SA-None File No. A-0004

AIRCRAFT ACCIDENT REPORT

JAPAN AIRLINES COMPANY, LTD.
CONVAIR 880, MODEL 22M, JA8028
GRANT COUNTY AIRPORT
MOSES LAKE, WASHINGTON
JUNE 24,1969

Adopted: June 17, 1970

NATIONAL TRANSPORTATION SAFETY BOARD
Bureau of Aviation Safety
Washington, D. C. 20591

For sale by Clearinghouse for Federal Scientific and Technical Information, U.S. Department of Commerce, Springfield, Va. 22151. Annual subscription price $12.00 Domestic; $15.00 Foreign; Single copy $3.00; Microfiche $0.65.

Report Number: NTSB-AAR-70-11

NATIONAL TRANSPORTATION SAFETY BOARD
DEPARTMENT OF TRANSPORTATION
WASHINGTON. D. C.

JAPAN AIR LINES COMPANY, LTD.
CONVAIR 880. MODEL 22M. JA-8028
GRANT COUNTY AIRPORT
MOSEWASHINGTON
JUNE 24. 1969

TABLE OF CONTENTS

File No. A-0004

NATIONAL TRANSPORTATION SAFETY BOARD
DEPARTMENT OF TRANSPORTATION
AIRCRAFT ACCIDENT REPORT

Adopted: June 17, 1970

JAPAN AIR LINES COMPANY, LTD.
CONVAIR 880, MODEL 22M, JA-8028
GRANT COUNTY AIRPORT
MOSES LAKE, WASHINGTON
JUNE 24, 1969

SYNOPSIS

Japan Air Lines training flight 90 of June 24, 1969, crashed at 1603 1/ while executing a takeoff on Runway 32R. Of the five crewmembers and trainees on board, three received fatal injuries and two sustained serious burn injuries. The two survivors were the flight instructor and the flight engineer.

Shortly after lift-off, the flight instructor reduced power on No. 4 engine to check the trainee's emergency procedures, and the aircraft began to yaw to the right. This yaw-continued to increase until, at a point approximately 6,500 feet down the runway, the right wing went down and the No. 4 engine pod made contact with the runway. In a severe sideslip to the right, the aircraft slid off the runway and thence in a northerly direction through 2,600 feet of rough terrain, breaking up and bursting into flames before it came to rest on an easterly heading. Four crewmembers escaped from the burning aircraft through a break in the fuselage, but of these four, only two survived. The body of one trainee was later found in the burned cockpit area. Ground impact and fire after impact almost completely destroyed the airplane.

The Safety Board determines that the probable cause of this accident was the delayed corrective action during a simulated critical-engine-out takeoff maneuver resulting in an excessive sideslip from which full recovery could not be effected.

1/ All times herein are Pacific daylight, based on the 24-hour clock.

1. INVESTIGATION

1.1 History of Flight

Japan Air Lines (JAL) training flight 90, June 24, 1969, was to be the final stage of a 12-hour, captain-upgrading training for three copilots, each of whom was type rated and had a minimum of 1 year's co-pilot experience in the Convair 880. The final check of these trainees was to be a JCAB (Japan Civil Aviation Bureau) Air Transport Rating Check, scheduled June 26, 1969. The subject flight was to be the third of June 24 for the aircraft and was scheduled for 1530 to 1930.

The aircraft arrived on the ramp at 1501 after completing its second training flight of the day. All turnaround checks were completed and the aircraft was readied for the final flight of the day.

Company records show that the crewmembers for Flight 90 reported to the training center at 1430 and spent the intervening time in preparation for the flight. The crew consisted of an instructor pilot captain, the flight engineer, and three pilot trainees. Company records showed that all crewmembers had an adequate rest period prior to reporting for duty.

According to the surviving crewmembers, the aircraft log reflected information about a sticking fuel quantity gauge and erratic indications on the copilot's attitude indicator involving errors of several degrees of pitch and roll. The captain was unable to recall the number of degrees involved. He stated he observed no abnormal readings on the horizon indicator while taxiing.

No items affecting the airworthiness of the aircraft were noted by either the captain or the flight engineer during the prestarting, ground operation, or takeoff roll.

The prestarting checklist included the requirement for a crewmember, deplaned for the purpose, to observe physically the operation of the rudder-boost system and proper movement of the rudders. The instructor captain and flight engineer both stated this was accomplished, as were all other preflight and ground checklist requirements. No discrepancies were noted by either crewmember.

The instructor captain was seated in the copilot's seat; and one of the pilot trainees was in the captain's seat. The flight engineer was at the engineer's station, and another pilot trainee in the observer's seat. The third pilot trainee's position could not be determined; however, he was expected to occupy a seat in the passenger cabin during takeoff and landing.

Aircraft performance computations prepared by the crew for the flight were lost in the ground fire. Reconstructed computations based on existing conditions are as follows: V_1 speed--125 knots, V_R--130 knots, V_2--145 knots. 2/ The captain's recollection was that V_R was 132 or 133 knots and that V_2 was 140 knots "plus something."

Recorded information from the FAA-operated control tower at Grant County Airport showed JAL 90 requested information as to the active runway, temperature, and time at 1537. At 1545, the flight reported ready to start engines for an IFR departure on a local flight. Wind was reported to JAL 90 as 240° at 15 knots with gusts to 20, altimeter 29.66. At 1548, a local clearance was issued to the flight and, at 1555, JAL 90 advised it was taxiing. The local control recording showed JAL 90 announced its readiness for takeoff on Runway 32R (right) at 1601:25 and takeoff clearance was issued at 1601:30. Wind was again reported from 240° at 15 knots.

According to one of the two tower controllers on duty, the aircraft started what appeared to be a normal takeoff at 1602. He said that approximately 5,000 feet down the runway and at a height of approximately 50 feet above the runway, the aircraft yawed to the right approximately 30°. At approximately 1603, he saw the right wing dip and appear to touch the ground. The aircraft continued in a northeasterly direction, descended, struck the ground, and appeared to groundloop to the right. There was considerable dust and what appeared to be smoke. The controller stated that approximately 5 to 10 seconds after the aircraft crashed, it burst into flames.

The other tower controller stated that he observed Japanair 90 make what appeared to be a normal lift-off. He said that immediately after lift-off, the aircraft began to yaw severely to the right at an altitude of not more than 50 feet. Approximately 6,000 feet down the runway, the right wing dipped to the surface, the aircraft groundlooped off the right side of the runway, slid in a northerly direction, and burst into flames within 10 seconds after coming to rest.

The two tower controllers were the only known eyewitnesses to the takeoff and crash.

The instructor captain described the following sequence of events: A rolling takeoff was made (from Taxiway 1, approximately 500 feet from the threshold end of Runway 32R). Upon reaching V_R, "rotation" was called out and the aircraft lifted off normally. According to the horizon instrument on his side, the rotation angle was 12°. He stated that shortly after lift-off, with a speed somewhere between V_R and V_2, he retarded the No. 4 power lever very slowly to check the trainee pilot on a one-engine-out emergency procedure. As No. 4 power was fully reduced, he had the feeling that the aircraft was leveling off, not climbing or sinking, and that at the same time it was turning to the right, wings level. The captain stated

---

2/ V_1 means critical-engine-failure speed; V_R means rotation speed, and V_2 means takeoff safety speed.

that upon retarding No. 4 power, the trainee pilot applied rudder in the correct direction but that his correction was "a little delayed," "rather light", or "not proper." He said that he took over control of the aircraft when he saw the yaw continuing "just about when we were going off the runway" (the nose of the aircraft turned beyond the side of the runway, and only the grass area of the airport was in view).

The instructor captain, in describing the actions he took to stop the yaw, stated, "I felt it strange that though I was pushing the left rudder to stop yawing the action has been ineffective at all, and the aircraft didn't follow so. At first (I used) moderate rudder and when yaw didn't stop I pushed rudder moderate to heavy - about three quarters rudder travel. I couldn't use full rudder because I was too close to the ground and afraid of contacting the ground with the left wing as a result of radical action." So, hoping to maintain the altitude he had already attained and start climbing, he advanced No. 4 engine power. This action stopped the nose from continuing its turn, but it was at this time that the aircraft contacted the ground. The captain stated that he then abandoned the idea of trying to continue lift-off and decided to make an emergency landing. During the ensuing ground shocks and rapid deceleration, the captain retarded all power levers to idle, pulled the No. 4 fire-pull "T" handle and, to the best of his recollection, pulled the No. 3 "T" handle part way out.

To explain why he had reduced No. 4 engine power very slowly, the captain stated that it was because of the existing crosswind, and it was the first takeoff of the day (for this particular training flight). He also inferred he used this technique to afford the trainee a greater opportunity to respond to the situation. He stated that he had previously, on infrequent occasions, used a slow movement of the power lever when simulating a one-engine-out maneuver. He was not sure whether or not he had done so previously with the trainee pilot involved.

Both the captain and flight engineer stated that engine power and other aircraft instrument indications were normal throughout the flight.

After the aircraft came to rest, four of the occupants escaped from the burning wreckage through a break in the fuselage. Of these, two succumbed to fire after getting outside the aircraft. The body of one trainee was later found in the burned cockpit area.

The accident occurred at latitude 47°13'30"N., longitude 119°18'10"W., during daylight hours.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Other
Fatal	1 (trainee)	0	2 (trainees)
Nonfatal	2	0	0
None	0	0	

1.3 Damage to Aircraft

The aircraft was demolished by impact, by disintegration as it slid through rough, rocky terrain, and by the ensuing ground fire.

1.4 Other Damage

Runway 32R was gouged, one runway light was smashed, and the portion of Taxiway 5 on which the main wreckage came to rest was damaged by fire.

1.5 Crew Information

All crewmembers were properly certificated and qualified for their positions. (For further details, see Appendix A.)

Captain Kazuhiko Suda, aged 37, held a currently effective JCAB Airline Transport Pilot Certificate with type ratings in the Convair 880 and Douglas DC-8, and an instructor-pilot rating issued March 14, 1967. His and company records showed he had accumulated a total pilot time of 7,639 hours, with 600 hours experience as an instructor-pilot, of which 100 hours were obtained instructing in the Convair 880. His most recent proficiency check in the CV-880 reflected an outstanding performance.

In December 1968 and January 1969, Captain Suda received approximately 12 hours of training in simulators and the actual aircraft for qualification as a CV-880 instructor-pilot. He acted in this capacity during January, February, and June 1969. During March, April, and May 1969, except for several trips as a Convair 880 copilot, he served as a DC-8 captain and instructor.

Pilot Trainee Jyunichi Murata, who occupied the captain's seat, was 29 years old and held a currently valid JCAB Commercial Pilot Certificate. Company records showed he had a total time of 2,773 hours. Of this total, 827 hours were acquired in the CV-880 as a copilot, 32 hours of which were in training and obtaining a type rating. In the last 90 days, he had accumulated 154 hours in the cv-880, including 11 hours and 43 minutes of captain-upgrading training.

In describing Trainee Murata's skill level, Captain Suda stated that he graded the trainee with "B minus" on the intermediate check of June 19, 1969, which was about the halfway point in the scheduled 12-hour training program. Captain Suda's report of this check, given when Mr Murata had received 8.5 hours of training, had the comment, "OK for ATR check. Depending upon the demands for left seat capability, judgment and planning is weak." The report projected an estimated 14 hours of training would be required (programmed time, 12 hours). Captain Suda said that Trainee Murata tended to scan the instruments slowly during his flight training and that it was necessary to remind him of altitude, heading, and airspeed. He judged Mr Murata's skill as "just average, or just below average." Captain Suda estimated that he had given Trainee Murata 20 or more one-engine-out procedures during his training.

Flight Engineer Nobuhiro Uematsu, aged 31, held a currently effective JCAB Flight Engineer Certificate. He had been a flight engineer instructor since March 11, 1968, and had accumulated a total time of 2,948 hours, of which 1,114 were in CV-880 aircraft.

1.6 Aircraft Information

The aircraft, a Convair 880, Model 22M, serial No. 49, was manufactured September 13, 1962, and had accumulated a total time of 14,278 hours. It was powered by four General Electric Model CJ805-3B axial flow jet engines, with total times which ranged between 8,914 and 11,326 hours.

The aircraft was certificated in accordance with existing regulations, and the records reflected that it had been maintained in an airworthy condition.

The takeoff gross weight was computed at 162,450 pounds, the center of gravity, at 27.6 percent MAC (mean aerodynamic chord). These were within the allowable limits of 193,000 pounds maximum gross weight, and the center of gravity range of 20.6 to 32 percent MAC.

The fuel load was Conoco Jet 50, which is equivalent to JP4 or MIL J-5624E. Records showed the aircraft was serviced to 71,500 pounds total fuel, distributed symmetrically in both wings. Takeoff fuel was calculated at 70,000 pounds.

1.7 Meteorological Information

Surface weather observations recorded by control tower personnel at the Grant County Airport nearest the time of the accident were made at 1555 and 1610. Both observations showed scattered clouds at 8,000 feet; thin, scattered cirrus; visibility 65 statute miles; temperature 74° F., dew point 38° F., and altimeter setting 29.66. The 1555 observation showed the wind from 250° at 15 knots, and the 1610 observation showed the wind from 280° at 10 knots.

The natural light condition was sunny.

1.8 Aids to Navigation

Aids to navigation were not involved.

1.9 Communications

Communications were not a factor.

1.10 Aerodrome and Ground Facilities

Grant County Airport is located 5.5 miles north-northwest of Moses Lake, Washington, at an elevation of 1,186 feet m.s.l. Publicly owned, the airport is operated by the Port of Moses Lake Commission. There are three runways, the longest of which is 14L-32R. Runway 32R used by the flight involved is 13,500 feet long, 300 feet wide, level, and is constructed of asphalt and concrete. There are stabilized over-runs on each end of this runway, 1,000 feet long. High-intensity runway lighting is installed. Runway 32L is a 3,100-foot day/VFR runway, converted from taxiway use to light aircraft operations. It is located at the northwest end of Fiunway 32R and is parallel to it.

A control tower operated by the Federal Aviation Administration is located on the airport. Tower personnel approved by the U. S. Weather Bureau record local weather observations, and complete weather service is supplied from the FAA Flight Service Station at Ephrata, Washington, located about 11 miles west-northwest of the airport.

Ground facilities were found to be well maintained. Fiunway 32R and the main taxiway from the operations apron to Runway 32R were both in excellent condition.

1.11 Flight Recorders

A United Data Control Flight recorder, Model FA-542, was recovered from the severely burned cockpit area. The recorder, which was located in the belly of the aircraft behind the nose gear well, was severely damaged by fire, but was decipherable after extensive cleaning of the burned foil.

Examination of the flight record pertinent to the takeoff and subsequent accident showed that all four parameters were functioning. A data graph reflecting the time period of 1 minute 40 seconds, beginning 1 minute before lift-off, was plotted.

Correlation of the four traces showed that takeoff was initiated with a rolling start following a left turn onto the runway heading. The actual takeoff roll was determined as nearly as possible, considering that a rolling takeoff was made, to have begun at time 0:20 (sec.).

The appearance of all traces showed that the takeoff run was normal and acceleration was steady, as evidenced by a nearly constant rate of increase in the airspeed trace.

Correlation of the traces showed that rotation began at time 0:55 at an airspeed of 131 KIAS (knots indicated airspeed), and lift-off occurred between times 0:58 and 1:00 (60 sec.).

At time 1:01.5 (61.5 sec.), the heading trace showed the beginning of a turn to the right, which in the next 5.5 seconds resulted in a heading change from 318" magnetic to 014°, a change of 56" at a rate of 10° per second. During the 4-second period of time between 1:06 and 1:10, the airspeed trace showed a drop in airspeed from 140 KIAS to 34 KIAS. It was determined that the magnitude of this decrease in airspeed resulted from a loss of dynamic pressure at the pitot head due to sideslip.

The altitude trace reflected that the aircraft reached a maximum height of 125 feet above field elevation at time 1:08.5 (68.5 sec.). By this time, the heading trace showed the turn to the right had stopped and a turn to the left had begun, which, in 2 seconds stopped again, and a generally stable heading of 345° magnetic was then recorded. Shortly thereafter, at time 1:10 (70 sec.), and after restoration of dynamic pressure to the pitot heads, the airspeed trace settled on a value of 122 KIAS.

The altitude trace showed a return to field elevation at time 1:13 (73 sec.), at which time the airspeed was recorded at 116 KIAS, and the heading at 347" magnetic. It was determined that ground impact occurred at this time. All traces beyond time 1:15 are considered to be meaningless.

No cockpit voice recorder was installed in this aircraft.

1.12 Wreckage

Gouges and scrape marks, starting at a point 6,504 feet from the threshold of the runway, showed where the bottom of the No. 4 engine pod began scraping the runway for a distance of 656 feet. Tire skid marks, which began shortly before the end of the engine scrape marks, continued for another 278 feet before leaving the runway. Both engine and tire skid marks showed that when the nose gear touched down, the aircraft was banked at a 37" angle to the horizontal and 18° to its direction of travel. When the left main landing gear made contact, the aircraft was at a 42° angle to the horizontal and at a sideslip angle of 22". As it left the mway, the aircraft was at an angle of about 46" to the runway and at a sideslip angle of about 22°.

Shortly after leaving the mway, the tail skid separated and the aircraft continued to slide approximately 2,600 feet on a magnetic heading of 351° before it came to rest on Taxiway 5. Over approximately the last 1,000 feet of travel, scattered fragments of engine pods, main landing gear components, wing fragments, parts from the structure of the lower section of the airframe, and two separated engines were found.

Evidence of fire appeared approximately 1,700 feet north of where the aircraft left the runway and beyond the point in the wreckage path where disintegration began.

When the aircraft reached Taxiway 5, which cuts through the terrain at a slightly lower level than the surrounding ground, the fuselage separated at the trailing edge of the wings, and its forward section came to rest on a heading of approximately 100° magnetic. From the pressure bulkhead forward, the aircraft was completely destroyed by fire. Only the empennage, engines, and other components scattered along the wreckage path escaped complete destruction by fire.

Measurement of jackscrews showed that the trailing edge flaps slat system and spoilers were at a setting of 22° and the horizontal stabilizer at 3.9 units--the proper positions for takeoff. All cockpit instrument readings and control settings were destroyed by fire.

The rudder-boost unit was removed from the empennage and sent to a bench-test facility at San Leandro, California, for functional checking. Functional tests of the unit showed that it was capable of normal operation. All other aircraft systems were damaged by impact and fire to the extent they could not be checked for preimpact operational capability.

All engines were separated during the ground slide and breakup of the aircraft. The No. 3 engine was found 2,000 feet from the runway, the No. 4 engine 2,300 feet, and Nos. 1 and 2 engines were found in the main wreckage. All engines were subjected to varied degrees of roll, tumbling, and fire damage.

A disassembly examination of the engines, performed at the General Electric overhaul facility, Ontario, California, showed that the No. 1 engine was at 90 percent r.p.m. or less, Nos. 2 and 3 at approximately 90 percent, and No. 4 more than 94 percent; all engines were decelerating. The fuel valves were determined to be in normal takeoff positions. No evidence of a preimpact malfunction or failure of the engines was found.

1.13 Fire

Evidence of ground fire was found approximately 1,700 feet north of where the aircraft left the mway and beyond the point where disintegration of the aircraft began. Upon coming to rest, the wings and the fuselage erupted in flames. The fuselage (except for the empennage) and the wings were almost completely consumed by fire. In addition, a brush fire occurred which spread over an area of approximately 300 acres before it could be extinguished.

Response to the crash alarm sounded by the control tower was immediate and crash/firefighting equipment reached the burning wreckage at 1607. One type 530A pumper, one type 0-10 crash truck, a tanker, and a pickup truck equipped with dry chemical were dispatched by the airport fire station. This equipment was augmented by a tanker truck provided by the Boeing Company. Foam was directed on the fuselage section of the aircraft in an attempt to extinguish fire in the area where survivors might be located. Approximately 3,500 gallons of premixed foam and 2,500 gallons of water were directed on the burning wreckage. Mutual aid from rural and city fire departments was obtained to combat the brush fire.

1.14 Survival Aspects

The surviving crewmembers stated that due to smoke and flames, they could not see outside the aircraft after it stopped. Attempts to leave the aircraft through the cockpit sliding windows, the main cabin passenger door, and the galley service door were unsuccessful because all of these exits were jammed and resisted all efforts to unlatch them. An opening at the rear of the remaining cabin section, resulting from separation of the aft fuselage section, was discovered and utilized to escape from the aircraft. Although the area in the vicinity of the fuselage break was engulfed in flames from the burning wing, Captain Suda and Engineer Uematsu looked for an area of least fire, jumped down approximately 6-1/2 feet into the fire, and then ran in their selected directions. Both successfully escaped from the fire area, but sustained serious burn injuries, primarily to their lower extremities. Two of the trainees were the first to leave the aircraft. These two apparently went to the right, near the area of the left wing, and were not able to escape the flames. The body of one was found approximately 75 feet from the fuselage to the northwest, and the other, approximately 50 feet farther northwest, in the grass fire area. The body of the trainee who was seated in the observer's seat was found near the observer's seat, in the burned cockpit area. According to the instructor's statement, before leaving the aircraft he found nobody remaining in the aircraft.

The airport manager and a security guard, the first persons to arrive at the wreckage, found both survivors together a short distance northwest of the empennage section. Both crewmembers were taken to Samaritan Hospital, Moses Lake, by emergency vehicle.

Because of destruction by fire, no evidence was available to determine the reason for the jammed exits encountered by the crew during their attempts to escape. However, examination of the available structure of the aircraft showed that the flexing and twisting forces to which it had been subjected during the disintegrating ground slide would have readily caused the locking pins of these exits to jam.

1.15 Tests and Research

In order to obtain first-hand knowledge of the handling characteristics of the Convair 880, Model 22M, under critical-engine-out conditions, demonstration flights were conducted, with Board investigators aboard, in a similar make-model aircraft at the Federal Aviation Administration Aeronautical Center, Oklahoma City, Oklahoma, on July 7, 1969. The aircraft and crew were provided by the FAA. Participating in the demonstration flights were the FAA Coordinator and a flight test pilot from FAA Western Region Flight Test Engineering. The demonstration consisted of a series of takeoffs simulating the critical engine inoperative, with such simulations and asymmetric thrust evaluations also performed at altitude. On the first takeoff, the gross weight was 160,853 pounds, fairly approximating the load conditions of JA-8028 at the time of the accident. The last takeoff of the series was performed at a gross weight of 137,000 pounds. The field elevation was 1,284 feet.

Six takeoffs during which three engine cuts at V_1, two at V_2, and one at V_R were made. In each simulation, the downwind outboard engine was retarded with a rapid movement of the power lever. To correct for the yaw produced by these power reductions, it was necessary in the first four instances to apply promptly full, or almost full, rudder travel. At the lighter gross weights, a V_R engine cut at 139,000 and a V_2 engine cut at 137,000, three-quarters and slightly more than one-half rudder travel, respectively, were required. Although less rudder travel was necessary during the lighter gross weight simulations, it was noted that the yaw developed more rapidly and corrections had to be applied more promptly. The use of aileron control to assist in maintaining straight flight was required in all cases.

At an altitude of 9,000 feet, a Board investigator took the controls to determine the mount of rudder and aileron necessary to compensate for critical engine inoperative conditions. A V_{mc} speed and other conditions were used by the FAA crew to equate performance to takeoff at field elevation. On three successive maneuvers, alternating with rapid reductions of power on the left-hand and right-hand engines, the Board's investigator found it necessary to apply promptly full rudder and some aileron to maintain straight flight.

On three additional maneuvers the power was reduced gradually to simulate the slow reduction described by the captain of the accident flight. On each of these maneuvers, the onset of yaw was gradual at first, giving rise to a feeling on the part of the investigator that no urgency was required in beginning correction and that light rudder pressure would be adequate. When corrective rudder and aileron were applied, directional control was maintained or restored. In some instances where full rudder and some aileron were applied, the yaw was arrested and resulted in over-control and entry into the dutch roll condition, which is characteristic of any swept-wing aircraft.

Results of the above-described tests demonstrated that during critical-engine-out maneuvers, it was necessary to apply promptly corrective rudder supplemented with aileron control to maintain directional control of the aircraft. The tests at altitude simulating engine cuts demonstrated that with the use of full rudder supplemented by aileron, a developing yaw could be arrested and the aircraft made to yaw in the opposite direction.

While at altitude, additional tests were made by the Western Region flight test pilot to determine the power increases required to overcome drag resulting from one-half-ball and one-ball sideslip displacements of the turn and bank indicator.

For the steady state zero sideslip condition, an E.P.R. (Engine Pressure Ratio) setting of 1.85 was required. The aircraft was then put into a one-half ball sideslip angle and thrust was increased to maintain airspeed and altitude. This required a power increase to 1.95 E.P.R. A one-ball deflection required an increase to 2.09 E.P.R. The data recorded from these tests were correlated with Chart 3.13 in Volume 111, Book II, of Convair document zc-22-028 (Aircraft Certification Data), which is included in the certification data for the Convair 880 (FAA Project CT-659-4D). It is a chart showing the relation between engine thrust and E. P.R. This chart shows that variation of E. P.R. and thrust is virtually linear, i.e., that thrust for 1.90 E.P.R. is 4,400 pounds thrust per engine and 2.05 E.P.R. results in 5,060 pounds thrust per engine. Thus a change of .05 E.P.R. results in a change of 220 pounds of thrust per engine, at a given airspeed and altitude.

A graphic presentation of the results of the above tests is shown as follows:

Ball	E.P.R.	#Thrust/Engine	#Thrust Required/Engine Over Initial	#Thrust Required For 4 Engines Over Initial
0	1.85	4,180	0	0
1/2	1.95	4,600	/420	1,680
1	2.09	5,240	/1,060	4,240

Thus it will be noted that an additional thrust of 4,240 pounds is required to maintain constant airspeed and altitude when the turn and bank indicator is displaced one-ball width, which is in excess of the thrust produced by one engine with the ball centered. This test demonstrated the high thrust penalty incurred resulting from additional drag due to sideslip.

Computed data pertaining to the takeoff performance of JA-8028 were studied in an effort to determine whether actual performance was or was not normal. The information shown in the appropriate JAL chart and the FAA Flight Test Engineering Chart gives the computed points for V_1, V_R, and V_{LOF} 3/ speeds. Though there are differences in the two sets of computations, the differences are not considered appreciable and were used for comparison with the flight recorder information. The three sets of data are:

3/ V_{LOF} means lift-off speed.

	V_1 - 125 Knots		V_R - 130 Knots		V_{LOF} - 140 Knots	
JAL	28.6 sec.	3,495 ft.	30.0 sec.	3,805 ft.	32.7 sec.	4,470 ft.
FAA	29.5 sec.	3,640 ft.	31.2 sec.	4,025 ft.	32.8 sec.	4,487 ft.
Flight Recorder			35.0 sec.	130 knots	38.0 to 40.0 sec.,	136-139 knots

The flight recorder traces show differences of 3.8 to 5.0 seconds at V_R and 5 to 7 seconds at V_{LOF} -- somewhat longer periods of time to reach these speeds. However, because of the rolling takeoff, it was impossible to determine the aircraft's precise starting point from the flight recorder trace. For this reason, it was considered that the flight recorder values shown could not be compared with the computed values with any appreciable degree of accuracy.

Japan Air Lines uses an approved derating system for power settings for the purpose of increasing engine life. The derating involves a takeoff E.P.R. power setting .07 below the manufacturer's performance chart figures, and is incorporated in all computed power settings shown in this report (except for the three-engine climb from lift-off to 50 feet).

Information concerning the aircraft performance and pilot techniques peculiar to the Convair 880 22M during critical-engine-out takeoffs was requested of the manufacturer to determine what, if any, characteristics may have been causal or contributory to the accident. Specifically, the manufacturer was asked to show at what point in a sideslip the rudder would no longer be effective. In reply, a Convair Division letter of September 23, 1969, included performance data relating to maximum rudder deflection for sideslip angle vs. airspeed. The data showed that at the maximum attained speed of 140 KIAS as shown by the flight recorder, a sideslip angle of more than 7° would result in the beginning of rudder "blowback," where the rudder hinge moment is overcome by slipstream forces and causes the rudder to streamline with the vertical stabilizer. Regarding this data, the manufacturer stated that it was based on calculated data not acquired by flight tests, but considered to be representative of the actual aircraft response.

Forwarded with the same letter was a paper written by Flight Captain A. P. Wilson, Engineering-Production Flight, Convair Division, entitled "A Pilot Reviews Swept-Wing Jet Transport Takeoff." The paper was used in the manufacturer's Convair 880 pilot training program. An excerpt of Captain Wilson's paper is considered pertinent to this accident, and is quoted as follows:

> "Direction should be controlled by rudder and by lifting of the dead-engine wing about 5 degrees. The 5 degrees bank away from the inoperative engine helps achieve a lower Vmc. At close to Vmc, full rudder must be used; as speed increases, less rudder will be required to maintain direction. The aircraft can be trimmed as desired, the minimum necessary being that desired.

"In the main, rudder must be used to maintain direction, keeping the slip to a maximum of 5 degrees. If slip is used instead of rudder, and if slip is allowed to increase to about 16 degrees, the added lift on the lower wing and the decreased lift on the upper wing produce a rolling moment that is sufficient to offset lateral control; at 15° slip condition the rudder, due to increased air load, folds back to a point where it is streamlined with the fin. At 17° to 18° slip, the vertical stabilizer is subject to stall and directional control is lost. With asymmetric power, a turning moment exists, the turning force as the rudder streamlines or the fin stalls is no longer held in check and the aircraft turns into the dead engine. Any yawing into these static limits will, proportionate to the yaw rate, aggravate the condition. The forward moving wing, due to its higher speed, and increased effective angle of attack, generates more lift, the backward moving (relatively speaking) wing generates less lift, and these differences (combined with the differences in lift due to the slip) cause the aircraft to roll rapidly. At low altitudes, it may be impossible to recover from such a condition; therefore, it is wise to maintain a considerable margin away from this degree of slip. By holding a maximum of 5 degrees slip, such a margin is ensured. This trait is characteristic of swept-wing aircraft, and it is essential to be careful not to expose one's self to such a hazard."

The flight operations training manuals of Japan Air Lines and other Convair 880 operators reviewed during the investigation did not provide specific information regarding the limits of rudder controllability, recommended maximum limits of slip angle allowable, and other information, in the explanatory detail found in Captain Wilson's paper. However, the approved Manufacturer's Flight Manual for the Convair 880, under the emergency procedures section relating to the missed-approach procedures with three engines operating, stated in part "CAUTION IT IS IMPERATIVE THAT LARGE SIDESLIP ANGLES (YAW ANGLES) ARE NOT ALLOWED TO DEVELOP. TO MINIMIZE THE PROBABILITY OF LARGE SIDESLIP ANGLES (YAW ANGLES) DEVELOPING WITH ONE OR TWO ENGINES OUT ON ONE SIDE, MAINTAIN DIRECTIONAL CONTROL WITH THE RUDDER INSOFAR AS POSSIBLE. KEEP BALL APPROXIMATELY CENTERED. DO NOT USE EXCESSIVE BANK ANGLES OR LATERAL CONTROL."

The Japan Air Lines Flight Training Guide, under "Take OFF (3 Eng at or after V_1)" states in part:

"In case of eng. out, apply sufficient rudder and aileron to maintain wings level. (Side slip must be checked by rudder. Never bank too steeply)."

Elsewhere in the Training Guide it is stated, without explanation, that the maximum bank shall be limited to 5° at V_2 speed.

2. ANALYSIS AND CONCLUSIONS

2.1 Analysis

Investigation of the physical evidence and records disclosed that the aircraft was airworthy, properly loaded, and capable of normal operation. The testimony of the surviving crewmembers showed that the flight progressed normally up to the point where the deterioration in performance due to excessive sideslip resulted in a loss of control.

The crew was properly certificated and qualified for the operation. Although the flight instructor's evaluation of the trainee was that his progress was slightly below average and he tended to scan the instruments slowly, the instructor also stated that with the additional instruction to be given him on the flight involved, he expected that the trainee would successfully complete the training program. As part of this instruction, the instructor intended to check the trainee's performance in a simulated critical-engine-out procedure. After this flight, the trainee was scheduled to receive a JCAB Air Transport Rating check.

Crew testimony revealed that the takeoff proceeded normally until shortly after lift-off when, somewhere between V_R and V_2, the instructor-pilot retarded the No. 4 power lever very slowly. He stated that the trainee's application of rudder to correct the resulting yaw to the right was "a little delayed" and that he assumed control from the trainee "just about when we were going off the runway" (aircraft heading such that the runway was no longer in view). The flight instructor stated that at first he used moderate rudder and when the yaw did not stop, he pushed about three-quarters rudder travel. He stated, "I couldn't use full rudder because I was too close to the ground and afraid of contacting the ground with the left wing as a result of radical action." The above statement shows that the trainee's corrective action was delayed and inadequate, and further, that the flight instructor's assumption of control and his corrective action were delayed and inadequate.

It is believed that the flight instructor's fear of ground contact with the left wing, had he used more corrective rudder, was due most likely to the relatively small angle of roll permissible near the ground. However, in view of the rapidly developing yaw to the right, with consequent likelihood of ground contact, his fear of using full left rudder is improper in this situation. When he found that his rudder action did not stop the yaw, the flight instructor reapplied power on the No. 4 engine. He stated that this action stopped the yaw but ground impact occurred shortly thereafter.

Familiarization with the corrective techniques to be used in simulated critical-engine-out procedures, gained by the Board's investigators during the course of the investigation, showed that prompt application of full, or almost full, rudder is required to correct for yaw, and that aileron control in maintaining direction is also required.

The flight recorder heading trace shows that shortly after lift-off, a turn to the right began which, after 5.5 seconds, ended in a heading change of 56". It is evident that during this period, excessive sideslip developed which exceeded the limits of rudder controllability. In view of the excessive sideslip, rapid yaw rate, and low altitude, it is considered highly unlikely that recovery of aircraft control was possible at this point in time. The rapidity of the yaw rate clearly suggests minimal corrective rudder vas being applied before the yaw had progressed to excessive proportions. A constant rate of the yaw during this period further supports this.

Engine scrape marks and landing gear tire marks on the runway revealed that the aircraft was on a heading of 37" to the right of the runway heading and 18' to the right of its direction of travel at initial ground contact. As the aircraft left the runway, these marks showed the aircraft heading vas about 46° to the right of the runway heading and about 22° to the right of the direction of travel of the aircraft.

Convair performance data relating to the Convair 880M maximum rudder deflection for sideslip angle vs. airspeed show that at 130 KIAS, maximum rudder deflection will control up to a 10° sideslip, and at 140 KIAS, this capability is reduced to about 7° sideslip. Considering the sideslip angle of between 18° and 22° disclosed by the engine and landing gear marks at impact, the aircraft was at that time in a sideslip which was well beyond the limits of rudder controllability. According to the manufacturer's Engineering Production Flight Captain A. P. Wilson, at a 17° to 18° sideslip, the vertical stabilizer is subject to stall and directional control is lost. Captain Wilson further emphasizes that at low altitudes, it may be impossible to recover from such a condition, and he recommends a maximum allowable sideslip of 5°.

The manufacturer's Flight Manual for the Convair 880 and the Japan Air Lines Training Guide present adequate information with respect to basic control techniques during three-engine-approach operations and three-engine takeoffs at or after V_1. However, these manuals and those of other operators reviewed during the investigation of this accident did not provide specific information regarding the limits of rudder controllability, recommended maximum limits of sideslip angle allowable, and other information in the explanatory detail found in Captain Wilson's paper.

The increased engine power required as a result of one-half and one-ball sideslip angles, as demonstrated by tests accomplished in Convair 880 aircraft, showed that a one-ball sideslip increased the drag by an amount approximately equal to the thrust of one engine. Thus it was determined that the sideslip condition which was allowed to develop during the flight not only adversely affected rudder controllability, but also resulted in a substantial loss of aircraft performance as well. The company's policy of a .07 E.P.R. decrease in power (to increase engine life), was being complied with by the crew at the time of the accident. This derating of engine power, however, is not considered significant to the accident in view of the excessive sideslip and rapid rate of yaw which occurred just before impact.

In an effort to obtain greater accident prevention value from this accident, the Safety Board endeavored to determine the underlying influences that may have resulted in the instructor pilot's obvious delay in taking corrective action before the aircraft reached the critical sideslip from which recovery could not be effected.

The evidence indicates that the instructor was thoroughly familiar with the characteristics of the aircraft during the critical engine-out takeoff maneuver. He was not only experienced in the Convair 880, but he also had the reputation of being an excellent pilot and a good instructor. In addition, he had been an instructor in the aircraft for several months and, in this assignment, had given trainee pilots many critical engine-out maneuvers. Also, he had passed satisfactorily regular checks on his own proficiency.

As a factor in the delayed corrective action, consideration was given to the possible effect of the slow retardation of power on the timely recognition of the onset of the yaw moment. This consideration could have definite merit with respect to the trainee's response but not with regard to the instructor's delayed actions. The instructor knew he was reducing power and that he was doing it slowly. He therefore would be ready for a less decernible response of the aircraft, and, indeed, the slower reduction of power would afford him greater reaction time as compared to a more rapid power reduction.

Consideration was also given to the tendency of an instructor to delay corrective action to give the trainee a greater opportunity to respond to a given situation. This trainee pilot had had some difficulty in his training and the instructor was probably concerned about the trainee's progress. This is borne out to some degree by the instructor's reserved evaluation of the trainee, but more so by the fact that it was necessary to give the trainee an estimated 20 critical-engine-out maneuvers in about 12 hours of training. There is reason to believe the instructor was still concerned about the trainee's performance, and used the slow power reduction technique not to make the aircraft response more difficult to detect by the trainee, but to afford him greater opportunity to respond to the situation.

The Safety Board is of the opinion that the foregoing, in conjunction with an instructor's normal desire to assist the trainee reach his objective, and to afford him maximum opportunity to respond to a given problem situation, may have caused the instructor to delay taking corrective action until a point was reached where full recovery could not be effected.

2.2 Conclusions

(a) Findings

1. The aircraft was properly loaded, properly certificated, airworthy, and capable of normal operation.

2. All flight crewmembers were certificated and qualified for the flight involved in accordance with existing regulations.

3. Air traffic control, communications, navigation aids, airdrome, and weather conditions were not involved.

4. The operation proceeded without incident until takeoff, when the No. 4 power lever was slowly retarded to idle in order to simulate the loss of a critical engine after V_1, and prior to attaining V_2.

5. The yawing moment resulting from cutting a critical engine was not controlled by the trainee and resulted in an excessive sideslip and a high rate of yaw. Attempts by the instructor-pilot to regain control were too late to be effective enough to prevent the accident.

6. Proper corrective action required for yaw produced by the critical-engine-inoperative maneuver is the prompt application of full, or nearly full, rudder at the onset of yaw. Aileron control is also required to maintain directional control.

7. For training purposes, the slow reduction of power during a critical-engine-out maneuver may be an undersirable technique, because it may result in a delayed recognition of the onset of yaw or overcontrol when it is recognized.

8. A heading change of 56° in 5.5 seconds toward the simulated inoperative engine was recorded by'the heading trace shortly after lift-off. The rapidity of this heading change shows that corrective action6 by the trainee pilot and the instructor were delayed and inadequate.

9. The pronounced depression in the flight recorder airspeed trace between times 1:06 and 1:10, reflected a substantial loss in dynamic pressure recovered by the pitot head. This pressure loss indicated the existence of an excessive sideslip angle. Engine contact and tire skid marks showed a sideslip angle of between 18° and 22°.

10. According to data from the manufacturer, sideslip angles in excess of 18° will stall the vertical fin and render the rudder relatively ineffective for directional control.

11. According to the manufacturer, a sideslip angle in excess of 5" should not be permitted during the critical-engine-inoperative maneuver.

12. The Manufacturer's Convair 880 Flight Manual cautioned of the danger of permitting excessive yaw angles to develop during critical-engine-out takeoffs. The Japan Air Lines Flight Training Guide described control procedures for the maneuver.

13. These manuals provided basic information but could have been more definitive and explanatory with respect to the limits of rudder controllability and sideslip, as reflected in Captain A. P. Wilson's paper on the overall subject.

14. The aircraft was destroyed by impact with obstacles in the groundpath and fire, which broke out during. the ground slide.

15. Jamming of the aircraft exits and fire complicated and delayed crew egress from the aircraft. The accident was survivable, except for the occurrence of fire.

(b) Probable Cause

The Safety Board determines that the probable cause of this accident was the delayed corrective action during a simulated critical-engine-art takeoff maneuver resulting in an excessive sideslip from which full recovery could not be effected.

3. RECOMMENDATIONS

Based on this accident and others which have occurred under similar circumstances, the Safety Board recommends to the Administrator of the Federal Aviation Administration, that through his Air Carrier Inspectors, all operators of the Convair 880 and similar type aircraft be asked to take the following actions: (1) re-emphasize to the pilot personnel the characteristics of these aircraft during critical-engine-out maneuvers; (2) assure that flight instructors, trainees, and line pilots are well aware of safe and proper critical-engine-out procedures, the limits of sideslip angles, rudder availability, and yaw limits for vertical stabilizer stall; and (3) caution all instructor personnel to emphasize that they must be most careful to avoid any tendency to delay corrective actions too long during critical training maneuvers even though the purpose of the training flight is to check the actions of trainees who must have an opportunity to respond properly.

In connection with recommendation number 2, the Safety Board considers the paper written by Captain A. P. Wilson, Convair Engineering, Production flight, an excellent example of information, the essence of which should be included in training manuals and curriculums by all operators of large swept-wing four-engine turbojet aircraft of the Convair 880 type.

In addition to the foregoing, as the result of the several above-referenced accidents involving engine-out maneuvers, the Safety Board made other recommendations to the Administrator. These recommendations and the Administrator's response thereto are included as Attachment 1 of this report. At the present time, deliberations on the recommendations are continuing.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

/s/ JOHN H. REED
Chairman

/s/ OSCAR M. LAUREL
Member

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

June 17, 1970

Crew Information

Instructor Pilot Captain Kazuhiko (NMI) Suda, aged 37, holds JCAB Air Transport Rating No. 313, issued September 5, 1960, and Medical Certificate (Class I) No. 40335, valid until October 31, 1969. He holds JCAB 3rd Class Aeronautical Radio Operator Certificate No. 335, issued January 10, 1956, with Medical Certificate No. 31060, valid until October 31, 1969. Captain Suda was employed by Japan Air Lines on April 1, 1954, from the Civil Aviation College of Japan. His employment record showed he had been assigned as copilot on DC-4, -6, -7, and Convair 880 aircraft, and thereafter as captain on Convair 880 on August 2, 1963, and DC-8 captain January 10, 1966. He received his Instructor Pilot Rating on March 14, 1967. Company records show Captain Suda had accumulated a total pilot time of 7,613 hours. Of this total, 2784:28 hours were as captain, 4245:43 were as copilot, and 583:17 as instructor pilot, as of May 31, 1969. According to Captain Suda, his personal records reflect an additional 25:49 hours of CV-880 instructor time, making a total of 100:14 hours as a Convair 880 instructor at the time of this accident. Captain Suda stated he was assigned as a CV-880 instructor in December 1968, and acted in this capacity during January, February, and June 1969. During March, April, and May 1969, he was serving as a DC-8 captain and instructor. He was then assigned to the Convair 880 training program at Moses Lake, Washington. Captain Suda had received the following CV-880 instructor training in addition to line pilot training and experience: Simulator training at Delta Air Lines, Atlanta, Georgia --12 hours; flight training at Nagoya, Japan, December 28, 1968 --2 hours and 40 minutes; and at Moses Lake, January 7, 1969 --3 hours and 23 minutes. He received a pilot proficiency check on December 28, 1968, in the Convair 880, which included engine-out takeoff. The check pilot's comment on this flight stated: "In spite of the fact that this check ride was made after extended period since the last CV-880 check ride the proficiency shown by the checkee was outstanding." Company records show that during the 90 days prior to the accident, Captain Suda acquired 110 hours pilot experience, of which approximately 25 hours were in the CV-880.

Pilot Trainee Jyunichi Murata, aged 29, held JCAB Commercial pilot Certificate No. 2150, issued June 8, 1967. His Medical Certificate (Class I) No. 30818 was valid until October 31, 1969. He held JCAB 3rd Class Aeronautical Radio Operator Certificate No. 1954, issued October 25, 1967, with Medical Certificate No. 31260, valid until October 31, 1969. His JCAB Instrument Rating No. 937 was issued February 21, 1968. Mr. Murata was employed by Japan Air Lines on October 1, 1966, from the Japan Self Defense Air Force. Company records show he was assigned as a student pilot on April 1, 1967, and as a CV-880 copilot on February 22, 1968. These records show he had acquired 1763:06 pilot hours in the J.S.D.A.F. and 1010:14 pilot hours with Japan Air Lines. His total pilot time as of May 31, 1969, was 2773:20 hours. He was assigned to captain-promotion training on June 12, 1969. Mr. Murata's records show he had 827:17 copilot hours, including 32:22 for a CV-880 type rating. He had acquired

154:25 hours in the CV-880 in the previous 90-day period. An intermediate check on June 19, 1969, conducted by Captain Suda at the halfway point in this training, showed Mr. Murata was progressing at a rate of average to slightly below average and would require about 14 hours to complete the course at the required skill level. Programmed time is 12 hours. Instructor Pilot Captain Suda's evaluation indicated Trainee Murata tended to scan the instruments slowly, and it was necessary to remind him to cross-check for overall control of altitude, heading, and airspeed during maneuvers. In addition, he tended to rotate the aircraft too rapidly for takeoff, although this problem had been corrected on previous flights. The instructor's comment on the intermediate check follows: "O.K. for ATR check depending on the demands for left seat capability, judgment and planning is weak."

Flight Engineer Nobuhiro Uematsu, aged 31, holds JCAB Flight Engineer Certificate No. 173, dated November 7, 1963. His Medical Certificate No. 3233, was issued October 31, 1969. He also holds First-class Aircraft Maintenance Engineer Certificate No. 839, dated April 19, 1966. Mr. Uematsu was employed by Japan Air Lines on April 1, 1956. During the course of his employment, he was rated as a Flight Engineer in E-6, -8, and CV-880 aircraft, the latter rating issued February 7, 1967. On March 11, 1968, he was issued a Flight Engineer Instructor Rating. Company records show that Mr. Uematsu had accumulated a total time of 2948:13 hours as of May 31, 1969, of which 1,114 hours were in CV-880 aircraft.

Crew information concerning Pilot Trainees Kawase and Yoshida is included in the company's report.

Investigation and Hearing

1. Investigation

The National Transportation Safety Board received notification of this accident shortly after its occurrence. An investigation team composed principally of personnel of the Field Investigation Division of the Safety Board's Bureau of Aviation Safety was immediately dispatched to the accident scene. Working groups were established to investigate the accident in the areas of Operations, Powerplants, Systems, Structures, Maintenance Records, Human Factors, and Witnesses.

Participants in the accident investigation were representatives of the Japan Civil Aviation Bureau, Japan Air Lines, the Federal Aviation Administration, Convair Division of General Dynamics, Inc., and General Electric, Inc.

The on-scene phase of the accident investigation lasted approximately 10 days. The accident inquiry was conducted in accordance with the provisions of Annex 13 of ICAO (International Civil Aviation Organization).

2. Hearing

A public hearing was not held in connection with the investigation of the accident.

3. Preliminary Reports

There were no preliminary reports issued in connection with the accident.

DEPARTMENT OF TRANSPORTATION
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20591

December 18, 1969

OFFICE OF
THE CHAIRMAN

Honorable John H. Shaffer
Administrator
Federal Aviation Administration
Department of Transportation
Washington, D. C. 20590

Dear Mr Shaffer:

Since September 13, 1965, we have investigated five major air carrier accidents which occurred while conducting simulated engine(s)-out training close to the ground. These accidents have resulted in total destruction of the aircraft; all but one resulted in loss of life, while four resulted in serious damage and loss of life on the ground.

As pointed out in your Notice of Proposed Rule Making 69-14, issued March 28, 1969, other less hazardous means of accomplishing this type of training are now available.

Present generation flight simulators provide the capability for simulating virtually every flight situation, including controllability characteristics of specific aircraft in flight with one or more engines inoperative.

The Board believes that a very limited amount of proficiency training may have to be conducted under actual. flight conditions, despite the advanced simulator technology presently available. The degree of aircraft vulnerability and attendant hazards would be appreciably reduced if such maneuvers were to be conducted at a safe altitude above the terrain. Should an actual failure of a critical system occur under these conditions, safe recovery could most likely be effected without actual derogation of the training value.

We are also concerned with another factor which may be detrimental to safety during training flights. The analysis of several training accidents disclosed that an additional crewmember had participated in the malfunction analysis and remedial actions taken by the crew. We do not question the additional crewmember's qualifications in any of these situations, but we do question whether his participation appreciably contributed to the crew's training and efficiency. In fact, one of our investigations indicates that the presence of the additional crewmember may have distracted the pilot at a critical time.

In addition to our comments forwarded to you regarding proposed changes to Federal Aviation Regulations Parts 61 and 121, as outlined in Notice of Proposed Rule Making 69-14, the Board recommends the following regulatory changes:

1. A21 maneuvers requiring simulated engine(s)-out operation of aircraft close to the ground should be conducted in and, to the maximum extent possible, limited to flight simulator training devices.

2. The Administrator should establish a minimum altitude above the terrain for those simulated engine(s)-out maneuvers which must be performed in flight.

3. Equally qualified crewmembers not directly involved in the training operation should be prohibited from the flight deck area on all proficiency flight checks.

The areas of concern have been discussed by personnel of our staff with your FS-452 staff.

Sincerely yours,

Original signed by
John H. Reed

John H. Reed
Chairman

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF
THE ADMINISTRATOR

30 DEC 1959

Honorable John H. Reed
Chairman, National Transportation Safety Board
Department of Transportation
Washington, D. C. 20591

Dear Mr. Chairman:

Thank you For your letter of 18 December 1969, concerning air carrier accidents involving simulated engine-out training.

Although the state-of-the-art of aircraft simulation provides, as you say, the capability for simulating almost all training maneuvers, an adequate visual system .is required to simulate maneuvers such as engine failure on takcoff and the circling approach to landing. A very limited number of these simulators are in use today.

X believe you would agree that the regulatory history shows increasing training credit for aircraft simulators as the stat@-of-the-arthas advanced. Beginning as early as July 1955, the Civil Aeronautics Administration initiated action which led to adoption of a regulation on 15 March 1957, which permitted the air carriers to substitute an approved simulator course for one of the required semi-annual pilot proficiency checks. This rule was subsequently amended so that only certain low altitude maneuvers need be accomplished in an airplane during the alternate proficiency check (e.g., ILS approach, engine failure on takeoff, circling approach), provided the balance of the required maneuvers were cocducted in an approved aircraft simulator. More recently, regulations became effective on 15 April 1967, which for the first time allowed certain emergency maneuvers to be conducted in a simulator for the aircraft type rating check. On 1 Nay 1968, the rules were amended to change *the* in-flight requirements for turbojets relative to the approach and landing maneuver with the simulated failure of 50 percent of the available powerplants.

Simulating an engine failure during takeoff at altitude is not a satisfactory substitute for accomplishing the maneuver in an airplane during an actual takeoff or in a visual simulator since, when done at altitude, the realism of an actual engine failure during takeoff is lost. Recent amendments to Parts 61 and 121 of the Federal Aviation Regulations permit this maneuver to be conducted during type rating and proficiency checks, in a simulator with an approved visual system which should encourage the air carriers to procure these systems. Since airplane performance is based on engine failure during takeoff, we must ensure that pilots can safely handle an engine-out situation during regular operations. The same rationale also applies to the engine-out missed approach. However, the recent amendments allow the person conducting the check the option of giving the pilot being checked either an all-engine missed approach or an engine-out missed approach, which has the advantage of introducing the element of surprise when the latter maneuver is given.

The amendments further provide for flight training and a flight check in an airplane simulator to the pilot in command or second in command level of proficiency, as appropriate, before the trainee advances to the actual airplane. Thus, the rule contemplates a thorough knowledge of each required maneuver and procedure and a predetermined level of skill prior to performing them in actual flight. Therefore, the performance of the maneuvers and procedures by the trainee on a one-time basis in the airplane during iaitial or transition flight training is, in practiccl effect, a determination that the proper transfer of learning from the simulator to the airplane has been achieved.

Although as you point out, one accident may have involved distraction of the pilot by an additional crewmember on the flight deck, there have been other cases during training flights where an additional crewmember has alerted the pilot to an unsafe condition. Flight training of crewmembers is usually accomplished in pairs so that each pilot may observe the other during their respective periods of flight instruction. Such training is highly desirable and advantageous to the pilots involved. Nevertheless, we will advise our Principal Operations Inspectors to see to it that their assigned air carricro have issued adequate instructions to ensure 'that other crewmembers on the flight deck do not interfere with the performance of the operating crewmembers during training flights.

Your interest in this matter is appreciated.

Sincerely,

D. D. Thomas

D. D. Thomas
Acting Administrator