United States General Accounting Office

GAO

Report to Congressional Requesters

November 1986

AMTRAK

Northeast Corridor Locomotive Engineer Stress

GAO/RCED-87-1

GAO

United States
General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

B-197192

November 18, 1986

The Honorable James J. Florio
Chairman, Subcommittee on Commerce,
Transportation and Tourism
Committee on Energy and Commerce
House of Representatives

The Honorable Bruce A. Morrison
House of Representatives

As you requested, we have analyzed the Brotherhood of Locomotive Engineers' (BLE) March and July 1984 studies on stress experienced by locomotive engineers operating Amtrak's Northeast Corridor passenger trains.[1] The studies were conducted for BLE by Decision Dynamics, Inc., a private consulting firm.

We undertook this study to examine the relationship between (1) the studies' methodologies and findings and (2) the studies' conclusions and recommendations in light of the methodologies used and the findings. We did not assess the priority stress should be given as a problem needing attention in relation to other Amtrak matters or in relation to other federal needs. The scope and methodology of our work are described fully in appendix I.

Background

Until January 1983, two Conrail employees—an engineer and a fireman—were present in the locomotive cab of most Amtrak trains in the Corridor. However, Amtrak decided to eliminate the fireman from the locomotive cab crew of Amtrak passenger trains operating in the Corridor, and it increased the number of round trips many engineers were to work each month.

The number of round trips per month was increased each year between 1983 and 1985 for locomotive engineers operating trains between Washington, D.C., and New York City and between New Haven and Boston. Locomotive engineers operating trains between Philadelphia and New York City and between New York City and New Haven experienced reductions in the monthly number of trips. Other locomotive engineers have continued to operate about the same number of trips each month.

[1]Amtrak's Northeast Corridor consists of 456 route-miles from Boston to Washington, D.C.; 62 route-miles from New Haven, Conn., to Springfield, Mass.; and 103 route-miles from Philadelphia to Harrisburg, Pa., for a total of 621 miles.

The work rule changes resulted from negotiations between Amtrak and BLE which changed the pay of the locomotive engineers from a rate based on mileage to an hourly rate of pay.

Results of Analysis

The studies represent a pioneering effort to assess the stressful job factors that affect passenger train engineers in the Corridor. The studies could be used by Amtrak and BLE along with other information to help find solutions to situations that are causing avoidable harmful stress to the train engineers. However, because the studies contain limitations, some of which are inherent in research efforts of this type, it may be inappropriate to modify engineer work duties or procedures solely on the basis of the studies' results.

The clinical interview/physiological measurement part of the studies provides valuable insight into some of the complexities of the various stressors examined by the consultants. This insight can be useful for future research on the extent to which the stressors examined negatively affect the health and well-being of the engineers and their ability to safely and effectively perform their duties.

Furthermore, the March 1984 study identified a number of factors that the engineers reported as being the most stressful when performing their work. The questionnaire designed for the study enables stress analysis by type of equipment operated and by work location of the engineer. The consultants' findings identified matters on engineer stress worthy of further Amtrak and BLE attention.

The consultants examined the relative levels of stress produced by certain job aspects listed in the questionnaire, such as operating faulty equipment, objects on the tracks, faulty speedometers, and working alone in the locomotive cab. The two studies provide some information about the magnitude of stress associated with selected job aspects.

As mentioned earlier, the studies have several limitations of which we believe users should be aware. (Appendix II discusses the limitations in more detail.) The first (Mar. 1984) study (1) did not consider the frequency and circumstances under which the stressful events occurred, limiting its value for determining what types of corrective actions are appropriate, (2) used data collected at one point in time, thus providing no information on any shifts in the stressors that may have occurred over time, and (3) was based on the relatively low response rate of 61 percent of the engineers.

The second (July 1984) study (1) cannot be used to validate the first study's identification of job stress magnitudes because the questionnaires used in the two studies were not comparable, although it contained statements indicating that validating the results of the first study was one of its objectives, (2) did not reveal that a high sampling error was involved for some observations because only a small sample of engineers were asked the questions on which the observations were based, and (3) did not compare the stress experiences of the Corridor locomotive engineers with the stress experiences of other engineers, other comparable groups, or the general public, thus leaving unknown whether the experiences of the Corridor engineers were better or worse than those of other groups.

The studies also did not directly address the work rule changes that occurred in January 1983. That is, when the number of days most engineers in the Corridor were required to work was increased, the engineers became Amtrak employees, and the firemen were eliminated from the locomotive crews, causing the engineers to work alone in the engine cab. These changes could have affected engineer stress and the study results.

In spite of the limitations discussed in this report, we believe that the studies are useful. They show that engineers working on passenger trains in the Corridor have experienced stress and they show which factors or events caused the most stress. However, more study and testing would be needed to make sure that the reported causes are valid, that the best corrective actions are identified, and that any corrective actions are cost-effective. We do not know whether such a study should be undertaken at this time, however, because we have not evaluated other needs with which more stress studies would compete for funding.

Amtrak and BLE Comments

We obtained comments from Amtrak and BLE on a draft of this report. Amtrak said that stress among Corridor engineers has not been shown to be greater than stress among the average locomotive engineer or stress among other railroad employees. It also provided us additional information on the work schedule changes that have occurred since January 1983 and on passenger safety. Amtrak also summarized the results of its own consultant's stress study and his comments on the BLE study. Amtrak's comments, dated June 17, 1986, are contained in appendix III.

BLE provided us comments prepared by its President; its Chairman, General Committee of Adjustment, Amtrak Northeast Corridor; and the consultant who performed its stress studies. The BLE President and

Northeast Corridor Chairman discussed their concerns about the stresses facing locomotive engineers in the Corridor. The pertinent comments, dated June 10, 1986, are contained in appendixes IV, V, and VI.

The BLE consultant disagreed with our comments about the studies' limitations. He said that, although his studies were limited, as are all scientific studies, they are not as limited as our report indicates and clearly indicate that action is warranted.

We believe that persons who use the BLE consultant's study reports should be aware of the studies' limitations so they can better understand the meaning of the studies' results. As previously discussed, whether further actions are appropriate depends upon additional study and competing priorities. The matters the consultant raised about our report draft and our responses are discussed in detail in appendix II.

Copies of this report are being provided to Amtrak and BLE. As requested by your offices, our distribution of this report to others will not be made until 7 days from its issue date. Copies will be made available to others upon request.

J. Dexter Peach
Assistant Comptroller General

Contents

Letter		1
Appendix I Background, Scope, and Methodology of GAO's Analysis		8
	Background	8
	Scope and Methodology	9
Appendix II BLE Studies' Limitations, Amtrak's and BLE's Comments, and GAO's Responses		10
	Frequency and Circumstances of Stressful Events Were Not Considered	10
	All Data Were Collected at One Point in Time	11
	A Higher Response Rate Would Have Provided More Reliable Information	11
	July 1984 Study	13
	Overall Observations	16
Appendix III Comments From the National Railroad Passenger Corporation (Amtrak)		20
	GAO Comments	23
Appendix IV Comments From the Brotherhood of Locomotive Engineers		24
	GAO Comments	28

Appendix V
Comments From the Chairman, General Committee of Adjustment, Brotherhood of Locomotive Engineers
GAO Comments 29 31

Appendix VI
Comments From Brian F. Blake, Ph.D., Consultant to the Brotherhood of Locomotive Engineers
GAO Comments 32 57

Abbreviations

BLE	Brotherhood of Locomotive Engineers
GAO	General Accounting Office

Background, Scope, and Methodology of GAO's Analysis

Background

From April 1976 to January 1983, Amtrak contracted with Conrail to provide crews to operate trains in its Northeast Corridor. When the Northeast Rail Service Act of 1981 became effective, Amtrak became responsible for hiring its own employees to operate its trains in the Corridor, and on January 1, 1983, Corridor train crews became Amtrak employees.

BLE undertook the studies of locomotive engineer stress to (1) identify job aspects that engineers operating passenger trains in the Corridor find stressful, (2) determine where high levels of engineer stress appear, and (3) recommend approaches to help engineers experiencing stress. Decision Dynamics, Inc., the consultants who conducted the studies for BLE, mailed a questionnaire to all of the 261 Corridor engineers. Responses were received from 160 of the engineers—61 percent. Subsequently, 6 of the 160 respondents participated in interviews and psychological tests to validate the questionnaire responses. A supplementary study, completed in July 1984, consisted of interviews and psychological tests of 22 volunteers from the 160 respondents.

The consultants reported that the following aspects of the engineers' job caused the most stress.

- inoperable safety devices,
- faulty speedometers,
- operating faulty equipment,
- vandalism along the right-of-way,
- objects on the track,
- working alone in the locomotive cab,
- chances of accident,
- operating trains in violation of rules, and
- lack of supervisor's respect.

The consultants concluded that the working environment facing engineers in the Corridor is overly stress inducing. They reported that the potential adverse impacts were even greater because the number of hours an engineer would spend in the locomotive cab each month was increasing. They concluded that implications for passenger safety and for higher levels of stress for the engineer were ominous. They recommended that Amtrak and/or BLE take a number of actions such as the following:

- Amtrak and BLE could give close attention to engineer complaints of stress.

- Amtrak could focus on several job aspects identified during the study as being stressful.
- Amtrak could take steps to improve the maintenance of speedometers and develop a more rational system for using the locomotive cab radio.
- Amtrak could retrain its middle-level management on how to deal with engineer stress.
- Amtrak could reinstate the assistant engineer (traditionally referred to as a "fireman") on all runs until empirical evidence proved that cab conditions have been corrected.

Scope and Methodology

In making our analysis, we reviewed the information contained in the consultants' reports, and we interviewed Amtrak officials, BLE officials, and the consultants who made the studies. A GAO social science research analyst with expertise in survey research and research design evaluated the studies using generally accepted standards for sampling and design of social science research.

We did not independently verify the studies' findings nor did we review the supporting documents developed by the consultants. Furthermore, we did not look into whether the methods used were properly implemented nor did we assess or prioritize stress as a problem needing attention in relation to other Amtrak or other federal needs because doing so would involve making judgments we are not prepared to make.

We concentrated on the relationship between the studies' methodologies and their findings, that is, whether the methodologies used were sufficient to support the findings, conclusions, and recommendations reported. We also compared the study reports with the information gathered in our review of Corridor train operations with one-person locomotive crews.[1] Our analysis was conducted between July 1985 and July 1986.

[1] Amtrak's Northeast Corridor Trains Operate With a One-Person Locomotive Crew (GAO/RCED-85-1, Apr. 18, 1985).

BLE Studies' Limitations, Amtrak's and BLE's Comments, and GAO's Responses

Frequency and Circumstances of Stressful Events Were Not Considered

The studies do not deal with how frequently and/or the circumstances under which engineers experienced the stressors examined. While it is possible to study the magnitude of perceived stress without considering how often the stressors occurred, information on the frequency and circumstances under which engineers experience high stressors is necessary to fully benefit from the studies' findings and to determine whether and what types of corrective actions are appropriate.

BLE Consultant's Comments and GAO's Response

The BLE consultant said that our suggestion appears to flow from the premise that (1) the stress studies should have queried engineers about how often each of the stressors has occurred and (2) the stressful job aspects occurring more often are more troublesome than those that occur less often.

We did not say that frequency of occurrence information should be obtained from the engineers. The data could be developed from several sources, such as maintenance records or engineer reports, as well as from the engineers. It may be possible to develop information from existing data, but it may be necessary or desirable to develop new data.

Also, we did not say that the most frequently occurring events are more troublesome and should be acted upon. We recognize that infrequently occurring events could be more stress inducing than those occurring more frequently.

The BLE consultant said that asking engineers frequency of occurrence questions would yield biased results because the engineers would systematically give undue emphasis to stressful events. He also said that persons adapt their behavior to stressful events and that, when successful, such adaptations can make highly frequent events less stressful than infrequent and unpredictable events.

We agree that asking the engineers about the stressful events could yield biased results and that the ability to adjust to stress could change their perceptions about those events. This factor, we believe, indicates that a number of data sources could be used in determining how frequently the stressful events occur. Although the frequency with which the events occur should be only one of the factors considered when considering corrective actions, it is nevertheless an important factor.

All Data Were Collected at One Point in Time

The stress information in the studies is based primarily on cross-sectional survey data, that is, information collected at one point in time. Engineers' perceptions regarding a stressor's severity could be influenced by events or circumstances that change over time. Questions regarding engineers' ability to adapt to changes in work rules (which could in themselves be viewed as stressors) cannot be examined with a cross-sectional study. While the consultants' studies can provide some information about the respondents' perceptions about stress over 2 years ago, they provide no information regarding shifts in the stressors over time. Updated information is needed to make a valid determination of whether corrective actions are currently needed.

BLE Consultant's Comments and GAO's Response

The BLE consultant said that it is possible that the job stresses may have changed in the 2 years since the studies were conducted but that it is unlikely that major changes have occurred in the engineers' stress levels because (1) his discussions with numerous engineers suggested that job pressures have not eased appreciably since the initial studies and (2) it would be a truly rare phenomenon if the engineers were able to adapt psychologically and/or behaviorally to the troublesome job aspects in the short period of time that has passed.

We believe that discussions with "numerous" engineers may provide an indication of how some engineers feel, but that such discussions do not provide statistically valid information useful for taking corrective action. Furthermore, the consultant's comment that it would be a truly rare phenomenon if the engineers adapted to the troublesome job aspects in the time period involved was not supported by any evidence that this applied to the job aspects identified in the study. This comment was also contradicted by other comments he made that "Individuals adapt psychologically to frequently occurring events which initially produce strong distress," that "persons adapt behaviorally to stressful events by changing work patterns, manner of dress, etc.," and that "When successful, such adaptations can render highly frequent events less stressful than infrequent and unpredictable events."

A Higher Response Rate Would Have Provided More Reliable Information

The consultants believed that the 61-percent response rate was good because it reflected the views of the majority of the 261 engineers. However, 39 percent, or 101, of the 261 engineers did not respond to the questionnaire. We believe that a 61-percent response rate is relatively low, even when surveying an entire population, and may be misleading because the views of the remaining 39 percent are not known.

The potential for the 39-percent nonresponse rate in this survey to provide misleading results is illustrated with the following example. The 261 engineers were asked to "write in" suggested ways to reduce the level of stress they experienced and 157 of them made suggestions. Forty-two percent of the 157 (25 percent of all Corridor engineers) suggested adding the assistant engineer back to the train crew as a way to reduce stress.

The consultants did not attempt to determine whether the nonrespondents (101 engineers) would have made this specific suggestion. Depending on the views of these nonrespondents, between 25 and 65 percent of all the engineers would have offered the suggestion to add an assistant engineer back to the train crew to help reduce stress.[1]

All surveys with a 61-percent response rate would be subject to a similar effect. While it is seldom possible to accurately determine differences between respondents and nonrespondents, survey researchers can employ methods to check for potential differences between these groups. One such method is to conduct a brief survey of a random sample of nonrespondents to determine if they differ in any important areas from the respondents. Since the consultants did not determine the possible views of the nonrespondents, we believe that caution should be used when interpreting the studies' findings.

BLE Consultant's Comments and GAO's Response

The BLE consultant said that the lack of a sample of non-respondents is a problem, however, he could not assume that the nonrespondents felt less job stress than respondents. He said that it could readily be argued that perhaps an unknown number of engineers encountering excessive stress did not respond because they wished to avoid thinking about an unpleasant topic. He said also that the data cannot be generalized to the remaining engineers without making a leap of faith.

We agree that lacking a sample of nonrespondents is a problem and that is why we mentioned it as a limitation. The consultant's comment that the data cannot be generalized without making a leap of faith is a further indicator of the problem. While it is possible that an unknown number of engineers encountering excessive stress did not respond because they wished to avoid thinking about an unpleasant topic, any assumptions about the nonrespondents is speculative.

[1]If none of the nonrespondents had offered this suggestion, the percentage would have been 25. Conversely, if all of them had, the percentage would have been 65.

The consultant said that the survey results are meaningful even though they cannot be generalized to the nonrespondents because the study used all the locomotive engineers rather than a sample and that since a majority of the engineers actually participated, by definition, the data obtained reflects the majority of the engineers. Our draft recognized this and demonstrated the fact that although BLE surveyed all the engineers, the 39-percent nonresponse rate induced considerable nonrespondent bias.

July 1984 Study

One objective of the July 1984 study was to validate the results of the March 1984 study. The July 1984 study used in-depth clinical interviews and physiological measurements to determine the accuracy of the engineers' statements about job stress. The consultants told us they randomly selected 30 engineers for the study and interviewed 22 who volunteered. This study has a number of limitations, several of which are discussed below.

July 1984 Study Validation Objective Not Attainable

Since one of the stated objectives of the July 1984 study was to validate the results of the March 1984 study, readers could interpret this to mean a validation of the procedures used to identify the job aspects inducing relatively more stress. However, to do this, the techniques used to obtain self-report information from engineers in the second study would have had to have been identical to those used in the first study. We found this was not the case. In the March study, respondents ranked stressors relative to each other, while in the July study respondents rated each stressor as "high," "medium," or "low."

In addition, the July study used a list of 46 stressors while the March study used a list of 42 stressors. The consultants told us they changed the number of stressors examined in order to clarify some of the problems identified with the original list. (We did not examine the extent to which the problems identified in the first study had a detrimental effect on that study.) Owing to the lack of comparability in the questionnaires used in these two efforts, we believe the second study cannot be used to validate the first study's identification of job stress magnitudes.

BLE Consultant's Comments and GAO's Response

The consultant stated that the second study was not intended to "replicate [validate] the Study I's identification of job stress magnitudes." We noted, however, that the second study contains several statements which could lead users to conclude that it was validating the first study's findings regarding magnitude of the stressors. For example, the second study stated that "the first study had previously found that driving a train with a faulty speedometer is highly stressful" and that the second study "has verified this."

Second Study Sample Size Subject to High Sampling Error

The July study reports findings about the 22 respondents who volunteered to be tested, such as the percentage of interviewees reporting headaches and other stress-related conditions as well as the percentage of interviewees over- or under-reporting stress. Because of the small sample size, extreme care should be taken in interpreting many of the reported findings. Samples of a small size are subject to high sampling errors, thus making their results imprecise. For example, the report finding that 50 percent of the engineers said they experienced stress-related headaches is subject to a 19-percent sampling error, which means that users of the study could be 95 percent certain that between 30 percent and 70 percent (50 percent $\pm$ 19 percent) of all the 261 Corridor passenger train engineers would have reported stress-related headaches.

BLE Consultant's Comments and GAO's Response

The consultant said that our statements imply that the second study's results are imprecise and potentially in error. He said that such a conclusion would be wrong because the really important estimates are highly precise while only the more tangential estimates are less stable and less precise.

The consultant's statement acknowledges that certain of the estimates are less precise. However, the BLE report does not state this fact nor does it state which of the estimates are less important or less precise. Also, the BLE report did not disclose the sampling error involved. The purpose of our comment was to alert study users that certain statements regarding the reporting of stress-related conditions had a high sampling error.

The consultant said that we had selected an example with the worst precision of all, that the example was not representative of the study, and that the example could mislead a reader. While the example we used was subject to the highest sampling error of the 31 conditions listed in

the BLE report, all the 31 conditions are subject to a high sampling error because of the small number of persons queried. The example we cited was not significantly different from the other conditions the consultant reported on. For example, 32 percent of the engineers reported that they experienced clenching of jaws, eyestrain, stomach pains, and sour stomach. At the 95-percent confidence level, these conditions are subject to a sampling error of + 19.9 percent and -16.4 percent.[2]

The consultant also said that a major objective of the second study was to determine the "consistency" of the verbal and physiological indications of stress and that the 22-person sample was actually quite large for this purpose in that it provided a very high level of precision in estimating to the population of engineers who had verbally stated their views on job stress.

We did not criticize the consultant's use of the data on the 22 engineers for measuring the consistency between the verbal and physiological indications of stress. The study was designed for that purpose. Our criticism rests with using information about the 22 engineers for other purposes, such as reporting the percentage of the 22 engineers stating they had experienced the 31 physical conditions. These other uses are subject to a high sampling error and we believe that users without a background in statistics could be misled.

Comparisons Were Not Made With Other Similar Groups

The July study reports percentages of engineers experiencing various stress-related conditions without any reference or comparisons to the incidence of these conditions in other comparable groups, such as train engineers working outside the Corridor or other workers. This means that the study does not show whether the experiences of the Corridor engineers are better or worse than those of other groups or the general population. For example, in stating that 50 percent of the 22 engineers complained of headaches, the study does not reveal whether the incidence of headaches experienced by the engineers is higher than, lower than, or about the same as for other comparable groups.

[2]This means that, based on a binomial distribution, users of the study could be 95 percent certain that between 15.6 percent and 51.9 percent of all Northeast Corridor locomotive engineers would have reported this condition.

BLE Consultant's Comments and GAO's Response

The BLE consultant said that lacking a control or comparison group is not a fatal flaw, although such groups could be beneficial. He also said that comparisons with other groups are not essential to the study because (1) an inappropriate control group could be selected for comparison and the practical difficulties of selecting an appropriate group would have been insurmountable given the resources available to BLE, (2) determining if the engineers had unduly high levels of stress was not an objective of the study, and (3) a reference to control groups implies that the engineers' stress must exceed some acceptable number before action should be taken.

We did not say that lacking a control group was a fatal flaw. However, we believe that comparing the stresses experienced by the locomotive engineers would be beneficial because such comparisons would provide benchmarks on the seriousness of the stresses experienced by the engineers. While some difficulties may occur in locating data on other groups, such comparisons would provide useful data for determining the seriousness of the engineers' stress problems and could help in determining whether the stress problems are job related.

The consultant's comment that determining if the engineers had unduly high levels of stress was not an objective of the study is in conflict with the statement in the first study that one study objective was to "determine where especially high levels of engineers stress appear." We agree that knowing the stress levels of comparison groups may not be needed to identify the stresses experienced by the Corridor locomotive engineers, but information about other groups could help indicate which stressors are more severe with the engineers than with other groups, and thus, whether the engineers suffer unusually high stress.

We also did not say that corrective action should be limited to stressors that exceed levels experienced by the control groups.

Overall Observations

Although diminished safety may be a possibility when safety-sensitive workers, such as engineers, are under stress, we believe that the studies' methodologies were not sufficient to prove that stress in Corridor engineers is a safety problem. For example, many of the events that were found to have a high amount of perceived stress (inoperable safety devices, objects on the track, vandalism along the right-of-way, faulty speedometers, etc.) were episodic in occurrence. Therefore, information about their frequency and the circumstances under which they occur should be analyzed in order to assess their seriousness as stressors.

The consultant's conclusion that the engineers' stress has affected safety does not seem to be supported by a widespread increase in safety-related incidents. A prior review we made on operating Corridor trains with one-person crews showed that the safety systems were inspected as required, that backup devices and procedures were available in the event of a malfunction, and that malfunctions occurred only infrequently.[3] In that review, we found few instances of safety problems, especially those in which engineer error would be suspected.

A factor not directly addressed in the studies that might have affected engineer stress is the fact that since January 1983, significant changes have been made to the engineers' work rules. Furthermore, there is the possibility that change, in and of itself, can be stressful. Prior to January 1983, Amtrak contracted with Conrail to provide the train crews, including engineers. In January 1983, when the engineers became Amtrak employees, the fireman position was eliminated, causing the engineers to work alone in the locomotive cab. Furthermore, most engineers were required to work more days each month, although the number of hours worked each day did not change. The number of trips many engineers worked each month was increased again in 1984 and 1985.

The first BLE study was conducted about a year after the work rule changes occurred. Whether the work rule changes occurring in January 1983 and afterward were an important factor in the engineers' stress levels is open to debate. However, such changes could increase stress by themselves, particularly in older workers who had come to regard the former work rules as traditional rights. Amtrak said that it and BLE recognized the need for a transition period and agreed to phase in the new work rules over a 3-year period. Amtrak said that on January 1, 1983, it also eliminated assignments that had extensive away-from-home layovers. No other special steps, such as making counseling available to the employees, were mentioned by Amtrak.

Amtrak's, BLE's, and BLE Consultant's Comments and GAO's Response

The BLE consultant agreed with our statement that engineer stress has not resulted in a widespread increase in safety-related incidents. The consultant said that his observations about safety pertain to the potential safety problems that could be caused by stressful working conditions and that if these conditions are not corrected serious accidents

[3] Amtrak's Northeast Corridor Trains Operate With a One-Person Locomotive Crew (GAO/RCED-85-1, Apr. 18, 1985).

could occur. We agree that safety is a valid concern and should be considered in any further research performed on locomotive engineer stress.

Amtrak acknowledged that railroad jobs have a certain amount of stress. However, it did not agree that its locomotive engineers operating in the Corridor were under any greater stress than the average locomotive engineer or other railroad employees. It believed that limited stop, high-speed (Corridor) trains are less stressful than many other locomotive engineer assignments.

It seems reasonable that the Corridor engineers face a certain amount of stress. However, since the BLE study did not compare the stresses experienced by the Corridor engineers with the stresses experienced by other persons, and we are not aware of any other comparative studies, we cannot comment on whether the stress the Corridor locomotive engineers experienced is excessive.

BLE said that its researchers had no direct access to Amtrak facilities, equipment, or operations and that their impressions of the problems and operations in question were developed second-hand from the engineers studied. BLE said further that the engineers had difficulty pinpointing the real causes of stress and talked instead about more immediate stress-inducing problems which were subordinate. The real causes of stress, said BLE, are the increases in speed, responsibility and frequency (of trips per month) instituted over the last 5 years. BLE also said that the studies made by Amtrak, BLE, and GAO point to the need for further independent, scientifically based study.

The BLE consultant said that the studies clearly indicate that action is warranted. He concurred that the studies had limitations, as do all scientific studies, but he believed the limitations are not as limiting as our report suggested. He said that extending the scope of the studies would require resources and opportunities beyond those available to BLE and that government support would be needed if Amtrak would be reluctant to disclose essential information. He also believed that Amtrak should immediately take steps to alleviate the sources of stress identified in the two BLE studies.

We believe BLE's lack of access to information and the consultant's concurrence that the study had limitations further points to the need for considering whether more research and analysis should be performed. Further research should enable Amtrak and BLE to determine the

severity of the stressors, identify causes and the most effective solutions, and identify how much attention should be directed to addressing them. We recognize, however, that before taking action on the matters raised by BLE, Amtrak will need to consider engineer stress' priority as compared with other problems it is facing.

Comments From the National Railroad Passenger Corporation (Amtrak)

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

National Railroad Passenger Corporation, 400 North Capitol St., NW, Washington, DC 20001 • (202) 383-3000

Amtrak

June 17, 1986

Mr. J. Dexter Peach
Director - Resources, Community and
Economic Development Division
United States General Accounting Office
Washington, DC 20548

Dear Mr. Peach:

Amtrak has reviewed the General Accounting Office proposed letter report, "Amtrak Locomotive Engineer Stress in the Northeast Corridor," which analyzes the Brotherhood of Locomotive Engineers' (BLE) March and July 1984 studies on stress experienced by locomotive engineers operating Amtrak's Northeast Corridor passenger trains.

See comment 1.

After reviewing the BLE stress studies, Amtrak felt it was necessary to examine the locomotive engineer stress issue from our own perspective. We commissioned Peter B. Silvain, Ph.D., to evaluate the BLE studies and address the overall question of engineer stress by conducting observations and interviews with passenger engineers.

See comment 1.

Our report, which included Dr. Silvain's findings, was provided to Congressmen Florio and Morrison and the General Accounting Office in October 1985. This report concluded that:

- The BLE studies were based on subjective and biased data and had minimal scientific validity.
- Engineer stress may be significantly reduced through environmental, communications and policy changes.
- The primary stress control mechanisms in locomotive operations are to be found in the engineer's psychological status and level of competency.
- There is no objective evidence that the absence of a second person in the cab is a stressor.

See comment 2.

Amtrak acknowledges that there is a certain amount of stress in all railroad jobs or, more universally, in all industrial jobs. However, we do not agree that the locomotive engineer operating in intercity passenger service in the Northeast Corridor is under any greater stress than the average locomotive engineer or other railroad employees. On the contrary, the operation of a limited stop, high-speed train is less stressful than many other locomotive engineer assignments.

See comment 1.

The BLE studies did not take into account engineers working in commuter services or freight train operations. This eliminates any comparison within the railroad industry.

See comment 1.

Probably the primary source of stress for an engineer is approaching and operating over highway crossings at grade. In the Northeast Corridor, all grade crossings have been eliminated between Washington, DC and New Haven, CT, a distance of over 300 miles.

See comment 1.

One of the most significant causes of stress for an engineer working in freight operations is the difficulty of controlling the slack action of a long train to prevent an undesired emergency brake application or a derailment resulting from improper train handling. Slack action is not a factor in a short passenger train.

See comment 1.

Amtrak firmly believes engineers' complaints about stress are primarily motivated by the requirement to work additional days and to a lesser extent, a desire to restore a second person (fireman) to certain runs.

See comment 3.

On Page 2, the report states that the number of round trips per week increased between 1983 and 1985. This increase was a direct result of contract negotiations and resulted in the phase-in approach to a scheduled five-day work week for Washington - New York and Boston - New Haven service. The trip frequency in the Philadelphia - New York and New York - New Haven service actually decreased. These schedule changes were a direct effort by Amtrak and BLE to successfully implement an overall change from the mileage rate of pay to the negotiated hourly rate of pay for Amtrak engineers. The number of hours in an engineer's workday and the average daily time an engineer is operating the train basically have not changed under the new labor agreement.

See comment 1.

Major schedule changes are reviewed and discussed with the BLE local chairman involved. This allows for direct input to identify any problems and work toward a mutual resolution.

Now on p. 8. See comment 2.

On Page 4, the report states that the consultants concluded that increased trips per month and working environment are overly stress inducing and have negative impacts on passenger safety. Since January 1983, there have been no train accidents attributable to engineer stress. Engineers and all employees are eligible to receive help through the Employee Assistance Program for stress or other related counselling.

See comment 1.

Now on p. 17. See comment 3.

On Page 16, the report incorrectly states that no special steps were taken to ease the engineer's transition from the old work rules to the new ones. The agreement phased in the rules changes over three years. Letter No. 2 of the BLE Agreement dated October 26, 1982, states, "Accordingly, in order to provide a reasonable transition to the five-day per week arrangement which will be established pursuant to the Agreement signed this date, it was further agreed that ..." Both parties recognized the need for a transition period and resolved it accordingly. In addition, assignments that previously had extensive away-from-home layovers were eliminated on January 1, 1983.

We appreciate the opportunity to comment to your letter report while in draft form.

Sincerely,

W. Graham Claytor, Jr.
President

The following are GAO's comments on the National Railroad Passenger Corporation's letter dated June 17, 1986.

GAO Comments

1. This additional information does not require a change to the text of the report.

2. We have responded to this statement in Appendix II of this report.

3. The statement in Appendix II has been revised to show the special steps taken to ease the transition from the old work rules to the new ones.

Comments From the Brotherhood of Locomotive Engineers

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

Brotherhood of Locomotive Engineers

B OF L E BUILDING
CLEVELAND, OHIO 44114

JOHN F. SYTSMA
President

June 10, 1986

Mr. J. Dexter Peach, Director
Resources, Community, and Economic
Development Division
United States General Accounting Office
GAO Building
441 G Street, N.W.
Washington, D. C. 20548

Dear Mr. Peach:

This is in response to your May 15, 1986 letter in which you enclosed two copies of your proposed letter report on the stress experienced by the locomotive engineers who operate Amtrak's high-speed passenger trains in the Northeast Corridor. The report is your analysis of the March and July 1984 stress studies of the Brotherhood of Locomotive Engineers (BLE).

See comment 1.

I am attaching as an official part of my response, the original copies of comments supplied by Amtrak BLE General Chairman W. G. Hausleiter, the representative of the locomotive engineers involved in this study, and two separate reports prepared by Brian F. Blake, Ph.D., of Decision Dynamics, Inc. It is my desire and request that the attached documents prepared by these two gentlemen, along with this letter, be placed on the record as my official response to your report.

See comment 2.

One of Dr. Blake's submissions pertains to the National Railroad Passenger Corporation's October 3, 1985 report entitled LOCOMOTIVE ENGINEER STRESS and was prepared at my request. This report is included because it is anticipated that Amtrak will respond by presenting their supposed study which includes a paper prepared by Peter B. Silvain, Ph.D., who was commissioned by the carrier to address the overall question of locomotive engineer stress.

See comment 3.

Regrettably, but not surprisingly, Amtrak "cherry-picked" from their own consultant's report, totally ignoring the fact that many of the very recommendations made by the BLE were echoed by their consultant. Instead, Amtrak likened being a locomotive engineer to being a person out for a drive on a sunny spring day. Sadly, the reality is a far cry from the portrait painted by Amtrak.

See comment 3.

Consequently, it would be an injustice to compare Amtrak's report on an equal basis with the BLE study and, therefore, I decided it was imperative to request a professional evaluation of Dr. Silvain and his methodology.

See comment 3.

Regardless of the debate or any dispute over the methodology used in the study performed by Drs. Blake and Wick, there is no denying that there is something wrong on Amtrak and its Northeast Corridor high-speed passenger train operations. There is too much stress caused by the combination of too many stressors encountered by the one individual who works alone, totally isolated from other crew members, operating the high-speed passenger trains.

See comment 3.

The BLE fully recognizes that there is a degree of stress inherent to the occupation of locomotive engineer. However, major structural changes of a nature such as those which Amtrak engineers have faced, have resulted in a dramatic increase in work load and responsibility, intensified the severity of many existing stressors and created new and unexpected ones. It is our belief that the burdens and stresses faced on a daily basis by the Amtrak Northeast Corridor locomotive engineers who operate the high-speed passenger trains have reached crisis proportions.

See comment 3.

Members of my staff and BLE officers have requested on numerous occasions that the GAO employees studying this situation hold a public hearing, forum or meeting where the locomotive engineers who are experiencing high degrees of stress while operating these trains could be given a chance to come forward and explain their working conditions. Such a suggestion was always denied with an excuse equivalent to "such a meeting would have no scientific value."

See comment 3.

What fascinates me is, after something happens, the first thing any railroad official wants to do is get to the locomotive engineer and find out what happened. Today if an accident occurs, railroad officials tear after the engineer with a urine sample container and a syringe to withdraw blood. They want to send body fluids to a laboratory to see if they can detect a trace of some prohibitive substance.

See comment 3.

It was our intention to expose GAO to the horror stories about the locomotive engineers' jobs. It was the BLE's study which led me to seek national legislation designed to amend the Federal Railroad Safety Act of 1970 (Public Law 91-458) to allow engineers to "mark off" and obtain counseling, if necessary, after experiencing a tragedy.

See comment 3.

There are situations in the workplace which interfere with the job performance of locomotive engineers. One thing that is certain is that recent involvement in a serious injury or death of a fellow crew member, person(s) at grade crossing accidents or pedestrian(s) trespassing on the property is a precursor to job stress. Many

engineers have a very difficult time coping with the short-term effects and long-term memories that affix a lifetime imprint consistently brought to consciousness whenever they operate another train past the place of the tragedy or see a person on the tracks.

See comment 3.

Actions required of the engineer when there is a serious accident can increase the engineer's stress level. Such actions should be reviewed and altered, as necessary, to facilitate stress reduction.

* Requiring an engineer to inspect the engine when a person or vehicle is hit may make sense technically, but it can be highly traumatic psychologically. This is especially true if bodily remains are splashed over the engine. Cannot a person other than the engineer inspect the engine under those circumstances?

* From a psychological point of view, it may be dangerous to require an engineer to continue to operate the train after a serious accident. Continued operation not only may compound the trauma for the engineer himself, but also it can result in unsafe or inefficient job performance.

See comment 3.

The engineer, if he/she chooses, should be permitted to relinquish control to another engineer without being harassed or without suffering a loss of pay. Guidelines must be established to permit this and post-traumatic stress reduction programs should be made available to engineers attempting to cope with the aftermath of major accidents in which persons have been maimed or killed. This type of program could certainly be incorporated with the carriers' Employee Assistance Programs.

See comment 3.

In all such events, it should be mandatory that railroad officials and/or police officers at the scene of any accident involving the engineer ask the engineer if he or she is O.K. and whether or not they feel up to continuing their tour of duty.

See comment 3.

Again, for official record, the stress being experienced by locomotive engineers who work alone in the cab operating Amtrak's high-speed passenger trains throughout the Northeast Corridor is overwhelming and will someday result in a very serious tragedy. This matter has been brought to the attention of many members of Congress, the Department of Transportation, the Federal Railroad Administration, the National Transportation Safety Board, the Government Accounting Office and Amtrak. The responsibility for answering to the public after a calamity in the Northeast Corridor will be referred to the aforementioned agencies.

See comment 3.

It is my professional position that we should PREVENT problems and not make the situation worse when the scandals of ignored reports are revealed in the ensuing investigations, after the fact. Is not the investigation of the space shuttle Challenger disaster enough of a learning experience for all of us?

Mr. J. Dexter Peach - 4 - June 10, 1986

The BLE remains ready to do all we can in resolving this matter by reducing the stressors in the workplace and helping our members cope with reasonable amounts of stress in the workplace.

Sincerely yours,

President

Enclosure

The following are GAO's comments on the Brotherhood of Locomotive Engineer's letter dated June 10, 1986.

GAO Comments

1. The comments from W. G. Hausleiter are included in appendix V of this report. The report prepared by Brian F. Blake, Ph. D., which contains comments on a draft of this report, is contained in appendix VI.

2. We did not include Brian F. Blake's report on the National Railroad Passenger Corporation's October 3, 1985 study "Locomotive Engineer Stress" because it did not comment on any matters in our draft report. His report is available from our office upon request.

3. This additional information does not require a change to the text of the report.

Comments From the Chairman, General Committee of Adjustment, Brotherhood of Locomotive Engineers

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

Brotherhood of Locomotive Engineers
General Committee of Adjustment
AMTRAK, N.E.C.

Suite 501, The Craddock Bldg.
146 Rt 130
Bordentown, NJ 08505-2219
Telephone (609) 298-3006

WILLIAM G. HAUSLEITER
Chairman

CHARLES M. CALLAN
Secretary-Treasurer

June 2, 1986

JUN 5 1986
10:02 A.M. - G.K.

Mr. John F. Sytsma
President
1110 Engineers Bldg.
Cleveland, OH 44114

Re: GAO Letter Report

Dear Sir & Brother:

In its' proposed letter report on Locomotive Engineer Stress in the Northeast Corridor the GAO refers to the two studies conducted by Decision Dynamics, Inc. for the BLE as a "Pioneering Effort" and "the first attempt to study the stresses associated with operating high speed trains in the United States". The report describes the studies as "A basis for future research," and states that the "findings identified matters on Engineer Stress worthy of further AMTRAK and BLE attention".

See comment 1.

Though the report does find certain limitations in the methodology employed it is important to recognize that the BLE researchers had no direct access to AMTRAK facilities, equipment, or operations. Their impressions of the problems and operations in question were developed second hand from the engineers studied. These engineers had difficulty pinpointing the real causes of stress and talked instead about more immediate stress inducing problems which were subordinate. The real causes of stress are the increases in speed, responsibility and frequency instituted over the last 5 years. It must be remembered however, that the studies are a "Pioneering Effort" and hopefully they will serve as the impetus for an independent, in-depth study of the issue.

See comment 2.

The larger issue which begs to be studied is the cumulative effects of stress resulting from basic changes in the nature and scope of the job. These changes which have been introduced at different times over the last 5 years include:

A. Increased speed of most trains from 80 to 120 MPH.

B. Increased responsibility resulting from elimination of second engineer position.

C. Increased work frequency from 10 to 22 trips per month resulting in a drastic reduction in time off between trips to allow the effects of stress to subside.

Serving Since 1863

See comment 2.

(Though some trains consisting of Metroliner type equipment had been operated in the past at very high speeds with no second engineer; the number of assigned trips never exceeded 10/month, and equipment technician was always on board, and the engineer was not isolated in a separate locomotive cab.)

See comment 2.

Problems such as vandalism, faulty equipment and management attitude add measurably to the level of stress, but methods to reduce them can be instituted. However, such problems are secondary to those listed above. Those primary sources of stress are inherent in the nature of the job as it is presently constituted. Train operation at very high speeds is necessary to maintain competition with alternate modes and indeed there is pressure to increase the top speed. On the other hand, crew size and work frequency are variables controlled by economic considerations. An important question is whether or not the safety of the passenger and the health and safety of the engineers are being sacrificed for economy.

See comment 1.

The studies made by Decision Dynamics, Inc. for the BLE and by AMTRAK, and the comments for the GAO point toward a need for further study. A truly independent, scientifically based in depth study is needed. We have no reason to fear and every reason to expect nothing less.

Fraternally yours,

W.G. Hausleiter
Chairman

WGH/iz

The following are GAO's comments on the Chairman's letter dated June 2, 1986.

GAO Comments

1. We have responded to this statement in Appendix II of this report.

2. This additional information does not require a change to the text of the report.

Comments From Brian F. Blake, Ph.D., Consultant to the Brotherhood of Locomotive Engineers

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

REJOINDER TO

GAO DRAFT REPORT

GAO/RCED-86-131

Brian F. Blake, Ph.D.
Tactical Decisions Group
June 6, 1986

The following paper has been prepared under the aegis of Tactical Decisions Group for the Brotherhood of Locomotive Engineers. Comments and judgements contained herein reflect common scientific knowledge and opinion regarding research methods and occupational stress. Any and all conclusions contained herein are of procedures and conclusions and are not intended to describe the character or qualifications of any person, organizations of persons, or corporation.

Brian F. Blake, Ph.D. June 6, 1986

See comment 1.

See comment 1.

See comment 1.

See comment 2.

See comment 1.

See comment 2.

I. BACKGROUND

Before addressing specific comments made by the GAO draft report of May 15, 1986 (GAO/RCED-86-131), let us establish three more general points about the Stress Studies sponsored by the Brotherhood of Locomotive Engineers.

Call to Action

The first point concerns the degree to which the Studies clearly indicate that action is warranted. Two actions are of concern. The first is conducting additional research involving more resources than are currently available to the Brotherhood of Locomotive Engineers (BLE). The second is Amtrak's taking steps immediately to alleviate those sources of stress identified in Studies I and II.

Research The GAO report notes that the BLE study is ground breaking and offers substantial guidance for more extensive research on the issue of engineer stress. The report also contends that the Studies have particular limitations and therefore are not definitive in themselves.

We concur that the Studies have limitations ... as do all scientific studies. As will be shown later, though, these limitations are nowhere near as "limiting" as a glance at the GAO report might suggest.

To extend the scope of the Studies, would require resources/opportunities beyond those available to BLE, e.g., access to Amtrak records, site inspections at times and locations chosen by independent investigators.

GAO's call to conduct such studies, then, is hollow unless those resources can be made available to the investigator. Governmental support would undoubtedly be needed, for one, in the not unlikely event of carrier reluctance to disclose essential information.

See comment 2.

****

In brief, GAO's indicating that more extensive research is needed is specious unless those resources and opportunities (particularly those requiring Amtrak support) are made available.

****

See comment 1.

Alleviation It would be foolish to expect any two studies to be all definitive and all comprehensive. That rarely happens in scientific research.

See comment 1.

YET this statement does not imply that our knowledge base is weak. Rather, we do have quite a substantial knowledge base, one indicating clearly that steps can and should be taken to correct the problems - now.

See comment 1.

Consider that our concrete data concerning the job stress of engineers flows from a voluminous body of past data about human stress and occupational performance. We can "get a handle" on these stressors. We can make a reasonable estimate of these job stressors if we follow several steps.

1) Based on past empirical investigations and relevant medical-psychological knowledge, identify those job aspects that have been shown to cause stress in particular groups of rail engineers (foreign and domestic) and/or in comparable jobs in the transportation industry.
2) Next, verify empirically that these job aspects have produced stress in those particular groups of United States rail engineers who have been studied.
3) Then, determine from government records, university studies, testimony of knowledgeable observers, etc., if these job aspects occur widely in the rail system in question.
4) Finally, if these known job stressors do appear to be widespread, conclude that the job of rail engineer is most probably stressful.

See comment 1.

This decidedly roundabout way of reasoning is quite conservative ... an approach clearly superior to relying upon "common sense," personal

observations of supposed experts, etc. Too often the latter are subject to human biases and distortions.

See comment 1.

In many ways, this situation is akin to our asking whether the American pilots engaged in the recent air strike on Tripoli experienced job stress. We do not have a scientific study to directly answer this question. But we can turn to other sources for help. We can turn to analogous studies of the Vietnam and Korean conflicts. Further, we can ascertain that job elements were present that are known to produce stress, e.g., by counting the precise number of anti-aircraft missiles and equipment malfunctions. We can even go so far as to talk to the pilots who returned, although critics might charge that these data are open to subjectivity and bias. We can go this roundabout way to answering the question. If we do, we should probably draw the same conclusion that an ounce of commons sense would suggest - it was probably hell up there!

It is the same with rail engineers.

See comment 1.

Further, the results of the two Stress Studies are very clear in their general thrust:

> ..... Certain aspects of the job induce relatively high levels of stress among rail engineers.
>
> ..... The stress levels are dysfunctional for the individual engineer's wellbeing as well as for his job performance.
>
> ..... These job aspects can be readily improved if Amtrak so desired.

See comment 1.

****

We need not wait forever for more data. We cannot act as if we are in the dark about that which we can see clearly in its broad outlines. We cannot wait until it is too late. At that point, we would have the only evidence that would be truly definitive - human breakdowns, accidents, rail system failures!

****

GAO note: Comments located here, which were not relevant to the contents of our report, have been removed. See comment 3.

See comment 1.

Conceptual Groundwork

The GAO report concerns the appropriateness of the Studies' methodology. Before one can assess the validity of the procedures used, though, one should be conversant with the conceptual underpinnings of those procedures. The

issues and terminology are, of necessity, somewhat technical; so please bear with me.

See comment 1.

The following is the conceptual justification for the methodology used to calculate the degree of stress associated with each job aspect. The material summarizes a paper presented at the Academy of Psychosomatic Medicine, November, 1984 ("Express Train - Stress Train: Occupational Stress in Locomotive Engineers," by E. Wick, B. F. Blake, J. Woischke, and G. Vincent). A companion report, at the request of the editor, is being prepared for the Journal of Stress Medicine.

The rationale can be described in terms of a series of points.

See comment 1.

1. Stress is an experience and must be measured as such. Why? Stress is an experience of distress generated by a particular job facet (stimulus), an experience which reflects one's previous adaptation to that class of stimuli. The result of these adaptive processes (a la Brickman and Campbell[1], and Helson[2]) is that the same "stressful situation" can be an unpleasant stimulus for some but an interesting and enjoyable challenge for others. Since there are various subjective responses to the same objective stimulus, stress must be measured as a subjective response.

See comment 1.

2. Individuals may perceive stress in an absolute framework, but the stress judgements cannot be measured in an absolute framework adequately for use in a scientific analysis. The difficulty lies in the impossibility of measuring absolute stress without recourse to a comparative standard.

See comment 1.

Physiological measures must be adjusted to each person's own baseline of arousal/reactivity. Thus, various indices of physiological arousal (e.g., heart rate) must be relative to a baseline representing an individual's

---

[1] P. Brickman and D. Campbell (1971) Hedonic relativism and planning the good society. In M. Appley (Ed.) Adaptation-Level Theory: A Symposium. New York: Academic Press.

[2] H. Helson (1964) Adaptation Level Theory: An Experimental and Systematic Approach to Behavior. New York: Harper and Row.

"steady state" (i.e., condition when not stressed) and/or his reaction to a baseline of known stress value (cf. Stress Study II). The result of this requirement is that physiological measures that are not relative are impossible to interpret.

See comment 1.

Self report measures of "absolute" stress are also inadequate for empirical analysis. Self reports measured in verbal units (e.g., "very unpleasant") even when put into numbers are poor. They cannot be aggregated across individuals to yield anything other than ordinal data at best. The differences among respondents in their interpretations of the verbal scale anchors prohibit comparability. This, in turn, makes invalid the determination of means, variances, etc. and other figures that can represent how much more stressful is one stimulus over another or, for that matter, how stressful is a stimulus to engineers as a group.

See comment 1.

Can we quantify absolute stress through numerical scales? No! Let us use a category scale as an example, but the point can be made for all manifest scaling techniques attempting to quantify a person's experience of stress. Consider a category scale of 1 (low stress) to 5 (high stress). The problem is that numerous individuals will undoubtedly not use scale numbers as an interval scale. Convincing evidence for the prevalence of this phenomenon is the well documented instances of a non-linear relationship between stimulus intensity scores measured on a category scale and scores obtained by a JND (just noticeable difference) or confusion scale (such as a Thurstone Case V scale). The relationships are often logarithmic rather than linear. See Stevens[3] for a review of the classic evidence of this point.

See comment 1.

What is found, then, is that: a) a given person can use unequal intervals on a rating scale, b) persons can differ on the size of the interval between given numbers of a scale (e.g., 4 - 5), c) individuals can differ on the zero point of the scale (due to adaptation level processes).

---

[3] S. Stevens (1966). A metric for social consensus. Science. 151, 530-541.

The result is that category scales of absolute stress do not yield numbers that can be aggregated across individuals to derive a composite absolute stress score.

See comment 1.

3. Stress can be measured numerically on a relative basis. Individuals can reliably report the relative stressfulness of stimuli on an ordinal scale (DeRogatis[4]). Comparisons among persons (and so aggregation) can therefore be made in an ordinal metric if there is a common baseline of comparison.

See comment 1.

The establishment of this standard of comparison should also be done in a manner that can differentiate between stressful and, for all intents and purposes, minimally stressful stimuli. This can be accomplished within an ordinal metric by including in the judgement tests a stimulus of known value (low-minimal stress). If the standard stimulus has minimal (though non-zero) stress value, then stimuli above that point can be judged to be stressful and stimuli below it as low or negligible stress.

See comment 1.

An ordinal scaling of engineer stress is not particularly desirable because it would not indicate how much more stressful is one stimulus than another or how stressful in a "pseudo-absolute" sense. Thus, the ordinal judgements should be rescaled in such a manner as to yield interval scaled scores of stress that pertain to the engineers in the aggregate.

See comment 1.

4. A viable scaling procedure must meet the several criteria below. It must:

a) yield numerical rather than verbal designations of the magnitude of stress
b) have a baseline or zero point corresponding to low stress
c) scale each person's judgements by a procedure which considers

[4] L. DeRogatis. Self report measures of stress. (1982) In L. Goldberg and S. Breznitz (Eds.) Handbook of Stress: Theoretical and Clinical Aspects. New York: Free Press.

only the ordinal properties of his numerical judgements, and not the unstable interval or ratio properties

d) yield an interval scale on which stimuli are scaled to reflect their relative stressfulness for the aggregated engineers

e) be based both upon how much above each person's own zero point is a stimulus and also upon how frequently (i.e., to how many different engineers) is a stimulus at a given ordinal position above the baseline.

See comment 1.

5. A data collection and analysis procedure can be devised to meet these criteria and thereby serve as a valid and reliable measure of perceived stress. This measure can be interpreted in a manner analogous to the concept of "absolute stress" but is based on a valid theoretical and empirical basis.

See comment 1.

The data collection procedure asks an engineer how much stress each job situation causes him. The framework would respond to the experienced effect of stimulus refined through each person's adaptation level. The engineer describes his judgements on an ordinal scale. Respondents assign numbers from 0 to 100, but only the ordinal properties of those numbers are used.

See comment 1.

The analytic procedure used to turn these ordinal judgements into interval scores has several steps. First, each individual's ordinal judgements are converted into an implicit paired comparison (0-1) matrix based on the transitivity inherent in ordinal scales (cf. Blake, Heslin, Landis and Tzeng[5]. Next, all respondents matrices are combined into a single choice probability matrix through simple matrix summation.

See comment 1.

Next the Bradley-Terry-Luce (BTL) procedure is used to convert each stimulus' choice probability into an interval scaled score with an arbitrary

[5] B. F. Blake, R. Helin, D. Landis and O. Tzeng. Issues in the assessment of attitudes in pre- and marginally literate cultures. In S. Irvine and J. Berry (Eds.) Human Assessment and Cultural Factors. New York: Plenum.

See comment 1.

See comment 1.

See comment 1.

See comment 1.

zero point[6]. The algorithm used to do this was devised by Shoneman and Wang[7].

This procedure yields an interval scaled stress score for each stimulus (job aspect) that meets the previously specified criteria.

6. A "pseudo-absolute" score, one that can be interpreted for policy purposes as an absolute score, is then derived by the difference between each job aspect and the standards of comparison. The standards of comparison in the Stress Study I were those indicated in pilot studies as being of very, very modest stress: dispatcher's tone of voice, need to synchronize watches, the need to adjust headlights, and checking the bulletin board. The BTL scores for these comparison items were averaged and the score of the most stressful of them determined. The latter was used as the lower bound of "real stress." Scores above this yardstick (actually, 20) were interval scaled reflecting greater stress. Scores below it were interval scaled and reflect negligible stress.

7. The above procedure appears valid and useful. Testimony to this conclusion is found in the reaction of the Academy of Psychosomatic Medicine and in the invitation to submit a report to the journal.

A review of this procedure makes it evident that the approach:

* is directly derived from the above framework and, so, flows from current theoretical and empirical research about the psychological processes involved in occupational stress
* it employs a psychometrically meaningful unit of measurement
* its measuring scale is statistically verifiable (by the Mosteller test)

---

[6] R. Bradley and M. Terry. (1952) Rank analysis of incomplete block designs: 1. The method of paired comparisons. Biometrika, 39, 324-345.

[7] P. Shoneman and M. Wang. (1972) An individual difference model for multidimensional analysis of preference data. Psychometrika, 37, 275-309.

* its validity is upheld by its correspondence to the physiological measures (Study II)
* it functions to provide the same type of information as a measure of absolute stress but has none of the weak theoretical and empirical underpinnings of the absolute stress concept.

II. PROCEDURAL POINTS

Let us now consider each of the specific points raised in the GAO draft.

See comment 2.

Point 1. Incident Frequency

The report indicated that the Stress Studies cannot be acted upon until the actual frequency with which each of the stressors occurs is documented. This suggestion appears to flow from two premises: a) that the Stress Studies should have queried engineers about how often each of the stressors have occurred, and b) that stressful job aspects occurring more often are more troublesome than those that occur less often. BOTH OF THESE PREMISES ABOUT FREQUENCY OF OCCURRENCE (FOC) ARE INCORRECT, AS CONTEMPORARY THEORY AND EMPIRICAL EVIDENCE ON JOB STRESS WOULD INDICATE.

See comment 2.

Direct Questions. Engineer memories will systematically misestimate the relative frequency of occurrence of highly and less stressful events. This misestimation is not necessarily due to conscious distortion but rather is due to the manner in which human memory operates. It is quite possible that the misestimation would result in the relative overestimation of FOC of highly stressful job situations and the comparative underestimation of situations involving little stress.

See comment 1.

Stressful events, by definition, stimulate highly intense affect (feelings, emotions), while low stress by definition, entails relatively little affective intensity. Under many situations - particularly those pertinent to survey interviews - a person recalls the occurrence of highly intense events more readily than the occurrence of less intense events (See Dutta and Kanungo[8,9]. Thus, it is likely that engineer FOC judgements would give

See comment 2.

[8] S. Dutta and R. Kanungo. Retention of affective material: A further verification of the intensity hypothesis. (1967) Journal of Personality and Social Psychology, 5, 476-481.

See comment 1.

undue emphasis to the stressful events, leading to the Stress Study's overestimating the prevalence of engineer stress. Along similar lines, additional "noise" (not systematic, a more random source of bias) is due to the readiness of persons to recall events with an affective tone consistent with their current mood state. Specifically, when currently distressed, one more readily recalls upsetting past events (see Bower[10]).

See comment 2.

The upshot of the above facets of human memory is that direct FOC questions to engineers would yield biased results.

See comment 2.

Frequency and Stress. The suggested need for FOC estimates appears to be predicated on the assumption that there is a linear (or at least monotonic) relationship between the FOC of a stressful event and the stress experienced when that event occurs. That is, that a distressing job aspect causes more stress the more frequently it does occur on the job.

See comment 2.

This assumption is in contradiction to a vast number of theories and empirical findings in the behavioral sciences. Individuals adapt psychologically to frequently occurring events which initially produce strong distress. Helson's work on adaptation level effects[11] and Brickman and Campbell's seminal exploration of the "hedonic treadmill"[12] document the processes by which individuals "become accustomed" to unpleasant events. The result of these adaptations is that FOC is non-linearly related to the magnitude of perceived distress. Further, persons adapt behaviorally to stressful events by changing work patterns, manner of dress, etc. When distressing events occur with a high, and therefore predictable, frequency,

---

[9] S. Dutta and R. Kanungo (1975) Affect and Memory: A Reformulation. Oxford: Pergamon Press.

[10] G. Bower (1981) Mood and memory. American Psychologist, 36, 129-148.

[11] H. Helson (1964) Adaptation Level Theory: An Experimental and Systematic Approach to Behavior. New York: Harper and Row.

[12] P. Brickman and D. Campbell (1971) Hedonic relativism and planning the good society. In M. Appley (Ed.) Adaptation-Level Theory: A Symposium. New York: Academic Press.

successful adaptations can occur. When successful, such adaptations can render highly frequent events less stressful than infrequent and unpredictable events. The many forms and impacts of these adaptations are reviewed in Goldberg and Breznitz[13].

See comment 1.

The upshot of the above is that FOC of stressors is not directly related to the magnitude of perceived stress.

****

See comment 1.

In summary, the Stress Studies could not, and should not, have obtained frequency of occurrence information from engineers. Even when obtained from other sources (e.g., Amtrak records), that information cannot directly indicate the difficulties occasioned by stressful job aspects.

****

Points 2 and 9: Temporal Specificity

See comment 1.

Point 2 notes that since the Stress Studies were conducted at a particular point in time (1984), we do not know whether the stressful job conditions observed then are still wreaking havoc. Point 9 observes that 1984 may have been a unique year for these engineers, in that they recently (January, 1983) had experienced a change in work rules. Both points boil down to the same issue.....Do the Studies' results still pertain to 1986 conditions?

See comment 2.

Of course it is possible that the stressfulness of varied job aspects may have changed in the two years since the studies were conducted. BUT we should not anticipate major changes in the engineers stress levels.

** Discussions with numerous engineers in the interim have

[13] L. Goldberg and Breznitz (Eds.) (1982) Handbook of Stress: Theoretical and Clinical Aspects. New York: Free Press.

suggested that job pressures have not eased appreciably since initial studies

** It would be a truly rare phenomenon if in this relatively short period engineers would be able to adapt psychologically and/or behaviorally to the troublesome job aspects.

****

See comment 2.

Thus, although it is possible that major changes have occurred, we see no evidence that those changes are actual.

****

Point 3. Non-Response Bias

See comment 1.

It was noted that 61% of the engineers responded to the survey. Without a separate sample of the 39% who did not respond, we cannot assume that the Studies describe the non respondents.

See comment 2.

The lack of a sample of non-respondents is a problem. We cannot assume, however, that non-responding engineers felt less job stress than respondents. It could as readily be argued that perhaps an unknown number of engineers encountering excessive stress did not respond because they wished to avoid thinking about an unpleasant topic. The data, though, technically cannot be generalized to the remaining engineers without making a leap of faith.

See comment 2.

We would suggest that the survey results are meaningful even though we cannot generalize to the non-respondents. Why? Because the study used a census not a sample of engineers. Thus, a majority of the population actually participated. Hence, by definition, the data obtained do reflect the majority of the engineers. We are not listening to a minority's voice. We are listening to the majority - though not all.

See comment 1.

In a nutshell, the difficulty produced by non-respondent bias can wreak havoc with a survey based on a small sample from a large population - but the difficulty is far, far less where a survey has actually queried a

majority of a finite population. We know the data represents majority viewpoints because respondents are the majority.

****

In brief, the possibility of non-respondent bias cannot be eliminated in Study I. However, the respondents compose the majority of the population of interest. Hence, the results do speak for the majority of the engineers, albeit perhaps not all. For this reason the results describe the bulk of the population and, hence, merit acceptance.

****

See comment 1.

Point 4. Item Format

See comment 1.

The GAO report observed, correctly, that the questionnaires used in Study I and in Study II were slightly different. Study I's questionnaire asked engineers to rank, in order of magnitude, various job stressors. Respondent, judgements, then, were comparative in nature. Study II's questionnaire asked engineers to evaluate each stressor separately; these judgements were then absolute in nature. In addition, other minor differences in item wordings appeared. The GAO report, unfortunately, then concluded incorrectly that the differences precluded using Study II to validate Study I's conclusions about which job aspects generate more stress.

See comment 2.

The flaw in the GAO conclusion is that it flows from a misunderstanding of the Studies. Study I yielded two outputs; the first is the identification of job aspects inducing relatively more job stress. The second result flowed from the inclusion of the "exaggeration scales" in the mail questionnaire and the small sample of in-depth clinical interviews by Dr. Wick. These procedures found no evidence that engineers' verbal reports were spuriously overestimating or underestimating distress. Study II was not designed to validate the first output of Study I. In fact, nowhere in Study II is there a statement of this purpose. Rather, Study II was designed to provide a finer test of the extent to which engineer verbal reports of stress are

See comment 1.

substantiated by their physiological "reports." Study II was intended to unearth evidence, if any existed, that engineer verbal reports are biased guides to what is truly the engineer's psychological/physiological reaction to job stressors. Study II, then, substantiated the second output of Study I in that the conclusion of Study I (i.e., that there was no evidence of systematic bias due to over- or underestimates in verbal reports) was replicated under more stringent tests in Study II.

See comment 1.

We should note in passing that the comparative format in Study I and the absolute format in Study II are quite appropriate - rather than being a limitation. As described earlier in the "Conceptual Groundwork" section, a comparative framework is necessary if we are to be able to interpret verbal reports of stress. The comparative approach, then, is needed for a mail survey. Conversely, the physiological measures suitable for measuring job stress are not sufficiently precise to gauge fine distinctions among stressors. Available recording devices are, however, more than sufficient to the task of calculating differences between a given job aspect and a baseline when those differences are in fairly molar units of "high," "medium," and "low."

****

See comment 2.

In brief, this criticism is groundless. It is based on a serious misreading of the Studies. We did not intend Study II to replicate Study I's identification of job stress magnitudes. Rather, Study II was geared to replicate that conclusion of Study I that there was no evidence that engineer verbal reports were systematically biased by tendencies to overexaggerate.

See comment 1.

The use in Study II of revised questionnaire item formats is therefore appropriate. Rather than being a limitation of the Studies, this fact is more a strength.

****

See comment 1.

Point 5. Comparison Groups

The contention of the GAO's survey specialist is that without a comparison group (e.g., engineers in other geographical areas, members of

other occupations) it is difficult to interpret whether the proportion of *engineers experiencing* particular stress symptoms is unduly high or low. Is a control or comparison group essential to the meaningfulness of the stress studies?

See comment 1.

We suggest that the answer is NO because ...

a) under any practical contingency, the results of a control group comparison would be equivocal.
b) control group comparisons are unnecessary to achieving the formal objectives of the study.
c) the policy implications of the studies' results are not contingent upon any specific comparisons to given control group(s).

See comment 1.

Aspects of these points are discussed in greater detail in Cook and Campbell[14] and in Blake and Heslin[15].

See comment 1.

Equivocal Comparisons While the use of control or comparison groups is intuitively appealing, in practice the use of one or more control groups will lead to equivocal results under any practical situations. The crux of the problem lies in the selection of appropriate control groups. Suppose, for example, that engineers in the Northeast Corridor are compared to engineers on lower speed freight runs in a midwestern locale and that the Northeast Corridor engineers are found to have markedly higher perceived stress. Does this result indicate that the Corridor engineers are experiencing an excessive amount of stress? Of course not. A critic could legitimately note that the differences between the two groups may be traceable to other causes; for example, the midwestern engineers might be exposed to unduly low levels of stress. Further, does a difference between

[14] T. Cook and D. Campbell. (1979) Quasi-Experimentation: Design and Analysis Issues for Field Settings. Chicago: Rand McNally.

[15] B. F. Blake and R. Heslin. (1984) Evaluating cross cultural training. In D. Landis and R. Brislin (Eds.) Handbook of Intercultural Training, Vol. 1. New York: Pergamon Press.

the two groups represent any specific factor, e.g., the greater speed of runs in the Corridor? Again, of course not.

See comment 1.

The problem would not be solved, in fact, by making an empirical comparison to all rail engineers in the country, for such a comparison leaves unanswered the question of whether rail engineers as a class have a low or high level of stress compared to other professions such as airline pilots or street cleaners.

See comment 1.

The only scientifically definitive comparison would be to norms or standards based on stress measures for a wide variety of occupations when those measures are derived from a standardized measuring instrument. Clearly such a comparison would be impossible, since the normative data do not exist either at the present time or, likely, in the foreseeable future.

See comment 1.

Would a comparison between a given group of engineers with other groups of engineers and with representatives of other particular professions, though "dirty" for the above reasons, increase the meaningfulness of the results? Clearly, such a comparison, if it involved a range of non-engineer occupations, and also represented a cross section of all the nation's engineers, would increase one's ability to interpret the results of a comparison. Even such an imperfect comparison, unfortunately, would not be

See comment 2.

workable at the present time. The practical difficulties in securing reasonable representative samples of non-engineers wold be insurmountable given the resources available to the BLE.

See comment 1.

In a nutshell, a selection of meaningful control groups would be practically impossible. Conversely, selection of available control groups would yield equivocal results.

See comment 1.

Fortunately, this dilemma is not fatal. As explained below, the use of a control group is not necessary to the objectives of the study.

See comment 2.

Unnecessary to Objectives The formal objectives of Study I were: a) to identify those aspects of the job which engineers in the Northeast Corridor

on passenger trains experience (perceive, feel) as stressful, and b) identify factors (e.g., geographical location, type of engine operated) associated with greater experienced stress among those engineers. The objective of Study I was not to determine if these engineers experience unduly high levels of stress. The former does not require a comparison group. The latter would - if it were the goal of the study.

See comment 1.

The conclusion of Study I that these engineers as a group are experiencing substantial job stress is based on the facts that:

a) every single engineer included in the mail survey experienced at least some stressful job aspects (the magnitude of stress experienced being measured in the manner described previously).
b) all 22 engineers clinically interviewed in depth by the licensed psychologist displayed quite high levels of stress at least periodically.
c) the physiological indices of stress of all 22 engineers in Study II revealed numerous job aspects that were above the commonly accepted baseline for high stress.

See comment 2.

Policy Implications The recourse to a control or comparison group assumes that the number of engineers experiencing intense stress must be greater than some given number considered "typical" and, hence, acceptable. For what other reason is a control group useful?

See comment 1.

Such an approach is difficult to justify in matters of health. It is tantamount to arguing that steps should not be taken to eradicate cancer if the death toll is not greater than that due to heart or other life threatening problems. It is equivalent to assuming that there is an acceptable "body count" due to a natural disaster.

See comment 1.

We would contend, consistent with the reigning standards of the medical and the psychotherapeutic community, that this approach is not acceptable. Rather, we contend that the documentation of the existence of pervasive and intense job stressors directly indicates the need for action to eliminate

those stressors. This need for action is especially evident when, as in the case of Amtrak, actions to eliminate the stressors can be cost effective and readily implementable!

****

See comment 2.

In summary, then, the absence of a control group is not a fatal flaw of the Stress Studies, although such groups could be beneficial. Under any practical contingency, the results of a control group comparison would be equivocal. Further, such comparisons are unnecessary to the success of the Studies.

****

See comment 1.

Point 6. Safety

See comment 2.

The authors of the GAO report feel that the methodology used in the Stress Studies can not test the impacts of engineer stress upon safety of the passengers and equipment. This fact, in combination with a review of Amtrak records (in GAO/RCED-85-1, April, 1985), prompted them to state, "The consultant's conclusion that the engineers' stress has affected safety does not seem to be supported by a widespread increase in safety related accidents."

See comment 1.

We fully agree with this former assessment. The procedures employed were not intended to estimate the impact of engineer stress on safety. That was not an objective of the study.

See comment 2.

The latter contention, though, is intriguing. Nowhere in the reports did we state that the stressful working conditions have already caused safety related incidents.

See comment 1.

What the reports did say was that we, as psychologists, are deeply concerned for the welfare of the engineers and the safety of the passengers. In the in-depth clinical interviews (especially in Study II) many instances of serious stress related problems were observed. Clinical and psychiatric knowledge rather clearly indicates that those problems can over time, if not

handled, lead to job ineffectiveness and even a breakdown which can then imperil others.

See comment 2.

Thus, our observations about safety pertained to the potential safety problems caused by stressful working conditions, e.g., Study II, page 23. We did not say that stress has already caused serious accidents. Rather, we said that, if not corrected, the stressful working conditions have the potential for causing serious accidents.

****

See comment 1.

Thus, this criticism by the GAO is predicated on a misreading to the reports. We contend that the potential safety problems due to unresolved stress are frightening. We never stated that stress has been shown to have already caused accidents and other safety related incidents.

See comment 2.

See comment 1.

The "time bomb" has not exploded ... as yet. But, unless defused, it could well do so and thereby imperil the safety of others.

****

Point 7. Precision of Study II Results

See comment 1.

The authors of the GAO report felt that Study II was based on a small sample. "Because of the small sample size, extreme care should be taken in interpreting any of the findings." (P. 12). The authors then provide an example of one finding (incidence of stress related headaches) with a sampling error of 20%.

See comment 2.

This comment is, we feel, written in a manner that can readily mislead a reader without a background in statistical analysis. It seems to imply that Study II's results are imprecise and potentially in error.

See comment 2.

Such a conclusion would be wrong!! As we will describe below, the really important estimates are highly precise while only the more tangential

estimates as are less stable and less precise. Also, the authors have selected for their illustration a finding with the worst (i.e., least) precision among all the Study's findings. This illustration then is not representative of the Study and so can easily mislead a reader.

See comment 2.

To be more specific, the major objective of Study II was to determine the consistency of verbal and physiological indications of stress. The 22 person sample was actually quite "large" for this purpose, in that it provided a very high level of precision in estimating to the population of interest, engineers who had voiced (verbally) their views of job stress.

See comment 1.

The prime test of this consistency was a "non-exaggeration test score," an index of the extent one's physiological reactions did not indicate that the verbal report overstated the degree of felt stress. This index could range from a low of 0 (absolutely no consistency) to a high of 52 (absolutely no evidence of overstatement). It was found that scores actually ranged from 47 to 52 with an average (mean) of 49.0. The standard error of estimate was 0.3. This means that we can be 95% certain that the relevant 160 Northeast Corridor engineers would most likely have a consistency score between 48.42 and 49.58. This precision is remarkable, given a possible range of scores from 0 to 52.

See comment 2.

Thus, the sample size of 22 was more than capable of providing thoroughly precise estimates. It follow then, that the sample is not unduly small, as is implied in the GAO report.

See comment 1.

Various secondary objectives of the Study, next, have somewhat less precision. The precision of these estimates, however, is far better than the "worst case scenario" noted by the GAO authors. A point by point description of these precision levels will be provided upon request.

See comment 1.

****

The conclusion should be clear. The precision and freedom from "noise" is far greater than the GAO author(s) imply. This conclusion is not a matter of opinion but, rather, follows mathematically for the data obtained in the Studies. The level of precision in Study II's conclusions is quite high- much more than enough to permit the reader to get a solid projection of the veracity of engineer verbal reports and, thereby, of the real need to act upon Study II's information.

****

See comment 1.

Allow me to conclude on a more personal note. I am concerned that the main outcomes of the Studies may be nit-picked to death. Debate about procedural details should not be allowed to distract us from the major conclusions of the study. Those conclusions should be immediately obvious to any unbiased observer, with or without the niceties of a scientific study.

See comment 1.

Engineers are encountering job stressors that are dysfunctional for their health and wellbeing. Those stressors can - and should - be corrected. Any other action, I feel, would be nonsensical.

The following are GAO's comments on the comments by Brian F. Blake, Ph. D.

GAO Comments

1. This additional information does not require a change to the text of the report.

2. We have responded to this statement in Appendix II of this report.

3. We have deleted comments that were not relevent to the contents of this report. These comments are available from our office upon request.

Requests for copies of GAO reports should be sent to:

U.S. General Accounting Office
Post Office Box 6015
Gaithersburg, Maryland 20877

Telephone 202-275-6241

The first five copies of each report are free. Additional copies are $2.00 each.

There is a 25% discount on orders for 100 or more copies mailed to a single address.

Orders must be prepaid by cash or by check or money order made out to the Superintendent of Documents.

United States
General Accounting Office
Washington, D.C. 20548

Official Business
Penalty for Private Use $300

Address Correction Requested

First-Class Mail
Postage & Fees Paid
GAO
Permit No. G100