

Fatigue Risk Management Systems for Personnel in the Refining and Petrochemical Industries

ANSI/API RECOMMENDED PRACTICE 755
FIRST EDITION, APRIL 2010



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Downstream Segment

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Foreword

Implementation of the recommendations in this document are intended to produce a step-change in fatigue management and are not to be thought of as the end point, but rather the beginning. To ensure this, it is anticipated that stakeholders and interested members of the scientific and academic communities will evaluate the effectiveness of the implementation of these guidelines over the next five years. At the end of this five year period, if not sooner, this document will be opened for review and amendment.

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Fatigue Risk Management Systems for Personnel in the Petroleum and Petrochemical Industries

1 Scope

This recommended practice (RP) provides guidance to all stakeholders (e.g. employees, managers, supervisors, contractors) on understanding, recognizing and managing fatigue in the workplace. Owners and operators should establish policies and procedures to meet the purpose of this recommended practice.

This RP was developed for refineries, petrochemical and chemical operations, natural gas liquefaction plants, and other facilities such as those covered by the OSHA Process Safety Management Standard, 29 *CFR* 1910.119. This document is intended to apply to a workforce that is commuting daily to a job location.

1.1 Overview

It has been documented that excess workplace fatigue is a risk to safe operations and that prescriptive Hours of Service rules should be supplemented as necessary. Thus, fatigue mitigation should be addressed through a comprehensive fatigue risk management system (FRMS) that is integrated with other safety management systems, as necessary.

Similar to other safety management systems, everyone—the workforce and senior management—has a role in recognizing the importance of workplace fatigue risk mitigation and actively working to support the goals of the FRMS.

The FRMS should be based on sound science and recognize operational issues, and shall include consultation with key stakeholders in the development and implementation of the local application of the FRMS. The FRMS should include a process to review and enhance the FRMS, as needed, with a goal of continuous improvement.

2 Normative References

This document contains no normative references. For a list of documents and articles associated with API RP 755 and fatigue risk management, please see the Bibliography.

3 Terms and Definitions

For the purpose of this publication, the following definitions apply.

3.1

call-out

Summoning an employee to the work site to perform work that (s)he was not scheduled to perform.

3.2

extended shifts

Time an employee is assigned to work that extends outside their regularly scheduled shift hours and into other shifts.

3.3

fatigue

Reduced mental and physical functioning caused by sleep deprivation and/or being awake during normal sleep hours. This may result from extended work hours, insufficient opportunities for sleep, failure to use available sleep opportunities, or the effects of sleep disorders, medical conditions or pharmaceuticals which reduce sleep or increase sleepiness.

3.4

holdovers

A periodic, occasional extended shift, where employees are at work beyond their regular shift to participate in training, safety meetings and the like. This does not include time needed for normal shift handoff.

3.5

normal operations

Operations that are not during outages.

3.6

open shifts

Foreseeable or planned vacancies where the vacancy is known at least one week in advance and overtime will be required to fill the vacancy (non-emergency). Examples include extended sick leave, special assignment or vacation.

3.7

outages

Planned or unplanned interruption in the normal operations of a unit or plant, including mobilizing and de-mobilizing. Outages include, but are not limited to, such things as turnarounds, unit shutdowns, operational responses, etc.

3.8

shift work

An organization of work where workers succeed each other at the same workplace while performing similar operations at different times of the day thus allowing longer hours of operation than feasible for a single worker.

3.9

work sets

Consecutive shifts with a minimum of 36 hours off before starting another work set.

4 Components of a Comprehensive Fatigue Risk Management System (FRMS)

4.1 Roles and Responsibilities

The FRMS should clearly define the roles and responsibilities for positions including, but not limited to the following:

- senior management;
- immediate supervisors;
- individual employees;
- contract companies and their employees;
- key support functions (e.g. medical, HR, safety, workforce planning and scheduling).

4.2 Positions Covered by the Fatigue Risk Management System

These guidelines are intended for all employees working night shifts, rotating shifts, extended hours/days, or call outs involved in process safety sensitive actions. They should also be considered for others making process safety-sensitive decisions.

On-site contractors involved in process safety sensitive actions shall have fatigue risk management systems equivalent to the criteria outlined in this document.

4.3 Staff-Workload Balance

The FRMS includes an initial and periodic assessment of the staffing levels and workload balance, such that the implementation of the hours of service guidelines discussed below are feasible and that fatigue risk is adequately managed. The FRMS should recognize the workload variability across shifts, weeks and months taking into account start-ups and shut-downs, as well as unplanned events (e.g. hurricane recovery) and emergency management situations. These assessments should also assess current and anticipated turnover and absentee issues.

NOTE Each company should define “periodic” for their FRMS.

4.4 Safety Promotion: Training, Education, and Communication

The FRMS shall include a process for educating all stakeholders on the causes, risks and potential consequences of fatigue. This education should acquaint all stakeholders with the basic scientific principles of sleep, sleep disorders, alertness, circadian, and fatigue physiology so that they can make informed decisions which will help them reduce the fatigue risk for themselves, their colleagues and the people they may supervise or manage. This education should also provide information designed to increase family member awareness of how they can help the stakeholder keep alert, safe and healthy.

The FRMS should provide specific training programs and supporting education and communications materials appropriately tailored to the responsibilities, duties, and work environment of the stakeholder. All stakeholders should receive initial and recurring training that includes the following:

- the scientific basis, the structure and the management of the corporate FRMS, and how it is integrated within the corporate safety management system;
- basic sleep, circadian, and fatigue physiology;
- strategies for achieving good quality, restorative sleep;
- recognizing the symptoms of sleep disorders and how to obtain appropriate medical advice and treatment;
- managing an alert and healthy lifestyle;
- understanding the specific risks of fatigue impairment in their own work environment and work duties;
- recognizing the signs of fatigue impairment and knowledge on the healthy and effective ways of mitigating them.

In addition, those who supervise or manage other employees or provide instructions to contractors should receive initial and recurring training that includes the following:

- the influence of staffing levels on employee fatigue;
- the effects of work and rest scheduling on employee fatigue, and how to schedule work to minimize the risk;
- how to manage a team of employees to minimize fatigue risk within the group;
- how to detect when employees are excessively fatigued;
- understanding policies and procedures for times when employees or contractors should be removed from duty due to fatigue;
- the continuous improvement process for assessing, updating, and increasing the effectiveness of the FRMS through a data-driven process.

4.5 Work Environment

A FRMS should take into account the type of work that is being done. Adequate opportunity for work breaks should be made available, based in part on the nature of the work. Heavy physical activity may be more fatiguing and require more breaks than lighter activities. Workers performing sedentary work that requires constant vigilance may need breaks to help prevent “automatic behaviors” (i.e. performing tasks without adequate conscious attention).

Where possible, the work environment should be designed to enhance alertness. Work spaces should be brightly lit, utilizing indirect lighting to avoid glare and eye strain. Indoor temperature should be controlled at the lower end of the comfortable range. Humidity should also be controlled within a comfortable range. Workstations should be designed utilizing ergonomic principles to prevent musculoskeletal fatigue associated with repetitive strain.

4.6 Individual Risk Assessment and Mitigation

Companies shall encourage individuals to be continuously aware of their level of fatigue and take appropriate steps to enhance their alertness while on duty. If and when they determine that they are too fatigued to work safely, they shall report this to their supervisor. Individuals should also be alert to evidence that others in the workplace may be fatigued and bring their concerns to their supervisor. In order to encourage this, a culture of fatigue management should be created in which workers are comfortable in disclosing their personal sleep or fatigue status, and seeking assistance is encouraged, consistent with the company protections afforded to reporting other safety concerns.

Individuals working shift work and others who may be involved in working extended hours during plant outages should use their time off the job to get appropriate sleep and maintain their alertness and fitness for duty.

Supervisors shall be alert to signs of excessive fatigue in employees and contractors. They shall be given the responsibility and the authority to take appropriate steps to ensure employees are alert enough to safely perform their work. Individuals who experience repeated bouts of excessive fatigue should be referred to their health professional or medical department for further evaluation and advice regarding actions they can and should take to maximize their alertness.

Because illness, stress and physical fitness impact fatigue, consideration should be given to implementing programs that are designed to encourage prevention and management of medical conditions, including sleep disorders, and promote psychological and physical fitness.

4.7 Incident/Near Miss Investigation

The investigation of incidents should be conducted in a manner that facilitates the determination of the role, if any, of fatigue as a root cause or contributing cause to the incident. Information collected should include the time of the incident, the shift pattern, including the number of consecutive shifts worked, the number of hours awake, the number of hours of sleep in the past 24 hours by the individuals involved; the shift duration (and any overtime worked); whether the incident occurred under normal operations or an extended shift; whether an outage was occurring; and, other fatigue factors. It should be noted that for individual incidents, often no definitive conclusion regarding the role of fatigue may be possible. However, aggregate analysis of incidents may reveal patterns suggestive of the role of fatigue that is not apparent by evaluating incidents individually.

4.8 Hours of Service Limits

The FRMS shall specify hours of service limits that shall not exceed those in this section, taking into account the exception process in 4.8.5. These limits have been developed in the context of the existence of a comprehensive FRMS. Consistently working at the limits shown is not sustainable and may lead to chronic sleep debt. The overall FRMS shall be designed to prevent employees from frequently working at or near these limits over the long term. The objective of these limits is to establish the triggers at which additional fatigue risk evaluations will be performed in the short term.

A base shift schedule will typically average 40 to 42 hours per week. It is recognized that during normal operations employees may work overtime, and the actual hours worked would be greater than the base schedule.

4.8.1 Twelve Hour Shifts

4.8.1.1 Normal Operations

The hours of service limits for normal operations for 12-hour shifts are as follows:

- Work sets shall not exceed 7 consecutive day or night shifts.
- To permit 2 consecutive nights of sleep after a work set, there shall be:
 - a minimum of 36 hours off after a work set,
 - a minimum of 48 hours after a work set containing 4 or more night shifts, or
 - a minimum of 48 hours off after a total of 84 or more hours worked regardless of day or night shift.
- Shifts are routinely scheduled for 12 hours and holdover periods should not exceed 2 hours and, where possible, occur at the end of the day shift.

4.8.1.2 Outages

The hours of service limits for outages for 12-hour shifts are as follows:

- Work sets shall not exceed 14 consecutive day or night shifts.
- There shall be a minimum of 36 hours off after a work set. Time off beyond 36 hours shall be addressed at the company or plant level.
 - During outages, individuals tend to work fixed shifts. 36 hours between work sets provides for 2 consecutive sleep opportunities, thereby allowing workers to remain on their established circadian cycle, rather than encouraging night shift workers to revert to night sleep on their off days, which likely would occur with longer time between work sets.
- Shifts are routinely scheduled for 12 hours and holdover periods should not exceed 2 hours and, where possible, occur at the end of the day shift.
- Start-ups and planned shut-downs (including partial)—The start-up and shut-down of a process is a critical time in operations and due consideration should be provided so safety critical personnel are well rested and fit for duty.

4.8.1.3 Extended Shifts

The hours of service limits for extended shifts for 12-hour shifts are as follows:

- Extended shifts (greater than 14 hours) shall occur only when necessary to avoid an unplanned open safety critical position or accomplish an unplanned safety critical task.
- The decision to work an extended shift greater than 16 hours shall be managed through an established management process per 4.8.5.
- Include 2 options for extended shifts:

- for extended shifts of 14 hours to 16 hours, a minimum of 8 hours off shall be provided before returning for the next shift;
- extended shifts greater than 16 hours shall provide a minimum of 10 hours off before returning for the next shift.

- The extended hour shifts shall not exceed 18 hours.
- No more than 1 extended shift longer than 14 hours should occur in a work set.

4.8.2 Ten Hour Shifts

4.8.2.1 Normal Operations

The hours of service limits for normal operations for 10-hour shifts are as follows:

- Work sets shall not exceed 9 consecutive day or night shifts.
- There shall be 36 hours off after a work set, or 48 hours after a work set containing 4 or more night shifts.
- Shifts are routinely scheduled for 10 hours and holdover periods should not exceed 2 hours and, where possible, occur at the end of the day shift.

4.8.2.2 Outages

The hours of service limits for outages for 10-hour shifts are as follows:

- Work sets shall not exceed 14 consecutive calendar days.
- There shall be a minimum of 36 hours off after a work set. Time off beyond 36 hours shall be addressed at the plant level.
 - During outages, individuals tend to work fixed shifts. 36 hours between work sets provides for 2 consecutive sleep opportunities, thereby allowing workers to remain on their established circadian cycle, rather than encouraging night shift workers to revert to night sleep on their off days, which likely would occur with longer time between work sets.
- Shifts are routinely scheduled for 10 hours and holdover periods should not exceed 2 hours and, where possible, occur at the end of the day shift.

4.8.2.3 Extended Shifts

The hours of service limits for extended shifts for 10-hour shifts are as follows:

- Extended shifts (greater than 14 hours) shall occur only when necessary to avoid an unplanned open safety critical position or accomplish an unplanned safety critical task.
 - A minimum of 8 hours off should be provided before returning for the next shift.
- The extended hour shifts shall not exceed 16 hours.
- No more than 1 extended shift longer than 14 hours should occur in a work set.

OR

- No more than 2 extended 12 hour shifts should occur in a work set.
 - If 3 or more 12 hour shifts occurs in a work set, follow the guidelines for the 12 hour shift in 4.8.1.

4.8.3 Eight Hour Shifts

8 hours shifts should rotate in the forward direction (e.g. days to evenings to nights).

4.8.3.1 Normal Operations

The hours of service limits for normal operations for 8-hour shifts are as follows:

- Work sets shall not exceed 10 consecutive day, evening or night shifts.
- There shall be 36 hours off after a work set, or 48 hours after a work set containing 4 or more night shifts.
- Holdover periods, where possible, should occur at the end of the day shift.

4.8.3.2 Outages

The hours of service limits for outages for 8-hour shifts are as follows:

- Work sets shall not exceed 19 consecutive calendar days.
- There shall be a minimum of 36 hours off after a work set. Time off beyond 36 hours shall be addressed at the plant level.
- Shifts are routinely scheduled for 8 hours and holdover periods should not exceed 2 hours and, where possible, occur at the end of the day shift.

4.8.3.3 Extended Shifts

The hours of service limits for extended shifts for 8-hour shifts are as follows:

- Extended shifts (greater than 14 hours) shall occur only when necessary to avoid an unplanned open safety critical position or accomplish an unplanned safety critical task.
 - A minimum of 8 hours off should be provided before returning for the next shift.
 - The extended hour shifts shall not exceed 16 hours.
 - No more than 2 non-consecutive extended shifts greater than 14 hours should occur in a work set.
- OR
- No more than 2 extended shifts of 12 hours or greater should occur in a work set. These extended shifts may be consecutive.
 - If 3 or more 12 hour shifts occurs in a work set, follow the guidelines for the 12 hour shift in 4.8.1.

4.8.4 Call-Outs

Because call-outs by their nature involve unpredictable patterns of work and rest, attention should be given to call-out practices to ensure adequate rest prior to returning to work. The following factors should be considered:

- call-outs during nocturnal hours will likely result in sleep disruption;
- multiple call outs during a day may provide little opportunity for consolidated, restorative sleep;
- call-outs that end shortly before the next scheduled shift or shortly after a shift effectively results in extended shifts, and should conform to those guidelines;
- call-outs occurring on the day prior to or immediately after a work set may contribute to cumulative sleep debt.

4.8.5 Exception Process

If any of the mandatory requirements (i.e. those indicated in “shall” statements) specified in the hours of service limits are expected to be exceeded or an extended shift is contemplated, an established management exception process shall be initiated. The exception process shall involve the employee’s immediate supervisor and one other management representative. The process shall include a documented risk assessment and mitigation plan. Examples of the plan include the following.

- The reason requiring the additional work hours or work days in excess of the hours of service limits.
- Planned mitigation steps.
- The tasks and work to be completed and the timeframe involved.
- An evaluation of the tasks and work to include identifying the following:
 - the types of errors for which fatigue may increase the probability of occurring;
 - potential consequences of errors from increased fatigue;
 - control measures to minimize errors and consequences.

In cases where the maximum daily work hours may be exceeded, the supervisor should also evaluate the personal travel situation for the individual(s) following completion of work and the need for alternate arrangements (i.e. ride home, hotel, etc.).

4.9 Periodic Review of the FRMS to Achieve Continuous Improvement

The FRMS should be subject to periodic assessments of its effectiveness and opportunities for continuous improvement. Targets should be set for key parameters of the FRMS [e.g. percentage overtime (median, mean—top of 10 % of employees), number of open shifts, number of extended shifts, length of worksets, number of exceptions], and metrics obtained to determine whether those targets are being met. Plans should be developed to close any gaps between targets and actual FRMS performance. In addition, key outcomes that may be impacted by fatigue (e.g. absenteeism, healthcare costs, safety and hazard loss data, including aggregate analysis of incident investigation results) should be monitored. While these outcomes should be assessed to aid in the determination of the effectiveness of the FRMS, it should be noted that many factors other than fatigue may impact them, so judgment will be required in the interpretation of this information.

Operating facilities shall conduct an initial assessment of staffing levels and work load to facilitate the implementation of the hours of service guidelines discussed in 4.8, including an evaluation of the number and causes of open shifts

that occurred in the previous year. A target level for open shifts should be set, as well as the estimated time associated with reaching the targeted level. Targets should be reviewed with key stakeholders annually and incorporated into the FRMS (see note at end of 4.3).

Table 1—Hours of Service Guidelines for 8-, 10-, and 12-hour Shifts

Operational Situation	12-Hour Shift	10-Hour Shift	8-Hour Shift
Maximum Consecutive Shifts (Day or Night) In a Work set			
a) Normal Operations	7 shifts	9 shifts	10 shifts
b) Outages	14 shifts	14 shifts	19 shifts
Minimum time off after a work set			
a) Normal Operations	36 hours	36 hours	36 hours
• Work set of 4 or more night shifts	48 hours	48 hours	48 hours
• After 84 hours or more regardless of day or night	48 hours	48 hours	48 hours
b) Outages	36 hours	36 hours	36 hours
Extended Shifts			
a) Unscheduled maximum shift	18 hours	16 hours	16 hours
b) Time off after shift			
• 10 to 16 hour shift	N/A	N/A	8 hours
• 12 to 16 hour shift	N/A	8 hours	N/A
• 14 to 16 hour shift	8 hours	8 hours	N/A
• >16 to 18 hour shift	10 hours	N/A	N/A
Maximum Number of Extended Shifts per Work set	1	1 for 14 hour shift or 2 for 12 hour shifts or for 3 or more 12 hour shifts, follow 12 hour normal operations guidelines above	2 if greater than 12 hours in duration; extended shifts must be non-consecutive. If >2, follow 12 hour normal operations above

The hours of service limits should include the following general requirements:

- For normal operations and outages, holdover periods should not exceed 2 hours and, where possible, occur at the end of the day shift.
- Start-ups and planned shut-downs (including partial)—the start-up and shut-down of a process is a critical time in operations and due consideration should be provided so safety critical personnel are well rested and fit for duty.
- Extended shifts shall occur only when necessary to avoid an open safety critical position or accomplish an unplanned safety critical task.
- The decision to work an extended shift shall be managed through an established management process per 4.8.5.

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