Second Visit-Three Mile Island
May 31-June 1, 1979

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My first visit to TMI was on May 8-9. This work is performed as technicial assistance to NRC under R-292

General Observations.

All of my comments are based on actual observations or discussions with the people involved. Of course there is much that I could not observe and so I am dependent on what I was told. The cooperation from all that I met was excellent.

The general plant appears to have been cleaned up considerably since my last visit. Security around the innermost vital area is tighter than before. Persons entering were frisked and briefcases examined. Also I was challenged frequently for my camera, for which I did have a pass.

Respirator Program.

Ray G. Ritthamel, Manager of Health and Safety for GPU Service Corp., is in charge of the respirator program. He is the supervisor of Russ Witzke, Industrial Hygienist, who appears to run the day-to-day operations of the program. The purchase and control of respirator equipment is apparently under the control of GPU except that Westinghouse retains this control for its own employees.

Air Purifying Respirators.

I reported the iodine sorbent results recorded by Gerry Wood to the GPU personnel; Ernie Murri, NUS corporation, acting as HP advisor to GPU, and to Tom Murphy, NRC HP, John Collins being occupied elsewhere.

The charcoal in the MSA GMR-I canister is not effective against methyl iodide. Five% TEDA impregnated charcoal in the Scott 600252-75 canister is highly effective against the methyl form. MSA supplied to LASL some 2% TEDA charcoal both loose and in canisters. This material immediately shows about a 3% penetration for methyl iodide corresponding to a canister protection factor (PF) of 33. I contacted MSA about the possibility of preparing a material with greater impregnation. MSA stated that their tests using the procedures for testing space filters indicated higher efficiency for methyl iodide.

Approximately 30-50 people are wearing air-purifying respirators daily.

Observations of Respirator Use.

I observed suitup, entry, and exiting from a contaminated area, the "Dog House," Auxiliary and Fuel Handling (Ox) building. The building is kept under negative pressure with a series of plywood air locks having been constructed to preserve the pressure differential.

Fitting begins in the locker room. Suiting up consists of donning several sets of cloth anti-C clothing and plastic rain gear, including plastic boots. The wearer has the option of having the cloth or plastic worn next to the skin. The skull cap is worn under the respirator straps but the dressing assistant is careful not to let the cap under the mask seal. The MSA Ultravue and GMR-I canisters were in use during my observations. The assistant assembled and checked the respirator visually, including the exhalation valve, and assisted the wearer in donning it. Then an isoamyl acetate fit test was performed. Only after the wearer and fitter were both satisfied was the hood tied around the facepiece.

The suited workers then log in at a desk where they are issued a dosimeter to compliment the TLD worn by everyone on site. Workers proceed through a series of air locks to the work site. Closed-circuit TV is used by the supervisor along with a PA system to control worker activity while in the comtaminated areas. A safety man available for rescue remains suited up within the entry airlock as long as men are at work inside.

Upon return the workers undress within the air lock, and reenter the clean area wearing only their shorts and dosimeter. They are then logged out and time of exposure is recorded. Showers are not provided. I was told that the site has great difficulty in handling contaminated water, as no discharges from the plant are permitted under a court injunction.

The present SOP for the use of air purifying respirators contains the following:

a) Allowable devices include an MSA full facepiece (Ultravue not specified) with GMR-I canister and a Scott full face with TEDA impregnated charcoal canister.
b) A fitting test is required, presumably a DOP quantitative test. Also an isoamyl acetate test is required before each entry.
c) The SOP implies that they are taking credit for a PF of 50, I am under the impression that NRC NRR has granted this.
d) Air purifying equipment can only be used to 100X the MPC or 9×10^{-7} uCi/cc for I-131. The maximum time that an individual can stay in the atmosphere is 20 MPC-hours for seven consecutive work days.

e) Whole body counting, previously done daily, is now required weekly, for persons working in areas that exceed the MPC. In addition any one who exceeds 10 MPC-hours within seven consecutive days is to be counted before the next entry. Persons whose body count indicate an uptake of greater than 70 nCi I-131 will not do further work in iodine with air purifying respirators until an evaluation is made.
f) Canisters may be used for only one shift, but may be reused for multiple entries during that shift.
g) There are detailed instructions for the taking of air samples to establish the level of contamination in the workplace.
h) I do not believe that any of the above restrictions apply to workers in self-contained breathing apparatus.

The men can work for only about 1 hour at a time. Their condition upon return to the clean area is very wet and tired. There is no body ventilation while dressed out and I believe that the heat loading is their greatest burden, rather than the respirator. The men I spoke to prefered the Ultravue to the Scottoramic, they felt that it was more comfortable and stayed on the face better during head movements.

While viewing the above operation, I was impressed by the health physics, respirator and supervisory personnel. Each man responsible for the safety of others acted like a "mother hen", not letting any of his charges into the work area unless he was satisfied that the clothing and respirator were comfortable and properly fitted. All of these personnel are apparently employees of Catalytic Construction.

Breathing Air Supply

I met with J. L. Bachofer, who holds a title something like Chief Engineer for Generation for GPU. He has taken on the task of assuring the adequacy and safety of the breathing air system. The breathing air supply for the reactor complex was supplied by a built in compressor using pistons with teflon rings. This has been supplimented by a portable electrically driven non-oil rotary screw compressor outside the buildings. The piping for air is entirely separate from all other lines. Air quality is sampled for the common contaminents on a frequent basis, I do not recall the exact schedule. The capacity of the system is in the order of 1000 CFM allowing about 150 users at 6 CFM each. An air receiver is included which allows the maximum number of users to exit with 8-10 minutes of air. Of course the number of users is usually smaller than 150 allowing considerably more time per user for escape. An alarm is sounded in the reactor control room when the air receiver pressure drops to 90 psi.

SCBA Use.

GPU discovered that one of their security guards, Dick Meyers, is a volunteer fireman and a trained Scott technician. He has been temporairily assigned to maintenance on the Scott Air Paks. A great deal of maintenance is required because of the heavy use of the Air Paks. They are required for all exposures greater then 50X MPC. Apparently there is no difficulty at this time in obtaining replacement parts from Scott. I discussed the check out procedures suggested by Dick Ronk of TCB, who recommended both blowing and sucking on the regulator to detect a damaged diaphram. Meyers may be able to fabricate a test jig to facilitate this testing. I would suggest that Meyers is more valuable to GPU working on breathing apparatus than as a security guard, and his activities should expand to maintenance on air purifying equipment also. Bottle filling is done from a cascaded bottle supply filled by an Eagle compressor and purifier station similiar to the Robbins systems with which we are familiar.

Inspection of SCBA stored on site for emergency use is done by the Safety Department, and consists of visual examination and looking at the air bottle gauge. The diaphram integrity is not checked during this routine inspection (the units used for the clean up are checked by Meyers).

Training in SCBA use consists of a short period of instruction and wearing. What is not taught is checking the diaphram by the user before use. Also I think that it is essential that the students wear the device until the alarm sounds and then until they run completely out of air. This is necessary so that they know the sound of the alarm, how much time remains, and how the device finally fails when it runs out of air.

Respirator Fitting.

I did not observe the quantitative fitting this trip, but did the last time. I continue to believe that the assigning of a PF of 50-100 to a wearer who achieves 1000 during a test is a conservative way to operate. I am concerned about the extent of the training that the wearer receives. If the mask is put on by the fitting technician during quantitative fitting, and by the dressing assistant before actual use, then the wearer may not really be learning how to don the mask himself.

Biomarine SCBA.

At LASL we have tested the BioPack 60 minute rebreather, and found it to provide protection in the same class as pressure-demand open circuit SCBA. TMI has 50 units on site, and might consider using it for operations where 20-30 minute duration is insufficient. A report of our tests on the unit is included.

Observations and Recommendations.

1. Air Supply

Mr. Bachofer appears to have taken every precaution to assure the safety and adequacy of the air supply.

2. Respirator Maintenance

It would be desirable to allow Mr. Meyers to continue to maintain the Scott Air Packs. He is well trained in this area and enthusiastic about his work. Maintenance of air purifying devices, now done by Mr. Witzke on an as needed basis, should be performed by a group of trained technicians such as Mr. Meyers. I do not have much concern about the details of the respirator laundry if the reassembly of the devices and the leak checking is performed by people directly responsible to GPU. I understand that an ATI test head and aerosol system will be purchased to check facepiece integrity after reassembly.

3. Training

Training in SCBA should be increased as discussed above. There was a case earlier where a user got lost inside a building, ran out of air, and had to remove his facepiece to escape. In this particular case there was no immediate hazard to life because the atmosphere was only slightly radioactively contaminated. However the same wearer could have been in a highly toxic or inert atmosphere where failure of the air supply could lead to death. This shows the requirement for more training and a buddy system.

4. Use of the Duo Flow Valve.

The MSA Duo Flow Valve is approved as a combination airline and air purifying (High Efficiency only) respirator. This device would have the following advantages: a) Use of supplied air would reduce dependancy on sorbents for methyl iodide with all of the problems that entails. Workers could use the air line except when entering or moving about, climbing ladders, etc. They should be able to use the air line for the majority of the work. b) The cooling provided by a continuous flow respirator could well increase the work time to two hours or longer. This might reduce the number of hours or people exposed to accomplish the same amount of work. A loose hood could be placed completely over the face piece which would reduce the contamination on the mask. c) All of the Ultravue facepieces on site (except pressure-demand units) can be used, with no modifications, in the continuous flow mode with the duo-flow valve. d) The valve is not approved with an iodine canister, but neither are any of the iodine canisters now in use at TMI approved.

5. Sorbent for iodine.
It would be very desirable for MSA to have a sorbent effective against methyl iodide for use with the MSA full facepiece or Duo Flow Valve. There are several alternatives such as 5% TEDA charcoal, silver zeolites, or other materials.

6. Qualitative Fitting
I am very pleased with the care used in dressing the work crews, and the qualitative fitting that I observed, but would suggest the use of irritant smoke rather than isoamyl acetate, as being a somewhat better test.

7. Use of Rebreathers
GPU must decide if the advantages of longer life and less weight of the Biomarine 60 minute unit exceed the difficulty of fielding another class of device different from any others on site. Extensive training will be required both by the wearers and maintenance personnel before the BioPack can be used.

Test Results BioMarine BioPaK 60P
Alan Hack, Los Alamos Scientific Laboratory
June 14, 1979
Preliminary Report

I visited Three Mile Island (TMI) on May 8-9, 1979 at the request of NRC Division of Health Standards (R-292) to advise and assist in respiratory protection for the clean up. While there I learned that GPU had purchased 50 BioMarine BioPak 60P SCBA. The units were not being used primarily because no one there was familiar with rebreathers. At this time it was not clear if the Scott Air Paks being used at TMI could be kept in service because of the problems that Scott was having with failed diaphragms. I borrowed two units from TMI and brought them back to LASL for a quick evaluation. We had intended to evaluate all available rebreathers for NRC this year under R-405. What follows is an interim report for use by NRC at TMI. The data included here will be combined with test results on the other units when a formal report is made to NRC later this year.

The BioPak 60P is a NIOSH approved, TC-13F-85, positive pressure 60 minute rebreather. It weighs about 24 pounds, and uses the Swedish AGA full facepiece. The 6 liter oxygen bottle uses a standard medical oxygen yoke for connection. There are only two controls, the oxygen valve and a bypass valve. The end of life alarm is a whistle that sounds for one minute when approximately 25% of the oxygen remains. Carbon dioxide (calcium hydroxide) sorbent is supplied in sealed bags and poured into the scrubber assembly before use, similiar to the old MSA McCaa 2 hour apparatus. Positive pressure is maintained by spring pressure on the breathing diaphragm. The instruction manual is unusually complete for breathing apparatus. The device duration is greater than one hour, even when subjects were running at 5-6 MPH on a treadmill, or running around the building. Oxygen content of the facepiece was in the range of 60-80%.

Protection Factors.

The two units returned from TMI were tested on anthropometrically selected test subjects according to the test schemes developed by LASL for NIOSH and others. Fred Parker and Mark Grady of BioMarine visited LASL on May 17-18, to observe and assist in the testing. They brought with them a modified unit which contained larger oxygen tubing to increase the system's maximum flow rate.

When tested, the original unit show a maximum flow rate of 0.8 CFM, and the modified system 3.4 CFM.

Mask Pressure.

The pressure in the facepiece was measured on a variable reluctance gauge and preserved on a strip chart recorder. The

lowest pressures occurred on inhalation, and the highest on exhalation. These maximum and minimum values were averaged and compared to the pressures measured with open circuit SCBA.

Pressure Recorded in the Mask While Being Worn
Demand 25 subjects, Pressure-Demand 10
Inches water column

Mask	Demand		Pressure-Demand	
	Inhal	Exhal	Inhal	Exhal
MSA	-0.7	0.3	0.5	2.6
Scott	-0.9	0.08	0.4	2.3
Surviv	-0.9	0.3	0.7	2.4
BioPac 60P (6 test subjects)			0.33	1.74
BioPac Modified (10 test subjects)			0.6	2.05

Both the minumum and the maximum pressures recorded for the 60P are lower than for the open circuit devices. Also as will be shown below, several test subjects showed mask leakage. Mr. Parker made further modifications on the prototype that he had brought from the factory to increase the positive pressure. The modified unit now has a mask pressure range similiar to that shown for pressure-demand open circuit equipment. This new unit is not approved, but the company intends to submit it to NIOSH for approval as a modification.

Quantitative fit tests were performed using DOP aerosol similiar to other recent LASL testing. The test results are shown below. The protection factor is the leak recorded by the individual divided into 100. The first several subjects were tested on both the original (approved) unit and the modified one. As the modifed unit was clearly superior, all subsequent testing was done only on the modified unit.

Protection Factors of the BioPak 60P Rebreather

Subject	Original PF	Modified PF	Facial Box	Leakage created with finger stuck through mask seal (PF)
J mC	300	20k	9	20k
ODB	20k	11k	8	(beard)
BJS	20K	20k	8	20k
AH	20k	20k	1	20k
JG	-	20k	4	-
AT	20k	20k	3	20k
KC	10k	20k	4	-
RB	-	20k	2	-
MM	-	20k	5	-
SD	-	-	7	
(incomplete test, one exercise produced a 1.5% leak, use of the bypass required 5 min to clean out to 0.015%)				
MP	-	20k	8	-
JM	-	11k	1	11
DM	-	16k	3	7
SV	-	20k	6	20k
MP	-	16k	7	8
LM	-	20k	10	16
VW	-	3k	6	20k (leaks along both sides of face)
KP	-	5k	7	- (out of air 6 min)
LM	-	6k	7	8 (" " " 14 min)

Facial boxes refer to the facial sizes of the test subjects, face length and width, as shown in the figure at the end of this report. Fifteen of the nineteen subjects tested achieved very high protection with the 60P. Only three small female faces showed leakages greater than about 0.01%. In two of these three cases the unit was blowing excess oxygen in an attempt to maintain the positive pressure, which accounts for the very short duration.

For comparison, recent tests on four U. S. open circuit pressure-demand SCBA produced the following results: Ten test subjects each wore the units. In two of the units all ten achieved PF of 20 000, or better. In the third, one subject made less than 5000 all others 20 000. The fourth unit had two subjects make 20 000, 7 make 10 000, amd all achieve 5000.

In general, the protection provided by the 60P is in the same range as that provided by open circuit positive pressure apparatus. It is necessary for wearers to perform the positive

and negative pressure checks before wearing the device for the first time.

Another consideration is the time required to clean out the system if a leak does cause the introduction of a contaminent. With an open circuit device, the mask atmosphere is vented during each exhalation, and the mask is filled with clean air with each inhalation. In all rebreathers however, the mask atmosphere will recirculate any contamination until it is removed by being vented, adsorbed on the scrubber, or cleaned out by the lungs. Use of the bypass can assist in this cleaning at a loss of operating time. The following table shows the time to clean out the system. At zero time the respirator was taken into the chamber not being worn. A leakage of 96% of the chamber concentration was seen. Then the mask was donned oxygen turned on and the clean up observed. The bypass was operated for a few seconds several times to speed up the clean out period.

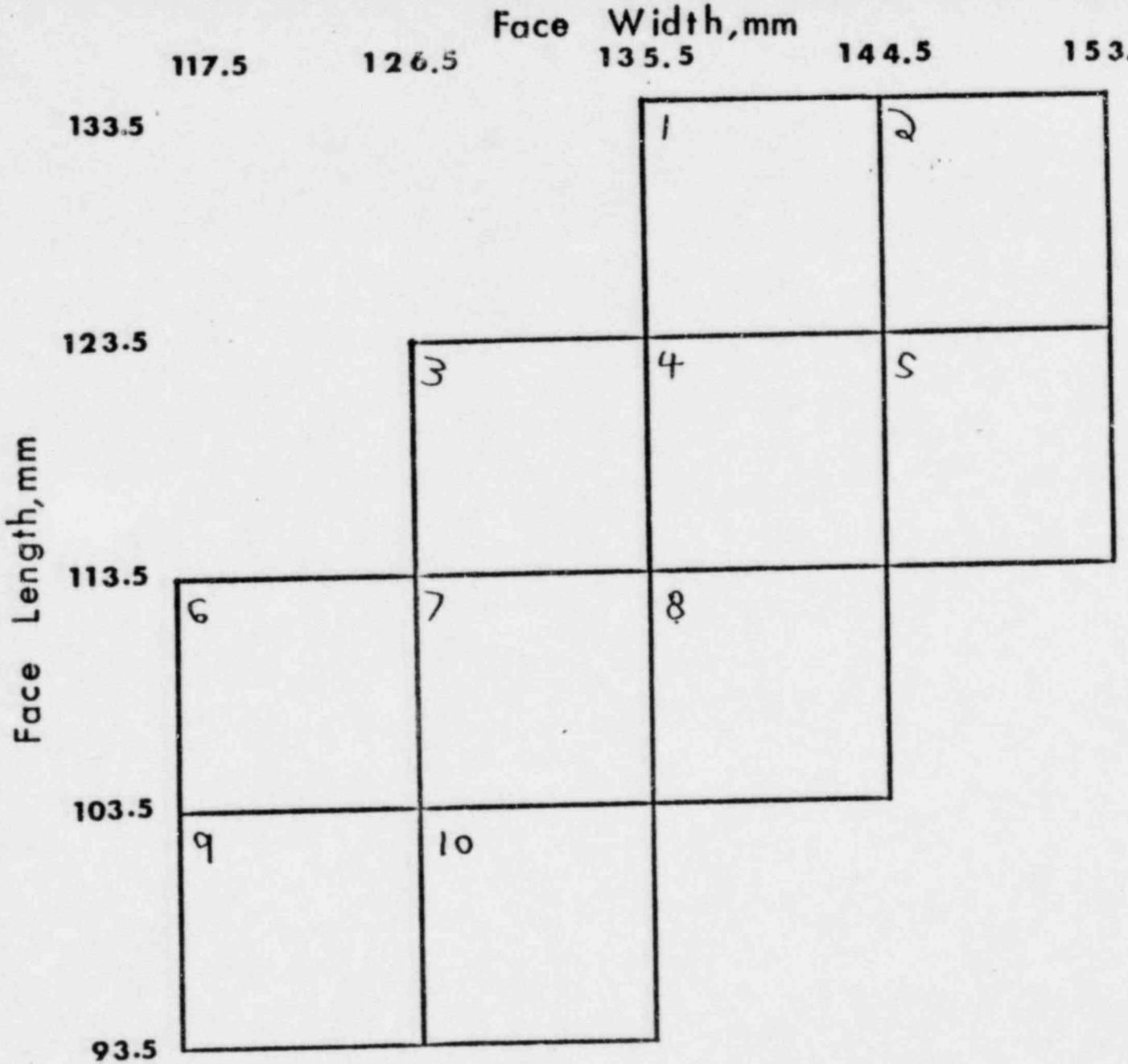
Subject AH, 60P Modified Clean out time

Time	Leak
0	96%
15 s	4
30 s	5
45 s	2.6
1 m	2.0
1.5 m	1.0
2.0 m	0.3
3.0 m	0.05
4.0 m	0.03
5.0	0.01

Our technicians, recently trained by Bureau of Mines instructors in mine rescue apparatus, believe the BioPAk to be sturdy and easy to maintain. However because the units are different from the more familiar open circuit SCBA, persons using the Biopaks will have to be trained in the differences between open and closed circuit devices.

In summary, the advantages of the device are true one hour duration, light weight, and ease of maintenance. Possible problems are requirement for retraining of personnel, recirculation of contamination, and possible risks (unknown at this time) of oxygen rich environment on fire or explosive hazards.

These conclusions are preliminary, reported at this time for the possible use of personnel at TMI. A continuing study of all types of recirculating SCBA is under way now, sponsored by NRC, with results expected in FY 1980.


Face Width, mm
117.5
126.5
135.5
144.5
153.5
Face Length, mm
133.5
123.5
113.5
103.5
93.5
1
2
3
4
5
6
7
8
9
10