## *EXHIBIT 9–2*

# Aviation Human Factors Analysis

**Sensory and Perceptual Factors**

• Misjudgment of distance, clearance, altitude, speed, and so forth.

• False perception caused by visual illusion. Conditions that impair visual performance:
  —Featureless terrain (such as a desert, dry lake, water, or snow).
  —Darkness and poor visibility.
  —Smoke and changing smoke patterns.
  —"Black-hole" effect.
  —No horizon or false horizon (unreliable visual attitude reference).
  —Mountainous terrain or sloping runway.
  —Helicopter-rotor downwash effects.
  —Anomalous light effects that cause flicker vertigo.
  —Low contrast of objects to background or poor illumination.
  —View into bright sunlight or moonlight.
  —Shadows.
  —Whiteout (such as rotor downwash in snow).

• False perception because of inner-ear (vestibular) disturbance. Types:
  —Spinning sensation caused by inner ear over stimulation (coriolis).
  —Gravity-induced false sensation of a pitch-up (somatogravic).
  —False sensation of rotation (somatogyral).

• Spatial disorientation and vertigo. Types:
  —Unrecognized loss of attitudinal awareness.
  —Recognized vertigo.
  —Incapacitating (such as vestibular-ocular decoupling induced by rapid acceleration and deceleration forces).

• Conditions that affect sense of body position or aircraft attitude:
  —Loss of visual cues and attitude reference. (especially with no natural horizon).
  —Acceleration (G-forces).
  —Adverse medical condition or physiological condition (alcohol and drug effects, hangover, dehydration, fatigue, and so forth).
  —Moving head up and down, looking in and out to change radios, making notes in a low-level environment while banking, accelerating, climbing, and descending.

• Loss of situational awareness. Types:
  —Geographic disorientation at low level in similar terrain, frequently in adverse conditions.
  —Geographic disorientation (such as deviation from route, operation outside chart limits, loss of position awareness).
  —General loss of situational awareness (such as failure to perceive hazardous condition).
  —Erroneous situational assessment (misinterpretation of situation or condition).
  —Failure to predict or anticipate changing conditions.
  —False hypothesis confirmation bias (persistent false perception or misconception of situation).

• Attention failure (such as failure to monitor or respond when correct information is available). Types:
  —Failure to visually scan outside the aircraft for terrain and other aircraft.
  —Omission of checklist items, standard calls, or crew challenge.
  —Failure to monitor flight progress or to maintain instrument scan.
  —Failure to respond to communication or warning.
  —Control-action error:
    • Failure to set, move, or reset control switch (lapse).
    • Unintentional activation of control switch (slip).
    • Control-substitution error (slip).
    • Control-reversal error (slip).
    • Control-adjustment or precision error (slip).

• Conditions that affect attention and situational awareness:
  —Inattention (focus on information unrelated to flight-deck tasks or flying).
  —Channelization, fixation (psychological narrowing of perception).
  —Distraction (preoccupation with internal [mental] event or with external event).
  —Task overload due to aircraft systems.
  —Task overload due to aircraft systems mission factors.
  —Cognitive workload (problem-solving concentration or information overload).
  —Habit influence or interference.
  —Excessive flight crew stress or fatigue.
  —Excessive mission tasking or workload.
  —Inadequate briefing or flight preparation.
  —Inadequate training or experience for mission.
  —Miscommunication (such as during transition to new aircraft).

*(Continued)*



Exhibit 9–2—Aviation human factors analysis.

## *EXHIBIT 9–2 (continued)*

# Aviation Human Factors Analysis

—Adverse meteorological conditions.
—Tactical-situation overload or display-information overload.
—Inadequate flight crew motivation or inadequate flight vigilance.
—Inadequate flightdeck design (control or display location or data format).

### Medical and Physiological

• Carbon monoxide poisoning.

• Self-medication (without medical advice or against medical advice).

• Motion sickness.

• Incompatible physical capabilities.

• Overexertion while off duty.

• Influence of drugs or alcohol.

• Cold or flu (or other known illness).

• Excessive personal stress or fatigue.

• Inadequate nutrition (such as omitted meals).

• G-induced loss of consciousness or G-induced illusion.

• Hypoxia.

• Heat.

• Cold.

• Stress induced by heightened state of alertness.

• Affects of smoke.

• Dehydration.

• Other medical or physiological condition. Conditions that may cause adverse medical or physiological state:
—Mission tasking or job fatigue (such as being on duty more than 14 hours, performing late-night or early morning operations).
—Cumulative fatigue (such as excessive physical or mental workload, circadian disruption, or sleep loss).
—Cumulative effects of personal or occupational stress (beyond stress-coping limit).
—Emergency flight condition or workload transition (from normal operation to emergency operation).
—Medical or physiological preconditions (health and fitness, hangover, dehydration, and so forth).

### Knowledge and Skill

• Inadequate knowledge of systems, procedures, and so forth (knowledge-based errors). Types:
—Knowledge-based.
—Inadequate knowledge of systems, procedures.
—Use of improper procedure.
—Ill-structured decisions.
—Failure in problem solving.

• Inadequate flight control and airmanship, or inadequate accuracy and precision of flight maneuvering (skill-based error). Types:
—Breakdown in visual scan.
—Failure to see and avoid.
—Poor flight control and airmanship.
—Over or under reacting.
—Over or under controlling.
—Inadequate experience for complexity of mission.
—Improper takeoff technique.
—Improper landing technique.

• Misuse of procedures or incorrect performance of flight-deck tasks (rule-based error), such as:
—Failure to perform required procedure.
—Use of wrong procedure or rule(s).
—Failure to conduct step(s) in prescribed sequence.
—Failure to complete performance computations for flight.

• Conditions that lead to inadequate operational performance:
—Lack or variation of standards.
—Loss of situational awareness in varying environment.
—Performance below required proficiency standards or currency standards.
—Inadequate performance or documented flight-aptitude deficiencies.
—Limited flight hours (total or type).

*(Continued)*

Exhibit 9–2

Exhibit 9–2—Aviation human factors analysis.

## EXHIBIT 9–2 (continued)

# Aviation Human Factors Analysis

—Inadequate essential training for specific task(s).
—Inadequate recent experience or inadequate experience in flight condition (such as instrument flight rules, night, weather).
—Transition (learning new aircraft system).
—Lack of sensory input.
—Limited reaction time.

### Mission Factors

• Failure of dispatch to provide correct critical information (such as frequencies, location, other aircraft).

• Poor communication with other resources (such as ground personnel or other aircraft).

• Inadequate or faulty supervision from supervisory tactical aircraft.

• Inadequate or faulty supervision of tactical aircraft by ground personnel.

• Lack or variation of standards.

• Nonparticipant or noncommunicative aircraft onscene.

• Loss of situational awareness in varying environment.

• Change of plans or tactics (change of teams on incidents).

• Unanticipated change of radio frequencies.

• Intentional deviation from procedures.

• Unintentional deviation from procedures.

• Performance below required or current proficiency standards.

• Inadequate performance or documented flight-aptitude deficiencies.

• Limited flight hours (total or type).

• Inadequate essential training for specific task(s).

• Inadequate recent experience or inadequate experience in flight condition (such as instrument flight rules, night, weather).

• Transition (learning new aircraft system).

• Inadequate knowledge of tactical situation.

• Lack of sensory input.

• Limited reaction time. Conditions that lead to inadequate special-use mission performance:
—Smoke.
—Wind shifts.
—Changes in fire behavior.
—Low visibility.
—Turbulence.
—Unexpected or nonparticipant aircraft.
—Mission intensity.
—Mission creep (scope of the mission increases).
—Mission urgency.
—Failure to recognize deteriorating conditions.
—Time compression.
—Diversion to new incidents.
—Excessive communication demands.
—Past mission success was based on high-risk behavior.

### Personality and Safety Attitude

• Overconfidence in flying ability.

• Excessive motivation to achieve mission.

• Reckless operation.

• Anger or frustration on the job.

• Stress-coping failure (such as anger).

• Overly assertive or nonassertive.

• Inadequate confidence to perform tasks or activities.

• Acquiescence to social pressure (from organization or peers) to operate in hazardous situation or condition.

(Continued)

Exhibit 9–2—Aviation human factors analysis.

## *EXHIBIT 9–2 (continued)*

### Aviation Human Factors Analysis

- Failure to report or act upon incidents of misconduct.
- Tolerance of unsafe acts and behaviors.
- Poor flight preparation.

**Judgment and Risk Decision**

- Acceptance of a high-risk situation or mission.
- Misjudgment of mission risks (complacency).
- Failure to monitor flight progress or conditions (complacency).
- Use of incorrect task priorities.
- Intentional deviation from safe procedure (imprudence).
- Intentional violation of standard operating procedure or regulation. Types:
  - —Violation of orders, regulations, SOP.
  - —Crew rest requirements.
  - —Inadequate training.
  - —Violation of agency policy or contract.
  - —Failure to comply with departmental manuals.
  - —Night training or special mission with PAX.
  - —VFR filing in marginal weather conditions.
  - —Failure to use radar advisories from ATC.
  - —PIC knowingly accepted noncurrent crew.
  - —Performance of unauthorized acrobatic maneuver.
  - —Scud running (avoiding a weather pattern).
  - —Failure to obtain valid weather brief.
  - —Acceptance of unnecessary hazard.
  - —Not current or qualified for mission.
- Intentional disregard of warning (by human or aircraft system).
- Noncompliance with personal limits.
- Noncompliance with published aircraft limits.
- Noncompliance with prescribed mission profile or parameters.
- Acquiescence to social pressure (from organization or peers). Conditions leading to poor safety attitude and risky judgment:
  - —History of taking high risks (personality-driven).
  - —Pattern of overconfidence (aggrandized self-image).
  - —Personal denial of wrongdoing.
  - —Documented history of marginal performance or failure.
  - —Excessive motivation (did not know limits).
  - —Reputation as a reckless pilot.
  - —Failure to cope with life stress (anger or frustration).
  - —Overly assertive or nonassertive (interpersonal style).
  - —Influenced by inadequate organizational climate or safety culture (such as lack of adequate supervision).

**Communication and Crew Coordination**

- Inadequate mission plan or brief or preflight.
- Inadequate or wrong mission information conveyed to flight crew (dispatch errors).
- Failure to communicate plan or intentions.
- Failure to use standard or accepted terminology.
- Failure to work as a team.
- Inability or failure to contact and coordinate with other aircraft or ground personnel.
- Inadequate understanding of communication or failure to acknowledge communication.
- Interpersonal conflict or crew argument during flight. Conditions leading to inadequate communication or coordination:
  - —Inadequate training in communication or crew coordination.
  - —Inadequate standard operating procedures for use of crew resources.
  - —Inadequate support from organization for crew-coordination doctrine.
  - —Failure of organizational safety culture to support crew resource management.
- Internal communication on aircraft:
  - —Inadequate crew coordination (challenge, cross-check).
  - —Intentional withholding, by a crewmember, of vital safety data.
  - —Failure of the pilot-in-command to lead or delegate.

*(Continued)*

Exhibit 9–2

Exhibit 9–2—Aviation human factors analysis.

## *EXHIBIT 9–2 (continued)*

# Aviation Human Factors Analysis

—Failure of the pilot-in-command to use all available resources.

**System Design and Operation**

- Use of wrong switch, lever, or control.
- Misinterpretation of instrument indication.
- Inability to reach or see control.
- Inability to see or interpret instrument or indicator.
- Failure to respond to warning.
- Selection or use of incorrect avionics system-operating mode (mode confusion).
- Overreliance on automated system (automation complacency). Conditions that contribute to design-induced flight crew errors:
  - —Inadequate primary aircraft control or display arrangement.
  - —Inadequate primary display data or data format.
  - —Incompatible flightdeck control or display activation, or aircraft-response mapping.
  - —Inadequate hazard advisory or warning display.
  - —Inadequate flight deck design (controls or displays outside crew vision or reach).
  - —Inadequate human-computer-display interface or usability (error-prone design).
  - —Inadequate system instructions or documentation.
  - —Inadequate aviation-system support or facilities. (navigation aids, airport, air traffic control).
  - —Nonstandard flightdeck layouts that may cause confusion.
  - —Inappropriate type or level of automation, or excessive mode complexity.
  - —Maintaining current skills in operating multiple aircraft.

**Supervisory and Organizational**

- Failure to adhere to rules and regulations.
- Inappropriate scheduling or crew assignment.
- Failure to monitor crew rest or duty requirements.
- Failure to establish adequate standards.
- Failure to provide adequate briefing for mission.
- Inadequate training.
- Lack of professional guidance.
- Failure to support or poor support of flight crews.
- Failure to monitor compliance with standards.
- Failure to monitor crew training or qualifications.
- Failure to identify or remove a known high-risk pilot.
- Failure to correct inappropriate behavior.
- Failure to correct a safety hazard.
- Failure to establish or monitor quality standards.
- Failure of standards, either poorly written, highly interpretable, or conflicting.
- Risk outweighs benefit.
- Poor crew pairing.
- Excessive mission tasking or workload.
- Intentional violation of a standard or regulation.
- Failure to perceive or to assess mission risks correctly, with respect to:
  - —Unseen or unrecognized hazards.
  - —Environmental hazards or operating conditions.
  - —Mission tasking and flight crew skill level.
  - —Aircraft and equipment limitations.
- Conditions leading to supervisory failures:
  - —Excessive operations or organizational workload (imposed by the organization or imposed by organizational chain of command).
  - —Inadequate organizational safety culture.
  - —Supervisor is over-tasked.
  - —Supervisor is untrained.
  - —Inattention to safety management (inadequate safety supervision).

*(Continued)*

Exhibit 9–2

Exhibit 9–2—Aviation human factors analysis.

## *EXHIBIT 9–2 (continued)*

### Aviation Human Factors Analysis

—Inadequate work standards or low performance expectations.
—Inadequate or poor example set by supervisors.
—Inadequate safety commitment or emphasis by supervisors.
—Organization lacks an adequate system for monitoring and correcting hazardous conditions.
—Supervisors do not promote and reward safe behavior or quickly correct unsafe behaviors.
—Organization lacks adequate policies and procedures to ensure high quality work performance.
—Organization had inadequate job qualification standards or a training program.
—Organization lacks internal communication.
—Organization has no system or an inadequate one for management of high-risk pilots.
—Organization lacks adequate process or procedures for operational risk management.
—Organization provide inadequate aeromedical or human factors training.
—Organization lacks sufficient involvement of medical and occupational health specialists.
—Organization has not established or enforced acceptable medical or health standards.

**Maintenance**

- Procedures.
  —Unwritten.
  —Unclear, undefined, or vague.
  —Not followed.

- Records.
  —Discrepancies entered—but not deferred to—or resolved.
  —Entries not recorded or not recorded in correct book(s).
  —Improper entries or unauthorized signature or number.
  —Falsification of entries.

- Publications, manuals, guides.
  —Not current.
  —Not used for the procedure.
  —Incorrect manual or guide used for procedure.
  —Not available.

- Training.
  —Not trained on procedure.
  —Training not documented.
  —Falsified.
  —Not current.

- Personnel.
  —Improperly licensed.
  —Insufficient (staffing).
  —Improper or insufficient oversight.
  —Insufficiently rested.

- Management.
  —Nonexistent.
  —Ineffective.
  —Understaffed.
  —Ineffective organization of assigned personnel.
  —Insufficiently trained.

- Quality Assurance.
  —Nonexistent.
  —Insufficient training.
  —Ineffective.
  —Not used.

- Inspection Guides.
  —Unavailable.
  —Procedures not followed.
  —Insufficient.
  —Not current.
  —Not approved.
  —Not signed off.
  —Falsified.
  —Unapproved signature or number.

- FAA 337s.
  —Not completed for major repair or alteration.
  —Incomplete.
  —Not turned into the Federal Aviation Administration.
  —Not with records or flight manual.
  —Not being complied with (inspection or procedure or limitations).
  —Falsified (improper signature or number).
  —Instructions for Continued Airworthiness (ICAs).
  —Nonexistent.
  —Not followed.
  —Insufficient.

- Tools or Equipment.
  —Improper use or procedure.
  —Not calibrated.
  —Not trained for the special equipment or tool.
  —Not used.
  —No tool control program.

Exhibit 9–2

Exhibit 9–2—Aviation human factors analysis.