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SURVEYS OF ORGANIZATIONAL CULTURE AND SAFETY CULTURE IN NUCLEAR POWER*

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The results of a survey of organizational culture at a nuclear power plant are summarized and compared with those of a similar survey which has been described in the literature on 'high-reliability organizations.' A general-purpose cultural inventory showed a profile of organizational style similar to that reported in the literature; the factor structure for the styles was also similar to that of the plant previously described. A specialized scale designed to measure 'safety culture' did not distinguished among groups within the organization that would be expected to differ.

BACKGROUND

In recent years, increasing attention has been given to the behavior of organizations whose operations entail high levels of hazard. Researchers at Berkeley (Roberts, 1993) have looked at 'high-reliability organizations' and considered how their organizational culture might differ from that of organizations that do not deal with high levels of hazard. In their studies, they use using a general-purpose, paper-and-pencil instrument to assess shared beliefs and behavioral norms in the organizations. On the assumption that high-reliability organizations would emphasize working safely, the Berkeley group also developed a specialized safety survey (Koch, 1993).

An examination of a commercial nuclear power plant is among the few studies of high-reliability organizations that appear in the organizational literature; the scale structure of the safety survey was based on its use in that study. Klein, Bigley, & Roberts (1995) compared organizational culture of a U.S. commercial nuclear power plant to that of mainstream organizations with less hazardous operations. They reported that the factor structure of the general organizational culture survey for the power plant was generally similar to the typical pattern. A notable exception was in the loading of a scale reflecting the value placed on competence and perfectionism for the nuclear power organization.

AIMS OF THE STUDY

Organizational and safety culture data from a second nuclear power plant were collected several years ago, but not described in the open literature; these data allow the generality of the findings described in the literature to be evaluated. Among questions considered were 1) whether cultural differences noted between the nuclear power organization and the typical norms are characteristic of nuclear power organizations generally or whether they reflect a specific organizational difference, 2) whether the structure of the scales developed by the Berkeley group based on the safety survey at the first power plant survey is similar for a second nuclear power organization, and 3) whether the safety survey distinguishes among groups within nuclear power organizations that might be expected to differ as to the value they place on safety.

ORGANIZATIONAL CULTURE INVENTORY

The Organizational Culture Inventory (Cooke & Szumal, 1993) consists of 120 statements describing behaviors that might be expected of members of an organization; respondents rate the extent to which each expectation applies in their organization. The items are interpreted as reflecting twelve styles; these are defined in the sidebar at the end of this paper. The three groupings of the styles (i.e, constructive, passive-defensive, and aggressive-defensive) are based on factor analyses of the styles.

Factor Loadings

Table 1 shows factor loadings for the organizational culture styles measured by the OCI. The values at the top left represent a sample of mainstream organizations. At the top right are loadings for the protoypical high-reliability sample, i.e., a U.S. Navy aircraft carrier. The lower part of the table shows loadings based on administrations of the OCI at two nuclear power plants in the United States. Those on the left are from the administration of the OCI at a nuclear power plant reported by the Berkeley group; BNL researchers collaborated on this effort as part of an effort to develop an approach for analyzing organizational factors in nuclear operations (Haber, O'Brien, Metlay, & Crouch, 1991). Results from an organizational culture assessment at a second plant, also conducted by BNL researchers in connection with that effort, are shown on the right.

In the table, shading is used to code the magnitudes of the factor loadings to make patterns more obvious; darker shading means greater loading; loadings less than .40 are not shaded. Where interpretable groups of factors were identified, they are enclosed in dark borders. For example, the normal partitioning of organizational style into constructive, passive/defensive, and aggressive/defensive complexes is indicated by the diagonally arranged grouping in the top left of the table (the mainstream organizations).

(Roberts, Rouseau, & La Porte, 1994) point out two ways in which the factor loadings for the aircraft carrier sample differ from the typical pattern. First they identify a 'self-protection' factor in addition to the 'satisfaction' and task/security factors found in other organizations. The factor contains elements typically associated with the 'passive-defensive' *and* the

Table 1. Factor Loadings for Organizational Styles in Nuclear Power Plants Compared to Other Types of Organizations

Mainstream Organizations

Cooke & Szumal (1993)

OCI Styles	Factors: Constructive	Passive-Defensive	Aggressive-Defensive
Achievement	0.81	-0.22	0.24
Self-actualizing	0.81	-0.15	0.13
Humanistic	0.84	-0.09	-0.15
Affiliative	0.86	0.11	-0.24
Approval	-0.05	0.70	0.28
Conventional	-0.25	0.79	0.32
Dependence	0.13	0.76	0.15
Avoidance	-0.36	0.63	0.39
Oppositional	-0.11	0.41	0.46
Power	0.04	0.25	0.74
Competitive	-0.06	0.19	0.77
Perfectionistic	0.07	0.36	0.63

Aircraft Carriers

Roberts, Rousseau and LaPorte (1994)

Factors: Satisfaction	Self Protection	Task Security
0.89	0.08	0.00
0.87	0.00	0.13
0.87	-0.14	-0.09
0.87	-0.04	-0.12
-0.13	0.74	0.23
-0.25	0.85	0.15
0.08	0.88	-0.05
-0.43	0.46	0.51
0.02	0.11	0.88
-0.03	0.63	0.49
0.00	0.54	0.60
0.17	0.76	0.29

Nuclear Power Plant A

Klein, Bigley, and Roberts (1995)

OCI Styles	Factors: Satisfaction	People/ Security	Task/ Security
Achievement	0.82	-0.13	0.07
Self-actualizing	0.84	-0.24	0.02
Humanistic	0.84	-0.18	-0.17
Affiliative	0.89	0.02	-0.26
Approval	-0.02	0.70	0.27
Conventional	-0.29	0.87	0.22
Dependence	-0.18	0.78	0.14
Avoidance	-0.43	0.51	0.49
Oppositional	0.01	0.09	0.65
Power	-0.25	0.50	0.66
Competitive	-0.11	0.36	0.79
Competence	-0.03	0.53	0.47

Nuclear Power Plant B

Haber et al. (unpublished)

Factors: Factor A	Factor B	Factor C
-0.90	-0.12	0.06
-0.85	-0.21	0.13
-0.88	-0.14	-0.03
-0.91	0.00	-0.11
0.06	0.84	0.22
0.30	0.83	0.24
0.15	0.89	0.12
0.49	0.56	0.41
-0.12	0.11	0.84
0.12	0.50	0.69
0.02	0.38	0.77
0.00	0.64	0.42

'aggressive-defensive' factor. Second, they note that the avoidance style loads on all three factors.

The patterns of factor loading for the two nuclear power plants are similar to those for the protoypical high-reliability organization, and they are even more similar to each other.

Style Profile

There were no significant differences between the plants on most of the organizational culture scales that composed the standardized survey. The scales on which the plants differed were among those that distinguished the power plant from the typical norms in the Berkeley comparison, and in each case the mean scale values for Plant B were further from the mainstream mean than those for Plant A. The profiles for the two plants are shown in Figure 1; the horizontal bars represent the average scores for mainstream organizations (as reported in Klein et al., 1995). The pattern of results indicates that nuclear power plants (appropriately) have more defensive or security-related organizational styles.

SAFETY SCALES

The items that comprise the Berkeley group's safety scale reflect issues believed to be important in jobs that demand high reliability. They were developed from responses elicited in focus groups with enlisted personnel serving aboard aircraft carriers. Each of the 40 items is presented with a seven-point rating scale and respondents are asked, "To what extent do each of the following help you meet what is expected of you to do you job well in this organization?"

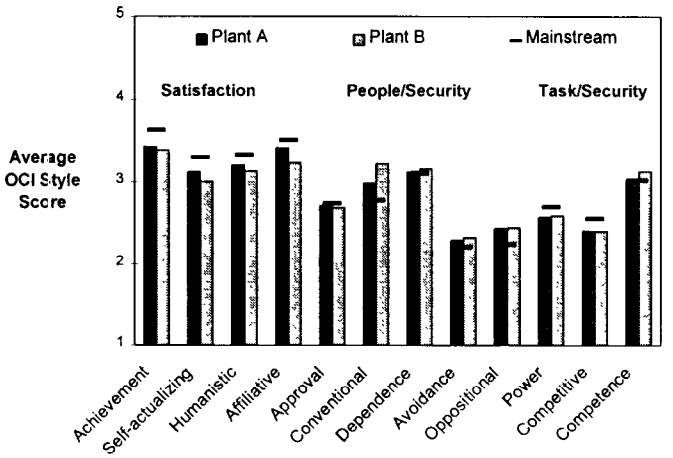

Figure 1. Profile of organizational styles for power plants compared to mainstream organizations.

Koch describes a principal components analysis of the safety scale based on the responses of employees at a nuclear power plant. The factors identified include 'accountability/ responsibility,' adaptiveness/responsivenenss', 'openness/ cooperation,' and 'inquisitiveness/search for detail.' Koch also reports that the scale succeeded in distinguishing the nuclear power plant employees from members of a non-high-reliability-seeking organization (undergraduate business students). However, (Haber et al., 1991) report that the safety scale did not distinguish among groups within a nuclear power plant (e.g., operations vs. support departments) that would be expected to differ in safety culture – this despite significant differences among those groups in the perceived hazard of their jobs. (Cooke & Szumal, 1993) cite this finding as evidence that instruments designed to assess specific types of organizations are not necessarily superior to general-purpose, standardized surveys for revealing relevant cultural dimensions.

Safety Scale Factor Loadings

The factor structure extracted from the data from Plant B corresponds generally to the factors proposed for the safety items by (Koch, 1993) based on results for Plant A. The factor loadings are shown in Table 2. The items are grouped by Koch's factors; horizontal lines separate one factor from the next. The values are coded as described earlier; in each column, groups of values that correspond to the factors are outlined.

The primary difference between these loadings and the factors previously proposed is that an 'adaptiveness/ responsiveness' factor is not evident. Two of the items identified with the factor by Koch load on 'hazard awareness,' and the rest load on 'accountability/responsibility.'

Although all of the factors shown had eigenvalues greater than 1, the scree plot was very steep; by this criterion only two of the factors would have been retained. Some of the factors (e.g., those with just three items) may in fact be 'specifics.'

Safety Scale Scores

Employees responding to the survey at Plant B were categorized according to their roles in the organization. This categorization was based on a management analysis concept

Table 2. Loadings of Berkeley safety scale items for data from Plant B

		Factors identified by Koch (1993) [1]						
	Item	F1	F?	F3	F4	F5	F6	F7
F1	7	.54	.21	.23	.25	.23	.08	.02
	8	.45	.51	.24	.28	.24	.07	-.06
	9	.40	.62	.23	.07	.19	-.02	.00
	10	.07	.67	.10	.14	.04	.22	.02
	14	.57	.29	.30	.04	.11	.01	.16
	15	.57	.31	.34	.05	.12	-.07	.17
	17	.09	.15	.45	.05	.17	.05	-.06
	18	.58	.16	.26	.21	.19	.20	.11
	19	.65	.21	.21	.09	.16	.09	.20
	36	.37	.02	.71	-.03	-.01	.12	.03
	37	.35	.11	.49	.16	.15	.15	.09
	38	.43	-.05	.66	.00	.03	.10	.10
F2	13	.52	.11	.07	.24	.15	.10	.00
	27	.58	.02	.18	.08	.15	.26	.13
	31	.54	-.08	.25	.56	.12	.06	.03
	32	.67	-.02	.22	.39	.10	.09	.02
	40	.32	-.15	.14	.50	.22	.05	.04
F3	24	.14	-.01	.55	.25	.17	.16	.19
	28	.32	.07	.33	.01	.25	.36	.18
	29	-.04	.06	.42	.40	.28	.21	-.05
	30	.21	.03	.49	.37	.24	.08	.34
	34	.29	.16	.59	.18	.15	.23	.13
	35	.14	.32	.66	.20	.01	.10	-.05
F4	11	.12	.38	.11	.78	.12	.02	.01
	12	.14	.18	.00	.80	.12	.08	-.04
	22	.23	.06	.19	.80	.02	.05	.07
F5	1	.13	-.08	.05	.19	.61	.23	-.08
	2	.38	.11	.01	.07	.61	.01	.22
	3	.42	.09	.12	.11	.60	.12	.24
	4	.10	.22	.40	.04	.59	-.01	.07
	5	.17	.25	.29	.22	.54	-.03	-.04
F6	25	.16	.10	.16	.09	.09	.86	.05
	26	.20	.14	.28	.09	.07	.80	.06
	33	.51	-.09	.32	.19	.18	.31	.02
F7	16	-.29	.02	.00	-.05	.06	-.12	.49
	23	.03	-.04	.02	.13	-.11	.01	.77
	39	-.12	.02	-.20	-.12	-.07	-.03	.71
	Prp.Totl	.14	.05	.11	.10	.07	.06	.05

[1] **Factor Names:**

- **F1** Accountability/Responsibility
- **F2** Adaptiveness/Responsiveness
- **F3** Openness/Cooperation
- **F4** Hazard Awareness
- **F5** Inquisitiveness/Search for Detail
- **F6** Role Clarity
- **F7** Maturity

for nuclear organizations adapted by (Haber et al., 1991) from the 'machine bureaucracy' organizational type described by (Mintzberg, 1979). An analysis of variance showed no significant differences among organizational groups on either the 40-item scale or on the 25-item subset identified by (Koch, 1993) as being more likely to differentiate reliability-seeking from other groups.

DISCUSSION

The pattern of factor loading of the organizational styles measured by the OCI supports the view that high-reliability organizations differ from mainstream ones in specifiable ways. As might be expected in a highly regulated environment, the plants emphasize the conventional style; the complex loading of the defensive styles, especially avoidance, reflect the paradoxes of these organizations; e.g., as Rochlin (1993) puts it, they 'seek...perfection but never expect to achieve it' and 'live by the book but are unwilling to die by it.'

The results for the specialized safety scale were less revealing. Expected differences were not seen, and the factor loadings were less orderly. The wording of some of the items in the safety scale, which attempted to preserve the vocabulary of the aircraft carrier personnel from which they were elicited, may not have 'translated' well from the original context. Likewise, it has been suggested that the 'root' statement used in the safety scale may produce different responses depending on which part he respondent concentrates (i.e., 'meeting what is expected' or 'doing your job well'). Thus it can not be claimed (cf Cooke & Szumal, 1993) that specialized surveys *per se* are not sensitive to cultural differences, only that this particular scale may not perform as intended. Safety culture surveys driven by organizational theory may fare better.

ACKNOWLEDGEMENT

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DESCRIPTIONS OF THE TWELVE STYLES MEASURED BY THE ORGANIZATIONAL CULTURE INVENTORY

Constructive Norms (Satisfaction)

[Styles Promoting Satisfaction Behaviors]

Achievement: do things well and value members who set and accomplish their own goals. Members of these organizations set challenging but realistic goals, establish plans to reach these goals, and pursue them with enthusiasm. (Pursuing a standard of excellence; openly showing enthusiasm)

Self-*Actualization*: value creativity, quality over quantity, and both task accomplishment and individual growth. Members of these organizations are encouraged to gain enjoyment from their work, develop themselves, and take on new and interesting activities. (Thinking in unique and independent ways; doing even simple tasks well)

Humanistic: managed in a participative and person-centered way. Members are expected to be supportive, constructive, and open to influence in their dealings with one another. (Helping others to grow and develop; taking time with people)

Affiliative: place a high priority on constructive interpersonal relationships. Members are expected to be friendly, open, and sensitive to the satisfaction of their work group. (Dealing with others in a friendly way; sharing feelings and thoughts)

Passive-Defensive Norms

[Styles Promoting People-Security Behaviors]

Approval: conflicts are avoided and interpersonal relationships are pleasant at least superficially. Members feel that they should agree with, gain the approval of, and be liked by others. (Making sure people accept you; 'going along' with others)

Conventional: conservative, traditional, and bureaucratically controlled. Members are expected to conform, follow the rules, and make a good impression. (Always following policies and practices; fitting into 'the mold')

Dependent: hierarchically controlled and non-participative. Centralized decision making in such organizations leads members to do only what they are told and to clear all decisions with superiors. Pleasing those in positions of authority; doing what is expected)

Avoidance: fail to reward success but nevertheless punish mistakes. This negative reward system leads members to shift responsibilities to others and avoid any possibility of being blamed for a mistake. (Waiting for others to act first; taking few chances)

Aggressive-Defensive Norms

[Styles Promoting Task-Security Behaviors]

Oppositional: confrontation prevails and negativism is rewarded. Members gain status and influence by being critical and thus are reinforced to oppose the ideas of others and to make safe (but ineffectual) decisions. (Pointing out flaws; being hard to impress)

Power: non-participative, structured on the basis of the authority inherent in members' positions. Members believe they will be rewarded for taking charge, controlling subordinates, and, at the same time, being responsive to the demands of superiors. (Building up one's power base; motivating others any way necessary)

Competitive: winning is valued and members are rewarded for outperforming one another. People in such organizations operate in a 'win-lose' framework and believe they must work against (rather than with) their peers to be noticed. (Turning the job into a contest; never appearing to lose)

Competence: perfectionism, persistence, and hard work are valued. Members feel they must avoid all mistakes, keep track of everything, and work long hours to attain narrowly-defined objectives. (Doing things perfectly; keeping on top of everything)

(from Cooke & Szumal, 1993)