CONF-801096--1

PSYCHOPHYSIOLOGICAL AND OTHER FACTORS AFFECTING HUMAN PERFORMANCE IN ACCIDENT PREVENTION AND INVESTIGATION

MASTER

by

Dr. Lawrence R. Klinestiver

EG&G Idaho, Inc.
Idaho Falls, Idaho 83415

To be presented

at the

18th Annual SAFE Symposium
"Reach Out For A Safe Tomorrow"

San Diego, California

October 12-16, 1980

Work supported by the U. S. Department of Energy under DOE Contract No. DE-AC07--61D01570

DISCLAIMER

PSYCHOPHYSIOLOGICAL AND OTHER FACTORS AFFECTING HUMAN PERFORMANCE IN ACCIDENT PREVENTION AND INVESTIGATION

Dr. Lawrence R. Klinestiver
Scientist
System Safety Division
EG&G Idaho, Inc.
Idaho Falls, Idaho

ABSTRACT. Psychophysiological factors are not uncommon terms in the aviation incident/accident investigation sequence where human error is involved. It is highly suspect that the same psychophysiological factors may also exist in the industrial arena where operator personnel function; but, there is little evidence in literature indicating how management and subordinates cope with these factors to prevent or reduce accidents. It is apparent that "human factors" psychophysiological training is quite evident in the aviation industry. However, while the industrial arena appears to analyze psychophysiological factors in accident investigations, there is little evidence that established training programs exist for supervisors and operator personnel.

INTRODUCTION. Human physiological problems were encountered in the last century during high-altitude balloon ascents. These physiological disturbances were documented as causal factors in balloon accidents[1]. As aircraft became more sophisticated, enabling them to venture into hostile environments, it became obvious that physiological and psychological factors were the cause of many accidents[2].

"Human Factors" entered the scene during World War II which implied not only human engineering, but also physiological and psychological aspects as well[2].

In the early fifties, the USAF became concerned about "pilot-error" problems and, as a result, numerous studies were conducted to define these problems. The American Institute for Research conducted an extensive study for the USAF School of Aviation Medicine, Randolph AFB, Texas, regarding human factors. This study not only involved aircraft accidents, but included various industrial and highway accidents[3]. Areas of interest were fatigue, anoxia, mood, personal stress and emotional upset, general state of health, nutritional status, morale, drugs, and attitude toward safety and safety practices.

A list of "Psychophysiological" and "Environmental Factors" were developed several years ago by the Joint Services Committee, and was designated the 711gA[4] (Figure 1). Accident investigators and flight surgeons have become very familiar with this human factors checklist. The 711gA has provided accident investigators a standardized method and broader visibility in order to prevent oversights and omissions during the accident investigation process.

Purpose and Objectives. Although psychophysiological and environmental factors are well-known terms throughout the aviation industry, they can be involved in many other disciplines during an accident/incident sequence where human error becomes evident. These factors may surface in such areas as nuclear power plants, coal-fired power plants, the transportation industry, and many other disciplines where human operators are involved.

The purpose, then, is to raise questions as to how management, supervisors, and operators understand, train, and control these psychophysiological factors that exist in their daily operational environment. The answers to these questions become our objective.

Approach. First, a literature search and review was conducted in known areas of expertise in accident investigation to see what common psychophysiological factors appear from the industrial accident investigations that are comparable

to the aviation terminology. Second, during this review, special considerations were directed to see how much emphasis was placed on human factors training in psychophysiology with regards to industrial operations.

Results of Studies Conducted in the Aviation Environment

1. A total of 18 jet-fighter aircraft mishaps were investigated or reviewed utilizing AF Form 711gA and a USAFSAM/HF profile[5] (Tables 1 and 2). A human factors evaluation summary indicates that supervision, experience/training, radio communications, environmental, and psychological factors were not prominent in these mishaps (Table 3). However, the 711gA category "Other Factors", specifically the expanded USAFSAM factors, were decidedly predominant in these mishaps. A notable observation in the 72-hour profile, normally prepared by the flight surgeon, was that it became a joint effort with the human factors advisor. Although the 72-hour profile does not appear to be a significant factor in these accidents, the importance of obtaining vital information regarding fatigue, nutrition, life style changes, and stress (physical and mental) sometimes determined the accident board's approach to the problem.

2. A second study was conducted at the Air Force Inspection and Safety Center (AFISC) Norton AFB, California, simultaneous to the prior field study[6]. This study was based on the premise that both humans and the environment inherently contain the potential for an accident. By isolating the operator and environmental variables, which historically have been co-occurring at the time of a mishap, future efforts of an investigating team will be aided in determining why the accident occurred. This study was accomplished by a retrospective analysis of 76 operator-induced mishaps over an 18-month period. Through a process of identifying and defining 110 variables, four major environmental and four major operator variables were isolated (Table 4). The environmental variables were weather, training deficiencies, special missions, and supervision (primarily command and control). The operator errors were situation orientation, task proficiency,

judgment error, and concentration deficiencies. These conclusions closely parallel those which were derived from on-scene participation in the investigation of the 18 mishaps mentioned in Study 1 above, despite the fact that these studies were conducted independant of each other.

3. The BDM study contained a systematic investigation of pilot factors involved in aircraft mishaps, focusing on Air Force fighter and attack aircraft[7]. These mishaps occur when the pilot is unable to respond with the proper flight-control mechanisms to avoid an accident, or more specifically, to avoid the situation altogether. There are other instances where mishaps will occur, not because of a pilot mistake or omission, but because the situational demands of the flight exceed the pilot's capabilities. Major pilot factors based on aircraft accident literature review are similar to the findings in the first two studies[5,6] (Tables 5, 6, and 7).

4. The Tri-Service safety centers have provided similar psychophysiological factors as indicated in earlier studies[8,9,10]. The common thread appears that in order to minimize human error, the amount of supervision, training, experience, attitude, and understanding of the operator's psychophysiological limitations must be determined.

Psychophysiological stress and emotional disturbance appear to be a dominant causal factor in human error accidents and incidents (Tables 8, 9, 10, and 11).

Results of Studies Conducted in the Civilian Environment

1. Nuclear Industry. Human factors, especially operator errors in nuclear power plants, have become an increasingly common source of expressed concern among legislators, regulators, the nuclear industry, and the general public[11]. Interest in human factors engineering has increased significantly since the Three Mile Island (TMI) incident and has influenced the design of equipment, systems, facilities, and operational environments to

promote safe, efficient, and reliable operator performance[12]. This also involves more efficient procedures, better operator selection and training, and control-room manning. The potential of "human error" is omnipresent and can result from a multitude of causes; however, not all causes imply a deficiency on the part of the operator[13]. A variety of psycho-physiological factors may have been involved in the TMI incident causing "human error" and possible performance deficiency (Table 12).

2. Transportation Industry. A recent stress/alcohol and motor-accident study conducted at USC revealed a surprising statistic on autopsies released from the Los Angeles County coroner's office. Sixty-one percent of driver fatalities show evidence of various stress diseases and often in advanced forms[14]. There are many contributing causes to every vehicle accident and many are vague. These vague, underlying causes do not usually surface in vehicle accident investigation; however, they are more important to accident prevention than those which are apparent from a mechanical and operational standpoint.

The vehicle accident rate for EG&G Idaho, Inc., is relatively low despite the enormous amount of miles traveled each year, coupled with environmental problems during the winter months. A review has revealed three important incidents where drivers fell asleep on the journey home from EG&G sites. Incident reports have indicated severe fatigue problems. EG&G Idaho, Inc., now has individual work guidelines which cover high- and low-sensitivity activities, that includes emotional or other psychological and physiological stresses (Table 13).

All three vehicle accident investigations were performed using a well-balanced checklist to determine the "why" of operator error if environmental or mechanical problems were not a cause (Table 14).

3. Coal-Fired Power Plant. Coal-fired power plant operation interviews with utility representatives clearly indicate that there is concern over

personnel reliability in fossil-fuel power plants[15]. Operators feel that some personnel errors are random and inevitable; however, they suggested that improvements could be made. The outstanding results from this study are the development of in-house programs to improve supervisor's understanding of personnel reliability. Training and reduction in turnover were the most frequent responses to reduce personnel errors. However, utility management personnel indicated there was a lack of quantitative evidence that additional training would reduce operator error. Psychophysiological factors were not strongly in evidence here; however, supervision, human factors, and discipline are questionable causes concerning personnel error (Table 15).

CONCLUSIONS. It is apparent from the literature review that psycho-physiological problems and other factors exist not only in the aviation industry, but in other industrial complexes where human operators are involved. There is very little evidence that industrial programs contain any type of human factors psychophysiological training. However, the Joint Services Safety Council recommended the need for greater awareness training in human factors and suggested that each service provide a curriculum outline/lesson plan for this training. Selection of personnel, training of personnel, and utilizing proper procedures, appears to be less than adequate in having direct effect on human performance. The review also suggests that deficiencies in engineering design may reduce human performance, causing or increasing human errors. Some researchers state that neither design improvement, training, motivation, procedures, rest, nor simulation can reduce all residual errors.

There is evidence that some companies utilize a type of an employee assistance program to help employees who have psychophysiological and emotional problems. These programs are usually conducted on an individual basis between employee and counselor, unless otherwise requested by specific groups.

RECOMMENDATIONS. To reduce the human error potential and minimize this error to prevent accidents, the following recommendations are given:

- Training. Establish a psychophysiological and other factors awareness training program that is compatible with the facilities involved in order for operators to gain insight into their life style. In other words, individuals should know and understand their psychophysiological limitations in regards to applications to stress and performance within the environment and the requirements of their job. Once a level of understanding is achieved, continual reinforcement should be maintained as an on-going process.

- Operational Aids. Management must assure that personnel occupying operator positions on complex consoles are able to perform tasks required under normal and stressful conditions. For example, can operators respond to complex displays under stress if they are not psychophysiologically alert at that particular time? (i.e., fatigue, hypoglycemia, etc.).

- Correct Performance During Operational Activities. Develop operation simulators to detect flaws in human performance that should be incorporated into training programs.

- Feedback of Information. Structure safety programs to include stress-related problems on lessons learned from prior accidents/incidents regarding human performance.

- Human Reliability and Assurance. Ensure that screening of personnel for high-risk assignments is given top priority. These programs may not appear to be economically feasible; however, when faced with a disaster in a highly sensitive industry, this program becomes vital.

- A/I Medical Investigators. Provide all medical investigators involved in the industrial arena with formal accident/investigation training in order to obtain a standardized psychophysiological profile where human erro is applicable.

BIBLIOGRAPHY

1. McFarland, R. A., "Human Factors in Relation to the Development of Pressurized Cabins," Aerospace Med., 42, 1303, 1971.

2. Simson, L. R. Jr., "Physiological and Psychological Investigations of Fatal Aircraft Accidents," Aerospace Pathology, 1973.

3. Thorndyke, R. L., "The Human Factor in Accidents With Special Reference to Aircraft Accidents," A Report to the School of Aviation Medicine, Project No. 21-30-001, Report No. 1, 1951.

4. Belk, W. R. Col., USAF, MC, "Psychophysiological Factors in USAF Aircraft Accidents, 1974-1975," 1978.

5. Klinestiver, L. R. Lt. Col., and Santilli, S. R., Major, USAF, "Human Factors Accident Investigation Report for TAC/SE Biodynamics Branch, Crew Technology Division, USAFSAM, Brooks, AFB, TX," 1979.

6. Santilli, S. R., "Critical Interfaces Between Environment and Organism in Class A Mishaps: A Retrospective Analysis.", USAF School of Aerospace Medicine, Aerospace Medical Division (AFSC), Brooks AFB, TX 78235, 1980.

7. The BDM Corporation, "Definition of Investigative Areas for Human Factors Aspects of Aircraft Accidents," McLean, Virginia 22102, 1980.

8. Anstine, G. Col., USAF, "A Risk Management Guide for Air Force Operations," Directorate of Aerospace Safety, Air Force Inspection and Safety Center, Norton, AFB, California, 1979.

9. Spezia, E., "Human Error Analysis at USAAAVS," US Army Safety Center, Fort Rucker, Alabama 36362, 1979.

10. Lederer, J. F., "Pros and Cons of Punishment for Achieving Discipline in Aviation," Electrical Power Research Institute and University of Southern California, Forum, The International Society of Air Safety Investigators, 1979.

11. Hagen, E. W., "The Human: Key Factor in Nuclear Safety," Nuclear Safety, Vol. 21, No. 4, 1980.

12. Seminara, J. I. et.al., "Human Factors in the Nuclear Control Room," Nuclear Safety, Vol. 18, No. 6, 1977.

13. Malone, T. B., et.al., Human Factors Evaluation of Control Program Design and Operator Performance at Three Mile Island - 2, Final Report, The Essex Corporation, 1979.

14. Dreher, J. Ph.D, Interview SAFE Journal, Vol. 9, No. 1, 1978.

15. Finnegan, J. P., Retting, T. W., and Rev, C. A. Jr., The Role of Personnel Errors in Power Plant Equipment Reliability, EPRI AF-1041/TPS 77-715, Final Report, 1979.

Lawrence R. Klinestiver, Ph.D. Dr. Klinestiver is presently a scientist in the System Safety Division for EG&G Idaho, Inc., Idaho Falls, Idaho. His Ph.D and MS degrees are from Colorado State University and the University of New Mexico. His undergraduate degrees are from Washburn University in Topeka, Kansas. His areas of expertise are Physiology, Biology, Psychology, Zoology, and Anatomy. Dr. Klinestiver retired from the U.S. Air Force with 27 years of service. He was a jet fighter pilot for 18 years coupled with assignments in Aerospace Physiology, Assistant Professor and Deputy Head, Chemistry and Biological Sciences, U.S. Air Force Academy, and the School of Aerospace Medicine where he held positions as Chief, Crew Performance Branch and Chief, Human Factors Accident Investigation.

Professional Affiliations

Aerospace Medical Association - Physiology Section
Registry of Medical Technologist Section (ASCP)
Air Force Association
Red River Valley Fighter Pilots Association
SAFE Organization
The Society of Sigma XI

Figure 1:... PSYCHOPHYSIOLOGICAL AND ENVIRONMENTAL FACTORS

PSYCHOPHYSIOLOGICAL AND ENVIRONMENTAL FACTORS

PHASES OF MISHAP
A – ACCIDENT
E – ESCAPE
S – SURVIVAL (Includes parachute landings)
R – RESCUE

FACTOR IMPORTANCE
D – DEFINITELY CONTRIBUTED
S – SUSPECTED FACTOR
P – CONDITION PRESENT, BUT DID NOT CONTRIBUTE TO ACCIDENT OR INJURY.

FACTORS		A	E	S	R
1. SUPERVISORY FACTORS					
INADEQUATE BRIEFING	101				
ORDERED/LED ON FLIGHT BEYOND CAPABILITY	102				
POOR CREW COORDINATION	103				
OTHER *(Specify)*	199				
2. PRE-FLIGHT FACTORS					
FAULTY FLIGHT PLAN	201				
FAULTY PRE-FLIGHT OF AIRCRAFT	202				
FAULTY PREPARATION OF PERSONAL EQUIP.	203				
HURRIED DEPARTURE	204				
DELAYED DEPARTURE	205				
INADEQUATE WEATHER ANALYSIS	206				
OTHER *(Specify)*	299				
3. EXPERIENCE/TRAINING FACTORS					
INADEQUATE TRANSITION	301				
LIMITED TOTAL EXPERIENCE	302				
LIMITED RECENT EXPERIENCE	303				
FAILURE TO USE ACCEPTED PROCEDURES	304				
OTHER *(Specify)*	399				
4. DESIGN FACTORS					
DESIGN OF INSTRUMENTS; CONTROLS	401				
LOCATION OF INSTRUMENTS, CONTROLS	402				
FAILURE OF INSTRUMENTS, CONTROLS	403				
COCKPIT LIGHTING	404				
RUNWAY LIGHTING	405				
LIGHTING OF OTHER AIRCRAFT	406				
PERSONAL EQUIPMENT INTERFERENCE	407				
WORKSPACE INCOMPATIBLE WITH MAN	408				
OTHER *(Specify)*	499				
5. COMMUNICATIONS PROBLEMS					
MISINTERPRETED COMMUNICATIONS	501				
DISRUPTED COMMUNICATIONS	502				
LANGUAGE BARRIER	503				
NOISE INTERFERENCE	504				
OTHER *(Specify)*	599				
6. PSYCHOPHYSIOLOGICAL FACTORS					
FOOD POISONING	601				
MOTION SICKNESS	602				
OTHER ACUTE ILLNESS	603				
OTHER PRE-EXISTING DISEASE/DEFECT	604				
GET-HOMEITIS	605				
HANGOVER	606				
SLEEP DEPRIVATION	607				
FATIGUE, OTHER	608				
MISSED MEALS	609				
DRUGS PRESCRIBED BY MEDICAL OFFICER	610				
DRUGS, OTHER	611				
ALCOHOL	612				
NAME OF INDIVIDUAL					

FACTORS		A	E	S	R
VISUAL ILLUSIONS	613				
UNCONSCIOUSNESS	614				
DISORIENTATION/VERTIGO	615				
HYPOXIA	616				
HYPERVENTILATION	617				
DYSBARISM	618				
CARBON MONOXIDE POISONING	619				
BOREDOM	620				
INATTENTION	621				
CHANNELIZED ATTENTION	622				
DISTRACTION	623				
PREOCCUPATION WITH PERSONAL PROBLEMS	624				
EXCESSIVE MOTIVATION TO SUCCEED	625				
OVERCONFIDENCE	626				
LACK OF SELF-CONFIDENCE	627				
LACK OF CONFIDENCE IN EQUIPMENT	628				
APPREHENSION	629				
PANIC	630				
OTHER *(Specify)*	699				
7. ENVIRONMENTAL FACTORS					
ACCELERATION FORCES, IN-FLIGHT	701				
ACCELERATION FORCES, IMPACT	702				
DECOMPRESSION	703				
VIBRATION	704				
GLARE	705				
SMOKE, FUMES, ETC.	706				
HEAT	707				
COLD	708				
WIND BLAST	709				
VISIBILITY RESTRICTION – WEATHER, HAZE, DARKNESS	710				
VISIBILITY RESTRICTION – ICING, WINDOWS FOGGED, ETC.	711				
VISIBILITY RESTRICTION – DUST, SMOKE, ETC., IN ACFT	712				
WEATHER, OTHER THAN VISIBILITY RESTRIC.	713				
OTHER *(Specify)*	799				
8. OTHER FACTORS TO BE CONSIDERED					
HABIT INTERFERENCE, USED WRONG CONTROL	801				
CONFUSION OF CONTROLS, OTHER	802				
MISREAD INSTRUMENT(S)	803				
MISINTERPRETED INSTRUMENT READING	804				
MISLED BY FAULTY INSTRUMENT	805				
VISUAL RESTRICTION BY EQUIP STRUCTURES	806				
TASK OVERSATURATION	807				
INADEQUATE COORDINATION OR TIMING	808				
MISJUDGED SPEED OR DISTANCE	809				
SELECTED WRONG COURSE OF ACTION	810				
DELAY IN TAKING NECESSARY ACTION	811				
VIOLATION OF FLIGHT DISCIPLINE	812				
NAVIGATIONAL ERROR	813				
INADVERTENT OPERATION SELF INDUCED	814				
INADVERTENT OPERATION MECHANICALLY INDUCED	815				
OTHER *(Specify)*	899				
SERVICE NO.					

TABLE 1

711gA: OTHER FACTORS

Habit interference...used wrong control

Confusion of controls....other

Misread instrument(s)

Misinterpreted instrument reading

Misled by faulty instrument

Visual restrictions....by equipment, structures

Task oversaturation

Inadequate coordination or timing

Misjudged speed or distance

Selected wrong course of action

Delay in taking necessary action

Violation of flight discipline

Navigational error

Inadvertent operation....self-induced

Inadvertent operation....mechanically induced

Other (Specify)

TABLE 2

USAFSAM: OTHER FACTORS

Aircrew discipline

Violation of directives

Command and control

- Judgment
- Crew coordination
- Flight coordination

Task evaluation

- Cockpit design
- Pilot distraction

Situational awareness

Pilot-induced error

Motivation

- Peer pressure
- Supervisor pressure
- Will to succeed

TABLE 4

INCIDENCE OF VARIABLES IN CLASS A MISHAPS

Variable	% Total	% Collision	% Control Loss
1. Weather			
a. Climatic Conditions	34	35	32
b. Time of Day			
(1) Daylight	83	74	92
(2) Darkness	16	26	5
(3) Transition	1	0	3
2. Equipment Failure	21	15	27
a. Aircraft	17	10	24
b. Support	5	5	5
3. Equipment Design	20	21	20
a. Aircraft	12	13	11
b. Support	8	8	8
4. Equipment Shortages	3	3	3
a. Aircraft	0	0	0
b. Support	3	3	3
5. Training	53	54	51
a. Event Proficiency	27	28	27
b. Procedure/Technique Inadequacy	38	38	38
6. Special Mission	33	44	32
a. Actual	2	0	5
b. Perceived	36	44	27
7. Supervision	46	51	41
a. Command Control	37	38	35
b. Supervisory Pressure	4	5	3
c. Double Standard	13	15	11
d. Briefings	20	28	11

TABLE 4 (cont'd)

Variable	% Total	% Collision	% Control Loss
8. System Overcommitment	21	28	11
a. Task Demands	17	23	11
b. Multiple Tasks	7	10	3
9. Phase of Flight			
a. Takeoff	0	0	0
b. Climbout	5	8	3
c. Enroute	12	13	11
d. Range	62	72	51
e. Descent	8	0	16
f. Landing	13	8	20
10. Mission Element			
a. SAM Break	1	0	3
b. L/L Nav	13	21	5
c. L/L Maneuver	28	46	8
d. Air-to-Grnd Ord	17	26	8
e. Air-to-Air Eng	18	23	14
(1) DACT	12	15	8
(2) SACT	8	8	8
f. Acrobatics	9	5	14
(1) Confidence	7	0	14
(2) Demonstration	2	5	0
g. Formation	34	44	24
(1) Rejoin	9	13	5
(2) Maneuvering	25	31	20
h. Search and Rescue	3	0	5
i. Basic Acft Maneuvers	26	13	41
11. Deployed	24	33	8
12. Preexisting Illness/Defect	14	21	8
13. Nutritional State	4	3	5

TABLE 4 (cont'd)

Variable	% Total	% Collision	% Control Loss
14. Drugs	3	5	0
15. Fatigue	22	28	16
16. G.A.S.	28	28	30
17. Situation Disorientation	47	64	30
18. Circadian Rhythm	4	0	8
19. Age (Average)	31	31	31
20. Task Proficiency	42	36	47
a. Total Time (Avg)	1892	1961	1823
b. UE Time (Avg)	646	668	624
c. No Prior	20	13	27
d. No Recent Prior	16	15	16
e. Recent but First	7	5	8
21. Confidence	28	28	27
a. Self	26	26	27
(1) Over	24	26	22
(2) Under	4	0	8
b. Equipment	1	3	0
(1) Over	1	3	0
(2) Under	0	0	0
22. Self-Overcommitment	36	44	27
a. Task Demands	42	41	44
b. Multiple Tasks	4	5	3
23. Habit Substitution	25	18	32
24. Decision Delay	12	13	11
25. Concentration	84	90	78
a. Channelized Attn	42	36	48
b. Distraction	37	38	35
(1) Physical	17	18	16
(2) Mental	24	23	24
c. Inattention	28	26	30
d. Habituation	4	3	5

TABLE 4 (cont'd)

Variable	% Total	%Collision	% Control Loss
26. Judgment Error	63	72	54
27. Discipline Breakdown	28	41	8
28. Weak Pilot	15	13	16
29. Co-pilot Syndrome	17	13	22
30. Violation of Regs	26	36	16

TABLE 5

MAJOR PILOT FACTORS BASED ON AIRCRAFT MISHAP LITERATURE REVIEW

FACTORS
CHANNELIZED ATTENTION
DISCIPLINE
DISORIENTATION/VERTIGO
DISTRACTION
EXPERIENCE
FATIGUE
PANIC
PERSONALITY CHARACTERISTICS
PILOT AGE
PILOT'S PHYSICAL CONDITION
STRESS
WORKLOAD

TABLE 6

MAJOR PILOT FACTORS ASSOCIATED WITH AIRCRAFT MISHAPS

Factor	BDM Coding	Air Force Coding
CHANNELIZED ATTENTION	32 (46%)	38 (54%)
DISTRACTION	26 (37%)	21 (30%)
DISORIENTATION/VERTIGO	22 (31%)	17 (24%)
EXCESSIVE MOTIVATION TO SUCCEED	14 (20%)	16 (23%)
OVER-CONFIDENCE		3 (11%)
STRESS	18 (19%)	4
APPREHENSION	a	10 (14%)
VISUAL ILLUSION	a	8 (11%)

[a]Did not evaluate this factor

TABLE 7

HUMAN FACTORS INVESTIGATED BY CANADIAN FORCES

PHYSIOLOGICAL STRESS

- HYPOXIA
- DISORIENTATION
- HEAT STRESS
- COLD INJURY
- INTOXICATION BY CO/OTHERS
- DECOMPRESSION SICKNESS
- AIR SICKNESS
- ACCELERATION
- BAROTITIS MEDIA
- UPSET OF CIRCADIAN RHYTHM
- INCAPACITATION
- HYPOGLYCEMIA
- HYPERVENTILATION
- COMBINED STRESSES: ALCOHOL
  FATIGUE
  NUTRITION
  SELF-MEDICATION

PHYCHOSOCIAL FACTORS

- PREVIOUS 30 DAYS DUTY/OFF DUTY HISTORY
- PREVIOUS 3 MONTHS HISTORY INCLUDING: LIFE CHANGE (FAMILY, PERSONAL, FINANCIAL, OCCUPATIONAL)
- LIFE STYLE (BIOGRAPHY, ACTIVITIES/HABITS, DRIVING)
- ATTITUDE AND MOTIVATION
- GENERAL INTELLIGENCE, EMOTIONAL STABILITY
- PERSONALITY CHARACTERISTICS AND BEHAVIOR

TABLE 8

ITEMS TO BE ANALYZED
FOR DEVELOPMENT OF A PRELIMINARY HAZARD LIST

ELEMENT: PERSONNEL

HAZARD/MISHAP CAUSE	REQUIRES EVALUATION	NOT APPLICABLE
Supervisory Factors		
Acceptance of Responsibility		
Qualifications/Intelligence/Experience		
Training (Including Emergencies)		
Team Coordination/Crew Discipline		
Morale		
Illness/Physical Disabilities		
Alertness		
Vertigo/Disorientation/Visual Illusions		
Responsiveness		
Perceptions/Human Factors		
Reactions		
Sight/Color Blindness		
Hearing		
Strength/Fatigue		
Stress (Physical, Psychological,Physiological)		
Buddy System Reliance		
Emotional Stability		
Communication/Language Difficulty		
Clothing/Protective Wear		
Boredom/Complacency/Fixation/Hypnosis		
Efficiency		
Capability (Task Loading)		
Overconfidence		

TABLE 9

ITEMS TO BE ANALYZED FOR DEVELOPMENT
OF A
PRELIMINARY HAZARD LIST

ELEMENT: AEROSPACE VEHICLE/SUBSYSTEM

HAZARD/MISHAP CAUSE	REQUIRES EVALUATION	NOT APPLICABLE
Fire/Corker Potential		
Explosion/Implosion/Overpressure		
Electrocution/Electrical Burns		
Electrical Failure/Backup Power		
Inadvertent Electrical Activation		
Radiation (Ionizing/Nonionizing)		
Structural Failure		
Engine Failure/Emergency Power		
Mechanical/Hydraulic Failure		
Humidity		
Leakage		
Impact		
Corrosion/Toxicity		
Acceleration		
Air/Fluid Contamination		
Excessive Noise/Vibration		
Extreme Cold/Heat		
Flooding/Loss of Buoyancy		
Instrument Readability/Control Accessibility		

AEROSPACE VEHICLE/SUBSYSTEM

TABLE 10

Rank	Life Event	Mean Value
1	Death of Spouse	100
2	Divorce	73
3	Marital separation	65
4	Jail Term	63
5	Death of close family member	63
6	Personal injury or illness	53
7	Marriage	50
8	Fired at work	47
9	Marital reconciliation	45
10	Retirement	45
11	Changes in family member's health	44
12	Pregnancy	40
13	Sex difficulties	39
14	Gain of new family member	39
15	Business readjustment	39
16	Change in financial state	38
17	Death of close friend	37
18	Change to different line of work	36
19	Change in no. arguments with spouse	35
20	Mortgage over $10,000	31
21	Foreclosure of mortgage or loan	30
22	Change in work responsibilities	29
23	Son or daughter leaving home	29
24	Trouble with in-laws	29
25	Outstanding personal achievement	28
26	Wife begins or stops work	26
27	Begin or end school	26
28	Change in living conditions	25
29	Revision of personal habits	24
30	Trouble with boss	23

TABLE 10 (cont'd)

Rank	Life Event	Mean Value
31	Change in work hours, conditions	20
32	Change in residence	20
33	Change in schools	20
34	Change in recreation	19
35	Change in church activities	19
36	Change in social activities	18
37	Mortgage or loan under $10,000	17
38	Change in sleeping habits	16
39	Change in no. family get-togethers	15
40	Change in eating habits	15
41	Vacation	13
42	Christmas	12
43	Minor violations of the law	11
44	Marital separation	65
45	Change in responsibility at work	29
46	Change in living conditions	25
47	Revision of personal habits	24
48	Change in working hours or conditions	20
49	Change in residence	20
50	Change in recreation	19
51	Change in social activities	18
52	Change in sleeping habits	16
53	Change in eating habits	13

TABLE 11

ACCIDENT OF AVIATION SYSTEM INADEQUACIES IN RANK ORDER

	No.	$ Cost $
Inadequate psychophysiological state: overconfidence in others	8	3,443,163
Inadequate psychophysiological state: judgment	16	2,953,571
Inadequate psychophysiological state: motivation or mood: command pressure, excessive self-motivation, get-hom-itis, peer pressure	17	1,712,853
Inadequate unit training	15	1,528,078
Inadequate school training	13	1,274,408
Inadequate psychophysiological state: inadequate written procedures for operation in normal man-machine-environmental conditions	15	1,223,405
Inadequate psychophysiological state: maintenance not performed or performed inadequately: inspection, installation, troubleshooting	10	1,155,415
Inadequate psychophysiological state: attention	12	943,129
Inadequate psychophysiological state: composure	2	681,247
Inadequate supervision/coordination: unit commander	7	564,826
Inadequate psychophysiological state: overconfidence	3	367,903
Inadequate psychophysiological state: habit interference	2	213,739
Inadequate written procedures for operation in abnormal/emergency man-machine-environmental conditions	3	204,077
Inadequate psychophysiological state: fatigue, illness, or effect of alcohol/drugs	1	34,392

* Cost = No. of inadequacies ÷ aircraft damage + property damage injury/fatality cost

TABLE 12

- OPERATOR FACTORS IN HUMAN ERROR INCIDENCES
  - fatigue
  - disorientation
  - distraction
  - motivation
  - forgetting
  - confusion
  - expectancy or set
  - psychological stress
  - inadequate reasoning/problem solving capability
  - inadequate skill levels
  - inadequate knowledge
- OPERATIONAL FACTORS IN HUMAN ERROR INCIDENCE
  - time constraints
  - interfering activities
  - poor communications
  - excessive workloads
  - environmental stress (noise levels, lighting, levels, temperature, etc.)
- DESIGN FACTORS IN HUMAN ERROR INCIDENCE
  - control/display location
  - control/display arrangement
  - control/display identification or coding
  - control/display operation or response
  - information availability
  - information readability
  - availability of feedback information
- PROCEDURAL FACTORS IN HUMAN ERROR INCIDENCE
  - erroneous instructions or directives
  - incomplete or inconsistent instructions
  - confusing directives
- TRAINING FACTORS IN HUMAN ERROR INCIDENCE
  - inadequate knowledge training
  - inadequate skill training

TABLE 13

EG&G INDIVIDUAL WORK DURATION GUIDES

Approvals / Work Type	Supervisors	Branch Managers	Directors or Division Managers	General Manager or SD Director
High Sensitivity	16 hrs. cont 24 hrs/48-hr period 48 hrs/wk	18 hrs. cont. 24 hrs/40-hr period 56 hrs/wk	20 hrs. cont. Over 24 hrs/40-hr period 64 hrs/wk	over 20 hrs. cont Over 64 hrs/wk
Low Sensitivity	18 hrs. cont 56 hrs/wk	20 hrs. cont. 64 hrs/wk	Over 20 hrs. cont. Over 64 hrs/wk	

High-sensitivity Activities: Activities where personnel are working under extreme psychological and physiological stress.

Low-sensitivity Activities: Light emotional or other psychological stresses.

TABLE 14

FACTORS CONSIDERED

Job Assignment
Responsibilities
Project pressure
Reliability of the employee
Health
Toxic exposures, historical
Radiation exposure
Driving experience
Driving record
Normal modes of transportation
Fatigue, immediate, and chronic
Food
Location of incidents
Toxic exposures, in the vehicle - vehicle condition
Driving boredom
Worries, on the job
Home life
Recreation
Habits, personal
Vehicle control
Group exposure (highway miles)
Hours of work control - contention
Availability of food
Availability of beds

TABLE 15

RECOMMENDATIONS TO REDUCE PERSONNEL ERROR,
THE NUMBER OF UTILITIES SUGGESTING IT

MOST IMPORTANT		SECOND MOST IMPORTANT		THIRD MOST IMPORTANT		OVERALL	
Training[1]	18	Training	13	Equipment Design	6	Training	32
Turnover[2]	5	Turnover	5	Turnover	5	Turnover	16
Equipment Design[3]	3	Human Factors	3	Supervision	3	Equipment Design	9
Personnel Selection	3	Discipline	2			Human Factors	3
Root Cause Analysis	2					Supervision	4
						Personnel Selection	3
						Root Cause Analysis	3
						Employee Attitudes	3
						Discipline	3
						Scheduling	2
						Vendor Instructions	2

[1] Increased training

[2] Reduced turnover

[3] Improved equipment design to reduce error