The Impact of the Accident at the Three Mile Island On the Behavior and Well-Being of Nuclear Workers

Part II: Job Tension, Psychophysiological Symptoms, and Indices of Distress

STANISLAV V. KASL, PHD, RUPERT F. CHISHOLM, PHD, AND BRENDA ESKENAZI, PHD

Part II: TMI workers experienced much greater job tension and lower occupational self-esteem (supervisors only). At the time of the accident, TMI workers reported experiencing more periods of anger, extreme worry and extreme upset, and more psychophysiological symptoms. Six months after the accident, some persistence of these feelings and symptoms was evident. Demoralization was greater primarily among TMI non-supervisory workers. The impact of the accident was not greater among TMI workers living closer to the plant. Presence of a preschool child at home enhanced the impact of the accident, but primarily among TMI supervisors. (*Am J Public Health* 1981; 71:484–495.)

Introduction

This report presents the results of a study of nuclear workers which was conducted under the umbrella sponsorship of the Public Health and Safety Task Force, under the Charter for the President's Commission on the Accident at the Three Mile Island. The report is in two parts; the methods of the study and a portion of the findings were presented in Part I.[34]

Results

Job Tension, Self-Esteem and Perceived Support

In Part II, we continue the examination of the impact of the accident as we begin to consider some of the traditional outcome variables in the industrial psychology of mental health.[35] Job tension, one of the variables in Table 9, includes the complete scale from a classical study of organizational stress.[20] The subjects were asked to recall the work situation at the time of the accident and to note what had bothered them. It is clear that there are substantial differences between PB and TMI workers at both supervisory and non-supervisory levels. Approximately five times as many PB as TMI workers reported themselves free of all 19 sources of job tension. Item specific analysis of PB-TMI differences revealed the following items to be particularly strong in separating the nuclear workers at the two locations: too little authority, unclear responsibility, conflicting demands, inadequate information, unclear about other's expectations, and job interfering with family life.

The next variable in Table 9 is a brief scale of occupational self-esteem, obtained from a study of occupational stress among factors workers.[36] It is apparent that only among the supervisors is there a significant PB-TMI difference. If one partitions the overall variance into two main effects (PB vs TMI and supervisory vs non-supervisory) and an interaction effect, one finds that the latter is significant ($p < .05$). Thus the differential impact of the accident on self-esteem, depending on level of supervision, is statistically reliable. The plausible inference from these results is that only at the supervisory level was there a real potential for self-blame concerning the handling of the accident, a self-blame which would translate into a lowered self-evaluation six months later.

The last set of variables in Table 9 concerns the concept of (perceived) social support. The three scales come from the national study of 23 occupations; [16] each scale has the same four items and the subject responds with respect to his supervisor, co-workers, and family and friends. The two scales describing the social environment at work fail to detect any reliable impact of the accident. The third scale suggests that the TMI workers (particularly those at the non-supervisory level) perceive the social support from family and friends as somewhat less adequate than do the PB workers. However, all three scales (particularly the last one) are highly skewed in the positive direction and the effect appears to be a small one. It may be speculated that the impact of the accident was to raise the need for support from family and friends, rather than to lower their actual supportiveness.

Additional analyses of Table 9 results by sex leave the fundamental findings quite unaltered. Because of a modest correlation between job tension and age ($-.20$), it is necessary to adjust the data on the TMI supervisors for this variable. The age-adjusted mean becomes 1.78, which is still significantly greater ($p < .001$) than the mean for the PB supervisors.

Affective Responses to the Accident

Tables 10, 11 and 12 deal with results from a section of the interview in which subjects were asked about "problems which people experience from time to time." The respon-

Authors' affiliations are footnoted in Part I.

TABLE 9—The Impact of the TMI Accident on Job Tension, Self-Esteem, and Perceived Support

		Supervisory		Non-Supervisory	
		PB	TMI	PB	TMI
	N*	114	110	181	212
Job Tension (19 items about "how often [each of these] bothered you while on the job *during the TMI incident*": too little authority; unclear responsibilities; too heavy a work load; conflicting demands; not fully qualified; inadequate information; interference with family life; etc.; 1 = never to 5 = nearly all the time)	Mean	1.45	1.86	1.37	1.75
	S.D.	0.57	0.59	0.49	0.54
		$p < .001$		$p < .001$	
	% with "never" on all 19 items	34.3	5.5	41.9	8.7
		$p < .001$		$p < .001$	
Occupational Self-Esteem (4 items on "how you see yourself in your work: unsuccessful-successful; not doing your best-doing your best; not being important-being important; not knowing your job well-knowing your job well; scoring 1 to 10)	Mean	8.27	7.87	7.90	7.78
	S.D.	0.70	0.92	1.03	1.00
		$p < .001$		n.s.	
Perceived Support (4 items on how selected persons: make your work life easier for you; how easy it is to talk with each; how much each can be relied on when things get tough at work; how much each willing to listen to problems; 1 = not at all to 4= very much)					
Your immediate supervisor	Mean	3.44	3.39	3.10	3.17
	S.D.	0.68	0.62	0.77	0.80
		n.s.		n.s.	
Other people at work	Mean	3.35	3.28	3.39	3.40
	S.D.	0.52	0.42	0.53	0.52
		n.s.		n.s.	
Your spouse, friends and relatives	Mean	3.77	3.68	3.76	3.64
	S.D.	0.38	0.47	0.37	0.49
		n.s.		$p < .005$	

*This N may be slightly reduced due to occasional missing data.

dent was to tell the interviewer if "any of them have bothered you at the times indicated: during the six months before March 28, anytime during the crisis (3/28 to 4/11), and at the present time." We realize, of course, that reporting problems and symptoms for three different periods is not a substitute for truly longitudinal data. Nevertheless, we felt that such an inquiry could provide anchor points, against which the reporting of symptoms for the time of the accident could be evaluated.

Table 10 gives the data for "periods of anger." It can be seen that the PB and TMI groups report highly similar prevalence rates for the six months before the accident, and that the two PB groups show no differences for the three periods. However, among both groups of TMI workers, there is about a 17 per cent overall net increase in "periods of anger" from six months before to the time of the accident. A comparison of six months before and the present time reveals about a 9 per cent overall net increase, which compared to no net change for the PB workers, is a significant difference (gamma = .36, $p < .005$). This suggests that the feelings of anger among the TMI workers had not yet returned to "normal" at the time of the interview.

Table 11 presents the data for "periods of extreme worry" and, like in Table 10, a strong impact of the accident is evident. The TMI supervisory and non-supervisory workers show a much greater increase, from six months before to

TABLE 10—"Problems Which People Experience from Time to Time": Periods of Anger

		Supervisory		Non-Supervisory	
		PB	TMI	PB	TMI
	N*	114	110	181	212
During the 6 months before March 28	% Yes	27.3	26.2	30.3	33.3
	Significance	n.s.		n.s.	
Anytime during the crisis (3/28-4/11)	% Yes	29.0	40.7	30.7	51.4
	Significance	$p < .05$		$p < .001$	
At the present time	% Yes	28.6	40.4	29.1	39.5
	Significance	$p < .05$		$p < .05$	
Change from 6 months before to crisis time	% Yes at crisis time only	4.7	20.6	5.6	22.5
	% with no change	92.5	73.8	89.3	72.7
	% Yes at 6 months before only	2.8	5.6	5.1	4.8
	gamma	.42		.49	
	Significance	$p < .01$		$p < .001$	
Change from 6 months before to present time	% Yes at present time only	2.9	20.2	3.5	11.3
	% with no change	95.2	74.0	91.8	83.3
	% Yes at 6 months before only	1.9	5.8	4.7	5.4
	gamma	.46		.29	
	Significance	$p < .01$		n.s.	

*This N may be slightly reduced due to occasional missing data.

TABLE 11—"Problems Which People Experience from Time to Time": Periods of Extreme Worry

		Supervisory		Non-Supervisory	
		PB	TMI	PB	TMI
	N*	114	110	181	212
During the 6 months before March 28	% Yes	16.1	5.6	10.6	11.8
	Significance	$p < .05$		n.s.	
Anytime during the crisis (3/28-4/11)	% Yes	19.1	30.8	16.2	40.1
	Significance	n.s.		$p < .001$	
At the present time	% Yes	17.3	12.3	12.8	22.3
	Significance	n.s.		$p < .05$	
Change from 6 months before to crisis time	% Yes at crisis time only	6.4	27.1	8.4	29.7
	% with no change	90.0	71.0	88.8	68.9
	% Yes at 6 months before only	3.6	1.9	2.8	1.4
	gamma	.63		.60	
	Significance	$p < .001$		$p < .001$	
Change from 6 months before to present time	% Yes at present time only	4.5	9.4	5.6	13.3
	% with no change	91.8	87.7	91.0	83.9
	% Yes at 6 months before only	3.6	2.8	3.4	2.8
	gamma	.29		.35	
	Significance	n.s.		$p < .05$	

*This N may be slightly reduced due to occasional missing data.

TABLE 12—"Problems Which People Experience from Time to Time": Periods of Extreme Upset

		Supervisory		Non-Supervisory	
		PB	TMI	PB	TMI
	N*	114	110	181	212
During the 6 months before March 28	% Yes	8.9	9.3	10.6	10.8
	Significance	n.s.		n.s.	
Anytime during the crisis (3/28-4/11)	% Yes	11.8	25.9	17.3	29.2
	Significance	$p < .01$		$p < .01$	
At the present time	% Yes	12.6	14.8	12.8	18.0
	Significance	n.s.		n.s.	
Change from 6 months before to crisis time	% Yes at crisis time only	4.5	19.4	9.0	20.3
	% with no change	93.6	77.8	88.8	77.8
	% Yes at 6 months before only	1.8	2.8	2.2	1.9
	gamma	.52		.39	
	Significance	$p < .01$		$p < .01$	
Change from 6 months before to present time	% Yes at present time only	5.4	8.3	5.1	10.9
	% with no change	92.8	88.9	92.1	85.8
	% Yes at 6 months before only	1.8	2.8	2.8	3.3
	gamma	.11		.26	
	Significance	n.s.		n.s.	

*This N may be slightly reduced due to occasional missing data.

crisis time, in reporting periods of extreme worry than do the two groups of PB workers. For a reason unknown to us, the TMI supervisors give a very low prevalence of worry for the six months before and are significantly below the PB supervisors for that period. At the time of crisis the TMI supervisors report a large increase, but "at the present time" their prevalence again falls below that of the PB supervisors. The data for TMI non-supervisory workers suggest that even "at the present time" they have not yet returned to "normal." It is also interesting to note that the PB workers show a net increase in worry between six months before and crisis time (net change of 4.5 per cent, significant at $< .05$, using the McNemar's test for correlated proportions). Thus a modest impact of the TMI accident on PB workers is suggested here as well.

The data on "periods of extreme upset," presented in Table 12, are quite similar to the findings in the previous Table. This includes the strong differential impact on PB vs TMI workers in the change in prevalence between six months before and crisis time, as well as the increase within PB for the same comparisons. The prevalence of worry "at present time" among TMI workers is not significantly greater than among PB workers.

The data in Tables 10-12 were reanalyzed to examine the effect of sex. Among the TMI non-supervisory workers, the women showed the same changes as the men, but at higher levels of prevalence.* There was also a suggestion that "periods of extreme worry" remained elevated up till the present time: 10 (40.0 per cent) of the 25 TMI female non-supervisors reported this symptom, compared to none among the seven PB female non-supervisors ($p = .05$, Fisher's exact test). Small numbers prevented meaningful additional analyses but there was a hint that the TMI female supervisors were reacting less to the impact of the accident than were the TMI female non-supervisors.

Psychophysiological Symptoms

The section of the interview which included the three questions on anger, worry, and upset contained an additional list of 14 psychophysiological symptoms, modified from Langner's[37] well-known scale of "psychiatric impairment." The findings are presented in Table 13 and demonstrate a clearcut impact of the accident. The PB-TMI contrast at six months before shows no significant differences and suggests the two groups of workers are comparable. The PB workers show no changes over time, while the TMI workers show a highly significant increase for the time of crisis. There is also

*The prevalence rates of "periods of anger" among TMI female non-supervisors were 42.3 per cent, 61.5 per cent, and 50.0 per cent for the 3 periods; for the men in that work group, the corresponding rates were 32.1 per cent, 50.3 per cent, and 38.1 per cent.

TABLE 13—"Problems Which People Experience from Time to Time": Various Psychophysiological Symptoms

		Supervisory		Non-Supervisory	
		PB	TMI	PB	TMI
	N*	114	110	181	212
Number of *symptoms* reported from a list of 14, e.g.: nausea, stomach troubles, headache, diarrhea, constipation, spells of crying, trouble sleeping, loss of appetite, etc.					
During the 6 months before March 28	Mean	0.59	0.43	0.94	0.85
	S.D.	1.12	1.09	2.01	1.47
	Significance	n.s.		n.s.	
Anytime during the crisis (3/28-4/11)	Mean	0.60	1.04	0.73	1.66
	S.D.	1.19	1.43	1.53	2.11
	Significance	$p < .01$		$p < .001$	
At the present time	Mean	0.58	0.68	0.90	1.06
	S.D.	1.15	1.37	1.76	1.58
	Significance	n.s.		n.s.	
Change from 6 months before to crisis time	% with more symptoms at crisis time	4.6	38.0	4.5	33.0
	% with no change	89.9	58.3	87.6	63.7
	% with more symptoms at 6 months before	5.5	3.7	7.9	3.3
	gamma	.73		.72	
	Significance	$p < .001$		$p < .001$	
Change from 6 months before to present time	% with more symptoms at present time	4.5	16.7	9.6	17.6
	% with no change	90.0	77.8	82.5	75.7
	% with more symptoms at 6 months before	5.5	5.6	7.9	6.7
	gamma	.39		.24	
	Significance	$p < .05$		$p < .05$	

*This N may be slightly reduced due to occasional missing data.

evidence that TMI workers report more symptoms "at present time" than for "the six months before" (a net difference of 11.0 per cent, $p < .001$), suggesting that they have not yet returned to "normal." In interpreting the data in Table 13, the reader must not lose sight of the highly skewed distribution of scores, with most subjects reporting no symptoms or only one out of 14. And even the highest increase, that for TMI non-supervisory workers between six months before and crisis time, represents an average change of less than one symptom per person.

When the data in Table 13 are also stratified by sex, one finds that female workers tend to report more symptoms than men. However, the TMI female workers also show the impact of the accident; their means for the three reporting periods are 1.20, 1.95 and 1.33, respectively. Separating the TMI women by supervisory status suggested a sensitivity to the crisis among the non-supervisory women only: 11 of 26 showed an increase in symptoms between six months and crisis time, compared to none among the seven TMI female supervisors ($p < .05$, Fisher's exact test).

Demoralization and Its Components

The concept of demoralization represents a recent development in psychiatric epidemiology.[38, 39] The fundamental idea is that existing psychiatric screening scales have a common core of symptoms which reflect nonspecific psychological distress. Such distress may be experienced in association with a variety of problems, such as severe physical illness, stressful life events, psychiatric disorder, and possibly conditions of social marginality. Such nonspecific distress or demoralization is a major factor in leading people to seek help. In the context of the present study, the alternative

of trying to assess specific psychiatric disorders seemed much less appropriate because of the implausibility of expecting to detect differential incidence of such specific disorders with a relatively small sample experiencing a transitional situational stress.

The basic findings on demoralization are presented in Table 14. As can be seen, the instructions requested that the subject describe feelings *at the present time*. The Table also lists the results for the six subscales which make up the total scale. As would be expected, these subscales are substantially intercorrelated (average r = .57 for PB subjects and .51 for TMI subjects).

Considering the total demoralization scale first, it can be seen that only among the non-supervisors is there a significant difference between PB and TMI workers. In practical terms, however, this is a small difference within a low range of pathology; a mean of .50 on this scale is equivalent to responding to one-half of the items with "never" and one-half, with "almost never." Of the six subscales, only hopeless-helplessness reliably discriminates the PB-TMI groups at both levels of job status. Three other subscales—confused, anxious, and psychophysiological symptoms—show PB-TMI differences among non-supervisors only.

Stratifying the results in Table 14 on sex revealed that female respondents had slightly higher scores on the total demoralization scale and some of the subscales (hopelessness-helplessness, dread, sadness). The impact of the accident, in general, appeared to be greater on the female workers than the male workers.

Residential Distance to TMI Plant

The reports of the Behavioral Effects Task Force of the President's Commission[2] and other reports[29] have emphasized the issue of residential proximity of the respondent to

TABLE 14—The Impact of the Accident on Demoralization and Its Components

		Supervisory		Non-Supervisory	
		PB	TMI	PB	TMI
	N*	114	110	181	212
Symptoms of "Demoralization", Total Scale (26 symptom items about "how you feel at *the present time*", scored 0 = never to 4 = very often)	Mean	0.40	0.41	0.44	0.54
	S.D.	0.40	0.36	0.39	0.42
	Significance	n.s.		$p < .01$	
Hopelessness-Helplessness (4 items, e.g. ". . . felt completely helpless . . .")	Mean	0.45	0.61	0.54	0.75
	S.D.	0.53	0.53	0.54	0.72
	Significance	$p < .05$		$p < .001$	
Dread (3 items, e.g. ". . . attacks of sudden fear or panic . . .")	Mean	0.13	0.11	0.22	0.24
	S.D.	0.32	0.31	0.43	0.40
	Significance	n.s.		n.s.	
Confused (2 items, e.g. ". . . feel confused & have trouble thinking . . .")	Mean	0.54	0.44	0.54	0.71
	S.D.	0.65	0.61	0.69	0.77
	Significance	n.s.		$p < .05$	
Sad (4 items, e.g. ". . . bothered by feelings of sadness, depression, or feeling blue . . .")	Mean	0.56	0.61	0.66	0.74
	S.D.	0.65	0.63	0.63	0.66
	Significance	n.s.		n.s.	
Anxious (6 items, e.g. ". . . feel anxious . . .")	Mean	0.56	0.52	0.55	0.65
	S.D.	0.51	0.49	0.50	0.51
	Significance	n.s.		$p < .05$	
Psychophysiological Symptoms (7 items, e.g. ". . . bothered by cold sweats . . .")	Mean	0.23	0.22	0.23	0.31
	S.D.	0.33	0.31	0.33	0.39
	Significance	n.s.		$p < .05$	

*This N may be slightly reduced due to occasional missing data.

the nuclear plant at TMI. In general, the impact of the accident, including leaving the area, was stronger the closer the community respondent lived to the TMI plant. Since the TMI workers worked at the accident site itself, it is possible that residential distance to the plant was not such a salient variable for workers as for the community residents, e.g., given immediate exposure of workers at the work site, the distance of the home may not operationalize adequately the concept of "closeness to danger."

Table 15 presents the major variables for which associations with distance (≤ 5 miles vs > 5 miles) were found. Because of this cutoff, data on PB workers cannot be included in this analysis.

Living closer to TMI was associated with leaving the area. Among TMI workers within a five-mile radius, 16.8 per cent of the respondents and 37.8 per cent of the spouses left the area; in contrast, among those outside this radius, 3.0 per cent of respondents and 15.9 per cent of spouses left ($p < .001$ for both differences in the distance contrast). Otherwise, it was difficult to detect an impact of the accident being modified by the residential distance. Distance was found unrelated to perceived exposure (variables used in Tables 2 and 3, Part I) and to the various indicators of general distress and demoralization (Tables 10-14).

The significant associations with distance which were obtained (Table 15) do not lend themselves easily to the interpretation of residential distance as "closeness to danger," which modifies the overall impact of the accident. Thus the first three variables in Table 15 show that the TMI workers who lived in the communities immediately surrounding the TMI plant attributed to the people in the community considerably more positive feelings about nuclear workers and their performance. The most plausible interpretation which occurs to us is that the immediate presence of a nuclear plant serves to reduce the normally ambivalent or somewhat negative feelings people have about the nuclear industry. Moreover, the nuclear worker belongs to two "communities": the one at work, and the one where his family and social ties are. Living in a town which also contains the nuclear plant may greatly increase the overlap between these two "communities."

There appear to be other "benefits" of living closer to the nuclear plant, albeit some of them apply only to the supervisors. Greater job satisfaction and greater certainty about job future is found among supervisors living close to the plant; for non-supervisors, the effect of distance is not reliable and may be in the opposite direction. TMI workers living closer to the plant have somewhat stronger identification with the company, have higher occupational self-esteem, and report lower job tension for the time of the TMI

TABLE 15—Role of Distance of Home from the TMI Plant

	Mean Scores for TMI Workers				
	Supervisory		Non-Supervisory		
	>5 miles	≤5 miles	>5 miles	≤5 miles	
N*	74	36	129	82	Comments
Perceived performance of nuclear workers (see Table 7)	4.25	5.24	4.20	5.27	>5 vs. ≤5, $p < .001$
Feel view was justified (see Table 7)	4.08	4.76	4.23	5.30	>5 vs. ≤5, $p < .01$
Public appreciated nuclear workers (see Table 7)	3.73	4.20	3.95	4.48	>5 vs. ≤5, $p < .10$
Job satisfaction (see Table 8)	3.84	4.50	3.97	3.76	Interaction, $p < .001$
Job future (see Table 8)	3.82	4.11	3.86	3.74	Interaction, $p < .025$
Someone criticizing Company (see Table 8)	3.73	3.94	3.38	3.49	n.s.
Son/daughter work for Company (see Table 8)	3.99	4.61	3.76	3.89	>5 vs. ≤5, $p < .05$
Job tension (see Table 9)	1.91	1.78	1.79	1.67	>5 vs. ≤5, $p < .05$
Occupational self-esteem (see Table 9)	7.77	8.09	7.73	7.85	>5 vs. ≤5, $p < .05$
Perceived support, supervisor (see Table 9)	3.33	3.45	3.23	3.08	Interaction, $p < .05$

*This N may be slightly reduced due to occasional missing data.

accident. The last variable, support from supervisors, is higher for supervisors living nearby and non-supervisors living farther away.

While it requires considerable speculation to begin to interpret these findings, their overall pattern does not fit the simple notion for which the analyses were undertaken in the first place; namely, that workers living in the close vicinity of the plant might have been particularly vulnerable to the impact of the accident. Instead, it appears that living close to the plant may permit closer ties to one's workplace and a closer integration of the workplace and one's residential community. It is impossible to reconstruct the causal dynamics involved in these associations. In part, we may be observing self-selection factors (i.e., which workers choose to live near the plant) and/or the consequences of living nearby (giving rise to either genuine changes in attitudes toward the company and the community, or leading to apparent changes only since complex processes of dissonance reduction may have been operating).

Presence of a Young Child at Home

The Governor's advisory regarding the evacuation of preschool children from the five-mile radius served to define the magnitude of the threat according to the presence or absence of such a young child in the home. All subjects (PB and TMI) were stratified according to the presence or absence at home of a child five years of age or younger.

In general, the findings failed to suggest that the presence of a preschool child in the homes of TMI workers affected either the perceived exposure to radiation or to other work hazards. Moreover, work-related attitudes, job tension, and occupational self-esteem were also not affected by this additional stratification variable. Presence of a preschool child did affect evacuation behavior, but only of spouses of TMI workers as noted earlier. Evacuation behavior for PB workers or their spouses was rare and not influenced by the presence of a preschool child.

The presence of a preschool child did appear to modify the impact of the accident on symptoms of distress among TMI workers, but only for the supervisors. The major findings are presented in Table 16. The stratification variables for the means presented for the TMI workers are supervisory vs non-supervisory status and presence vs absence of a preschool child. The significance testing, however, takes into consideration any effects of presence-absence of a child ≤ 5 years of age on the same variables among PB workers. This is because we wish to examine only the interaction between exposure to the accident (PB vs TMI) and the presence-ab-

TABLE 16—Symptoms of Distress and Presence of a Preschool Child at Home

		Mean Scores for TMI Workers			
		Supervisory		Non-supervisory	
		Present	Absent	Present	Absent
	N*	37	71	56	155
Psychophysiological Symptoms (see Table 13)					
Anytime during crisis		1.62	0.73	1.62	1.67
	significance**	$p < .001$		n.s.	
At present time		1.25	0.38	1.18	1.01
	significance**	$p < .01$		n.s.	
Symptoms of "Demoralization" (see Table 14)					
Total Scale		0.53	0.35	0.56	0.53
	significance**	$p < .025$		n.s.	
Hopelessness-Helplessness		0.71	0.55	0.82	0.73
	significance**	$p < .01$		n.s.	
Dread		0.21	0.06	0.18	0.25
	significance**	$p < .05$		n.s.	
Confused		0.65	0.32	0.72	0.71
	significance**	$p < .001$		n.s.	
Sad		0.76	0.53	0.76	0.74
	significance**	$p < .05$		n.s.	

*This N may be slightly reduced due to occasional missing data.

**The significance testing takes into consideration the effect, if any, of the presence-absence of a preschool child for PB workers; the test is for significance of interaction in a 2-way ANOVA.

sence of a young child, but not any more general effects of such a young child on the workers. Obviously, families with young children are at a different stage in the life cycle, but such life cycles per se are irrelevant to our inquiry here.

Table 16 offers a rather consistent set of findings: TMI supervisors who had a preschool child at home report more psychophysiological symptoms (at crisis time and at the present) and more symptoms of demoralization, particularly hopelessness-helplessness, dread, confusion, and sadness. Among the non-supervisors, no reliable differences on these scales, by presence-absence of a young child, can be detected.

Correlates of Evacuation Behavior

In examining the correlates of evacuation behavior of the TMI worker and his/her family, subjects grouped as "left the area" include those where the respondent and/or the spouse (and almost always the children) left the area during the time of crisis. Conversely, those classified as "didn't leave" were those where neither the worker nor a member of his/her family left. Some 31 per cent of TMI workers were classified as "left the area." And, already noted, leaving the area was associated with living closer to the TMI plant and with having a preschool child at home.

The interest in correlates of evacuation behavior stems from a desire to understand two processes: determinants of evacuation behavior (e.g., residential distance) and the consequences of such behavior (e.g., reduction of distress). Unfortunately, our cross-sectional retrospective design cannot yield conclusive interpretations about which of these processes is involved. In fact, an absence of an association is also ambiguous: it could mean either that the two processes both took place but canceled each other out (e.g., higher levels of distress leading to evacuation but evacuation then lowering distress) or that nothing at all was going on with respect to that particular variable. Consequently, our presentation of the results will be brief and descriptive.

Evacuation behavior was found associated with perceived exposure to radiation "during the TMI incident" (see Table 2, Part I): gamma = .24 ($p < .05$). However, an even stronger association (gamma = .30, $p < .01$) was observed for evacuation behavior and perceived exposure to radiation "during the six months before March 28." Thus it is doubtful that the increase in perceived radiation exposure specific to the accident was influencing evacuation behavior; rather it appears that perceived radiation chronically associated with the respondent's job was influencing evacuation behavior.

Most variables were not associated with evacuation behavior. Major variables which did show significant associations included:

- Powerlessness: subjects who left the area were about one-fifth of a standard deviation above those who did not leave ($p < .05$);
- Demoralization and some of its components: subjects who left the area were higher on total demoralization, on hopelessness-helplessness, on dread, and on sadness.

In all instances, these differences were stronger for the non-supervisory workers than for the supervisors.

Intercorrelations among Study Variables

Table 17 presents the intercorrelations for selected major study variables for PB and TMI workers (ignoring level of supervision) in order to give the reader some sense of the overlap among the impact criteria; to show their associations with perceived exposure to radiation hazards; and to explore the possibility that the pattern of associations in the two settings is different because only one experienced an accident.

Regarding the latter, it is quite evident that the intercorrelations for PB and TMI workers are rather similar. One exception is the three pairs of correlations which reflect "temporal stability" (not true stability since these are only quasi-longitudinal data): variables No. 1 with 2, 7 with 8, and 8 with 9. These correlations suggest that because of the accident, the "temporal stability" is lower in the TMI setting. The only other notable exception is the higher correlation between job tension and psychophysiological symptoms for the time of the accident at TMI vs PB ($r = .41$ vs. $r = .14$, $p < .001$ for the difference). Otherwise, the correlation matrix reveals no substantial differences across the two settings. This would suggest that the underlying dynamics of the variables and their associations are not altered by the accident; only the levels, but not the slopes, appear to be affected.

The relatively low correlations between "Exposure to Radiation, TMI time," and the several impact indicators also merit a comment. Note, for example, the low correlation ($r = -.09$) between the exposure variable and "Job Future" for the TMI workers; this is in spite of the fact that there are large PB-TMI differences for both variables (Tables 2 and 8, Part I). This suggests that it would be quite incorrect to assume that most of the impact of the accident worked through increased danger of radiation. On the contrary, it is quite evident that the TMI workers could, for example, see the accident as threatening their job security even if none of them believed that they were exposed to increased radiation.

Concluding Comments

The major findings presented in this report may be summarized as follows:

- The TMI workers differed from PB workers only in their reported exposure to radiation at the time of the accident and in their feelings that their health had been thereby endangered. They did not differ in perceived exposure to other work hazards at the time of the accident, or to exposure to any work hazards (including radiation) for the period six months before the accident.
- Data on residual concerns and feelings revealed only small differences between TMI and PB workers, suggesting that at the time of the interview six months after the accident, the TMI workers did not perceive a persistence of dangerous conditions.
- A good deal of evidence supported the notion that TMI workers experienced more uncertainty and conflict at the time of the accident: they felt less well informed, they were less certain about the outcome of the accident, and they experienced more conflict.

TABLE 17—Intercorrelations among Major Variables*

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Exposure to Radiation, 6 mos before (Table 2)	(—)**	.58	−.29	.01	.14	−.10	.06	.20	.10	.17
2. Exposure to Radiation, TMI incident (Table 2)	.84	(—)	−.31	−.09	.31	−.22	.09	.26	.19	.26
3. Job Satisfaction (Table 8)	−.43	−.38	(.78)	.42	−.36	.42	−.19	−.26	−.27	−.31
4. Job Future (Table 8)	−.12	−.06	.34	(.58)	−.23	.27	−.17	−.21	−.24	−.25
5. Job Tension (Table 9)	.24	.20	−.26	−.16	(.89)	−.31	.13	.41	.21	.44
6. Occupational Self-Esteem (Table 9)	−.28	−.28	.43	.41	−.19	(.63)	−.15	−.22	−.15	−.21
7. Psychophysiological Symptoms, 6 mos before (Table 13)	.17	.18	−.13	−.13	.10	−.19	(.73)	.53	.69	.46
8. Psychophysiological Symptoms, TMI incident (Table 13)	.24	.25	−.17	−.06	.14	−.21	.76	(.72)	.66	.57
9. Psychophysiological Symptoms, present time (Table 13)	.25	.25	−.21	−.10	.12	−.20	.74	.87	(.72)	.56
10. Demoralization, total (Table 14)	.25	.25	−.33	−.22	.29	−.31	.40	.45	.53	(.91)

*The values below and to the left of the diagonal are for all PB subjects; to the right and above the diagonal, for all TMI subjects.
**The values in the parentheses in the diagonal represent alpha coefficients (internal consistency), averaged over the four groups, PB vs TMI by supervisory vs non-supervisory.

• Coping responses, such as going to a doctor, taking drugs, and increasing alcohol consumption—all because of the accident—were rather infrequent, but some excess of these among TMI workers was noted.

• There was some evidence that more TMI than PB workers had a sense of disjuncture between their views and the views attributed to people in the community, both regarding level of concern about the accident and the justifiability of their evaluations of the performance of nuclear workers during the accident.

• TMI workers had a much lower job satisfaction than PB workers and a much greater uncertainty about their occupational future. And while TMI workers were likely to disagree if someone were criticizing the company they work for, they were at the same time less inclined to see their child come to work for the same company.

• At the time of the accident, the TMI workers clearly experienced much more job tension. The accident appears to have adversely affected the TMI workers' occupational self-esteem (supervisors only) but not influenced their perceptions of social support in the work setting (from supervisor and from coworkers). TMI non-supervisory workers, however, judged the support from family and friends to be lower.

• Comparisons of PB and TMI workers and changes within the TMI group over time clearly revealed the impact of the accident in the reports of greater frequency of periods of anger, extreme worry, extreme upset, and various psychophysiological symptoms. There was also evidence that, at interview time, the frequency of these symptoms among TMI workers was greater than for the period six months before the accident.

• Analysis of demoralization and its components suggested an impact of the accident, but primarily on the TMI non-supervisory workers. Only the component of hopelessness-helplessness showed reliable PB-TMI differences for both supervisory and non-supervisory workers.

• Examination of the role of distance of the TMI worker's home from the TMI plant failed to support the notion that the impact of the accident might be greater for those living nearby. Instead, it appeared that such residential distance reflected ties to the workplace and the degree of the integration of the workplace and one's residential community.

• Presence of preschool child at home was associated with a greater impact of the accident, but only among the TMI supervisors and primarily for symptoms of demoralization and psychophysiological functioning.

• Evacuation behavior among TMI workers and their family members was a function of residential closeness to the TMI plant, presence of a preschool child, and a perception of greater exposure to chronic radiation hazards on

one's job (not just acute radiation hazards associated with the accident). Demoralization and powerlessness were also higher among those leaving the area.

• Examination of the inter-correlations among major study variables for the PB and TMI workers did not reveal large or striking differences in the patterns of associations. This suggests, very tentatively, that the accident did not create unique dynamics (e.g., the mutual influence between perceived radiation exposure and the experiencing of psychophysiological symptoms); rather, existing dynamics, perhaps chronically associated with the work environment of the nuclear workers, were enhanced during the accident to elevate the levels of the many impact criteria.

The above conclusions cannot be accepted without qualifying statements which refer to the study design methodology. Several of these issues were discussed in the section in Methods entitled "Limitations of the Study Design": the limitation inherent to the time at which the data were collected (approximately half-a-year after the accident), the logic of inferring the impact of the accident on TMI workers from differences obtained between PB and TMI workers, and possible biases inherent to subject attrition and non-response.

In the course of data analyses by sex, we noticed repeatedly that the impact of the accident seemed to be greater on female TMI workers than on the males. This was in spite of the female worker's lower perceptions of exposure to radiation hazards. However, the very small numbers involved prevent us from making more definite observations regarding the role of sex of the TMI workers.

We cannot claim that accounts of the accident and its impact would have been the same had we contacted the subjects at some earlier (or later) point in time. Furthermore, we do not really know to what extent we can trust the method of asking for responses for two or three different periods of time (e.g., perceived hazards, psychophysiological symptoms). This certainly heightens the subject's awareness of the possibility that (s)he felt or behaved differently during the contrasting periods, or may even raise the expectation that (s)he should have felt or behaved differently. Asking about radiation exposure "during the TMI incident" may not yield the same answers when it is preceded vs when it is not preceded by an inquiry regarding "during the six months before."

The overall set of findings lead us to feel that the impact of the accident may be seen at several levels. One is via the increase in perceived radiation hazards and health endangerment, impacting on such variables as psychophysiological functioning and symptoms of demoralization. At this level, the impact may be similar to that on community residents in general. At other levels, however, the impact may be unique to the nuclear workers. For example, aside from the issue of possible physical danger, the accident created an uproar in the workplace with consequent probable stress, conflict, overload, and role ambiguity; job tension and occupational self-esteem would be the relevant impact criteria. At still another level, the accident precipitated questions regarding the future of the TMI plant, the relations between the plant and the surrounding community, and perhaps the future of the nuclear industry. The impact criteria here are future career insecurity, identification with the company, and perception of acceptance-rejection by the community.

We firmly believe that the story of the TMI accident cannot be told with one or another piece of research, and that these findings have to be put together with results of other studies of the accident, both those carried out concurrently on other populations as well as those carried out at different points in time after the accident. Only in this way can we monitor the longer lasting effects of the original accident, as well as the de novo effects of later events, such as those associated with the release of krypton gas or with preparations to reopen the plant. For this reason we have avoided speculations about the "larger" significance of our findings. And above all, we have tried to avoid gratuitous inferences about the impact of the accident being "large" or "small" or "about as expected."

Nevertheless, one reader has detected a "company apologist" bias in our report. Since this is so far from our basic orientation, and since we have tried to keep our language clean, we are inclined to believe that our findings may represent somewhat of a projective test, and anticipate accusations of an "anti-nuclear industry" bias as well. In the meantime, we wish to acknowledge fully that reasonable arguments can be offered regarding the possibility that aspects of our study may lead to an underestimation of the impact. Among these arguments are:

• Some of the TMI respondents, particularly at the supervisory level, may carry a sense of shared responsibility for some aspect of the accident, and thus may be inclined, intentionally or unintentionally, to underestimate the impact.

• Some respondents may identify with the Company and/or with the nuclear industry and thus may wish to minimize, consciously or unconsciously, the impact of the accident.

• Mistrust about the confidentiality of our interview procedure and the belief that denying a problem is the "safer" answer, may have led to some underreporting of impact.

• Nuclear workers greatly concerned with potential hazards in the work setting may move on to other employment, thus leaving behind those who have become better adapted to and/or better defended against potential hazards; detecting an impact of the accident among this remainder may be more difficult.

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