PLYWOOD MANUFACTURING PLANT

Nacogdoches, TX

April 16, 1984

NFPA INTERNATIONAL

FIRE INVESTIGATIONS

NATIONAL FIRE PROTECTION ASSOCIATION

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Investigation Report

Plywood Manufacturing Plant
Nacogdoches, Texas
April 16, 1984

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In Cooperation with

Federal Emergency Management Agency/
United States Fire Administration

and

National Bureau of Standards/
Center for Fire Research

ABSTRACT

At approximately 12:25 p.m., on April 16, 1984, workmen were performing arc welding operations on a hot press in the International Paper Company's Nacogdoches, Texas plywood manufacturing plant. During welding operations, deposits of oil, pitch, and wood dust which had collected on the press, the catwalks, the wood structural members of the roof assembly, and the plywood roof deck ignited. The fire spread rapidly over the accumulated deposits both above and below the automatic sprinklers. Fire department units began arriving at the plant at 12:28 p.m. and found the plywood manufacturing facility heavily involved in fire. Within five minutes after the arrival of the initial fire department units, the building was "fully involved." Roof collapse began approximately ten minutes later. The fire destroyed the plywood manufacturing facility, resulting in an estimated loss of 32.5 million dollars.

Construction of the plant facilities began in 1969 and the plant was operational in August, 1970. The plywood manufacturing building encompassed approximately 218,000 undivided square feet of all wood construction. In 1979, a 19,000 square foot addition of steel construction was added to the south end of the original building. This addition housed the jet dryers and other additional processing equipment.

The building was protected throughout by twelve dry-pipe automatic sprinkler systems and two dry-pipe standpipe systems.

Three factors were identified during the investigation as significant in the rapid fire spread and loss of the building. These factors were:

- The accumulation of highly combustible deposits of oil, pitch, and wood dust generated in the plywood manufacturing process;
- The lack of adequate fire prevention measures during the arc welding operations;
- The obstructed piping within the dry-pipe automatic sprinkler systems.

INTRODUCTION

The National Fire Protection Association (NFPA), with assistance from the Southern Building Code Congress International, Inc. (SBCCI), investigated the International Paper Company's Nacogdoches, Texas Plywood Manufacturing Plant fire in order to document and analyze significant factors that resulted in the loss of property.

This study was conducted under a major fire investigation agreement among the Federal Emergency Management Agency/United States Fire Administration (FEMA/USFA), National Bureau of Standards/Center for Fire Research (NBS/CFR), and the NFPA. The agreement, funded by FEMA/USFA, NBS/CFR, and NFPA, provides for the investigation of technically significant fires by the NFPA's Fire Investigations and Applied Research Division to document and analyze incident details and report lessons learned for loss prevention purposes.

The NFPA was assisted in the data collection and analysis by the Southern Building Code Congress International, Inc. (SBCCI) under an agreement among NFPA and the three model building code organizations to investigate significant structural fires throughout the United States. In addition to SBCCI, the other cooperating building code groups are the Building Code Officials and Code Administrators International (BOCA) and the International Conference of Building Code Officials (ICBO). The three model building code groups are supporting NFPA by lending technical staff support for on-site field work and building code analysis.

The NFPA became aware of the International Paper Company's Plywood Manufacturing Plant fire on the day it occurred. Tom Timoney, Fire Protection Specialist in the Fire Investigations and Applied Research Division, and Gary L. Fisher, Associate Engineer, Southern Building Code Congress International,

traveled to Nacogdoches, Texas to document the facts related to the fire. A two-day, on-site study and subsequent analysis of the incident are the basis of this report. Detailed data collection activities were made possible by the cooperation of the Nacogdoches Fire Department. This report represents the findings of the data collection and subsequent analysis efforts.

This report is another of NFPA's studies of fires having particular educational or technical interest. The information presented is based on the best data available during the on-site data collection phase and further data acquired through subsequent follow-up. It is not the NFPA's intention that this report pass judgment on, or fix liability for, the loss of property at the International Paper Company's Plywood Manufacturing Plant. This report describes fire protection conditions at the International Paper Company's Plywood Manufacturing Plant and presents findings on contributing factors to the loss of property based on NFPA's analysis of collected data and observations during the investigation.

The cooperation and assistance of Chief C. E. Duffin and Captain Rusty Sanders of the Nacogdoches Fire Department is greatly appreciated. A special thanks to Mr. Gary L. Fisher, Associate Engineer, Southern Building Code Congress International, and Mr. Edwin R. Bayley, Senior Loss Prevention Specialist, Factory Mutual Engineering, for their on-site assistance in the data collection phase and for their input into the code analysis and report writing process.

BACKGROUND

The International Paper Company's Nacogdoches, Texas, Plywood Manufacturing Plant was located in an industrial area of the city of Nacogdoches. The city of Nacogdoches, Texas is located approximately 130 miles northeast of Houston, Texas. This area of the state has abundant forest lands of southern pine.

Construction of the facilities on the plant site was initiated in 1969 and completed in August, 1970. Buildings on the plant site included a boiler house, cooling shed, planing mill, stud mill, and the main plywood manufacturing facility.

The plywood manufacturing building had three undivided sections. The manufacturing section of the plant had approximate dimensions of 330 feet by 520 feet. Attached to the north end of the manufacturing section was a 110-foot by 200-foot "green end section." In 1979, a 213 to 303-foot by 75-foot addition was added to the south end of the manufacturing section. The three sections combined to create a single undivided area of approximately 236,000 square feet (see diagram #1).

The manufacturing section was built using heavy timber and laminated timber structural members and plywood walls and roof decking. The roof assembly was designed using 330-foot long laminated bow string wood trusses placed on 20-foot centers, running east to west. The trusses were supported at the exterior walls by wood columns with approximate dimensions of 12 inches by 16 inches spaced 20 feet on center. Alternate trusses were also supported at the center by wood columns with approximate dimensions of 12 inches by 16 inches spaced 40 feet on center.

The bow string wood trusses were a maximum of 23 feet in depth and were

placed 22 1/2 feet above the floor slab to create a maximum ceiling height of 45 1/2 feet. The top and bottom chords of each truss were approximately 15 inches by 7 inches. These laminated chords were formed by nine layers of wood with approximate dimensions of 1 1/2 inches by 7 inches. Two-inch by 10-inch wood joists were framed into the trusses on 24-inch centers and supported the half-inch thick plywood roof deck. The half-inch plywood roof deck was covered with a composition-type roll roofing material.

Side walls of the building were generally half-inch thick plywood siding on wood framing. Examples of large openings in the side walls throughout the facility included a roll-up door in the southeast corner of the building and a railroad boxcar loading platform on the east side of the building. In addition, a natural draft and venting system had been designed into the building which incorporated numerous louvered openings in the side walls with nine roof mounted gravity vent houses concentrated in the center of the east bay. Running east to west at approximately 100-foot intervals were draft curtains of half-inch plywood.

There was a 23-foot deep, 2040-square foot draft hood around the two hot presses utilized in the plywood bonding operation (see diagram #1). The draft hood was designed to collect the heat, steam, and vapors generated by the hot presses and assist the two roof-mounted exhaust fans located above the presses. The hood and the hot presses below accumulated deposits of oil, pitch, glue, and wood dust. These accumulations were reported to be at least 1/4 inch deep on the steel catwalks and in the press area.

Hydraulic analysis of the dry-pipe automatic sprinkler systems protecting the 2040-square foot draft hood area indicates that with 22 sprinklers operating, the minimum anticipated distribution density would be .26 gpm/ft^2 with an average anticipated distribution density of .31 gpm/ft^2 at a minimum sprinkler operating pressure of 21 psi.

Reportedly, wood dust from the manufacturing processes routinely escaped into the plant covering the truss structures and process equipment. In areas of the plant away from the presses, lathes, and dryers, the dust accumulations were reported to be light in weight, and dry.

The dust control program established at the plant included pneumatic cleaning of the hot press area weekly and brushing down one of the three dryers each Wednesday. Pneumatic cleaning of the entire plywood manufacturing facility reportedly occurred each year during December. During this cleaning operation the 2040-square foot draft hood was also washed to remove the accumulated deposits of oil, pitch, and wood dust. The entire plywood manufacturing facility was pneumatically cleaned and the draft hood washed clean in December, 1983.

Plant production was estimated to be approximately 750,000 square feet per day of 3/8-inch to 3/4-inch thick plywood. The plant routinely operated two or three shifts per day, 5-7 days per week.

Fire Protection

The 236,000-square foot manufacturing facility was protected throughout by 12 pipe schedule, dry-pipe automatic sprinkler systems, and 2 dry-pipe standpipe systems supplying water to 30 hose stations located throughout the facility. In addition, two deluge systems provided fire suppression capability to three steam heated veneer dryers.

Each of the 12 pipe schedule, dry-pipe automatic sprinkler systems was equipped with a dry-pipe valve and an accelerator. Review of the design plans for these systems shows the majority of the sprinklers to be rated at 160 degrees F. In areas with elevated ambient temperatures, the sprinklers were rated at 212 degrees F or 286 degrees F. In the special case of the system providing protection of the dry kiln area, the sprinklers were rated at 500 degrees F.

The 520-foot by 330-foot manufacturing portion of the plant was divided into a manufacturing section and a storage section for purposes of sprinkler system design. The 520-foot by 230-foot manufacturing section was protected by sprinklers spaced at 100 square feet per sprinkler. The 520-foot by 100-foot storage section was protected with sprinklers spaced at 90 square feet per sprinkler. The design of the sprinkler systems throughout the manufacturing portion of the plant utilized extra hazard pipe schedule. A plant representative stated that the distance between the sprinkler deflectors and the plywood roof deck varied from 12 to 18 inches.

Two standpipe systems equipped with dry-pipe valves provided water supply to the 30 hose stations located throughout the facility. The design plans for the two standpipe systems reviewed by investigators did not indicate the design method used or list any performance specifications. Nine of these stations were exterior to the facility on the roof. These nine roof-mounted hose stations were positioned approximately 100 feet in from the east and west walls of the facility and were spaced at approximately 160-foot intervals. The 21 remaining hose stations providing protection to the interior of the plant were positioned on the perimeter and down the center line of the building at intervals varying between approximately 80 and 120 feet. Each hose station was equipped with a 50-foot length of cotton, rubber-lined 1 1/2-inch hose and an adjustable pattern nozzle. The 21 interior hose stations were connected to overhead distribution piping by lengths of 1-inch and 1 1/2-inch piping.

Water supply to the sprinkler and standpipe systems was provided solely by the city water system. The 12 dry-pipe automatic sprinkler systems and 2 dry-pipe standpipe systems were connected to a 10-inch fire main loop around the perimeter of the manufacturing facility. A post indicator valve was located in each of the water lines connecting the sprinkler and standpipe systems to the 10-inch fire main loop (see diagram #1). The separation

distance between the post indicator valves and the manufacturing facility varied from approximately 135 feet on the west side to approximately 15 feet on the east side. These post indicator valves were locked in the open position and were inspected weekly by maintenance personnel.

A 12-inch city water line connected into the 10-inch fire main loop at a valve pit located on the west side of the facility and an 8-inch city water line connected into the 10-inch fire main loop at a valve pit located on the north side of the plant site. The valve pit located on the west side of the facility had two 12-inch OS&Y valves, a 12-inch check valve, and a fire department connection. The valve pit located on the north side of the plant site had two 8-inch OS&Y valves, a 8-inch check valve, and a fire department connection.

The city water system utilizes both elevated tanks and electric pumps to maintain pressure and flow requirements throughout the city. Located approximately 2 miles west of the plant site is the city's no. 2 pumping station. This normally unattended station has four 1000 gpm at 100 psi turbine-type electric pumps, all four of which are manual start. Under normal conditions one of the pumps is operating. Approximately 2 miles east of the plant, a 1000 gpm at 100 psi centrifugal pump supplied by the 12-inch city water line is utilized to boost pressures throughout the city water system.

Flow tests completed during the investigation found that when the booster pump is out of service, the pressure at the plant site ranges from approximately 120 to 130 psi and when the booster pump is operating, water pressure at the plant site ranges from approximately 80 to 100 psi. The booster pump is designed with a remote control capability and can be operated from the city's main pump station. When the booster pump is operating, the water supply available to the plant site is approximately 2000 gpm at 20 psi residual.

Plant Fire Brigade

The plant fire brigade was comprised of plant employees who were trained in basic fire fighting under a cooperative program with the Nacogdoches Fire Department. Employee training concentrated on the proper use of the 1 1/2-inch handlines, the basic operating features of the dry-pipe automatic sprinkler systems, and the importance of the immediate notification of the fire department in a fire situation. In several previous fires at the plant, the plant fire brigade had successfully contained or extinguished the fire by the time the fire department arrived on the plant site.

Public Fire Protection

The city of Nacogdoches, Texas encompasses an area of approximately 26 square miles with a population of 28,000 people. A force of 51 career fire fighters operates five engine companies, three brush units, two tankers, and a truck company from four stations. Supplemental manpower to the career fire fighter force is provided by 20 call fire fighters.

Weather Conditions

Weather data collected at 1200 hours by the National Weather Service for the Nacogdoches area on April 16, 1984, was as follows:

Temperature	-	$68^{o}F$
Humidity:	-	30-35%
Wind:	-	2.65 mph from the northeast

The Incident

At approximately 1200 hours on April 16, 1984, workmen initiated operations to replace a motor on hot press #2 (see diagram #1). Before repair work on a broken bracket began, the workmen shut down the hot press, removed all the plywood in the press, and shut down both roof-mounted fans in the 2040-square foot draft hood. Before arc welding operations were begun to repair the broken bracket for an interlock switch, positioned approximately 15 feet above the floor level, a fire watch was established and the area was wet down with a small garden-type hose supplied from a 3/4-inch line tied into the plant water system.

Shortly after the arc welding operations were begun at approximately 1225 hours, the welder sensed considerable heat and looking upward discovered a fire above him on the catwalk and press frame. The employee at floor level then attempted to extinguish the fire with the small garden-type hose but was unsuccessful because he could not generate an effective hose stream with enough distance or capacity to attack the fire.

The fire then spread rapidly to the top of the press and entered the 2040-square foot draft hood above. Two workmen traveling from the press area to a hose station approximately 80 feet away described the fire as rapidly spreading through the draft hood and trusses within. At this point in the fire development, neither of the workmen observed any evidence of water flow from the ceiling sprinklers.

An employee in a breakroom approximately 170 feet west of the hot presses saw the fire, sounded an alert over the plant's public address system, and instructed the plant telephone operator to notify the fire department. He then moved quickly to the hot press area and attempted to place a 1 1/2-inch

standpipe hose in operation; however, he describes the stream from the 1 1/2-inch handline as "spurting" and abandoned the line. (The "spurting" the employee described experiencing when initially attempting to place the 1 1/2-inch handline in service is characteristic of a dry-pipe standpipe system and results from the air contained in the dry-pipe system being exhausted through the nozzle). He then ran west out of the plant to a hose cabinet adjacent to a hydrant and began stretching a 2 1/2-inch handline to the building. When he re-entered the building, the fire was "breaking out of the draft hood area in all directions" and he decided based on the magnitude of the fire to abandon his extinguishment effort and shut down the power supply to the plant.

The plant manager was in the second story of the office section about 165 feet west of the hot presses when he was alerted to the fire at approximately 1227 hours. When he entered the plant, the fire had already traveled approximately 120 feet south to the dryers. He described the fire as spreading along the trusses in all directions.

The plant manager and other plant employees described the flames as ranging from a few inches high to more than 24 inches. Neither the plant manager nor plant employees could see fire involvement of the roof deck at this point nor did they note any evidence of water flow from the overhead sprinklers, although they described hearing a "hissing noise" overhead. The plant manager then ordered the building evacuated. Several employees later reported "muddy" or "rusty" discharges from the sprinklers, but no employee described a characteristic full sprinkler flow.

Fire Department Operations

The Nacogdoches Fire Department received telephone notification of the fire at 1227 hours and dispatched 3 engine companies and a truck company. The fire department dispatcher also notified the public works department, and the booster pump 2 miles east of the plant site was shut off by remote controls to

conserve the largest quantity of water available for the fire attack. When the first due engine company pulled out of the station located approximately 1 mile west of the plant, fire fighters noted "fire showing." The initial arriving fire department units were confronted with severe draft problems and the potential for intense heat exposure to a 5,000-gallon propane tank located on the west side of the plant building.

Within 5 minutes of the arrival of the initial fire department units, the manufacturing facility was "fully involved" in fire. Fire fighters continued to stretch 2 1/2-inch hose lines to supply master stream appliances. Two of the four 1000 gpm at 100 psi pumps were in operation at the city's no. 2 pumping station when water department personnel arrived at approximately 1245 hours. The pumps showed a pressure of approximately 65 psi which indicates a flow of approximately 2500 GPM. The water department personnel then placed a third pump in operation.

During the initial fire department operations, four fire fighters were injured when an ammonia tank from an abandoned operation exploded. In addition, there were several other smaller explosions which were thought to be propane tanks used to fuel the plant forklifts. Approximately 15 minutes after the arrival of the initial fire department units, the roof assembly on the manufacturing portion of the plant collapsed, rupturing sprinkler system piping. Once this occurred at approximately 1245 hours, a decision was made to close the PIV valves on the supply lines to the 12 sprinkler systems and 2 standpipe systems. However, fire fighters were unable to close several of the PIV valves on the east side of the building due to their limited separation distance from the building of approximately 15 to 35 feet.

Approximately 10 to 15 minutes after fire department units arrived, firebrands from the burning plywood and veneer storage ignited a fire at a lumber storage building in a building materials business approximately 1/4 to 1/2 mile from the plant site. In addition, firebrands ignited numerous brush

fires in wooded areas as far as 3 1/2 miles from the plant site. At the height of the fire, fire fighters located firebrands as far as 9 miles from the plant site.

The Nacogdoches Fire Department began requesting mutual aid at 1229 hours. The fire eventually involved 20 fire departments who assisted in fire fighting operations and the backfill of empty stations over the 23 hours that units from the Nacogdoches Fire Department were committed to the plant site. In order to more effectively coordinate and analyze fire conditions at the plant site and throughout the surrounding area, the fire ground commander utilized a helicopter which was a valuable tool in assisting the Texas State Forestry Service with the numerous brush fires in the surrounding forest areas.

Damage

The entire plywood manufacturing capability at this facility was destroyed in this fire. Initial loss estimates of this fire totaled 32.5 million dollars. As of the time of this report, International Paper had announced that they planned not to rebuild the plywood manufacturing facilities at the Nacogdoches, Texas plant site.

Injuries

The 4 fire fighters injured when the ammonia tank exploded were taken to local hospitals, treated and released.

Table 1

Summary Time Line of Significant Events
International Paper Company Plywood Manufacturing Plant

Time	Significant Event
Monday, April 16, 1984 1200 hours	Workmen initiate actions to replace a motor on hot press #2
1225 hours	An arc welder repairing a bracket for an interlock switch senses considerable heat and discovers a fire above him on the catwalk and press frame.
1227 hours	The Nacogdoches Fire Department receives telephone notification of the fire from the plant telephone operator and dispatches 3 engine companies and a truck company.
1229 hours	"First in" fire department units arrive at the plant site. Officers report the 236,000 ft^2 manufacturing building heavily involved in fire and request mutual aid companies.
1229 hours	The fire department dispatcher notifies the water department of the fire and the booster pump 2 miles east of the plant is remotely shut off.
1235 hours	Fire ground officers report the 236,000 ft^2 manufacturing building "fully involved" in fire.
1235-1245 hours	Firebrands from the burning plywood manufacturing plant ignite a fire at a building materials warehouse 1/4 to 1/2 mile from the plant site.
1245 hours	Water company personnel place a third 1000 gpm pump at the city's no. 2 pumping station in operation.
1245 hours	The wood truss roof assembly of the plant collapses, rupturing sprinkler and standpipe system piping.

1245 hours	The decision is made to close the PIV valves on the supply lines to the 12 sprinkler and 2 standpipe systems. Fire fighters are unable to close PIV valves located 15 to 35 feet from the east side of the building.
Tuesday, April 17, 1984 1130 hours	Fire extinguishment completed.

ANALYSIS

Origin and Cause of Fire

Investigators from the Nacogdoches Fire Department and Factory Mutual Engineering, along with plant representatives, determined that the cause of this fire was the accidental ignition, during an arc welding operation on hot press #2, of highly combustible deposits of oil, pitch, and wood dust which had accumulated on the open grate steel catwalk and the press frame.

Fire Growth and Development

The plywood manufacturing building was a large undivided open area of approximately 236,000 square feet with massive quantities of wood contained in the structural assemblies in addition to the thousands of square feet of in-process veneer and finished plywood storage. At the time of the fire, the outdoor temperature, and the low humidity, combined with an ample supply of air through the building's natural ventilation system, contributed to ideal conditions for a rapidly spreading intense fire.

Once the highly combustible deposits were ignited, the fire developed undetected until the welder sensed considerable heat and, looking upward, saw the open grate steel catwalk on fire. The fire spread quickly to involve the truss members and plywood roof deck in the 2040-square foot draft hood which were also covered with the highly combustible deposits of oil, pitch, and wood dust.

Unimpeded by the automatic sprinklers or hose streams from 1 1/2-inch standpipe handlines, the fire extended outside the draft hood and began to spread rapidly along the trusses and on the underside of the plywood roof deck in all directions. Large numbers of additional sprinklers activated which further reduced the overall sprinkler discharge density. As the sprinkler

discharge densities were reduced, the quantity of water and the effectiveness of the discharge patterns were also further reduced which ultimately eliminated the ability of the sprinkler systems to control or extinguish the rapidly spreading fire. The intense fire which rapidly developed spread throughout the 236,000-square foot facility in approximately 8 minutes, causing the roof assembly of the building to collapse approximately 10 minutes later.

Summary of Significant Factors

Plant management had an established cutting and welding procedure which was designed to provide safeguards against the ignition of fires during cutting or welding operations in the plywood manufacturing facility. The work crews assigned to the repair and welding operations took fire prevention precautions which included the shutdown of the No. 2 press and the two exhaust fans in the draft hood, the removal of all the plywood in the press, the establishment of a fire watch, and the wet down of the welding area with the small garden-type hose before beginning the arc welding operations. However, these fire prevention precautions were inadequate in preventing the ignition and the sustained burning of the highly combustible deposits of oil, pitch, and wood dust accumulated on the hot press, the open grate steel catwalk, and in the draft hood on the roof trusses and plywood roof deck.

Although a fire watch had been established at the floor level prior to initiating the welding operations, both the welding and fire watch crews were solely dependent on a single small garden-type hose to provide immediate fire fighting capability. This small garden-type hose which the workmen attempted to use could not provide the quantity of water required to effectively attack the rapidly spreading fire in the draft hood.

The 1 1/2-inch handline the workmen then attempted to place in service also did not provide the quantity of water required to attack the fire in the

2040-square foot draft hood. The workmen described the stream of water as "spurting" from the adjustable pattern nozzle. Whether the employees had completely opened the gated hose connection at this hose station and allowed the time required for air in the dry-pipe standpipe system to vent without the assistance of a quick opening device was not firmly established. Investigators identified lengths of standpipe piping with a build-up of pipe scale which would have had no significant effect on the flow of water in the piping but could have caused clogging of the adjustible pattern nozzles on the 1 1/2-inch handlines.

NFPA 51B, the Standard for Fire Prevention in Use of Cutting and Welding Processes, warns that too often individuals with key responsibilities in cutting and welding processes do not fully appreciate that improper use can result in fires similar to the occurrence at this plywood manufacturing plant. The standard outlines measures to be taken to reduce the likelihood for the ignition of combustible materials located in the welding area and stresses the importance of having standpipe hose lines ready for service prior to initiating cutting and welding operations. The Standard Fire Prevention Code also stresses the importance of proper fire prevention precautions in the use of cutting and welding equipment by referencing NFPA 51B.*

Automatic Sprinkler System Performance

Following the fire, investigators discovered obstructed piping in the dry-pipe automatic sprinkler systems. Internal examination of distribution piping in sprinkler systems Nos. 2, 4, 19, and 20 revealed large amounts of pipe scale and deposits high in silicon content in branch lines up to 1 1/2-inch diameter.

*Jurisdictions may elect to adopt the Standard Fire Prevention Code in support of the provisions of the Standard Building Code.

Sprinkler systems No. 19 and 20 should have been the first to activate. It is estimated that at least 50 percent of the 20 to 30 sprinklers located within the 2040-square foot hot press draft hood may have been obstructed with this material.

The inspector's test valves for these dry-pipe automatic sprinkler systems were located on the perimeter walls of the plant approximately 160 feet from the point of connection to the systems. Investigators cut open the 1-inch diameter test lines at several places and found no obstructions in the analyzed lengths. This may have reduced the likelihood that maintenance personnel flow testing these systems would have been alerted to severe problems created by the buildup of the pipe scale in the sprinkler system piping.

The effectiveness of automatic sprinkler systems in controlling and extinguishing fires in buildings with a wide spectrum of uses has been firmly established. NFPA 13A, the Standard for Inspection, Testing and Maintenance of Sprinkler Systems, stresses that automatic sprinkler systems installed in accordance with NFPA standards require a minimum of inspection, testing, and maintenance; however, if not properly maintained, a sprinkler system may become inoperative. The standard provides a series of recommended practices and guidance designed to protect against sprinkler system deterioration or impairment that may result in failure of the system.

Contained in the Chapters of NFPA 13A are practices specific to dry-pipe systems. Section 4-8.1 of the code warns that dry-pipe systems should not be converted to wet-pipe systems during the warm weather because this practice will cause corrosion and the accumulation of foreign matter in the pipe system.

Further, dry-pipe systems that have been maintained wet or dry alternately over a period of years are particularly susceptible to the accumulation of

scale. Also, in systems continuously dry, condensation of moisture in the air supply may result in the formation of a hard scale along the bottom of the piping. When sprinklers open, the scale is broken loose and carried along in the pipe, plugging sprinklers or forming obstructions at the fittings.

Section 4-8.4 requires a "full flow" trip test of each dry-pipe valve with the control valve wide open be completed at least once every three years or when the system is altered. This test should be conducted by opening the inspector's test pipe causing the dry-pipe valve to trip, and should continue until clean water is flowing from the inspector's test pipe. Separate records containing data such as the initial air and water pressures, tripping time, and dry-pipe valve operating conditions should be kept for comparison with previous test records. However, before any dry-pipe valve is tripped or tested, Section 4-8.3.3 recommends the water supply line to the system be thoroughly flushed to clean the line of any accumulation of scale or foreign material.

The Standard Fire Prevention Code also stresses the importance of sprinkler system maintenance by referencing NFPA 13A. Detailed written maintenance procedures for the dry-pipe sprinkler systems protecting the manufacturing building along with any test records were unavailable to the NFPA investigation team and were reportedly destroyed in the fire.

Discussion

Fire loss experience documented by Factory Mutual for the past 15 years in sprinklered buildings with wood roofs in fires which opened 20 or more sprinklers found no case in which the fire overcame properly operating sprinkler systems. In the cases where dry-pipe automatic sprinkler systems were protecting buildings with "clean" wood roof decks which were not impregnated with liquids such as oils, the sprinklers were able to control the fire within a 2500 to 4000 square foot area. This was also true in cases

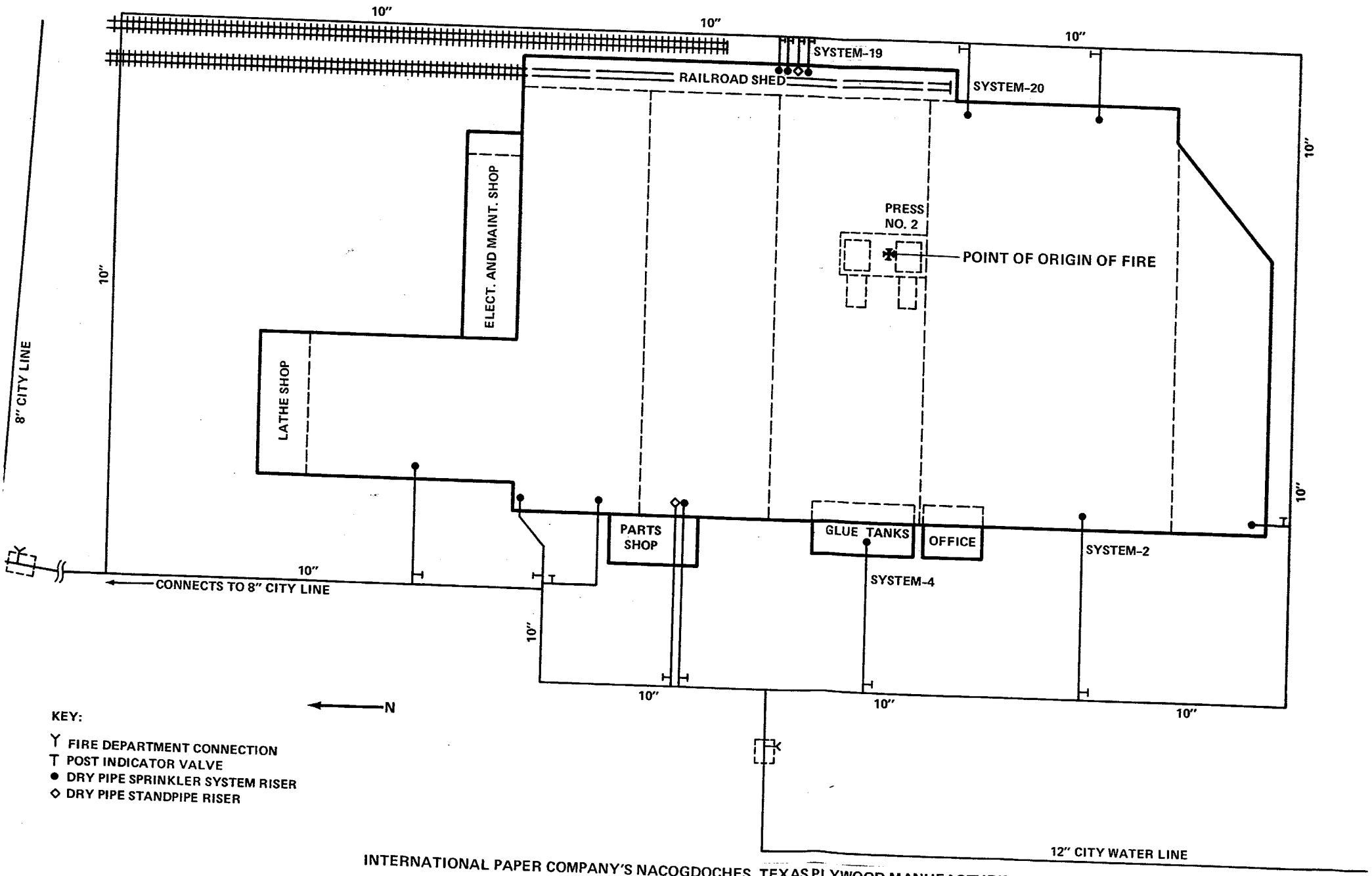
where the wood roof decks were covered with dry or powdery combustible deposits. However, in the cases where the wood roof decks were impregnated with oil or covered with tackie deposits, such as the combination of oil, pitch, and wood dust in the draft hood, the sprinklers were unable to control the spread of the fire until the fire encountered a physical barrier such as a draft curtain and the fire attack was quickly supplemented with standpipe hose lines. This loss experience suggests that, had a large number of sprinklers not been clogged with pipe scale and had the workmen been able to quickly place in operation 1 1/2-inch lines providing additional quantities of water, the fire spread would have been contained to the 2040-square foot draft hood.

Further, in order to limit the fuel load and reduce its potential area of fire involvement, Table 403 of the 1980 Standard Building Code would have required four-hour separations between the storage and manufacturing sections. NFPA 664 would have required that the facility be Type I or Type II construction.

When portions of the roof assembly collapsed rupturing sprinkler system piping, any chance the fire department had to save the facility was eliminated. The fire department was also confronted with a serious threat that firebrands from the burning plant would ignite fires in other structures and in the abundant forest lands in the surrounding area. Fortunately, in the case of a building materials storage warehouse located approximately 1/4 to 1/2 of a mile southeast of the plant, the immediate notification of the fire department combined with prompt employee actions limited the fire damage to the warehouse. A helicopter used by the fire ground commander proved to be a very valuable tool in coordinating the deployment of the 20 mutual aid fire departments and crews from the Texas State Forestry Service combating fires both at the plant site and in the surrounding areas.

The three factors identified during the investigation as significant in the rapid fire spread and loss of the building were:

- The accumulation of highly combustible deposits of oil, pitch, and wood dust generated in the plywood manufacturing process which resulted in the rapid spread of the fire both above and below the sprinklers;
- The lack of adequate fire prevention measures during the arc welding operations;
- The obstructed distribution piping within the dry-pipe automatic sprinkler systems.



INTERNATIONAL PAPER COMPANY'S NACOGDOCHES, TEXAS PLYWOOD MANUFACTURING PLANT.