TMI-2事故における放射性ヨー素の放出量
―瀬尾・岡本論争への提言―

('84. 7. 3.)

1. 公式報告値と瀬尾批判

公式報告値 (Ci)	根拠データ	瀬尾批判
< 1.4 (S; 1) [1) 2)]	定点モニタリングデータ (Met Ed.)	地表数小(8)を考慮してもなお低すぎる[2)]
13 ~ 17 [3, 4, 5)]	Stackガス分析値(カートリッジ捕集)の時間積分[1)]	○データ平均化の長短に疑義, 事故発生初期のカートリッジ捕集効率低下?[6, 2)] ○Middletownにおける測定値と矛
10 ~ 32 [3, 5)]	補助ボイラー燃料取扱の各建屋の排気口, フィルターの捕集量[5)]	○事故前からの連続使用で捕集効率低下[2)] ○Stackからの直接流出を無視[8)]

2. 瀬尾推定値

放射性希ガスとの流出比一定として推定[6, 2)]

根拠データ	131I 推定流出量(Ci)
'79. 4/20の流出比 = 1/3,400 [7)] → 事故発生直後 1/8,800	5; 100
'79. 3/28 9:00の流出比 = 1/700 [3)]	64,000

3. 瀬尾・岡本論争

岡本	瀬尾
○ TMI事故は指導派さえ予想しなかった安全性を示した[9]	○「予想外に安全」は強引な結論[8]
∵ ①ヨー素の放出量 10Ci前後で Windscale事故の 10^{-3} 以下	∵ ①放出公表値は $\frac{1}{1000}$ ～ $\frac{1}{100}$ 過小評価の恐れ
② Levenson & Rahn 論文[10]の指摘	③「絶対起こらぬ」等の事故が起こった。
○瀬尾論文[6]読んだ時はもっともと思ったが、牛乳などの汚染ないので否定した。放射能汚染の無いことを説明せよ[11,12]	○現地を調査した人たちから「牛の飼育は低放飼料」と聞いているから、汚染ないのは当然
○ TMI事故以外にも記述あり	○データ明確化は指導側の責任[13]

4. 米国での瀬尾論文評価

(1) 論評抜きの紹介

"TMI Iodine Release 340 Times NRC Estimate, Says Japanese Scientist", Inside N.R.C., Vol 2, No. 7 (Apr. 7, 1980)

(2) 批判

J. A. Auxier から Dr. A. O. C. Nier (Univ. of Minnesota) あて私信 (Jan. 23, 1981) :「都合の良いデータだけを瀬尾は利用している」

①希ガス放出量は"生き残り"のモニター値から、②牛乳の汚染なく人体取り込みもない

5. その後の調査結果

5-1. Windscale[14]事故との比較

	Windscale	TMI
推定放出量 (Ci)	2×10^4	I5 : 5×10^3~6×10^4
主な放出時間 (hr)	24	—
放出高さ (m)	120	49+α
気象安定度	D	—
風速 (m/sec)	5	—
C_{air} (μCi/cc)	3~9Km 9×10^{-8} (計算)	NRC: 3×10^{-14}~4.7×10^{-10} Met.Ed: $<5\times10^{-9}$~6.8×10^{-7}
C_{grass} (μCi/cm^2)	<17Km 10^{-3}	max (4/3~4/16) 7.3×10^{-8}
C_{milk} (μCi/cc)	10^{-3}	max 3.6×10^{-8}
人体摂取量 (mMCi/thyroid)	約3W後 1~8	

5-2. plant内データ[15]

(1) 事故発生直後のStackガス捕集データの信頼の無さ判明

3/28 0400~3/29 2200 の間 採用データなし

∴次の3データのみ. ①"sample unlabeled" and "questionable"

②3/28 date with no time ③"1015 hours on 3/29"

(2) 燃料操作建家の排気フィルターの無効

3/31 の測定

フィルター入口モニター I. 3.7×10^{-8} μCi/cc

〃 出口 〃 I. 5.9 〃

補助建屋は入口モニター不調のため 4/18 まで測定せず

(3) 炉心内蔵量の約10% (7×10^{6} Ci) の ^{131}I 行方不明.

∵ ① 炉心外/内蔵量：

^{131}I 36%, ^{137}Cs 51%, ^{134}Cs 68%

② sump 内量不足

推定 (3/29~3/28) 17~30%, 実測 (3/28) 20%

5-3 環境データ

(1) 牛乳非汚染の原因

- 保存飼料 5.7)
- 蓄舎収容勧告 7.16)

(2) 公式報告中の C_{air} の評価

	NUREG-0600	Kemeny	Rogerin
Middletown (3/28 15:27)	特記なし	1.2×10^{-8} ^{131}I μCi/cc	引用なし 1~2mR/hのみ
Goroshoro (3/28 9:22)	9:00 sample ≦ 2×10^{-9} 9:40 sample (GeLi) 1.5×10^{-11} at 13:00	10^{-8} (Xeのため不正確と記)	10^{-8} ^{131}I と明記

(3) ハタネズミ (Meadow Vole) 甲状腺中の捕集量[17]

○測定結果

Table 1. Iodine-131 activity in the thyroids of the meadow vole (Microtus pennsylvanicus) on 9 April 1979 in the vicinity of the Three Mile Island nuclear generating plant

Site	Sample size	I-131 activity (pCi/thyroid) Mean*	Standard error
I	20	0.0$_a$	0.8
II	22	2.2$_a$	1.1
III	18	5.6$_b$	1.2

*Means with the same subscript do not differ significantly; $p < 0.01$ (Fcal = 6.76).

○ C_{air} の推定

Vole 捕集量 5.6 pCi/甲状腺(3mg) = 1866 pCi/g

をもたらす C_{air} を算定

仮定

- 吸入摂取のみ
- 摂取時間 24h
- 吸呼率は甲状腺重量に比例するとして

$$0.833\ m^3/h \times \frac{3mg}{20g}$$

- 甲状腺への移行率は人間と同じ 0.23

$$C_{air,\ ^{131}I} = 8.3 \times 10^{-9}\ \mu Ci/cc$$

$8.3 \times 10^3\ pCi/m^3$

(4) 安全審査評価値 (高浜3,4号) との比較

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文献

1) NRC概算報告書('78. 4/12) (Cf 2)

2) 瀬尾, 技術と人間, 1980年4月号

3) NUREG-0600 (Aug. 1979)

4) "Kemeny Report" (Nov. 1979)

5) "Rogovin Report" (Jan. 1980)

6) 瀬尾, 原子力工業, 26 (1980) NO.3, 49~52

7) 瀬尾, TDR-TMI-116, 1979.7月

8) 瀬尾, 朝日新聞 1982年10月12日 夕刊

9) 岡本, 同上 1982年9月7日 夕刊

10) "Realistic Estimates of the Consequences of Nuclear Accidents" M. Levenson & H. Rahn, EPRI, Nov. 1980

11) 岡本, 瀬尾あて私信

12) 岡本, 文芸春秋, 1982年12月号

13) 瀬尾, 岡本あて私信

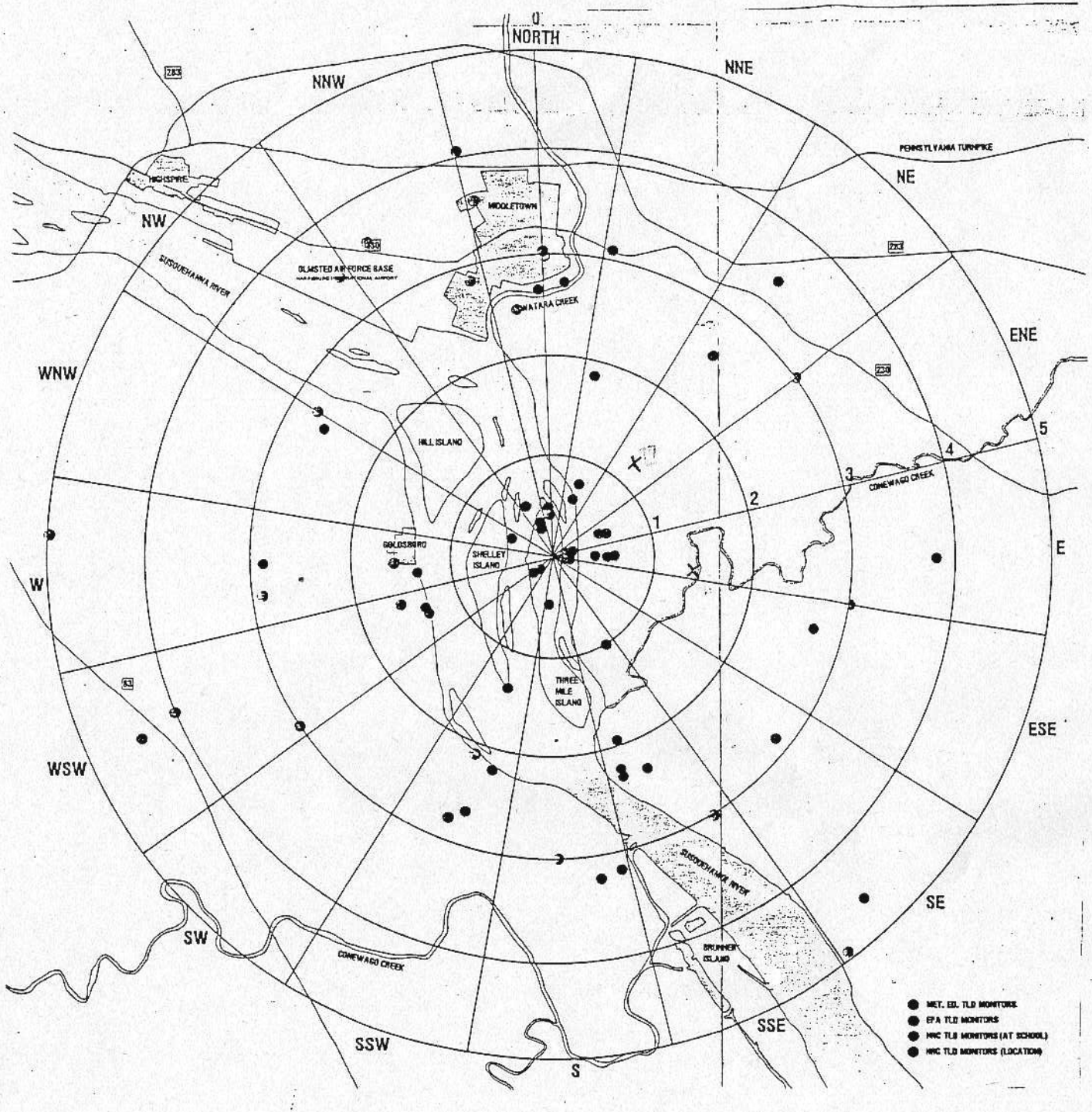
14) Windscale事故関係

- K.G. Stewart & R.N. Crooks, Nature, NO.4636, Sept. 6, 1958
- A.C. Chamberlain & H.J. Dunster, 同上
- G. Maycock & J. Vennart, Nature, NO. 4696, Dec. 6, 1958.
- A.C. Chamberlain, Quart. J. Roy. met Soc. 85 (1959) 350
- H. Clarke, Annals of Nuc. Sci. and Eng. 1 (1974) 73

15) "Iodine-131 Behavior During the TMI-2 Accident", NSAC-30, Sept, 1981.

16) 中尾ハジメ「スリーマイル島」

17) "Iodine-131 in Thyroids of the Meadow Vole in the Vicinity of the TMI Nuclear Generating plant", R.W. Field etal, Health Physics, 41 (1981) 297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NORTH
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HIGHSPIRE
MIDDLETOWN
OLMSTED AIR FORCE BASE
SWATARA CREEK
SUSQUEHANNA RIVER
HILL ISLAND
GOLDSBORO
SHELLEY ISLAND
THREE MILE ISLAND
CONEWAGO CREEK
BRUNNER ISLAND
1
2
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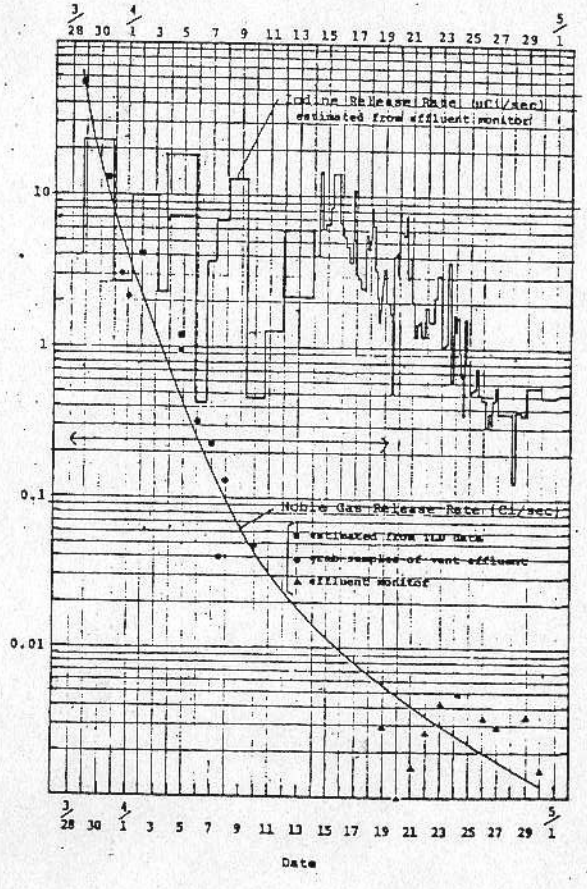
MET. ED. TLD MONITORS
EPA TLD MONITORS
NRC TLD MONITORS (AT SCHOOL)
NRC TLD MONITORS (LOCATION)


Iodine Release Rate (uCi/sec)
estimated from effluent monitor
Noble Gas Release Rate (Ci/sec)
estimated from TLD data
grab samples of vent effluent
effluent monitor
10
1
0.1
0.01
3/28 30 4/1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 5/1
Date

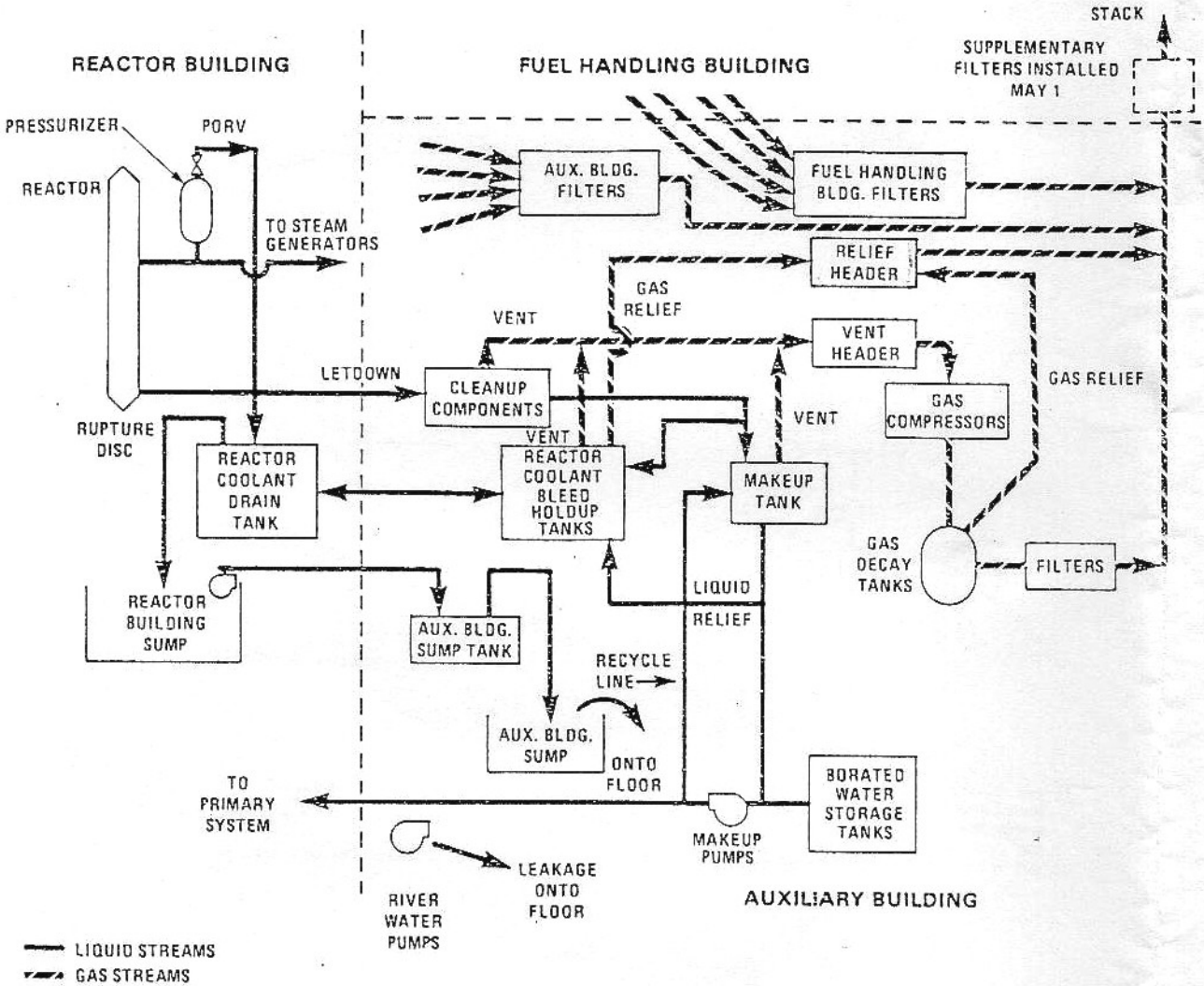
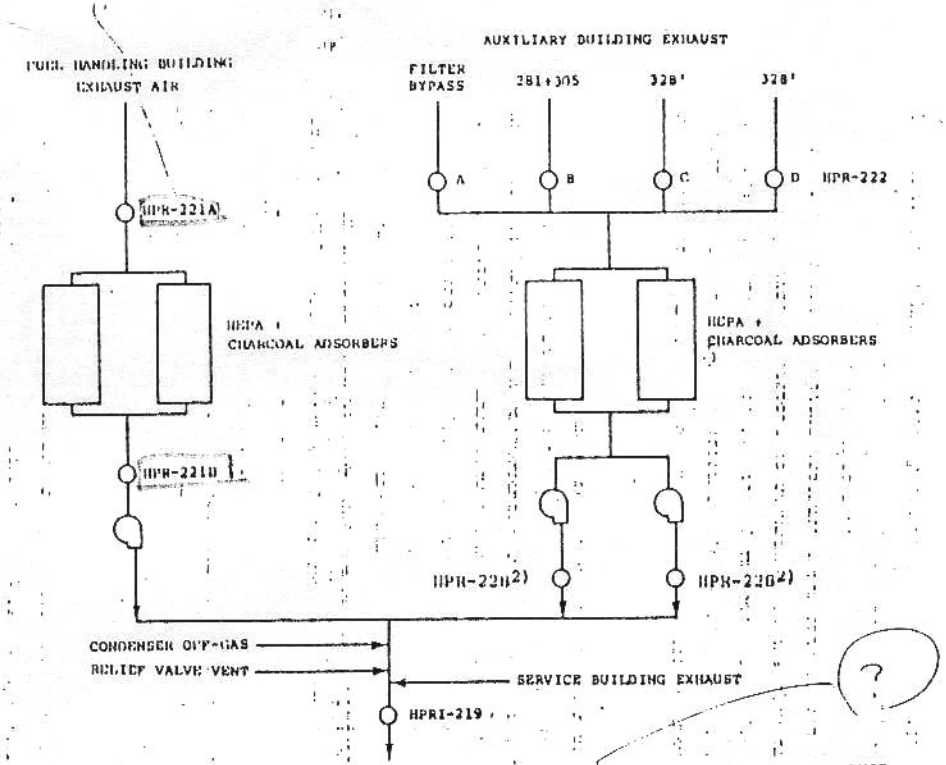


FIGURE II-12. Release Pathways

Figure C.1

SIMPLIFIED FLOW DIAGRAM



1) THE HPR-222 MONITOR IS DESIGNED TO SAMPLE FROM ONE OF 4 DUCTS. POSITION A SAMPLED A FILTER BYPASS DUCT DOWNSTREAM OF A DAMPER. IN EFFECT, POSITION A WAS SAMPLING AIR AFTER IT HAD PASSED THROUGH THE FILTERS. POSITION B SAMPLED THE COMBINED EXHAUST FROM THE 281' AND 305' LEVELS.' POSITIONS C & D SAMPLED EXHAUST AIR FROM THE 328' LEVEL.

2) THE SYSTEM IS DESIGNED SO THAT DUCT CARRYING EXHAUST AIR IS SAMPLED AUTOMATICALLY BY 228 OR 228A.

Department of Health, Education, and Welfare

TABLE II-13. Raw milk sample program for HEW[86]

Milk Supplier	Product	Feeds	Animal Location	Dairy to Which Sold	Herd Size
Christian Becker	Raw Milk	Stored	Inside	Hershey Foods Hershey, PA	40
H. Risser (Meadow Vista)	Raw Milk	Stored	Inside	Mt. Joy Farmer Corporation Mt. Joy, PA	200
Ken Glatfelter	Raw Milk	Stored	Inside & Dry Lot	Rutter Bros York, PA	125
J.R. Alwine	Raw Milk	Stored	Inside & Dry Lot	Mt. Joy Corp. Mt. Joy, PA	102
Jim Williams	Raw Milk	Stored	Inside & Grazed	Interstate Coop. S. Hampton, PA	108
Jeremiah Fisher	Raw Milk	Stored	Inside & Dry Lot	Interstate Coop. S. Hampton, PA	42
Clarence Lytle	Raw Milk	Stored	Inside & Dry Lot	Harrisburg Dairy Harrisburg, PA	102
Beshore Farms	Raw Milk	Stored	On Dry Lot	Rutter Bros. York, PA	82
Masonic Homes	Raw Milk	Stored	Under Roof	Harrisburg Dairy Harrisburg, PA	115
Jay Swope	Raw Milk	Stored	Under Roof	Lehigh Valley Allentown, PA	25
Leroy Hertzler	Raw Milk	Stored	Inside & Dry Lot	Rutter Bros. York, PA	27
Avalong	Raw Milk	Stored	In & Out	Own Processor	100
Bruce Zell	Raw Milk	Stored	Inside	Hershey Foods Hersney, PA	80
Myers Farms	Raw Milk	Stored	On Property	Hershey Foods Hershey, PA	35
Sunnyhill Farms	Raw Milk	Stored	Inside & Dry Lot	Own Processor	160
Timothy Tyson	Raw Milk	Stored	Under Roof	Mt. Joy Corp. Mt. Joy, PA Lehigh Valleys Allentown, PA	54
Paul Nolt	Raw Milk	Stored	Under Roof	Mt. Joy Corp. Mt. Joy, PA Lehigh Valleys Allentown, PA	39
H.E. Heindel	Raw Milk	Stored	In & Out	Maryland Coop.	138
Rutter Bros.	Raw Milk	Stored	Inside	Own Processor	60
Ashcombe Farm Dairy	Raw Milk	Stored	Dry Lot	Own Processor	200

TABLE II-13. Raw milk sample program for HEW—Continued

Milk Supplier		Product	Feeds	Animal Location	Dairy to Which Sold	Herd Size
Allon Hower	16	Raw Goat's Milk	Graze	Outside	Own Processor	3
Lloyd Sarver	2	Raw Goat's Milk	Stored	Inside	Own Processor	1
Dale Barshinger	6	Raw Milk	Stored	Pasture 3 hrs/day	Maryland Coop.	38
Dott L. Zirkle	5	Raw Milk	Stored	Pasture 3 hrs/day	Interstate Coop.	43
Evergreen Valley Farm	25	Raw Milk	Stored	Inside Dairy	Hershey Food Hershey, PA	42
Lester Hawthorne	5	Raw Milk	Stored	Inside	Penn Dairies Lancaster, PA	150
Menno Gruber	5	Raw Milk	Stored	Inside	Hershey Foods Hershey, PA	60
Bruce Taylor	7	Raw Milk	Stored	Inside	Rutter Bros. York, PA	50
Joseph Conley	28	Raw Milk	—	—	—	30

5.3.1.2 Milk Pathway

Population doses from ingestion of milk produced within fifty miles were also estimated. These estimates were developed using detailed cow inventories out to 5 miles. Beyond 5 miles, county milk production rates were used to estimate cow populations assuming each cow produces 34 pounds of milk per day. Milk production rates within a 50-mile radius suggest a population of about 300,000 dairy cows. The population density in sectors to the ENE, E, ESE, and SE is about 75 cows per square mile which is approximately 2.5 times that in other sectors. There is evidence from cow population surveys within five miles that stored feed is an important fraction of the dairy cattle diet. Supporting evidence was found on page 2.1-4 of the TMI-2 FSAR which shows that in three counties near the plant only 5 to 10 percent of the land is used for pasture. At the grass yield (0.7 kg wet/m^2) specified for dose calculations in Regulatory Guide 1.109 (Rev. 1), pasture grass from 7.5 percent of the land within fifty miles of the plant could provide only twenty percent of the diet for 300,000 cows each consuming 50 kg per day. For these reasons and since warnings had been issued to keep cows in barns during the period following the accident, it has been assumed in making estimates of doses due to consumption of milk that pasture grass accounted for ten percent of the average cow's diet. All milk produced was assumed to be consumed in the form of fresh milk. Conversion to cheese and other processed forms would lead to reduction in doses due to decay of the iodine-131 during processing and storage.

The portion of iodine that was released in organic form does not deposit on grass. It was measured periodically in the exhaust vent and found to be at least 50 percent of the total on the average. This has been taken into account in making the thyroid dose estimates.

		放射性希ガス				放射性ヨー素（^{131}I）		
		流出量		被曝量		流出量		被曝量(吸入)
		炉外 (%)	環境 (キュリー, 0.5 MeV γ換算)	敷地外最大 (ミリレム)	集団 (人・レム)	炉外 (%)	環境 (キュリー)	敷地外最大 (ミリレム, 幼児)
TMI (96万KWe)	米国公表	71	$1.9\sim1.7\times10^{6}$	790	$5\times10\sim6.5\times10^{3}$	86	$1.0\sim3.2\times10$	→ (6.5, 16 Km 以内)
	瀬尾	—	$>8\times10^{6}$	———	$>1.5\times10^{4}$	—	$0.5\sim6\times10^{4}$	———
高浜 (87万KWe)	重大事故	2	3.9×10^{3}	4	———	1	4.1×10	2.5×10^{3}
	仮想事故	100	2×10^{5}	200	6.3×10^{4}	50	2.1×10^{3}	1.3×10^{5}