be a contributor to accidents and injuries, the next step will be to correct the situation that resulted in the operator becoming fatigued. The Transportation Safety Board of Canada developed the investigation procedure guide that follows. It consists of a series of questions and responses that are indicative of a fatigued state.

The accident investigation procedure begins by examining the following four factors:

1. Time of day of the occurrence.
2. Disruption of the operator's normal circadian rhythm.
3. Number of hours since the operator's awakening.
4. Operator's 72-hour sleep history.

If any of these factors indicates a problem, then fatigue should be investigated in depth using a two-stage process. First, establish that the operator was in a fatigued state, and second, determine if the unsafe act or decision was consistent with the type of behavior expected of a fatigued person.

Application of this procedure requires an individual who is knowledgeable regarding human fatigue and the consequences of fatigue in terms of human performance.

Fatigue Investigation Procedure

Fatigue should be considered as a potential underlying factor in virtually all accidents and injuries. Four questions provide guidance as to the initial assessment of fatigue as a contributing factor to an occurrence:

1. *At what time of day did the occurrence take place?* If it occurred between 3 and 5 p.m. or 3 and 5 a.m., fatigue may have played a role.

2. *Was the operator's normal circadian rhythm disrupted?* If the operator was working at a time when s/he was normally sleeping, fatigue may have played a role.

3. *How many hours had it been since awakening?* If the operator was awake for more than 16 hours, fatigue may have played a role.

4. *Does the 72-hour sleep history suggest a sleep debt?* If the operator was averaging less than 7 hours of sleep per night, fatigue may have played a role.

If the answer to any of the above questions indicates a situation where fatigue may have contributed to the incident, then fatigue should be investigated in depth.

To establish fatigue as a contributing factor, it must be demonstrated that:

- The person or crew was in a fatigued state.
- The unsafe act or decision is consistent with the type of behavior expected of a fatigued person or crew.

Checklists on the following pages can be used to aid in the collection of fatigue-related data and the determination of fatigue as a causal factor:

Checklist 1, ***Establishing the fatigued state,*** consists of four columns: *Issue*, *Probes*, *Desirable Responses and Notes*. The first column, *Issue,* is a listing of significant factors relating to fatigue. Each *Issue* is accompanied by a list of *Probes,* questions that examine various aspects of the issue. Probe questions are important in determining whether the *Issue* is pertinent to the occurrence. The third column, *Desirable Responses,* provides a foundation for analysis of fatigue; that is, any response different from the best-case represents a potential reduction in rested state. The fourth is for investigator notes.

Checklist 2, ***Establishing the link between fatigue and the unsafe act/decision,*** consists of three columns. The first two, *Performance Impairment* and *Indicators,* describe the possible effects of fatigue on performance. The third is for investigator notes.

Checklist 1 - Establishing the fatigued state

Issue	Probes	Desirable Response	Notes
Quantity of Sleep	What was the length of last consolidated sleep period?	7.5 to 8.5 hours	
	Start time?	Normal circadian rhythm, late evening	
	Awake Time?	Normal circadian rhythm, early morning	
	Was your sleep interrupted (for how long)?	No	
	Have you had any naps since your last consolidated sleep?	Yes	
	Duration of naps?	Had opportunity for restorative (1.5 to 2 hours) or strategic (20 minutes) nap prior to start of late shift	
Summary - establish whether or not there was a sleep debt	Describe your sleep patterns in the last 72 hours. (Apply sleep credit system)	2 credits for each hour of sleep; loss of one credit for each hour awake - should be positive value	
Quality of Sleep	How did the sleep period relate to the individual's normal sleep cycle i.e., start/finish time? (See "Quantity of Sleep")	Normal circadian rhythm, late evening/early morning	
	Sleep disruptions?	No awakenings	
	Sleep environment?	Proper environmental conditions (quiet, comfortable temperature, fresh air, own bed, dark room)	
Summary - establish whether or not the sleep was restorative	Sleep pathologies?	None	

Checklist 1 - Establishing the fatigued state (continued)

Issue	Probes	Desirable Response	Notes
Work History	Hours on duty and/or on call prior to the occurrence?	Situation dependent - hours on duty and/or on call and type of duty that ensure appropriate level of alertness for the task	
Summary - establish whether the hours worked and the type of duty or activities involved had an impact on the quantity and quality of sleep	Work history in preceding week?	Number of hours on duty and/or on call and type of duty that do not lead to a cumulative fatigue effect	
Irregular Schedules	Was he/she a shiftworker?	No (Shiftworkers never fully adapt in terms of sleep quality)	
	If yes, was it a permanent shift?	Yes – Days	
	If no, was it rotating (vs. irregular) shiftwork? How are overtime or double shifts scheduled?	Yes - Rotating clockwise, rotation slow (1 day for each hour advanced), night shift shorter, and at the end of cycle	
	How are overtime or double shifts scheduled?	Scheduled when operators will be most alert in the context of their circadian rhythm	
	Scheduling of critical safety tasks?	Scheduled when operators will be most alert in the context of their circadian rhythm	
Summary - establish whether the scheduling was problematic with regards to its impact on quantity and quality of sleep	Is there a fatigue countermeasure program in place?	Yes	

Checklist 2 - Establishing the link between fatigue and the unsafe act/decision

Performance Impairment	Indicators	Notes
Attention	Overlooked sequential task element Incorrectly ordered sequential task element Preoccupied with single tasks or elements Exhibited lack of awareness of poor performance Reverted to old habits Focused on a minor problem despite risk of major one Did not appreciate gravity of situation Did not anticipate danger Displayed decreased vigilance Did not observe warning signs	
Memory	Forgot a task or elements of a task Forgot the sequence of tasks or task elements Inaccurately recalled operational events	
Alertness	Succumbed to uncontrollable sleep in form of microsleep, nap, or long sleep episode Displayed automatic behavior syndrome	
Reaction Time	Responded slowly to normal, abnormal or emergency stimuli Failed to respond altogether to normal, abnormal or emergency stimuli	

Checklist 2 - Establishing the link between fatigue and the unsafe act/decision (continued)

Performance Impairment	Indicators	Notes
Problem-solving Ability	Displayed flawed logic Displayed problems with arithmetic, geometric or other cognitive processing tasks Applied inappropriate corrective action Did not accurately interpret situation Displayed poor judgement of distance, speed, and/or time	
Mood	Was less conversant than normal Did not perform low-demand tasks Was irritable Distracted by discomfort	
Attitude	Displayed a willingness to take risks Ignored normal checks or procedures Displayed a "don't care" attitude	
Physiological Effects	Exhibited speech effects - slurred, rate, content Exhibited reduced manual dexterity - key-punch entry errors, switch selection	