Application of The Human Factors Analysis and Classification System To Marine Terminal Operations

Marc Chaderjian

California State Lands Commission, Marine Facilities Division

INTRODUCTION

It is often cited that the majority (around 80%) of industrial accidents and incidents result from human and organizational errors rather than mechanical or structural failures. In his book Managing The Risks of Organizational Accidents, James Reason has argued that while true, the 80 percent figure does little to add to understanding as to why and how these errors occur. People design, build, operate, maintain, manage and defend hazardous technologies; we should not be surprised that human organizations play a major role in both causing and preventing accidents. Effective prevention efforts must acknowledge that human errors take a variety of forms, occur in different parts of the system, and require different methods of management.

Incidents result from a combination of active failures and latent system conditions. Applied to industry-related oil spills in marine waters, active failures are the 'sharp end' or immediate cause of an oil spill incident. They include the

unsafe acts of individuals working the operation as well as the failures of vessel or terminal structures and equipment used in the operation (e.g., a damaged gasket or broken pipe that leads to a release of product). These on-site, highly visible failures have historically absorbed the majority of attention in efforts to manage safety on the terminal and identify causes of spills. But active failures are more often a consequence of latent conditions within the operation and management of the terminal.

Latent conditions include the conditions and practices of operators present at the time of the incident, the adequacy of equipment and workspaces, the adequacy of immediate supervision and oversight, as well as the adequacy of policies, practices, and resources provided by the organization. These situational factors represent the holes in safety defenses that need to be addressed by an effective safety management program.

As discussed earlier in this session, incident inquiry supported by a taxonomy that captures the range of active failures and latent conditions outlined above can inform intervention strategies aimed at mitigating the risk of oil spills and other industrial accidents. Dr. Rothblum described a step by step “how to” process for building an investigation system (Rothblum, Wheal, Withington, Shappell, Wiegmann, Boehm, and Chaderjian, 2002) and Dr. Wiegmann described a supporting taxonomy - The Human Factors Analysis and Classification System (HFACS) (Shappell and Wiegmann, 2000) - that was developed to identify causal factors associated with aviation incidents. This paper describes California State Lands Commission’s (CSLC) prevention-based

incident inquiry program, which adapts the HFACS taxonomy to Marine Terminal Operations. Key features of the implementation are discussed below, followed by a listing of several prevention-relevant lessons we've learned through its application.

HOW IT WORKS

CSLC's Marine Facilities Division (MFD) staff monitor oil transfers, inspect marine oil terminals, and review operations manuals for regulatory compliance and safe operating procedures. Following a class 3 violation (violations of sufficient severity to have caused a spill) or an oil spill notification, MFD staff members conduct inquiries to determine reasons the incident occurred. A narrative of the event is formed and contributing factors are identified and classified using the HFACS taxonomy. The classification consists of listing actors and actions that describe key incident events, and then categorizing each of these contributing factors using HFACS definitions.

Marine Safety Specialists in each Field Office lead inquiry teams. Team members question the involved parties, review established organizational policy and procedures, and consult with MFD's Human Factors Specialist to identify areas for follow–up questioning. While staff is familiar with the basic concepts of human and organizational factors and the HFACS taxonomy, they rely on extensive experience in vessel and terminal operations – not formal investigative training - to guide inquiry. The objective of inquiry and analysis is prevention: team members are charged with identifying areas in the operation where

defenses against incident fail or are absent, rather than with formulating a finding of fault. Consistent with this goal, generic names and roles (TPIC, VPIC, terminal organization, vessel organization) are used in de-identified event narratives and in the listing of key contributing factors.

Cases are finalized when team members judge the “completeness” of an inquiry. Judgments are made four each of the four major HFACS factor classes (i.e., unsafe acts and mechanical failures, preconditions for adverse events, unsafe supervision, organizational influences): If members believe the inquiry was sufficient to determine whether factors at each level played a role in the incident, they judge that major class to be complete. For example, if unsafe supervision was not identified as a contributing factor, but the team believes the inquiry was thorough enough to uncover any unsafe supervision that might have occurred, they judge the inquiry to be complete at that level. The completeness rating is intended to alert users of the database against directly interpreting changes in the frequency of particular error types over time as either improvements or newly emerging problems. Changes might also reflect the completeness of investigations. MFD’s HFACS system is intended to identify problem areas for further study and to inform prevention solutions rather than to act as a “scorecard” measuring industry success.

LESSONS LEARNED

A few prevention themes have emerged in the brief time (May, 2001 – June, 2002) HFACS analyses have been applied to Marine Terminal Operations by CSLC. These “lessons learned” are outlined in what follows.

1. *Parts problems are often people problems and people problems are often parts problems.* The majority of cases in which either structural damage or mechanical failure trigger an incident also involve at least one latent, organizational problem. Most often, equipment is poorly maintained and an adequate maintenance program is either not in place or not followed. Similarly, errors that occur during equipment use or facility maintenance are sometimes favored by the design of the equipment or workspace. For example, a valve is mistakenly opened because the signage indicating its function is ambiguous.

2. A substantial portion of transfer-related incidents could have been averted with better use of the Declaration of Inspection (DOI). The DOI serves as a reminder of items to check prior to and during a transfer, and signature from both terminal and vessel representatives is required prior to oil transfers. In about one-third of incidents, we find DOIs endorsed by one or both parties without evidence that all items have actually been checked. This most often occurs because one or more of the following: items on the checklist are under-specified, one or both parties sign without making the checks, checks are made but done so inattentively. The current issue of

HFACtS Reports details the problem and potential solutions as it relates to the risks associated with electrical arcing of transfer connections.

3. *Transfer-related incidents involve weakened defenses on <u>both</u> the vessel and terminal side*. While in most cases failed defenses are restricted either to the terminal or the vessel side of an oil transfer, a substantial number (about one-quarter) involve both. A common latent condition in these cases is inadequate crew resource management, most often taking the form of poor communications between involved parties.

CONCLUSIONS

Over the past year, CSLC has implemented a prevention based inquiry system that has identified problem areas and potential solutions within the marine terminal operations industry. Users of the system are not experts in investigation technique but do have considerable and varied industry experience. A quarterly newsletter – *HFACtS Reports* - is used to familiarize maritime industry readers with HFACS, the taxonomy that is used to classify active failures and latent conditions into categories that can assist the development of prevention strategies. The newsletter also provides statistical summaries and articles that describe commonly observed problems.

REFERENCES

Reason, J. (1997). Managing The Risks of Organizational Accidents. Burlington, VT: Ashgate Publishing.

Rothblum A.M., Wheal D., Withington S., Shappell S.A., Wiegmann D.A., Boehm W., and Chaderjian M. (2002). Human Factors in Incident Investigation and Analysis. Proceedings of the 2nd International Workshop on Human Factors in Offshore Operations (HFW200), held April 8-10, 2002, in Houston, TX.

Shappell, S. and Wiegmann, D. (2000). The Human Factors Analysis and Classification System – HFACS. Federal Aviation Administration, Office of Aviation Medicine Report (DOT/FAA/AM-00/7).