CHARTS USED FOR

PRESENTATION TO

CONGRESSMAN ALLEN F. ERTEL,

NRC COMMISSIONER VICTOR GILINSKY

AND STAFF

APRIL 25, 1980

Based on our experience, a review of existing documents and various discussions with those we consider to be experts in the field of dose assessment we would technologically conclude with full knowledge of the altenatives:

- The best approach to the ^{85}Kr problem would be the prolonged, controlled venting of the containment atmosphere to the environment.
- Venting should be accomplished without detectable increase of our natural background as monitored by trained independent groups.
- For continued safety at the TMI site early entry into containment is necessary for equipment maintenance and radiation surveys.

Since March 29, 1979, the Oak Ridge National Laboratory has been involved in the TMI situation.....

- Providing emergency on-site assistance in contaminated air and water effluent control.
- Providing consultation to the Kenemy Commission
  - In post-accident cleanup
  - In understanding the chronology of events
  - In technical guidance in a series of "what-if" studies
  - In providing dose assessment information
  - In other technological areas not related to this discussion
- Providing analytical chemistry service where unique capabilities are mandated.
- Providing assistance to the TMI Technical Advisory Group.
- Providing continuous assistance in the area of high-level water flowsheet development and verification.
- Providing "trouble shooting" service to on-going cleanup operations as required.
- Providing input to NRC in understanding the in-depth technical situation on water and waste treatment.

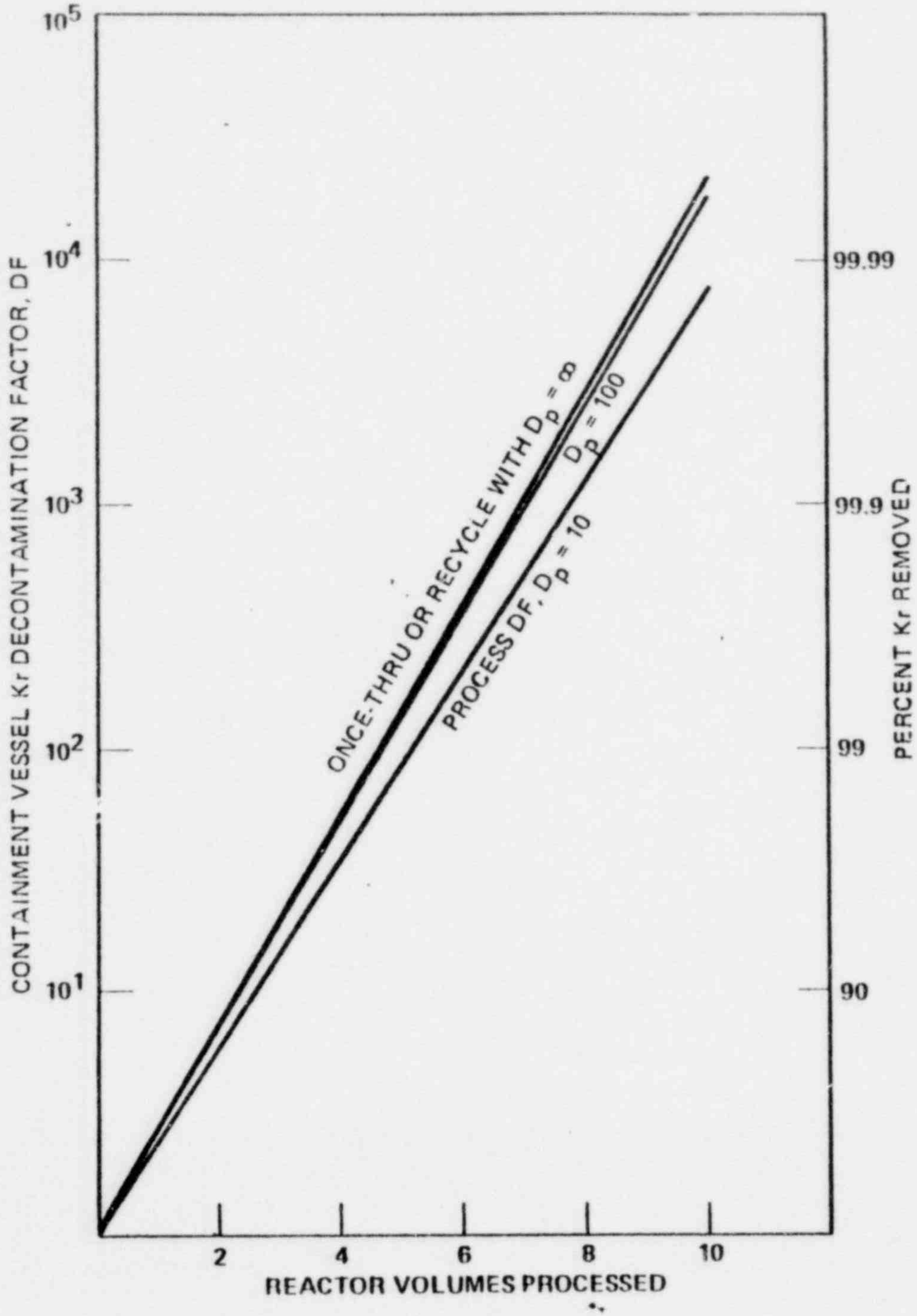
DWG. NO. K/G-80-1267

- OBJECTIVES OF EFFORTS DURING WEEK OF APRIL 21, 1980 IN RESPONSE TO REQUESTS MADE BY CONGRESSMAN ERTEL DURING HIS VISIT TO OAK RIDGE ON APRIL 19, 1980:
    - MAKE CALCULATIONS SHOWING TRADE-OFFS/OPTIONS AMONG DECONTAMINATION FACTORS, FLOW RATES, PROCESSING TIMES, ETC.
    - EVALUATE APPLICABILITY OF PILOT PLANT EQUIPMENT FOR TMI-2 SYSTEM
    - IDENTIFY PRIMARY ISSUES, PROBLEMS, ETC., IN IMPLEMENTING A SELECTIVE ABSORPTION SYSTEM UP TO TEN TIMES THE PILOT PLANT SIZE

4/25/80

UNION CARBIDE

DWG. NO. K/G-80-1255



4/25/80

UNION CARBIDE

DWG. NO. K/G-80-1275

KRYPTON PROCESSING TIMES

% REMOVAL	APPROXIMATE WEEKS TO ACHIEVE REDUCTION AT INDICATED FLOW RATE		
	15 scfm	50 scfm	150 scfm
90	33	10	3
99	66	20	6
99.9	99	30	9

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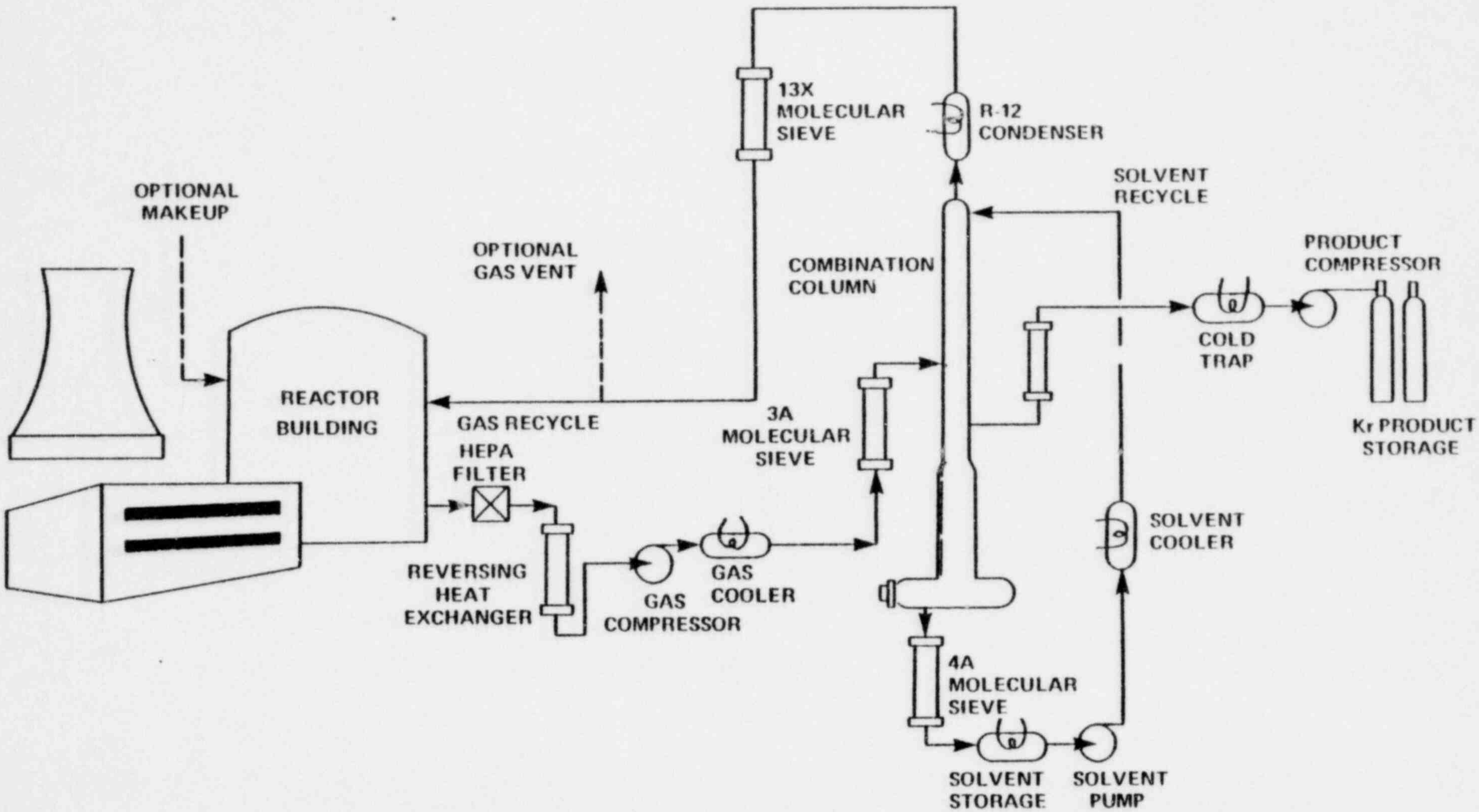
SCHEMATIC OF THE SELECTIVE ABSORPTION PROCESS



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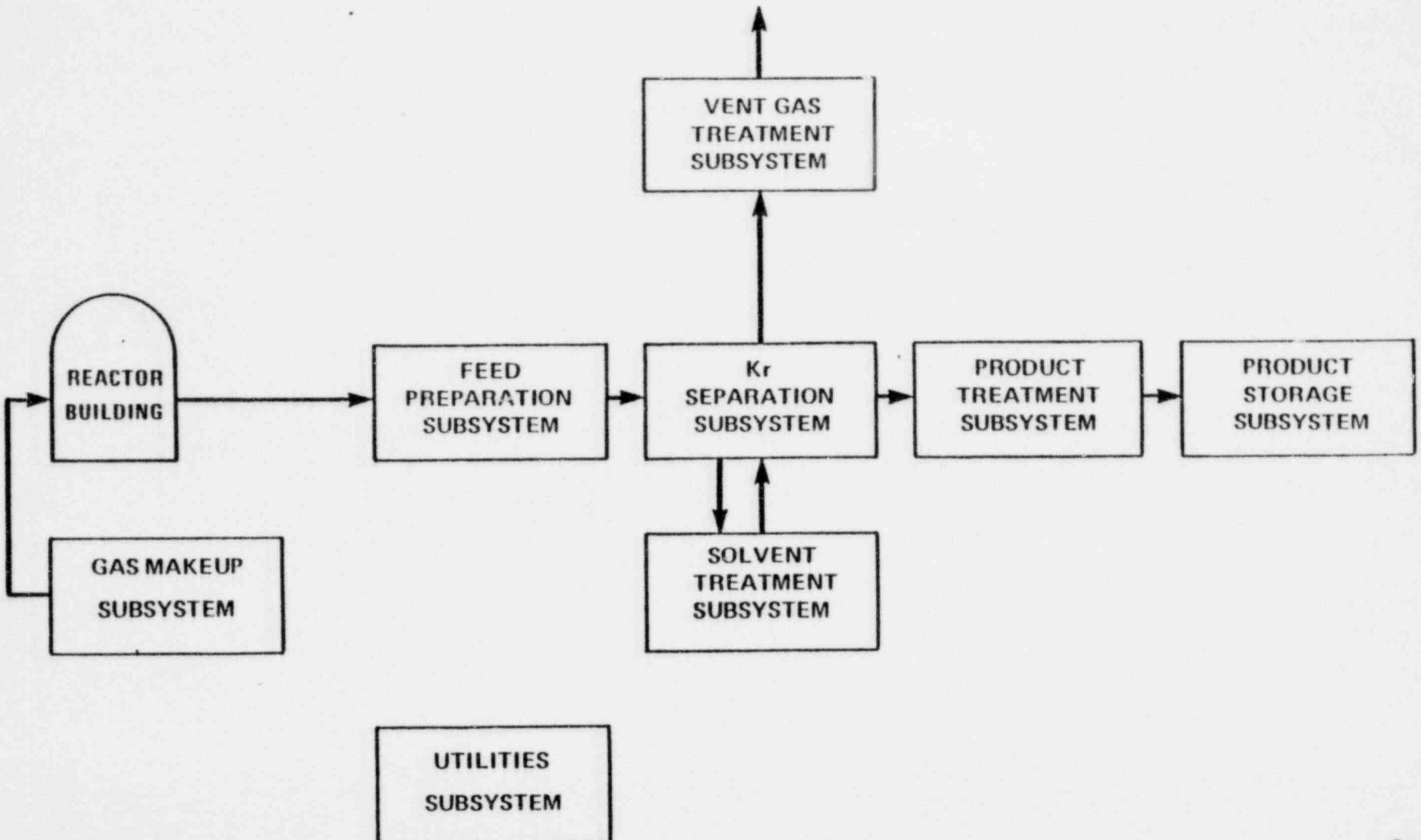
DWG. NO. K/G-80-1280

SELECTIVE ABSORPTION PROCESS BLOCK DIAGRAM



4/25/80

UNION CARBIDE

SUBSYSTEM DESCRIPTION

SUBSYSTEM:	FEED PREPARATION
PRIMARY FUNCTION:	FILTER, DRY, COMPRESS, COOL, AND METER FEED GAS
MAJOR EQUIPMENT	HEPA FILTERS REVERSING HEAT EXCHANGERS GAS COMPRESSOR GAS HEAT EXCHANGER/REFRIGERATION SYSTEM MOLECULAR SIEVE BEDS WATER STORAGE TANKS
OPERATING REQUIREMENTS:	GAS FLOW PICKED UP AT SUBATMOSPHERIC PRESSURE, DISCHARGED AT 150 PSIA, DRIED TO A DEW POINT OF – 90°F (MEASURED AT 1 ATMOSPHERE), AND COOLED TO – 30°F
CONSIDERATIONS:	TRITIATED WATER MUST BE COLLECTED FOR STORAGE AND SUBSEQUENT PROCESSING; MOLECULAR SIEVES PROBABLY MUST BE DISPOSED OF AS CONTAMINATED WASTE AFTER USE

4/25/80 UNION CARBIDE

DWG. NO. K/G-80-1263

SUBSYSTEM DESCRIPTION

SUBSYSTEM:	Kr SEPARATION COLUMN
PRIMARY FUNCTION:	REMOVE Kr FROM THE FEED GAS, CONCENTRATE Kr, AND REGENERATE SOLVENT FOR RECYCLE
MAJOR EQUIPMENT:	COMBINATION COLUMN WITH INTEGRAL REBOILER
OPERATING REQUIREMENTS:	Kr DECONTAMINATION FACTOR OF 100, Kr CONCENTRATION FACTOR OF 2×10^4
CONSIDERATIONS:	ALSO REMOVES Xe AND CO_2

4/25/80 UNION CARBIDE

DWG. NO. K/G-80-1261

SUBSYSTEM DESCRIPTION

SUBSYSTEM:	VENT GAS TREATMENT
PRIMARY FUNCTION:	REMOVE R-12 VAPOR FROM PROCESS OFF-GAS TO REDUCE SOLVENT LOSS AND PREVENT VAPOR FROM BEING RECYCLED BACK TO THE REACTOR BUILDING (IF RECYCLE IS EMPLOYED)
MAJOR EQUIPMENT:	CONDENSER/REFRIGERATION SYSTEM MOLECULAR SIEVE BED
OPERATING REQUIREMENTS:	R-12 CONTENT IN THE EFFLUENT GAS LESS THAN 1 PPM
CONSIDERATIONS:	SMALL AMOUNTS OF R-12 VAPOR MIGHT BE RECYCLED TO THE REACTOR BUILDING IN RECYCLE CASE

4/25/80 UNION CARBIDE

DWG. NO. K/G-80-1272

SUBSYSTEM DESCRIPTION

SUBSYSTEM:	SOLVENT TREATMENT
PRIMARY FUNCTION:	PURIFY, PUMP, COOL, AND METER SOLVENT FLOW TO THE ABSORBER
MAJOR EQUIPMENT:	MOLECULAR SIEVE BED SOLVENT STORAGE TANK SOLVENT PUMP SOLVENT COOLER/REFRIGERATION SYSTEM
OPERATING REQUIREMENTS:	SOLVENT FLOW AT CONDITIONS REQUIRED BY THE OPERATION OF THE ABSORBER
CONSIDERATIONS:	DISPOSAL OF MOLECULAR SIEVES AS CONTAMINATED WASTE

4/25/80 UNION CARBIDE

DWG. NO. K/G-80-1271

SUBSYSTEM DESCRIPTION

SUBSYSTEM:	PRODUCT TREATMENT
PRIMARY FUNCTION:	REMOVE SOLVENT VAPOR, Xe, AND CO_2 FROM PRODUCT Kr
MAJOR EQUIPMENT:	MOLECULAR SIEVE BED COLD TRAP/REFRIGERATION SYSTEM
OPERATING REQUIREMENTS:	R-12 CONCENTRATION IN THE PRODUCT Kr LESS THAN 1 PPM, Xe AND CO_2 LESS THAN 0.1 MOLE PERCENT
CONSIDERATIONS:	DISPOSAL OF THE Xe AND CO_2, REGENERATION OF MOLECULAR SIEVE BED INTO SYSTEM AS PRECAUTION

4/25/80 UNION CARBIDE

DWG. NO. K/G-80-1270

SUBSYSTEM DESCRIPTION

SUBSYSTEM:	PRODUCT STORAGE
PRIMARY FUNCTION:	STORAGE OF CONCENTRATED KRYPTON
MAJOR EQUIPMENT:	GAS COMPRESSOR STORAGE CYLINDERS STORAGE CASKS
OPERATING REQUIREMENTS:	DOUBLE CONTAINMENT, RADIATION SHIELDING, AND COOLING OF PRODUCT AS REQUIRED FOR STORAGE
CONSIDERATIONS:	LONG-TERM PROTECTION

4/25/80 UNION CARBIDE

SUBSYSTEM DESCRIPTION

DWG. NO. K/G-80-1269

SUBSYSTEM:	GAS MAKEUP
PRIMARY FUNCTION:	REGULATE REACTOR BUILDING PRESSURE
MAJOR EQUIPMENT:	NITROGEN MAKEUP SYSTEM FOR VAPORIZATION OF LIQUID NITROGEN AND CONTROL SYSTEM TO REGULATE MAKEUP FLOW; ABSORBER OFF-GAS RECYCLE PIPING PROVISIONS
CONSIDERATIONS:	NITROGEN MAKEUP PREFERRED OVER USE OF ATMOSPHERIC AIR TO AVOID UNNECESSARY CO_2 BURDEN ON ABSORBER PROCESS AND PRODUCT TREATMENT
	OFF-GAS RECYCLE WOULD PERPETRATE CLOSED LOOP CONTAINMENT DURING DURATION OF ABSORBER PROCESSING
	OFF-GAS RECYCLE MIGHT INTRODUCE A SMALL QUANTITY OF R-12 VAPOR TO THE REACTOR BUILDING IF VENT GAS TREATMENT SYSTEM MALFUNCTIONS

4/25/80 UNION CARBIDE

DWG. NO. K/G-80-1265

IMPLICATIONS OF CURRENT GAS INVENTORIES IN TMI-2

COMPONENT	VOLUME, FT^3	CONCENTRATION, PPM
Kr (TOTAL)	$\sim$ 16	$\sim$ 8
Xe	$\sim$110	$\sim$ 55
CO_2	660	330

NOTE: BASED ON ESTIMATED CONCENTRATIONS; MEASUREMENTS DESIRED

- ABSORPTION PROCESS OFF-GAS RECYCLE TO CONTAINMENT OR NITROGEN MAKEUP FOR ONCE-THROUGH SYSTEM AVOIDS ADDITIONAL CO_2 AND Kr BURDEN ON PRODUCT TREATMENT AND PRODUCT COLLECTION SUBSYSTEMS IMPOSED BY FRESH AIR MAKEUP
- SUBSTANTIAL REDUCTION OF EXISTING CO_2 AND Xe VIA PRODUCT TREATMENT SUBSYSTEM IS DESIRABLE TO REDUCE VOLUME STORED

4/25/80 UNION CARBIDE

SUBSYSTEM DESCRIPTION

DWG. NO. K/G-80-1268

SUBSYSTEM:	UTILITIES
PRIMARY FUNCTION:	PROVIDE UTILITIES REQUIRED BY THE ABSORBER SYSTEM
MAJOR EQUIPMENT:	ELECTRICITY; PUMP POWER, LIGHTING, HEATING; COOLING WATER FOR REFRIGERATION SYSTEMS, SUPPLY AND RETURN CONNECTIONS; COMPRESSED AIR FOR PNEUMATIC INSTRUMENTATION; NITROGEN FOR SIEVE REGENERATION
OPERATING CONDITIONS:	SPECIFIC UTILITY DEMANDS WOULD RESULT FROM TOTAL SYSTEM SIZING AND DESIGN
CONSIDERATIONS:	ASSUME THAT SPECIFIED UTILITIES WOULD BE AVAILABLE TO THE BUILDING HOUSING THE ABSORBER SYSTEM WHEN THE COMPONENTS ARE SET UP ON SITE

4/25/80 UNION CARBIDE

PILOT PLANT HARDWARE APPLICABILITY

SUBSYSTEM	MAJOR EQUIPMENT ITEMS	AVAILABILITY AT 15 SCFM SIZE FROM PILOT PLANT
FEED PREPARATION	HEPA FILTERS	NO
	REVERSING HEAT EXCHANGER	NO
	GAS COMPRESSOR	X
	GAS HEAT EXCHANGER/REFRIG.	X
	MOLECULAR SIEVE BEDS	NO
Kr SEPARATION	COMBINATION COLUMN WITH INTEGRAL REOILER	X
VENT GAS TREATMENT	CONDENSER/REFRIGERATION	NO
	MOLECULAR SIEVE BED	NO
SOLVENT TREATMENT	MOLECULAR SIEVE BED	X
	SOLVENT STORAGE TANK	X
	SOLVENT PUMP	X
	SOLVENT COOLER/REFRIGERATION	X
PRODUCT TREATMENT	MOLECULAR SIEVE BED	X
	COLD TRAP/REFRIGERATION	X
PRODUCT STORAGE	GAS COMPRESSOR	NO
	STORAGE CYLINDERS	NO
	STORAGE CASKS	NO
GAS MAKEUP SUBSYSTEM	ALL	NO
UTILITIES	ALL	NO
	INSTRUMENTATION	X (PARTIAL)*

*SOME INSTRUMENTATION ALSO APPLICABLE TO LARGER SYSTEM.

4/25/80 UNION CARBIDE

DWG. NO. K/G-80-1260

SOME CONCERNS ABOUT RELOCATION OF THE ORGDP SELECTIVE ABSORPTION PILOT PLANT TO TMI-2 AND INCORPORATION OF THE TEST UNIT AS PART OF A KRYPTON REMOVAL SYSTEM THERE:

- ONLY HALF OF THE MAJOR EQUIPMENT ITEMS NECESSARY FOR THE TMI-2 APPLICATION ARE USED IN AND AVAILABLE FROM THE PILOT PLANT
- EXISTING REFRIGERATION SYSTEMS ARE OLD
- OTHER ITEMS WHICH MIGHT BE AVAILABLE DO NOT APPEAR TO BE ON THE CRITICAL PATH. THEREFORE, SCHEDULE ADVANTAGES ARE NOT APPARENT
- THE PILOT PLANT FLOW RATE (15 SCFM) IS LOWER THAN WHAT WE CONSIDER TO BE A PRACTICAL MINIMUM (ABOUT 50 SCFM) FOR THIS APPLICATION
- RELOCATION COST SAVINGS (IF ANY) VERSUS NEW FABRICATION WOULD BE MODEST
- SYSTEM NOT DESIGNED FOR RELOCATION

DWG. NO. K/G-80-1262

4/25/80 UNION CARBIDE

PROBLEMS, ISSUES, CONCERNS ASSOCIATED WITH USE OF A SELECTIVE ABSORPTION PROCESS SYSTEM (~100 ± 50 SCFM) FOR REDUCING Kr RELEASE AT TMI-2

DWG. NO. K/G-80-1273

- CRITERIA FOR Kr-85 STORAGE
- BASIC OBJECTIVES AND CRITERIA WHICH GOVERN PROJECT SCOPE, SCHEDULE, COST, AND PROGRAMMATIC IMPACT (IS SECTION 8 ASME ADEQUATE?, WHAT IS TARGET DF?, WHAT ARE REGULATORY REQUIREMENTS?, ETC.)
- RESPONSIBILITIES FOR PROJECT PHASES: TECHNOLOGY SPECIFICATION, DESIGN, APPROVAL, PROCUREMENT, CONSTRUCTION, OPERATION (DOE, NRC, AE'S, GPU/MET.ED.) AND INTERFACES AMONG PARTICIPANTS
- POTENTIAL LONG LEAD HARDWARE ITEMS, SUCH AS:
  - SEALED GAS COMPRESSORS — 8 - 10 MONTHS
  - HEPA FILTERS — 10 - 12 MONTHS
  - REFRIGERATION SYSTEM — 8 MONTHS
  - CONTROLLERS/INSTRUMENTATION — 6 MONTHS
  - Kr-85 CASK, CYLINDERS — LONG ??
- BUILDING ISSUES (AVAILABILITY, ETC.)
- EXACT COMPOSITION OF REACTOR BUILDING ATMOSPHERE

4/25/80 UNION CARBIDE

DWG. NO. K/G-80-1258

KEY ELEMENTS OF A "CRASH" PROGRAM

- EARLY CHECK WITH INDUSTRY TO DETERMINE COMPONENT AVAILABILITY (AND EVEN PLACE OPTIONS) PRIOR TO FREEZING ON DESIGN FLOW RATE
- NEGOTIATE ALL PROCUREMENTS AND CONTRACTS RATHER THAN BID
- USE ACCEPTED INDUSTRIAL STANDARDS AND PRACTICES FOR HAZARDOUS MATERIALS RATHER THAN NUCLEAR REACTOR CODES (EXCEPT FOR NUCLEAR STANDARDS FOR Kr STORAGE)
- NO REGULATORY PROCESS DELAYS
- NO SPECIAL EFFORT TO MAKE SYSTEM MOBILE (I.E., NO EFFORT TO MAKE THE UNIT GENERALLY APPLICABLE TO OTHER SITUATIONS)

4/25/80 UNION CARBIDE

DWG. NO. K/G-80-1299

PREVIOUS UCC-ND ESTIMATES OF COSTS AND SCHEDULES FOR SELECTIVE ABSORPTION UNIT FOR TMI-2

CONSTRAINTS	COST, $ MILLIONS	SCHEDULE, YR
LICENSABLE – NORMAL PROGRAM	15-20	4
LICENSABLE – 'CRASH' PROGRAM	15-20	2
NOT LICENSABLE – NORMAL PROGRAM	10-15	3-1/2 - 4
NOT LICENSABLE – 'CRASH' PROGRAM	10-15	1-1/2 - 2

BASIS: COMPLETE MOBILE UNIT, 275 SCFM CAPACITY

4/25/80 UNION CARBIDE

ALLEN E. ERTEL
17TH DISTRICT, PENNSYLVANIA
1030 LONGWORTH HOUSE OFFICE BUILDING
WASHINGTON, D.C. 20515
(202) 225-4315

COMMITTEE ON PUBLIC WORKS
AND TRANSPORTATION

COMMITTEE ON SCIENCE
AND TECHNOLOGY

Congress of the United States
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April 21, 1980

Hon. John F. Ahearne
Chairman
Nuclear Regulatory Commission
1717 H Street, N.W.
Washington, D.C. 20555

Dear Chairman Ahearne:

Having had the opportunity to review the various cleanup options presented to the Nuclear Regulatory Commission and having studied the reports on the Selective Absorbtion System prepared by Dr. Gerald Pollack at the request of Commissioner Gilinsky, I felt the Selective Absorbtion System required more consideration.

On Saturday, April 19, NRC Commissioner Victor Gilinsky and I flew to the Oak Ridge Gaseous Diffusion Plant, in Oak Ridge, Tennessee, to examine the pilot plant designed to remove Krypton-85 (Kr-85) from a contained atmosphere through the Selective Absorbtion process. This process is described on pages 6-32 through 6-38 of the NRC Environmental Assessment for Decontamination of the Three Mile Island Unit 2 Reactor Building Atmosphere (NUREG-0662). Commissioner Gilinsky and I also had the opprtunity to discuss this process with the engineers who have designed and operated this pilot plant, and officials from Union Carbide which has conducted the program under contract with the Department of Energy.

The Selective Absorbtion System has been worked on at the Oak Ridge Gaseous Diffusion Plant since 1967. The system today is a third-generation process which has been operating successfully for one and one-half years. Its flow rate is 15 cubic feet per minute. With the obvious exception of venting, the Selective Absorbtion process is the least expensive of the options presented in NUREG-0662 and could be placed in operation at TMI 2 in less time than the other options. According to the engineers at Oak Ridge, assuming the availability of materials and the necessary approvals, this system can be built and tested in about three months. This contrasts with the time requirement discussed in NUREG-0662.

Because I believe that the Nuclear Regulatory Commission, and all other active parties, are moving toward approving the venting of the radioactive gases in the damaged reactor, I am concerned that adequate consideration has not been given to the Selective Absorbtion System. The Selective Absorbtion System has already been proven to be effective, and it can be put into place quickly. Passing the gases in TMI Unit 2 through the system only once would reduce the Kr-85 in containment by a factor of 100 to 1000 times. Scaling the pilot plant up from a 15 cubic feet/minute flow rate to a rate of

4/22..To EDO to Prepare Reply for Signature of Chairman..Date due Comm: May 1
Cpys to: Chm, RF, Oliu...80-0794

200 cubic feet/minute does not represent any significant problems. The system is not a complex one and its components are all "off-the-shelf" items which should be readily available.

We must remember in assessing this option that: the Kr-85 is already in the reactor at TMI; unless we implement the Selective Absorbtion System, the Kr-85 will be vented into the atmosphere; the worst that could happen with the Selective Absorbtion System is a failure requiring venting (an option which will be otherwise approved). In addition, it is not necessary to require that the Selective Absorbtion System be built to nuclear code construction standards. This will only delay the process and, because of the small volume of gases in the system at any one time, even a total failure would not result in any major detrimental release.

I believe that venting is unacceptable for a number of reasons. The Selective Absorbtion System appears to be a viable alternative. The longer we spend debating the various options, the more we force ourselves into a situation where venting is the only alternative because of time constraints. In accordance with our converation, it is my understanding that a detailed analysis on this system will be prepared by Oak Ridge by this Friday. This detailed analysis should confirm the initial conclusion that this sytem should be utilized.

I am anxious to work with you in moving forward with this process and will do everything in my power to expedite its installation and operation.

Sincerely,

Allen E. Ertel
MEMBER OF CONGRESS

AEE/bh

cc: Hon. Victor Gilinsky, Commissioner, Nuclear Regulatory Commission
Hon. Peter Bradford, Commissioner, Nuclear Regulatory Commission
Hon. Joseph M. Hendrie, Commissioner, Nuclear Regulatory Commission
Hon. Richard T. Kennedy, Commissioner, Nuclear Regulatory Commission
Hon. Charles Duncan, Secretary, Department of Energy
Mr. George W. Cunningham, Assistant Secretary for Nuclear Energy, DOE
Mr. Jack H. Watson, Jr., Assistant to the President for Intergovernmental Affairs
Hon. Richard Thornburgh, Governor, Commonwealth of Pennsylvania
Mr. Herman Dieckamp, President, General Public Utilities
Mr. Robert Arnold, President, Metropolitan Edison
Mr. Walter Vannoy, President, Babcock and Wilcox
Mr. R. J. Hart, Union Carbide

MICHIGAN STATE UNIVERSITY

COLLEGE OF NATURAL SCIENCE · DEPARTMENT OF PHYSICS

EAST LANSING · MICHIGAN · 48824

March 31, 1980

The Honorable Victor Gilinsky
Commissioner
US Nuclear Regulatory Commission
1717 H Street, NW
Washington, DC 20555

Dear Dr. Gilinsky:

Here is my report on the suitability of the Selective Absorption Process System for removing Krypton-85 from the atmosphere of the reactor building of Unit 2 at Three Mile Island. This is a follow-up to my previous report, of March 24, to you. In order to prepare this and to learn more about the system at first-hand I visited and talked with the group which developed it at the Oak Ridge Gaseous Diffusion Plant. While I was there I examined as well as I could the pilot-plant scale system which they've constructed. I also read and studied some of their reports. I asked them many questions and I made the questions as probing as I could; I think that I have an accurate picture of their system and its properties.

My main conclusion is that the Selective Absorption Process System could be used to remove the Kr-85 from TMI-2 and would probably do an excellent job. My visit to the facility confirmed my opinion that Selective Absorption is the best choice of the five alternative methods for Kr-85 decontamination discussed in the NRC Staff Report's Environmental Assessment.

The Cryogenic Process System is the second best choice, in my opinion. I do not have any first-hand experience with the Cryogenic Process System so this is still somewhat tentative. The Reactor Building Purge is my third choice. In view of what I learned about the Selective Absorption

System, I think that there is probably no need to actively consider further the Charcoal Adsorption System or the Gas Compression System. These were, respectively, the fourth and fifth choices in my report of March 24. I see now that they would have all of the disadvantages but none of the advantages of the Selective Absorption System.

The only disadvantage of the Selective Absorption System compared to any of the other four alternatives is that it would take longer and cost more than the Reactor Building Purge. The advantage of Selective Absorption over purging is that it is a zero-release system and so would have minimal public and environmental effects. I understand that during the time it would take to set up a decontamination system, emergencies could arise which would require that extensive work be done in the reactor atmosphere. I haven't included this problem since I don't know its details.

In the main body of this report I shall discuss several of the scientific, engineering, and other aspects of the Selective Absorption System which bear on its use at TMI-2. I have kept the discussions brief but I am prepared to provide you with quantitative details of any of the points.

A. <u>How the Selective Absorption System removes Kr-85 from a contaminated atmosphere</u>.

Krypton is preferentially soluble in the common refrigerant Freon (a fluorocarbon, CCl_2F_2). The idea is to dissolve Kr-85 in a counterflowing stream of liquid Freon. The contaminated reactor atmosphere is fed into the absorption section of the system where the refrigerant is cold and absorbs Kr-85. Absorbed gas is carried by the stream to the stripping section of the system where the refrigerant is heated and therefore releases the Kr-85 and other volatile soluble contaminants into a collecting system. The Kr-85 ultimately is concentrated in standard-sized gas cylinders.

B. <u>What has been done with the system so far</u>.

The group at the Oak Ridge Gaseous Diffusion Plant (ORGDP) has been working on the Selective Absorption System since about 1967. From 1974-1978 they operated a second generation working, pilot-plant system (a three-stage system with separate columns for absorption, intermediate stripping and final stripping). They made extensive tests on studying, varying, and optimizing the parameters of this system in order to improve it and they have constructed a third generation pilot-plant system. This system is an improved, single-stage, system and has been operating for 1 1/2 years. It is operated regularly now for 4 days a week. It was working when I visited ORGDP and I examined it.

The principle motivation of the ORGDP group in developing this system was for use to treat and decontaminate the off gas from nuclear fuel reprocessing plants. However, the system can also be straightforwardly adapted and used for cleaning radioactive atmospheres from a reactor accident such as the one at TMI-2. The relevant divisions at ORGDP have considered the problem of the TMI-2 reactor atmosphere decontamination and they have written a preliminary proposal on how they would go about it. I read the proposal and the scientific and engineering parts seem to me to be solid.

There is a unique aspect of this Selective Absorption System which strengthens it. There are three people at ORGDP who have worked on the system extensively: Drs. J. R. Merriman, M. J. Stephenson, and B. E. Kanak. A large fraction of their scientific careers has been involved with the system and it has been the subject of doctoral and master's degree theses. This means that the group has a firm, first principles, understanding of the system. I think that is an invaluable advantage to have in using the system and scaling it up.

C. <u>What are the scientific and engineering considerations in using this system for the cleanup at TMI-2?</u>

The Selective Absorption System that is proposed for use at TMI-2 would process about 250 Standard Cubic Feet per Minute (SCFM) of reactor atmosphere. It would achieve 90% removal of Kr-85 on a single pass of atmosphere through the column and provisions could be made for recycling. Such a system would clean up the reactor atmosphere in about 60-70 days, once it was functioning in place.

The scale of the system that would have to be built for TMI-2 is naturally larger than the pilot-plant scale. For example: The present pilot plant uses absorption column tubes that are 3" in diameter, whereas the TMI system would use tubes about 20" in diameter. The pilot plant has a throughput of 15 SCFM compared to 250 SCFM for the TMI system, as mentioned above. In my judgment this scale-up would cause no problems.

Because the system has built-in elasticity of design, it will probably be easy to optimize and, if necessary, trouble-shoot. For example: (a) One can vary the pressure and temperature, presently planned at 125 psig and -30°F, since these regions are convenient to work in. (b) One can vary the gas throughput rate as well as the solvent flow rate. (c) In the pilot-plant scale, separations in a single pass of 99.9% for Kr-85 have been achieved but for application at TMI only 90% is required in a single pass. (d) One can vary the number of cylinders and the pressure inside them for collection and final storage of the Kr-85; presently this is planned at about 5 standard cylinders at 500 psia.

There is one important point which, in my opinion, requires further experiment now. That point is the different Kr concentration scale that we encounter at TMI-2 compared to the pilot plant. The pilot-plant system has been tested at Kr concentrations from 0.1 ppm to 880 ppm. However my calculations show that at TMI-2 the Kr-85 concentration now is 0.7 ppm and it will probably be necessary to reduce the total Kr levels to well below 0.1 ppm. It is important to test the pilot-plant system at these lower levels to be sure that good separation factors can be achieved. I am fairly confident that this will not be a serious problem but it must be tested.

D. <u>What is the cost and how long would it take to set up a Selective Absorption System at TMI-2?</u>

The people involved give cost estimates for the Selective Absorption cleanup of Kr-85 ranging from $4-20 million and estimated times from 1 1/2 to 4 years. The higher cost and longer time estimates are due to concerns they have about special expensive hardware, materials and techniques required for the system to be built and operated rigorously to nuclear code construction standards. The estimates also reflect their concerns about potential delays due to legal and political problems.

Finally there is feeling that there may be unforeseen delays and expenses associated with interactions between DOE and General Public Utilities and NRC. In this connection it's natural to ask whether in the interests of economy and speed in the cleanup: Is it possible to smooth these interactions? Is it advisable to modify the construction standards?

In contrast it should be emphasized that scientific and engineering considerations alone are consistent, in my opinion, with a time of 1 1/2 years and a relatively low cost estimate. The Selective Absorption System is less complicated than current automobile emissions systems, its principles of operation are simpler and it is easier to fix.

E. <u>Other advantages associated with developing the Selective Absorption System for use at TMI-2</u>.

(1) The system could be mobile. One design proposed by ORGDP would fit on five trailers so that after use at TMI the system could be used at any future reactor accidents.

(2) Once the system is scaled up for use at TMI, it would be closer to the further scale up necessary for decontamination of off gases from operation of reprocessing plants. That is a problem that we shall soon have to solve and this is probably a good approach.

(3) The present system traps tritium (99.99% removal in a single pass). Since there is a lot of tritium in the reactor building at TMI (3.6×10^{-5} $\mu Ci/cm^3$), one could use the same selective absorption system for the tritium cleanup.

(4) Once the system were developed for use at TMI and should it prove as efficacious as anticipated in the cleanup, the portable system might be marketable worldwide (DOE has a patent on the process).

(5) Finally, and somewhat conjectural: The system collects and concentrates Xe as well as Kr. This opens up the possibility that a Selective Absorption System could be used to decontaminate the off gases associated with normal operation of nuclear reactors. One might then be able to achieve essentially zero radioactive gas release from reactor operation. I believe this would lead to better public acceptability of nuclear power.

Report submitted by,

Gerald L. Pollack

Gerald L. Pollack
Professor of Physics

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The Honorable Victor Gilinsky
Commissioner
US Nuclear Regulatory Commission
1717 H Street, N.W.
Washington, DC 20555

Dear Dr. Gilinsky:

Here is my report on the alternative methods for removing Krypton-85 from the atmosphere of the reactor building of Unit 2 at Three Mile Island. In preparing this report, I have studied the NRC Environmental Assessment as well as other relevant scientific and engineering literature. It's a hard problem and my conclusions are still tentative. I should like to get first-hand experience with the alternatives. Then I will be able to reconsider and firm up the conclusions.

The first part of this report is an introduction to the problem. The second part is a brief discussion of each of the five alternatives; they are discussed in order from most preferred, in my opinion, to least preferred.

I. Introduction

The problem we need to solve is how to decontaminate the atmosphere of the reactor building at TMI-2. The main contaminant is Kr-85, a radioactive inert gas. The resulting radioactivity concentration now is high, 1.0 $\mu C/cm^3$. The atmosphere must be cleared so that there can be free and safe access to the building to get on with the rest of the cleanup. We would like the decontamination to be safe, with minimal exposures to the public and to workers, and to be as inexpensive and quick as possible within these constraints.

The amount of Kr-85 that is in the reactor building is 57,000 Ci. The particular difficulties involved with getting rid of Kr-85 are: (a) It has a long half-life (10.76 years) so that it decays slowly, (b) It is an inert gas so there are no easy chemical means for removing it, and (c) It is mixed in with the 2×10^6 ft^3 of air in the reactor building.

Although the radioactivity due to the Kr-85 is large, the amount of gas is fortunately small. The actual amount of gas is only 1.7 moles, which at standard temperature and pressure (STP) conditions would occupy only 38 liters or 1.4 ft^3. Thus if the Kr-85 gas could be efficiently separated out it would all fit easily into one standard-sized gas cylinder at low pressure. As it is there are alternatives available which will contain the Kr-85 in a few gas cylinders at somewhat higher pressures. In my judgment the most natural solution to the problem is to take advantage of this; I recommend a method that in the end concentrates the gas in cylinders and, as far as possible, has zero release to the atmosphere. Fortunately two of the available alternatives do that, the Selective Absorption System and the Cryogenic Processing System.

Will long-term storage of Kr-85 be safe? If the Kr-85 gas is to be concentrated and stored we must provide for long-term safe storage. I believe that this is not difficult to do when one considers the nature of the emitted radioactivity. For Kr-85, 99.6% of the nuclear decays result in emission of a beta ray of energy 690 keV. Since this radiation consists of charged particles it will be stopped by the walls of any containing vessel. The other 0.4% of the nuclear decays emit mainly gamma rays of energy 514 keV. I have calculated that the intensity of this radiation is reduced by a factor of 10^6 by lead shielding 3.25" thick or by 27" of concrete. Thus the storage might simply consist of a few stainless-steel cylinders of gas contained in a few bookcase-sized lead and concrete containers. Outside these containers the radiation will be undetectable. If the storage is carried out for 100 years (i.e. 9.3 half-lives) the total radioactivity will be down to 91 Ci. I believe that good quality stainless-steel cylinders and valves will last this long without significant deterioration.

II. Alternative Methods for Decontaminating the Reactor Building

I have tentatively concluded that the best method of those available is the Selective Absorption Process System and that the second best method is the Cryogenic Process System. The remaining methods are, in my opinion, all considerably less desirable than these first two. The Reactor Building Purge is, on balance, my third choice, the Charcoal Adsorption System is fourth, and the Gas Compression System is fifth. Each of these systems is discussed briefly below.

A. Selective Absorption Process System

The operating principle of this system is that Freon (CF_2Cl_2) absorbs noble gases. The idea is to run the reactor building atmosphere through a column of liquid Freon. The Kr-85 will be removed from the air, the decontaminated air is returned to the reactor building, and the Kr-85 may be isolated and concentrated.

In my opinion this system is probably the best alternative for these reasons: (1) The end product is radioactive Kr-85 in a few standard-sized gas cylinders. I believe that these can be relatively easily handled and stored safely as previously described. (2) It is a zero-release system, i.e. in principle no Kr-85 will get out to the atmosphere and thus there will be minimal offsite doses. (3) The system has already been extensively developed to a pilot-plant scale at Oak Ridge National Laboratory. The Oak

Ridge-Union Carbide people are apparently confident that the system can be satisfactorily scaled up. (4) Except for purging, this system is the least expensive alternative ($4-10 million) and the fastest to bring into operation (about 1 1/2 years). (5) The pressure and temperature at which the system operates are easily handled.

My main hesitation with recommending this system is that I have no first-hand experience with it. I would like to study it more closely and learn more about the details of its operation before making a final judgment.

B. Cryogenic Process System

The operating principle of this system is that Kr-85 may be separated from the other gases in the reactor building atmosphere by preferential condensation. The idea is that the boiling-point temperature (120°K) and the triple-point temperature (116°K) of Kr are higher than those of the nitrogen and oxygen in air. Thus if the atmosphere is exposed to a suitably cooled surface, the Kr-85 will be preferentially deposited by condensation. This allows for concentration of the radioactive gas.

This system is probably the second best alternative. These are some of the considerations: (1) The end product is isolated radioactive Kr-85 which could, for example, be contained in 57 gas cylinders each with 10^3 Ci. These could be safely handled and stored. (2) Unfortunately, this system is rather complex and somewhat more expensive ($10-15 million) than the Selective Absorption System. (3) Offsetting this is the advantage that there is an available system, which is about to be scrapped, which could be purchased and used at TMI. I take it that the system is functional and that its characteristics are well-known to the present owners. (4) The system is not quite a zero-release system; about 0.1% of the Kr-85 would be released.

C. Reactor Building Purge

The operating principle of this system is that the Kr-85 can be released through the plant vent stack over an extended period. For the suggested 60-day release period the average emission rate is 0.66 Ci/min. This is the least expensive and quickest of the alternatives but it has the greatest public dose of radioactivity. One can calculate from the usual meteorological considerations that the offsite public dose would be within design objectives.

The idea behind this system is the antithesis of the previous alternatives (A and B). Those previous alternatives ended up with maximum concentrations of isolated Kr-85 with minimal release of radioactivity. This system produces maximum dilution of the Kr-85 by releasing all of it to the atmosphere.

In my opinion this alternative is substantially less desirable than the Selective Absorption or Cryogenic Process Systems. Some of the considerations are these: (1) Meteorological conditions are notoriously hard to predict and values of the meteorological dispersion parameter (χ/Q) are notoriously uncertain. Once the Kr-85 goes out of the stack it is out of control. (2) As long as the Kr-85 is contained, the beta rays it emits will be absorbed by the container walls. It is only when the Kr-85 is in the open air that these beta rays can give doses to skin, lung epithelia, etc. (3) In my opinion some of the claimed advantages are largely semantic. Thus it is claimed (page 6-7 of NUREG-0662) that purging "eliminates the need for long term surveillance of Kr-85." I submit that the need for surveillance is still there after purging but our ability to carry it out is unfortunately eliminated. (4) Finally, I think that considerations of public sentiment and psychological stress point strongly against this alternati e.

D. Charcoal Adsorption System, and

E. Gas Compression System

These systems can be discussed together since they share some common features. The systems both remove the Kr-85 from the reactor building atmosphere and the resultant radioactive gas is stored in large volume containers. Both methods are expensive and would require construction of large permanent structures on site, in which the Kr-85 is stored in dilute form.

In the Charcoal Adsorption System the Kr-85 is ultimately adsorbed on charcoal and stored in from 150 (refrigerated adsorber) to 450 (ambient adsorber) tanks each 60 feet high. In the Gas Compression System the Kr-85 is ultimately stored under pressure mixed in with 23,000,000 ft^3 (STP) of air. Since the Kr-85 alone would occupy only 1.4 ft^3 this seems like a needlessly inefficient procedure. The storage procedure for this alternative involves 28 miles of pipe of 36" outside diameter. In my opinion the problems of maintaining the large Kr-85 storage systems for long term, and free of leaks, as required by both of these alternatives are very serious.

Report submitted by,

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