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AIRCRAFT ACCIDENT REPORT

PAN AMERICAN WORLD AIRWAYS, INC.

BOEING 707-321C, N458PA,

BOSTON, MASSACHUSETTS

NOVEMBER 3, 1973

ADOPTED: DECEMBER 2, 1974

NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D.C. 20591

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16. Abstract At 0939 e.s.t., November 3, 1973, Pan American World Airways, Inc., Boeing 707-321C (N458PA) crashed at Logan International Airport, Boston, Massachusetts. The airplane was destroyed, and its three crewmembers were killed. The National Transportation Safety Board determines that the probable cause of the accident was the presence of smoke in the cockpit which was continuously generated and uncontrollable. The smoke led to an emergency situation that culminated in loss of control of the aircraft during final approach, when the crew in uncoordinated action deactivated the yaw damper in conjunction with incompatible positioning of flight spoilers and wing flaps. The Safety Board further determines that the dense smoke in the cockpit seriously impaired the flightcrew's vision and ability to function effectively during the emergency. Although the source of the smoke could not be established conclusively, the Safety Board believes that the spontaneous chemical reaction between leaking nitric acid, improperly packaged and stowed, and the improper sawdust packing surrounding the acid's package initiated the accident sequence. A contributing factor was the general lack of compliance with existing regulations governing the transportation of hazardous materials which resulted from the complexity of the regulations, the industrywide lack of familiarity with the regulations at the working level, the overlapping jurisdictions, and the inadequacy of government surveillance.			
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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D. C. 20591

AIRCRAFT ACCIDENT REPORT

Adopted: December 2, 1974

PAN AMERICAN WORLD AIRWAYS, INC.
BOEING 707-321C, N458PA
BOSTON, MASSACHUSETTS
NOVEMBER 3, 1973

SYNOPSIS

At 0939 e. s. t., November 3, 1973, Pan American World Airways, Inc., Clipper Flight 160, a Boeing 707-321C (N458PA) crashed at Logan International Airport, Boston, Massachusetts. The aircraft was destroyed, and its three crewmembers were killed.

About 30 minutes after Clipper 160, a cargo flight, departed John F. Kennedy Airport, New York, the flightcrew reported smoke in the cockpit. The flight was diverted to Logan International Airport where it crashed just short of runway 33 during final approach.

The National Transportation Safety Board determines that the probable cause of the accident was the presence of smoke in the cockpit which was continuously generated and uncontrollable. The smoke led to an emergency situation that culminated in loss of control of the aircraft during final approach, when the crew in uncoordinated action deactivated the yaw damper in conjunction with incompatible positioning of flight spoilers and wing flaps.

The Safety Board further determines that the dense smoke in the cockpit seriously impaired the flightcrew's vision and ability to function effectively during the emergency. Although the source of the smoke could not be established conclusively, the Safety Board believes that the spontaneous chemical reaction between leaking nitric acid, improperly packaged and stowed, and the improper sawdust packing surrounding the acid's package initiated the accident sequence.

A contributing factor was the general lack of compliance with existing regulations governing the transportation of hazardous materials which resulted from the complexity of the regulations, the industrywide lack of familiarity with the regulations at the working level, the overlapping jurisdictions, and the inadequacy of government surveillance.

As a result of the accident, the Safety Board has made 16 recommendations to the Administrator of the Federal Aviation Administration (FAA). (See Appendix I.)

I. INVESTIGATION

1.1 History of Flight

Pan American World Airways Clipper Flight 160 was a scheduled cargo flight from John F. Kennedy International Airport (JFK), New York, to Frankfurt, Germany, with a scheduled stop at Prestwick, Scotland. At 0825 e. s. t. ^{1/} the flight departed JFK. The aircraft was carrying 52,912 lbs. of cargo, 15,360 lbs. of which were chemicals.

The flightcrew consisted of a captain, a first officer, and a flight engineer. The captain neither received nor signed written notice of the amount and type of restricted articles ^{2/} he was carrying as required by Federal Aviation Regulations.

After departure, Clipper 160 was vectored on course while climbing to flight level 330 (FL 330). At 0844, Clipper 160's clearance was amended, and it was instructed to maintain FL 310 as a final cruising altitude. Clipper 160 reported level at FL 310 at 0850. As the flight approached Sherbrooke VORTAC ^{3/} 100 miles east of Montreal, Canada, at about 0904, it advised Pan American Operations (PANOP) in New York that smoke had accumulated in the "lower 41" electrical compartment, and that the flight was diverting to Boston.

At 0908, Clipper 160 advised Montreal Center that they were level at FL 310 and wanted to return to JFK. Montreal Center cleared Clipper 160 for a right turn to a heading of 180°.

At 0910, Clipper 160 advised PANOP that it was returning to New York and that the smoke seemed to be "getting a little thicker in here."

^{1/} All times used herein are eastern standard, based on the 24-hour clock.

^{2/} The terms "restricted articles," "dangerous articles," "hazardous materials" are used on an interchangeable basis in this report, depending upon the document, organization, or source under discussion at the time.

^{3/} Collocated VOR (very high frequency omnirange station) and the TACAN (ultra-high frequency tactical air navigational aid).

At 0911, the crew advised PANOP that they were now going to Boston and that "this smoke is getting too thick." They also requested that emergency equipment be available when they arrived at Boston. During this conversation, the comment was made that the "cockpit's full back there."

During its return to Boston, the flight was given preferential air traffic control treatment, although it had not declared an emergency.

After issuing appropriate descent clearances en route so that fuel could be burned off more rapidly at lower altitudes, at 0926:30 Boston Center advised Boston Arrival Radar (AR-2) that the flight was at 2,000 feet. At 0929, Clipper 160 asked Boston Center for the flight's distance from Boston, and added, "The DME's don't seem to be working." The Center answered, "You're passing abeam, Pease Air Force Base, right now, sir, and you're about 40 to 45 miles to the northwest of Boston." The first communication between Clipper 160 and AR-2 was at 0931:21. The flight was cleared "direct Boston, maintain 2,000." AR-2 asked if the flight was declaring an emergency; the reply was "negative on the emergency, and may we have runway 33 left?" The AR-2 controller approved the request, and the flight proceeded to Boston as cleared. At approximately the same time, the captain instructed the crew to "shut down everything you don't need."

At 0934:20, AR-2 asked, "Clipper 160, what do you show for a compass heading right now?" Clipper 160 answered, "Compass heading at this time is 205." AR-2 then asked, "will you accept a vector for a visual approach to a 5-mile final for runway 33 left, or do you want to be extended out further?" The crew replied, "Negative, we want to get it on the ground as soon as possible."

At 0935:46, the AR-2 controller stated, "Clipper 160, advise anytime you have the airport in sight." Clipper 160 did not reply. At 0937:04, the AR-2 controller made the following transmission: "Clipper 160, this is Boston approach control. If you read, squawk ident on any transponder. I see your transponder just became inoperative. Continue inbound now for runway 33 left, you're No. 1. There is a Lufthansa 747 on a 3-mile final for runway 27, the spacing is good. Remain on this frequency, Clipper 160."

At 0938:31, the AR-2 controller, who was talking to another flight, stated: ". . . this Clipper has lost his transponder and nobody's working him, and he's been given a clearance to land in the blind. He's just about 4 miles east of Boston now."

At 0940:23, the AR-2 controller transmitted the following message: "All aircraft on the frequency, the airport is closed at Boston." The AR-2 controller transmitted the message, because ATC personnel had seen Clipper 160 crash. Witnesses saw the left cockpit window open and smoke come through the window. Aeronautically qualified witnesses saw the aircraft approach runway 27 at a faster-than-normal speed and saw it enter roll and yaw maneuvers. These maneuvers increased in severity until the aircraft assumed a final nose-high attitude. The nose-high attitude was followed by an abrupt nosedown attitude, and the left wing and nose contacted the ground simultaneously. The aircraft was nearly vertical at impact.

1.2 Injuries to Persons

<u>Injuries</u>	<u>Crew</u>	<u>Passengers</u>	<u>Other</u>
Fatal	3	0	0
Nonfatal	0	0	0
None	0	0	

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

An approach light structure was extensively damaged by the aircraft and fire.

1.5 Crew Information

The captain, first officer, and flight engineer were qualified and certificated according to Federal Aviation Administration (FAA) regulations. (See Appendix B.)

1.6 Aircraft Information

The aircraft was certificated and maintained according to FAA regulations. (See Appendix C.) The aircraft's gross weight at takeoff was 293,872 lbs., which was below the maximum allowable takeoff weight and was within the allowable center of gravity limits.

1.7 Meteorological Information

Clipper 160 received the following weather information: 4,000 feet scattered, visibility - more than 15 miles, altimeter - 29.73 in., wind - 290° at 18 kn.

1.8 Aids to Navigation

Not applicable.

1.9 Communications

Communications between Clipper 160 and ground facilities were normal until 5 minutes before impact, when the flight's response to AR-2 advisories ceased. At 0914:25.5, when Clipper 160 contacted Boston Center, the first officer asked the Center to keep him on the same frequency, 126.65 MHz, because "it's too hard to change." Boston Center approved the request. At 0937:04, the AR-2 controller lost the secondary radar return from the aircraft's transponder. The primary radar target was received on the AR-2 radarscope until the recorded time of impact.

Although examination of the aircraft's communications and navigation equipment disclosed that the No. 1 transponder was set at code 7700, the code was never received by an air traffic facility.

1.10 Aerodrome and Ground Facilities

Not applicable.

1.11 Flight Recorders

N458PA was equipped with a Lockheed Aircraft Services Model 109C flight data recorder (FDR), serial No. 1266. The flight recorder was recovered after the accident and did not exhibit mechanical damage; some evidence of smoke was noted. The unit's interior and recording mechanism were clean, undamaged, and had not been exposed to heat. The aluminum recording foil was not damaged. All parameters had been recorded, and there was no evidence of a malfunction or abnormality.

The readout, which covered 34 minutes 10 seconds of flight, began when the aircraft was at FL 310 and on a northerly heading. The readout stopped when all recorded traces ended in severe aberrations.

The readout included altitude, indicated airspeed, magnetic heading, vertical accelerations, and radio transmissions from the aircraft to ground stations. The readout is plotted in Appendix D. The FDR was installed in the unpressurized section of the tail.

The aircraft was also equipped with a Fairchild Model A-100 cockpit voice recorder (CVR), serial No. 281. Light to moderate heat damage and heavy sooting were found on the recorder's outer case. The tape was not damaged and was transcribed. (See Appendix E for complete CVR transcript.) The CVR was installed in the pressurized section of the tail, just forward of the pressure bulkhead.

1.12 Aircraft Wreckage

The aircraft struck the ground about 262 feet from the right edge of the approach end of runway 33. Sections of the left leading edge flaps and the No. 2 engine starter and constant speed drive were located forward of the initial impact point. The empennage, complete with the flight controls, separated from the fuselage near fuselage station (FS) 1440 and came to rest on the right side of the approach end of runway 33. Except for the areas destroyed by fire, all control surfaces and tabs were intact and movable. The rudder power unit attach brackets were intact. All control cables aft of the pressure bulkhead were also intact. (See Appendix F.)

The stabilizer jackscrew was set at about 1.5 units aircraft noseup. Both cables to the jackscrew drum were separated forward of the pressure bulkhead.

Although about 90 percent of the wings and associated control surfaces were recovered, the positions of the ailerons and spoilers at impact could not be determined because of impact damage. The inboard, outboard, and fillet flap jackscrews were in the 50° (full down) position. All leading edge device actuators were in the extended position. The main and nose landing gear actuators were in the "gear down" position.

The compressor blades on the four engines, which remained attached to the compressor rotors, were bent opposite the direction of normal rotation. The compressor and turbine cases on the engines were twisted. The front compressor (N₁) rear hub had broken away from the N₁ turbine shaft on all engines. None of the four engines failed or malfunctioned in flight.

Examination of the electrical power generation and distribution system disclosed that the Nos. 1, 2, and 3 generators and the Nos. 1, 2, and 3 bus tie breakers were closed. The essential power selector switch was in the "external power" position. The battery switch was in the "off" position. The generators were connected mechanically to their drive units.

Although the captain's and first officer's attitude and heading indications are operable from either of two separate power sources, both units were found at the same general magnetic heading indications of 200° and 210°, respectively. The approximate impact heading was 210°.

Both engine turbocompressor shutoff valves were closed. The main cabin hot-air valve was also closed, but the back-pressure valve was open. Two valves, which were identified by part numbers as pack valves, were also recovered. One of these was open, and the other was closed.

The aircraft's electrical system and components disclosed no evidence of in-flight fire or preimpact overload or overheat conditions.

The engine fire extinguishing system's components were examined. Two of the extinguishing agent bottles remained charged to 600 and 625 lb/in²g. One bottle was damaged during impact, and one bottle was not recovered. No evidence was found to suggest that the aircraft's fire extinguishing system was used in flight.

Recovered oxygen system components disclosed that required oxygen was on board the aircraft; however, the functional capability of the system or the degree to which the system had been used during the emergency could not be determined. The CVR transcript indicates that the flightcrew donned oxygen masks during the emergency. There was no evidence to suggest that the walk-around oxygen bottle had been used.

VHF radio frequencies were set at 120.60 and 128.70 MHz for communications and at 112.70 and 110.70 MHz for navigation.

The captain's altimeter was not recovered. The first officer's altimeter was set at 29.75 in. and 1007.5 mbar.

The captain's HZ-6A attitude indicator sphere was about 45° left wingdown and at a pitch attitude of 20° to 30° nosedown. The first officer's attitude indicator sphere was about 45° left wingdown and at a pitch attitude of 30° nosedown.

Both central air data computers were examined. The No. 1 computer indicated airspeed (IAS) module was damaged extensively. The MACH module gear train was in the "low stop" position. The unit is designed to move to this position when electrical power to the unit is terminated. The altitude module gear train was also damaged; the cam follower was positioned near the "low stop," or a "below sea level" indication. The unit is also designed to move to this position when electrical power is terminated.

The No. 2 computer was recovered. It had been damaged slightly by impact and salt water. The IAS potentiometer was in a position equivalent to a 150 to 160 KIAS indication. The actuating cam also indicated 150 KIAS. The altitude followup assembly was at "sea level."

1.12.1 Cargo Recovered

The cargo loaded in the aircraft's cabin was carried on 13 88-in. by 125-in. metal pallets, 2 of which incorporated fiberglass contoured covers (igloos). Other palletized material was covered with semitransparent plastic sheets before it was strapped to the pallets. The shipments were packed on pallets by Pan American personnel, except for the igloo pallets in positions 11 and 12, which were packed by the Emery Airfreight Corporation. The cargo included merchandise, machinery, equipment, mail, and restricted articles. Except for the restricted articles, no other spontaneously reactive materials were found in the palletized cargo.

The restricted articles were loaded on four pallets which were placed into the aircraft at pallet positions 1, 6, 7, and 9. (See Appendix G.) The various chemicals were not segregated from each other or from other articles being shipped.

According to cargo loading personnel, the cargo on pallets 1, 6, 7, and 9 was arranged to provide the required crew access to the hazardous cargo.

The cargo pallets used by Pan American were given serial numbers. After each pallet was loaded, its serial number and its position in the airplane were recorded.

The cargo-carrying portion of the aircraft was demolished and the cargo was scattered along the shoreline and in the waters of Boston Harbor. During the crash, the pallets were thrown from the aircraft. Most cargo was thrown free of the pallets, except part of that cargo on pallet 13, and one container of nitric acid trapped in the cargo net on pallet 7. Some cargo had floated a considerable distance from the accident site.

Most of the mail and other cargo in the aft cargo compartments remained in place. The cabin floor above the mail was burned away. There were no chemical reactions on the mail that was recovered. Several mail bags recovered from the water smelled like jet fuel.

1.13 Medical and Pathological Information

The three crewmembers were killed in the crash. Toxicological tests on the deceased disclosed no evidence of carbon monoxide, hydrogen cyanide, alcohol, or drugs.

1.14 Fire

At 0925, the Massachusetts Port Authority Fire Department was alerted to stand by for Clipper 160, because Clipper 160 had a fire warning indication in the No. 4 cargo hold. The Fire Department was not advised that the aircraft was carrying restricted cargo. Consequently, during the firefighting activity, the firefighters were not aware of the hazardous cargo aboard the flight.

The fire equipment was positioned to respond to a landing on runway 33; however, shortly before the crash, the fire equipment was repositioned for a runway 27 landing. Four pieces of airport fire equipment responded to the accident. After impact, fire personnel began to apply extinguishing agent to the fire within 30 seconds. Except for the fire at the approach light pier, the fire was in complete control within 2 minutes. To assist in fighting the fire, city fire units were requested. They arrived at the accident site within 7 minutes after the accident. The city force, which included a fire boat, concentrated its efforts on the pier fire, which required more than 1 hour to contain. About 20,000 gallons of water and 1,200 gallons of foam were used.

There was evidence of ground fire on the right side of the cockpit and inside and below the J-6 electrical panel. Examination of the exterior fuselage skin disclosed a soot trail leading from the left cockpit sliding window area upward and rearward over the cockpit area fuselage skin. The left sliding window, itself, disclosed no evidence of fire

or sooting. Its locking handle was in the unlocked position. The copilot's sliding window had been damaged by ground fire. Its locking handle was also in the unlocked position.

There was no evidence of in-flight fire in the cockpit area or lower 41 section of the aircraft. There was evidence of sooting on the aft side of the floor beams, near the air outlet from the cabin to the lower 41 compartment, and on the access door grill leading from the lower 41 compartment to the cockpit.

There was a heavy black soot deposit on the inside fuselage side panels, aft of the crash net and above the floor line. The equipment cooling air exhaust port and the forward lavatory vent port exhibited soot trails going aft on the exterior of the fuselage.

There was severe fire damage to the fuselage skin between stations 960M and 980, from 12 in. below the floor line to 24 in. above the floor line on the right side of the fuselage. A large, intergranular crack and buckles to the fuselage structure were evident at FS 960N and progressed through a rivet line starting at WL 197, then up 10 in. From this point, the crack followed a rivet line aft to FS 980. A Safety Board metallurgist reported that:

"The extent and characteristics of these fractures and deformations suggested that they were produced by impact forces after they were heated near or above 1,000° F."

A Boeing Company metallurgist examined the same area; he reported:

"The right-angle fracture within the R. H. Body Station 960N Skin-Stiffener panel occurred while the material was at temperatures within the eutectic melting range of 935° to 1,180° F for the 2024 Fuselage Skin."

1.15 Survival Aspects

This was not a survivable accident.

The smoke goggles used by Pan American World Airways were examined. The goggles were found to fit loosely around the temporal region of the head, especially if the crewmember is wearing glasses. The goggles were rigid and would not mold readily to facial contours.

1.16 Tests and Research

1.16.1 Smoke Evacuation Tests

During March and April 1963, tests were conducted to certify the Boeing Commercial Transport Model 707-321C. These tests were made "... to demonstrate the ability of the Sta. 382 crew rest curtain and the passenger/cargo divider to exclude hazardous quantities of smoke from entering the crew and passenger compartments and to demonstrate the upper cargo area Fyr-Fyter type A1-V smoke detector installation."

The testers assumed that the smoke source could be terminated by shutting off airflow to the compartment from which the smoke was being generated. At that time, the possibility of a self-oxidizing agent being the source of smoke or fire was not considered.

From March 5 through March 9, 1974, the Boeing Company conducted smoke evacuation tests using two 707 aircraft and personnel furnished by Pan American. These tests were made to evaluate smoke evacuation and smoke penetration characteristics of a Boeing 707-321C convertible airplane and those of a 707-321C "stripped freighter."

Only oil smoke was used. Two "cloud makers" were used alternately to generate smoke for as long as 1 hour 15 minutes. Before conducting the first test, airflow at various locations was checked. Airflow at the top of the cargo liners averaged about 10 fpm with little indication of flow at the return air grilles. Flow from holes for electrical plug access in the liner on the left side of the cargo compartment averaged 150 fpm. Flow at the smoke chute was 25 fpm.

During cruise at 30,000 feet, puffs of smoke were generated in the forward and aft ends of the main deck cargo compartment. The smoke moved aft, but usually dissipated and went down the return air grilles. Smoke generated at the chute, hovered, and moved slowly down the chute; some drifted aft. Dense smoke was generated in the cockpit to evaluate the smoke goggles. The smoke was rapidly cleared through the sextant port. During normal cruise, smoke was generated 3 feet aft of the smoke barrier. The generator was pointed rearward. Within 5 minutes, there was a gradual buildup of smoke in the crew rest area. The barrier door was opened to simulate generation in the galley and lavatory areas. After 15 minutes, there was no smoke in the cockpit, but it was very dense in the crew rest area. The equipment blower was turned off, and 4 minutes later, the electrical equipment (E/E) dump valve was opened. When the valve

was opened, a light haze formed in the cockpit, and the density of the smoke in the crew rest area increased. The dump valve was closed, the blower was turned on, and the cockpit cleared. The aircraft was descended to 15,000 feet, and the Class-E fire checklist was performed while the E/E dump valve was open. The aircraft was then descended to 3,000 feet, and a simulated approach was conducted. During the descents and stabilized flights at 15,000 and 3,000 feet, various smoke evacuation procedures were accomplished.

Usually, the crew rest area barrier allowed some smoke to leak through during normal cruise, but the dense smoke from the crew rest area did not enter the cockpit unless the E/E dump valve was open. Only a small quantity of smoke entered the cockpit. Unpressurized, with ram air ventilation, with wing root valves closed, and with one turbocompressor on, smoke did not enter the cockpit as long as the lower 41 access door was covered with a temporary cover plate. It was questionable whether crew auxiliary heat was also necessary to prevent infiltration. Smoke was very dense in the lower 41 section.

As a result of the information obtained from the above flight tests, depositions were taken from Boeing Company personnel, from Pan American personnel who participated in the tests, and from FAA personnel who were involved in developing and approving current smoke evacuation procedures.

Subsequent to the flight tests, the FAA Northwestern region communicated to the Boeing Company, a concern that the PA-160 cockpit voice recorder showed that the crew followed the smoke evacuation procedures specified in the 707 Airplane Flight Manual for pressurized flight. It was further stated by the same FAA sources that in contrast to the 707-121 initial certification flight tests, large quantities of smoke did enter the cockpit. Air flow through the cockpit floor in the case of PA-160 was the reverse of that during the aforementioned 707-121 flight tests. (See Appendix J.)

The Boeing Co. was advised by FAA that a program was being initiated to review all aspects of airplane fire/smoke protection and to develop, where necessary, new and improved criteria.

In response to FAA's communication, Boeing disagreed with FAA and stated that they believed it could not be determined from the (PA-160) voice recorder whether the smoke evacuation procedures were followed. (See Appendix J.)

In describing the results of the March 1974 flight tests, the Boeing Company agreed that airflow was observed to move downward through the barrier smoke chute into the lower 41 compartment and that previous testing with smoke sources exterior to the cockpit, i.e., Class B cargo, passenger cabin or lower compartment 41, had assumed smoke source identification and extinction before smoke evacuation.

Based on the March 1974 flight tests results, The Boeing Company arrived at the following conclusions and recommendations aimed at providing greater assurance of satisfactory smoke evacuation from all cargo configured 707 airplanes in the presence of a continuous smoke source:

1. Minor revisions in the procedures should be made to assure maximum inflow of clean air to the cockpit, particularly at low engine power conditions such as during approach.
2. The addition of a means of closing the lower 41 compartment grill in the cockpit floor, which provides venting to avoid pressure differential between the cockpit and the lower 41 compartment, would assure that the clean air being supplied to the cockpit will flow outward through the miscellaneous openings through which smoke would otherwise enter the cockpit.
3. In the case of a continuous source of heavy smoke, the smoke curtain/barrier installation which separates the crew rest area (immediately aft of the cockpit) from the cargo area, will not preclude entry of some smoke into the crew rest area over an extended period of time, particularly if the curtain has not been maintained in good condition or is improperly installed. Investigation of other means preventing or accommodating smoke in this area appears warranted. (Note however, that during the flight testing of the stripped cargo aircraft, even when the aircraft was flown at slow speeds with the nose gear extended, smoke did not enter the cockpit in hazardous quantities when current Class E Procedures were followed). Boeing has also indicated that design studies had been initiated to investigate measures to provide a separate source of fresh air flow into the crew rest area, or to provide the occupants of this area with oxygen and smoke masks equivalent to those which are supplied to the flightcrew in their duty stations. (See Appendix J.)

1. 16.2 Test of Leaking Nitric Acid

Numerous hazardous materials on Clipper 160 had not been packaged according to regulations. Nitric acid was one. 49 CFR 173.268 requires that nitric acid bottles "be placed in tightly closed metal containers, and well cushioned therein on all sides with incombustible mineral packing material, such as whiting, mineral wool, infusorial earth (kieselguhr), asbestos, sifted ashes, or powdered china clay, etc. The metal container must be packed in outside containers and well cushioned by incombustible mineral packing material as described in this section."

The nitric acid bottles were found packed in marked wooden boxes and were cushioned by sawdust. There were no inside metal containers. On November 13, 1973, tests were conducted to determine the effects of leaking nitric acid.

Tests conditions:

Wind Velocity	11 kn.
Temperature	54° F.
Dew Point	31° F.

Packing materials recovered were air-dried. The packing material was then used to repack a bottle of nitric acid. The bottle cap was in place, but completely loose--no threads were engaged.

The box into which the bottle had been packed was then inverted, and the time recorded as 0:00 minutes.

The following observations were made:

<u>Time Lapse</u>	<u>Reaction</u>
7 min:	Bluish-white smoke was observed from around the lower surface on the container.
11 min:	The smoke downwind had an odor similar to that of burning wood.
13 min:	The white smoke flared profusely around the box and was orange momentarily.
15 min:	The quantity of smoke reduced.

<u>Time Lapse</u>	<u>Reaction</u>
17 min:	The odor of the smoke was similiar to that of burning wood.
19 1/2 min:	Flames were visible near the bottom of the box.
21 1/2 min:	Flames penetrated the top of the container.

The ground on all sides of the nitric acid box was sooted heavily. (See Appendix I.)

1.16.3 Analysis of Chemicals

In order to establish positive identification of the chemicals and associated packing materials carried on board Clipper 160, an analysis of these materials was made. The contents of the packages were chemically tested and were found to be as indicated on the labels on the inner containers.

1.16.4 Test Conducted by the United States Naval Research Laboratory

At the request of the Safety Board, the U.S. Naval Research Laboratory was requested to conduct tests and analyze soot samples which were found on aircraft debris after the accident. Specifically, the laboratory was asked to determine if traces of nitrates were present in the soot and if the soot that was not burned during the ground fire differed from the soot which was burned during the ground fire.

Mass Spectrometer tests showed organic molecules with at least six chlorine atoms in the soot which had not been exposed to ground fire. The chemical analyses attributed the chlorine atoms to polyvinyl chloride (PVC), which is used in the cabin interior lining. Test by Scanning Electron Microscope and Mass Spectrometer did not identify any soot which contained chlorine on the specimens which had been exposed to the ground fire. The tests did not identify any nitrates.

1.17 Handling of Air Cargo

1.17.1 Items of Restricted Articles on Board Clipper 160

Article	Dot Classification	Max Quantity Per Package	DOT Applicable Packaging-Fed. Regulations	No. of Boxes Shipped
Butyl Acetate, (normal) Shipper classified as combustile liquid (IATA)				
Poisonous liquids N.O.S. (stripping solution A-20)	Poison B	55 gal.	49 CFR 173.346	1
Isopropanal	*Flammable Liquid	10 gal.	49 CFR 173.119	10
Hydrogen Peroxide (containing more than 8% hydrogen peroxidé)	Corrosive	1 gal.	49 CFR 173.226	16
Xylene	*Flammable Liquid	10 gal.	49 CFR 173.119	4
Acetone	*Flammable Liquid	10 gal.	49 CFR 173.119	10
Nitric Acid	Corrosive	5 pints	49 CFR 173.268	160
Methanol	*Flammable Liquid	10 gal.	49 CFR 173.125	3
Hydroflouric Acid	Corrosive	10 pints	49 CFR 173.264(a)	50
Sulfuric Acid	Corrosive	10 pints	49 CFR 173.272	60
Acetic Acid, Glacial	Not regulated	10 gal.	49 CFR 173	9

* Classification depends on actual flashpoint of material being shipped.

1.17.2 Regulations on Shipment of Restricted Articles By Air

a. Federal Regulations

At the time of the accident, 14 CFR 103, "Transportation of Dangerous Articles and Magnetized Materials," governed the shipment of restricted articles by air.

The regulations incorporated sections of 49 CFR 170 through 178, which apply to packaging, labeling, and transporting hazardous materials before shipping by air.

Generally, the same regulations that applied to rail express transportation of hazardous material shipments applied to air transportation as well. The Federal Aviation Administration and The Bureau of Motor Carrier Safety were responsible for enforcement of the regulations. However, it could not be established which agency was responsible for enforcement of specific regulations during the packaging and moving of the shipment from the manufacturer to the carrier.

b. International Air Transport Association (IATA) Regulations

The IATA's Restricted Articles Board has developed rules relative to the carriage of restricted articles by International Air Carriers. Although the IATA regulations have no legal standing in the United States and many other countries, they are used widely as a guide for packaging and shipping restricted articles internationally.

c. Pan American's Procedures

Pan American World Airways, Inc., uses a "cargo traffic manual" to incorporate and interpret IATA and Government regulations on handling restricted articles. The manual includes company policy and procedures and serves as a guide for personnel who accept, handle, and process restricted articles. There is no formal program to assure compliance with these procedures.

1. 17. 3 History of Restricted Articles On Board Pan American Flight 160

The chemicals which were placed on board Clipper 160 were manufactured by the Allied Chemical Corporation in New Jersey and California. The shipper of record was the National Semiconductor Corporation (NSC) of Santa Clara, California.

P. Calahan Inc., Interamerican Freight Forwarding Corporation, Lyon-Commercial Export and Packing Division, Burlington Northern Airfreight, Trans World Airlines, The Seven Santini Brothers, and Pan American World Airways, subsequently became involved in handling the restricted articles. The histories of their involvement follow:

a. Allied Chemical Corporation (ACC), California and New Jersey

The periodic orders for chemicals for NSC in Scotland began about September 24, 1973. Original contacts with Allied personnel were made by NSC.

NSC advised Allied personnel that shipments were to be made by air, and inquired about an exporter/repacker who could assist in handling the air shipments. The office manager for Allied tried to work out an arrangement with a chemical firm to repack some of the items which were not legal size for air shipment. However, the firm contacted was not interested.

On October 25, purchase orders from NSC, Santa Clara, California, were sent to Morristown, New Jersey, from Allied Chemical Company's office in Los Angeles. Allied Chemical Company personnel were aware that the chemicals would be transported by air, but advised NSC that they would be packaged for surface export. The order was to be picked up by buyer's truck. This was changed and arrangements were made to have the articles destined for the east coast moved by P. Calahan, Inc., a trucker on an "exclusive-use" basis. Calahan moved it directly to the facilities of the Seven Santini Brothers, a repacking and trucking facility in Maspeth, New York.

b. National Semiconductor Corporation, Santa Clara, California

According to the Manager, NSC International Traffic and Manufacturing Support, their traffic manager and purchasing agent, purchase orders for the restricted articles to be shipped on Clipper 160 were given to the (ACC) sales representatives at the offices of NSC. Shipping arrangements were made with Interamerican Freight Forwarders, Lyon-Commercial and Export Packing Division, and The Seven Santini Brothers.

The NSC traffic manager prepared blank "Shippers Restricted Article Certification" for Interamerican's use and provided Lyon and Santini packaging instructions.

The NSC traffic manager closely monitored the shipments and requested expedited trucking service to take the east coast portions of the shipment to Santini, because of the urgent need for the materials by the ultimate consignee.

Since NSC did not produce such chemicals, they had no procedures or manuals for handling shipments of restricted articles. The traffic manager, who had served in that capacity for about 1 year,

received some instructions about handling restricted articles and applicable regulations from Pan American in San Francisco about 9 months before the accident.

c. Interamerican Freight Forwarding Corporation, San Francisco, California

Interamerican is an IATA cargo agent and had been appointed by Pan American as their cargo agent. The vice president of Interamerican did not consider the company a freight forwarder. It does, however, have a forwarder's license from the Federal Maritime Commission; it does not have a CAB certificate. As an agent of the air carrier, the vice president of Interamerican signed the Pan Am air waybill; he signed the air waybill on behalf of the shipper based on the instructions received from NSC.

NSC gave the vice president of Interamerican the list of the east coast chemicals by phone. He was requested to move the shipment on October 30 and to prepare the commercial invoice and have it delivered to Santini. Interamerican subsequently contacted Santini and provided delivery instructions, including the air waybill number and instructions to have the shipment moved to Pan American at JFK no later than midnight, November 2. On November 1, the Santini representative furnished Interamerican with the number of outside packages and the weight of each chemical. Documentation for the shipment was sent via Burlington Northern Air Freight (BN) to Santini at noon on November 2. NSC furnished the information for the documents (air waybill, shippers restricted articles certification, commercial invoice, and export declaration). Interamerican prepared the documents and examined them for errors. Santini filled in the number of pieces shipped and the gross weight. When the papers were received, Interamerican also filled in the signed shipper's restricted articles certification, except for the package number.

The shipment file for the sulfuric acid was started in Los Angeles on October 30. The sulfuric acid was packed by Lyon-Commercial Export and Packing Division. Interamerican had originally scheduled the shipment to move from Los Angeles to Chicago on October 31, then on to Scotland via Pan Am on the same date. Available space, however, could not be confirmed from both parties. On October 31, Interamerican rescheduled the shipment for Clipper 160. Availability of space was confirmed for November 2 for 300 pieces, weighing about 10,000 pounds. Interamerican prepared the documentation (air waybill, shippers RA certification and export declaration) based on information received from NSC and Lyon. Interamerican also prepared the Burlington Northern

airbill for the transportation of the shipment from Los Angeles to JFK via TWA.

Interamerican relies on the professional packers, air carriers, and shippers to know the regulations and interpret them. Interamerican had provided IATA Restricted Articles books to packers.

d. Lyon Commercial and Export Packing Division

On October 25, 1973, Lyon picked the material up from Allied Chemical Corporation. A work order had been written to cover the packing in accordance with IATA regulations. Lyon packed, for air shipment, 60 boxes of sulfuric acid which were carried on Clipper 160 under AWB No. 026-42096806.

On October 30, 1973, NSC gave the order to Lyon by phone. The material had been picked up on October 25 from Allied Chemical Corporation.

The bottles of sulfuric acid were packed in wooden containers with vermiculite as the absorbent material. The wooden containers were nailed closed. Corrosive liquid labels had been preapplied, and box markings consisted of box numbers and the address of the consignee. The boxes were palletized on forklift skids and secured with nylon fiber tape. Interamerican provided the air waybill number and instructed Lyon to deliver the shipment to Burlington Northern Air Freight on October 31. Lyon prepared only the freight bill and delivery receipt to accompany the shipment.

Lyon checked the IATA regulations and used the following procedures:

1. Work-order writer checked requirements against the regulations.
2. The Production section implemented the work order.
3. Quality Control reviewed the package against the regulations.

The above actions included a label-check to verify the contents of the packages and an audit of the container's volume.

Lyon is a member of the International Network of Packing and Routing Organizations (INPRO) and may interpret United States restricted articles regulations for foreign INPRO members who ship

materials into the United States. Lyon personnel were aware of the regulations of the Bureau of Explosives, the Association of American Railroads, DOT Regulations on Hazardous Materials, and had a copy of 14 CFR 103 in their files. Lyon builds and sells boxes to DOT 15A specifications and could issue certifications upon request. The boxes in the Pan Am shipment were manufactured to Federal specification PPP-Bp601 Style A, page 27 of Revision C, dated August 12, 1970, which Lyon personnel believed would meet IATA specification T4B.

e. Burlington Northern Air Freight, Inc., Los Angeles, California

Burlington Northern Air Freight (BN) had been in business for about 18 months and was certificated by the CAB as an indirect carrier for domestic and international transportation. Tariffs on file with CAB were identified as CAB 403 and CAB 492. BN first learned about the shipment of 60 sulfuric acid packages from Interamerican, who also furnished the shipping documents to them. The BN airbill No. 087646 and an envelope containing the other documents (PA air waybill, shippers RA certification and commercial invoice) arrived on October 31, just before the packages arrived from Lyon. BN rated the shipment as Item 117 in BN Specific Commodity Tariff No. 2, "chemicals, N. O. S." ^{4/}

After the packages were received at the BN loading dock, they were moved to a holding area in the same building, and a representative of Interamerican's Los Angeles office visited the facility to apply the Pan Am "lot labels" on each package.

The boxes were then moved to the loading dock and placed into an "igloo." Other freight was also loaded into the same igloo. The igloo was then closed and delivered to the TWA receiving dock at the Los Angeles airport by a BN truck.

BN prepared TWA air bill No. 2785743, which described the contents as "EL MACH" (electrical machinery). This description was subsequently changed during a telephone conversation between a Bn rate clerk and a TWA representative to "EL APP" (electrical appliances). The change was made after the flight departed. A manifest describing the contents of the igloo was not furnished to TWA.

^{4/} N. O. S. - Abbreviations for "Not Otherwise Specified," Ref. 49 CFR 172.4(a) "Explanation of Signs and Abbreviations."

None of the personnel interviewed could remember seeing the "white corrosive labels" on the packages, but they could remember seeing arrows on the packages.

BN described four measures taken to assure compliance with restricted articles safety regulations:

1. The night operations supervisor is expected to control restricted articles during the routing of shipments passing through his station. However, no formal training is provided for this purpose.
2. Dock employees are expected to detect restricted articles and to tell the supervisor about them.
3. Supervisors have an opportunity to check the documents accompanying the shipments against copies of shipping documents in the office. They rely on CAB 82 for information about restricted articles regulations.
4. BN relies on truckdrivers to check shipments when they are picked up. These truck operators work on a commission basis for BN. None of those interviewed could remember bringing any restricted articles packaging errors to the driver's attention.

There was no formal training program for BN employees or testing of employees on restricted articles rules. Two supervisors from stations where hazardous materials were known to be handled frequently had attended DOT/FAA Hazardous Materials training seminars.

BN relied upon the carriers to interpret the restricted articles regulations.

f. Trans World Airlines, Inc., Los Angeles, California

On October 31, 1973, TWA received two closed igloos from Burlington Northern Air Freight on TWA Domestic Airbill No. 27835743. The containers were contoured to fit in the main cargo cabin of a Boeing 707 freight aircraft. The containers were delivered to the TWA freight facility at Los Angeles by a Burlington Northern truck. Before TWA accepted the containers, seals were placed over the closures, and the numbers of the seals were recorded on the domestic airbill.

TWA's procedure for acceptance of cargo and its handling was explained as follows:

Anyone listed as a participating carrier in the CAB tariffs was allowed to act as a shipper's or carrier's agent and could consolidate freight for presentation to the direct air carrier. The shipper can purchase his own containers or procure the containers from the air carrier to load them on his own property.

Shipments are delivered to TWA either as loose, individual shipments or consolidated in closed containers. The shipper, or his agent, presents the paperwork to the TWA cargo rate agent. He accepts the shipment and issues a receipt for the goods. The paperwork includes a straight bill of lading or an airbill. If there is no airbill, the TWA agent makes one for the shipper. If the shipment contains restricted articles, the billing has to be accomplished by two copies of a shippers certification or restricted articles certification (RAC).

The TWA cargo rate agent checks the commodity against the IATA Restricted Articles Regulations or the Air Transport Association Tariff 6-D (CAB Tariff No. 82) for its proper shipping name, proper classification, proper labels, and any apparent damage. Restricted articles are never opened to check the packaging. If the cargo rate agent feels that the shipment complies with the tariffs, it is accepted for carriage.

Prepackaged containers are accepted only if they are sealed. TWA policy requires that the container be sealed before it is accepted so that TWA will not be liable for goods missing.

TWA personnel consider it to be the responsibility of, and rely upon, the shipper or his agent to properly describe the commodity presented, accurately state its weight, and have the proper paperwork completed. They also rely on the shipper to properly package the material to comply with all applicable regulations. They rely specifically on the shipper or his agent to advise them if he is shipping restricted articles. All containers are weighed on the automated line before loading aboard an airplane.

g. Seven Santini Brothers, Maspeth, New York

Santini Brothers, a member of INPRO engaged in the business of packaging, was made aware of the shipment when NSC phoned them that the materials would be coming from Allied Chemical. Santini verbally "contracted" to overpack ^{5/} the materials according to IATA specifications. The Santini facility was not equipped to pour and rebottle chemicals.

5/ Provide specified outside containers for existing inside containers.

On October 31, the shipment arrived at Santini, was checked for condition, and counted. It was accepted by a representative of Santini.

When the order was received by Santini from NSC, the office manager for Santini prepared a packing worksheet, using information in the LATA Restricted Articles Regulations, 14th edition, to determine the type packaging and labeling required. Since sawdust was specified as the cushioning material for red label materials, it was presumed by the packer that if it was "OK" for red label materials, it was "OK" for white label materials. Since Santini did not stock noncombustible cushioning material and had no metal cans to encase the nitric acid, the Lyon representative was contacted. The Lyon representative advised the Santini office manager that a metal can was not necessary and that sawdust was permissible. The worksheet was then attached to a job control sheet and released to the shop for the production of the boxes, packing, and marking.

Work on the shipment began on October 31, and was completed on November 2. New boxes were built for the shipment in accordance with Federal Specification PPP-B-621b, Style 4. Cushioning material, markings, and labels to be used were specified on the worksheets. The plant manager and a production supervisor checked the shipment. Additional information regarding box numbers and weights was added to the worksheets. The worksheets were then returned to the accounting department, where invoices and packing lists were prepared and forwarded to NSC.

Because of the size of the shipment, the boxes were palletized on 10 pallets and delivered by Santini trucks to Pan American at JFK on November 2, 1973. Pan Am personnel unloaded the shipment and signed Santini's bill of lading.

Shipping documents for the air transportation of the restricted articles to Scotland were forwarded to Santini by Interamerican and arrived at Santini on the morning of November 2, 1973.

Santini personnel assumed that the innermost container packaging was satisfactory as received from Allied. Santini did not have DOT specification prints, nor did they mark the boxes with the manufacturer's name or symbol.

In addition, Santini did not affix the required "this end up" labels. The "for cargo aircraft only" and "corrosive liquid" labels required by IATA regulations were also omitted.

Santini has been an IATA agent for more than 15 years. Except for the office manager, no personnel at Santini had been trained for handling hazardous materials shipments.

h. Pan American World Airways, Inc.

The larger of the two loads of restricted articles arrived at the Pan American receiving dock from Santini Brothers.

(1) Palletizing. -- The restricted articles were the last cargo palletized for Clipper 160. Although 3 pallets had been reserved, more space was required, and cargo was taken off a fourth pallet on which some of the 274-piece shipment was loaded with 2 large boxes which were described as containing "machinery" or "IBM equipment."

The first three pallets of the larger shipment were loaded by placing one large skid on each pallet and by breaking up the remaining skids and placing the boxes individually to establish the proper contour. The contour was established by placing fewer boxes in the upper tiers so that the cargo would fit within the cross-section of the upper fuselage.

The second shipment, which consisted of 60 boxes, was also broken up. Fifty-five boxes were placed on one pallet, and five boxes were placed on one of the three pallets which had originally been allocated for the restricted articles.

During loading, personnel discovered that the boxes along the outer edges of the upper tiers were stacked too high to fit within the contour of the aircraft's fuselage. Cargo personnel, who loaded part of the shipments, testified that they were instructed by their supervisors to lay the boxes on their sides on two or three pallets, including the pallet which contained "IBM" cargo. Another individual testified that he was told that boxes were loaded upside down. Still another individual stated that he was assigned during the midnight shift to wrap three pallets which had not been completed by the previous shift. He said he informed his supervisor that boxes were loaded on their sides, but was told to wrap them as they were. He then covered the cargo on the three pallets with cargo nets.

Those who were later associated with the palletized restricted articles generally described the pallets as being "neat" or "well assembled" with secure or tight netting. Personnel observed no leakage or unusual odors from the packages except for one aircraft loader who stated that the pallet in position No. 9 had a smell of mildew.

(2) Cargo Loadmaster Activities. --Two individuals shared the duties of cargo loadmaster during the handling of the shipment on the midnight shift. One loadmaster, who was considered to be in training status because of a break in service with the company, observed the loading of the pallets into the aircraft; the other loadmaster determined the sequence in which the pallets were to be loaded on to the aircraft and numbered the pallets accordingly. All of the restricted articles could not be placed in the forward pallet positions because of weight and balance considerations. Since the shift was to change before the flight departed, arrows were marked on the loadmaster's worksheet to notify the loadmaster on the next shift that aisles were required because of the restricted articles cargo.

The next shift's (0800 to 1600) loadmaster was on duty when the aircraft departed. He said that he did not talk to the loadmaster of the preceding shift and that he forgot about the restricted articles in the cargo. He was occupied with the loading of the lower cargo compartments. The pilot notification was not offered to him, nor was he aware of the specific nature of the cargo on board until after the aircraft departed.

(3) Loading of Aircraft. --Those associated with loading Clipper 160 testified that their work proceeded smoothly and rapidly. The pallets appeared to be new, and they were easily moved and locked into place. The aircraft was loaded in about 13 to 30 minutes; the loading was completed at 0540, on November 3.

Personnel who saw the cargo cabin of the loaded aircraft agreed that the first nine pallets were loaded to provide an aisle of proper width; however, they agreed movement down the aisle would have been impeded by the cargo net straps which extended across the aisle to the tiedown rings near the outer edges of the 125-in. pallets. The pallets extended nearly the full width of the cabin floor. Because of the somewhat circular cross-section of the fuselage, a large man would have to bend forward at the waist and walk sideways down the aisle. The spacing between the pallets and their cargo was such that a man could not squeeze between them.

(4) Notification for Loading Restricted Articles. --14 CFR 103 requires that the captain of a flight carrying restricted articles be notified, in writing, of the cargo's contents. For Clipper 160, the cargo dispatcher prepared the "Notification for Loading Restricted Articles." Usually the notification is signed either by the dispatcher or by the palletizing "leadman," and is given to the loadmaster, who presents it to the captain for signature. The notification for Clipper 160

was signed by the cargo dispatcher and taken aboard the aircraft. The individual who carried the notification aboard the aircraft testified that he told the captain about the restricted articles in the cargo. He also testified that he left the original and all copies of the notification under the handle of the dispatch box. The second page of the notification was recovered in the wreckage without the captain's signature.

(5) Training of Personnel. -- Except for those personnel authorized to receive inbound cargo, none of the personnel whose responsibilities included decisions regarding the correctness of the restricted articles shipment had received any recent, formal training. The majority of key personnel were familiar with IATA regulations; however, a limited number of cargo personnel were familiar with Pan American's cargo traffic manual. Cargo operating personnel generally did not know of the existence of 49 CFR.

1.17.4 FAA Surveillance of Restricted Articles Shipments

The overall management of the Restricted Articles Program within the FAA is the responsibility of the Operations Division of the Flight Standards Service. Each region within FAA has the line operating responsibility for the administration of the program.

Although the FAA had authority to enforce certain rules regarding the packaging and shipper's certification of restricted articles, there was no program, either within DOT or FAA, which would provide surveillance of shipper's facilities or would detect improperly packaged, labeled, or certificated restricted articles before they are submitted for shipment.

During the Safety Board's investigation, conflicting data were obtained regarding FAA's hazardous materials surveillance program. FAA testimony indicated that neither the FAA nor the air carrier had specific authority to open restricted articles packages which, in their opinion, did not comply with regulations. Other testimony indicated that FAA could request, through the carrier, to have the shipper open such packages.

Other areas of conflict relate to the regulatory material contained in 14 CFR 103.31(b) "Cargo Location," which states: "Each person carrying articles acceptable only for cargo aircraft shall carry those articles in a location accessible to a crewmember in flight."

FAA testimony in connection with accessibility disclosed that the regulation intends that materials carried with "Cargo Only" labels must be readily accessible in flight so that a fire extinguisher may be used if necessary and so that packages can be removed to prevent contamination of other packages.

A review of the FAA surveillance program and the actual practices by the carrier disclosed that there is virtually no access to restricted articles pallets, except for the one side of the pallet which faces the aisle and possibly the top of the pallet.

1.17.5 Other Regulations

Local and Joint Air Cargo Tariff No. CR-3 Rule No. 6 (H) on file with the Civil Aeronautics Board, in effect since April 1, 1954, states: "Carrier reserves the right to examine the contents of all consignments, but shall be under no obligation to do so."

Pan American's Cargo Traffic Manual Bulletin Number 305, Section 300, "Acceptance of Shipments - Doubtful Cases," states: "If any doubt as to acceptability, telex Chief Chemist (MIAMQPA) giving complete facts such as chemical name, hazardous characteristics and other properties, use of articles, details of packing, etc. If shipping documents and outside container do not provide sufficient information, it is permitted to open outside container (except radioactive materials) to examine labels on inner containers only when necessary to prevent excessive delay in movement, and only when possible to re-pack to original condition. Only Chief Chemist, MIA, may open inner containers, or outer containers, in contact with the articles (such as drum of liquids), and then only with shipper's permission. Failure to observe this rule could contaminate contents and be dangerous to the offender. For example, certain materials will ignite spontaneously or will emit toxic or corrosive fumes upon exposure to air."

2. ANALYSIS AND CONCLUSIONS

2.1 Analysis

2.1.1 Operation of the Flight

The flight was routine until just before 0904, when the crew advised Pan American operations at JFK that smoke had accumulated in the lower 41 and that they were turning back to Boston or New York. From 0904 until 5 minutes before the crash, several conversations regarding smoke

in the aircraft were recorded by the CVR. According to the CVR, the crew donned oxygen masks at 0911 and put on their smoke goggles at 0912.

At 0914, they asked to remain on the current radio frequency because "its too hard to change." This remark infers that the smoke in the cockpit was so dense that they had difficulty seeing the frequencies on the control panels. The crew, however, did not at any time become alarmed by the situation. At 0931, shortly before the CVR ceased to function, the captain noted that the smoke was suddenly getting worse and advised the crew to "shut down everything you don't need."

Other conversations recorded on the CVR indicate that the crew was firmly convinced it was an electrical problem.

The final actions taken by the flight engineer, as prescribed by procedures if smoke continues, include the positioning of the "essential power selector" in the "external power" position. If the selector is positioned to "external power," the yaw damper becomes inoperative. The FDR parameters and the CVR disclosed that the wing flaps had been lowered. There is evidence that spoilers had been extended for about 4 1/2 minutes and probably had remained selected at the extended position when the speed was reduced for final approach.

Performance data for the Boeing 707-321C show that lateral control capability may be extremely limited, if not impossible, with an inoperative yaw damper, extended spoilers, and lowered flaps.

The evidence suggests that the captain was not aware that the flight engineer's actions had rendered the yaw damper inoperative. In addition, the position of the spoiler control lever may not have been visible through the smoke in the cockpit.

Since the smoke detector indicators apparently failed to provide an early and positive indication of the source of the smoke, the flightcrew assumed that the smoke in the lower 41 was from an electrical or avionic source. This assumption probably influenced the subsequent actions of the flightcrew more than any other factor.

Although the exact reason for the captain's decision to fly to Boston instead of landing at an appropriate airfield en route could not be determined, these factors were considered:

1. Since the flightcrew believed the smoke to be from an electrical source, they knew that the source could be

readily isolated and, therefore, would not constitute a serious threat.

2. There is no evidence to indicate that any member of the flightcrew was aware of the restricted articles on board. It is possible that the cabin cargo areas would have been immediately suspect as a smoke source had the flightcrew been aware of the quantity, nature, and location of the chemicals on board; however, the smoke migration pattern, which caused smoke to emerge from lower 41 compartment would have further confused the crew as to the origin of the smoke and thus would have seriously impeded timely and accurate assessments.

The Safety Board recognizes, that while safety considerations are foremost in the operations of a flight, underlying logistic considerations may enter into the decision making processes of the operating flightcrews and company management.

The Safety Board believes that had an electrical problem in lower 41 actually been the source of the smoke as the flightcrew suspected, the logical decision from a safety and logistic viewpoint would have been to land at the nearest airport where Pan American maintenance personnel and facilities were available to accomplish required maintenance, return airplane to service, and to continue the flight. In this case, the nearest airport with such Pan American facilities was Logan International Airport at Boston.

Apparently, the problem was underestimated or misunderstood by the crew of Clipper 160. Late during the approach to Boston, conditions in the cockpit rapidly deteriorated. Serious impairment of visibility inside the cockpit and drastic impairment of outside visibility prompted the opening of the cockpit window. Since opening the window was not prohibited, this action taken by the crew is understandable. The procedure was prescribed by Boeing and Pan American at the time of the accident. However, as discovered during smoke evacuation tests after the accident, opening the cockpit window allows even more smoke into the cockpit when the source of the smoke is continuing and originates in the cabin.

One of the critical factors in the final accident sequence was the flight engineer's execution of emergency procedures while other crewmembers were not aware of his actions. Various switch settings found on the flight engineer's panel after the crash and information from the CVR indicate that the flight engineer performed the "smoke

evacuation emergency procedure" and was in the process of performing the prescribed steps of the "electrical smoke and fire procedures," as prescribed in the Boeing 707 flight manual. The latter procedure requires that the essential bus power switch be placed in the "ground power position," thus removing all power from the systems on the essential bus. Included on the essential bus are: The captain's flight instruments, the No. 1 VHF radio, the cockpit voice recorder, intercom, the yaw damper, and the No. 1 transponder. If these systems are deactivated without the captain's knowledge, the captain may conclude that the smoke problem in the lower 41 compartment had worsened.

The "electrical smoke and fire emergency procedure" requires that the radios be changed to the No. 2 position before the essential bus is isolated. Since the radio was not changed, only the flight engineer knew what had occurred when the essential bus was isolated. Why the flight engineer did not return the power to the bus could not be determined.

Flight recorder data indicates that a stable approach was never established. The airspeed, altitude, and heading traces fluctuated constantly throughout the approach. Under conditions in which the flight parameters are constantly changing, careful monitoring by the crew is necessary in order to avoid entering a dangerous flight regime. However, since the crew of Clipper 160 could not communicate verbally with each other and probably could not see the instruments because of dense smoke, they could not monitor airspeed and altitude during the final phase of the approach. This could easily lead to a stall or an uncontrollable maneuver at an altitude too low for recovery. Heading excursions during the final moments of flight also indicate that the crew may have had difficulty seeing the runway because of the dense smoke in the cockpit.

According to FDR traces, the airspeed deteriorated from about 160 to 122 kn. during the last portion of the flight. Stall speed for the aircraft's configuration at the time of the accident was 118 kn. in wings level, unaccelerated flight. Since the FDR indicates a continuous heading change, the aircraft must have been in a bank or a yaw. If the aircraft stalled during such a maneuver, considerable altitude would have been required to recover safely.

The FDR reading of 344 KIAS, 5 minutes before impact could possibly be explained by either exposure to or severance from heat on air data sensors which lead to the FDR unit. Although high speeds were observed by ground witnesses, the aircraft's performance characteristics suggest that an IAS of 344 knots would not have been possible.

2.1.2 Involvement of Hazardous Materials on Clipper 160

While discrepancies were found in the packaging, documenting, and labeling of most of the restricted articles on board Clipper 160, the most serious and potentially dangerous discrepancy was the manner in which the nitric acid was packaged and stowed.

The nitric acid, although noncombustible, is an oxidizing material which reacts with many materials. When nitric acid comes in contact with most organic materials, a spontaneous reaction begins to produce heat and large quantities of smoke, as verified by tests. IATA regulations require packaging of nitric acid in T4A specification wooden boxes with 1C.1 earthenware or glass inside containers of not more than 2.5 liters capacity, individually enclosed in tightly closed metal cans. The regulations recognize the reactivity of nitric acid and, therefore, require that nitric acid be packaged with suitable non-combustible mineral cushioning material. In addition, the IATA regulations require that the boxes be labeled "cargo aircraft only" and "corrosive."

The boxes used for the outer packaging were not manufactured to DOT specifications nor were they marked with required specification numbers. The bottles were not packed in metal containers, and the cushioning material used was combustible sawdust. The required "cargo aircraft only" labels were not affixed to the outer containers. The "corrosive liquid" labels required for air shipment were not affixed to the boxes. "Corrosive" labels required for surface shipment were present. Arrows pointing to the top of the box were present, but the required "this end up" labels were omitted.

In addition to deviations from packaging requirements, numerous boxes which fit the description of those containing the nitric acid, were placed on their sides on the pallets during the repalletizing operation. Therefore, it was entirely possible for the nitric acid to leak into the sawdust. A cracked or broken bottle, a bottle cap which was loose, overtightened, or cracked, or a cap that was tight at sea level pressures could have started to leak when the airplane reached its cruising altitude of 31,000 feet.

The latter possibility is considered the most likely in view of the 14-minute interval between Clipper 160 leveling off at 31,000 feet and the first appearance of smoke.

The variable smoke density could be explained if a series of reactions were set off by the heat and/or fire created by the leakage

from one bottle. The fact that laboratory analysis of soot samples did not detect traces of nitrates is not considered of major significance, since the soot samples were of limited quantity and were in all probability either immersed in sea water or subjected to the firefighting operations after the crash. Any contact with water could easily have dissolved and removed detectable traces of nitrate deposits.

The theory that there was intense heat in the cabin area is further supported by the metallurgical findings in the area of fuselage station 960N and 980, which suggest the possibility of temperatures as high as 1,000° F. The possibility that the elevated skin temperatures occurred after impact is not likely in view of the structural deformation which apparently took place at impact.

The termination of the CVR operation about 5 minutes before impact and about 1 minute before radio communications were lost may also be related to a fire or high temperatures in the aft cabin. The recording ceases when the 600Hz cyclic tone appears. The 600Hz tone can only be produced by activating the CVR test circuit or grounding of the test circuit wiring. The evidence, therefore, suggests that the wiring in question may have been heated or burned during the last minutes of the flight. This type of condition would strongly support a rapidly deteriorating situation aboard the airplane at that time.

2.1.3 The System of Hazardous Materials Regulations and Control

During its investigation, the Safety Board found that the system for regulating the shipment of hazardous materials by surface and by air are extremely complex, widely misunderstood, and poorly enforced; and therefore pose a serious and continuous threat to life and property.

The FAA did not exercise adequate surveillance of shippers and carriers to effectively detect and cause the removal of improperly prepared or otherwise illegal shipments from commerce. The FAA did not have adequate resources, authority or technical capabilities to conduct effective surveillance of shippers and carriers.

The DOT Office of Hazardous Materials did not have adequate resources or jurisdiction to insure an effective hazardous material compliance program. No single document that contains all applicable regulations was available to operating personnel handling restricted articles shipments. The lack of such a document resulted in widespread confusion and misunderstanding as to what was expected. Because of

its simplicity of use as a working document, personnel who need to know the requirements for air transportation of hazardous materials have used the IATA Restricted Articles Regulations. IATA regulations, however, are not enforceable under U. S. regulations.

Eight parties were involved in the process by which restricted articles were handled for air carriage. The responsibility for certification of compliance at each interface with the parties is unclear. The Director of the DOT Office of Hazardous Materials, who is also the Chairman of the Hazardous Materials Regulations Board, indicated that he understood that the shipper or his agent was responsible for this certification at each interface. The number of parties handling such shipments for air carriage, their geographic separation, and the time constraints suggest that this expectation requires reexamination. It follows that enforcement would be difficult, if not impossible, in these circumstances.

The handling of these shipments by the air carriers indicates that existing FAA regulations were neither known or internally disseminated to carrier personnel. Noncompliance with DOT regulations was found to be commonplace. For example, regulations regarding accessibility to restricted articles on board all cargo flights were ambiguously interpreted, and if enforced to the letter, virtually impossible to cope with.

2.1.4 Emergency Procedures

Extensive testimony by FAA technical personnel, the Boeing Company, and Pan American Flight Operations personnel disclosed conflicting data regarding the validity of smoke evacuation procedures in force on November 3, 1973.

Initial testimony by the FAA and the Boeing Company indicated that existing procedures for evacuating smoke were adequate if followed to completion. However, data developed during and subsequent to the smoke evacuation tests disclosed that the smoke test conducted during the initial certification of the Boeing 707 did not take into consideration a continuing source of smoke. In view of these findings, the Safety Board believes that the procedures in effect at the time of accident were not effective in controlling or evacuating smoke. On the contrary, it appears that smoke origin and circulation made it virtually impossible to determine accurately the source of the smoke.

In view of the data developed during the March 1974 smoke evacuation tests, the Safety Board believes that if effective smoke

detection and smoke evacuation procedures had been available to the crew of Clipper 160, the ultimate events resulting in loss of control might have been averted.

An examination of the smoke goggles of the type used by the crew disclosed that an adequate fit with or without glasses was difficult, if not impossible. Therefore, the crewmembers of Clipper 160 did not have adequate eye protection. In fact, eye irritation by toxic smoke would probably make it virtually impossible for an individual to keep his eyes open.

2.2 Conclusions

(a) Findings

1. The flightcrew of Clipper 160 was qualified and certificated.
2. The aircraft was maintained in accordance with applicable regulations.
3. Certification of the basic aircraft was in accordance with applicable regulations.
4. There was no failure or malfunction of the aircraft's flight controls, systems, structure, or powerplants.
5. Initial certification smoke evacuation testing of the aircraft did not consider procedures for evacuation of continuously generated smoke.
6. Dispatching of the flight was accomplished in accordance with applicable regulations, with the exception of the handling of pilots notification of restricted articles.
7. The captain was not properly notified of the restricted articles on board as required by regulation.
8. The aircraft's weight and c. g. were within allowable limits.
9. The flightcrew was misled by the appearance of smoke from the lower 41 compartment and initiated emergency actions required for electrical problems.

10. The severity of the emergency was underestimated by the flightcrew.
11. Clipper 160 overflew several airports capable of accommodating the aircraft.
12. Flaps and spoilers had been extended for speed reduction.
13. The yaw damper was rendered inoperative by the uncoordinated execution of emergency procedures.
14. The Boeing 707 becomes extremely difficult to control at low speeds with wing flaps and spoilers extended and yaw damper inoperative.
15. Handling of the restricted articles shipments was in violation of many Federal and company regulations.
16. Most personnel handling the restricted articles shipments were inadequately trained to do so.
17. Nitric acid was improperly placed on the pallets and probably leaked. The leakage produced intense smoke and heat when it spontaneously reacted with the sawdust surrounding the bottle.
18. Federal regulations and enforcement programs governing the transportation of hazardous materials were inadequate.
19. The carrier's procedures for handling hazardous materials were inadequately enforced by the carrier and the FAA.
20. DOT jurisdiction over certain parties handling restricted articles moving in air transportation is questionable.

(b) Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the presence of smoke in the cockpit which was continuously generated and uncontrollable. The smoke led to an emergency situation that culminated in loss of control of the aircraft

during final approach, when the crew in uncoordinated action deactivated the yaw damper in conjunction with incompatible positioning of flight spoilers and wing flaps.

The Safety Board further determines that the dense smoke in the cockpit seriously impaired the flightcrew's vision and ability to function effectively during the emergency. Although the source of the smoke could not be established conclusively, the Safety Board believes that the spontaneous chemical reaction between leaking nitric acid, improperly packaged and stowed, and the improper sawdust packing surrounding the acid's package initiated the accident sequence.

A contributing factor was the general lack of compliance with existing regulations governing the transportation of hazardous materials which resulted from the complexity of the regulations, the industrywide lack of familiarity with the regulations at the working level, the overlapping jurisdictions, and the inadequacy of government surveillance.

3. RECOMMENDATIONS

As a result of the accident, the Safety Board has made 16 recommendations to the Administrator of the Federal Aviation Administration (FAA). (See Appendix H.)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JOHN H. REED
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

December 2, 1974

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

At 0945 on November 3, 1973, the National Transportation Safety Board was notified of the accident by the FAA Communications Center in Washington, D. C.

An investigation team was dispatched immediately to Boston, Massachusetts. Working groups were established for operations, air traffic control, human factors, structures, systems, powerplants, aircraft records, flight data and cockpit voice recorders, and hazardous materials.

The FAA, DOT Office of Hazardous Materials, Pan American World Airways, Air Line Pilots Association, Flight Engineers International Association, The Boeing Company, Pratt & Whitney, and Massachusetts Port Authority participated in the investigation.

2. Hearing

A public hearing was held at Boston, Massachusetts, from January 29, 1974, through February 1, 1974, and at Washington, D. C., from February 5, 1974, through February 8, 1974. Parties to the investigation included the FAA, DOT Office of Hazardous Materials, Pan American World Airways, Air Line Pilots Association, Flight Engineers International Association, Transport Workers Union, National Semiconductor Corporation. The United States Senate and House of Representatives were represented.

Depositions were taken from additional Pan American cargo personnel in New York on April 2, 1974.

Depositions were taken from FAA, Boeing Company, and Pan American World Airways personnel at Seattle, Washington, on May 29 and 30, 1974. On June 27, 1974, written interrogatories were obtained from the Deputy Director of the Bureau of Motor Carrier Safety.

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APPENDIX B

CREW INFORMATION

Captain John J. Zammett

Captain John J. Zammett, 53, was employed by Pan American World Airways on May 1, 1951; he held an Airline Transport Pilot Rating. He received his initial Boeing 707 training and type rating on February 2, 1965. His initial check as captain was September 14, 1967. He completed recurrent emergency training on February 7, 1973. Captain Zammett had accrued approximately 16,477 flight-hours of which 5,824 were in the Boeing 707.

Captain Zammett held FAA First-Class medical certificate issued on August 6, 1973. The following limitation was issued against this certificate: Must possess corrective glasses for near vision while exercising the privileges of his airman certificate.

First Officer Gene W. Ritter

First Officer Gene W. Ritter, 34, was employed by Pan American on February 14, 1966. He had accumulated approximately 3,843 flight-hours, all of which was in the Boeing 707. He completed initial training in the Boeing 707 on April 11, 1966, and received his type rating in the airplane on July 7, 1969. He completed the recurrent emergency training on January 8, 1973.

First Officer Ritter, held an FAA First-Class medical certificate issued on June 19, 1973. There were no waivers or limitations to his certificate.

Flight Engineer Davis Melvin

Flight Engineer Davis Melvin, 37, was employed by Pan American on June 5, 1967. He had accrued approximately 7,261 flight-hours, 3,260 of which was in the Boeing 707. He received his initial training in the airplane as a regular copilot February 2, 1968. On August 21, 1970, he acquired his Boeing 707 Flight Engineer's rating. March 13, 1973, was the date on which he completed his last recurrent emergency training.

APPENDIX B

Flight Engineer Melvin, held an FAA Second-Class medical certificate issued on March 16, 1973. There were no waivers or limitations to his certificate.

Each of the crewmembers had adequate rest time before the flight.

APPENDIX C

AIRPLANE INFORMATION

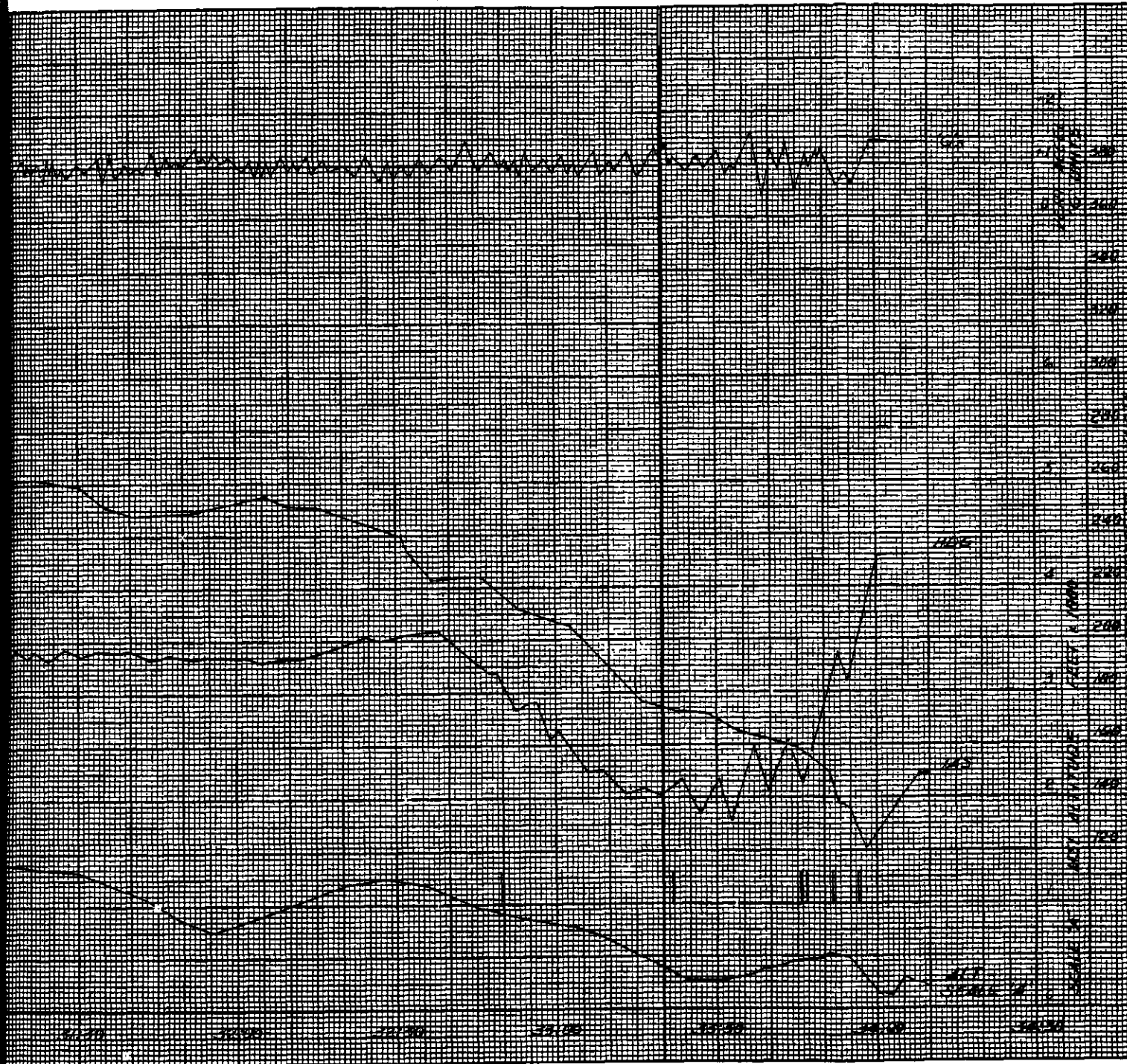
The airplane, a Boeing 707-321C, United States Registry N458PA, Serial No. 19368, was manufactured on November 7, 1967. It was received by Pan American World Airways on the same date and placed in service on November 10, 1967. The airplane was received and operated in a cargo configuration. The airplane had accumulated 24,537 flight-hours.

The basic airplane was certificated and maintained in accordance with existing regulations and company procedures at the time of the accident.

During March 1974, additional flight testing was accomplished by the Boeing Company and Pan American World Airways in order to determine the adequacy of smoke evacuation procedures as established during initial certification flight testing. It was determined that initial tests did not deal with a continuous smoke source. Revisions to the FAA Approved Flight Manual (AFM) reflecting revised smoke evacuation procedures were issued on June 3, 1974.

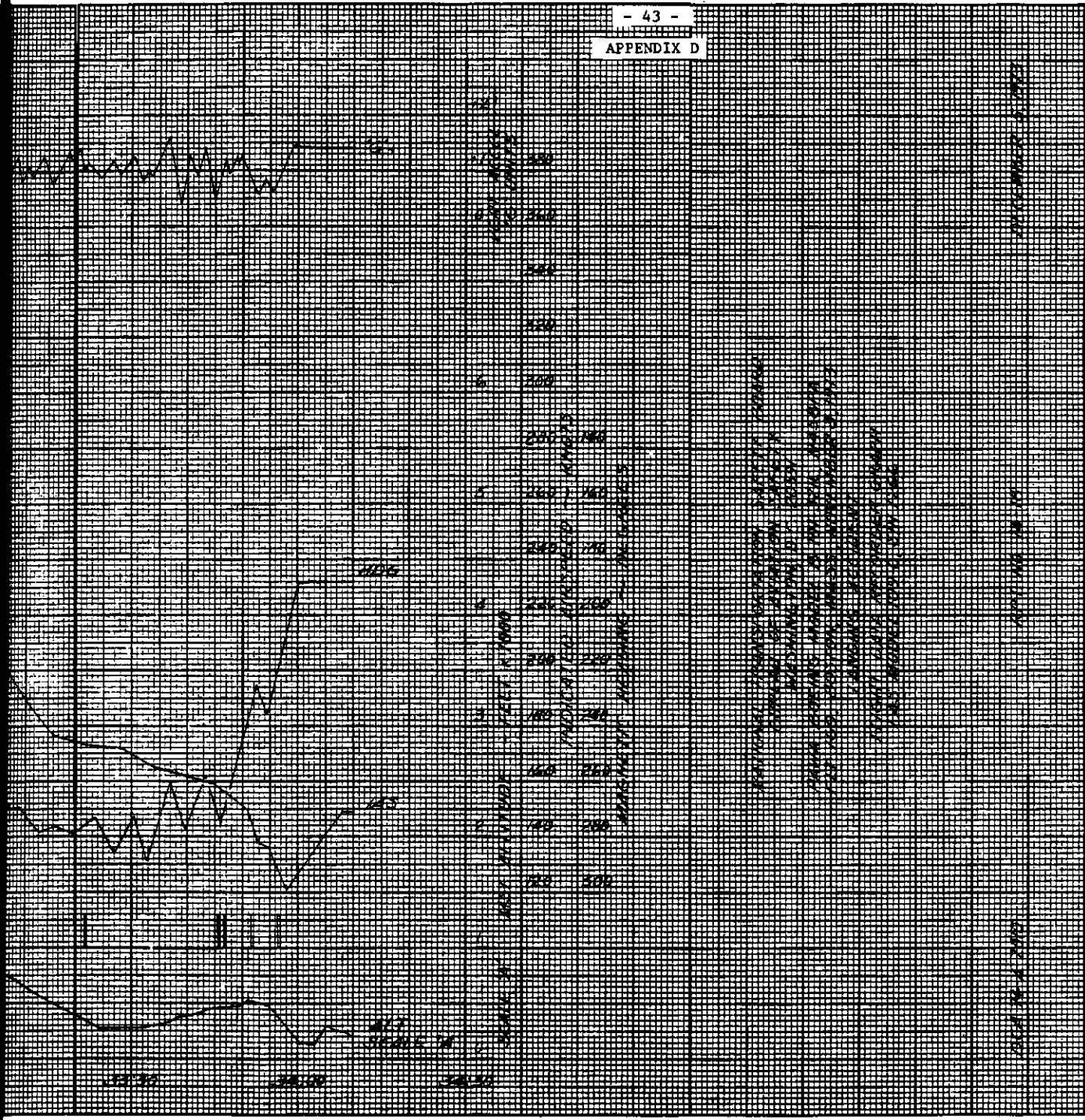


43A



43 B

APPENDIX D



43 C

APPENDIX E

Docket No. SA-441
Exhibit No. 12A

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

SPECIALIST'S FACTUAL REPORT OF INVESTIGATION
COCKPIT VOICE RECORDER

By

John D. Rawson

Warning

The reader of this report is cautioned that the transcription of a CVR tape is not a precise science but is the best product possible from an NTSB investigative group effort. The transcript or parts thereof, if taken out of context, could be misleading. The attached CVR transcript should be viewed as an accident investigation tool to be used in conjunction with other evidence gathered during the investigation. Conclusions or interpretations should not be made using the transcript as the sole source of information.

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APPENDIX E

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

January 11, 1974

SPECIALIST'S FACTUAL REPORT OF INVESTIGATION
COCKPIT VOICE RECORDER

A. ACCIDENT

Location : Logan International Airport, Boston, Massachusetts
Date : November 3, 1973
Aircraft : Boeing Model B-707-321C, N458PA
Operator : Pan American World Airways
Flight No.: 160
CVR Type : Fairchild A-100, S/N 281
Ident. No.: DCA 74-A-10

B. COCKPIT VOICE RECORDER GROUP

John D. Rawson, National Transportation Safety Board, Chairman
John E. Hemmert, Jr., Federal Aviation Administration
Harold F. Marthinsen, Air Line Pilots Association
S. W. Reichert, Air Line Pilots Association

C. SUMMARY

The cockpit voice recorder (CVR) was recovered at the accident scene and forwarded under NTSB supervision, to Washington, D. C., via an FAA aircraft. The recorder was taken from the FAA aircraft by the undersigned and brought to the Audio Laboratory, Bureau of Aviation Safety for examination and readout. A transcript was prepared of the pertinent recorded information and appears as an attachment to this report.

D. DETAILS OF INVESTIGATION

A visual examination showed the outer case sustained light to moderate heat damage with heavy sooting noted on the front of the unit. No mechanical damage was noted externally. The tape was removed with no internal mechanical or heat damage found. The tape was read out in the normal manner.

The entire recording was reviewed and all pertinent data regarding the subject aircraft was transcribed. The transcription covers a period of 30:34.5 minutes from 1404:22.0 to 1434:56.5 GMT. The starting time occurred when Pan Am Company Radio, New York (PAN OP NY) acknowledged a transmission from Flight 160 just prior to their reporting smoke detection in the aircraft. The last data recorded from the CVR was at time 1434:56.5 minutes when electrical power was removed.

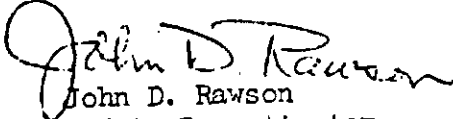
CVR Specialist's Factual Report (2)

D. DETAILS OF INVESTIGATION (Cont'd)

Timing accuracy was established by using the Digital Coded Time Source, supplied by FAA Air Traffic Control (ATC). Copies of ATC tapes from Montreal Canada Center, Boston Massachusetts Center and Boston Approach Control were used to establish real time. Since all three time sources varied slightly, the Boston Approach Control (AR-2) position times were used as the master time references.

Several significant items of interest are reflected during the last few minutes of recording. These are as follows:

1. At time 1434:27.0, the test feature of the CVR was activated, resulting in a cyclic 600 Hz tone being sequentially recorded on all four tracks.
2. The cockpit area microphone (CAM) ceased recording cockpit data after time 1434:42.0.
3. The cockpit voice recorder ceased operation at time 1434:56.5 during a radio transmission from AR-2 to Flight 160.
4. Certain aircraft VHF radio equipment continued to operate after the CVR ceased operation, since the AR-2 ATC tape shows that radio communication with Flight 160 continued until at least time 1435:05.5.


John D. Rawson
Air Safety Investigator

Attachment

APPENDIX E

TRANSCRIPTION OF COCKPIT VOICE RECORDER DATA, FAIRCHILD A-100, S/N 281,
PAN AMERICAN WORLD AIRWAYS, FLIGHT 160, BOEING MODEL B-707-321C,
N458PA, LOGAN INTERNATIONAL AIRPORT, BOSTON, MASSACHUSETTS,
NOVEMBER 3, 1973

LEGEND

CAM	Cockpit area microphone
I/P	Interphone
RDO	Radio transmissions from Flight 160
-1	Voice identified as Captain
-2	Voice identified as First Officer
-3	Voice identified as Flight Engineer
-?	Voice unidentified
MCTR	Montreal Center
BCTR	Boston Center
AR-2	Boston Arrival Approach Control No. 2
PAN OP NY	Pan American Operations, New York
PAN OP B	Pan American Operations, Boston
*	Unintelligible word
#	Nonpertinent word
%	Break in continuity
()	Questionable text
(())	Editorial insertion
---	Pause

- Notes:
1. Times expressed in Greenwich Mean Time (GMT).
 2. When CAM voices appear after time 1411:20.0, this denotes crewmember did not depress interphone microphone key when speaking or did not have oxygen mask on.

INTRA-COCKPIT/INTERPHONE

TIME &
SOURCE

CONTENT

1404:43.0

CAM-1

New York is not that much further on so we can just go ahead back

CAM-2

Do you think, do you wanna go to New York?

CAM-1

I ask him where did he want us now

CAM-1

Put New York on yours and see how far out we are from it

CAM-2

It won't show

1405:07.0

CAM-1

Dave?

CAM-3

Yeah

1405:08.5

CAM-1

You don't think you could get down there and spot that huh?

AIR-GROUND COMMUNICATIONS

TIME &
SOURCE

CONTENT

1404:22.0

PAN OP NY

One six zero Pan Op, go ahead

1404:24.5

RDO-1

Ah, yes sir, we have, uh, accumulation of smoke in the lower forty-one and we're gonna go back to Boston. Do you want us back in Boston or back in New York?

1404:34.0

PAN OP NY

Ah, stand by, one sixty, we'll find out

APPENDIX E

AIR-GROUND COMMUNICATIONS

TIME & SOURCE CONTENT

INTRA-COCKPIT/INTERPHONE

TIME & SOURCE CONTENT

CAM-3 I can't get around down there at all.
I ---

1405:15.5
CAM-3 I don't see any reason up here why that
#, it shoulda popped a breaker by
now. It oughta short out somewhere

CAM-? I'm gonna be doing ---

CAM-2 (Can) we increase our airflow so we get
rid of some of the smoke through the outflow
valve(s) and equipment cooling (circuit)?
((Begins with word "doing" above))

CAM-? Yeah

1405:38.0
CAM-1 Just stick your head down there and see if
it's still coming

CAM-2 I requested direct Boston radar vectors,
but they haven't given me anything yet

1405:47.0
CAM-1 I know that's right standby

SELCAL Modulation

1405:49.5
RDO-1 Pan Op from the Clipper one sixty

PAN OP NY Sixty, go ahead

INTRA-COCKPIT/INTERPHONE

TIME & SOURCE

CONTENT

1406:20.5
CAM-1

Tell them we want to go back to New York

AIR-GROUND COMMUNICATIONS

TIME & SOURCE

CONTENT

RDO-1

Uh, did you get that message? Do you want us to come back to New York or go into Boston?

1405:59.5
PAN OP NY

One sixty, they're checking on that right now. Copied you've got an accumulation of smoke in your lower forty-one they're, uh, finding out where they would like you

1406:03.5
BCTR

((Simultaneous with above word "accumulation"). Clipper one sixty contact Montreal Center one three two point, ah, three five and make your request to them, good day

RDO-1

Okay, we'll stand by

PAN OP NY

Ah, one sixty, they say come back to New York, and, uh, when you get a moment you can give us a good ETA for New York

1406:17.0
RDO-1

Stand by. We'll just get our, uh, routing back to New York first

1406:21.0
BCTR

Clipper one sixty Boston

APPENDIX E

INFLIGHT-COCKPIT/INTERPHONE

TIME &
SOURCE

COMMENT

AIR-GROUND COMMUNICATIONS

TIME &
SOURCE

COMMENT

1406:23.5
RDO-2

Ah, Clipper one sixty requesting present position direct New York, direct New York at this time

1406:32.5
BCIR

'per one sixty contact the Montreal Center one three two point three five and Montreal, ce-- ah, Montreal Center

1406:41.0
RDO-2

Roger roger

1406:53.0
RDO-2

Montreal Center good afternoon, it's Clipper one sixty

1407:09.5
RDO-2

Montreal Center, Clipper one six zero

CAM-?

**

1407:05.5

This # sure is comin' John

CAM-3

CAM-1 What was our last frequency?

1407:20.5

** lemme see if I can shut this, ah, blower off

CAM-3

1407:30.5

I'm gonna raise the cabin up

CAM-3

CAM-2 Did you ---

The one frequency I didn't write down

CAM-2

Up to ten thousand? ((Possible reference to cabin altitude control setting on emergency smoke evacuation checklist))

CAM-3

INTRA-COCKPIT/INTERPHONE

TIME & SOURCE CONTENT

CAM-? Up to ten thousand:

CAM-1 Let's see ----

CAM-1 That was one twenty-eight seven five

CAM-1 One twenty-seven eight five ---- try that, Boston

CAM-1 Try that

CAM-1 Ask him if ----

AIR-GROUNDED COMMUNICATIONS

TIME & SOURCE CONTENT

RDO-2 Boston Center, Clipper one sixty

1408:04.5

RDO-2 Boston Center, Clipper one six zero

1408:07.0

BCTR One six zero, go ahead

1408:09.5

RDO-2 Clipper one sixty, you, uh, told us to go to Montreal Center on one twenty-two thirty-five.. Unable

1408:16.0

BCTR One thirty-two thirty-five, right now. One thirty-two thirty-five

RDO-2 One thirty-two thirty-five

1408:24.0

RDO-2 Montreal Center, Clipper one sixty

CAM-? * *

1408:31.5

CAM-3 Could open a bleed %

CAM-1 All right

INTEA-COCKPIT/INTERPHONE

TIME & SOURCE CONTENT

CAM-? Up to ten thousand:

CAM-1 Let's see ---

CAM-1 That was one twenty-eight seven five

CAM-1 One twenty-seven eight five --- try that, Boston

CAM-1 Try that

CAM-1 Ask him if ---

CAM-? * * *

1408:31.5 CAM-3 Could open a bleed %

CAM-1 All right

AIR-GROUND COMMUNICATIONS

TIME & SOURCE CONTENT

RDO-2 Boston Center, Clipper one sixty

1408:04.5 RDO-2 Boston Center, Clipper one six zero

1408:07.0 BCTR One six zero, go ahead

1408:09.5 RDO-2 Clipper one sixty, you, uh, told us to go to Montreal Center on one twenty-two thirty-five. Unable

1408:16.0 BCTR One thirty-two thirty-five, right now. One thirty-two thirty-five

RDO-2 One thirty-two thirty-five

1408:24.0 RDO-2 Montreal Center, Clipper one sixty

NAVY LIBRARY

APPENDIX E

INTRA-COCKPIT/INTERPHONE

<u>TIME & SOURCE</u>	<u>CONTENT</u>
CAM-3 CAM-1 CAM-1	And try and get some air in this # # # Go ahead # #
CAM-1	Tell 'em we wanna go to * * (direct)
CAM-?	* * frequency * *
1409:19.5 CAM-1	It's still getting thicker, isn't it?
CAM-3	Seems like there could be equipment
CAM-1	There is no smoke in those smoke detectors though, is there?
1409:29.5 CAM-3	Yes, there is now
CAM-1	There is?

AIR-GROUND COMMUNICATIONS

<u>TIME & SOURCE</u>	<u>CONTENT</u>
RDO-2	Montreal Center, Clipper one sixty
1408:45.0 MCTR	Clipper one six zero Montreal --- squawk --- ident say the altitude
1408:48.5 RDO-2	Clipper one sixty level at three one zero and we wanna go right back to Kennedy at this time
MCTR	Clipper one six zero, roger. Turn right heading one eight zero
RDO-2	Right turn to one eight zero, thank you
MCTR	And Clipper one six zero go ahead the problem
RDO-2	Did you call Clipper one six zero?
1409:16.0 MCTR	Ah, disregard, Clipper

CAM-1 There is?

AIR-GROUND COMMUNICATIONS

TIME & SOURCE CONTENT

INTRA-COCKPIT/INTERPHONE

TIME & SOURCE CONTENT

- CAM-3 Yeah
- CAM-1 Where would that pick it up from, back there or ---
- CAM-3 Well it's probably going up this way and coming back around
- CAM-2 Yeah
- CAM-1 Yeah
- CAM-3 Through the forward one
- 1409:45.5
CAM-3 Turn the equipment cooling blower off. I think you don't need to go in the (back then)
- CAM-1 Right ((simultaneous with "then" above))
- CAM-3 Because it should pop a breaker some place
- CAM-? Yeah
- 1409:58.0
CAM-3 We oughta go on oxygen, this # getting a little thick, eh?
- CAM-2 I do too
- CAM-1 Just wait 'til we --- GO ahead

1410:04.0
RDO-1 Pan Ops from the Clipper one sixty

APPENDIX E

INTRA-COCKPIT/INTERPHONE

TIME &
SOURCE

CONTENT

CAN-2

We can increase our ventilation ---
((begins at word "that" in transmission
to right))

AIR-GROUND COMMUNICATIONS

TIME &
SOURCE

CONTENT

PAN OP NY One sixty Pan Op New York go

RDO-1

Yes sir we just got our clearance to,
ah, --- for a one eighty. We're coming
back to New York and it seems to be
getting a little thicker in here

PAN OP NY

New York Clipper one sixty understand
that you're turning around now and
returning to New York and the smoke is
thicker. Ah, will you be requesting
equipment on arrival?

1410:27.0
MCTR

Clipper one six zero you're cleared to
Kennedy direct ---

RDO-1

Ah, we'll let you know a little later
on. I think we have a few minutes.
We're just up around Sherbrooke ---
between Sherbrooke and Cambridge right
now so we have another twenty minutes
or half an hour. ((Begins with word
"direct" in above transmission))

PAN OP NY

Very good sir, thank you

RDO-2

Montreal you were blocked out. Under-
stand direct Kennedy and say the rest.
((Begins with word "now" in above
transmission))

AREA-COCKPIT/INTERPHONE

TIME & SOURCE CONTENT

CAM-1 where --- what do you see?

1410:53.5
CAM-1 # # --- it is getting heavy

CAM-? huh?

CAM-3 I think we better take it to Boston

CAM-1 Yeah

1410:58.5
CAM-3 This # thing is getting thick back here

CAM-1 And tell 'em we wanna get down and head for Boston

CAM-2 Right

AIR-AROUND COMMUNICATIONS

TIME & SOURCE CONTENT

MCTR For now contact Boston one two eight seven five

1410:45.0
RDO-2 Roger roger direct Kennedy one twenty-eight seventy-five, good day

1411:00.5
RDO-2 New York this is the Clipper one sixty

PAN OP NY Okay, go ahead

RDO-2 Yes sir, I think we're gonna take this thing into Boston, this smoke is getting too thick

PAN OP NY Understand you're going to Boston ('cause) the smoke is too --- stand by one

APPENDIX E

AIR-GROUND COMMUNICATIONS

TIME & SOURCE CONTENT

1411:17.0
RDO-2 Boston Center, Clipper one ((transmission broken)). ((Note: start of oxygen mask sound))

1411:33.0
RDO-2 Boston Center, Clipper one sixty requesting direct Boston and, ah, requesting descent

1411:40.0
BCTR Clipper one sixty, ah, roger stand by just one sec --- and, ah, wha---, how low would you like to go?

INTRA-COCKPIT/INTERPHONE

TIME & SOURCE CONTENT

1411:20.0
CAM-1 Wait a minute. What the # was that number?

CAM-2 One twenty-eight seventy-five

I/P-3 ((Breathing))

CAM-1 You back on that one, okay

CAM-2 Descent check

I/P-3 Ready * for this?

CAM-1 Get it ready

1411:25.0
CAM-2 Somebody's breathing in my (ah) ((masks go on))

INTRA-COCKPIT/INTERPHONE

TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATIONS

TIME &
SOURCE CONTENT

1411:46.0
RDO-2

Ah, say again please

BCTR

One sixty Boston, are you in an emergency or anything?

1411:54.0
RDO-2

Boston, please give me a heading direct Boston at this time

BCTR

One sixty pick up a heading of, ah, one seven zero and when able, proceed direct to Boston

RDO-2

Thank you very much

1412:07.0
RDO-1

Ah, we'd like to start our descent also if possible

BCTR

One sixty, descend and maintain flight level one eight zero, correction --- one nine zero

1412:14.0
PAN OP NY

Sixty, Pan Op

1412:16.0
RDO-1

Yessir, we're out of three one for one nine zero

PAN OP NY

Sixty ---

1412:20.0
I/P-3

Go ahead

APPENDIX E

INTRA-COCKPIT/INTERPHONE

TIME & SOURCE CONTENT

1412:25.0
I/P-1 D' you guys want to get your goggles?

1412:33.0
I/P-3

D' you want equipment on arrival at Boston? Probably wouldn't hurt, huh?

I/P-1

Stand by one, I don't --- know --- what did --- how's the smoke doing?

1412:43.0
I/P-3

That # # # is full back there

1412:48.0
I/P-1

Better have the equipment

AIR-GROUND COMMUNICATIONS

TIME & SOURCE CONTENT

1412:28.0
RDO-3 Pan Op go ahead

PAN OP NY

Are you requesting equipment on arrival (at) Boston sir?

1412:52.0
RDO-3

Okay, we want the equipment Boston, uh, cockpit's full back here

PAN OP NY

Okay, we're on the phone with them right now

1412:57.5
RDO-2

Boston Center, Clipper one sixty

1413:14.0
RDO-2

Bost--

1413:26.0
RDO-2

Boston Center, Clipper one sixty

INTRA-COCKPIT/INTERPHONE

TIME & SOURCE CONTENT

1413:36.0
I/P-3 Okay, I'll give ya the descent check here, stand by

I/P-3 Okay, radio altimeters

I/P-3 They're on

1413:44.5
I/P-1 Got your Boston plates out?

I/P-3 Okay fire warning, I'm gonna check the fire warning

1413:51.0
I/P-1 Go ahead

CAM Sound of fire warning bell

I/P-3 Okay

I/P-3 Test the instrument warning

I/P-3 Aux pump two

CAM-? Aux pump two

I/P-1 It's on

AIR-GROUND COMMUNICATIONS

TIME & SOURCE CONTENT

1413:43.0
BCTR One sixty, Boston, would you say the nature of your problem please?

1413:47.0
RDO-2 The Clipper one sixty is out of twenty-five point five

1413:53.0
BCTR One sixty, ah, Boston roger can you say again the, uh, nature of your emergency?

1413:58.0
RDO-2 Ah, we have smoke in the cockpit at this time

1414:01.0
BCTR Sixty roger

APPENDIX E

INTEA-COCKPIT/INTERPHONE

TIME & SOURCE CONTENT

1414:09.0
I/P-3 Test the radio altimeters

I/P-1 Tested

I/P-3 Okay KIFIS, we don't have

I/P-3 Pressure altimeters

I/P-3 We got a Boston altimeter?

1414:18.5
I/P-1 Not yet

I/P-2 Kennebunk

AIR-GROUND COMMUNICATIONS

TIME & SOURCE CONTENT

1414:14.5
BCTR Sixty Boston Center now at one two six point six five

1414:17.5
RDO-2 One twenty-six sixty-five

1414:25.5
RDO-2 Boston Center, Clipper one sixty

BCTR One sixty Boston Center, ident

RDO-2 Identing and, uh, please, uh, just keep me on this frequency. It's too # hard to change

BCTR Okay, I'll keep you on this frequency, roger sir, fly direct Kennebunk, Victor one thirty-nine skipper Boston

1414:42.5
RDO-2 Kennebunk, uh, Victor one thirty-nine skipper Boston, roger

BCTR And, uh, understand you have smoke in the cockpit sir

INTRA-COCKPIT/INTERPHONE

TIME & SOURCE CONTENT

I/P-2 Ah, just stay on this one --- one
seventeen one

I/P-2 One seventeen one

I/P-1 Okay, I got it

1415:37.5
CAM Sound of altitude alert

AIR-GROUND COMMUNICATIONS

TIME & SOURCE CONTENT

RDO-2 Affirmative
1414:52.0
BCTR Maintain one nine zero, report reaching

RDO-2 Roger

1415:35.5
BCTR Clipper one sixty is cleared direct to
Boston

RDO-2 Clipper one sixty is cleared direct Boston

BCTR Clipper one sixty is cleared direct to
Boston

RDO-2 Cleared direct Boston, Clipper one sixty

RDO-2 Can you give me the landing runway please?

BCTR Clipper one sixty squawk code one five
zero zero

1416:19.0
RDO-2 Squawking one five zero zero, level one
nine zero

1416:26.0
I/P-1 How does it look in the back Dave?

1416:31.0
I/P-3 It's full

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INTRA-COCKPIT/INTERPHONE

TIME & SOURCE CONTENT

I/P-1 Is your DME in on Boston?

I/P-2 No, it's not comin' in

I/P-1 'kay, watch the airplane, I'm gonna get my Boston plates

I/P-2 You bet

1416:56.0

I/P-1 Smoke detector showin' much?

1416:57.5

I/P-3 No, ah, it's showin' the same as it was

I/P-3 We're somehow gettin' it up through the floor from down below and it's goin' in the back I think

AIR-GROUND COMMUNICATIONS

TIME & SOURCE CONTENT

1417:24.0

ECTR Clipper one sixty, I don't know whether you received it. You're cleared direct to Boston

RDO-2

Understand direct Boston. Do you read me?

ECTR

Read you five by now

RDO-2

Thank you

1417:48.0

RDO-2

And, uh, how far am I from Boston right now?

INTRA-COCKPIT/INTERPHONE

<u>TIME & SOURCE</u>	<u>CONTENT</u>
I/P-3	We weigh two seventy-eight right now
I/P-1	Okay, I think we'll take it on in * *
I/P-3	Just ease it on --- it should be okay
I/P-1	Right

AIR-GROUND COMMUNICATIONS

<u>TIME & SOURCE</u>	<u>CONTENT</u>
1418:04.0 BCTR	Uh --- a hundred miles, uh, out of Boston
RDO-2	Okay, thank you

1418:40.5
BCTR

One sixty, uh, what is your, uh, altitude now please and if I can be of assistance in any manner let me know

1418:47.0
RDO-2

Ah, we're at one nine zero and it's fine for us

BCTR

Real fine, okay, thank you

RDO-2

Okay we're ready to descend now, Clipper one sixty

CAN-2 We ready to descend now?

((SELCAL Modulation))

BCTR

Sixty, roger, stand by

I/P-1

As a matter of fact we'd like ---

1419:01.0
RDO-1

We'd like to get down as soon as possible so we can burn off some fuel ((Note: Sound of Boston ATIS "Julliet" broadcast thru copilot's audio selector panel. No VOR ident discernable))

APPENDIX E

INTRA-COCKPIT/INTERPHONE

TIME & SOURCE CONTENT

I/P-3 We'll see

I/P-? ((Unidentified background noise))

AIR-GROUND COMMUNICATIONS

TIME & SOURCE CONTENT

1419:13.5
RDO-1

Boston from Clipper one sixty

BCTR

One sixty go ahead

RDO-1

Yes sir we'd like to get down as soon as possible so we can burn off some fuel rather than dump

BCTR

Coordinatin' with the (uh, the) lower sector now

BCTR

Clipper one sixty descend and maintain one zero thousand

1419:29.0
RDO-2

Down to one zero thousand, Clipper one sixty ((sound of Boston ATIS "Julliet" broadcast follows above transmission))

1419:45.0

I/P-3 I can't find a thing wrong back here

I/P-1 What's that?

I/P-3 I can't find anything wrong

I/P-1 Okay, uh, maybe it's in a package

I/P-3 Could be

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AIR-GROUND COMMUNICATIONS

INTRA-COCKPIT/INTERPHONE

TIME & SOURCE CONTENT

TIME & SOURCE CONTENT

1419:59.5
I/P-1 Ah, you didn't get in to open the door into the back section, did you?

I/P-1 Ah, they're suppose to be flame resistant or fire resistant anyhow, isn't it?

1420:06.5
I/P-3 Well I --- I looked back there --- the smoke --- there's more smoke back there but there's none up here now

I/P-3 It must --- it's in the lower forty-one someplace

I/P-1 I think so

I/P-1 What was the altimeter twenty nine seventy three, thank you

1420:32.0
BCIR

Sixty the Boston altimeter two nine seven five

Two nine seven five ((Note: sound of Boston ATIS "Julliet" broadcast heard during two transmissions above))

RDO-2

I/P-1 Are we on vectors?

I/P-1 It's direct Boston, wasn't it?

I/P-2 Right

I/P-3 Want to make a normal landing out of it, Johnny?

I/P-1 What's that?

INTRA-COCKPIT/INTERPHONE

<u>TIME & SOURCE</u>	<u>COMMENT</u>
I/P-3	Normal landing?
I/P-1	I think so, yeah
I/P-3	Okay

I/P-1 Ah, negative we

1421:23.5 CAM Altitude alert

AIR-GROUND COMMUNICATIONS

<u>TIME & SOURCE</u>	<u>COMMENT</u>
1421:11.5 BCTR	One sixty you anticipating flying, ah, locally to burn off fuel?
RDO-1	Ah, negative, we, negative we're coming right in
BCTR	Yes sir
RDO-1	Ah, we would like as low as possible to burn it off as we're coming down and in
1421:30.5 BCTR	The Clipper one sixty, yuh got a rough, ah, ETA Boston for me?
1421:35.0 RDO-1	Yes, it'll be, ah, ETA Boston about three five
1421:42.5 BCTR	Sixty descend and maintain six thousand
1421:45.5 RDO-2	Down to six thousand Clipper one sixty

1421:56.0 I/P-3 Maybe we should advise the fire department that we suspect electrical *

INTRA-COCKPIT/INTERPHONE

TIME & SOURCE

COMMENT

1422:21.0
I/P-1

How long is thirty-one and how long is two seven?

I/P-2

Twenty-seven is seven thousand and thirty three is ten thousand

I/P-1

How much you is, ah, two seven

I/P-2

Two seven, seven thousand, seven zero

I/P-1

We'll take thirty-one --- thirty-three runway thirty-three

1422:46.0
I/P-1

One two eight two

AIR-GROUND COMMUNICATIONS

TIME & SOURCE

COMMENT

1421:58.5
ECTR

Sixty two, ah, Boston, ah, weather four thousand, ah, scattered, visibility fifteen plus, runway twenty-seven is the active runway, thirty-three left is available, the winds two eight zero, ah, stand by the winds, ah, two eight zero variable three one zero fifteen gusts two five, altimeter two nine seven, ah, five

1422:27.0
BCTR

The current altimeter now two nine seven three

1422:40.0
BCTR

Clipper one sixty, if you lose communications with me your backup frequency 'll be one two eight point two

RDO-2

Okay, one twenty eight two if we lose contact with you ---

BCTR

Yes (sir)

RDO-2

And we'll be taking runway three three please

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APPENDIX E

INPA-COCKPIT/INTERPHONE

TIME & SOURCE COMMENT

I/P-1 Yes

1423:13.0
CAM Altitude alert

I/P-3 Shall I advise the tower that we got a --- that we suspect it's electrical in the forward end of the airplane?

CAM-1 What's Pan Ops?

I/P-3 One twenty-nine eight

I/P-3 One twenty-nine seven (I think)

1423:30.5
I/P-2 Comin' up on six thousand

1423:34.0
I/P-3 I'll tell Pan Op all right?

AIR-GROUND COMMUNICATIONS

TIME & SOURCE COMMENT

BCTR I'll advise Boston approach --- and you want equipment standing by?

1423:03.0
RDO-2 Roger on the equipment Clipper one sixty

1423:28.5
BCTR One sixty are you reading Boston suitable for navigation?

1423:40.5
RDO-3 Ah, Pan Op Clipper one sixty ((F/E mask off))

PAN OP B Clipper one sixty go ahead sir

INTRA-COCKPIT/INTERPHONE

TIME &
SOURCE

CONTENT

AIR-GROUND COMMUNICATIONS

TIME &
SOURCE

CONTENT

1423:48.0
RDO-3

Okay, we suspect this problem is electrical and it's in the forward end of the airplane. It's either in lower forty-one or the forward cargo hold it seems like. There's quite a bit of smoke in the cockpit-- in the, ah, --- cabin %

1423:57.5
RDO-2

Boston Center Clipper one sixty can you get us down about two thousand feet, we're right in the clouds ((begins with word "ah" above))

RDO-3

--- but, ah, there doesn't, there isn't too much in the cockpit right now ((completed during above transmission))

PAN OP B

Ah, roger, roger, I have your equipment standing by, and what's your ETA sir?

RDO-3

About thirty-five and have 'em open the lower forty-one when we get there and, uh, --- stairs up the front door, it doesn't seem to be that much of a problem

RDO-2

Boston Center Clipper one sixty ((begins with "forty" above))

BCTR

One sixty go ahead ((begins with "uh" above))

RDO-2

Can you get me down about two thousand feet?

BCTR

(Stand) by

INTRA-COCKPIT/INTERPHONE

TIME & SOURCE

CONTENT

I/P-3 Pressure altimeters

I/P-1 Twenty-nine seven-five is okay

I/P-2 Set right

I/P-3 Set both times in the back

I/P-3 Landing bugs, we weigh two seventy-eight

I/P-2 D' you want two?

I/P-1 I'd rather bump a little bit and get down there and burn some of this fuel off

I/P-2 Say again that landing gross weight

I/P-3 Okay, it was two seventy-eight but we're not burning it up very fast

I/P-3 Call it two seven five for landing

1426:01.0
CAM Altitude alert

AIR-GROUND COMMUNICATIONS

TIME & SOURCE

CONTENT

1425:09.0
BCTR

One sixty our radar shows your overhead Kennebunk right now ((begins with word "have" on left))

RDO-2 Thank you

BCTR

Sixty, two thousand is available. Just let me know

1425:30.0
RDO-2

Clipper one sixty is out of four thousand for two thousand

BCTR

Sixty, roger

INTRA-COCKPIT/INTERPHONE

<u>TIME & SOURCE</u>	<u>CONTENT</u>
I/P-2	Okay, that looks like one forty-three --- for number one bug
I/P-1	Ah, throw the gear out please
I/P-2	Gear coming dow--
I/P-3	* * *
I/P-1	Hold it, hold it, I'm sorry, wait 'til I slow it down, we'll tear the # doors off ((begins on top of " * * " above))

CAM-1 What'd he say?

CAM-3 Boy, this # # # won't slow down
CAM Click

AIR-GROUND COMMUNICATIONS

<u>TIME & SOURCE</u>	<u>CONTENT</u>
1426:32.0 PAN OP B	Ah, Clipper one sixty, if you're on the freq would you advise us if the lower motor CB has been pulled
RDO-3	I'm sorry say that if the what?
PAN OP B	The blower motor CB
RDO-3	I tried that, it didn't make any difference
PAN OP B	Roger, thank you
BCTR	Sixty, say again
1426:58.5 RDO-2	Disregard sir

INTRA-COCKPIT/INTERPHONE

TIME & SOURCE

COMMENT

I/P-3

Okay, we're down to the landing bugs, did we decide on those?

I/P-1

Ah, yes, stand by one, put the gear down now please

CAM

Sound of increase in ambient noise

1427:30.0

CAM

Altitude alert

I/P-1

What position was he in?

I/P-2

I think he said twelve o'clock

I/P-3

Yeah he did

1427:59.0

I/P-1

I don't smell that smoke as much now, there doesn't seem to be as much, does it?

I/P-3

Ah --- ah, it doesn't seem to be as much

AIR-GROUND COMMUNICATIONS

TIME & SOURCE

COMMENT

1427:10.5

RDO-2

One sixty's level at two thousand

BCTR

Sixty, roger

BCTR

One sixty has traffic at, ah, twelve o'clock four miles opposite direction, slow, altitude unknown

RDO-2

Okay Clipper one sixty, ah, negative contact

INTRA-COCKPIT/INTERPHONE

<u>TIME & SOURCE</u>	<u>CONTENT</u>
--------------------------	----------------

I/P-1 Huh?

I/P-3 It doesn't seem to be as much

1428:35.0
I/P-3

Okay the engineer's check is complete, the approach check is complete, the landing is next

I/P-1 Okay, stand by

I/P-2 For the ILS you might wanna turn that three thirty into your course selector --- I've got the ADF's set up

1428:56.0
CAM

Altitude alert

1429:30.0
I/P-3

Ah, it's definitely comin' out of lower forty-one

I/P-2 Still coming out huh?

I/P-3 Yeah

I/P-1 Is it?

I/P-3 It is

I/P-1 Okay

AIR-GROUND COMMUNICATIONS

<u>TIME & SOURCE</u>	<u>CONTENT</u>
--------------------------	----------------

BCTR Sixty is passing your traffic at this time

RDO-2 Thank you, Clipper one sixty

RDO-1 Boston from the Clipper one sixty

BCTR Sixty go ahead

INTRA-COCKPIT/INTERPHONE

TIME & SOURCE CONTENT

1430:01.5
CAM

Altitude alert ((appears simultaneous with word "now"))

1430:17.5
I/P-3

That's worse. I don't see

I/P-1

It's getting worse?

1430:20.5
I/P-3

Ah, I turned the, ah, equipment cooler off and that --- that made it worse

I/P-1

Okay, then if that'll blow it out if you take the --- keep it moving won't it?

I/P-3

Yeah, I just pulled the breaker out again. I tried the CB to see if that'd do it, but the ---

I/P-3

Okay

I/P-3

It's ah ---

1430:36.5
I/P-1

All of a sudden it is getting worse in here

I/P-3

Yeah

I/P-3

It's somewhere down in lower forty-one

AIR-GROUND COMMUNICATIONS

TIME & SOURCE CONTENT

RDO-1

Ah, what is our distance out. The DME's don't seem to be working

1429:59.5
BCTR

You're passing abeam Pease Air Force Base right now sir, and you're about, ah, forty-five, --- ah --- forty to forty-five miles to the northeast of Boston

RDO-1

Okay, thank you

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APPENDIX E

INTRA-COCKPIT/INTERPHONE

TIME & SOURCE CONTENT

1430:46.5
I/P-3

Tell ya what, turn the radar off, the doppler's off --- anything yuh don't need, let's shut 'em down

I/P-3

That's off

I/P-3

Okay, it's VFR could I turn the, ah, ra--, radio altimeter (off)?

AIR-GROUND COMMUNICATIONS

TIME & SOURCE CONTENT

1430:51.5
BCTR

One sixty Boston Approach Control now one two zero point six ((begins with "don't" to left))

RDO-2

One twenty point six for Clipper one sixty

1431:06.5
RDO-2

Boston Approach Control, it's Clipper one sixty

1431:18.0
RDO-2

Boston Approach Control, Clipper one sixty

1431:20.5
AR-2

One sixty Bost-- Approach Control, radar contact thirty-five miles northeast of Boston, proceed direct Boston, maintain two thousand, and are you declaring an emergency?

1431:29.5
RDO-2

Negative on the emergency and, ah, may we have runway three three left?

AIR-GROUND COMMUNICATIONS

TIME & SOURCE CONTENT

1431:33.0
AR-2

That is correct, you can plan three three left understand negative emergency, maintain two thousand and, ah, expect a visual approach to runway three three left. The Boston altimeter two nine seven three, the wind is two nine zero at one eight, the Boston weather four thousand scattered, visibility more than one five

1431:50.5
RDO-2

Roger, roger Boston, Clipper one sixty

RDO-2

Sound similar to AIF carrier frequency

INTRA-COCKPIT/INTERPHONE

TIME & SOURCE CONTENT

1432:22.5
I/P-3

Hum ((expression of awareness))

1432:29.0
I/P-1

Uh, using two hundred and seventy, what is our landing gro-- ah, bugs?

1432:35.5
I/P-2

One forty-five and one fifty-five it you wanna use the other ten

1432:42.5
I/P-1

Forty-five and fifty-five at two seventy?

1432:46.0
I/P-2

Roger, actually, ah, two seventy, one four two --- one forty-two

1432:54.5
I/P-1

One four two?

1432:55.5
I/P-2

Roger

APPENDIX E

AIR-GROUND COMMUNICATIONS

<u>TIME & SOURCE</u>	<u>CONTENT</u>
RDO-?	Sound of dit dah dit dit, dit dit ((HULL LOH))

INTRA-COCKPIT/INTERPHONE

<u>TIME & SOURCE</u>	<u>CONTENT</u>
1433:42.0 I/P-3	Doesn't seem to be gettin' any worse
1433:44.5 I/P-1	No, but I don't think it's getting any better, is it?
1433:46.5 I/P-3	No, it's not getting any better
1433:48.5 I/P-1	Beg pardon
1433:49.5 I/P-3	Its not getting any better
1433:51.0 I/P-1	No
1433:52.0 I/P-2	It's getting worse right now, you can see it blowin' around here
1433:54.0 I/P-3	Yeah
I/P-1	Yeah *
1433:58.5 I/P-2	Gear up?
1434:01.0 I/P-1	Nav, I want to burn up fuel

AIR-GROUND COMMUNICATIONS

INTRA-COCKPIT/INTERPHONE

TIME & SOURCE CONTENT

CAM ((High pitched noise squeal))

1434:15.0
I/P-3

Okay, landing gear

1434:18.0
I/P-1

Three green

I/P-2

Down three green

1434:20.0
AR-2

Clipper one sixty, what do you show for a compass heading right now?

1434:23.0
RDO-2

Compass heading at this time is two zero five

1434:26.0
AR-2

Okay fine and will you accept a vector for a visual approach to a five mile final, ah, will that be sat --- compatible with you?

1434:27.0
Note:

600 Hz tone begins sequencing with words "will you" to the right on all four tracks and continues until the end of the recording ((tone is similar to test feature on CVR))

1434:32.0
I/P-1

I didn't hear that, try it again

I/P-(2)

* first time we lost that circuit

1434:35.5
RDO-2

What was that, approach?

APPENDIX E

INTRA-COCKPIT/INTERPHONE

TIME & SOURCE

CONTENT

1434:42.0
CAM

Recording ceases except for 600 Hz cyclic tone

Note:

Two short duration tones approximately 400 Hz appears simultaneously with "Ah negative" at 1434:44.0

AIR-GROUND COMMUNICATIONS

TIME & SOURCE

CONTENT

1434:36.5
AR-2

Will you accept a vector for a visual approach to a five mile final for runway three three left, or do you want to be extended out further?

1434:43.0
RDO-1

Ah negative, we want to get in as soon as possible

1434:46.5
AR-2

Okay proceed to the Boston VOR, advise when you have the airport in sight Clipper one sixty, you're number one for runway three three left

1434:53.5
RDO-2

Roger, Clipper one sixty

1434:55.5
AR-2

Are you able to maintain two thou---

1434:56.5

End of CVR Recording

Note:

All radio transmissions hereafter taken from ATC AR-2 tape

1434:57.5
RDO-2

That's affirmative

INTRA-COCKPIT/INTERPHONE

TIME &
SOURCE

CONTENT

AIR-GROUND COMMUNICATIONS

TIME &
SOURCE

CONTENT

1434:58.5
AR-2

Okay, fine. There will be traffic at ten o'clock, one zero miles westbound --- an Air Canada viscount descending to three

1435:05.5
RDO-2

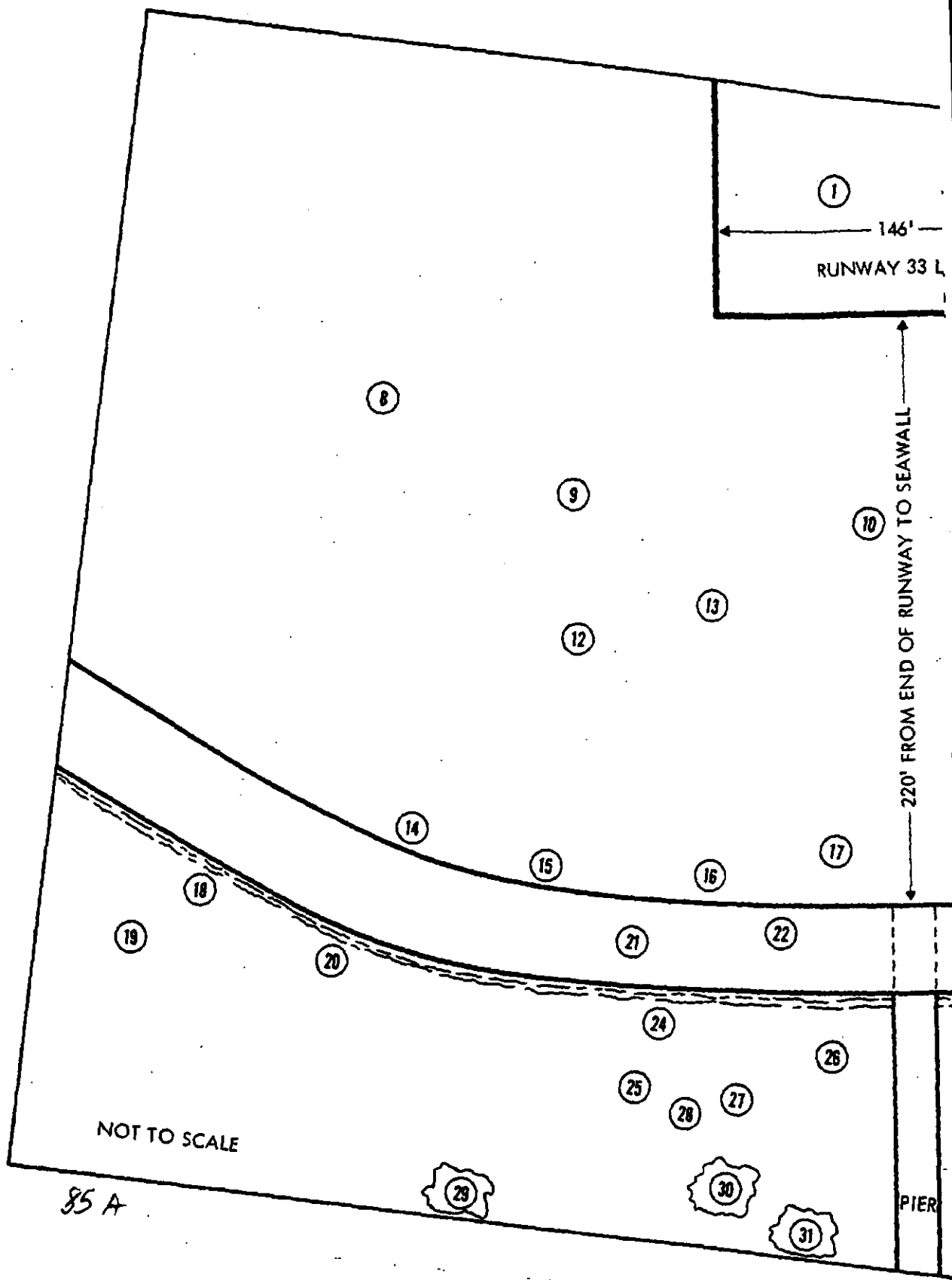
Roger ((last radio transmission received from Pan Am Flight 160))

1435:46.0
AR-2

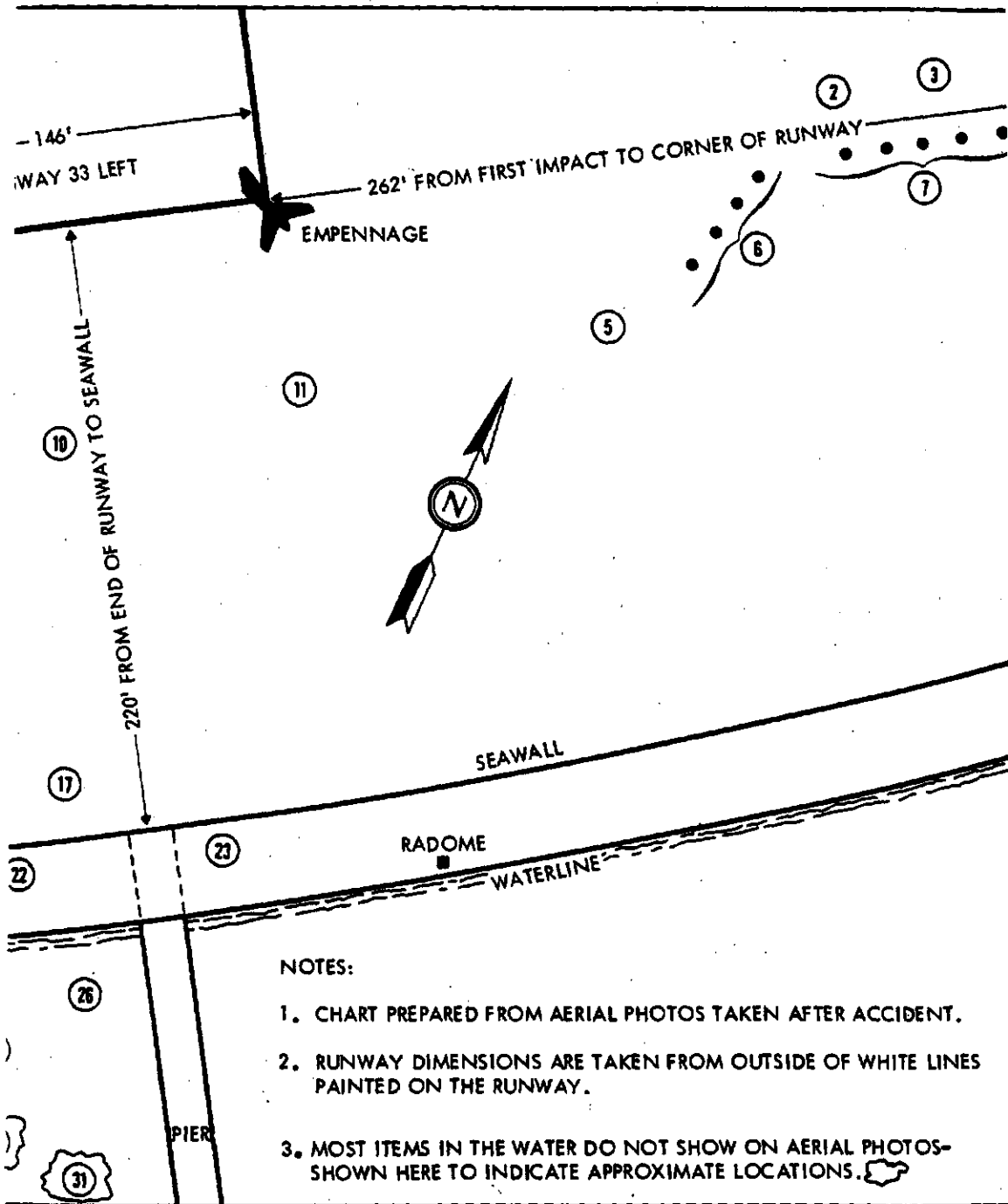
Clipper one sixty, advise anytime you have the airport in sight

1440:06.0

IMPACT ((based on AR-2, Local Control and Ground Control ATC tape correlation))



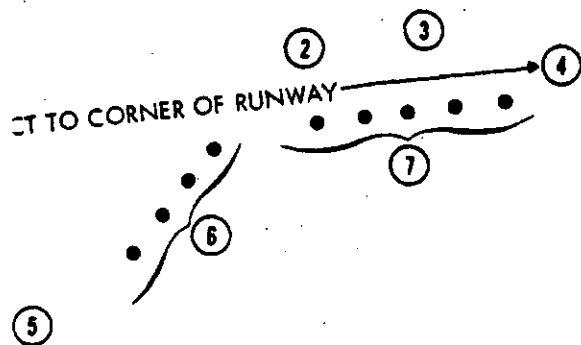
85 A



NOTES:

1. CHART PREPARED FROM AERIAL PHOTOS TAKEN AFTER ACCIDENT.
2. RUNWAY DIMENSIONS ARE TAKEN FROM OUTSIDE OF WHITE LINES PAINTED ON THE RUNWAY.
3. MOST ITEMS IN THE WATER DO NOT SHOW ON AERIAL PHOTOS—SHOWN HERE TO INDICATE APPROXIMATE LOCATIONS.

85 B



LEGEND

1. NO. 2 ENGINE
2. GOUGE IN EARTH
3. CSD AND STARTER FROM NO. 2 ENGINE
4. FIRST IMPACT GOUGE IN EARTH
5. AIR CONDITIONING, HEAT EXCHANGER
6. ENGINE ACCESSORY PARTS
7. SECTIONS OF LEADING EDGE FLAP
8. REAR FUSELAGE SECTION
9. MAIN LANDING GEAR SECTION
10. NO. 1 ENGINE
11. ENGINE REVERSER
12. ENGINE COWL
13. WING SECTION
14. MAIN LANDING GEAR, WHEEL WELL SECTION
15. TRAILING EDGE, WING FLAP
16. NOSE GEAR, TRUNNION BOX, HF TUNER, VHF
17. WING SECTION
18. NO. 3 ENGINE
19. MAIN LANDING GEAR, AND WING SECTION
20. NOSE GEAR
21. WING SECTION
22. GENERATOR LOAD CONTROL, STICK SHAKER, CABIN PRESSURE CONTROL AND OTHER AVIONICS PARTS, COCKPIT ASHTRAY
23. TURBO COMPRESSOR COWL, CARGO DOOR ACTUATOR COMPASS SYSTEM PARTS
24. PYLON SECTION
25. ENGINE SECTION
26. ENGINE SECTION
27. FUSELAGE, COCKPIT SECTION
28. FUSELAGE, CARGO NET SECTION
29. WING CENTER SECTION
30. RIGHT WING LEADING EDGE INBOARD SECTION
31. NO. 4 ENGINE AND PYLON

AL PHOTOS TAKEN AFTER ACCIDENT.

TAKEN FROM OUTSIDE OF WHITE LINES

O NOT SHOW ON AERIAL PHOTOS-
PPROXIMATE LOCATIONS.

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D. C.

WRECKAGE DISTRIBUTION CHART

PAN AMERICAN WORLD AIRWAYS

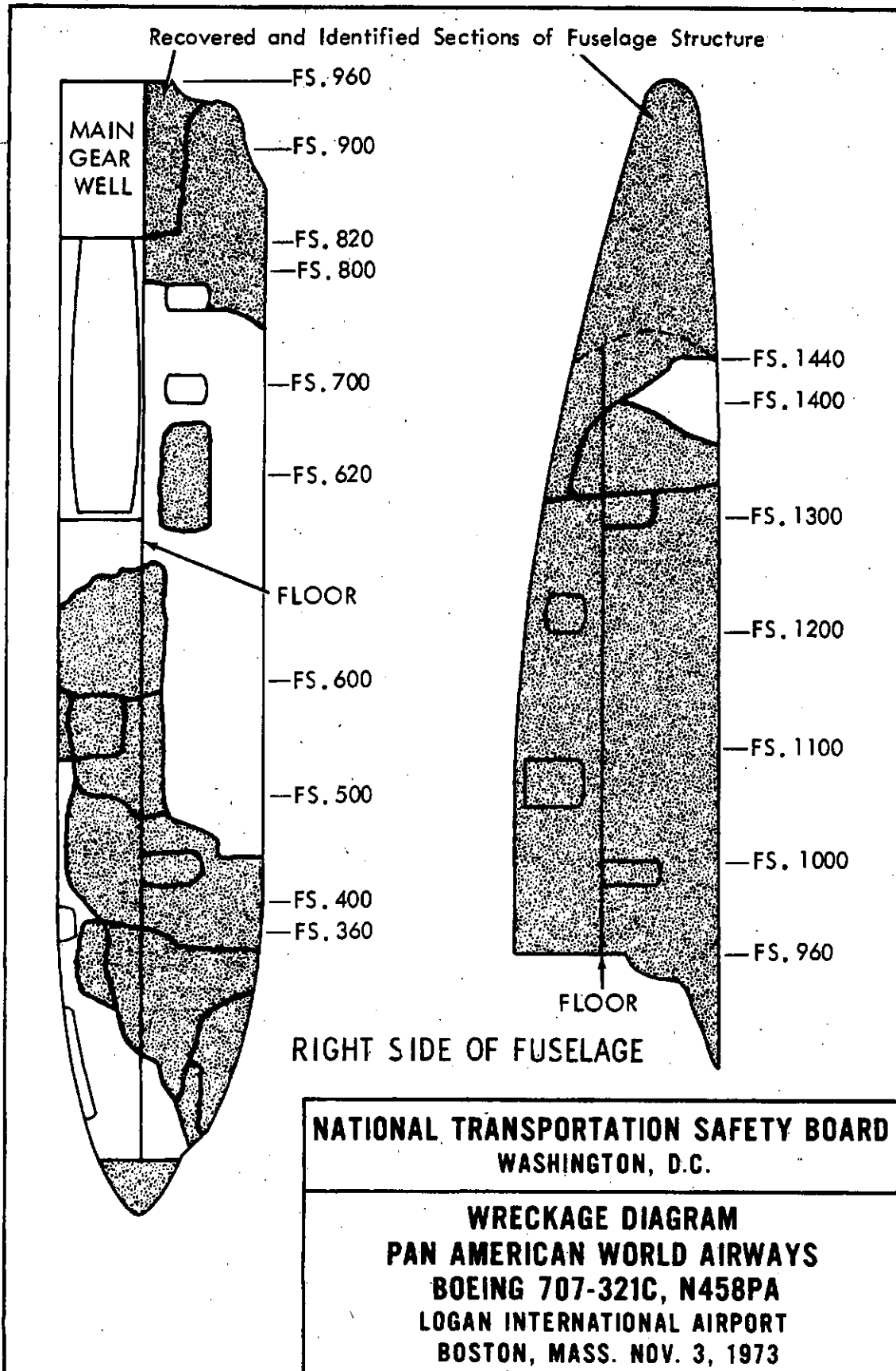
BOEING 707-321C, N458PA

LOGAN INTERNATIONAL AIRPORT

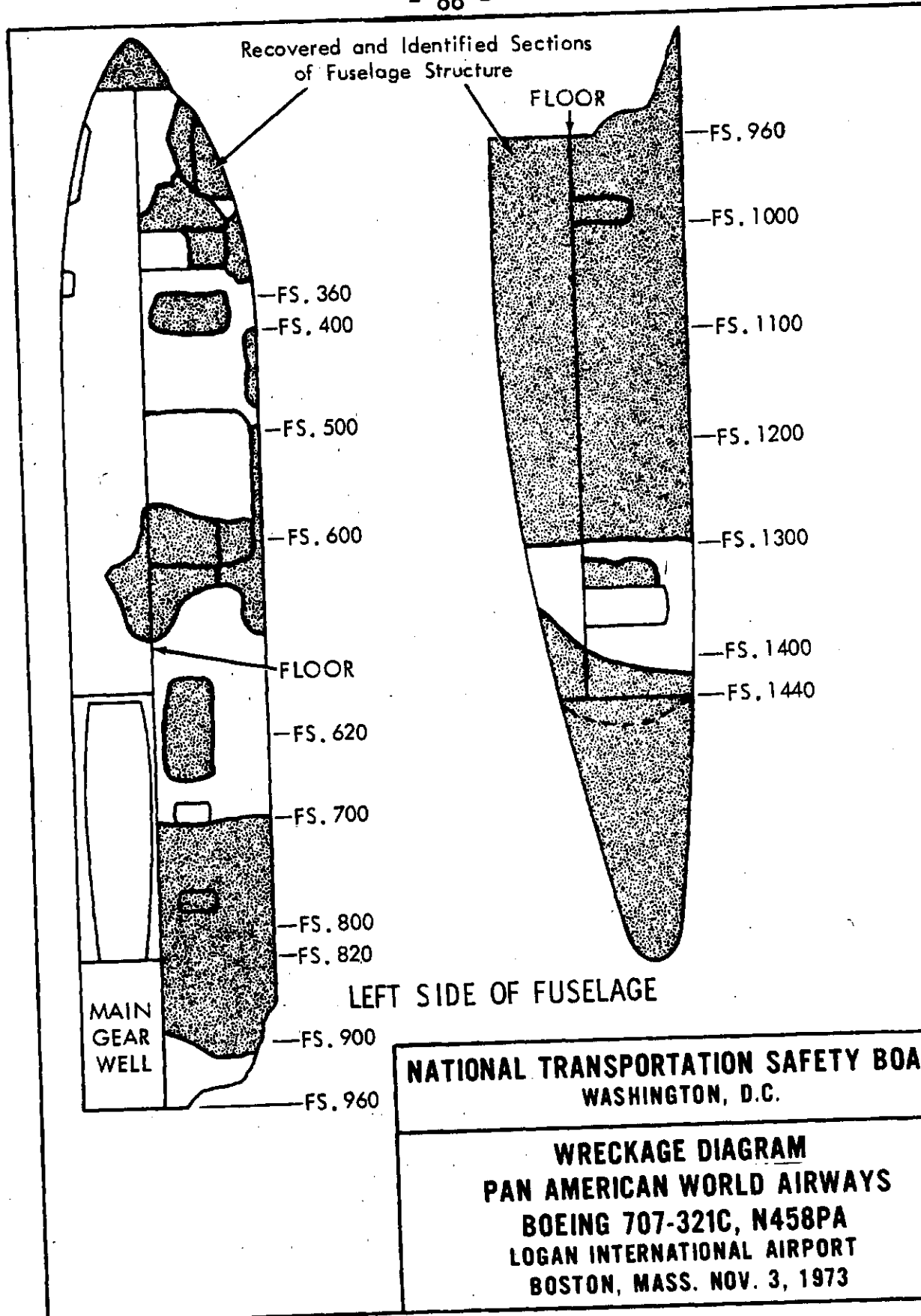
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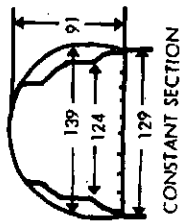
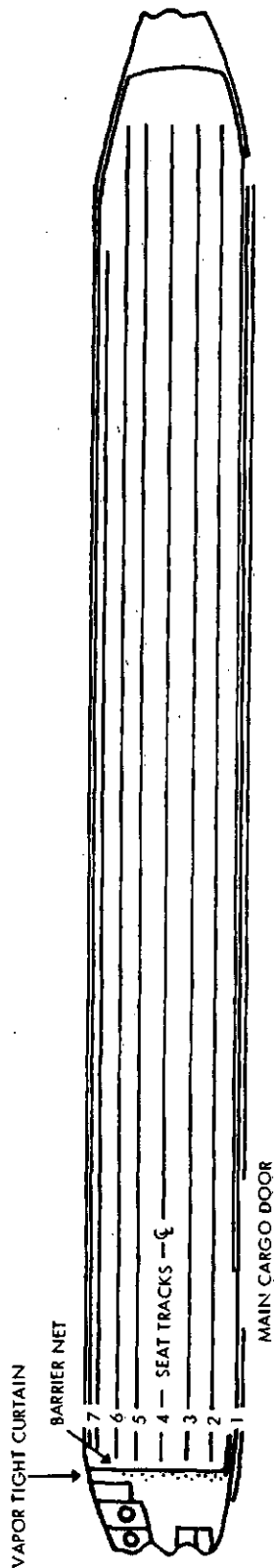
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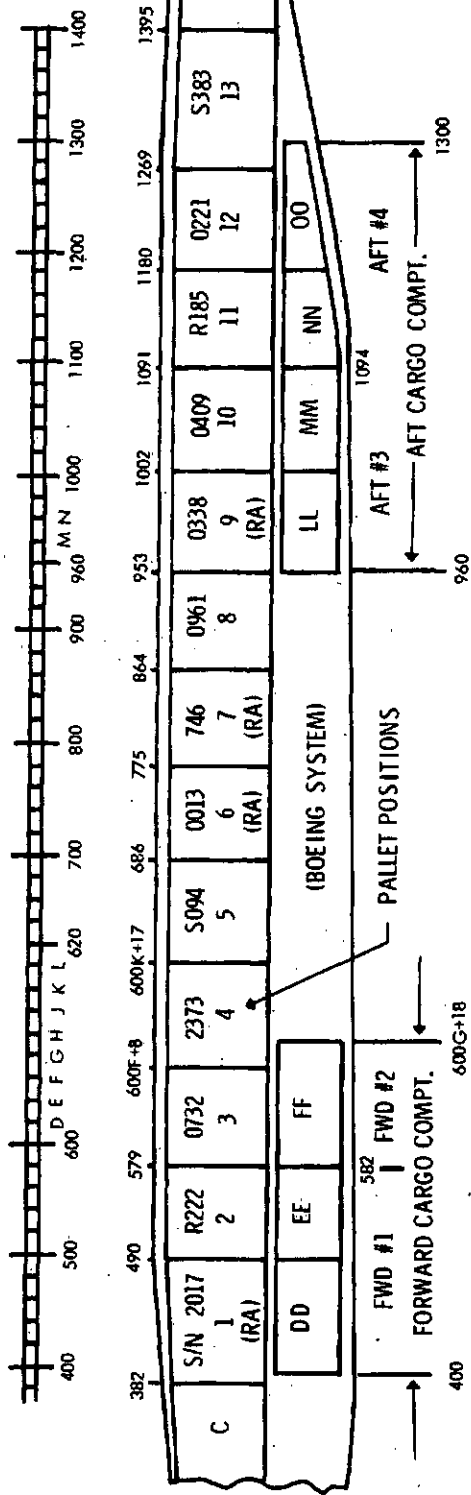
NATIONAL TRANSPORTATION SAFETY BOARD
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WRECKAGE DIAGRAM
PAN AMERICAN WORLD AIRWAYS
BOEING 707-321C, N458PA
LOGAN INTERNATIONAL AIRPORT
BOSTON, MASS. NOV. 3, 1973

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BOEING 707-300C CARGO COMPARTMENTS



NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D. C.
PALLET LOCATION CHART
PAN AMERICAN WORLD AIRWAYS
BOEING 707-321C. N458PA
LOGAN INTERNATIONAL AIRPORT
BOSTON, MASSACHUSETTS NOVEMBER 3, 1973

APPENDIX G

LOCATION OF CARGO - RECONSTRUCTED FROM
PAN AMERICAN PALLET WORKSHEETS

Pallet/Position No./Cargo Com- partment	Pallet Serial No.	Air Waybill	Contents
1	2017	026-42096810	Various chemicals Restricted Article
2	R222	026-42119416	Electronic equipment & parts
3	0732 (001)	026-42119416	Electronic equipment & parts
4	2373	026-42119416	Electronic equipment & parts
		026-39560485	Machines
		026-41947710	Electronic computer parts
5	S094	026-42119416	Electronic equipment & parts
		026-39560006	Electronic computer parts
		026-39560463	Electronic computer parts
		026-41943322	Electronic accounting machine parts
6	0013	026-42096810	Various chemicals Restricted Article
		026-49147710	Electronic computer parts
7	746	026-42096810	Various chemicals Restricted Article
		026-42096806	Sulphuric acid
8	0961	026-42119416	Electronic equipment & parts
		016-01656712	Military stores
9	0338	026-42119816	Electronic equipment & parts
		026-49147710	Electronic computer parts
		026-41919920	Electronic computer parts
		026-42096806	Sulphuric acid Restricted Article
10	0409	026-41947710	Electronic computer parts
11	R185	026-41894775	Emery consolidation (Loaded by Emery) Machine parts, electrical parts, auto parts, power supplies, sporting goods, printed matters, measuring instruments, rubber rings
12	0221	026-41894775	same as above (Loaded by Emery)
13	5383	026-41947710	Electronic computer parts
Fwd. No. 1			Mail "SAM" (Surface Air Mail) 100% fu
Fwd. No. 2			Mail "SAM" 90% fu
Aft No. 3		026-41762663	Mail first-class military Air Mail in sacks, electrical parts, 3 crew bags 50% fu
Aft No. 4			Mail first-class military air mail and civilian mail in sacks 50% fu

NATIONAL TRANSPORTATION SAFETY BOARD WASHINGTON, D.C.

APPENDIX H

ISSUED: November 29, 1973

Forwarded to:

Honorable Alexander P. Butterfield
Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATION(S)

A-73-110

In our continuing investigation of the Pan American World Airways, Inc., Boeing 707, accident at Boston, Massachusetts, on November 3, 1973, we have identified unsafe conditions that should be brought to the immediate attention of all air carriers involved in the transportation of hazardous materials.

A portion of the cargo carried aboard this all-cargo aircraft was chemicals classified as dangerous articles under the provisions of 14 CFR Part 103.1. Included was nitric acid in five one-pint, plastic-capped glass bottles packaged inside wooden boxes cushioned with combustible material similar to sawdust. The outer package did not carry the specification marking "This Side Up" or "This End Up," although two arrows were stenciled on all four sides, suggesting how the package was to have been oriented. The packages appear to have carried the label "White acid" before the accident.

In a test involving induced spillage in one of the nitric acid packages recovered at the scene of the accident, smoke developed within 13 minutes and the outer wooden package started to burn fiercely within 16 minutes. An extremely hazardous condition could be caused accidentally by a bottle cap that was insecure and an outer package that was not properly oriented because of inadequate markings and warnings, or because of improper handling or storage while in a carrier's possession. If a fire were to break out the chemical reaction would be extremely difficult to control, particularly in flight.

Preliminary indications are that on the accident aircraft some of the packages containing hazardous materials may have been placed on their sides.


APPENDIX H

Honorable Alexander P. Butterfield - 2 -

Our investigation of this aspect of the problem is continuing; however, the National Transportation Safety Board is concerned about the likelihood of serious dangerous article incidents involving hazardous materials which are not packaged, labeled, and handled according to the provisions of 14 CFR 103 and 49 CFR 172, 173, and 178.

Accordingly, the Safety Board recommends that the Federal Aviation Administration issue a telegraphic alert to all air carriers involved in the transportation of hazardous materials citing the dangers associated with the handling and transportation of liquid restricted articles, including the need to preclude the air shipment of any improperly labeled hazardous materials packages, and the need to comply with regulations concerning "This Side Up" or "This End Up" stencils on properly labeled hazardous materials packages, to prevent spillage from improperly oriented packages.

McADAMS, THAYER, and BURGESS, Members, concurred in the above recommendation. REED, Chairman, and HALEY, Member, were absent, not voting.


By: Louis M. Thayer
Acting Chairman

**DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION**

WASHINGTON, D.C. 20590



OFFICE OF
THE ADMINISTRATOR

DEC 5 1973

Notation 1209

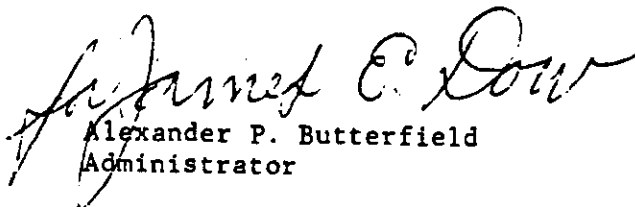
Honorable John H. Reed
Chairman, National Transportation Safety Board
Department of Transportation
Washington, D. C. 20591

Dear Mr. Chairman:

This responds to your Safety Recommendation A-73-110 issued November 29, 1973, concerning Pan American World Airways, Inc., accident of November 3, 1973, at Boston, Massachusetts.

The unsafe condition identified during the course of your investigation of the accident has been brought to the attention of all FAA regions, all U.S. and foreign air carriers, and personnel concerned.

Sincerely,


Alexander P. Butterfield
Administrator

APPENDIX H

**NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.**

ISSUED: January 10, 1974

Forwarded to:

Honorable Alexander P. Butterfield
Administrator
Federal Aviation Administration
Washington, D.C. 20591

SAFETY RECOMMENDATION(S)

A-73-119 thru 122

Investigation of the Pan American World Airways, Inc., Boeing 707 accident at Boston, Massachusetts, on November 3, 1973, has disclosed some findings about which the National Transportation Safety Board is concerned.

Our review of the involved cargo compartment ventilation system leads us to believe that sections 25.855(e)(2) and 25.857(e)(3) and (4) of the Federal Aviation Regulations (FAR), regarding cargo and baggage compartments, are not complied with in the present Boeing 707 configurations.

Two Boeing 707's involved in accidents this year had smoke or fire in the cabin area. On each flight the crewmember in the left seat opened the cockpit side window for visibility and ventilation. In each case the smoke from the cabin area was drawn forward into the cockpit and out through the window.

According to FAR 25.857, a class "E" cargo compartment must have a "means to exclude hazardous quantities of smoke, flames, or noxious gases from the flight compartment." The smoke chute installed in this aircraft by the manufacturer provides no means to contain smoke or fumes that emanate from the cabin or cargo area, nor to prevent smoke or fumes from entering the cockpit through the lower electronic compartment. Therefore, the installation of the smoke chute and the open grill access to the lower electronics compartment in the cockpit floor does not appear to comply with the intent of FAR 25.857.

The Boeing Company has issued Service Bulletin 2695 for 707 aircraft, on January 8, 1968, which permits installation of a smoke chute in the passenger-cargo configuration similar to that used in the all-cargo configuration. The cargo compartment in the passenger-cargo

configuration is ventilated down through the cabin floor forward into the lower avionics area. No mechanical means exist for shutting off air flowing from the cabin-cargo areas into the avionics compartment.


Our staff learned also that the associated flight tests required in FAR 25.855 had not been made during the approval of the Boeing 707 - 321C.

Accordingly, the National Transportation Safety Board recommends that the Federal Aviation Administration:

1. Take immediate steps to determine whether the present smoke chute installation on Boeing 707 cargo and cargo-passenger aircraft satisfies the provisions of FAR 25.855 and 25.857.
2. Effect retroactive modifications on all subject aircraft to ensure full compliance with provisions of FAR 25.855 and 25.857 pertaining to prevention of hazardous quantities of smoke, flames, or noxious gases from entering the flightcrew compartment.
3. Provide operators of the subject aircraft with data to enable flightcrews to identify smoke sources, and require operators to establish procedures in their operating manuals to control and evacuate smoke effectively during the specific flight regimes.
4. Reevaluate previous smoke evacuation tests conducted during certification relative to the quantity and source of smoke as applicable to smoke evacuation procedures currently employed by operators of Boeing 707 aircraft.

Our Bureau of Aviation Safety staff is available for further consultation.

McADAMS, BURGESS, and HALEY, Members, concurred in the above recommendations. REED, Chairman, and THAYER, member, were absent, not voting.


By: William R. Haley
Acting for the Chairman

APPENDIX H

**DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION**

WASHINGTON, D.C. 20590



OFFICE OF
THE ADMINISTRATOR

JAN 25 1974

Honorable John H. Reed
Chairman, National Transportation Safety Board
Department of Transportation
Washington, D.C. 20590

Notation 1209A

Dear Mr. Chairman:

In further response to your Safety Recommendations 119-122 issued January 10 concerning the PAA Boeing 707-321C accident at Boston on November 3, 1973, we wish to provide the following information.

During the Federal Aviation Administration (FAA) certification program, the Boeing 707-321C configuration (and the associated smoke chute installation) involved in the Boston accident was flight tested with large quantities of smoke generated in the Class E cargo compartment. When specified emergency procedures were followed, smoke was excluded from the cockpit, thus showing compliance with the smoke exclusion provisions of FAR 25.855 and 25.857, (ref: CAR 4b.383 and 4b.384).

Means are provided to shut off the normal ventilating airflow to the Class E cargo compartment as required by FAR 25.857(e)(3). Further visual observation during the above flight tests confirmed that there was no reverse airflow through the smoke chute during smoke evacuation tests.

Separate flight tests with small amounts of smoke generated in the Class E cargo compartment were performed to show compliance with the smoke detection provisions of FAR 25.857. Results from these tests indicated satisfactory detection performance.

We are further investigating the need to improve the emergency smoke evacuation procedures with respect to clarity and operational use. Following this investigation, if warranted, we will request our field inspectors to implement improved air carrier smoke evacuation procedures.

Additional corrective action will be taken if factual information from the forthcoming hearings indicates a need.

Sincerely,

Handwritten signature of Alexander P. Butterfield.
Alexander P. Butterfield
Administrator

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590



OFFICE OF
THE ADMINISTRATOR

January 11, 1974

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

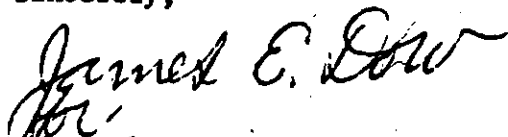
Notation 1209A

Dear Mr. Chairman:

This is in reply to your Safety Recommendations 119 - 122 issued January 10 regarding the Pan American World Airways, Inc., Boeing 707 accident which occurred on November 3, 1973, at Boston, Massachusetts. We are presently assessing the adequacy of the cabin smoke evacuation provisions on the 707. This will involve a review of the design, past testing and the testing presently being conducted by the manufacturer.

Based upon our findings of this assessment, we will, together with the manufacturer, develop any needed corrective actions in consonance with your recommendations to prevent future occurrences.

Sincerely,


Alexander P. Butterfield
Administrator

APPENDIX H

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590



OFFICE OF
THE ADMINISTRATOR

NOV 25 1974

Notation 1209A

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

Dear Mr. Chairman:

This is in response to your letter of September 5 concerning your Safety Recommendations A-73-119 through 122 on the Boeing 707 accident of November 3, 1973.

We have been advised by our Northwest Regional Office that the primary purpose of the Boeing/Pan American flight tests was to verify the adequacy of the B-707 Approved Flight Manual (AFM) cockpit smoke evacuation procedures and the Pan American Operation Manual smoke evacuation procedures. Although these tests were not witnessed by the Federal Aviation Administration (FAA), it appears that the test results reconfirmed the adequacy of the applicable B-707 AFM limitations and procedures for an aircraft maintained in accordance with the applicable type design. Revisions to the B-707 AFM emergency procedures were made as you indicated. These revisions involved an expansion of the AFM emergency procedures for purposes of clarity and to assure proper pilot action. Copies of the superseded and revised AFM sections are enclosed.

Our field offices which have responsibility for Pan American Operations are presently reviewing proposed changes to the Pan American smoke evacuation procedures which are intended to conform to the revised AFM procedures. Revisions to the Pan American Operation Manual will be made subsequent to the approval of these proposed changes.

Sincerely,

Alexander P. Butterfield
Alexander P. Butterfield
Administrator

2 Enclosures:
Cockpit Smoke Evacuation Procedures
Cargo Compartment Fire Procedures

E.R.A.U.C. LIBRARY

**NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.**

ISSUED: February 6, 1974

Forwarded to:
Honorable Alexander P. Butterfield
Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATION(S)

A-74-5&-6

The National Transportation Safety Board's continuing investigation of the Pan American World Airways, Inc., B-707 freighter accident at Boston, Massachusetts, on November 3, 1973, has disclosed an unsafe condition that should be corrected.

Although the cockpit voice recorder indicates that crewmembers were wearing smoke goggles during the final phases of the flight, the Board's investigation indicates that the captain may have had difficulty seeing because of smoke.

The captain's medical records revealed that he was required to possess corrective glasses while flying. The Board examined smoke goggles from other Pan American B-707 aircraft which were the same type as the goggles used by the crewmembers of the accident aircraft. The examination disclosed that if a crewmember wore corrective glasses, the smoke goggles would not fit properly at the temples and, therefore, would not provide the needed protection against smoke.

Additionally, an examination of smoke goggles used by Pan American and several other air carriers on transport aircraft disclosed that they do not comply with the provisions of FAR Part 25.1439. Specifically, some of these smoke goggles do not adequately protect the flightcrew from smoke when worn either with or without corrective glasses. Other smoke goggles in use restrict the wearer's vision appreciably.

The accident aircraft was certificated under Part 4b of the Civil Air Regulations at a time when smoke goggles were not required to be designed to accommodate a user wearing corrective glasses.

APPENDIX H

Honorable Alexander P. Butterfield - 2 -

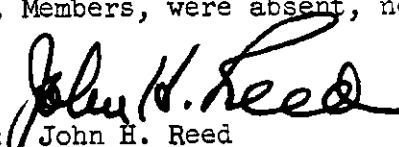
Subsequent amendments to Part 4b (Amendment 4b-8) and paragraph 25.1439 of the currently effective FAR Part 25 provide that smoke goggles shall allow for corrective glasses to be worn.

FAR Part 25.1439 provides that smoke goggles must be designed to protect the flightcrew from smoke, carbon dioxide, and other harmful gases and allow for the wearing of corrective glasses. The Safety Board believes that this safety requirement should apply to all transport category airplanes, notwithstanding the regulations applicable at the time of aircraft certification.

Accordingly, the National Transportation Safety Board recommends that the Federal Aviation Administration:

1. Require that transport category airplanes certificated under Part 4b of the Civil Air Regulations prior to the effective date of Amendment 4b-8 comply with Part 25.1439 of the Federal Aviation Regulations;
2. Require that a one-time inspection be made of all smoke goggles provided for the flightcrew of all transport category airplanes to assure that these goggles conform to the provisions of Part 25.1439 of the Federal Aviation Regulations.

REED, Chairman, McADAMS, and HALEY, Members, concurred in the above recommendations. THAYER and BURGESS, Members, were absent, not voting.

By: 
John H. Reed
Chairman

73758

**DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION**

WASHINGTON, D.C. 20590



OFFICE OF
THE ADMINISTRATOR

APR 27 1974

Notation 1209

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

Dear Mr. Chairman:

This is in further response to our February 5 letter concerning Safety Recommendations A-74-5 and 6 resulting from the Board's investigation of the Pan American World Airways, Inc., accident at Boston, Massachusetts, on November 3, 1973.

The one-time inspection recommended has been completed. This included an evaluation of smoke masks provided the flight crews for conformance with FAR 25.1439 as well as the operators' smoke evacuation procedures and crew training. The inspection revealed that a number of the smoke goggles provided for the flight crews did not meet the requirements of FAR 25.1439. Corrective action has been taken.

This inspection also revealed that FAR 25.1439 is not being interpreted as an inclusive rule for all pressurized transport airplanes since it alludes to cargo compartment configuration rather than to the general protection for the crew. Therefore, we plan to propose an amendment to FAR 25.1439(a) to clarify the requirement to provide protection from smoke, carbon dioxide, and other harmful gases for all appropriate crewmembers of pressurized transport airplanes. An additional amendment to FAR 121.337 is planned to specify that protective breathing equipment for flight crews required in the operating rules are to meet the requirements of FAR 25.1439 and that procedures be established for crewmembers to use 100% oxygen in a smoke/fire emergency.

We believe that the actions taken and planned are consistent with the Board's Safety Recommendations A-74-5 and 6.

Sincerely,

James E. Dow
Alexander P. Butterfield
Administrator

APPENDIX H

**NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.**

ISSUED: March 26, 1974

Forwarded to:

Honorable Alexander P. Butterfield
Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATION(S)

A-74-20 thru 26

On February 11, 1974, the National Transportation Safety Board concluded its public hearing into the Pan American World Airways accident which occurred on November 3, 1973. The aircraft was a jet-freighter carrying nearly 16,000 pounds of restricted cargo.

The Safety Board heard extensive testimony that shippers, packers, manufacturers, and carriers of restricted cargo or dangerous articles are either unaware of, or not complying with, current regulations which govern the carriage of hazardous materials by air. Therefore, the Safety Board is concerned about the lack of compliance with these regulations.

The Safety Board realizes that Federal manpower to enforce all aspects of the regulations governing the transportation of hazardous materials is not available. Therefore, it seems appropriate to focus on a limited number of check points at which noncomplying shipments can be halted. The Safety Board believes that the principal check point is the air carrier's receiving dock.

The Safety Board received several recommendations from witnesses and parties to the hearing intended to remedy the shortcomings in the handling of hazardous articles. The Air Line Pilots Association formally recommended to the Safety Board that "... all hazardous materials be banned from interstate air transportation." The Safety Board shares the Association's concern, but believes that conscientious compliance with current regulations and procedures would obviate such a drastic step. Therefore, the immediate emphasis should be on a concerted program by the carriers and the FAA to assure compliance with current regulations.

Honorable Alexander P. Butterfield

2

The recommendations submitted herein are intended to be interim measures, pending a more definitive resolution of the hazards disclosed during this inquiry.

Accordingly, the National Transportation Safety Board recommends that the Administrator, Federal Aviation Administration:

1. Conduct a comprehensive inspection of each air carrier's procedures for compliance with 14 CFR 103 and 14 CFR 121.433(a), specifically with regard to receiving, palletizing, consolidating, and aircraft loading, as well as the related training. This inspection should be completed at the earliest possible date and not later than 60 days from the date of this recommendation.
2. Develop, in cooperation with the Department of Transportation, Office of Hazardous Materials, a compliance checklist to determine whether or not a shipment conforms to Federal hazardous materials regulations. This checklist should be circulated to all involved agencies and organizations.
3. Develop and disseminate information about Federal regulations which apply to air carriage of hazardous materials to the air carriers' marketing or sales representatives and their appointed agents.

The Board believes that recommendations two and three should be acted upon immediately inasmuch as they are within the scope of current regulatory authority.

The Board recognizes that the following recommendations may require additional research and evaluation before they can be implemented. However, they should be implemented as quickly as possible in light of the hazards involved.

4. Amend 14 CFR 121.597 to require the person authorized to exercise operational control over the flight in the case of supplemental air carriers and commercial operators of large aircraft to inform the captain of any dangerous articles aboard the flight, as outlined in 14 CFR 103.25. Further, amend 14 CFR 121.601 to make the dispatcher responsible in the case of scheduled air carriers, for informing the captain of dangerous articles aboard the flight, in addition to the notification required by 14 CFR 103.25.

APPENDIX H

Honorable Alexander P. Butterfield

3

5. Amend 14 CFR 135 to require each operator under this part to develop procedures to insure that the captain is informed of any dangerous articles aboard. This notification should contain the information outlined in 14 CFR 103.25.
6. Rescind the provision in 14 CFR 103.3(a) which allows the aircraft operator to rely on the shipper's statement as prima facie evidence that the shipment complies with the requirements of this part. Instead, require the air carrier to institute a monitoring system to assure that all dangerous articles shipped by air are inspected against all regulatory safety controls which can be verified at the air carriers receiving point.
7. Institute rulemaking to require that air carriers notify the shipper and the FAA when a shipment, or its documentation, deviates in any manner from Federal or air carrier regulations. Further, require that when non-conforming shipments are detected by the air carrier, they may not be moved until the deficiency is remedied, or the transportation of the deficient packages-- with prescribed safety controls-- is authorized by the cognizant Federal agency. The deficiencies should be entered on the shipping documents, a copy of which should be retained by the carrier and be made available to the cognizant Federal agency.

REED, Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendations.



By: John H. Reed
Chairman

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590



OFFICE OF
THE ADMINISTRATOR

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

Notation 1209C

Dear Mr. Chairman:

I have reviewed your Safety Recommendations A-74-20 thru 26. They are quite timely and, in large measure, are in accord with actions contemplated or underway by this agency.

As you point out, manpower is a major problem and we are trying, as quickly as possible, to fill 18 field Hazardous Material Coordinator positions. These people will work full-time in the surveillance and inspection of air shipments of these materials. As you probably know, our Flight Standards Service has established a Hazardous Materials Staff at Headquarters and the three authorized positions are presently filled.

The following comments are on each of the seven recommendations listed and in the order presented:

1. With regard to the provisions of Section 121.433a requiring hazardous materials training, the Director, Flight Standards Service on March 4 wrote all of our Regional Directors requesting follow-up by each district office to assure operator compliance with the training requirements. Last week, our Headquarters Flight Standards Evaluation Staff began a comprehensive evaluation of the effectiveness of agency and air carrier programs, which include compliance inspections at air carrier receiving docks. This effort will cover cities having a high volume of hazardous materials shipments. As soon as the evaluation team makes its recommendations, we will be in a position to direct field surveillance of deficient areas. This could well require a 60-day effort, as you recommend.
2. Our Hazardous Materials Staff has developed a compliance check list and it will be printed and distributed to the field in the near future.

APPENDIX H

2

3. We believe this is an excellent recommendation and we will get on it immediately. We will include in the package the compliance check list recommended in No. 2 above.
4. We would like to give this recommendation further thought. As you know, Part 121 requires all categories of air carriers and commercial operators to include in their manuals procedures for notifying the captain whenever dangerous articles are on board. I think our decision in this regard will largely be determined by the results of the ongoing evaluation.
5. Again, since Part 135 requires each operator's manual to contain procedures for notification of the captain, we will consider this recommendation in the same manner as discussed in No. 4 above.
6. We wholeheartedly concur with this recommendation. We will establish a regulatory project to amend Part 103, to rescind the provision which allows the aircraft operator to rely on the shipper's statement as prima-facie evidence that the shipment is in compliance.
7. The recommendation that air carriers notify the shipper and FAA when a shipment or its documentation is in non-compliance has merit. Accordingly, we will initiate a rules project in this regard. Part 103 presently prohibits air carriers from carrying hazardous materials that are not packed, marked, and labeled in accordance with the provisions of 49 CFR Part 173 for shipment by rail express (see sections 103.7 and 103.9). Therefore, further rulemaking action on this aspect of your recommendation appears unnecessary.

I share your concern and we will continue our efforts to assure compliance with the regulations.

Sincerely,


Alexander P. Butterfield
Administrator

APPENDIX H
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: October 1, 1974

Forwarded to:

Honorable Alexander P. Butterfield
Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATION(S)

A-74-65 & 66

On November 3, 1973, a Pan American World Airways B-707-321C (N458PA) was involved in an accident at Boston, Massachusetts. The National Transportation Safety Board's continuing investigation has disclosed information which should be brought immediately to the attention of carriers and regulatory agencies that are concerned with the air carriage of certain dangerous articles on cargo airplanes.

The Safety Board has found that accessibility by flightcrews to dangerous articles as required by 14 CFR 103.31 is severely limited on a cargo airplane that is fully loaded with palletized cargo.

Cargo accessibility required by 14 CFR 103 and the provisions of 14 CFR 121 for smoke evacuation and fire control or containment will not enable a flightcrew to cope safely with in-flight occurrences of smoke or fire from self-sustaining chemical reactions of dangerous articles. These regulatory requirements might mislead flightcrews in their assessment of whether their safety is seriously threatened when self-sustaining chemical reactions of restricted cargo occur in flight.

The National Transportation Safety Board, therefore, recommends that the Federal Aviation Administration:

- (1) Issue appropriate notices to alert air carriers to inform flightcrews who may be involved in carriage of certain dangerous articles capable of producing self-sustaining chemical reactions that reliable in-flight threat assessment of problems associated with such articles often will be extremely difficult, if not impossible.

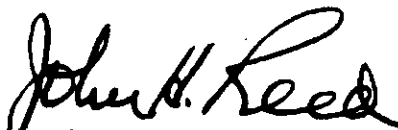
APPENDIX H

Honorable Alexander P. Butterfield - 2 -

- (2) Advise air carriers to inform flightcrews that smoke or fire caused by oxidizing agents and certain other chemicals cannot be controlled by existing emergency procedures, and that any abnormal in-flight occurrence which could be linked to dangerous articles should be considered an unsafe condition as prescribed by 14 CFR 121.557 and .559, requiring an immediate decision and action to "Land the airplane at the nearest suitable airport, in point of time, at which a safe landing can be made."

Our staff is available for further consultation in this matter.

REED, Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendations.


By: John H. Reed
Chairman

**DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION**

WASHINGTON, D.C. 20590



OFFICE OF
THE ADMINISTRATOR

November 19, 1974

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

Notation 1209E

Dear Mr. Chairman:

I have reviewed your Safety Recommendations A-74-65 and 66 and find them in accordance with actions contemplated or underway by the FAA.

With regard to your first recommendation, we believe that flight crews are being made aware of the chemical reaction characteristics of hazardous materials. Section 103.25 of the Federal Aviation Regulations (FARs) requires that the pilot in command be informed in writing, before takeoff, of the shipping name, classification, quantity, and location of the hazardous materials aboard the aircraft. To further assure that the pilot in command receives this information, we are developing a notice of proposed rule making that would require the pilot in command to acknowledge receipt of this information in writing. We are considering publishing this proposal in the very near future.

The training requirements of Sections 121.433a and 135.140, which became mandatory on December 6, 1973, are designed to assure that pilots have sufficient knowledge of the characteristics of the materials being carried to make an assessment of the potential problems involved and take whatever action he deems necessary, including refusal to accept the shipment.

We agree with the second recommendation and will act on it immediately.

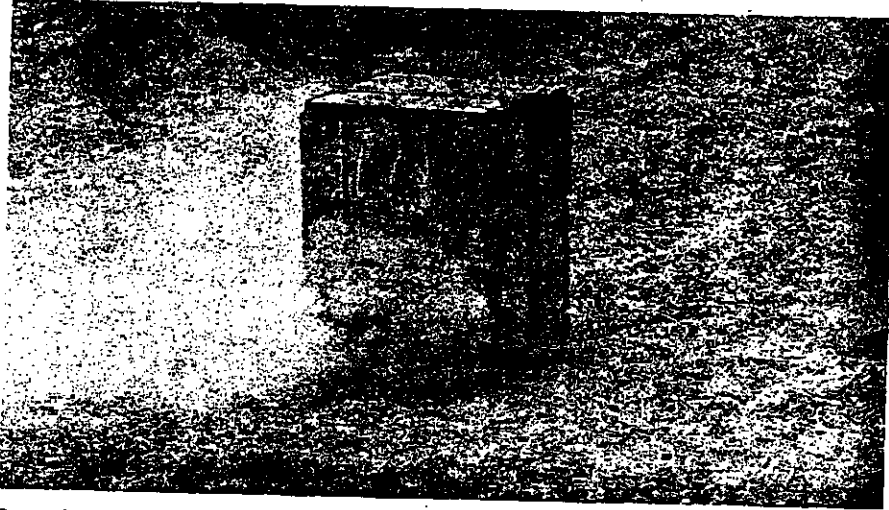
I share your concern in the safety of air transportation of hazardous materials and will continue our efforts to assure compliance with the regulations.

Sincerely,

James E. Dow
Deputy Administrator for
Alexander P. Butterfield
Administrator

APPENDIX I

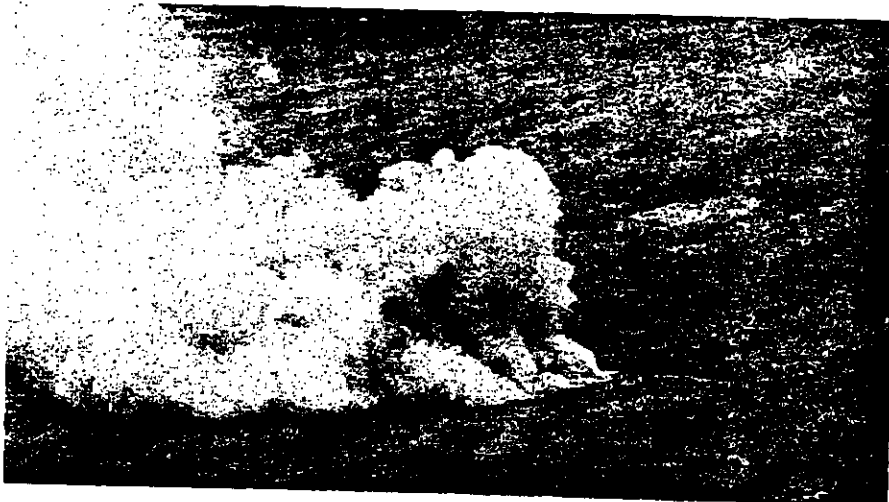
TESTS - DEMONSTRATING NITRIC ACID LEAKAGE INTO SAWDUST



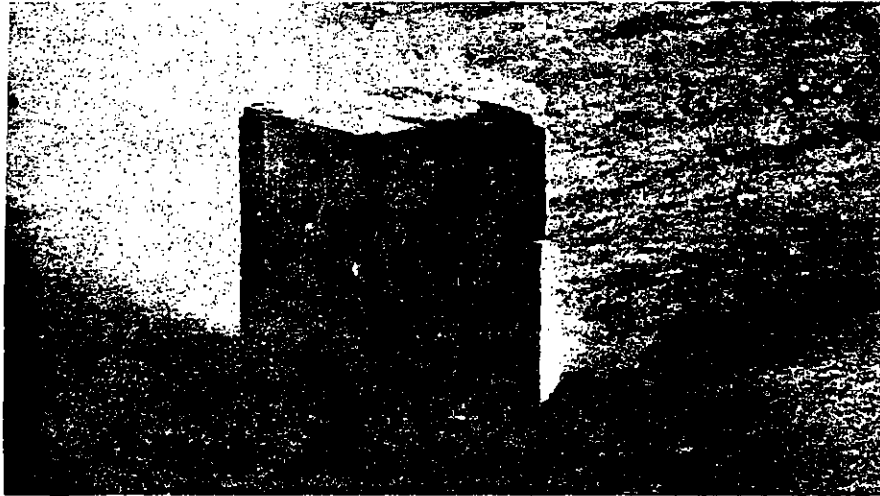
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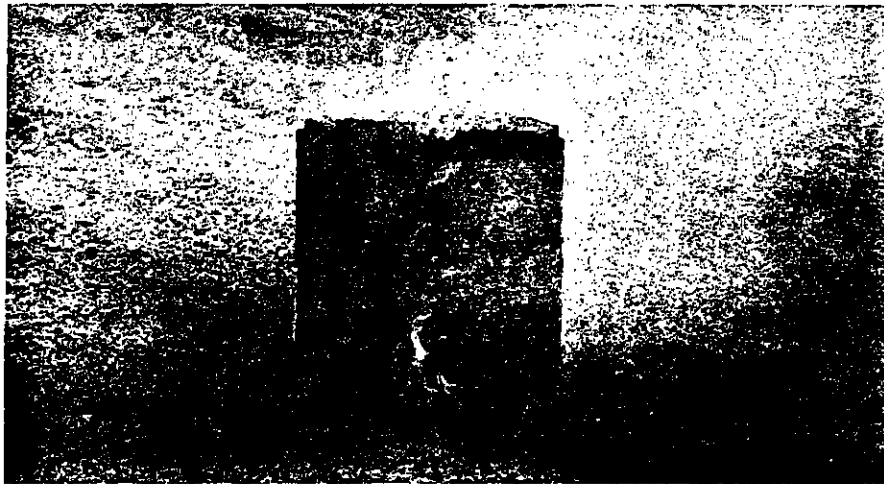
0 + 13 min.



0 + 15 min.



0 + 19 min.



0 + 21-1/2 min.



Remains of box & bottle.

BOEING COMMERCIAL AIRPLANE COMPANY

P.O. Box 3707
Seattle, Washington 98124

APPENDIX J

A Division of The Boeing Company

MAY 20 1974

B-7670-RA-4531 ✓

Department of Transportation
Federal Aviation Administration
FAA Building, Boeing Field
Seattle, Washington 98108

Attention: Mr. C.C. Schroeder, Chief ANW-210
Engineering & Manufacturing Branch

Subject: Investigation of PA B707-321C, S/N 19368,
Reg. No. N458 PA Accident November 3, 1973

References: a) FAA letter ANW-213:8110-5, dated
March 15, 1974 Same Subject
b) Boeing Document D6-41154, Section 3.10.004,
Title: Smoke Evacuation Flight Test, Revision
"B", dated May 3, 1974

Gentlemen:

ROUTING		NOTE	ACTION
210			
210a			
210A			
210B			
210C			
210D			
212			
213		✓	
214			
216			
219			
CMDO-41			
CRF:			
Mail Control			
Number			
Due			
Reply by			
DATE			

This response is presented in answer to your reference (a) letter. Boeing does not believe that it can be determined from the PAA airplane voice recorder whether the smoke evacuation procedures were followed. In addition, the voice recorder is not clear with regard to smoke location and in no instances are large quantities of smoke indicated in the cockpit.

Flight tests (reference (b)) analyzing smoke exclusion/evacuation procedures with a continuous source of smoke have recently been accomplished on a PAA 707-300C (N 796PA) convertible airplane in Seattle and a PAA 707-300C (N 460PA) stripped cargo airplane in San Francisco. A total of 15-1/2 flight hours were expended during the four flights conducted. Copies of the reference (b) report were transmitted by our letter B-7670-RA-4511 dated May 13, 1974.

Current Class E cargo fire/smoke procedures were found effective. The tests demonstrated that there was no hazardous quantity of smoke penetration into the cockpit and crew rest area and no ventilation in the main cargo compartment. If the procedure is followed, a continuous source of smoke will not exist as the fire will be smothered except in the rare case where a hazardous material is carried which is packaged and handled such that it is released, generates heat and provides its own source of oxygen.

RECEIVED

MAY 20 1974

E&M BRANCH, NW-210

BOEING

Mr. C.C. Schroeder

B-7670-RA-4531

Following are some pertinent observations made during the flight tests on the stripped cargo airplane (N460PA):

Under all test conditions with smoke generated continuously exterior of the cockpit, even with a leaky smoke barrier and the equipment cooling overboard dump valve open, no hazardous quantity of smoke entered the cockpit. Smoke that did enter was noticed to be relatively minor and came in underneath the cockpit door. It was exhausted down through the cockpit floor grill. During approach conditions in the Class E configuration there was some increase in the quantity of smoke entering the cockpit.

Smoke generated in the main deck cargo compartment could only be seen in lower Section 41 (through the cockpit floor grill) when the equipment cooling overboard dump valve was open. The smoke did not come up into the cockpit through the floor grill.

Airflow was observed to move downward through the barrier smoke chute into lower Section 41.

During testing on N796PA in Seattle, as a matter of interest, with the airplane in a cargo configuration and smoke generated continuously in the main deck cargo compartment while unpressurized and with no ventilation source, the cockpit window was opened. Smoke flow was into the cockpit and out the open window. It is noted that this procedure was not found necessary during any of the testing. Previous testing with smoke sources exterior to the cockpit, i.e., Class B cargo, passenger cabin or lower Section 41 has assumed source identification and extinction prior to smoke evacuation.

On the basis of analysis of the data obtained and observations made during the reference (b) flights, Boeing has arrived at the following conclusions and recommendations aimed at providing greater assurance of satisfactory smoke evacuation from all-cargo configured 707 airplanes in the presence of a continuous smoke source.

1. Minor revisions in the procedures should be made to assure maximum inflow of clean air to the cockpit, particularly at low engine power conditions such as during approach.
2. The addition of a means of closing the grill in the cockpit floor, which provides venting to avoid pressure differential between the cockpit and lower Section 41, would assure that the clean air being supplied to the cockpit will flow outward through the miscellaneous openings through which smoke would otherwise enter the cockpit.

BOEING

APPENDIX J

Mr. C.C. Schroeder

B-7670-RA-4531

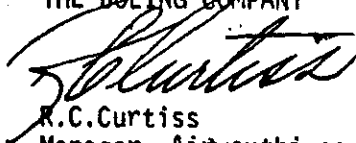
3. In the case of a continuous source of heavy smoke, the smoke curtain/barrier installation which separates the crew rest area (immediately aft of the cockpit) from the cargo area, will not preclude entry of some smoke into the crew rest area over an extended period of time, particularly if the curtain has not been maintained in good condition or is improperly installed. Investigation of other means of preventing or accommodating smoke in this area appears warranted. (Note however, during the flight testing of the stripped cargo aircraft, even when the aircraft was flown at slow speeds with the nose gear extended smoke did not enter the cockpit in hazardous quantities when current Class E procedures were followed).

Boeing has initiated design studies with respect to Item (2) above and intends to investigate alternative measures appropriate to Item (3) such as providing a separate source of fresh air flow into the crew rest area, or providing the occupants of this area with oxygen and smoke masks equivalent to that which is supplied to the flight crew in their duty stations.

The referenced flight testing included evaluation of passenger configurations. Existing procedures generally appear to be satisfactory for these configurations based on the currently accepted premise that the source of smoke entering the passenger compartment is not continuous, i.e., will be reached and extinguished by the crew. However, design studies will be initiated to establish if any airplane procedures or configuration improvements can handle isolation of continuous sources of smoke.

Very truly yours,

THE BOEING COMPANY



R.C. Curtiss
Manager, Airworthiness
707/727/737 Division
Boeing Commercial Airplane Company

BOEING

**DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION**

MAR 15 1974

NORTHWEST REGION
FAA BUILDING BOEING FIELD
SEATTLE WASHINGTON 98108



In Reply
Refer To: ANW-213:8110-5

Boeing Commercial Airplane Company
P. O. Box 3707
Seattle, Washington 98124

Attention: Mr. R. C. Curtiss, M.S. 69-10
Manager, 707/727/737 Airworthiness

Subject: Investigation of PA B707-321C, S/N 19368, Reg. No. N458PA
Accident November 3, 1973, at Logan Airport, Boston, Mass.

References: (a) Boeing letter B-7670-RA-3954 dated January 8, 1974
(b) Boeing letter B-7670-RA-3955 dated January 23, 1974

Gentlemen:

The following areas of concern have been raised with this office and we would appreciate your comments on them as soon as possible for inclusion in our reply.

These areas involve the performance of the 707 smoke evacuation system and effectiveness of procedures under conditions associated with the PAA accident. They also concern the adequacy of existing regulations FAR 25.855 and 25.857. In order to be assured that the system, procedures, and appropriate regulatory requirements provide for an acceptable level of safety, further information, in supplement to the referenced letters, is requested.

The following PAA airplane cockpit voice recorder excerpts indicate that during the period of the recording, the crew followed the smoke evacuation procedures specified in the 707 Airplane Flight Manual for pressurized flight (cockpit smoke removal----normal ventilation and maximum ventilation) and used during the flight test of the passenger version (707-121) to demonstrate that smoke from a galley fire would not penetrate the cockpit:

TIME AND SOURCE

CONTENT

1405:15.5
CAM-2

(Can) we increase our airflow so that we get rid of some of the smoke through the outflow valve(s) and equipment cooling (circuit)?

CAM-?

Yeah

APPENDIX J

TIME AND SOURCE

CONTENT

1407:30.5
CAM-3

I'm going to raise the cabin up to ten thousand? ((Possible reference to cabin altitude control setting on emergency smoke evacuation check list)).

1408:31.5
CAM-3

Could open a bleed %.

CAM-1

All Right.

CAM-3

And try to get some air in this ##

CAM-1

Go ahead.

However, the following recorder excerpts indicate that, in contrast to the 707-121 flight test, large quantities of smoke did enter the cockpit:

TIME AND SOURCE

CONTENT

1409:58.0
CAM-3

We outa go on oxygen, this # is getting a little thick, eh?

CAM-2

I do too.

CAM-1

Just wait 'till we----go ahead.

1410:53.5
CAM-1

##----it is getting heavy.

1411:25.0

-masks go on.

1412:25.0
1/P-1

D'you guys want to get your goggles?

1430:36.5
1/P-1

All of a sudden it's getting worse.

1433:52.0
1/P-2

It's getting worse right now, you can see it blowing around here.

It is difficult to attribute the above smoke penetration to turning off the equipment cooling fan as it appears likely from the voice recorder that the fan was turned off only for a short period of time at 1407:20.5 and momentarily at 1430:17.5. It seems likely that the air flow through

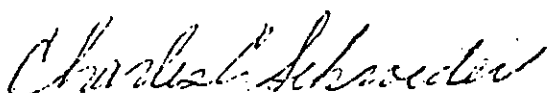
the cockpit floor in the PAA case was the reverse of that during the 707-121 flight test. This would seem to indicate that the passenger version procedures and/or systems are not adequate to prevent heavy smoke penetration into the cockpit from a passenger cabin fire of the magnitude experienced on the PAA accident. Consequently, it has been suggested that the system and procedures be evaluated for the accident conditions and if necessary be modified to cope with these more realistic conditions.

It was noted that there exists no warning concerning the incorrect use of the "cockpit smoke evacuation procedures" when sources of fire/smoke are not located in the cockpit. It is believed that in such cases, opening the cockpit window will tend to draw smoke into the cockpit and that increased ventilation may aggravate the fire/smoke generation elsewhere. We firmly believe that a reassessment of these procedures should be undertaken and limitations included where needed in the approved FAA flight manuals.

It has been indicated that exclusion of smoke from the cockpit is dependent upon the ventilation system except that in the case of a ventilation system failure, the cockpit could be (at least partially) cleared by opening the cockpit window as a last resort. Also evidence from the PAA accident shows some dependency on the equipment cooling fan to exclude cargo or electronic compartment smoke from the cockpit. To this extent, it may be necessary in future certification under the present standards to require the capability of excluding smoke from the cockpit and of evacuating smoke from the passenger cabin after system failures. We would appreciate your recommendation in this regard.

A program is being initiated to review all aspects of airplane fire/smoke protection and to develop, where necessary, new and improved criteria. As existing smoke detection and evacuation provisions contained under FAR 25.855 and 25.857 will be considered under this assessment, your recommendations in view of recent accidents (PAA, Varig, etc.) are requested.

Sincerely,



CHARLES C. SCHROEDER

Chief, Engr. & Mfg. Branch, ANW-210