National Aeronautics and Space Administration







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Fatigue and Mishap Risk



Fatigue Often Contributes to Major Accidents







Photo: Chemical Safety Board





Texas City Refinery:

Operators had been

working 12-hour

shifts for ~30 days in

a row.

Photo: US Coast Guard

Exxon Valdez:

Third mate had little sleep after a physically demanding day and was working beyond his normal watch period at the time of high-risk navigation tasks. Three Mile Island: Reactor core started to melt between 0400 and 0600 in the morning.







Nearly 20 percent of major National Transportation Safety Board investigations identify <u>fatigue</u> as a probable cause or contributing factor.





3/5/2018



STS-61-C Launch Countdown LO2 Drain Error



18,000 pounds of LO2 were inadvertently drained from the external tank due to operator error, prior to aborted launch attempt.

A micro-switch failed in a replenish valve.

overridden the automatic sequencer, but

The console operator should have manually

instead pressed "Continue." This caused the

vent and drain valves to open prematurely.

This offload remained unrecognized until

after the launch was scrubbed.













The operators had been on duty at the console for 11 hours during the third day of working 12-hour night (8:00 p.m. to 8:00 a.m.) shifts.





3/5/2018

Fatigue Effects



Fatigue can result from extended work periods, exertion, sleep loss, or disruption of sleep patterns.

Prolonged wakefulness can result in the following:

- Impaired judgement and decision-making
- Reduced short- and long-term memory
- Slowed reaction time and reduced vigilance
- Poor communication
- Visual/cognitive fixation

Shift work can desynchronize circadian rhythms and affect human performance by:

- Disrupting the normal wake-sleep cycle
- Causing emotional stress because of impact to personal lives



There is often poor self-awareness of fatigue conditions.



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Effect on Performance: Fatigue vs. Inebriation



After 17 hours of wakefulness, performance degradation is equivalent to a blood alcohol concentration of 0.05 percent. After 24 hours, to 0.10 percent.

Dawson, Drew, and Kathryn Reid, "Fatigue, Alcohol and performance impairment," *Nature*, Vol. 388, 17 July, 1997, pp235-236.





NPR 1800.1: Shift Work and Balancing Work-Rest Cycles

"2.14.3.1 For **Non-Critical Positions**, employees shall not work in excess of the following maximum work times (MWT)

a. 12 consecutive hours (16 consecutive hours in emergency situations with approval)

b. 60 hours during a seven (7) day work week;

c. Seven (7) consecutive days without at least one (1) full day off;

d. 240 hours during a four (4) week period; and

e. 2,500 hours during a rolling 12-month period.

"2.14.3.9 Under no circumstances shall an employee be required to work such that there is not at least eight (8) hours off duty between shifts. A minimum of ten (10) hours off duty is preferred and 12 hours or more is optimal to accommodate employee commute time and domestic and sleep needs."

Deviation from these times requires approval by supervisor. For *Critical Positions*, that approval must include consideration of human factors.

Unexpected overtime shall not exceed these guidelines.



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Summary



Recommendations to reduce fatigue-related risk:

- Ensure work hour requirements are communicated across the organization
- Maintain focus on total work hours, both short-term and long-term
- Minimize schedule irregularity and consider circadian desynchronization during shift changes and travel
- Look out for fatigue as a potential factor during mishap investigations
- Schedule to allow employee 8 hours of <u>rest</u> between shifts
- Educate personnel on the risks of fatigue and encourage a culture of fatigue self-assessment







"The willingness of NASA employees in general to work excessive hours, while admirable, raises serious questions when it jeopardizes job performance, particularly when critical management decisions are at stake."

Rogers Commission Report, Volume 2 Appendix G



