FIREFIGHTER INJURY REPORT

ATLANTIC CITY FIRE DEPARTMENT

ATLANTIC CITY, NEW JERSEY

NOVEMBER 18, 1993

DIVISION OF FIRE SAFETY
STATE OF NEW JERSEY

REPORT ISSUED SEPTEMBER 15, 1995

STATE OF NEW JERSEY
Christine Todd Whitman, Governor

DEPARTMENT OF COMMUNITY AFFAIRS
Harriet Derman, Commissioner

DIVISION OF FIRE SAFETY
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INTRODUCTION

The investigation of this incident was conducted by the New Jersey Division of Fire Safety in conjunction with the New Jersey Department of Labor and the New Jersey Department of Health. This report was prepared in accordance with N.J.S.A. 52:27D - 192 *et. seq.,* Duties of the Division. The purpose of these firefighter casualty investigations is to report the causes of serious firefighter injuries or deaths and identify those measures which may be required to prevent the future occurrence of deaths and serious injuries under similar circumstances. In some cases new information may be developed, or old lessons reinforced, in an effort to prevent similar events in the future. Recommendations contained in this report will fall into two categories: those that pertain directly to this particular incident; and, those that pertain to all incidents and/or operations. Fire cause and origin investigation is not a part of this report.

The Division acknowledges Atlantic City Fire Chief Benjamin Brenner and his firefighters for their assistance in this investigation. In particular, the Division thanks Atlantic City Deputy Fire Chief John Bereheiko; Darlene Skelton, President, and Investigators Ralph Craven and James T. Steffens of the National Institute of Emergency Vehicle Safety; Harold Swartz, Atlantic County Fire Marshal; and firefighter Christian Osbeck, for their assistance.

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SUMMARY

At 2006 hours on November 18, 1993 a structure fire was reported at 1515 Pacific Avenue, located in Atlantic City, Atlantic County, New Jersey.

During the course of the incident, a 100 ft. aerial ladder, manufactured in 1970 by the Peter Pirsch Company, was operating in an elevated position at the fire scene. Suddenly and catastrophically, the ladder collapsed and fell on top of an adjacent engine. A 23 year old firefighter of the Atlantic City Fire Department, Christian Osbeck, was climbing the ladder at the time. Osbeck held on as the ladder was falling and was then thrown to the ground when the ladder impacted the engine. FF Osbeck suffered a broken leg, injuries to his mouth and teeth, and various other traumas due to the impact. Osbeck was hospitalized until November 23, 1993. He returned to active duty until June 15, 1994. A rod which was inserted in Osbeck's left tibia has yet to be removed. It is anticipated this will be done sometime in the Fall of 1995.

The Division of Fire Safety initiated an investigation into the failure of the ladder and, for this incident, contracted the services of the National Institute of Emergency Vehicle Safety (NIEVS) for a technical analysis of the occurrence. Failure Analysis Corp. (FA) was contracted to conduct a scientific analysis of the ladder.

OVERVIEW

The Municipality

Atlantic City is an 11.84 square mile[1] municipality in Atlantic County located on the southeast coast of New Jersey, about 60 miles southeast of Philadelphia. It is situated on Absecon Island, a sandbar that is 10 miles long. A narrow waterway and marshes separate the island from the mainland. Amusement piers jut into the ocean from the Boardwalk, which is 60 feet wide and 5 miles long. The first legal casino to be operated in the United States outside of Nevada was opened in Atlantic City in 1978. Major highway routes that traverse the city include the Atlantic City Expressway, and U.S. Routes 30 and 40.

Atlantic City is classified as an urban center with a mix of mainly multi-family residential, commercial and public assembly occupancies. The 1990 census data showed 37,986 year round residents and a population density of 3,208.3 persons per square mile.[2] According to city estimates, 250,000 people visit the city daily.

Atlantic City has been a popular oceanside resort since the first wooden walkway was built along the beach in 1870. Today's other attractions include blockbuster entertainment, gambling casinos, and a huge convention center with a 40,000 seat auditorium. The city has been the home of the Miss America Pageant since it was established in 1921.

Atlantic City is a trade and shipping center for agricultural products and seafood as well as a tourism center. The city, incorporated in 1854, has a mayor-council form of government.

Fire Department

The Atlantic City Fire Department (ACFD) is responsible for providing fire protection for the city. The department responds to over 2800 alarms annually.

The department is comprised of 276 career employees operating from seven stations. These stations house fire apparatus consisting of seven engines, four aerial apparatus, and twelve support units configured for various functions.

A Fire Prevention Bureau staffed by twelve full time employees; a Fire Official, three Supervising Fire

[1]Square mileage data taken from 1990 Statement of Financial Condition of Counties and Municipalities, Division of Local Government Services, New Jersey Department of Community Affairs

[2]Population data is taken from Total Resident Population, New Jersey, Counties and Municipalities, 1980 and 1990, State Data Center, New Jersey Department of Labor

Prevention Specialists, and eight Fire Inspectors; enforces the New Jersey Uniform Fire Code.

The fire department reports all incident data to the Division's Fire Incident Reporting Section .

The Atlantic City Emergency Communication Bureau (ACECB), a bureau of the Atlantic City Police Department, provides dispatch service to the department. Professional Ambulance Service, Inc. (PAS), an independent paid ambulance service contracted with by the city, provides primary Emergency Medical Services.

The department has an active local mutual aid system and is a member of the Atlantic County Mutual Aid Association. Members train and drill with various fire departments from the other municipalities in the county, both within the city limits and at the Anthony Canale Fire Training Center, Atlantic County's fire academy in Egg Harbor.

The fire department utilizes Public Employees Occupational Safety and Heath Act (PEOSHA) approved personal protective equipment (PPE). The department purchases, issues and maintains the following PPE: turnout coats and pants with PBI® shells and Gortex® batt liners, leather gloves, composite helmets, PBI® hoods, rubber bunker boots and personal alert safety system (P.A.S.S.) devices.

Fire Location

The fire was located at 1515 Pacific Avenue in Atlantic City. The building was a five story multi-family dwelling with commercial occupancies located on the street level. The building was of unprotected ordinary construction. It was classified as a mixed use occupancy consisting of Use Groups R-2 and M, and Construction Type 3-B according to the BOCA National Building Code. The building was classified as a Non-Life Hazard Use by the New Jersey Division of Fire Safety. It should be noted that there were smoke detectors installed in the structure and the detector in the area of origin was reported to be operating. The building did not contain fire sprinklers.

The fire was investigated by the ACFD Arson Squad and was determined to be accidental in nature. The point of origin was identified in the building's basement in fixed electrical wiring directly adjacent to and supplying current to a Modine heating unit. This unit was independent of the building's primary heating system. The cause of the fire was listed as defective wiring at the point of origin.

The major avenue of fire travel was an unprotected vertical pipe chase which ran from the basement to the cockloft of the building. This accounted for the rapid spread of fire to uninvolved floors and the roof area.

There were no civilian casualties noted at this incident.

Weather

The weather conditions at the time of the incident were clear and the temperature was approximately 50^0. There was a slight breeze blowing from the east.

Communications

The fire department's primary operating frequency is 154.025 MHz. Three other frequencies are available, 153.770 MHz., 154.415 MHz., and the Atlantic County Mutual Aid Frequency, 154.310 MHz.

Water Supply

The water supply for Atlantic City is provided by a municipal water system. For this particular incident, no water problems were noted.

Mutual Aid

The fire department utilizes mutual aid from the surrounding fire departments to fill in at vacant stations during major emergencies. For this incident, mutual aid was provided by the fire departments of Absecon and Northfield.

Emergency Medical Services

Professional Ambulance Service, Inc. (PAS) provides basic life support (BLS) for the ACFD. Paramedics from West Jersey Health Systems (WJHS) operating from the Atlantic City Medical Center (ACMC) provide advanced life support (ALS). Primary aeromedical evacuation is provided by the New Jersey State Police through Southstar.

For this incident, PAS had resources standing by on the fire scene within the first few minutes which provided BLS and transportation service. ALS was provided by WJHS upon arrival.

The Incident

The fire at 1515 Pacific Avenue, Atlantic City, was reported to the ACECB at 2006 hours on November 18, 1993, which in turn dispatched the ACFD. The initial dispatch assignment consisted of two engine companies, two ladder companies and a battalion chief. At the time of dispatch, the building was reported to be involved with fire.

Upon arrival, ACFD Battalion Chief James Herbert began scene operations and established command. Observations made during size-up indicated heavy fire showing in the basement, first and second floors of the structure. It was reported that fire was extending through an unprotected vertical pipe chase to the cockloft area.

At 2015 hours a second alarm was called for which consisted of two additional engines and a deputy chief. Upon arrival, Deputy Chief Vincent Rifice conferred with BC Herbert and assumed command of the incident.

Crews from the four engine companies and two ladder companies who were involved in interior attack and search operations reported to the command post that fire had extended to all floors and the roof area. A third alarm was called for by DC Rifice at 2107 hours which consisted of two more engine companies. All personnel were subsequently ordered out of the building and defensive operations were initiated utilizing master stream devices on the B, C, and D Divisions[3] of the building. Exposure buildings on these sides of the structure were also protected through the use of master streams.

At this time, Ladder 2 was operating on the Division C-D corner of the building, applying water by way of a non-prepiped ladder pipe. At approximately 2245 hours, as FF Christian Osbeck was climbing Ladder 2 to adjust the stream of the nozzle, the ladder experienced a structural failure and collapsed. The ladder crashed down onto the cab of Engine 4, which was operating in close proximity to Ladder 2. Osbeck, who held on during the ladder's descent, was thrown to the ground when it impacted with Engine 4. Firefighters, who were working nearby, rushed to Osbeck's aid. After being treated at the scene, he was transported to the Atlantic City Medical Center.

After the ladder collapse, firefighters continued to battle the blaze. DC Rifice declared the fire under control at 0200 hours on November 19, 1993.

In all, 100 firefighters were required to extinguish the fire which caused an estimated one million dollars worth of damage and resulted in the demolition of the fire building.

The Apparatus Failure and Casualty Scenario

FF Christian Osbeck, a 23 year old member of the Atlantic City Fire Department, had one and one half years of service at the time of his injury. His assignment was to Ladder Company 4. At the time of the incident alarm, Osbeck was off duty and was in the town of Brigantine, a nearby community. From his location, he was able to see the smoke of the Pacific Avenue fire and responded to the scene to find out if his assistance was necessary. Upon arrival, about the time

[3]*National Fire Academy, Incident Command System*, Federal Emergency Management Agency, Emmitsburg, MD

of the third alarm dispatch, he was assigned to work with Ladder 2.

During the course of the incident, FF Osbeck ascended the ladder of Truck 2, a 1970 Pirsch 100 ft. articulating tiller aerial apparatus, for the purpose of redirecting the stream of an appliance that was operating at the tip. The appliance was being supplied by a 3 inch supply hose which was not permanently affixed to the ladder. The angle of the ladder before the failure was determined to be approximately 41 degrees as indicated by the apparatus inclinometer. The ladder was unsupported. The ladder was extended to 94.5 feet as indicated by the apparatus extension meter. The tractor and trailer were jackknifed, forming an angle of approximately 30 degrees. The operator indicated that due to obstructions in the area of the apparatus, the placement and positioning of the unit was less than optimal. As Osbeck, who was utilizing a ladder belt but had not yet locked it to the ladder, reached approximately two-thirds the length of the ladder, it began to sway and shake. The ladder then twisted slowly to the left and Osbeck held on in a "bear hug" fashion. With the ladder twisted and the walkway at a 90 degree angle to the ground, it began to collapse. It fell slowly at first then accelerated in a manner similar to a falling tree. Witnesses reported hearing loud screeching and popping noises as the ladder came down. The ladder, with Osbeck still holding on, impacted with the roof of the cab of Engine 4. Osbeck was then catapulted from the ladder as it bounced back up as a diving board would, approximately twelve feet into the air. It then hit with the ground and he was rendered unconscious. Firefighters in the immediate area rushed to his aid and began medical treatment. Treatment at the scene was continued by PAS who transported Osbeck to ACMC.

DC Alfred Sacco, who was in charge of Division C, stated that he had directed the acting captain of Ladder 2, Allen Huggins, to send someone up the ladder to adjust the water stream. Huggins stated that when Osbeck arrived at the location of the aerial, he felt that Osbeck seemed anxious to climb the ladder. Further, it was reported by the operator of the apparatus, Henry Hahn, Jr., that as Osbeck arrived at the aerial's location to begin his climb, he was told by Hahn that the ladder was "shaky" and was not suitable for climbing. The operator said he had reached this conclusion when he had climbed the ladder earlier in the incident with Huggins to adjust the stream of the nozzle. In statements obtained from Osbeck, he states that he doesn't remember being told the ladder was at an unsafe angle.

Firefighter Osbeck's Injuries

FF Christian Osbeck suffered various injuries due to his impact with the failed ladder, the engine upon which it fell, and the ground. They included a broken tibia and fibula of his left leg, the tibia requiring metal rods to be inserted; a fracture of his upper right center incisor; various other injuries to his mouth including loosened upper teeth; Adjustment Disorder caused by an enclosed head injury; and related traumas.

Osbeck was admitted to ACMC and remained there until November 23, 1993. He was unable to return to active duty until June 15, 1994. The rod in Osbeck's left tibia has yet to be removed. It

is anticipated this will be done sometime in the Fall of 1995.

COMMENTS

Personal Protective Equipment

An inspection was performed on FF Osbeck's Personal Protective Equipment (PPE) which revealed that all components were in full compliance with the New Jersey Public Employees Occupational Safety and Health Act (PEOSHA).

The Failed Aerial Apparatus

The aerial apparatus that failed on November 18, 1993 was manufactured in 1970 by the Peter Pirsch Co. of Kenosha, Wisconsin. It is an articulating, tiller type apparatus, equipped with a full complement of ground ladders and a midship, 100 foot, aluminum, hydraulically-operated, four-section, telescopic aerial ladder. The apparatus was designated by the fire department as a reserve aerial and was placed back in regular service in January of 1993 as a replacement for a newer apparatus which was out of service for the purpose of being completely refurbished.

Testing and Repairs to the Failed Aerial Apparatus

Records provided by the Atlantic City Fire Department indicate that the ladder was tested on September 15, 1988 by National Testing (NT) of Folcroft, PA. The testing was conducted within the parameters of NFPA 1914; *Standard for Testing Fire Department Aerial Devices; 1988 ed.*[4] At that time, NT reported that the ladder had failed the testing process due mainly to both of the base section baserails exhibiting signs of cracking. The ladder was placed out of service and repairs of the baserail sections and other items indicated in the test report were scheduled with the Peter Pirsch Co. On December 7, 1988 the truck left Atlantic City for the Pirsch repair facility in Kenosha, WI. While travelling through Bradford PA later that day, the truck broke down and had to be towed to a local engine service facility, Penland Diesel. At Penland several engine and transmission deficiencies were identified and extensive repairs were initiated. All work was completed on March 20, 1989 at which time the apparatus continued on to Wisconsin. On April 19, 1989, the truck arrived at Pirsch and the work, including the replacement of the baserails was begun. All work was completed on May 10, 1989. At that time the ladder was retested by NT and was recertified for a period of one year from the initial test date of September 15, 1988.

No records of further formal testing of the ladder could be identified. The lack of a test plate dated after September 15, 1988 on the apparatus indicate that, most likely, no further testing was done.

[4] *National Fire Protection Association Standard 1914, Standard for Testing Fire Department Aerial Devices, 1988 edition,* National Fire Protection Association, Quincy, MA

Failure Analysis of the Aerial Apparatus

The Division of Fire Safety contracted with The National Institute of Emergency Vehicle Safety Inc. (EVS) to assist with the investigation of this incident. EVS is a nonprofit organization whose primary function is to inform the emergency services of safety issues relating to the purchase, application, operation and maintenance of emergency response vehicles. Additionally, EVS has provided similar investigative services to several fire agencies with respect to aerial apparatus failures which have occurred throughout the United States.

In preliminary discussions with representatives of EVS, it was indicated that metallurgy testing of the failed ladder would be appropriate in order to determine if defects and/or fatigue of the materials used to construct the ladder played a causal role in the failure. For this aspect of the investigation, the Division, through EVS, contracted with Failure Analysis Associates, Inc. (FA) of Alexandria, Virginia.

The ladder was disassembled and transported via flatbed trailer to the laboratories of FA. The ladder was subjected to chemistry and hardness testing. Testing revealed that the materials, while showing slight deterioration due to intergranular corrosive attack, conformed to the manufacturer's specification in both chemistry and strength. It was FA's conclusion that there was no conclusive evidence that weakness or defects in the ladder material were the primary cause of the failure.

The conclusion of EVS as to the primary cause of the failure was the improper placement and operation of the aerial device. EVS noted that the ladder was overloaded by operating at an extension that was twice that allowed by the manufacturer for the angle of 41 degrees as indicated on the inclinometer at the time of the failure.

The Apparatus Operator's Training

The operator of the aerial apparatus at the incident where the failure occurred had, at the time, twenty years of service with the ACFD and specifically, eight years of service with Ladder Company 2. ACFD Departmental Orders require all ladder companies to drill with their apparatus each Tuesday. These drills are to provide for the entire operation of the apparatus and driver/operator training. Training records indicate that this particular operator had trained extensively on this and other similar units throughout his career.

Critical Incident Stress Debriefing Team Use

The purpose of a Critical Incident Stress Debriefing (CISD) Team is to provide individual counseling, group sessions and, if necessary, referrals to members of an emergency response organization involved in traumatic events. These events include death or serious injury of a co-worker, multiple deaths or the death of a child. The teams are made up of specially trained fire, police and EMS personnel.

Teams include mental health professionals who provide training and guidance to the team members and assist at the debriefing sessions. The assistance provided by the CISD Team helps to sensitize the firefighters to the possibility of stress reactions, hopefully avoiding future stress related problems. It allows the members to understand the range of normal reactions and provides a method to deal with the incident and its after effects. CISD Teams are regionalized in New Jersey and are part of a statewide network.

Two members of the ACFD are assigned to the CISD team that covers the Atlantic City area. These members were utilized for this incident. It was reported that the CISD team provided a significant amount of assistance to fire department members in dealing with FF Osbeck's injuries and the event of the ladder collapse in general. Continuing counseling for firefighters by the CISD team has been extremely beneficial in helping them deal with the long term effects of this traumatic occurrence.

RECOMMENDATIONS

Incident Management System

The ACFD utilizes the National Fire Academy's (NFA) *Incident Command System* as the department's Incident Management System. At this incident, all command staff positions were utilized. The Division of Fire Safety recommends that all fire departments adopt a nationally recognized incident management system. NFPA 1500, *Fire Department Occupational Safety and Health Program*[5] recommends the use of an incident management system on all incidents. Proposed legislation, currently being discussed in the state legislature, would make the adoption of an Incident Command System, which would be determined by the Division, mandatory for all fire departments in the state.

Safety Officer

At this incident, the ACFD assigned a dedicated safety officer to observe operations and terminate potentially unsafe actions.

The Division of Fire Safety recommends the assignment of a dedicated safety officer(s) on all significant incidents. This action lessens the load on the incident commander and allows for continuous monitoring of safety conditions at the incident scene. Additionally, NFPA 1500, *Fire Department Occupational Safety and Health Program* and NFPA 1501, *Standard for Fire Department Safety Officer*[6] suggest the use of a dedicated safety officer.

At this particular incident, the safety officer and/or line officers should have noted the unsafe positioning of the aerial apparatus before it failed and ordered the correction of the situation. Additionally, FF Osbeck and all others should have been prevented from climbing the apparatus until it was placed in a safe position.

Positioning and Operation of Aerial Devices and Training of Operators

Each aerial apparatus is provided with detailed instructions for placement and operation which are specific to that particular apparatus. These instructions are customarily in the form of printed manuals, manufacturer provided training at time of delivery, and various warning labels, gauges, and meters, including inclinometers, placed directly on the apparatus. Manufacturer provided training, if any,

[5] *National Fire Protection Association Standard 1500, Fire Department Occupational Safety and Health Program, 1992 edition,* National Fire Protection Association, Quincy, MA

[6] *National Fire Protection Association Standard 1501, Standard on Fire Department Safety Officer, 1992 edition,* National Fire Protection Association, Quincy, MA

would have occurred when the apparatus was delivered in 1970, thus making it inconsequential to anyone joining the department after the training would have been provided. Written operational manuals, however were retained by the department. Additionally, this unit's inclinometer was operational at the time of the failure and was clearly marked with the acceptable parameters of the ratio between ladder angle and extension. Whether intentionally or unintentionally, the maximum safe allowable limits of extension for the ladder angle as determined by the manufacturer were not heeded.

It is common practice for manufacturers to incorporate during engineering and design reasonable margins of safety to cover operations that may fall slightly out of the accepted use of their product. The Division of Fire Safety recommends however, that all apparatus operators be continually trained in accordance with manufacturer's recommendations regarding the proper and safe use of the apparatus utilized by the fire department. Further, the Division recommends that all design limitations of apparatus be known by operators and other personnel who come in contact with a particular piece of apparatus, and that under all conditions, the apparatus be operated strictly within those limitations.

Stated quite simply, if an apparatus cannot be operated safely, or an operation performed safely, an alternate means of accomplishing a goal or objective must be found.

Periodic Testing of Aerial Apparatus

Although it was discovered through the process of destructive testing after the failure of the ladder that the materials were within the manufacturer's specifications, this particular apparatus was not within acceptable test date certification. *NFPA 1914; Standard for Testing Fire Department Aerial Devices; 1991 ed.*[7] stipulates that aerial ladders be subjected to visual inspection, operational tests, and load testing at least annually or after major repairs and/or unusual stress or load. The standard requires the previously mentioned testing with the addition of nondestructive testing to include: ultrasonic; magnetic particle; liquid penetrant; radiographic; and, hardness tests, to be conducted every five years.

The Division of Fire Safety recommends that all aerial apparatus be tested in accordance with *NFPA 1914; Standard for Testing Fire Department Aerial Devices; 1991 ed.*

Personnel Accountability System and Firefighter Assistance and Search Team

The ACFD does not currently use a personnel accountability system for its firefighters. A system such as this provides for the safety of personnel by providing a means of accounting for and quickly locating each firefighter at the incident scene. The use of a Firefighter Assistance and Search

[7] *National Fire Protection Association Standard 1914, Standard for Testing Fire Department Aerial Devices, 1991 edition,* National Fire Protection Association, Quincy, MA

Team (FAST) is a tenet of a department's accountability system. This team is a group of firefighters designated for the sole purpose of locating and rescuing firefighters who become trapped or incapacitated at an incident. The ACFD is planning for the implementation of these concepts for the near future.
The Division of Fire Safety recommends that all fire departments adopt a personnel accountability system which incorporates the use of the FAST concept and is compatible with the operations of the department and provides a method for locating each firefighter at the incident scene.

Emergency Evacuation Signal

The ACFD utilizes an emergency evacuation signal which incorporates multiple blasts of apparatus airhorns and a radio tone alert with voice message.

The Division of Fire Safety recommends that all fire departments adopt an emergency evacuation signal for use when personnel must exit a structure or other hazardous area due to deteriorating conditions. This may consist of a pattern of airhorn blasts or similar distinctive signals or alerts tailored to the needs of the department. All members should be aware of and train on the procedures concerning the use of and response to the signal and accompanying radio evacuation broadcast.

Cardiopulmonary Resuscitation

The ACFD provides training and certification for all members in the application of Cardiopulmonary Resuscitation (CPR).

The Division of Fire Safety recommends that CPR certification training be given to all firefighters, career and volunteer. The ability to immediately initiate CPR could be vital in reviving a civilian or firefighter at an incident scene, in training, during normal station duties, etc. The first few minutes are critical for providing CPR and if all firefighters were certified in its application there would be an increased chance of survival for any victims that may be encountered.

With the protection from infectious diseases of members who provide EMS treatment being critical, fire departments should also issue each CPR-trained member a pocket mask with a one-way valve and appropriate gloves, or have them immediately available for use on an apparatus. Members should receive appropriate training for the use of these universal precautions.

Fire departments should also consider the purchase of minimum emergency medical services equipment, such as oxygen, blood pressure cuffs and an assortment of bandages and immobilization devices, to allow trained personnel to handle incidents while awaiting the arrival of EMS.

Critical Incident Stress Debriefing Team Use

The ACFD utilized a CISD Team for this incident. The department continues to provide counseling for its members through the use of the team.

The Division of Fire Safety recommends the notification and use of CISD teams when the CISD trigger events are found to be present. Such significant events may include[8]:

- √ line of duty death of a co-worker
- √ mass casualty incidents
- √ death of a child
- √ death occurring after prolonged rescue efforts
- √ when a victim reminds an emergency worker of a loved one
- √ during highly dangerous or highly visible events
- √ when the emergency worker influences death or injury
- √ co-worker suicides
- √ any other unspecified highly traumatic event

Further information on critical incident stress debriefing is available from the CISD Network of New Jersey at (201) 592-3528. The statewide emergency contact number for activation of a CISD team is (609) 394-3600.

New Jersey Fire Incident Reporting System

The ACFD provides all incident data to the Division's Incident Reporting System.

New Jersey's Fire Incident Reporting System (NJFIRS) is a component of the National Fire Incident Reporting System, which is operated by the United States Fire Administration. This system provides a means for tracking and identifying trends in fire incidents; injuries and fatalities, both firefighter and civilian; and, types of fires, causes and related factors. Additionally, it can be used by departments and fire code authorities as a planning tool in training, equipment purchase, and code administration and implementation.

The Division recommends that all fire departments report incident data in the prescribed form to the Division's Fire Incident Reporting Section. For more information on how your department can begin reporting, or if your department is currently reporting on printed forms and would like to begin reporting electronically via computer, contact NJFIRS at (609) 633-6324.

[8]Trigger events information from the Critical Incident Stress Debriefing Network of New Jersey

CONCLUSION

The Atlantic City Fire Department displayed a high level of professionalism in handling this incident after the collapse of the ladder, especially considering the extreme emotional stress experienced by the department's members relative to the severe injuries to one of their own and the loss of a major piece of apparatus. Almost immediately after the incident was completed, the fire department showed a willingness to discover the cause of the failure by launching a complete internal investigation, including a virtual reconstruction of the events of the collapse.

During the course of this investigation, no violations were noted with regard to the New Jersey Uniform Fire Safety Act, and/or regulations of the New Jersey Departments of Health and Labor.

The results of the destructive testing conducted by Failure Analysis are quite clear. The materials of which the ladder was constructed were within the manufacturer's original specifications. Some corrosion was noted but there was no conclusive evidence to suggest that this was the primary cause of the failure.

Evidence obtained by the Division of Fire Safety indicates with certainty that this apparatus was operated in an unsafe manner, well outside the acceptable limits of operation. It can be concluded that the primary cause of failure for the aerial device was due to improper placement and use of the device on November 18, 1993.

At this particular incident there were multiple failures of the Atlantic City Fire Department's safety protocols. This began with the apparatus operator and the apparatus officer for the improper placement and operation of the aerial device. Further responsibility for the occurrence is proportionately shared between the safety officer who was operating in the area of the ladder failure, and ultimately, the incident commander, who may delegate authority to subordinates but retains overall responsibility for the incident.

AFTERWORD

Events such as these can prove trying to fire department members. However, it must be remembered that in such instances, the department administrators must take the responsibility from the outset to make certain the proper actions are initiated to provide needed assistance to the firefighter's family and to ensure that investigating agencies will have the necessary documents, information and evidence to conduct a thorough assessment of the incident. The Atlantic City Fire Department fulfilled their obligation in this respect.

As a reminder, in the event of a line of duty firefighter serious injury or death, fire departments should immediately contact the Division of Fire Safety to report the casualty and obtain necessary information regarding actions to take. Equipment that was involved with the injury or death and all firefighter protective clothing and equipment, including SCBA, should be impounded to preserve it for evidence. Written statements and/or depositions should be obtained from firefighters who may have been involved and from any other witnesses to the incident.

The Division of Fire Safety has made available to all fire departments in the state the *Firefighter Line of Duty Death and Serious Injury Guidelines.* If your department has not received a copy and would like one, please call the Fire Department Programs Unit at (609) 633-6071.

Following these guidelines will help ensure that the family of the fallen firefighter will receive the benefits and assistance they are entitled to and will aid in the process of any investigations that may follow.

APPENDIX
A

REPORT OF

THE

NATIONAL INSTITUTE
OF
EMERGENCY VEHICLE SAFETY, INC.

National Institute of Emergency Vehicle Safety, Inc.

A Special Investigative Report

of the

Atlantic City Fire Department (N.J)

Pirsch Aerial Device

Prepared For:

New Jersey Division of Fire Safety

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PURPOSE

At the request of the New Jersey Division of Fire Safety, Investigators from the National Institute of Emergency Vehicle Safety, Inc. (EVS), traveled to Atlantic City, New Jersey on December 17, 1994, to investigate the causatory failure of an aerial device owned and operated by the Atlantic City Fire Department.

OBSERVATIONS

Upon the arrival of the Investigators from EVS, it was discovered that the failed aerial device, manufactured by Pirsch & Sons Company of Kenosha, WI., had been removed from the chassis and was being stored at the Fire Department shops. A replacement ladder was being installed on the chassis that originally was involved in the failure incident.

The failure occurred while operating at a fire located at 1515 Pacific Avenue on November 18, 1993. The time of the initial alarm was 2006 hours.

The following information was taken from a report dated November 22, 1993 and developed by Victor J. Francesco, Deputy Chief, Training and Safety Division, Atlantic City Fire Department (Appendix A). Photographs were taken at the failure site to accompany the report. EVS Investigators were unable to confirm any of the measurements taken in the report.

1. The formal investigation by the Atlantic City Fire Department began at 0830 hours on November 19, 1993.

2. The failed ladder was examined at the site and revealed the following information: (As indicated in the Francesco Report)

    A. The inclinometer reading was approximately 41 degrees.
    B. The extension meter indicated that the device was extended to 94.5 feet.
    C. The hydraulic pressure gauge indicated 310 psi.
    D. The hydraulic cylinder lock valve was in the closed position.
    E. There appeared to be no obvious leaks in the hydraulic system.
    F. The hydraulic fluid level in the reservoir measured eight inches.
    G. The ladder locks were engaged and found in the locked position.

3. In addition the Francesco Report indicates the following:

    1. The apparatus was positioned in the parking lot of the bank located at New York and Pacific Avenues.
    2. The tractor and trailer were jackknifed and formed an angle of approximately 30 degrees.
    3. The outrigger on the left side of the turntable was deployed and placed in a foot pad. The outrigger was measured on center, was positioned at a distance of 79 feet 3 inches from the rear northeast corner of 1511-1513 Pacific Avenue.

D. Using measurements taken from the turntable, the resting angle of the ladder was calculated to be 40.5 degrees.

E. When the ladder failed, it came to rest on top of Atlantic City Pumper 4.

F. Members of the Atlantic City Fire Department reconstructed the incident at 1205 hours on November 19, 1993 with another similar piece of equipment.

It should be noted that the reconstruction did not replicate the data identified during the failure.

On December 18, 1994, EVS Investigators reviewed the documents provided which included:

1. Photographs of the failed aerial device immediately after the failure.
2. Maintenance records for the device.
3. Copies of reports and notes compiled by staff members of the Atlantic City Fire Department.
4. National Testing Report Dated September 15, 1988

A site review of the incident site was also conducted by the Investigators on December 18, 1994.

On December 19, 1994, Investigators met with Chris Eckert of the New Jersey Department of Community Affairs, Battalion Chief Daniel Tamburilla, Atlantic City Fire Department and John Kiesar, Shop Supervisor, Atlantic City Fire Department at the Fire Department Shops which are housed in Fire Station 3.

An inspection of the remaining portion of the failed aerial device was then undertaken. A portion of the failed device was still attached to the turntable. It was measured at approximately 13 feet in length. It was photographed, video taped and loaded on a truck for transport to an independent testing laboratory.

An inclinometer mounted on the device indicated that at 40°, the maximum extension was 60 feet in the unsupported position, and 85 feet in the supported position. When being used as a water tower, maximum extension is 50 feet.

The remaining sections from the failed device were then inspected by the investigators. A sample of the material was then taken from one of the sections that was involved in the failure. It was removed by a firefighter from the Atlantic City Fire Department using a gasoline powered cutoff saw.

The maintenance records for the vehicle were provided to the Investigators by Chief Kiesar. The records revealed that the device had undergone the Non Destructive Testing Process required by National Fire Protection Association (NFPA)Standard 1914. The device was tested by National Testing on or about September 15, 1988. It was recommended by the technician that the device be taken out of service for repairs. The shop records indicate that cracks in the base section was the primary cause for removing the ladder from service. After the device was taken out of service discussions arose as to the necessary repairs required to adequately restore the vehicle back to service. The vehicle was to be driven to the Pirsch Facility in Wisconsin for repairs. The vehicle left Atlantic City on December 7, 1988 to travel to Wisconsin. While enroute the vehicle broke down in Bradford, Pennsylvania. and had to be repaired. It appears that the motor/transmission package was installed improperly by Pirsch. The repairs were finally completed on March 20, 1989 and the vehicle arrived at the Pirsch Facility on April 19, 1989.

After the repairs, the ladder was again tested by National Testing on May 10, 1989. The records provided to EVS were incomplete because there were no other records attached to the Aerial Ladder Test Record dated May 10, 1989.

The device remained out of service until August 22,1989 and was then placed back in service.

The Certification provided by National Testing was effective for one year from the September 15, 1988 date.

The records did not indicate any further testing according to NFPA 1914 prior to the failure and after the test dated May 10, 1989.

ANALYSIS

The portion of the failed device was delivered via commercial truck transport to the Failure Analysis Associates labs in Alexandria, Virginia on December 20, 1994.

The scope of the work identified to be performed by Failure Analysis Associates included the following:

1. Visual examination
2. 35mm photography of the failed section
3. Metallographic sections of the device
4. Chemical analysis
5. Hardness Measurements
6. Fractography of fracture surfaces using scanning electron microscope.

The tests revealed the following:

Chemistry and Hardness-

1. The alloy used in the device conforms to ASTM-B221 2014, a precipitation-hardened aluminum alloy commonly used for applications requiring high strength, including service at elevated temperatures.

2. Hardness test indicated a Rockwell Hardness of 74.8-74.9. Manufacturers specifications required a Rockwell value of 74.

Metallography and Fractography-

1. The grain size of the material is large and elongated in the direction of the rail axis, consistent with recrystallization following extrusion.

2. It should be noted that grain boundary corrosion attack was indicated.

3. All regions of the fracture surface showed ductile dimpled rupture, consistent with tensile overload.

CONCLUSIONS

Based on information developed by the National Institute of Emergency Vehicle Safety, Inc., and coupled with testing conducted by Failure Analysis; it can be concluded that the primary cause of failure for the aerial device was due to improper placement and use of the device on November 18, 1993.

The aerial device was overloaded by operating at an extension that was twice that allowed by the Manufacturer for the angle indicated.

APPENDIX
B

REPORT OF THE
METALLURGICAL EVALUATION

PERFORMED BY

FAILURE ANALYSIS ASSOCIATES, INC.

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FaAA-DC-FR-95-05-02

METALLURGICAL EVALUATION OF THE ATLANTIC CITY FIRE LADDER

Prepared for:

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May, 1995

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May 8, 1995

Ms. Darlene Skelton
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Castro Valley, CA 94546-3852

SUBJECT: ***Metallurgical Evaluation of Atlantic City Fire Ladder***
FaAA Project No.: DC17800

Failure Analysis Associates (FaAA) is pleased to summarize the results of its metallurgical examination of a failed aluminum alloy fire ladder from Atlantic City, NJ, manufactured by Pirsch & Sons Company of Kenosha, WI.

The scope of work involved visual examination and 35 mm photography of the failed ladder segment, metallographic preparation of sections cut from the ladder, chemical analysis, hardness measurements and fractography of fracture surfaces using a scanning electron microscope (SEM). Additional chemical analyses of the ladder exterior surface and a fracture surface were done using energy dispersive spectroscopy (EDS).

Figures 1 and 2 show overall views of the failed segment of the ladder. Figure 3 shows the underside of the failed segment, including the fracture of the T-section rail (right hand side). To obtain specimens for metallurgical evaluation, the T-section rail was cut and sectioned as shown in Figures 4 and 5. Figure 4 shows the locations of sections 1A-1 and 1A-2 on the right side T-section rail, close to, and away from, the fracture surface, respectively. Figure 5 shows the location of section 1A-3 on the left side T-section rail.

Chemistry and Hardness Testing

The chemical composition of a sample of the rail alloy was assessed by optical emission spectrocopy; the results are shown in Table 1. Tests results shown in Table 1 were obtained by optical emissions spectrometry in accordance with ASTM-B209-93 and ASTM-E351. The alloy conforms to ASTM-B221 2014, a precipitation-hardened aluminum alloy commonly used for applications requiring high strength, including service at elevated temperatures.

Rockwell hardness measurements were made on sections 1A-2 and 1A-3 (ten measurements on each; average values of HRB 74.9 for section 1A-2 and HRB 74.8 for section 1A-3 were recorded. The manufacturer's specification for this material calls for a T6 heat treatment which has a Brinell hardness HB 135, equivalent to HRB 74.

Table 1: Chemical Composition of Ladder Sample

Element	Result (wt.%)	ASTM-2014 Spec. low (wt.%)	ASTM-2014 Spec. high (wt%)
Mg	0.30	0.20	0.80
Si	0.81	0.50	1.20
Ti	0.03	0.00	0.15
Mn	0.68	0.40	1.20
Fe	0.34	0.00	0.70
Cu	3.98	3.90	5.00
Zn	0.01	0.00	0.25
Cr	0.01	0.00	0.10
OE	< 0.05	0.00	0.05
OT	< 0.15	0.00	0.15
Al	Balance	Balance	Balance

Metallography and Fractography

Figure 6 shows the microstructure of a section (typical) of the 2014 ladder alloy. The grain size is large (i.e., 1-4 mm in cross section) and the grains are elongated in the direction of rail axis, consistent with recrystallization following extrusion. The microstructure is as expected for 2014-T6 alloy, containing precipitates of $CuAl_2$ and particles of $(Fe, Mn)_3SiAl_{12}$, seen within the grains as white outlined and dark dots, respectively.

Evidence of grain boundary corrosion attack was found, as shown in Figure 7. This attack is localized corrosion along grain boundaries from a free surface, leading to grain separation[1]. High strength 2014-T6 aluminum alloy is particularly susceptible to this type of corrosion cracking if the material is underaged following quenching[2].

Fractography was performed on the fracture surface from the right side T-section rail in the scanning electron microscope (SEM). Figure 8 shows a photograph of the fracture surface. Figure 9 shows an SEM micrograph that reveals the surface detail. All regions of the fracture surface showed ductile dimpled rupture, consistent with tensile overload. Although surface cracks exist elsewhere on the rail (e.g., Figure 7), no evidence of cracking was found at the fracture surface. No cracks found were deep enough to cause failure of the rail by fast fracture.

[1] U. R. Evans, An Introduction to Metallic Corrosion, 3rd. Ed., American Society of Metals, Metals Park, OH., p. 152 (1981).

[2] B. W. Lifka and D. O. Sprowls, "Significance of Intergranular Corrosion in High-Strength Aluminum Alloy Products" in Localized Corrosion - Cause of Metal Failure, ASTM STP 516, Philadelphia, PA., pp. 120-144 (1968).

The chemistry of the fracture surface was probed using energy dispersive spectometry (EDS) and the results are shown in Figure 10. For comparison, the exterior surface of the rail was probed to determine the EDS signature of the surface corrosion, also shown in Figure 10. No evidence of extensive corrosion of any region of the fracture surface was found, supporting the conclusion that surface cracks did not contribute significantly to the rail failure.

Conclusion

The right hand side T-section rail of the ladder segment examined failed by tensile overload. The rail material conforms to the manufacturer's specification in both chemistry and strength. While this particular alloy is susceptible to intergranular corrosive attack (and evidence of this type of attack was found) there is no conclusive evidence to suggest that this was the primary cause of the failure.

It has been our pleasure to assist you in the evaluation of this fire ladder. If you have any questions regarding the analyses, please feel free to call me or Dr. Lee Dickinson at (703) 549-9565.

Yours sincerely,

Timothy R. Smith, Ph.D.
Senior Engineer

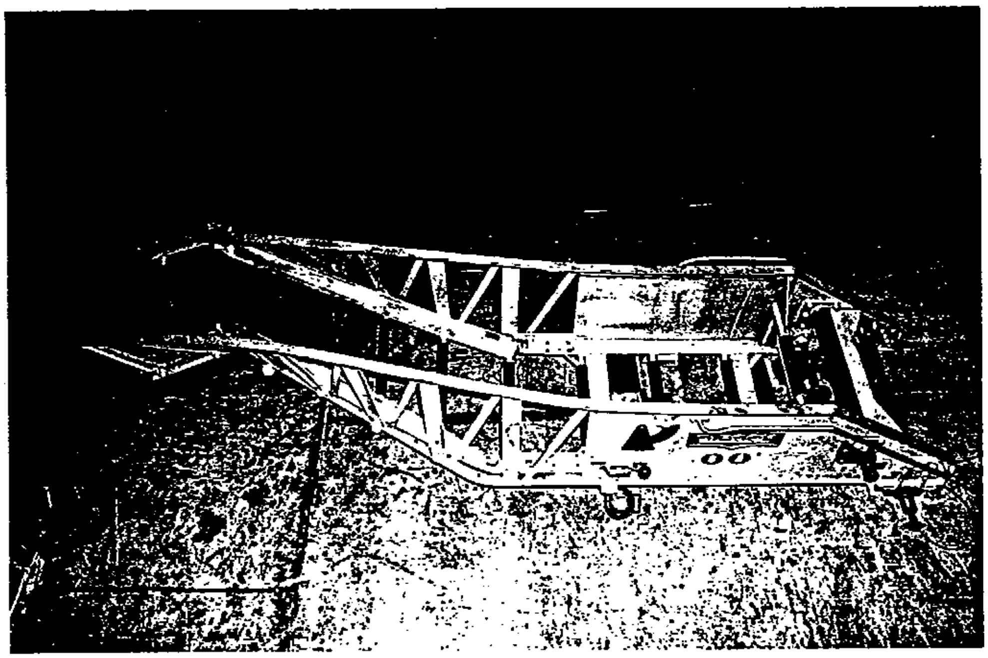


Figure 1. Overall view of failed ladder segment
Photo Id: DC17800-R1E1

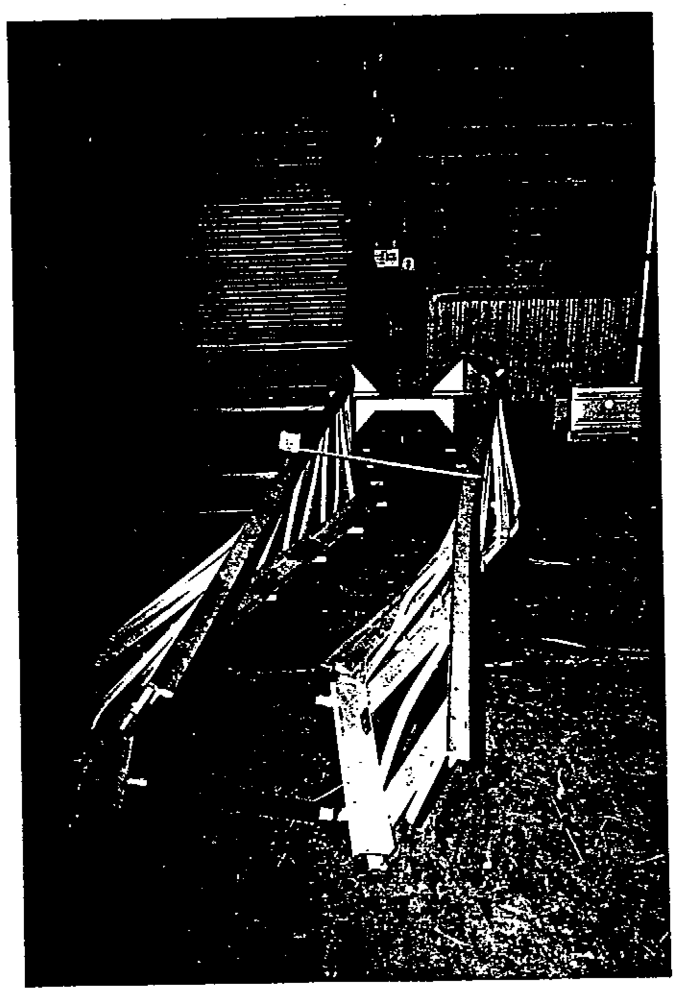


Figure 2. Overall view of failed ladder segment
. Photo Id: DC17800-R1E6

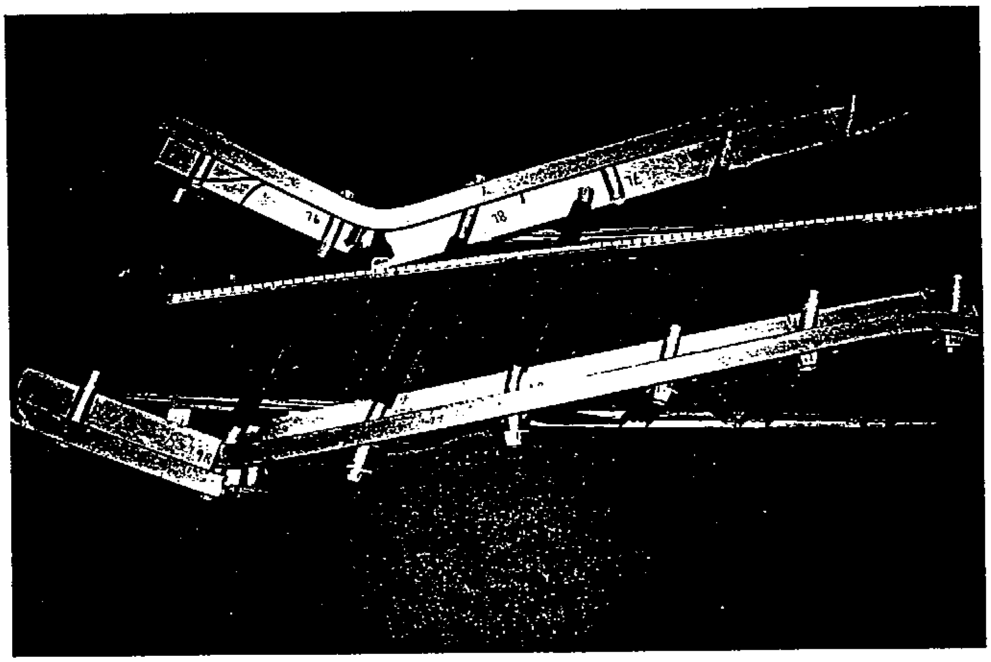


Figure 3. Underside of failed ladder segment
Photo Id: DC17800-R3E3

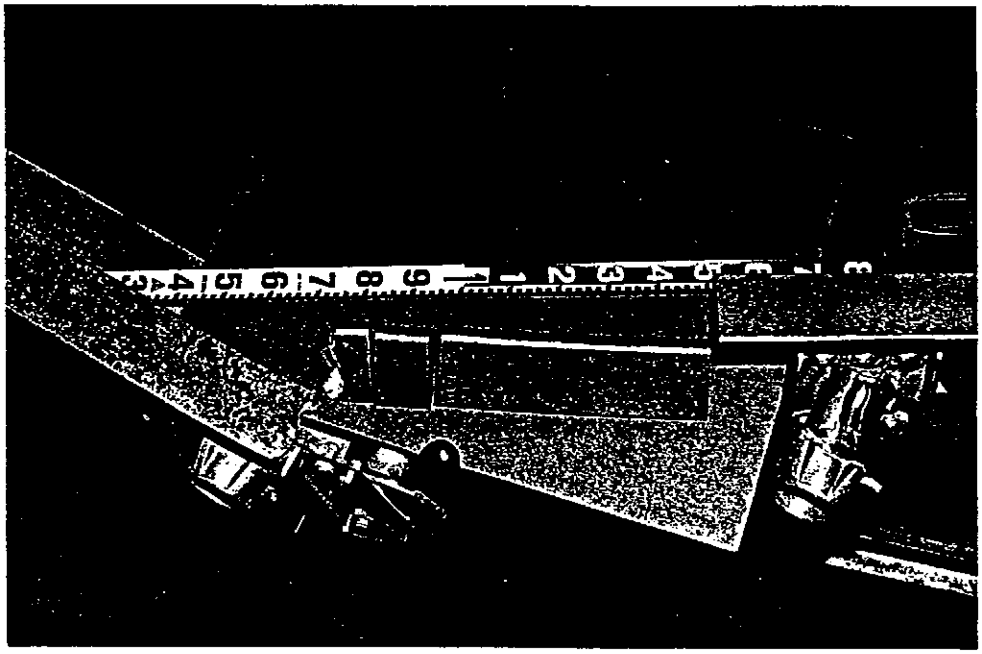


Figure 4. Fracture surface and sections 1A-1 and 1A-2 locations
Photo Id: DC17800-R4E1

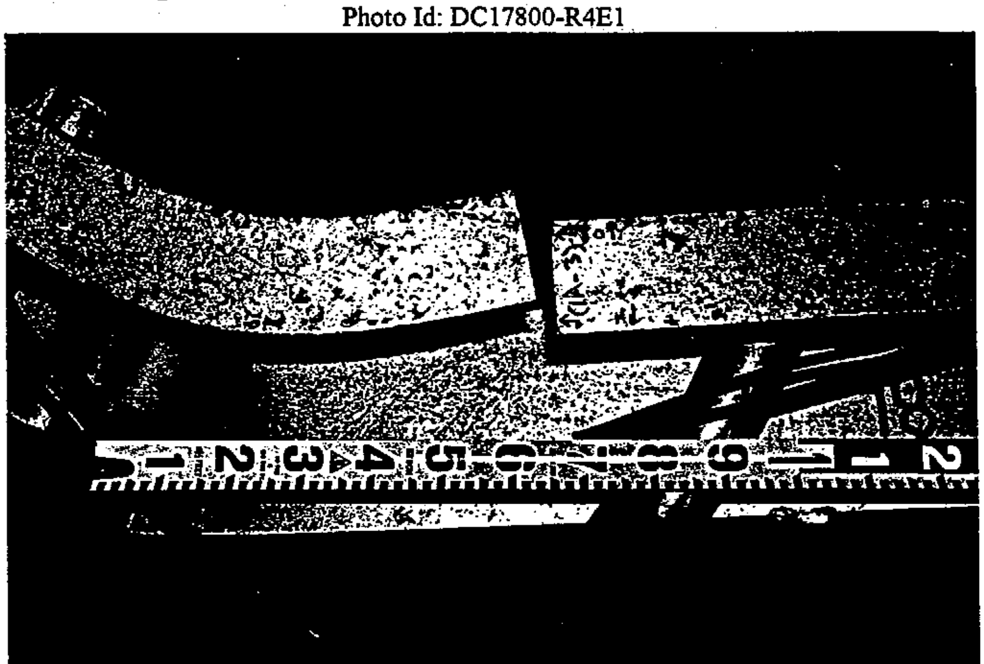


Figure 5. Section 1A-3 location
Photo Id: DC17800-R1E2

Figure 6. Microstructure of ladder (typical)
100 X Keller's reagent
Photo Id: DC17800-PAL-1-3/24/95

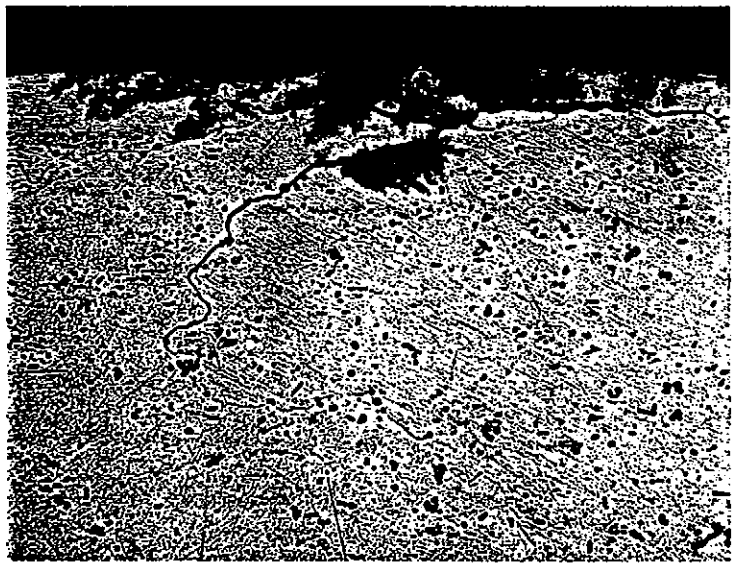


Figure 7. Intergranular corrosion crack
200 X Kellar's reagent
Photo Id: DC17800-PAL-3-3/24/95

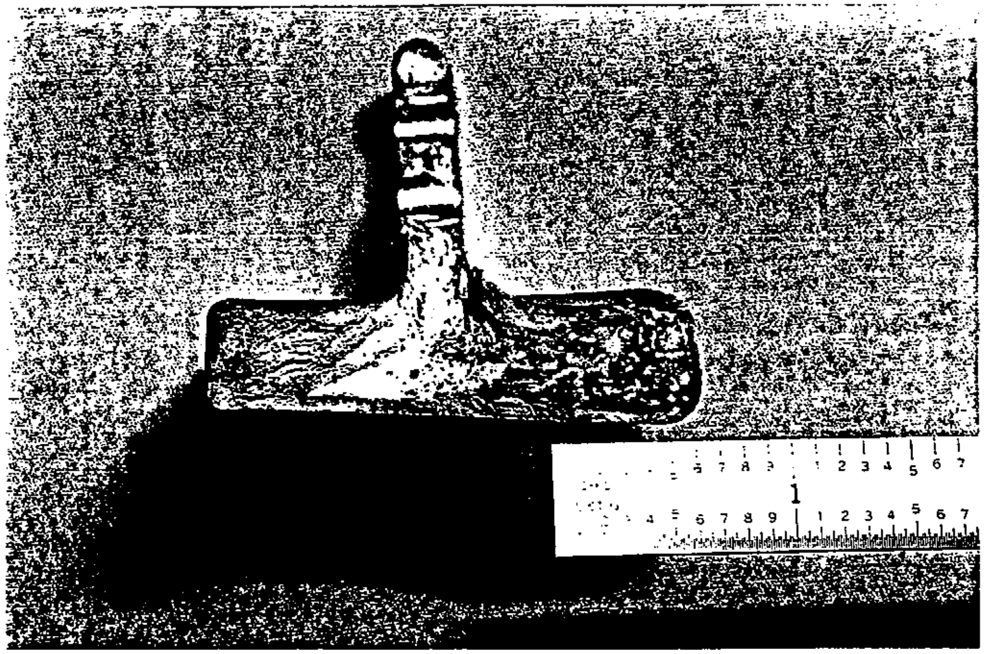
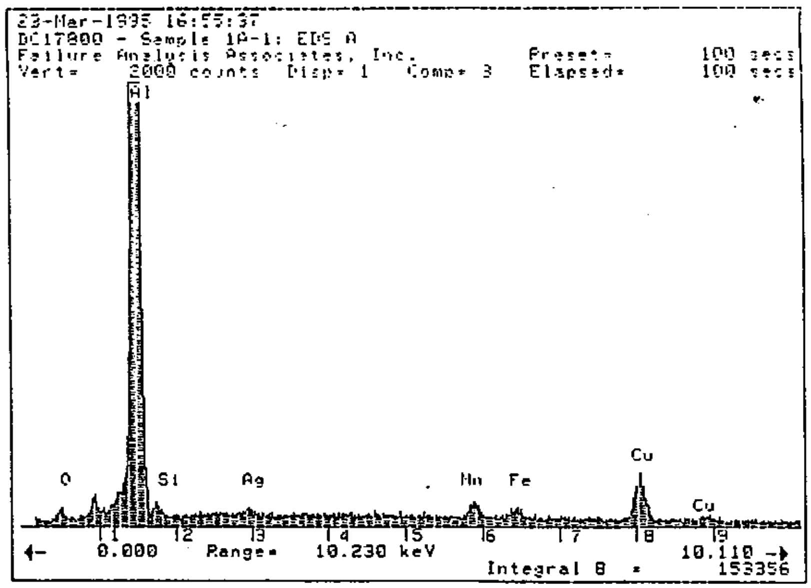
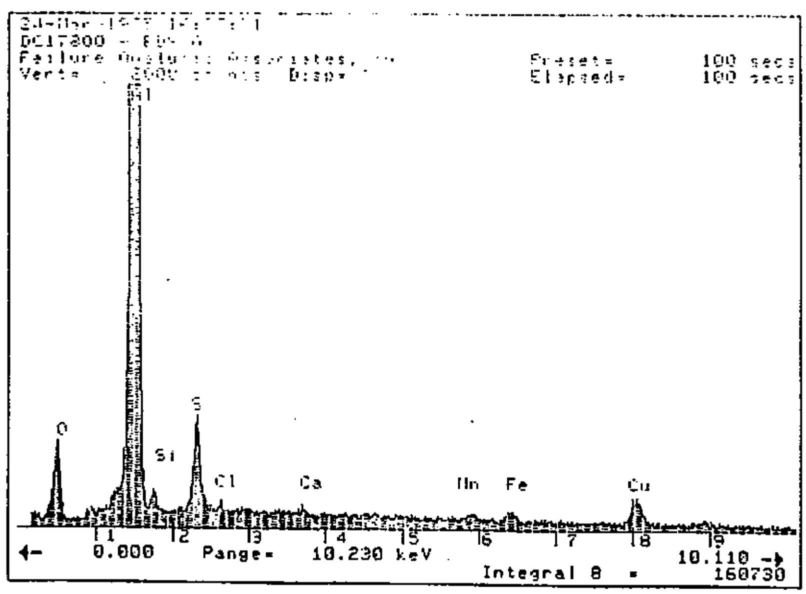


Figure 8. Photograph of the fracture surface
Photo Id: DC17800-R4E4

Figure 9. SEM micrograph showing detail of the fracture surface.
Failure mode is ductile dimpled rupture.
Photo Id: DC17800-PAL-1-2/7/95



(a)



(b)

Figure 10. EDS spectra showing surface chemistry
a) fracture surface
b) corrosion scale