STATEMENT OF THE HONORABLE DONALD D. ENGEN, FEDERAL AVIATION ADMINISTRATOR, BEFORE THE HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY, SUBCOMMITTEE ON TRANSPORTATION, AVIATION, AND MATERIALS, CONCERNING THE CONTROLLED IMPACT DEMONSTRATION, APRIL 2, 1985.

GOOD AFTERNOON MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE. I AM PLEASED TO APPEAR BEFORE YOU TODAY TO DISCUSS THE CONTROLLED IMPACT DEMONSTRATION CONDUCTED BY THE FEDERAL AVIATION ADMINISTRATION (FAA) AND THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA) LAST DECEMBER. I AM ACCOMPANIED BY NEAL BLAKE, THE DEPUTY ASSOCIATE ADMINISTRATOR FOR ENGINEERING, AND TONY BRODERICK, THE ACTING ASSOCIATE ADMINISTRATOR FOR AVIATION STANDARDS. FOLLOWING MY TESTIMONY, DR. JOHN MARTIN, NASA ASSOCIATE ADMINISTRATOR FOR AERONAUTICS AND SPACE TECHNOLOGY, WILL DISCUSS THE NASA ACTIVITIES.

AS THE SUBCOMMITTEE IS AWARE, THE FAA HAS CONDUCTED A VARIETY OF PROGRAMS IN THE AIRCRAFT SAFETY AREA SINCE THE EARLY 1960'S. ONE KEY AREA IN WHICH WE HAVE CONDUCTED EXTENSIVE RESEARCH AND DEVELOPMENT WORK INVOLVES FIRE PROTECTION AND SUPPRESSION, SINCE FIRE IS A MAJOR THREAT TO PERSONS WHO OTHERWISE SURVIVE THE IMPACT OF A CRASH. IN 1979, TO OBTAIN THE VIEWS OF EXPERTS IN THIS AREA AND TO PROVIDE MORE DIRECTION TO OUR EFFORT, WE ESTABLISHED AN ADVISORY COMMITTEE (REFERRED TO AS THE SPECIAL AVIATION FIRE AND EXPLOSION REDUCTION COMMITTEE) TO EXAMINE THE ABILITY OF THE AIRCRAFT OCCUPANT TO SURVIVE IN AN AIRCRAFT FIRE ENVIRONMENT. IN 1980, WE FORMALIZED AN AIRCRAFT SAFETY PLAN, WHICH INCLUDED MANY OF THE RECOMMENDATIONS OF THAT COMMITTEE AND WAS KEYED TO PRODUCING A

NUMBER OF REGULATORY ACTIONS IN THE 1982-1985 TIME PERIOD. THE PLAN CALLED FOR WORK IN SIX MAJOR AREAS: CRASHWORTHINESS, ANTIMISTING KEROSENE, CABIN INTERIORS, A LARGE TRANSPORT CATEGORY AIRCRAFT CONTROLLED IMPACT DEMONSTRATION, EMERGENCY EVACUATION, AND AIRCRAFT SUPPORTING SYSTEMS.

TO SUPPLEMENT OUR PREVIOUS REPORTS TO YOU ON OUR AIRCRAFT SAFETY RESEARCH AND DEVELOPMENT EFFORTS, THIS AFTERNOON I WILL REPORT ON SOME OF THE PRELIMINARY RESULTS FROM OUR ANALYSIS OF THE CONTROLLED IMPACT DEMONSTRATION (CID) CONDUCTED ON DECEMBER 1, 1984. THE RESULTS ARE CONSIDERED PRELIMINARY BECAUSE NOT ALL OF THE RECORDED AND PHOTOGRAPHIC DATA HAVE BEEN ANALYZED.

THE OVERALL PURPOSE OF CID WAS TO VALIDATE TECHNOLOGY DEVELOPED TO IMPROVE TRANSPORT AIRCRAFT OCCUPANT SURVIVABILITY IN AN IMPACT SURVIVABLE ACCIDENT THROUGH REDUCED POST-CRASH FIRE HAZARD AND IMPROVED STRUCTURAL CRASH PROTECTION.

OTHER OBJECTIVES OF THE CID WERE TO DEMONSTRATE IMPROVED, CRASHWORTHY DESIGNED SEATS AND RESTRAINT SYSTEMS, AND TO ACQUIRE CRASH DATA ON A TRANSPORT AIRCRAFT UNDER CONTROLLED CONDITIONS. OUR PLAN HAS BEEN TO USE THESE DATA TO VERIFY AND IMPROVE COMPUTER MODELS THAT HAVE BEEN DEVELOPED TO PREDICT TRANSPORT AIRCRAFT STRUCTURAL CRASH BEHAVIOR.

THE AIRCRAFT USED IN THIS DEMONSTRATION WAS A BOEING 720, FOUR-ENGINED, INTERMEDIATE RANGE, JET TRANSPORT THAT ENTERED AIRLINE SERVICE IN THE MID-1960'S. ALTHOUGH THE BOEING 720 IS NOW CONSIDERED OBSOLETE, FOR THE PURPOSE OF THIS TEST, ITS STRUCTURAL DESIGN AND CONSTRUCTION WERE CONSIDERED TO BE SUFFICIENTLY SIMILAR TO BE REPRESENTATIVE OF TRANSPORT AIRCRAFT CURRENTLY USED BY DOMESTIC AND FOREIGN AIRLINES.

THE CID PROGRAM WAS A JOINT FAA/NASA RESEARCH AND DEVELOPMENT UNDERTAKING WITH SUPPORT FROM THE NATIONAL TRANSPORTATION SAFETY BOARD (NTSB), DEPARTMENT OF DEFENSE (DOD), INDUSTRY, AND THE BRITISH AND FRENCH GOVERNMENTS. JOINTLY FINANCED BY FAA AND NASA, THE CID REPRESENTS AN $11.8 MILLION INVESTMENT IN AIR SAFETY. OF THIS AMOUNT, FAA EXPENDED $8.1 MILLION AND NASA $3.7 MILLION. FAA, THE OVERALL PROGRAM MANAGER, WAS RESPONSIBLE FOR THE ANTIMISTING FUEL EFFORT, THE CABIN FIRE SAFETY WORK, AND SOME OF THE STRUCTURAL CRASHWORTHINESS EXPERIMENTS. NASA DEVELOPED THE DATA ACQUISITION SYSTEM AND REMOTELY PILOTED CONTROL SYSTEM (RPV) FOR THE AIRCRAFT, AND A NASA PILOT, USING THE RPV SYSTEM, FLEW THE AIRCRAFT INTO THE IMPACT SITE. IN ADDITION TO MANAGING THE FLIGHT PROGRAM, NASA HAD EXPERIMENTAL SEATS ABOARD THE AIRCRAFT AND CURRENTLY IS ANALYZING THE EFFECTS OF THE IMPACT FORCES ON THE STRUCTURE.

THE CID SCENARIO WAS DESIGNED TO BE REPRESENTATIVE OF AN "IMPACT-SURVIVABLE" ACCIDENT. BY THIS, WE MEAN AN AIRCRAFT ACCIDENT IN WHICH THE FUSELAGE MAINTAINS HABITABLE SPACE AND SOME PASSENGERS AND CREW WOULD BE ABLE TO SURVIVE THE CRASH IMPACT FORCES.

FOLLOWING IMPACT, THE AIRCRAFT WAS TO SLIDE OUT OVER A PACKED STONE BED THAT WAS BUILT TO PROVIDE A FRICTION IGNITION SOURCE FOR THE FUEL. THE PREPARED IMPACT SITE ALSO HAD EIGHT HEAVY STEEL STRUCTURES BOLTED TO CONCRETE FOUNDATIONS THAT WERE DESIGNED TO OPEN THE WING FUEL TANKS TO INSURE FUEL SPILLS OF 20 TO 100 GALLONS PER SECOND. OPERATING APPROACH LIGHTS WERE ALSO INSTALLED IN THE SLIDEOUT AREA TO SERVE AS IGNITION SOURCES. THE AIRCRAFT WAS FITTED WITH TWO JET FUELED FLAME GENERATORS IN THE TAIL CONE TO PROVIDE AN ADDITIONAL AND POSITIVE IGNITION SOURCE.

INSIDE THE AIRCRAFT THERE WERE 73 DUMMIES, OF WHICH 13 WERE INSTRUMENTED ANTHROPOMORPHIC DUMMIES WHICH HAVE SIMILAR CHARACTERISTICS TO HUMAN BODIES IN REGARD TO RESPONSE TO IMPACT FORCES. THESE 13, INCLUDING THE PILOT DUMMY, WERE FITTED WITH ACCELEROMETERS INSTALLED IN THE HEAD, THORAX, AND PELVIC AREAS TO MEASURE IMPACT FORCES. LOAD CELLS WERE INSTALLED TO MEASURE THE FORCES ON THE LAP BELTS AND SHOULDER HARNESSES. THE SEATS OCCUPIED BY THESE INSTRUMENTED DUMMIES WERE ALSO EQUIPPED WITH MULTIPLE SENSORS TO MEASURE IMPACT AND SLIDEOUT FORCES. OTHER FORCE SENSORS WERE INSTALLED AT 175 LOCATIONS IN THE WINGS, FUSELAGE, FLOOR, GALLEY, AND OVERHEAD STOWAGE COMPARTMENT. DATA FROM THESE SENSORS WERE RECORDED ONBOARD AND TELEMETERED TO GROUND RECORDERS.

THE CID AIRCRAFT ALSO CARRIED 11 HIGH-SPEED MOTION PICTURE CAMERAS INSIDE THE CABIN, ONE HIGH-SPEED MOTION PICTURE CAMERA MOUNTED ATOP THE VERTICAL STABILIZER, AND ONE MOTION PICTURE AND TWO VIDEO

CAMERAS MOUNTED IN THE NOSE. THE NOSE VIDEO CAMERAS WERE DESIGNED PRIMARILY TO AID THE PILOT IN THE REMOTE OPERATION OF THE AIRCRAFT. ADDITIONAL PHOTOGRAPHIC COVERAGE WAS PROVIDED BY APPROXIMATELY 100 FIXED AND REMOTELY CONTROLLED CAMERAS POSITIONED AROUND THE IMPACT SITE. TWO HELICOPTERS AND A NAVY P-3 PHOTO AIRPLANE EQUIPPED WITH SPECIAL LONG-RANGE, HIGH-SPEED CAMERAS PROVIDED AERIAL PHOTOGRAPHIC COVERAGE.

THE B-720 WAS FUELED WITH 11,325 GALLONS OF INLINE BLENDED ANTIMISTING KEROSENE (AMK). TESTS SHOWED THE FUEL WAS OF HIGH QUALITY AND HAD THE DESIRED FLAMMABILITY RESISTANCE. THE ENGINES WERE STARTED AND OPERATED NORMALLY ON AMK THROUGHOUT THE 40 MINUTES OF PREFLIGHT CHECKS.

AT 9:13 A.M. ON DECEMBER 1, THE CID AIRCRAFT TOOK OFF FROM EDWARDS AIR FORCE BASE, CALIFORNIA, FOR ITS REMOTELY PILOTED FINAL FLIGHT. WEATHER CONDITIONS WERE IDEAL. VISIBILITY WAS EXCELLENT, AND THE WIND SPEED WAS LESS THAN 5 KNOTS. THE AIRCRAFT WAS CLIMBED TO 2,300 FEET ABOVE GROUND LEVEL AND FLOWN ALONG A PREDETERMINED FLIGHT PATH TO INTERCEPT A SIMULATED INSTRUMENT LANDING SYSTEM TO BEGIN ITS DESCENT. APPROACH SPEED WAS 150 KNOTS, AND THE SINK RATE WAS WITHIN THE TARGETED RANGE. A 150-FOOT DECISION HEIGHT WAS SET, BELOW WHICH THERE WOULD BE NO ABORT. WHEN PASSING THIS DECISION HEIGHT, THE AIRCRAFT WAS SLIGHTLY BELOW THE GLIDESLOPE AND TO THE RIGHT OF THE DESIRED PATH. THE PILOT TOOK APPROPRIATE CORRECTIVE ACTIONS, WHICH RESULTED IN A MILD ROLL OSCILLATION.

AT 9:22:11 A.M., THE AIRCRAFT'S LEFT OUTBOARD ENGINE IMPACTED THE GROUND. THE AIRCRAFT WAS IN A SLIGHTLY NOSE-DOWN/LEFT WING DOWN ATTITUDE WITH WHEELS RETRACTED AND WING FLAPS DEPLOYED AT 30 DEGREES. INITIAL GROUND CONTACT OF THE LEFT OUTBOARD ENGINE WAS APPROXIMATELY 300 FEET SHORT OF THE TARGET AREA, WITH THE AIRCRAFT IN A SLIGHT YAW TO THE LEFT. THE LEFT INBOARD ENGINE THEN CONTACTED THE GROUND FOLLOWED BY THE INITIAL FUSELAGE IMPACT.

DURING SLIDEOUT, THE AIRCRAFT CONTINUED TO YAW TO THE LEFT AND CAME INTO CONTACT WITH THE FIRST OF THE STEEL WING OPENING STRUCTURES AT A YAW ANGLE OF 38 DEGREES. INITIAL CONTACT WAS WITH THE NEXT TO THE OUTERMOST OF THE FOUR WING OPENERS ON THE RIGHT SIDE.

THE CUTTER ENTERED AND PASSED THROUGH THE RIGHT INBOARD ENGINE. IT THEN HIT THE LEADING EDGE OF THE WING AND DIAGONALLY SLASHED OPEN THE LOWER WING SKIN BACK TO THE VICINITY OF THE MID-CHORD, LEADING TO THE FAILURE AND SEPARATION OF THE RIGHT WING. FOLLOWING CONTACT OF THE CUTTER WITH THE ENGINE, THERE APPEARED TO BE IMMEDIATE IGNITION OF ENGINE FLUIDS INCLUDING DEGRADED AMK, ENGINE OIL, AND HYDRAULIC FLUID. THE FIRE THAT RESULTED CONTINUED THROUGHOUT THE AIRCRAFT SLIDEOUT WITH THE ENGINE ACTING AS THE MAIN FLAME HOLDER OR ATTACHMENT POINT. THE INTENSITY OF THE FIRE APPEARS TO HAVE BEEN CAUSED AT LEAST IN PART BY THE CONTINUED FLOW OF FUEL UNDER PRESSURE, POSSIBLY FROM RUPTURED FUEL LINES, DIRECTLY ONTO THE HOT ENGINE SURFACES. THIS INTENSE FIRE OCCURRED IN THE IMMEDIATE AREA WHERE THE WING TANKS HAD BEEN OPENED AND RESULTED IN VAPORIZATION

AND IGNITION OF THE FUEL VAPORS BEFORE MUCH ANTIMISTING ACTION HAD OCCURRED. THIS WAS IN PART DUE TO THE FACT THAT THE AIRCRAFT WAS YAWED TO THE LEFT SUCH THAT THE ENGINE BLOCKED AIR FLOW INTO THE AREA OF GREATEST FUEL RELEASE. THIS IN TURN INHIBITED THE DESIRED ANTIMISTING ACTION OF THE AMK FUEL AND INCREASED THE EXPOSURE TIME OF THE FUEL TO THE INTENSE IGNITION SOURCE. THE RESULTING FLAME PASSED OVER THE RIGHT SIDE OF THE FUSELAGE AS THE AIRCRAFT CONTINUED TO YAW TO THE LEFT. THE FUSELAGE APPEARED TO BE ENGULFED IN FLAME FOR APPROXIMATELY 9 SECONDS, AND PHOTOGRAPHIC EVIDENCE REVEALED ONLY RELATIVELY MINOR DAMAGE TO THE EXTERIOR OF THE FUSELAGE DUE TO THE SHORT EXPOSURE TIME AND THE REDUCED HEAT TRANSFER TO THE CABIN SKIN WHICH IS CHARACTERISTIC OF AMK. THE INSTRUMENTATION STRIPES PAINTED ON THE FUSELAGE REMAINED VISIBLE AND DISTINCT.

A SECOND CUTTER STRUCK THE RIGHT INBOARD WING LEADING EDGE FLAP AND SLASHED DIAGONALLY THROUGH THE LOWER WING SKIN TO THE RIGHT MAIN GEAR WHEEL WELL. PART OF THE CUTTER BROKE OFF AND ENDED UP IN THE LOWER AFT CARGO COMPARTMENT.

ANOTHER CUTTER STRUCK THE LEADING EDGE OF THE RIGHT WING AND SLASHED DIAGONALLY TO THE REAR. IT PASSED THROUGH THE LOWER CENTER WING BOX SECTION AND PENETRATED THE LEFT MAIN GEAR WHEEL WELL, THUS PERMITTING THE BURNING FUEL TO ENTER THE FUSELAGE FROM THE BOTTOM. FUEL ALSO ENTERED THE AIRCRAFT THROUGH THE FORWARD RIGHT CARGO DOOR WHICH HAD OPENED ON IMPACT.

THE CUTTER ON THE FAR RIGHT PASSED THROUGH THE TRAILING EDGE OF THE INBOARD RIGHT WING FLAP SEGMENT AND THEN SLICED DIAGONALLY THROUGH THE LOWER AFT FUSELAGE, THEREBY PROVIDING AN ADDITIONAL OPENING THROUGH WHICH FUEL COULD ENTER THE FUSELAGE.

AT 9:22:21 A.M., THE CID AIRCRAFT CAME TO REST. WITHIN 2 MINUTES THE EDWARDS AFB FIRE DEPARTMENT WAS ON THE SCENE. THE EXTERNAL FIRE WAS RAPIDLY EXTINGUISHED, USING STANDARD CRASH-FIRE-RESCUE PROCEDURES, AND THE CABIN ENTERED. THE PROCEDURES USED HAVE PROVEN EFFECTIVE IN MAXIMIZING PASSENGER PROTECTION DURING THE EVACUATION AND RESCUE ACTIVITIES. HOWEVER, IN THE CASE OF CID, AN UNDETECTED FIRE IN THE BAGGAGE COMPARTMENT DEVELOPED RAPIDLY. THIS FIRE ESCAPED DETECTION INITIALLY DUE TO THE INTENSE SMOKE FROM THE EXTERNAL FIRE PRIOR TO ITS EXTINGUISHMENT. THE EVENTS THAT LED UP TO THIS FIRE WERE SOMEWHAT UNIQUE, IN THAT THE WING CUTTERS OPENED THE FUSELAGE, SEVERED THE RIGHT WING TANKS, AND THE AIRCRAFT THEN YAWED IN A MANNER THAT INTRODUCED FUEL DIRECTLY INTO THE LOWER PORTION OF THE FUSELAGE. EARLIER DETECTION OF THE BAGGAGE COMPARTMENT FIRE WOULD POSSIBLY HAVE RESULTED IN EARLIER CONTROL AND EXTINGUISHMENT WHICH, IN TURN, WOULD HAVE PRESERVED MORE OF THE AIRCRAFT INTERIOR FOR SUBSEQUENT DETAILED ANALYSIS.

SINCE THE ENTIRE FIRE SEQUENCE WAS DOCUMENTED ON FILM AND VIDEO TAPE, WE BELIEVE THAT THIS MATERIAL WILL BE EXTREMELY VALUABLE AS A TRAINING AID IN POST-CRASH FIRE FIGHTING.

I WOULD LIKE NOW TO REVIEW BOTH THE OBJECTIVES AND THE ACTUAL ACCOMPLISHMENTS OF THE THREE MAJOR PROGRAM ELEMENTS OF THE CID:

1. CRASHWORTHINESS/CRASH BEHAVIOR

2. ANTIMISTING FUEL PERFORMANCE AND BEHAVIOR

3. CABIN FIRE SAFETY/EGRESS POTENTIAL

THE MAJOR ELEMENTS OF THE CRASHWORTHINESS AND CRASH BEHAVIOR PORTION OF THE CID WERE DESIGNED TO:

- DETERMINE CRASH IMPACT FORCES AND THE TRANSMISSION AND ATTENTUATION OF THE FORCES THROUGH THE FUSELAGE STRUCTURE, THE FLOOR, AND THE SEAT TO THE OCCUPANT.

- EVALUATE THE FUSELAGE AND AIRCRAFT STRUCTURAL RESPONSE AND INTEGRITY IN A CRASH ENVIRONMENT.

- VALIDATE MODELS USED TO PREDICT STRUCTURAL RESPONSE IN A CRASH ENVIRONMENT.

- DETERMINE THE PERFORMANCE OF EXISTING AND ADVANCED ENERGY ABSORBING SEATS AND RESTRAINT SYSTEMS IN A SURVIVABLE IMPACT.

- EVALUATE THE PERFORMANCE OF NEW DIGITAL FLIGHT DATA RECORDERS AND COCKPIT VOICE RECORDERS.

- EVALUATE THE ADEQUACY OF HAZARDOUS MATERIAL CONTAINERS CARRIED AS CARGO ONBOARD THE AIRCRAFT.

- EVALUATE THE PERFORMANCE OF OVERHEAD STORAGE BINS AND GALLEYS.

THE IMPACT SCENARIO WAS SELECTED TO BE REPRESENTATIVE OF AN ACCIDENT OCCURRING ON FINAL APPROACH OR SHORTLY AFTER TAKEOFF. THE CHARACTERISTICS OF THE SCENARIO WERE DERIVED FROM A STUDY OF PAST IMPACT-SURVIVABLE ACCIDENTS. THESE INCLUDED: A DESCENT RATE OF 17 FEET PER SECOND, A TRUE AIRSPEED OF 150 KNOTS, A SLIGHTLY NOSE-UP ATTITUDE, AND MINIMUM ROLL AND YAW.

TO VERIFY THAT A DESCENT RATE OF 17 FEET PER SECOND WOULD NOT RESULT IN LOSS OF INTEGRITY OF THE FUSELAGE STRUCTURE, FAA CONDUCTED A NUMBER OF DROP TESTS INVOLVING SECTIONS OF BOTH WIDE AND NARROW BODY AIRCRAFT, AS WELL AS A DROP TEST INVOLVING A COMPLETE B-707 AIRCRAFT. THESE DROP TESTS INDICATED THAT THE AIRCRAFT FUSELAGE WOULD REMAIN INTACT WITH ONLY MINOR WARPAGE OF THE FUSELAGE AND LOCALIZED MINOR DEFORMATION OF THE FLOOR STRUCTURE OCCURRING IN THE VICINITY OF SEVERAL BULKHEADS. THE TESTS ALSO INDICATED THAT THE VERTICAL LOADS TRANSMITTED THROUGH THE STRUCTURE TO THE SEAT OCCUPANTS REMAINED WITHIN THE SURVIVABLE RANGE OF HUMAN IMPACT TOLERANCE.

IN THE CID EVENT, THE INITIAL IMPACT FORCES WERE MEASURED AS THE LEFT OUTBOARD ENGINE, LEFT INBOARD ENGINE, AND THE FUSELAGE TOUCHED DOWN IN SEQUENCE. THE INITIAL IMPACT OF THE FUSELAGE WAS IN THE

FORWARD AREA OF THE CABIN. THE DATA ON THE IMPACT FORCE MAGNITUDE AND PULSE SHAPE AND THE ATTENUATION OF THAT FORCE BY THE FUSELAGE AND SEATS WAS MEASURED AT A NUMBER OF LOCATIONS IN THE FUSELAGE. AS ONE WOULD EXPECT, THE IMPACT FORCES WERE HIGHEST IN THE FORWARD CABIN AREA AND ALSO IN THE COCKPIT. THESE INITIAL FORCES, AS MEASURED IN THE INSTRUMENTED DUMMIES, WERE ALL WITHIN THE ENVELOPE OF HUMAN TOLERANCE. SEAT AND RESTRAINT SYSTEMS REMAINED IN PLACE. IMPACT LOADS WERE SUCH THAT THE ENERGY ABSORBING SEATS SHOWED LITTLE "STROKING," INDICATING THAT THESE SEATS WERE CAPABLE OF ABSORBING HIGHER IMPACT LOADS.

SHORTLY AFTER THE INITIAL IMPACT, THE AIRCRAFT ENCOUNTERED THE WING CUTTERS IN A YAWED CONDITION WHICH PLACED HIGH LATERAL AND LONGITUDINAL LOADS ON THE FUSELAGE, SEATS, AND RESTRAINT SYSTEMS. THIS IMPACT APPEARED, IN LARGE MEASURE, TO CAUSE A FUSELAGE AND FLOOR RUPTURE ON THE LEFT SIDE OF THE AIRCRAFT JUST AFT OF THE WING BOX. THIS WAS DUE PRIMARILY TO THE PASSAGE OF ONE OF THE WING CUTTERS THROUGH THE FUSELAGE WHICH RESULTED IN DESTRUCTION OF THE AIRCRAFT MAIN STRUCTURAL MEMBER CALLED THE KEEL BEAM. THIS DESTRUCTION OF THE AIRCRAFT STRUCTURE IN THE WING BOX AREA SUBSTANTIALLY WEAKENED THE FUSELAGE. DESPITE THE DAMAGE INFLICTED BY THIS AND SEVERAL OTHER CUTTERS, THE FUSELAGE REMAINED ESSENTIALLY INTACT AND PROVIDED A HABITABLE SPACE FOR THE OCCUPANTS.

THE SECOND IMPACT ALSO APPEARED TO HAVE CAUSED THE FAILURE OF THE LATERAL BRACING ON SEVERAL SEATS. DESPITE THESE FAILURES, THE SEATS REMAINED IN PLACE AND PROTECTED THE OCCUPANTS.

IN THE AREA OF THE FUSELAGE BREAK, THE FLOOR SEPARATED AND A DISPLACEMENT OF OVER 1 FOOT OCCURRED. THIS RESULTED IN RELEASE AND FAILURE OF THE OUTBOARD ATTACHMENT FITTINGS ON ONE ROW OF SEATS. THE LATERAL FORCES, RESULTING FROM STRIKING THE WING CUTTERS IN A YAWED POSITION, CAUSED THE SEAT TO ROTATE INTO THE AISLE. RELEASE OF A SEAT IS TO BE EXPECTED WHEN SEVERE FLOOR TRACK DEFORMATION OR BREAKAGE OCCURS.

NASA HAD POSITIONED TWO OF ITS ANTHROPOMORPHIC DUMMIES IN THE BRACED POSITION, AND THESE DUMMIES DID NOT APPEAR TO HAVE BEEN MOVED SIGNIFICANTLY BY THE IMPACT FORCES. OTHER DUMMIES, SEATED UPRIGHT, DID MOVE DURING IMPACT AND SLIDEOUT. THE ROW OF SEATS PROVIDED BY THE FRENCH GOVERNMENT, WHICH WAS INSTALLED IN THE AFT END OF THE AIRCRAFT ON THE LEFT, REMAINED IN PLACE BUT WAS SUBSEQUENTLY CONSUMED BY FIRE.

AS PART OF THE CID CRASHWORTHINESS EVALUATION EXPERIMENTS, TWO OVERHEAD STORAGE COMPARTMENTS WERE INSTRUMENTED. WHILE THE OVERHEAD COMPARTMENTS OPENED DURING THE IMPACT, THE COMPARTMENTS AND GALLEYS REMAINED IN PLACE. THE CARRYING OF HEAVY ITEMS IN AIRLINE OVERHEAD COMPARTMENTS IS OF GREAT CONCERN TO ME, AND WE ARE TAKING STEPS TO FURTHER DEFINE WHAT CAN BE CARRIED IN THESE COMPARTMENTS.

THE IMPACT FORCE MAGNITUDE AND SHAPE MEASURED AT VARIOUS POINTS IN THE FUSELAGE WERE IN CLOSE AGREEMENT WITH SIMILAR DATA RECORDED IN THE DROP TESTS. THE CID DATA WILL BE USED TO CALIBRATE AND TO VALIDATE ANALYTICAL MODELS USED TO PREDICT STRUCTURAL RESPONSE IN A CRASH SCENARIO.

THE NEW DIGITAL FLIGHT DATA RECORDERS (FDR) AND COCKPIT VOICE RECORDERS (CVR) WERE REMOVED FROM THE AIRCRAFT AND THE DATA ARE BEING EVALUATED. ALL UNITS APPEARED TO OPERATE NORMALLY. SINCE THE AIRCRAFT WAS HEAVILY INSTRUMENTED, IT WILL BE POSSIBLE TO EVALUATE THE ADEQUACY OF THE FDR INFORMATION FOR ACCIDENT INVESTIGATION.

THE HAZARDOUS MATERIAL CONTAINERS APPEARED TO PROVIDE THE DESIRED LEVEL OF PROTECTION.

ALL OBJECTIVES OF THE CRASHWORTHINESS PORTION OF THE CID WERE ACHIEVED.

THE MAJOR OBJECTIVE OF THE ANTIMISTING FUEL PERFORMANCE AND BEHAVIOR ELEMENT WAS TO DEMONSTRATE THAT USE OF AN ANTIMISTING ADDITIVE IN THE FUEL WOULD INHIBIT THE FORMATION OF A FINE FUEL MIST THROUGH WHICH FLAME COULD PROPAGATE BACK TO THE RUPTURED FUEL TANKS AND GENERATE A LARGE FIREBALL THAT COULD ENGULF THE AIRCRAFT AND, SUBSEQUENTLY, IGNITE SPILLED FUEL ON THE GROUND. PRIOR TO CID, THIS ANTIMISTING POTENTIAL HAD BEEN DEMONSTRATED IN OVER 300 WING SPILLAGE TESTS AT THE FAA TECHNICAL CENTER AND IN SIX CATAPULT CRASH

TESTS OF OBSOLETE MILITARY AIRCRAFT AT THE LAKEHURST NAVAL AIR ENGINEERING CENTER. THE CID WAS ALSO TO DEMONSTRATE THAT AMK IS COMPATIBLE WITH PROPULSION SYSTEMS AND, AFTER THE ANTIMISTING ADDITIVE IS DEGRADED, WILL BURN SATISFACTORILY IN A JET ENGINE COMBUSTOR DURING FLIGHT.

DESPITE THE FORMATION OF THE FUEL-FED FIRE, THERE IS PHOTOGRAPHIC EVIDENCE FROM THE TEST THAT SOME AMK FROM THE RUPTURED FUEL TANK ESCAPED THE FIRE IN THE DESIRED FORM OF LARGE DROPLETS.

THE ENGINES AND DEGRADERS OPERATED NORMALLY AND UNEVENTFULLY ON THE ANTIMISTING FUEL PRIOR TO AND DURING THE CID FLIGHT. ON THE DAY FOLLOWING THE IMPACT, FUEL SAMPLES WERE TAKEN FROM THE FUEL TANKS THAT HAD REMAINED INTACT. THESE FUEL SAMPLES WERE ANALYZED, AND ALL WERE NORMAL. ALL INDICATIONS SO FAR ARE THAT THE DEGRADED AMK IS FULLY COMPATIBLE WITH THE PROPULSION SYSTEM, CORROBORATING EARLIER GROUND AND FLIGHT TEST DATA.

TO SUMMARIZE THE ANTIMISTING FUEL PERFORMANCE AND BEHAVIOR ELEMENT OF THE CID, THE IMPACT SCENARIO WHICH OCCURRED AT EDWARDS AFB DEMONSTRATED THAT THERE ARE CONDITIONS WHERE ADDING AN ANTIMISTING CHARACTERISTIC TO JET FUEL IS NOT SUFFICIENT TO PREVENT A POST-CRASH FIRE. ONE EXAMPLE OF SUCH CONDITIONS, AS ILLUSTRATED BY THE CID, IS THE CASE WHERE THERE IS THE DESTRUCTION OF AN ENGINE AND THE RUPTURE OF FUEL LINES ON THE ENGINE PYLON WHICH PRODUCED AN INTENSE IGNITION

SOURCE NEAR THE LEADING EDGE OF THE WING AT THE POINT OF FUEL RELEASE. WHILE THE ANTIMISTING CHARACTERISTIC OF THE FUEL WOULD HAVE PREVENTED FORWARD PROPAGATION OF THE FIRE HAD THE FIRE SOURCE BEEN FARTHER AFT IN THE CID, IT PROVIDED LIMITED--ALTHOUGH STILL SIGNIFICANT--PROTECTION IN THE FOLLOWING RESPECTS. EXTERIOR AND INTERNAL FILM DOCUMENTATION INDICATES THAT THE RESULTANT FIREBALL DIMINISHED AFTER A PERIOD OF 9 SECONDS. EXAMINATION OF THE FILM FOOTAGE AND THE FUSELAGE INDICATES THAT THE FUSELAGE SUSTAINED RELATIVELY LITTLE DAMAGE DURING THE DURATION OF THE FIREBALL. THE REDUCED INTENSITY OF THE FIREBALL IS ATTRIBUTED TO THE ANTIMISTING CHARCTERISTICS OF THE FUEL. A FOLLOW-ON EVALUATION OF PREVIOUS ACCIDENTS IS BEING CONDUCTED TO DETERMINE THE PROBABILITY OF THIS TYPE ACCIDENT SCENARIO OCCURRING, BUT I HAVE LEARNED FROM YEARS OF CONDUCTING AVIATION ACCIDENT INVESTIGATIONS THAT YOU CANNOT PLAN A CRASH.

WITH REGARD TO CABIN FIRE SAFETY AND EGRESS POTENTIAL, EVEN THOUGH WE DID NOT EXPECT A MAJOR FIRE TO OCCUR, WE DECIDED TO TAKE ADVANTAGE OF THE OPPORTUNITY TO TEST SOME OF THE TECHNOLOGY THAT HAS EVOLVED FROM OUR CABIN FIRE SAFETY RESEARCH IN CASE THERE WAS SUCH A FIRE. WE INSTALLED FIRE BLOCKING LAYERS OVER THE CUSHIONS IN ALTERNATE ROWS OF SEATS. IN THOSE AREAS OF THE CABIN INTERIOR NOT ENTIRELY CONSUMED BY FLAME, THOSE SEATS WITH THE FIRE BLOCKING LAYERS SHOWED MUCH GREATER RESISTANCE TO HEAT AND BURNING THAN THE UNBLOCKED SEATS. MOREOVER, STRUCTURAL FIRE DAMAGE IN THE AREAS ABOVE AND ADJACENT TO BLOCKED SEATS WAS LESS SEVERE THAN IN THE AREAS OF THE UNBLOCKED SEATS.

ADVANCED MODIFIED EPOXY RESIN WINDOWS, WHICH PROVIDE ADDITIONAL TIME BEFORE BURN THROUGH, WERE INSTALLED ON THE CID AIRCRAFT IN ALTERNATE WINDOWS IN THE CABIN AREA BEHIND THE WING BOX. THESE WINDOWS ARE DESIGNED TO DELAY THE PENETRATION INTO THE CABIN OF AN EXTERNAL POOL FIRE. IN CID, FIRE PENETRATION WAS PRIMARILY THROUGH THE FLOOR. FOLLOWING THE FIRE, SEVERAL ADVANCED AND INTERSPERSED STANDARD PANES REMAINED IN PLACE ON BOTH SIDES OF THE AIRCRAFT IN THE REAR PART OF THE CABIN. DUE TO THE LENGTH AND INTENSITY OF THE FIRE, WE ARE UNABLE TO DRAW ANY CONCLUSIONS ON THE PERFORMANCE OF THE ADVANCED PANES.

NEW LOW-LEVEL, SELF-CONTAINED, EMERGENCY LIGHTS FOR FLOOR PROXIMITY ESCAPE PATH MARKING WERE INSTALLED ON EIGHT SEATS IN THE AIRCRAFT. THREE OF THE TRITIUM LIGHTS REMAINED BONDED TO SEATS WHICH SURVIVED THE FIRE. THE RAPID BUILDUP OF SMOKE IN THE CABIN, COMBINED WITH THE LOCATION OF THE CAMERAS HIGH IN THE CABIN, PREVENTED EVALUATION OF THE EFFECTIVENESS OF THESE LIGHTS.

WITH REGARD TO CABIN EGRESS, WE HAVE CONCLUDED THAT THE CID FLIGHT ENDED IN A SURVIVABLE IMPACT AND THE FUSELAGE, WHICH REMAINED ESSENTIALLY INTACT, PROVIDED THE OCCUPANTS WITH A HABITABLE POST-IMPACT SPACE.

MOREOVER, FOLLOWING THE IMPACT, HIGHLY EXPERIENCED ACCIDENT INVESTIGATORS FOUND THAT ALL THE EMERGENCY EXITS WERE STILL

OPERABLE; THAT IS, THEY OPENED EASILY. FLIGHT DECK ESCAPE WINDOWS WERE OPERABLE AND ESCAPE STRAPS WERE AVAILABLE FOR PILOT AND COPILOT LOCATIONS. THE FORWARD LEFT MAIN EXIT AND THE RIGHT REAR EXIT APPEARED TO BE SUFFICIENTLY CLEAR OF FLAMES THAT THEY COULD HAVE BEEN USED FOR PASSENGER EGRESS.

ANALYSIS OF PICTURES FROM HIGH-SPEED CAMERAS IN THE CABIN SHOW A RAPID BUILDUP OF SMOKE AFTER THE AIRCRAFT CAME TO A STOP WITH OBSCURATIONS OCCURRING IN UP TO 20 SECONDS AFTER SLIDEOUT DEPENDING ON THE AREA OF THE CABIN. THE SMOKE APPEARED TO COME FROM THE FUEL FIRE BENEATH THE CABIN FLOOR, ENTERING THE CABIN THROUGH HOLES IN THE FLOOR AND THROUGH VENTILATION GRILLS. ALTHOUGH WE CAN NEVER BE SURE, WE BELIEVE THAT "PASSENGERS" COULD HAVE ESCAPED, DEPENDING ON THEIR LOCATION RELATIVE TO THE USABLE EXITS.

AN ACCIDENT INVESTIGATION TEAM MADE UP OF FAA, NTSB, DOD, AND INDUSTRY CONDUCTED A POST-CRASH INVESTIGATION TO EVALUATE CURRENT INVESTIGATION TECHNIQUES. WHILE THE INVESTIGATION TEAM LEADER ARRIVED AT THE SCENE WITH THE FIRE-FIGHTING CREWS, THE REMAINDER OF THE TEAM ARRIVED SOMEWHAT LATER, AS THEY WOULD IN THE CASE OF A REAL ACCIDENT. THE INVESTIGATION INCLUDED A CAREFUL EXAMINATION OF THE WRECKAGE AND THE SITE. THE TEAM CONCLUDED THEIR INVESTIGATION IN 8 DAYS AND THEIR FINAL REPORT WILL BE AVAILABLE IN APRIL. THIS REPORT WILL INCLUDE AN EVALUATION OF CURRENT PROCEDURES. A PRELIMINARY ANALYSIS OF RESULTS SHOWS THAT THE INVESTIGATION METHODS USED TO RECONSTRUCT THE IMPACT CONDITIONS WERE ACCURATE AS VERIFIED BY THE FILM RECORDINGS.

WAS CID WORTH THE INVESTMENT? WE THINK IT WAS. IT PROVIDED EXTENSIVE IMPACT DATA AND INFORMATION ON THE RESPONSE OF AN AIRCRAFT STRUCTURE TO REAL CRASH IMPACT FORCES. IT ALSO HIGHLIGHTED THE FACT THAT ACCIDENT SCENARIOS ARE UNPREDICTABLE. IN THE CASE OF AMK, IT SHOWED THAT THERE ARE CONDITIONS WHERE AMK PROVIDES LITTLE PROTECTION.

THE EXTENSIVE DOCUMENTATION FROM THE INSTRUMENTATION AND CAMERA COVERAGE WILL PROVIDE INFORMATION TO SUPPORT FUTURE AIRCRAFT SAFETY ACTIVITIES.

IN SUMMARY:

- ALTHOUGH THE IMPACT SCENARIO DEVIATED FROM THE PLAN, THE TEST VALIDATED THAT THE PARAMETERS SELECTED FOR THE CRASH SCENARIO WOULD RESULT IN A SURVIVABLE IMPACT. IT FURTHER INDICATED THAT THE AIRFRAME DESIGNS IN CURRENT USE WOULD REMAIN ESSENTIALLY INTACT IN THIS TYPE OF IMPACT.

- OVER 97 PERCENT OF THE PHOTOGRAPHIC AND ELECTRONIC DATA RECORDERS WORKED SUCCESSFULLY. DATA ON THE STRUCTURAL RESPONSE OF THE FUSELAGE, WINGS, SEATS, RESTRAINT SYSTEMS, GALLEYS, AND OVERHEAD COMPARTMENTS WAS SUCCESSFULLY TELEMETERED BACK TO THE

GROUND STATION, AS WELL AS RECORDED ON BOARD THE AIRCRAFT. THE ONBOARD DATA ACQUISITION SYSTEMS SURVIVED THE IMPACT AND SUBSEQUENT FIRE. THE DATA, IN ADDITION TO CONFIRMING THAT THE CID WAS IMPACT SURVIVABLE, WILL BE USED TO VERIFY AND REFINE THE ANALYTICAL MODELS AND PROVIDE IMPACT FORCE CHARACTERISTICS FOR TESTING OF ADVANCED SEATS, RESTRAINT SYSTEMS, AND COMPOSITE STRUCTURES. THE MODELS, AS WELL AS CRASH SCENARIOS, WILL BE THE SUBJECT OF ADVISORY CIRCULARS TO BE ISSUED IN JUNE OF THIS YEAR.

- THE SEATS, EXCEPT FOR ONE AT THE FUSELAGE RUPTURE, REMAINED IN PLACE, AND THE RESTRAINT SYSTEMS RESTRAINED THE OCCUPANTS. A TRANSPORT SEAT STRENGTH NPRM IS PLANNED FOR ISSUANCE THIS JUNE.

- TESTS OF HAZARDOUS MATERIAL CONTAINERS, NEW FLIGHT DATA RECORDERS, AND COCKPIT VOICE RECORDERS SHOWED THAT THEY WERE CAPABLE OF SUCCESSFULLY PERFORMING THEIR INTENDED FUNCTIONS IN SUCH A CRASH SCENARIO.

- THE TEST, ALTHOUGH LIMITED IN EXTENT, DID DEMONSTRATE THE OPERATIONAL COMPATIBILITY OF AMK WITH AIRCRAFT AND ENGINE FUEL SYSTEMS AND THE TECHNICAL FEASIBILITY OF "DEGRADING" THE ANTIMISTING KEROSENE.

- IN ONE AREA, AMK FIRE PROTECTION, THE LOCATION OF THE FIRE SOURCE AT THE LEADING EDGE OF THE WING, PRECLUDED A DEMONSTRATION OF THE MAJOR ADVANTAGE OF AMK FUELS; NAMELY, THAT THE FORMATION OF LARGE FUEL DROPLETS PREVENTS THE FORWARD PROPAGATION OF A FIRE AND ATTACHMENT OF THE FIRE TO THE AIRCRAFT. THE USE OF THE ADDITIVE, HOWEVER, APPEARED TO REDUCE THE HEAT TRANSMITTED TO THE FUSELAGE BY THE FIREBALL.

- THERE WAS EVIDENCE THAT THE SEAT CUSHION FIRE-BLOCKING LAYERS, WHICH WILL BE REQUIRED PURSUANT TO A NEW FAA RULE, DELAYED THE SPREAD OF INTERNAL FLAMES.

BASED ON THE PRELIMINARY RESULTS AVAILABLE FROM CID, I AM PROCEEDING WITH ALL OF OUR ANTICIPATED RULEMAKING ACTIONS, EXCEPT THAT WITH RESPECT TO AMK. WE WILL WAIT FOR THE COMPLETE ANALYSIS OF CID DATA BEFORE DECIDING ON FURTHER ACTION IN THIS AREA.

THE VIDEO YOU ARE ABOUT TO SEE WILL COVER MOST OF THE POINTS I HAVE ADDRESSED. I BELIEVE THAT IT WILL PROVIDE YOU WITH A REALISTIC ILLUSTRATION OF WHAT ACTUALLY TOOK PLACE ON DECEMBER 1 AT EDWARDS AIR FORCE BASE.

WHEN THE VIDEO PRESENTATION IS COMPLETE, MY ASSOCIATES AND I WOULD BE PLEASED TO RESPOND TO ANY QUESTIONS YOU MAY HAVE.

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