codorrl Socialist Uapublic vhore tmrttor(d# h4?r, Cwotv+d radioactire trllout, are orternal g.mr-lrradlatlor md +be imqrtlon of ladino-131 with food prvducts, but la quurtltios tb4t ds not eWttkrk9 u rtik to th* populrtton.

Various lots of milk with an iodine-131 content in exces(i of thuse norms have been passed on for processing into products which can be sCored Cor one or two months.

As re6erds vesetables, fruit and cereals to be harvasted in the mid-sumner and autumn, there &re no grounds for supposing that they rill be found to be contrainated with radioactive iodine-131.

Daily reports oR the radiological situation around Chernobyl' and along the western frontier# of the Soviet Union are bein6 oent to tho LAU.

A certain mount of activity was carried beyond the frontiers of the USSR io north-westerly, westerly rnd, later. ooutb-westerly directioas.

In a number of Buropeen counkriar, influbaced by tbo ornotimes falme and usurlly tendeatlous *mrss* media reports concerning the scale of the accident at the Chernobyl' nuclear power station. the population showed great anxiety with regard to possible effects of the eccidont on their health and on the environment. 'In thir connection It *fr* worth recalling the conclueloan and rocoumendationr of *s* rpecirl experts' meeting convanod by the WHO Be&iounl Office for Kurope at the instance of the Director Gonerd of — *o*, rad tha official report8 by a nuabor of national ~ ~ T V ~ C Yinçhdin6 oopo publluhod by the IAKA, which bear witnosr to tba fact that tho radioactivity leva1 in thooo countrirs did not conrtitute a horlth hazard to tho populatioo.

A serious situation was producod by the rccideat. It uaa nvcoaaary to evrluato *it* Quickly and compatoatly, and as soon a8 toltablo initial infonution had boon obtrinod, it was sant through diplautic cbannols to the governrunt8 of foreign couatrler rad to the IMA. Th UEA Sactatrrirk and the USSR Mission rriataioad conrtut lldroa with reg&rdtO Qsrwtloas colatin$ to tho rccldbnt. Tho SOviLt rid. exprot~rodit# willingness to CO–OQ4r.te with tho &oacr in a11 uttorr of Intocost to tho IIU. 'Loforw'\Oj, &bout tb6 rcclbont was publi8b.d ia the boncy'r pro## r&l@a$@l*;II* addition tho SOviLt Govorwnt invitod tho IAKA Dlroctot (kaetal, ttr, 11+ Cllr, to cDY to the Soviot Union and to see for hiuelC tho rltoation foll#dM tha aCCid1)At *rt* tho Choraobyl' nuclew powor rkrtlOn red to dircusr Wy) of increasing tho refoty of ouclerr p o ~ by broador intoroat~oaalco-op.retb,rr and an enhrocrrrat of the UU's to10 in thir area..

During their stay in the USSR, Hr. 31ir and the IAEA OffiCial.S accompunying him, tlr. L. Konstantinov and ttr. M. Roeen, had meeting8 with the Deputy Chairman of the Council o€ HInisters and Chairman of the Covornmerit Comniosion, Mr. Boris E. Shchecbina. and with ministers responsible oCEkcials and experts, and uleo visited the urea of the Cherrrobyl' nuclear power station, where they received additional information about the oituation on the site and the *measures* token to eliminate the consequences of the accident. During thie visit it uae agreed that the radiological eituation near Chernobyl end on the western frontiers of the Soviet Onion would be reported to the IAEA eacb day for transmiesion by the Agency to the respective national bodies dealing with radiation nnfoty.

Pursuant to thir agreement the USSR commenced regular transmissions of data on 9)lay 1986.

The information is transmitted daily by telex and includes data €rom seven different meteorological stations. The first of these, Ostor, ia located 60 km fton Cheraobyl'. The oir other stations lie along the wastern boundary of the USSR. Thog include Leningrad, Riga and Viloyur Lo tho Baltic region. Brest (on the Polish border, 52^o northern lrtitudo), rad two ntdtions - at Rakhov and Kishinev - further oouth near tha hungarian and Rollanfan borders. Thus, practically all orctloao of tbo USSR's wegtorn boundary across which radioactive substances could bo crrtid into tho terrltorj of neighboring European States aco covercsd.

Tho drily report8 include the following data an agreed witb tho I÷

1. Radiation dose rete (In dllLtoeotgen per hour);

2. Air temperature (^{o}C);

3. Dew point (oC) ;

4, Wind diroctioa;

5. Wind speed (&a);

6. nature os atmospheric precipitation.

Data on the natural background levels were also offlclally reported to the IAU so that they could be taken into account in analysing the daily reports on the radiological Eltuation.

Ourin& the period which has elap6ed since the be6inning of regular data transmissions to the IAEA. the tadiologicnl sitution near the nuclear power station hao gradually improved. Accordin8 to data from the utatlou ut Oatsr. the dose rate characterizing the radioactivity level hao fallen from 0.33-0.36 nilllroentgen per hour to 0.17 as recorded yesterday.

In the north-weotern arear along the USSR'o frontier no significant increases in the radioactivity level above natural back~roundvaluer huve been recorded. Tho dose rate value6 mewured there are noatly at bbck&tound level: 0.01 aillitoentgen per hour.

In the west. in the rasion of Brest, the rituition *is* appronchlng notnu1 as well. Yeoterdry the dose cats tbere wan also it tho noma1 background level. Somo Increase over the natural background has reanlaed until recently in the routk-weatern ro&ionr (R~khov*0.025*, Klsblnev 0.03-0.04 ailliroent6en per hour). apparently because of tho atrospheric sitution, with weak winds and no pcacipitatioa.

On the wholo, tbe trdlological and neteorologicrl data meat to the IAKA make it porrible to 4 significant extent to evaluated and forecast the tadiolo~icalsituation for mort of Central rad western rurop.. The WHO nl@o has exprerred &n intoreat in roceirio~there data. *Aa* oC 15 tfmf 1986, tbr Soviet Union ha8 been sending duplicates OP the iaCotution described above to WHO.