



# Union of Concerned Scientists

Citizens and Scientists for Environmental Solutions

February 25, 2002

Dr. David R. Desaulniers  
Office of Nuclear Reactor Regulation  
United States Nuclear Regulatory Commission  
Washington, DC 20555-0001

**SUBJECT: WORKER FATIGUE RULEMAKING**

Dear Dr. Desaulniers:

The February 21, 2002, stakeholder meeting for the development of a proposed worker fatigue rule was very useful to the Union of Concerned Scientists. I came away from that meeting with a better understanding of what the NRC staff intends under the Option 2 approach to the proposed rule development. I also have a better understanding of the tasks planned between now and July 2003.

UCS views worker fatigue rulemaking as one of the top three priorities for our nuclear safety program. The rulemaking approach outlined by the staff in Option 2 provides a framework to address our concerns on worker fatigue. We will participate in future stakeholder meetings to the maximum extent possible.

The purpose of this letter is to provide the NRC staff and other stakeholders with our perspectives on the worker fatigue issue and on the Option 2 approach to the proposed rulemaking. We recognize this is the very early stage of what will be a process lasting many, many months and involving numerous stakeholder meetings. We enter this process with an open mind. Rather than reserving the right to alter our position down this long road, we feel an obligation to constantly assess our position as new information becomes available and to make appropriate adjustments to our position.

**Problem Statement**

Many stakeholders at the February 21<sup>st</sup> meeting asked for a better definition of the problem to be solved by the proposed rulemaking. As with beauty, problems are often in the eye of the beholder. Rather than proffering this problem statement as being universal for all stakeholders, UCS will outline the problem we seek to remedy with this rulemaking.

Nuclear plant workers perform vital safety tasks. A recent report by the Idaho National Engineering and Environmental Laboratory stated "human performance accounts for 5-8% of risk"<sup>1</sup> of core damage. On the plus side, their actions can and do prevent safety challenges. Their actions can and do mitigate initiating events. On the negative side, their mistakes can and do initiate events and complicate events. As

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<sup>1</sup> Jack E. Rosenthal, Chief - Regulatory Effectiveness and Human Factors Branch, Nuclear Regulatory Commission, to John T. Larkins, Executive Director - Advisory Committee on Reactor Safeguards, Nuclear Regulatory Commission, "Meeting with the Advisory Committee on Reactor Safeguards Human Factors Subcommittee, March 15, 2000, on SECY-00-0053, "NRC Program on Human Performance in Nuclear Power Plant Safety,"" March 6, 2000.

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*Per D. Desaulniers*

documented in the NRC staff's paper on working hour limits,<sup>2</sup> human performance is impaired by fatigue. Fatigue thus could degrade the ability of nuclear plant workers to perform vital safety tasks.

The NRC issued a policy statement and associated regulatory guidance on working hour limits nearly two decades ago. The working hour limits were intended to control worker fatigue. But these working hour limits are not consistently implemented and enforced. Some plant sites are governed by work hour limits codified within Technical Specifications; others have no such requirements. Rulemaking is needed to provide unambiguous working hour limits that all plant owners can implement and the NRC can enforce.

Today's worker fatigue issue is similar to the drug and alcohol issues that led to the fitness-for-duty rulemaking in the mid-1980s. There was awareness that drug or alcohol abuse can impair human performance. While there were isolated reports of drug and alcohol problems among workers at nuclear power plants under construction and operating, there were no direct links between these problems and events. For example, the worker mistakes contributing to the Three Mile Island accident in March 1979 were not caused by inebriation. The fitness-for-duty rule was promulgated to avoid safety problems in the future rather than fix past safety problems. This approach is consistent with the nuclear industry's oft-cited slogan of "safety first."

As promulgated, the fitness-for-duty rule reduced but did not eliminate the potential for nuclear plant workers to be on the job impaired by either drugs or alcohol. More complete protection could have been achieved by requiring all workers to be tested for drugs within the residence time of the listed drugs (i.e., 30 days) and by requiring all workers to be tested for alcohol each time they reported for work. But those measures were properly deemed impractical and the final rule featured initial, periodic, and for-cause testing for drug and alcohol usage. Statistics compiled and published annually by the NRC strongly suggest that the fitness-for-duty rule as implemented and enforced produced work forces at nuclear power plants virtually free from impairment by either drugs or alcohol.<sup>3</sup>

The worker fatigue problem of today is not rampant abuses leading to facilities staffed by "zombies." It is not daily near-misses caused by fatigued workers. **The problem is inconsistently implemented and enforced work hour limits that fail to provide reasonable protection against undue risk from fatigued workers.** That condition is aggravated by the staff downsizing that has occurred and will likely continue occurring as the electric power industry deregulates. Rulemaking is needed now to prevent worker fatigue from reducing safety levels just as fitness-for-duty rulemaking was needed in the mid-1980s to prevent drug and alcohol misuse from reducing safety levels.

### Thresholds

Generic Letter 82-12 provided the following work hour limits: 16 hours in any 24-hour period, 24 hours in any 48-hour period, and 72 hours in any 7-day period with at least an 8 hour break between shifts worked.<sup>4</sup> Shift turnover time was excluded. According to NRC staffer Jay Persensky, the principal author of Generic Letter 82-12, the working hour limits were developed based on a model featuring 8-hour work days and 40-hour work weeks. Many nuclear power plant sites have subsequently adopted 12-hour work days for operating crews.

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<sup>2</sup> William D. Travers, Executive Director for Operations, to Commissioners, Nuclear Regulatory Commission, "Fatigue of Workers at Nuclear Power Plants," SECY-01-0113, June 22, 2001.

<sup>3</sup> Nuclear Regulatory Commission, Information Notice 2001-02, "Summary of Fitness-for-Duty Program Performance Reports for Calendar Years 1998 and 1999," March 28, 2001.

<sup>4</sup> William D. Travers, Executive Director for Operations, to Commissioners, Nuclear Regulatory Commission, "Fatigue of Workers at Nuclear Power Plants," SECY-01-0113, Attachment 1, Table 5, page 28, June 22, 2001.

The NRC staff concluded that the 16 hours in 24-hour period limit may not provide adequate protection against short-term or acute fatigue and that the 72 hours in 7-day period limit may not provide adequate protection against long-term or chronic fatigue. This NRC conclusion was based on various human performance data.

UCS explored the use of multiple thresholds—one applied to workers on 8-hour work days and another to workers on 12-hour work days. Very early in this exploration, UCS became aware that some plant sites allowed workers to work four 10-hour days. Rather than add another threshold to cover workers in this category, UCS realized that it was only necessary to address the limiting case of workers on 12-hour work days. All other work schedules would be bound by that case.

UCS also explored the use of multiple thresholds based on plant condition—one applied during plant operation and another during outages. Very early in this exploration, UCS realized that conditional thresholds became complicated at multiple unit sites. For example, which threshold applies when one unit is operating and another is in an outage? Conditional thresholds also involve a transition issue, assuming that the work hour limits are most restrictive when the plant is operating than when it is not. Compliance with the 7-day work hour limit during outages, for example, may suddenly become non-compliance if the reactor starts up and the more restrictive thresholds apply.

The strongest argument against configuration-conditional thresholds is risk. Nuclear plants do not change from risky to benign simply by entering an outage as the following chart from an NRC document illustrates:

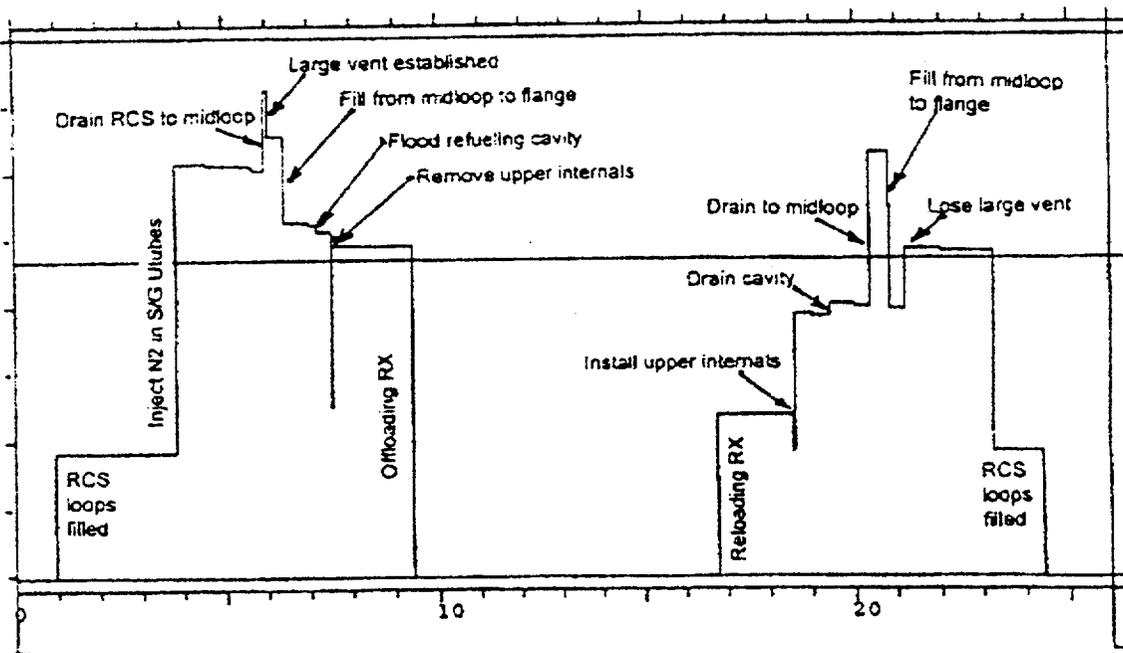


FIGURE 2 - Typical PWR Outage Risk Profile

An NRC study on outage management concluded that pressurized water reactors faced about 10 percent of their annual at-power risk in essentially one day of mid-loop operation.<sup>5</sup> There is no justification in a risk-informed world for automatically relaxing work hour limits throughout an entire outage. The following example demonstrates that near-misses can occur even when a reactor is in cold shutdown:

On October 4, 1990, approximately 600 gallons drained from the reactor coolant system at Braidwood Unit 1 during cold shutdown when a technical staff engineer directed a valve to be opened before confirming that another valve had fully closed. Fatigue was identified as a contributing factor because the technical staff engineer had been working 17 to 19 hours.<sup>6</sup>

January 3, 1961, is perhaps the strongest argument for applying worker fatigue protection during outage. On this date, workers at the SL-1 reactor in Idaho were preparing to restart the research facility after a two-week outage. An explosion destroyed the reactor and killed every worker on duty at the time. Simply because a reactor is subcritical is inadequate grounds for lessening safety standards.

Lastly, UCS examined the use of multiple thresholds based on worker classification as raised by Jay Persensky during the February 21<sup>st</sup> stakeholder meeting. As we understood this concept, one threshold would apply to the operating crew while another threshold would apply to maintenance personnel. Other workers would be governed by one of these thresholds or yet other thresholds. Classification thresholds represent secondary screening of workers. Primary screening determines the segment of the work force that requires protection from fatigue. The NRC staff proposed limiting this segment to only those workers performing safety-related tasks and functions. Classification thresholds seem aimed at further subdividing this work force segment by relative job importance based on risk. Nuclear industry experience does not support such job ranking. Researchers at the Idaho National Engineering and Environmental Laboratory (INEEL) assessed 35 operational events from 1992 to 1997 culled from the accidental sequence precursor and licensee event report databases. These INEEL investigators concluded:

"Evidence from these analyses suggests that latent errors, including those associated with maintenance errors, are an important contributor to the significance of the highest conditional core damage probability events this have occurred over the last five years."

and

"The most predominant errors that contributed to the increase in plant risk were latent errors. ...Active errors also occurred during events but to a lesser extent. Eighteen percent of errors were active versus 82% latent errors."<sup>7</sup>

These observations make sense. An event occurs over a relatively short duration and involves a small number of workers. The opportunities for active errors are limited when compared to the opportunities for making latent errors by hundreds to thousands of workers in the months and years preceding the events. Thus, while the segment of the work force actively involved during an event might be very small (i.e., essentially the control room operating crew and a handful of support personnel), the segment of the work force whose latent errors can and do increase plant risk is larger. Worker fatigue rulemaking should not set up situations where bright-eyed and bushy-tailed operators struggle with poorly maintained safety

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<sup>5</sup> Arthur T. Howell III, Director - Division of Reactor Safety, Nuclear Regulatory Commission, Memo to File, "Region IV Refueling Outage Risk - An Operational Perspective," August 29, 2000.

<sup>6</sup> Brookhaven National Laboratory, Letter Report to the Nuclear Regulatory Commission, "Identification of Issues Associated with Nuclear Power Plant Shift Staffing Levels," July 20, 1994, page A-1. (NRC ACN No. 9510030174)

<sup>7</sup> Jack E. Rosenthal, Chief - Regulatory Effectiveness and Human Factors Branch, Nuclear Regulatory Commission, to John T. Larkins, Executive Director - Advisory Committee on Reactor Safeguards, Nuclear Regulatory Commission, "Meeting with the Advisory Committee on Reactor Safeguards Human Factors Subcommittee, March 15, 2000, on SECY-00-0053, "NRC Program on Human Performance in Nuclear Power Plant Safety,"" March 6, 2000.

equipment using ill-revised procedures. Therefore, the thresholds should apply equally to all workers within the primary screening scope.

The only threshold that appears useful is one based on 12-hour work days. There are many work schedules featuring 12-hour work days, but a common one alternates weeks of four 12-hour days and three 12-hour days. The limiting case for acute and chronic fatigue thus becomes the work week with four 12-hour days. Acute fatigue can be addressed by limiting work days to 14 hours including shift turnover time. This limit provides up to two hours for shift turnover and to call in replacement workers when workers fail to report for work or leave due to illness. Chronic fatigue can be addressed by limiting work hours to 56-hours in 7 days. This limit allows workers to cover four 12-hour shifts in a week even with up to two extra hours per shift for turnover.

**UCS proposes thresholds of 14 hours per 24-hour period and 56 hours per 7-day period, both including shift turnover time.**

### **Deviations**

As UCS understands the Option 2 approach, the thresholds do not represent absolute work hour limits. Instead, the thresholds represent decision points. Before a threshold is exceeded, a decision must be made that plant risk will not be significantly increased by that individual working potentially impaired by fatigue. Approval may be conditional on compensatory measures taken.

The proposed threshold/deviation concept appears workable, particularly when worker fatigue rulemaking includes training for workers and supervisors on fatigue consequences and fatigue counter-measures. Increased awareness of the factors controlling fatigue should enable better decision-making.

The threshold/deviation concept is similar to the approach adopted by the NRC in its Maintenance Rule to allow emergency equipment to be intentionally removed from service during plant operation for testing and maintenance. This online maintenance is performed under controls that guard against undue risk. Thresholds/deviations allow workers to put in longer hours under controls that guard against undue risk.

The NRC staff referred to the decision points for deviations as being risk assessments. While that term seems to suggest more formal analysis than is intended, UCS will use the same language to minimize confusion. It seems possible that three layers of risk assessments could be developed. One layer would be "generic" risk assessments that always apply and are accepted by NRC in a form such as a regulatory guide. An example of a "generic" risk assessment might be a situation where a worker on midnight shift stays over for 4 hours for a training course. While UCS wouldn't envy nuclear workers having to sit through training courses after midnight shifts, it can be argued that proficiency is demonstrated by test results. It seems likely that other "generic" risk assessments could be accepted by NRC.

A second layer of risk assessments would be plant-specific risk assessments. For example, consider a site using workers on 8-hour shifts electing to cover vacations/illnesses with workers picking up the extra shifts. The plant-specific risk assessment might allow a worker to cover an extra shift and work 16 hours as long as the extra shift wasn't a midnight shift. This ban would be consistent with the recommendation by human reliability experts that "the second 8 hours [of a 16-hour shift] should not occur during a person's normal sleep time."<sup>8</sup> Such plant-specific risk assessments would be controlled by plant procedures subject to NRC audit.

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<sup>8</sup> William D. Travers, Executive Director for Operations, to Commissioners, Nuclear Regulatory Commission, "Fatigue of Workers at Nuclear Power Plants." SECY-01-0113, Attachment 1, page 7, June 22, 2001.

The third and final layer of risk assessments would be case-specific. Basically, these risk assessments would address deviations that did not fall within one of the generic or plant-specific risk assessments. These risk assessments may address situations expressly prohibited by the generic or plant-specific risk assessments. A plant-specific risk assessment may permit a deviation except when that deviation results in a worker's final 8 hours being during his or her normal sleep time. The case-specific risk assessment may authorize an individual deviation even under those circumstances based on other factors.

The objective of the three layers would be to provide reasonable control over deviations with minimal administrative burden. A deviation based on either a generic or plant-specific risk assessment could be as simple as a slip with the appropriate category checked, signed by the worker, and approved by the proper level of management. A case-specific risk assessment would be more involved to document why equivalent protection was ensured.

This layered approach enables individual sites to revise procedures to include additional plant-specific risk assessments based on actual experience with case-specific risk assessments. It also enables the NRC to revise its regulatory guide to include additional generic risk assessments based on feedback from multiple sites.

Unless a site uses some objective measure (i.e., the fatigue-o-meter), an essential element of all deviations must be the worker's formal acceptance. A worker professing to be fatigued should not be over-ridden by a supervisor contending "no, no you're not." Likewise, a worker's self-declaration of feeling fatigued must not—in and of itself—be used as the basis for discipline. It may be used if the worker is abusing the process as evidenced by a pattern or large number of self-declarations.

The current fitness-for-duty rule requires plant owners to annually report the number of drug and alcohol tests given to nuclear workers along with the number of positive tests. The worker fatigue rule should also require plant owners to annually report the number of workers covered by the rule along with the number of deviations.

Revisiting the concept proposed by NRC staffer Jay Persensky in the threshold arena, worker classifications may have a role in the deviation arena. The Maintenance Rule requires plant owners to trend system reliability/availability. Among other things, it is this monitoring that supports the safety evaluations conducted prior to approving online maintenance of safety systems. If workers were viewed as fundamental elements of the defense-in-depth approach to nuclear safety, it seems possible for plant owners to trend worker reliability. If the work force were subdivided by job function (i.e., control room operators, equipment operators, radiation protection technicians, etc.), deviation trending could provide insights into staffing or management issues with the potential for adversely affecting worker reliability. For example, such trending might suggest that the staffing level for radiation protection technicians does not permit the work load to be carried out without incurring a high level of deviations.

The threshold/deviation concept using limits of 14 hours in any 24-hour period and 56 hours in any 7-day period would not prevent any nuclear plant owner from continuing to use current work schedules. For example, it would still be possible at a plant site using 8-hour shifts for workers to cover extra 8-hour shifts. Because these arrangements would exceed the 14 hour in 24-hour limit, risk assessments would be required to ensure that they did not incur undue risk. Likewise, a plant site could use workers on five 12-hour day work weeks with appropriate risk assessments.

### **Conclusions**

The problem is inconsistently implemented and enforced work hour limits that fail to provide reasonable protection against undue risk from fatigued workers. The Option 2 concept of thresholds and deviations can resolve the problem.

UCS proposes thresholds of 14 hours per 24-hour period and 56 hours per 7-day period, both including shift turnover time.

The deviation concept for controlling times when thresholds are exceeded parallels the safety evaluation process used to control on-line maintenance. For the deviation concept to work, self-declarations of fatigue by workers must not be over-ruled by management without reliance on objective performance metrics.

Sincerely,

A handwritten signature in black ink, appearing to read "David Lochbaum". The signature is written in a cursive, flowing style.

David Lochbaum  
Nuclear Safety Engineer