FIRE AT BROWNS FERRY NUCLEAR PLANT

TENNESSEE VALLEY AUTHORITY

MARCH 22, 1975

FINAL REPORT

OF

PRELIMINARY INVESTIGATING COMMITTEE

MAY 7, 1975

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I. INTRODUCTION

A preliminary investigating committee was established on March 23, 1975, to conduct an early fact-finding investigation of the fire and related events which occurred at the Browns Ferry Nuclear Plant on March 22, 1975. The interdivisional committee consists of the following members:

H. S. Fox, Chairman - Division of Power Production

Charles Bonine, Jr. - Division of Construction

Harry S. Collins, Reporter - Manager of Power's office

David G. Powell - Division of Law

M. N. Sprouse - Division of Engineering Design

Felix A. Szczepanski - Manager of Power's office

The committee's charter is included as appendix A. The committee reported to the plant on March 24, 1975, to initiate its investigation of the fire. A preliminary assessment of the damage was made, numerous interviews were conducted, and a preliminary report of the committee's findings was transmitted to the Manager of Power on April 7, 1975.

II. PURPOSE AND SCOPE

The purpose of this report is to present the committee's findings of facts on conditions and events relative to the fire and to provide a point of reference for other evaluations which may be required.

This report describes events leading up to, during, and after the fire until each unit was placed in the cold shutdown condition.

III. FINDINGS

A. Construction and Operational Status of Plant at the Time of the Fire

Units 1 and 2 were operating at normal full-load capacity, and construction work was proceeding on unit 3.

B. Relevant Design and Construction Features

1. Plant

A positive air pressure is maintained in the control bay, which includes the cable spreading room, with respect to the reactor building. In order to maintain the pressure differential, all penetrations between the control bay and reactor building are designed to provide an air pressure seal. A vertical cross section of the reactor building, control room, and spreading room, which is the area under consideration, is shown as figure 1.

2. Electrical Cable Penetrations

Electrical cable penetrations provide a means of routing cables through barriers such as floors and walls. They can be in the form of conduit or special fabricated steel sleeves.

a. Wall Penetration as Designed

The cable penetration where the fire started is contained in a 48-inch-square opening through the concrete wall separating the units 1 and 2 cable spreading room from the unit 1 reactor building. Division of Engineering Design (DED) drawings require the installation of a 1/2-inch-thick steel plate bulkhead slightly less than 48 inches square in the center of the opening in the concrete wall. Ten openings are cut in the bulkhead plate, and two stacks of five 18-1/2- by 5-1/2-inch steel sleeves are welded into the openings. The steel sleeves are 6 inches long and extend 3 inches on each side of the bulkhead centerline. The vertical clearance between the sleeves is 4 inches, and the horizontal clearance is 5 inches. The steel bulkhead assembly is framed and attached to the wall inside the concrete opening by 1-1/2- by 1-1/2- by 1/4-inch mounting angles. The cable trays abut the wall and are secured to angle iron extending horizontally across the face of the wall. Only the cables extend through the wall penetration. (See figures 2 and 3.)

The design requires that the penetration sleeves, with the cables installed, be filled with polyurethane foam to create an air pressure seal. (See figure 3.) A flameproofing compound, Flamemastic 71A, was specified to be applied 1/8 to 1/4 inch thick over the foam and the cables on both sides of the bulkhead for a distance of 12 inches to form a fire stop.

Field tests were conducted on a typical cable penetration at the site in 1973. Later a test sample was sent to the TVA Singleton laboratory for fire performance testing. A DED staff engineer evaluated the test data and approved the results.

b. <u>Wall Penetration as Originally Constructed</u>

To facilitate sealing of the penetrations and to provide a practical starting point for filling the space around the cables with polyurethane foam, a means of forming a dam is required to prevent the liquid foam from flowing out of the sleeves. A preformed, resilient polyurethane foam was cut to size for insertion into the sleeve opening to form a dam. Other materials, such as styrofoam, were also used in some instances as a back dam. Pourable polyurethane foam was applied over and around the installed cables; after hardening of the pourable polyurethane foam, sprayable Froth Pak Insta-Foam polyurethane was used to finish filling the sleeve. The pourable foam is used since it more easily fills the voids between the cables. The sleeve and 12 inches of cables on both sides of the penetration were then coated with Flamemastic to provide the fire stop. The steel bulkhead as constructed was mounted in the opening with the centerline 3 inches from the surface of the wall on the reactor building side and 23 inches from the surface of the wall on the spreading room side, as indicated by dimensions on figure 4. Materials in addition to polyurethane foam were used to form the pressure seal.

3. Materials Used in Penetrations

Materials used for construction of fire stops, air pressure seals, and resealing after modifications to penetrations are described on table 1.

Diligent efforts are being made to secure from the manufacturers the physical and chemical properties of the materials in table 1, items 1-8, and will be made available if received.

For small leaks in cable penetrations, RTV silicone rubber was typically used as a sealant. For larger leaks, resilient polyurethane foam was typically used as a dam or a plug to contain the RTV silicone rubber or polyurethane foam.

4. Status of Penetration at Time of Fire

The penetration in which the fire started had been originally sealed with polyurethane foam. There is evidence that the penetration had originally been coated with Flamemastic on the spreading room side. An examination after the fire indicates that Flamemastic had been applied to the unit 1 reactor building side of the penetration at some time prior to the fire and modifications which made resealing necessary.

Additional cables had been pulled through the penetration since initial installation. In order to make an opening for additional cables through the penetration, holes were punched with a wooden stick similar to a broom handle. This resulted in breaching any flameproofing that had been applied. This process usually resulted in pieces of polyurethane and Flamemastic in the penetration being knocked onto the cables on both sides of the penetration. This procedure has been generally followed when additional cables are pulled through completed penetrations. Fragments of these materials were observed on the cables in a number of other trays adjacent to the penetrations.

C. Activities Preceding the Fire

The areas within the plant are designed such that the air movement from one plant area to another will always be toward the area of possible higher radiation. This is controlled by supply and exhaust fans. The area of the reactor building and refueling floor (secondary containment) is the area of lowest pressure, and any leakage between secondary containment and other plant areas will be inleakage into the secondary containment.

Under certain conditions, the standby gas-treatment system must exhaust air from the reactor building to maintain a negative pressure. In order not to exceed the capacity of the system, inleakage to the reactor building must be kept at a minimum.

In the completed plant, the refueling zone is common for all three reactor units. During construction an airtight partition is required between operating units and those under construction; and one exists between operating units 1 and 2, and unit 3 which is under construction. Before this partition between units 2 and 3 could be removed, it was necessary to ascertain the degree to which the standby gas-treatment system could handle the added inleakage from the unit 3 reactor building. The Division of Power Production (DPP) was requested to run leakage tests on the units 1 and 2 reactor buildings. The results of those tests indicated that leakage had to be reduced to a minimum if the unit 3 reactor building could be included and inleakage remain within the requirements of the units 1 and 2 technical specifications.

In a program to reduce leakage, the Division of Construction (DEC) wrote workplan 2892. The plan required (1) that all leaks be identified and listed, (2) that leaks be sealed, and (3) that work be verified and signed off by an engineer.

The method for detecting air leaks was largely left to the discretion of the engineer in charge. Several methods have been employed at Browns Ferry. These include smoke devices, soap solutions, and candles. The movement of the flame of a candle was an effective method in locating leaks in dimly lighted areas and generally was the method used.

A list was made of all leaking penetrations. These were identified by elevation and wall location, cable tray identification, and conduit number. The list was given to the electrical craft supervision with a requirement for the foreman to sign off for completed items.

Checking the resealed penetrations was basically the same as inspecting for leaks. However, experience had shown that as the number of leaks was reduced, the differential pressure increased; and other penetrations that originally did not seem to leak began to show airflow. Therefore, the inspectors (engineering aides) were instructed to check all penetrations in their assigned areas. The inspectors were accompanied by electricians who sealed any leaking penetrations as they were discovered. The inspectors often aided the electricians by checking penetrations as they were being sealed.

A successful leakage test and its documented approval were considered as evidence of the pressure seal's integrity.

For production efficiency, application of the Flamemastic did not immediately follow the sealing activities but was applied at intervals when sufficient numbers of seals were made ready.

On March 22, 1975, DEC workers were in the spreading room, sealing and leak-testing cable penetrations between the cable spreading room and the reactor building, when (at approximately 1220 hours--all times are Central Daylight Time) some of the sealant material in the penetration was unintentionally ignited at cable tray VE.

D. Fire

1. Spreading Room Area

a. Sequence of Events

Six men were working in the units 1 and 2 cable spreading room, checking conduit and cable penetrations for air leaks and sealing leaks.

An engineering aide and an electrician were checking cable penetrations through the wall between the spreading room and the unit 1 reactor building, in a window containing 10 cable trays in 2 vertical rows of 5 trays.

The engineering aide was using a candle flame to detect air leaks.

A differential air pressure existed between the spreading room and the reactor building, with the reactor building having a slightly negative pressure and thus causing air to flow from the spreading room through leaks into the reactor building.

The aide detected a strong air leak in the penetration for the second tray from the bottom on the west row.

The leak was caused when additional cables were pulled through the penetration, which resulted in breaching the originally installed air pressure seal and fire stop.

The electrician could not reach the penetration since it was recessed into the wall farther than he could reach.

The aide volunteered to seal the leak for the electrician. The electrician handed the aide two pieces (about 2 inches by 2 inches by 4 inches) of resilient polyurethane foam which the aide inserted into the hole.

After inserting the resilient polyurethane foam into the leak, the aide placed the candle about 1 inch from the resilient polyurethane foam.

The airflow through the leak pulled the candle flame into the resilient polyurethane foam, which sizzled and began to burn.

The aide immediately told the electrician that the candle had started a fire.

The electrician handed the aide a flashlight, which was used to try to beat out the fire with no success.

Another construction worker heard the aide state that there was a fire and gave the aide some rags to use to smother the fire, which was also unsuccessful.

The electrician called for fire extinguishers.

When the rags were pulled away from the penetration, they were smoldering.

Meanwhile, the other worker brought a CO_2 fire extinguisher to the aide.

The fire burned for about 1-1/2 minutes before the first extinguisher arrived.

The entire contents of this CO_2 extinguisher was emptied on the fire. The fire appeared to be out.

About 1/2 to 1 minute later, the fire started up again.

The aide stated that the fire was now on the reactor building side of the wall.

Two construction workers left the spreading room for the reactor building to fight the fire.

The electrician took two fire extinguishers to the aide who remained in the spreading room. Each extinguisher gave only one good puff.

When the aide received the third extinguisher, he heard a fire extinguisher being discharged on the reactor building side of the wall.

As the aide prepared to discharge the fourth extinguisher, the spreading room CO_2 system alarm was sounded; and all workers evacuated the spreading room.

A plant operator, assistant shift engineer (ASE), after ensuring that no workers were in the spreading room, attempted to initiate the spreading room fixed CO_2 system from outside the west door to the room but was unable to do so because it had been deenergized while workmen were in the spreading room.

The ASE then ran to the east door of the spreading room, where he restored the electrical power and initiated the CO_2 system, which then operated properly.

Another ASE later operated the CO_2 system a second time.

After the CO_2 system had been operated the second time, the first ASE checked the spreading room and found that the fire had restarted.

He then directed the fire brigade in fighting the fire in the spreading room.

At 1310 hours, the ASE in charge of the reactor building fire requested the Athens Fire Department to come to the plant.

Employees from the Athens Fire Department assisted in fighting the spreading room fire.

The spreading room CO_2 system was operated one additional time.

An off-duty shift engineer (SE) arrived about 1500 hours and took charge of firefighting in the spreading room and relieved the ASE.

The spreading room fire was extinguished between 1600 hours and 1630 hours, primarily by using dry chemicals.

b. Description of Fire in the Spreading Room

The material ignited by the candle flame was resilient polyurethane foam.

Once the foam was ignited, the flame spread very rapidly.

After the first application of the CO_2, the fire had spread through to the reactor building side of the penetration.

Once ignited, the resilient polyurethane foam splattered as it burned.

After the second extinguisher was applied, there was a roaring sound from the fire and a blowtorch effect due to the airflow through the penetration.

The airflow through the penetration pulled the material from discharging fire extinguishers through the penetration into the reactor building.

Dry chemicals would extinguish flames, but the flame would start back up.

c. Equipment

Portable CO_2 and dry-chemical fire extinguishers were used in the spreading room fire.

The spreading room fixed CO_2 system was activated three times.

Breathing apparatus (air packs) received limited use in the spreading room.

The doors to the spreading room were kept open most of the time to assist in keeping smoke out of the control room.

An inplant fire hose was run from an outlet in the turbine building to the spreading room. This was not used.

The Athens Fire Department made available in the spreading room about 5 gallons of an agent which, when combined with water, forms "light water." This was not used.

Athens Fire Department employees discussed with the SE the possibility of using water on the fire in the spreading room.

No water was used in the spreading room since there was no assurance that the cables were deenergized.

d. Time of Events

(Approximate times shown with ∿)

∿ 1220	Fire started in penetration
∿ 1230	Two construction workers leave spreading room for reactor building
1235	Plant fire alarm sounded. Fire logged in SE's log
∿ 1237	First fire extinguisher discharged in reactor building
∿ 1240	CO_2 alarm sounded in spreading room; CO_2 system operated
?	Spreading room CO_2 system operated second time

?	ASE assumes direction of fire brigade in fighting fire
?	Spreading room CO_2 system operated third time
~ 1500	SE assumes charge of spreading room firefighting
~ 1600-1630	Spreading room fire extinguished

e. Reporting the Fire

Two construction workers left the spreading room at about 1230 hours to go to the reactor building to fight the fire.

One worker stopped at post 8D, a construction portal manned by the Public Safety Service (PSS), and informed the public safety officer on duty that there was a fire in reactor building number 1 and took the fire extinguisher with him to use in fighting the fire.

The officer immediately called the SE and reported a fire in unit 1 reactor building.

The ASE who received the fire report immediately gave the message to the SE and the unit 1 operator and then proceeded to the control room and switched the fire alarm to assure continuous sounding.

The unit operator (UO) immediately began to announce over the PA system that there was a fire in the unit 1 reactor building.

At this time, operators in the control room did not know the exact location of the fire.

An ASE located the fire in the unit 1 reactor building shortly after the construction workers had begun to fight it there. He telephoned the exact location to the operators in the control room.

Shortly thereafter another ASE in the reactor building reported the spreading room fire to the operators in the control room.

2. Reactor Building Area

a. Sequence of Events

When workers in the spreading room saw that the fire had spread into the reactor building, two construction workers left the spreading room and proceeded to the reactor building to fight the fire.

One worker told the public safety officer at post 8D that there was a fire in the reactor building and took a fire extinguisher with him. The other construction worker proceeded to the reactor building where he met a third worker; each of the three workers took a fire extinguisher to the fire.

All three workers arrived at the fire at about the same time. It was burning in the trays which were 20 feet above the second floor of the reactor building. One moved a ladder, already at the scene, next to the fire. Another worker climbed the ladder and discharged a dry-chemical extinguisher on the fire. This application knocked down the flames, but the fire flared up again.

One of the workers alerted other workers on the second level of the unit 1 reactor building of the fire.

The worker who applied the first extinguisher was affected by the smoke and fumes around the cable trays at the top of the ladder.

The unit 1 control room operator was informed by telephone of the precise location of the fire by a plant operator on the scene.

An ASE then arrived and, along with another operator, discharged a CO_2 and a dry-chemical extinguisher simultaneously on the fire. The ASE assumed charge of firefighting activities. Construction workers were instructed to leave the operating units.

Smoke was becoming so dense that breathing apparatus was required; approximately 5 minutes after it was requested, it was available. Until it arrived, CO_2 was applied to the cable trays from the floor.

After the breathing apparatus (air packs) arrived, it was utilized in fighting the fire until visibility became so bad that the workers could not get near the fire. The smoke backed them up to the area of the reactor building closed cooling water system heat exchangers.

The ASE left the fire to assist in unit shutdown. An assistant unit operator (AUO) assumed charge of firefighting activities. The first floor of the reactor building was also evacuated. The AUO went to the control room due to some ill effects of the smoke. Another ASE assumed charge of firefighting activities.

Power to the elevator was lost. The second floor of the reactor building was then evacuated. Some time was utilized to check 5 floors of the reactor building for the elevator to ensure that no one was trapped on the elevator. A head count was made, and from that point on a count was kept of all personnel leaving and entering the reactor building.

About 1330 hours, lighting was lost in the reactor building.

Limited firefighting was resumed in the reactor building for a period between 1430 hours and 1500 hours. A wire was used to rig a guideline. At this time the fire was still confined to the area in the cable trays near the north wall and had not proceeded very far on the south trays.

At this time, the doors between units 1 and 2 were opened, which improved visibility on the second level of unit 1 to about 5 feet.

At about 1630 hours, the SE who had been directing activities in the spreading room took charge of fire-fighting in the reactor building in order to concentrate activities there. The SE consulted the plant superintendent frequently during fighting of the reactor building fire.

On inspection of the fire at 1630 hours, the major fire was in the cable trays running south from the penetration, with a smaller fire in the cable trays running west from the penetration.

The SE established a routine of sending 2 to 3 people in at a time to fight the fire, using dry chemicals primarily.

Shortly after 1630 hours, temporary d.c. lighting was strung on the second level of unit 1.

A rope was utilized as a guideline, which assisted employees from the Athens Fire Department in approaching the fire to inspect it. The SE went into the vicinity of the fire between 1730 hours and 1800 hours.

On one of his trips into the second level, the SE laid out the fire hose installed there and checked to ensure that water was available. The plant superintendent authorized the use of water as an emergency backup, for example, in case a worker's clothing caught fire. Otherwise, there was a decision not to use water on the fire due to the electrical shock hazard. The Athens fire chief suggested that water would be the best thing to use on the fire if it could be used.

The SE suggested to the plant superintendent that water be used on the fire. The superintendent made the decision to allow the Athens Fire Department employees to use water on the fire.

Water was initially applied to the trays running west; however, from the floor level, the water would effectively reach only the bottom tray. Athens Fire Department employees attempted to utilize one of their nozzles on the hose, but the thread did not match; and the nozzle came off when pressure was applied.

Water was also applied to the fire in the cable trays along the north wall and successfully extinguished it.

Firefighters began using Chemox respirators as the supply of compressed air for the air packs ran low.

The SE and two other operations workers entered the area of the fire to utilize water to fight the fire. The SE took the hose and climbed within four feet of the fire with assistance of the other two men. He sprayed water on the fire in the south cable trays for approximately 10 seconds, which extinguished the fire.

The fire hose was left stuck in a position so that it continued to apply water to the south cable trays.

The second level was entered again and water reapplied. It was then determined that the fire was out. There were subsequently some reports of sparks, but investigation failed to reveal any further fire.

During the course of the fire, it was noticed that a small diameter station control air line under about 90 pounds of pressure, running along the north wall, had parted. The line was later isolated.

Several fire extinguishers were discharged early in the the fire from the third floor through an opening in the floor, but all missed the fire in the cable trays since the opening was not directly over the fire.

b. Description of Fire in Reactor Building

The fire was initially observed in the lower cable trays, extending out from the penetration a distance of 2 to 4 feet. Height of the flames varied from a few inches to a few feet, dying down as extinguishing materials were applied and flaring up between applications. The flames were coming straight up.

Some polyurethane foam was flowing from the penetrations into the trays, and bright yellow flames were coming from the penetrations.

The fire did not advance significantly into the south trays until after 1500 hours.

Scaffold boards had been previously placed below the trays in the unit 1 reactor building, near the cable tray penetration where the fire started. These boards were used to work from in pulling cables through the penetration. These boards were charred by the fire. The charring did not extend to the side away from the fire, indicating little influence as fuel for the fire.

c. Equipment

Portable CO_2 and dry-chemical fire extinguishers were used in the reactor building fire.

MSA air packs were used that had a rating of 30 minutes for moderately heavy activity of the user. A cascade system of large air cylinders was available for charging the packs, but the supply was eventually depleted. There are no air compressor facilities at the plant to fully recharge the air packs. The charges in some air packs did not last 30 minutes. Air packs from Athens Fire Department were also used along with their recharging facilities on their truck and at their station in Athens.

MSA Chemox respirators were used. Several users experienced difficulty when using these for very strenuous activity.

The fire hose and nozzle provided in the second level of the reactor building functioned properly and successfully extinguished the fire.

A nozzle from the Athens fire truck did not fit the threads on the hose on the second floor of the reactor building.

Ladders present on the second level of the reactor building were utilized.

Temporary d.c. lighting was utilized.

A wire and a rope were utilized as guidelines.

A fire hose was laid out on the third floor of the reactor building but was not utilized.

d. Time of Events

∿ 1230	Two construction workers leave spreading room for reactor building
∿ 1237	First fire extinguisher discharged in reactor building
∿ 1240	Unit operator informed of exact location of fire in reactor building
?	Air packs requested and received
∿ 1310	ASE requested that Athens Fire Department come to the plant
∿ 1330	Lighting lost in reactor building
∿ 1645	Temporary d.c. lighting installed
∿ 1835	Water applied to fire
∿ 1930	Fire determined extinguished

e. Minor Fires on Thrusday, March 20

There were two minor fires on Thursday, March 20, arising from the use of candles for leak-testing in electrical cable penetrations different from the penetration involved in the March 22, 1975, fire. In the first fire, the candle flame ignited some RTV silicone rubber. The construction worker using the candle extinguished the flareup with his fingers.

In the second fire, the candle flame ignited dust and debris in the cable tray. The fire lasted about 30 seconds and was extinguished with a discharge from a CO_2 extinguisher.

The first fire was reported orally to construction supervisory workers; the second fire was entered in the SE's log and reported in writing to construction supervisory workers.

There was no damage from either fire.

E. Effect on Plant Systems and Operations

1. Status of Plant Operations Prior to Fire

At the time of the fire on March 22, 1975, units 1 and 2 were each producing approximately 1,100 MWe gross. Unit 1 was declared in commercial operation on August 1, 1974, and unit 2 on March 1, 1975.

2. Unit 1

The ignition of the fire in the cable penetration has been established as accurately as possible to have occurred at 1220 hours on March 22, 1975. The first indication of its effect on unit 1 operation came 20 minutes later, at 1240 hours. This was 5 minutes after the UO's were notified of the fire and the alarm initiated at 1235 hours.

The first effect on the unit was almost simultaneous annunciation of several events: residual heat removal (RHR) or core spray (CS) automatic blowdown permissive, reactor water level low-automatic blowdown permissive, and core cooling system/diesel initiate.

At this point the UO observed that normal conditions of reactor water level, reactor steam pressure, and drywell atmosphere pressure existed.

Over the next 7 to 8 minutes, a mounting number of events occurred, including the automatic starting of RHR and CS pumps, high-pressure coolant-injection (HPCI) pump, and reactor core isolation coolant (RCIC) pump; control board indicating lights were randomly glowing brightly, dimming, and going out; numerous alarms occurring; and smoke coming from beneath panel 9-3, which is the control panel for emergency core cooling systems (ECCS). The operator shut down equipment that he determined was not needed, such as the RHR and CS pumps, only to have them restart again.

When the reactor power became affected by an unexplained runback of the reactor recirculating pumps, the SE instructed the operator to reduce recirculating pump loading and scram the reactor. While this was being done, the recirculating pumps tripped off. The reactor was scrammed by the operator at 1251 hours.

The turbogenerator was then removed from service; steam from the reactor was bypassed around the turbine to use the condenser as a heat sink; and unneeded condensate, condensate booster, and reactor feed pumps were removed from service. One of each pump was left running to maintain reactor water level. Beginning at approximately 1255 hours and continuing for about 5 minutes, several electrical boards were lost, supplying control voltages and power voltages of 120, 480, and 4,160 volts a.c. and 250 volts d.c. These mainly affected reactor shutdown equipment.

As a result of the loss of these electrical boards and previous effects, many of the systems used in cooling the reactor after it is shut down became inoperative. This included the RHR system, core spray system, HPCI, and RCIC. This is attributed to loss of valve control signals, valve power voltage, motor control signals, motor power voltage, or a combination of these. In addition, many of the instruments and indicating lights were put out of order. Also, the outboard main-steam isolation valves (MSIV's) closed. This isolated the steam generated by reactor decay heat from the condenser heat sink. The valve closure also isolated the steam supply to the turbine-driven reactor feed pumps, and consequently this high-pressure source of water to the reactor was lost. At this time the water input to the reactor was limited to the control rod drive pumps as a high-pressure water source since the steam pressure built to a pressure of 1,080 psi and was being relieved by automatic operation of the relief valves to the suppression pool.

Alternative systems were available and were used effectively to shut down and cool the reactor. This was accomplished by manual opening of the relief valves to reduce reactor pressure below 350 psi where the condensate booster pumps could pump an adequate supply of water to the reactor. The reactor water level decreased during this operation, but it did not drop below a point 48 inches above the top of the active fuel and was returned to normal level by 1345 hours.

Early in the chain of events, the diesel generators started and were allowed to run on standby. During a short period of time the four diesel generators were used to supply their respective shutdown buses. About 1443 hours one of the diesel generators became unavailable.

Soon after the loss of electrical boards, operating workers began attempts to restore the electrical supplies.

Initially, this was generally unsuccessful. Attempts to manually position valves and locally operate the equipment were hampered by darkness and the smoke and fumes from the fire filling the reactor building, requiring the use of air-breathing packs. Some smoke and CO_2 came into the units 1 and 2 control room from firefighting efforts in the spreading room, but it was not necessary to vacate the control room at any time. Two of the operators in the unit 1 control area donned breathing apparatus for a short period of time because of the smoke and fumes. To establish the electrical supply boards, maintenance electricians joined the operators in isolating faulted circuits in order that the boards could be reenergized. This was done over several hours, and needed equipment to provide suppression pool cooling and reactor long-term shutdown cooling was gradually made available.

With adequate electrical power, along with some manual valve alignment, the operators established suppression pool cooling at 0130 hours on March 23, 1975, 12 hours 39 minutes after the unit 1 reactor was scrammed. Normal reactor shutdown cooling was achieved at 0410 hours on March 23, 1975, 15 hours 19 minutes after the unit was scrammed.

3. Unit 2

Nine minutes after unit 1 was scrammed, abnormal events began occurring on unit 2. At 1300 hours the 4-kV shutdown bus 2 deenergized; and the operator observed decreasing reactor power, many scram alarms, and the loss of some indicating lights. The operator put the reactor in shutdown mode, and it scrammed at 1300 hours.

The turbine was immediately tripped, along with the reactor feed pumps. In approximately 4 minutes after scram, the MSIV's closed, isolating the reactor steam from the condenser heat sink and the reactor feed pumps steam supply. RCIC was immediately initiated for reactor water level control and the HPCI to aid as a heat sink for the steam being generated in the reactor by decay heat. These two systems tripped several times over the next hour, and at approximately 1345 hours HPCI became unavailable. RCIC continued to run and supply high-pressure water to the reactor.

When suppression pool temperature began to increase from relief valve steam heating, RHR suppression pool cooling was established at 1320 hours; and the temperature of the water in the torus did not exceed 135° F.

When the MSIV's closed, reactor pressure was relieved by manual operation of the relief valves. Manual operation of the relief valves was lost at 1320 hours and the relief valves lifted intermittently on pressure until 1415 hours, when manual operation was restored; and the reactor was depressurized by use of the relief valves.

At 2010 hours the MSIV's were reopened, making the condenser heat sink available. At 2020 hours on March 22, 1975, equipment was made available to establish operation of the RHR system to be used for reactor long-term shutdown cooling. This was 7 hours 20 minutes after the unit was scrammed.

4. <u>Detailed Operating Events, Operator Action, and Equipment Response and Nonresponse</u>

Tables 6 and 7 provide the sequence of events, operator action, and equipment response which occurred during the fire and until conditions were stabilized (initiation of shutdown cooling) on both units 1 and 2. The events listed on tables 6 and 7 are arranged chronologically, with the best possible establishment of times without the benefit of complete operator logs.

Most of the time, particularly during the early stages of the fire, operators were too busy to log the frequent events and actions. Some of the times and facts were established by charts and printers but for the most part by interviews with operating personnel, both individually and in groups.

5. Status of Major Plant Equipment and Systems and Plant Parameters at the Initiation of Reactor Long-Term Shutdown Cooling

a. Unit 1 at 0410 hours on March 23, 1975

Reactor coolant temperature 360° F

Reactor vessel water level normal

Suppression pool water level +5"

Suppression pool water temperature 153° F

Control rod drive pump and condensate pumps providing makeup water to reactor vessel

Standby liquid control system available

Core neutron monitoring provided by two temporary source range monitors connected outside primary containment with the monitors manned by a licensed reactor operator in communication with a licensed reactor operator in the control room

Primary and secondary containment integrity being maintained

All 4-kV shutdown boards available

Shutdown bus 2 available and supplying offsite power to the shutdown boards

Remote indications (amps, watts, and volts) being read locally at shutdown boards where equipment operation required

Diesel generators A, B, and D available and operable from shutdown boards--diesel generator C unavailable because of control cable problems

RHR loop I pumps and valves available

RHR loop II pump B and valves available

Control for 3 RHR pumps available from control room; control from local stations for most valves

All loop I and loop II core spray pumps and valves available

Four relief valves remotely operable from unit control board

No automatic initiation of diesel generators, core spray system, or RHR system in low-pressure coolant-injection (LPCI) mode available

Suppression pool cooling in service

Suppression pool water level indication and drywell pressure indication operable

Train A of standby gas-treatment system operable

Control rod drive pump in operation--system flow and pressure indication unavailable

Process computer in service (40 analog inputs damaged by fire)

Telephone communication out of service for unit 1 reactor building, offgas vent building, and stack; in service for other areas

Liquid monitor on the effluent from the reactor building closed cooling water system, raw cooling water, and residual heat-removal heat exchangers out of service.

Grab samples of effluent water taken periodically by chemical laboratory personnel.

b. Unit 2 at 2240 hours on March 22, 1975

Reactor coolant temperature 260° F

Reactor vessel water level normal

Control rod drive and condensate pumps providing makeup water to reactor vessel

All RHR pumps operable

HPCI pump inoperable

Core spray loop I pumps A and C and RHR loop I pumps A and C operable only from shutdown boards

Conditions of long-term reactor shutdown cooling were considered normal

F. Damage Assessment (Cable Tray System, Conduit and Grounding System, and all Cables Routed Through These Raceway Systems)

This section summarizes the extent of the physical damage to the cables and the raceway systems involved in the fire at Browns Ferry on March 22, 1975, and indicates the detail to be found in a complete report provided by DED for use in the restoration program. The complete report is numbered BF-DED(BHP-1).

Excluded from the damage assessment are the effects of faults in these cables to mechanical and electrical systems; damage to other equipment resulting from products of combustion and the chemicals and water used in extinguishing the fire; possible structural and concrete damage; and damage outside the zone of influence of the fire. These areas are being evaluated in detail by others within TVA.

A fire consultant has been retained by DED to perform a thorough investigation with the purpose of providing a factually accurate and professional determination or assessment of the mechanisms and their interactions responsible for the initiation, propagation, magnitude, duration, and extent of damage of the fire. The consultant's report has not been received at the time of issuance of this report.

1. <u>Zone of Influence of the Fire</u>

   It has been determined that the fire started when an open flame came into contact with material used as the seal around the cables where they penetrate the wall between the units 1 and 2 control bay spreading room and the unit 1 reactor building. Figures 5 and 6 indicate the area being considered in this description. Figure 6 shows the zone of influence of the fire. Figure 7 shows a cross section of trays near the point where the fire started. The cables and raceways in the spreading room were damaged approximately 5 feet north of the wall penetration; and the fire propagated along all trays, as marked on figure 8, in the reactor building on floor elevation 593. Many photographs were taken, and 10 key ones are included in this report as appendix B. Figure 9 shows affected trays and their intersections in single-line representation. Checkpoints used for routing cables on each cable tray are also shown. (See table 2 for loading of cable types onto each tray at each checkpoint.)

Visible damage in the reactor building was observed east along the double stack of 3 trays to the wall between units 1 and 2, south along the 4 trays to a fire stop approximately 28 feet from the wall between the reactor building and the control bay, and west along the double stack of 5 trays, for a distance of approximately 38 feet from the wall between units 1 and 2. Cables were also damaged on 2 of the 4 vertical trays from the top about 10 feet down, and cables in 1 of the other 2 trays were damaged about 4 feet down. Figures 10-12 show the zone of influence of the fire for all damaged or assumed-damaged conduits and grounding systems.

2. Identification of Damaged Conduits, Cable Trays, and Cables Routed Through Raceways

A total of 117 conduits and 26 cable trays was damaged by the fire, and it is assumed that all supports for the raceway system were also damaged. There was a total of 1,611 damaged cables, and these are tabulated on 204 cable tablulation sheets prepared by DED. Table 3 is a sample sheet of the 204 cable tabulation sheets which show the purpose of each cable and other pertinent information needed by DEC to be used in a procedure for identification and removal of damaged cables.

This procedure is being written by DEC to require that the damaged portion of each cable be identified and measured during its removal. This procedure will also require that a section of the undamaged portion of each cable be removed, identified, and stored for future reference. This section will be cut to assure that all manufacturer's data stamped on the outer jacket will be included in the sample.

As of this date there have been 1,169 cables identified as damaged for unit 1, 75 for unit 2, 27 for unit 3, and 340 common to plant. Of the total cables identified and listed in table 3, it was determined that a total of 628 safety-related cables was damaged. These are grouped into categories shown on table 4.

The bare ground cable used for grounding the cable tray system was also damaged by the fire. It was routed along the 480-volt power trays FM, FK, and FO-ESII through the zone of influence.

3. Materials Available as Possible Fuel For the Fire

Of the 1,611 cables, there were 65 different-type cables involved in the fire, as listed on table 5. Figure 7 shows a cross section of the cable trays where the fire started. (See table 2, sheets 8 and 9, for the type cables found there.) These types are representative of each voltage level tray in the area. Types WBB through WNF are power and control cables manufactured in accordance with TVA standard specification and are composed of insulating material footnoted on table 5, sheets, 2, 3, and 4. The remaining types are signal cables which are specified and documented on numerous individual contracts. These are composed of insulating material footnoted in table 5, sheets 2, 3, and 4. In all cases, the actual types used will be verified in the removal of cables and will be included in the final DED report BF-DED(BHP-1). The filler materials in these cables and cable ties are included in the listing at the conclusion of this section.

Another possible "fuel" was the wall penetration pressure seal materials used between the spreading room and the reactor building. A typical penetration is shown in figures 2 and 3. The sealant material was polyurethane expandable foam, a pressure seal, which is covered with Flamemastic, a flameproofing compound. Another sealant material which is a possible fuel source would be the RTV silicone rubber compound used in sealing conduits through walls and in some cases to seal around new cables added through penetrations.

4. General List of Materials Associated With the Fire

   a. Candle

   b. Polyurethane foam, Froth Pak Insta-Foam

   c. Polyurethane, pourable type

   d. Polyethylene

e. Nylon

f. Cross-linked polyethylene

g. Polyvinyl-chloride

h. Mylar

i. Aluminum foil and rigid aluminum conduit

j. Polyolefins

k. Chlorosulfonated polyethylene

l. Neoprene

m. Fiberglass

n. RTV silicone rubber

o. Galvanizing material on raceways

p. Carbon

q. Thermoplastic nonhygroscopic cable filler material

r. Preformed, resilient polyurethane foam

s. Marinite panels

t. Styrofoam

u. Copper

v. Steel

w. Flamemastic 71A

G. <u>Radiological Assessment</u>

Based on interviews with the plant health physics supervisor and the plant chemical engineer, and information provided by the Plant Results Section and the Division of Environmental Planning, the following has been established.

1. Releases Within the Plant and Personnel Exposures

a. At the time of the fire, one health physics technician was present at the facility. As requested, off-shift technicians reported to the plant, with the health physics supervisor arriving at approximately 1600 hours. At one time as many as 9 health physics workers were onsite.

b. Direct radiation surveys conducted within the reactor building indicated there was no increase in direct radiation above normal levels.

c. Numerous samples to detect airborne radioactivity present within the reactor buildings showed that the only significant particulate or halogen isotope present was the isotope Rubidium 88, a daughter product of the fission gas Krypton 88, with a half-life of 17 minutes. The buildup of Rubidium 88 is attributed to the shutdowns of the reactor building ventilation systems during the fire.

d. Analyses of the samples showed the maximum concentration of this isotope approximated only 35 percent of the maximum concentration permitted under NRC regulations in 10CFR20 for a 40-hour workweek.

e. Following the fire, a number of individuals, including operations and construction workers, who were considered the most likely to have received internal radiation exposure from being in the unit 1 reactor building, were whole-body counted (on March 24 and 25). All whole-body counts showed no indication of internal deposition of radioactive material.

f. Based on dosimetry information, no plant individual is shown to have exceeded the daily radiation exposure limit; and the film badge readings for the Athens Fire Department employees indicated they received no detectable radiation exposure.

2. Releases From the Plant

a. As a result of the fire, the radiation detectors that monitor the ventilation air exhausted from the unit 1 and the unit 2 reactor buildings were made inoperable. The unit 2 monitor was restored at about 1900 hours on March 22, 1975, and the unit 1 monitor restored at 1600 hours on March 23, 1975.

b. During the course of the fire and the time the monitors were out of service, grab samples were taken from the units 1 and 2 exhausts on the reactor building roof starting at approximately 1645 hours and each hour thereafter and analyzed in the plant radiochemistry laboratory to determine concentrations of radioactivity. Charcoal filter and particulate filter samples were also taken from these airstreams periodically during the event.

c. All other required building ventilation duct monitors and the plant stack release monitors remained operable.

d. Gamma spectrum analysis of the grab samples indicated that the principal isotopes present were Xenon 133, Xenon 133m, Krypton 85m, and the Rubidium 88 detected in the inplant air samples. Analysis of the charcoal samples indicated no detectable amount of iodine.

e. Review of the airborne release rate information shows that the total plant release rate was the highest at 2200 hours on March 22 and corresponds to about 8 percent of the technical specification allowable limit for gross activity release.

f. Liquid radwaste is discharged from the plant periodically and on a batch basis. The last batch released before the fire occurred was on March 19. While as a direct result of the fire the liquid radwaste monitor became inoperable, no release from the plant was being made at the time; and the monitor was returned to operation on March 24 before the next batch was released.

3. Environmental Consequences

a. While not required, the Environs Radiological Emergency Plan was activated for precautionary purposes at approximately 1500 hours on March 22, with the Environs Emergency Staff remaining active until approximately 0500 hours on March 23.

b. A report on the radiological environmental consequences of the fire, made at the committee's request, is summarized below:

(1) Analyses of air particulate and charcoal filter samples collected by monitoring teams in the downwind direction from the plant, based on continual evaluation of data from the plant's meteorological station, show that no radioactivity except that due to naturally occurring radionuclides was detected in the environment.

(2) Results from both particulate and charcoal filters collected from environmental-monitoring stations for the week of March 17-24, 1975, reveal no significant differences between concentrations at local and remote monitors.

(3) Results of thermoluminescent dosimeter analysis for the quarter January 8 to April 3, 1975, when compared with preoperational-monitoring data indicate no basic differences from the data collected during the preoperational-monitoring program.

(4) Calculations utilizing the reactor building ventilation exhaust air grab sample results, the data from other operable building vent monitors, the stack release monitoring data, and data from the plant meteorological station indicate the maximum whole-body dose in any 1 of 16 sectors about the plant for the period 1300 hours on March 22 to 1800 hours on March 23 would be only 0.7 mrem at the site boundary.

(5) The report states that "Based on actual measurements and collected data, calculations show that during the incident at the Browns Ferry Nuclear Plant, amounts of radionuclides released to the environment were well below the plant technical specification limits. Conservative calculations show that the radioactivity released to the environment had a very minimal and insignificant environmental impact."

H. Personnel Injuries

Information provided by the TVA medical director states that 7 TVA employees (6 from DPP and 1 from DEC) reported to the Browns Ferry construction project medical office and the health station with complaints associated with smoke inhalation. Under the direction of a TVA physician, each was evaluated and treated by the nurses on duty and released with instructions to report immediately any delayed effects. Shortly after being seen, one of the employees reported the onset of generalized chest discomfort on respiration. He was referred immediately to a local hospital, where he was examined and released by the physician. None of the employees revealed evidence of severe effects from their exposure.

Followup medical evaluations revealed no residual effects from the activities and exposures associated with fighting the fire.

There has been no medical indication for lost time from work. Each employee was medically approved to resume full duties on the next scheduled work shift.

I. Administrative Controls

1. DPP-DEC Interface for Work by Construction Forces in an Operating Unit

a. Under DEC Quality Control Procedure BF-104, Administrative Procedures to Maintain Physical Separation Between Construction and Operating Units and Control of Work in Restricted Access Areas, all modifications and completion work required on a licensed unit by construction employees are done under a workplan. This procedure also specifies (1) that workplans can be written by either DEC or DPP, (2) must be approved by the DEC coordinator, and (3) the DPP coordinator will determine the level of review required within DPP and finalize approval with his signature.

b. BFNP Standard Practice BFA-28, Plant Modifications, describes how modifications to the plant will be requested, performed, and documented, including the approvals necessary, depending on whether the modification is categorized as safety related or nonsafety related.

c. The work being performed at the time the fire started was approved by the DEC coordinator and authorized by the DPP plant modification coordinator under BFNP workplan 2892 which was issued under BF-104 on March 7, 1975.

d. On workplan 2892, the work to be performed is described as follows: "Check electrical and mechanical sealing for secondary containment. (1) make a punch list of sleeves and cable penetrations that require sealing, (2) complete sealing, (3) verify and sign off areas that were found leaking."

A list of identified secondary containment air leaks is attached to the workplan.

e. The space provided for identification of drawings associated with the work has the letters N/A (not applicable) entered.

f. A review of workplan 2892 and applicable administrative procedures indicates the work being performed under this workplan was not processed as a modification under BFA-28 but was processed under BF-104 which does not require that an unreviewed safety question determination be made according to the provisions of 10CFR50.59.

2. Construction Work Control

With regard to the control of the work being performed by construction forces, the committee established the following:

a. There were no written procedures or work instructions covering the sealing and testing of penetrations for the original installation or the modifications except for notations on DED drawings.

b. At the time the fire started, the engineering aide whose assigned responsibility was to inspect the work (i.e., to find the air leaks) was actually doing the work himself (i.e., plugging the leaks) instead of the journeyman electrician.

3. Fire Reporting

a. The existence of a fire was not reported immediately by construction workers discovering the fire. When reported to the PSS officer manning construction portal post 8D, the exact location of the fire was not specified.

b. BFNP Standard Practice BFS3, Fire Protection and Prevention, instructs DPP personnel discovering a fire, whether in a construction area or an area for which DPP is responsible, to report the fire to the construction fire department, telephone 235. BFNP Fire, Explosion, and Natural Disaster

Plan instructs personnel discovering a fire to dial 299 (PAX). The construction extension cannot be dialed from the PAX system, and the plant extension cannot be dialed from the construction phone system.

c. Dialing instructions for reporting fires are located on telephones and are also included on the emergency procedure sheet posted at various locations in the operating areas.

4. Work Hazards Control

While control requirements exist for certain potentially hazardous work, e.g., welding and burning operations, no written procedures or instructions have been issued at Browns Ferry regarding the introduction into and use of potentially hazardous materials or substances in connection with construction work in operating plant areas such as ignition sources and flammables.

J. Other Findings

The possibility of sabotage was investigated, and no reason to suspect sabotage was found.

IV. OTHER GENERAL INFORMATION

A. Central Emergency Control Center (CECC)

1. The CECC was activated on March 22, 1975, during the Browns Ferry fire as a precautionary measure, although no

radiological emergency existed. The CECC was directed from the Edney Building in Chattanooga, beginning at 1525 hours CDT on March 22, 1975, by the Assistant to the Director of Environmental Planning. Other available members of the CECC were notified of the fire.

2. The CECC performed a valuable function--keeping the Nuclear Regulatory Commission (in Atlanta), the Alabama State Department of Public Health, and the Tennessee State Department of Public Health informed rather than fulfilling a requirement of the Radiological Emergency Plan (REP). The CECC was in direct communication with the DPP Emergency Control Center.

3. The CECC office was secured at 2230 hours on March 22, 1975.

B. DPP Emergency Control Center

1. The DPP Emergency Control Center in Chattanooga was established at 1510 hours on March 22, 1975, with the Chief, Nuclear Generation Branch, in charge. By 1630 hours, approximately 20 DPP staff members had assembled at the control center, including the division director and other key management personnel. The branch chief and others were in frequent communication with the superintendent at Browns Ferry. This management team participated in all major decisions associated with the plant operation and firefighting activities.

2. The major group of the staff assembled left at 2200 hours on March 22, 1975. A small group manned the DPP Emergency Control Center until 1500 hours on March 23, 1975.

C. Other Programs for Repair and Return to Service of Equipment

A number of programs have been initiated to evaluate various aspects of the fire and its consequence and return to service of the equipment. A memorandum from E. F. Thomas to R. H. Dunham and H. H. Mull dated March 28, 1975, subject "Repair of Damage Caused by the Cable Fire and Return to Service of Browns Ferry Nuclear Plant Units 1 and 2" has been issued and is being updated to provide directions for these efforts.

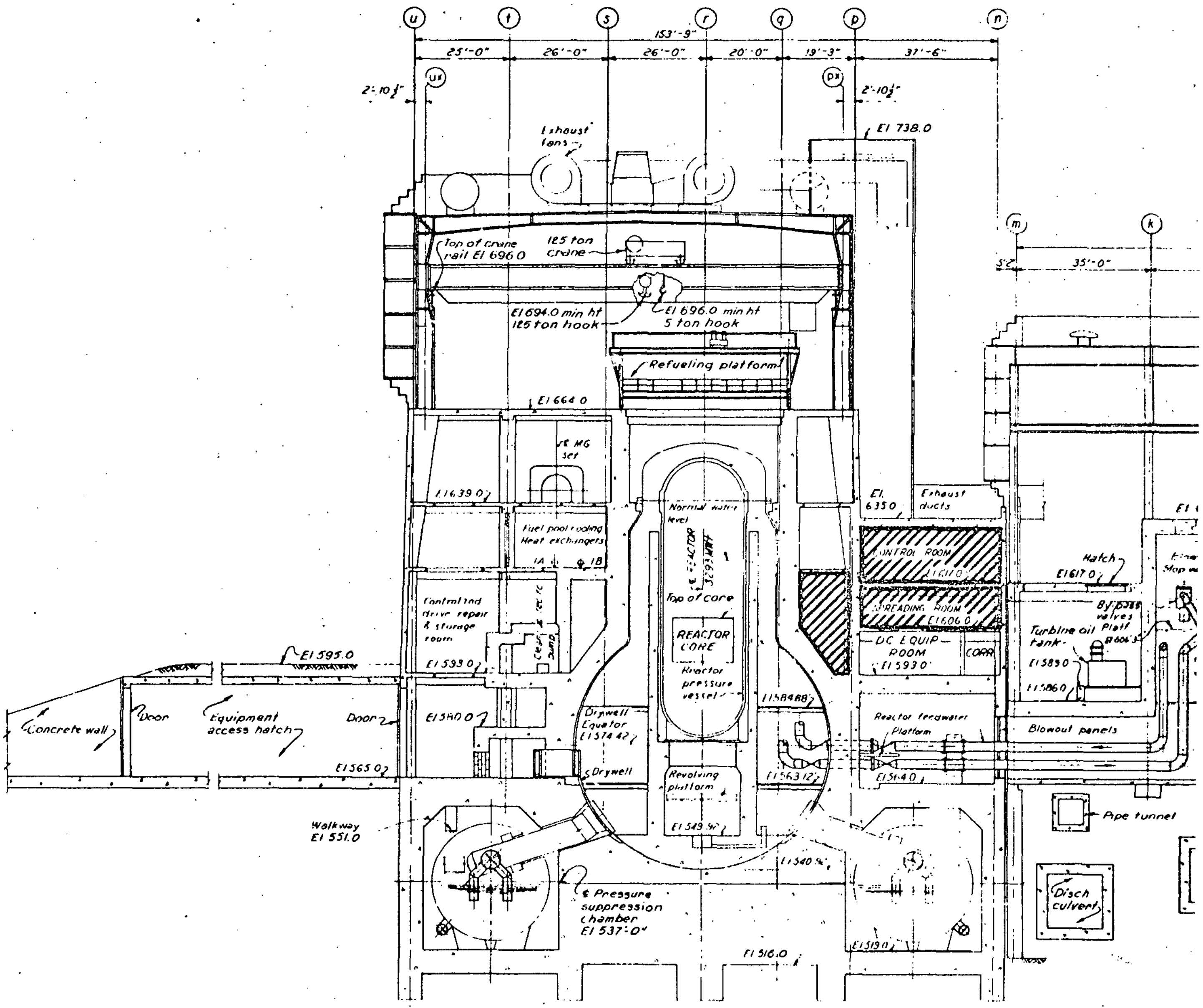


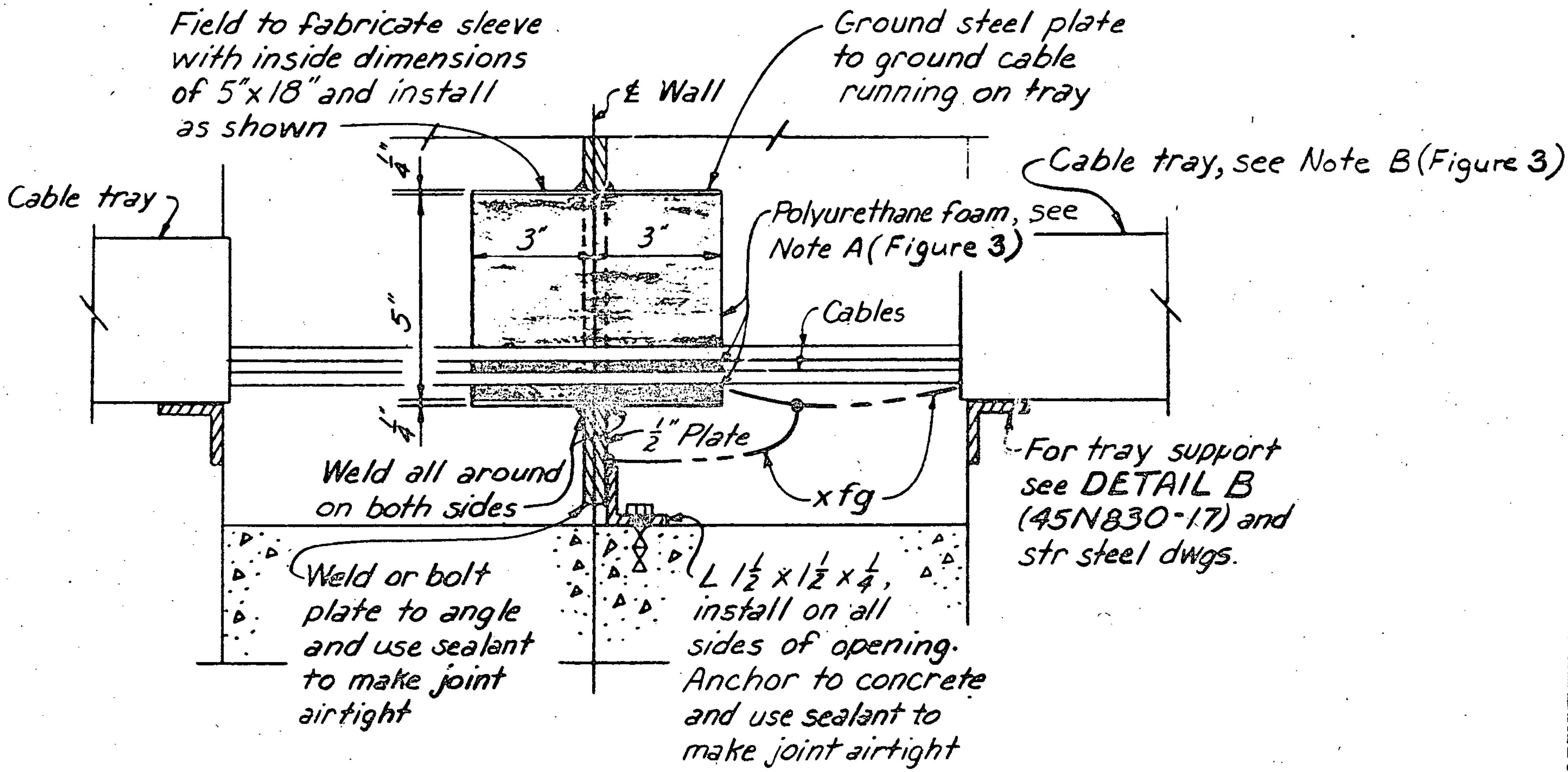
FIGURE 1

Vertical Cross Section

Reactor Building, Control Room, and Spreading Room

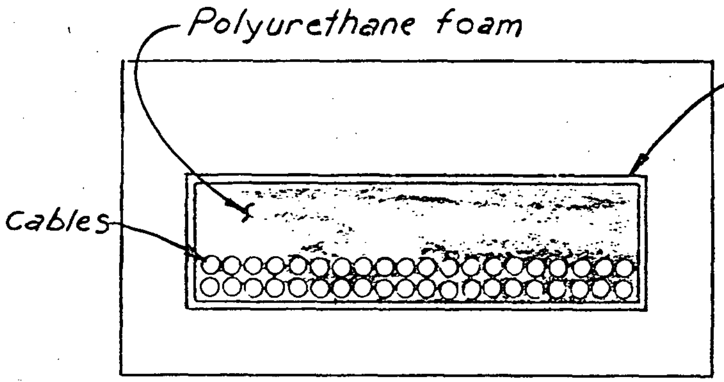
47W200-8 R2

FIG. 1



SIDE VIEW
Scale: 3"=1'-0"

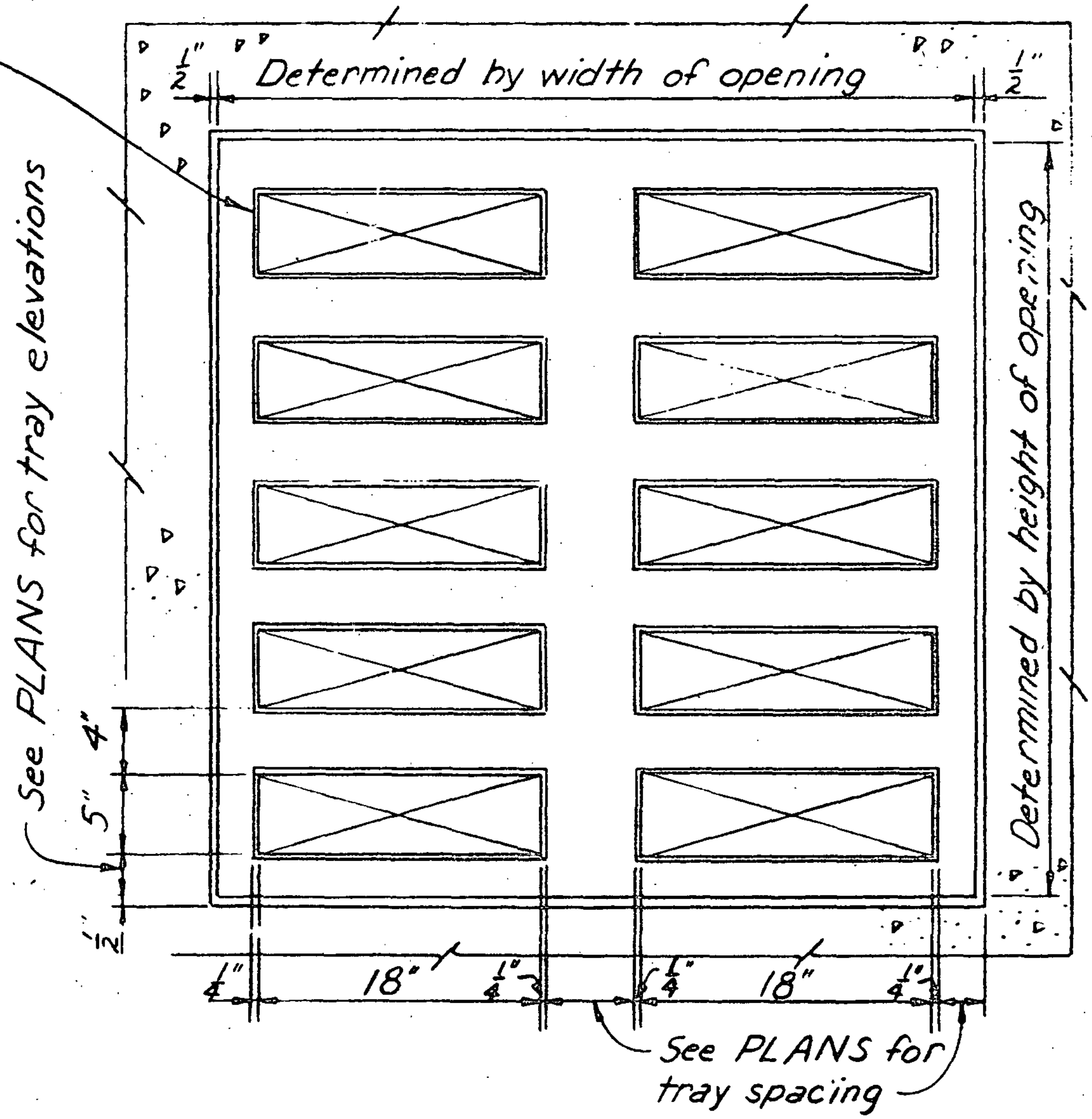
FIGURE 2
TYPICAL WALL PENETRATION



NOTES:

A. When all cables have been installed through cable sleeve, seal the remaining opening and voids with 6" ± of Urethane foam or equal before applying flame proofing compound, Flamemastic 71A or equal.

B. Apply approximately 1/8" to 1/4" of flame proofing compound on the steel sleeve and on both top and bottom of the tray and cables for 12" on both sides of the barrier.

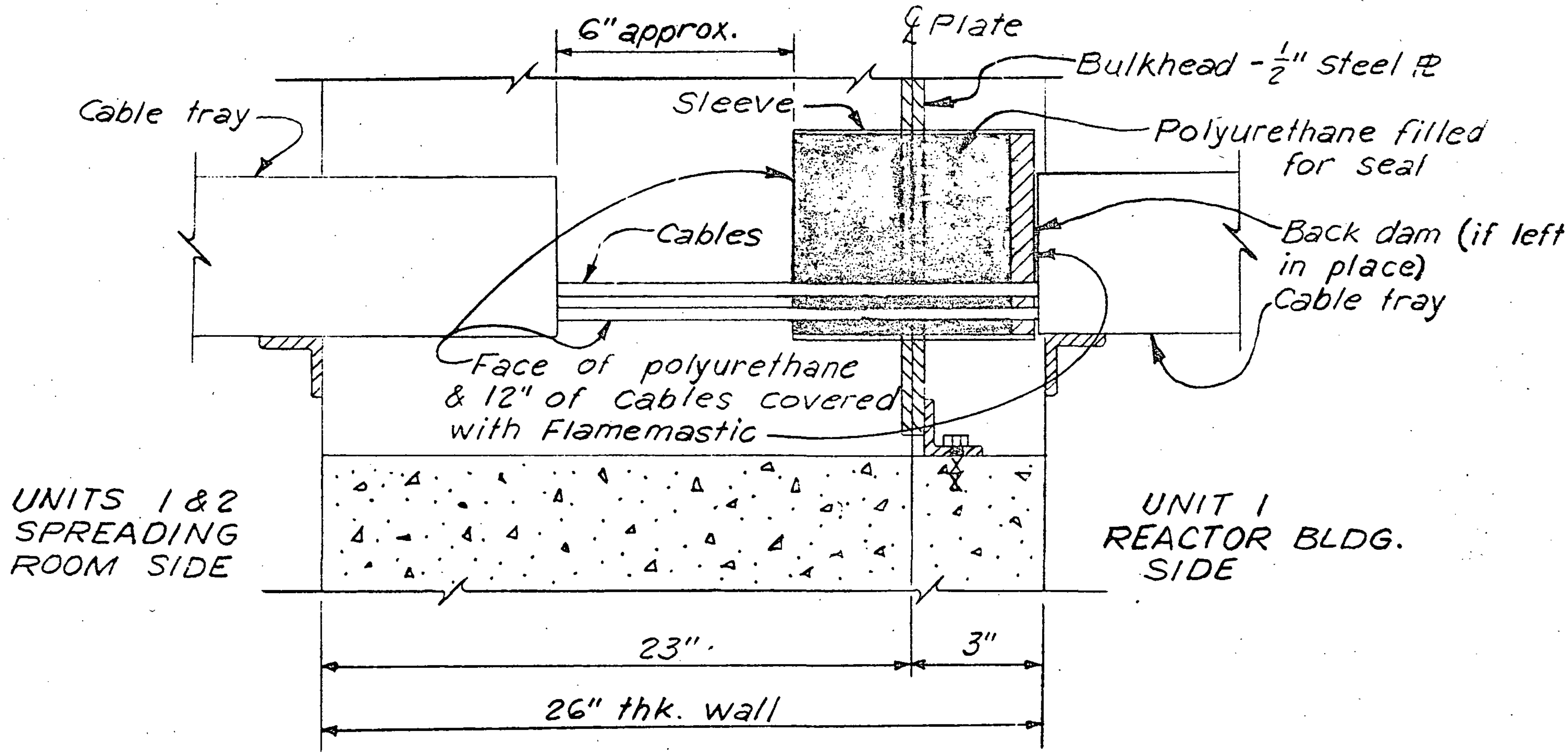


FRONT ELEVATION
Scale: 1"=1'-0"

FIGURE 3
TYPICAL WALL PENETRATION

FIG. 3

NOTE: FIRE STARTED IN SECOND PENETRATION FROM BOTTOM - TRAY VE



SIDE VIEW

FIGURE 4

PARTIAL CROSS SECTION OF PENETRATIONS
(TO SHOW BULKHEAD LOCATION IN WALL AS CONSTRUCTED)

FIG. 4

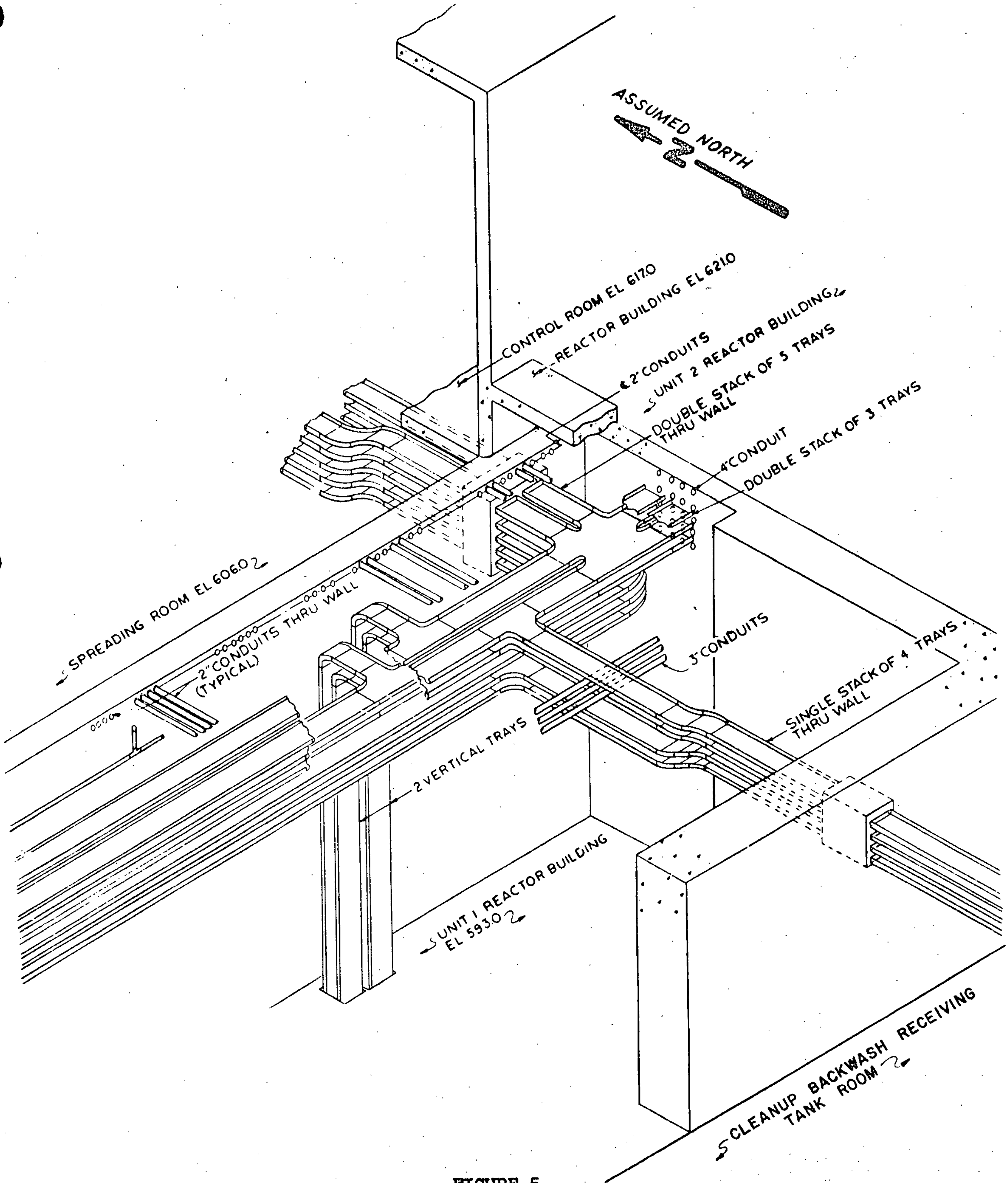


FIGURE 5

AREA OF FIRE

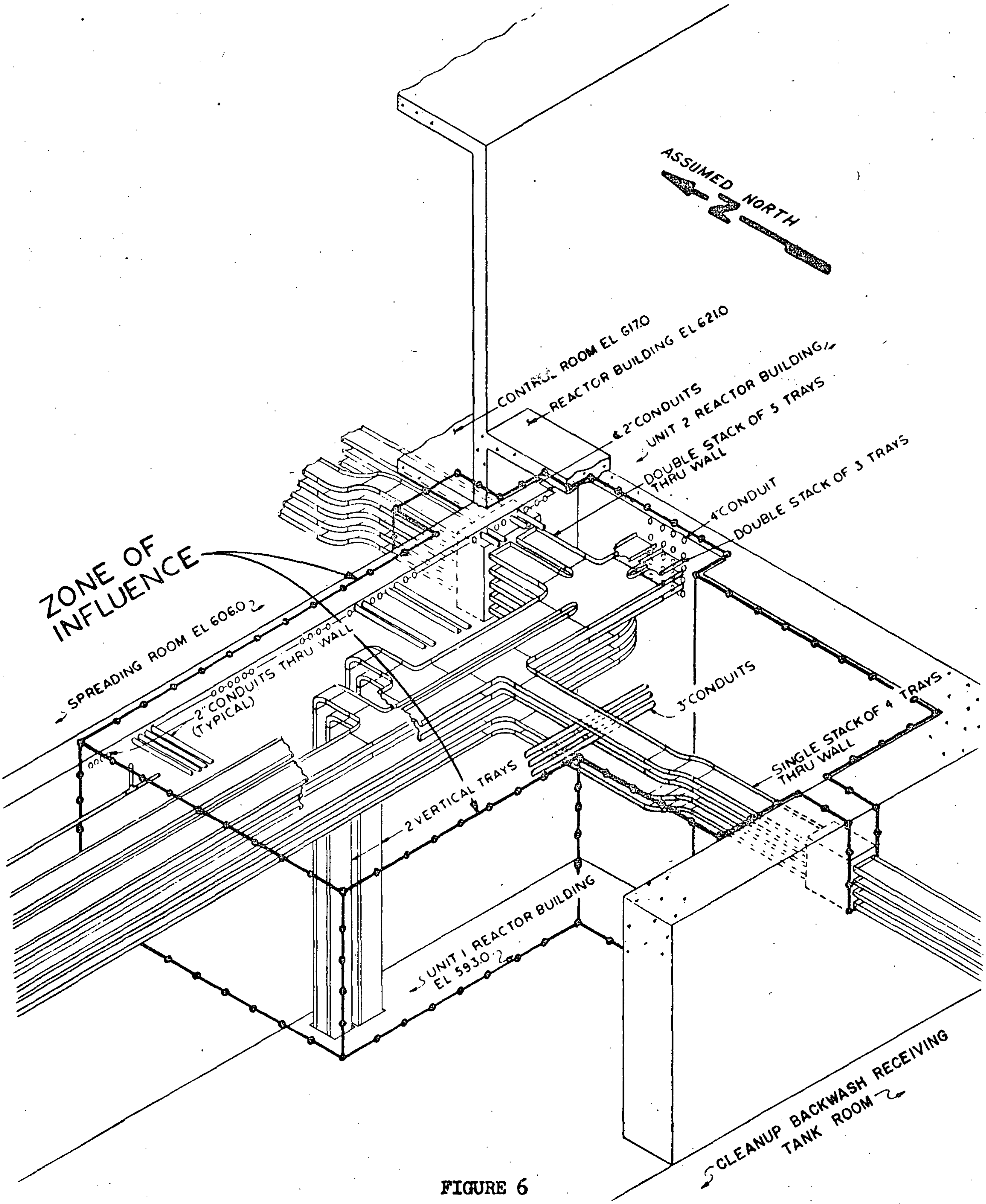


FIGURE 6

AREA OF FIRE

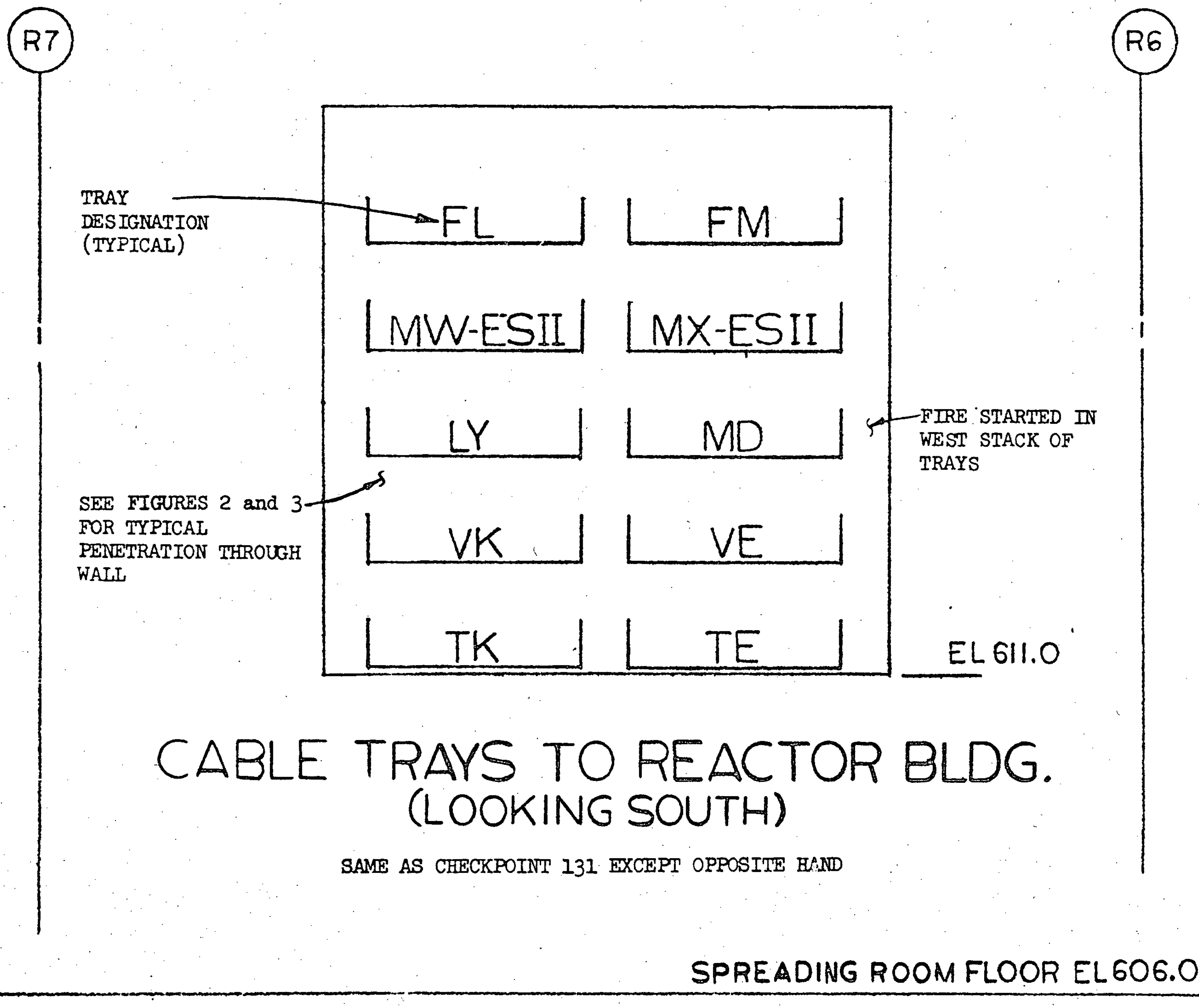


FIGURE 7

FIG. 7

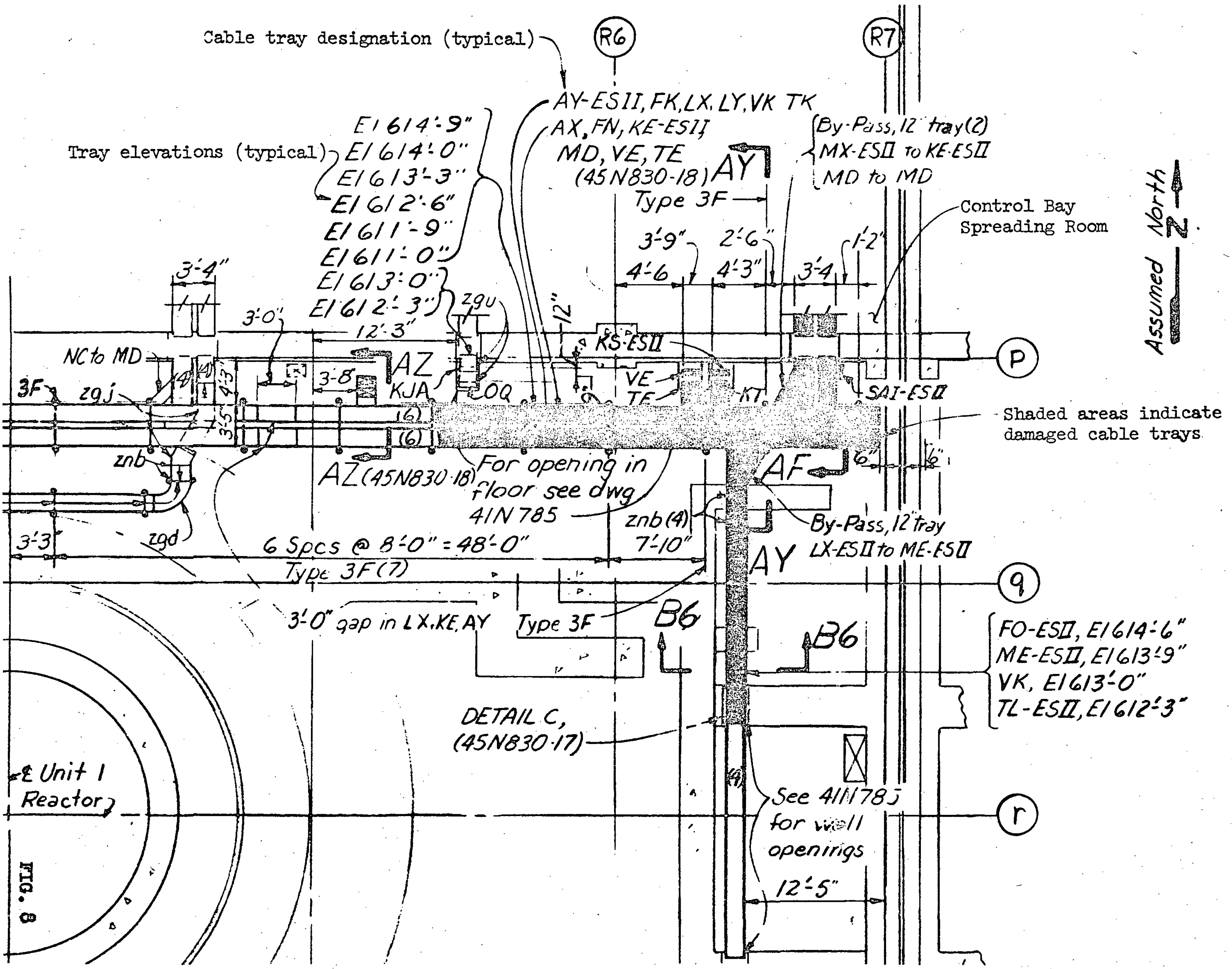
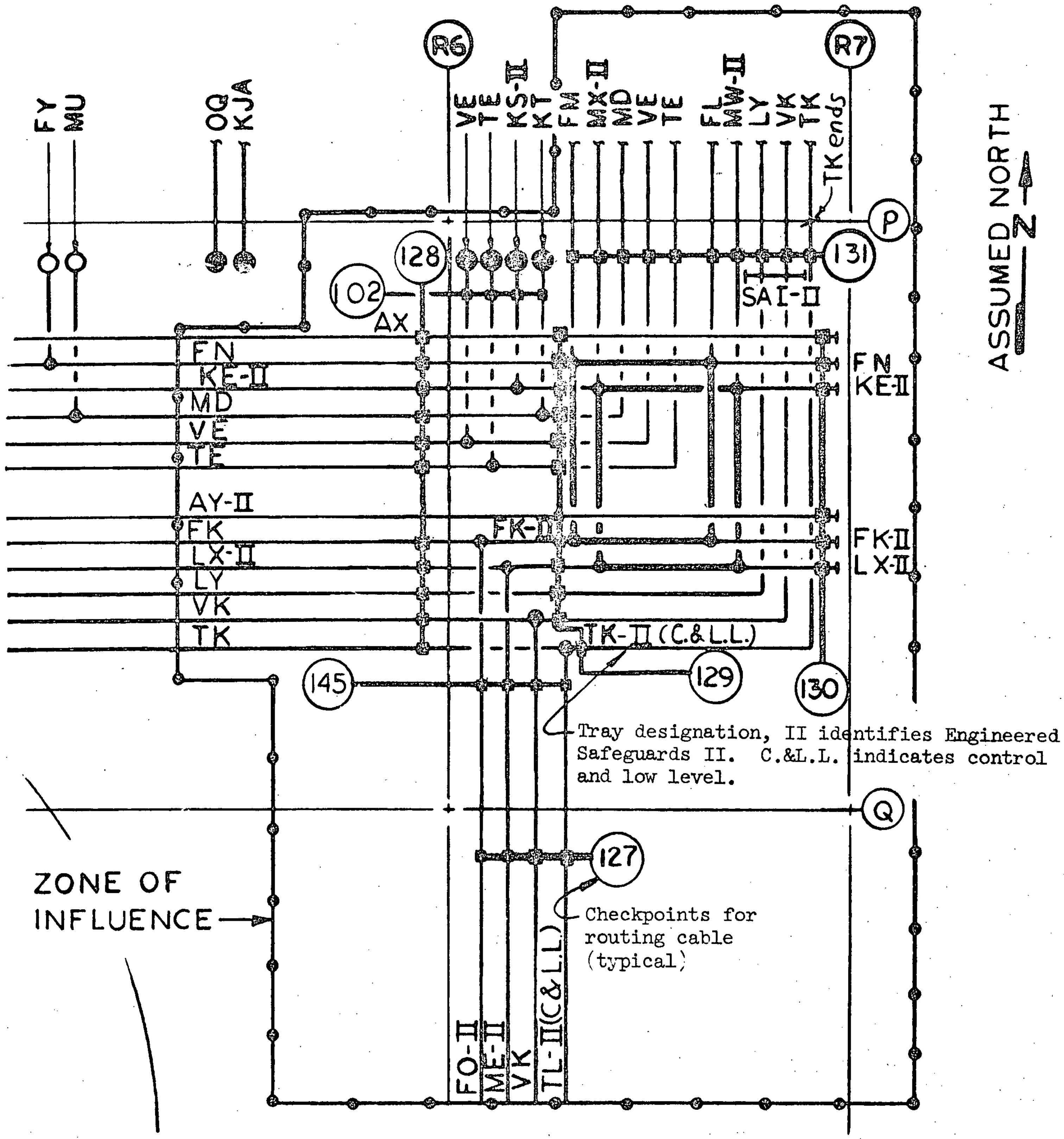


FIG. 8

FIGURE 8
PART PLAN VIEW OF CABLE TRAYS

FIGURE 9
CABLE TRAY SINGLE LINE



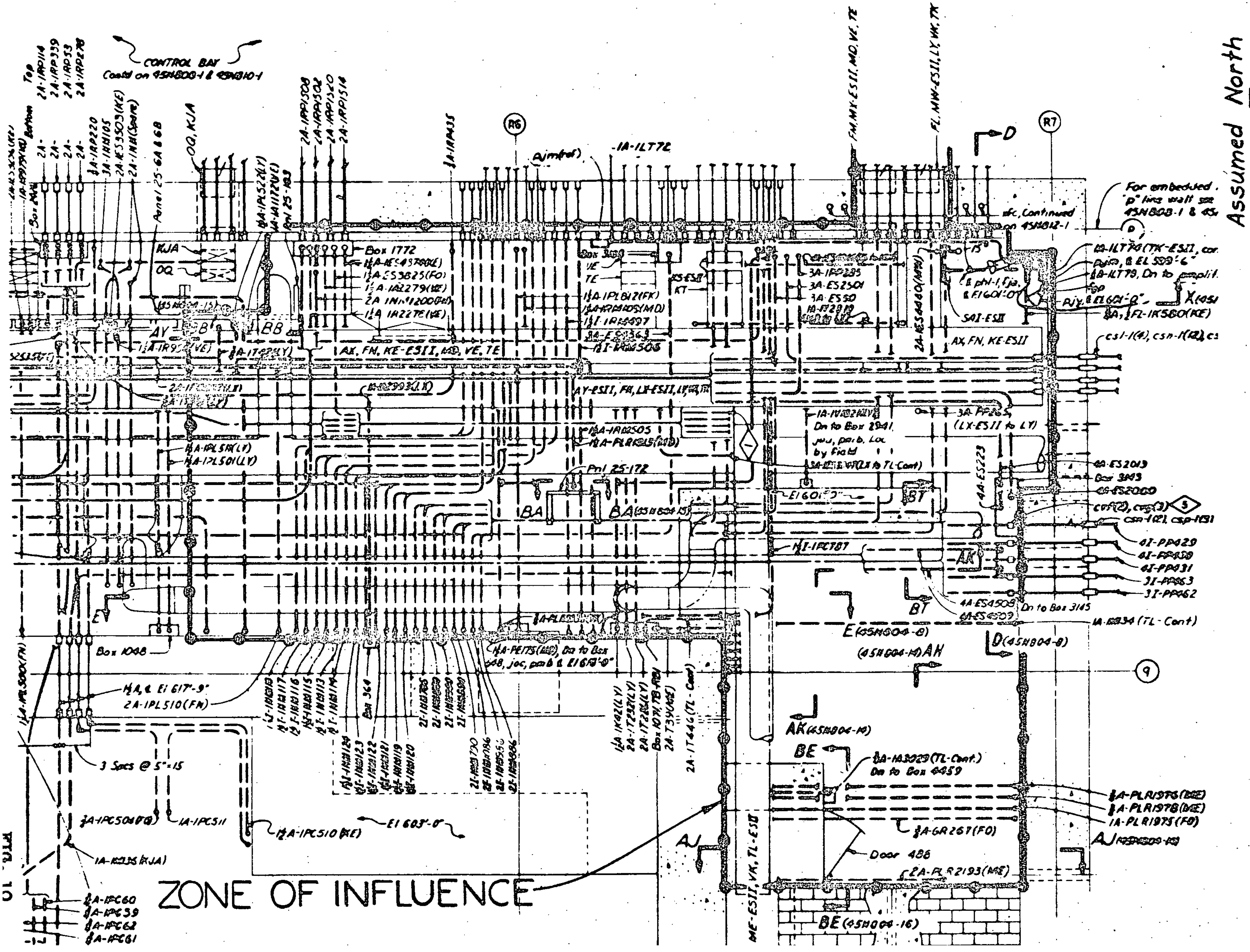


FIGURE 10
PART PLAN VIEW OF CONDUITS NEAR TRAYS

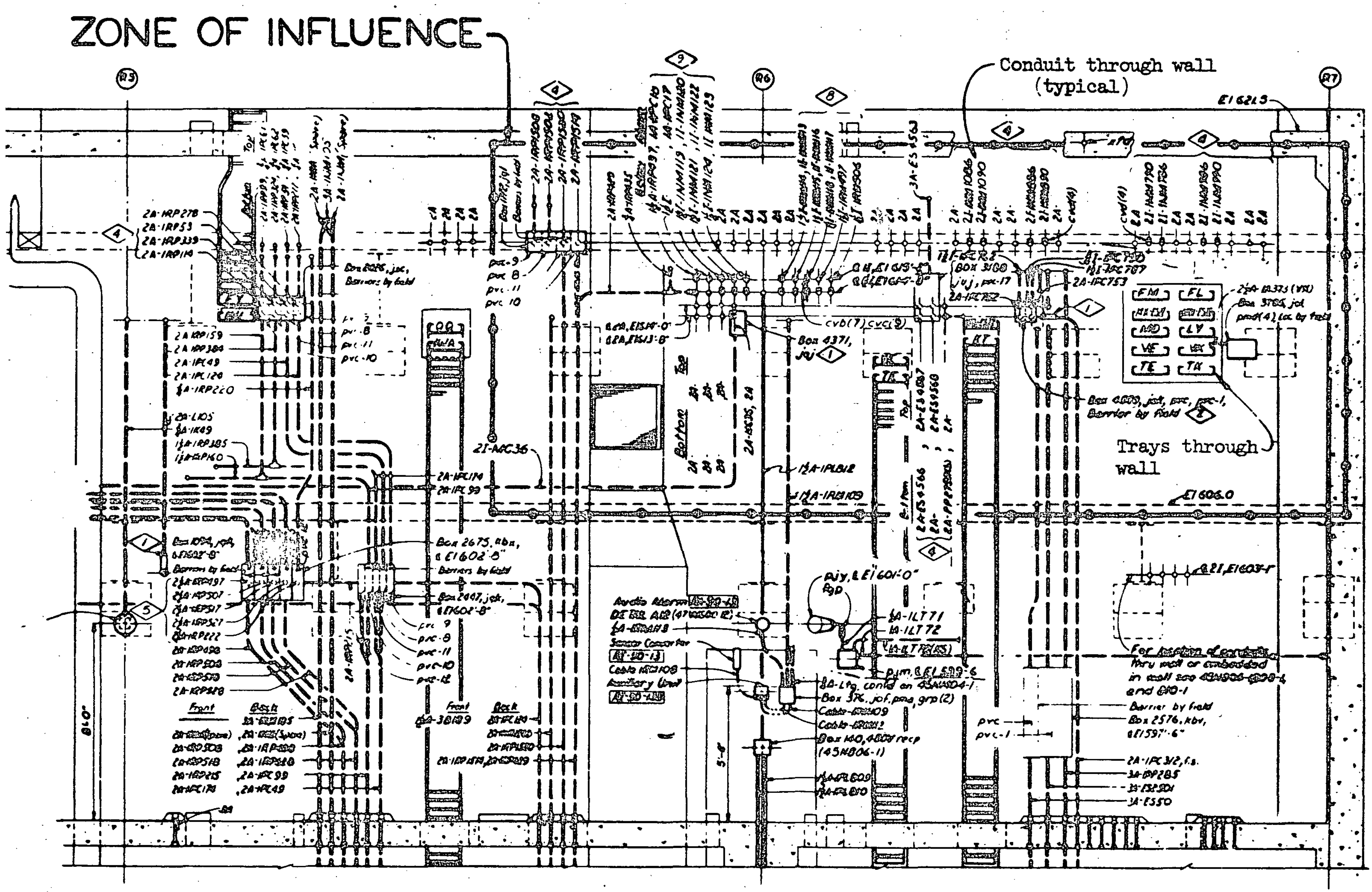
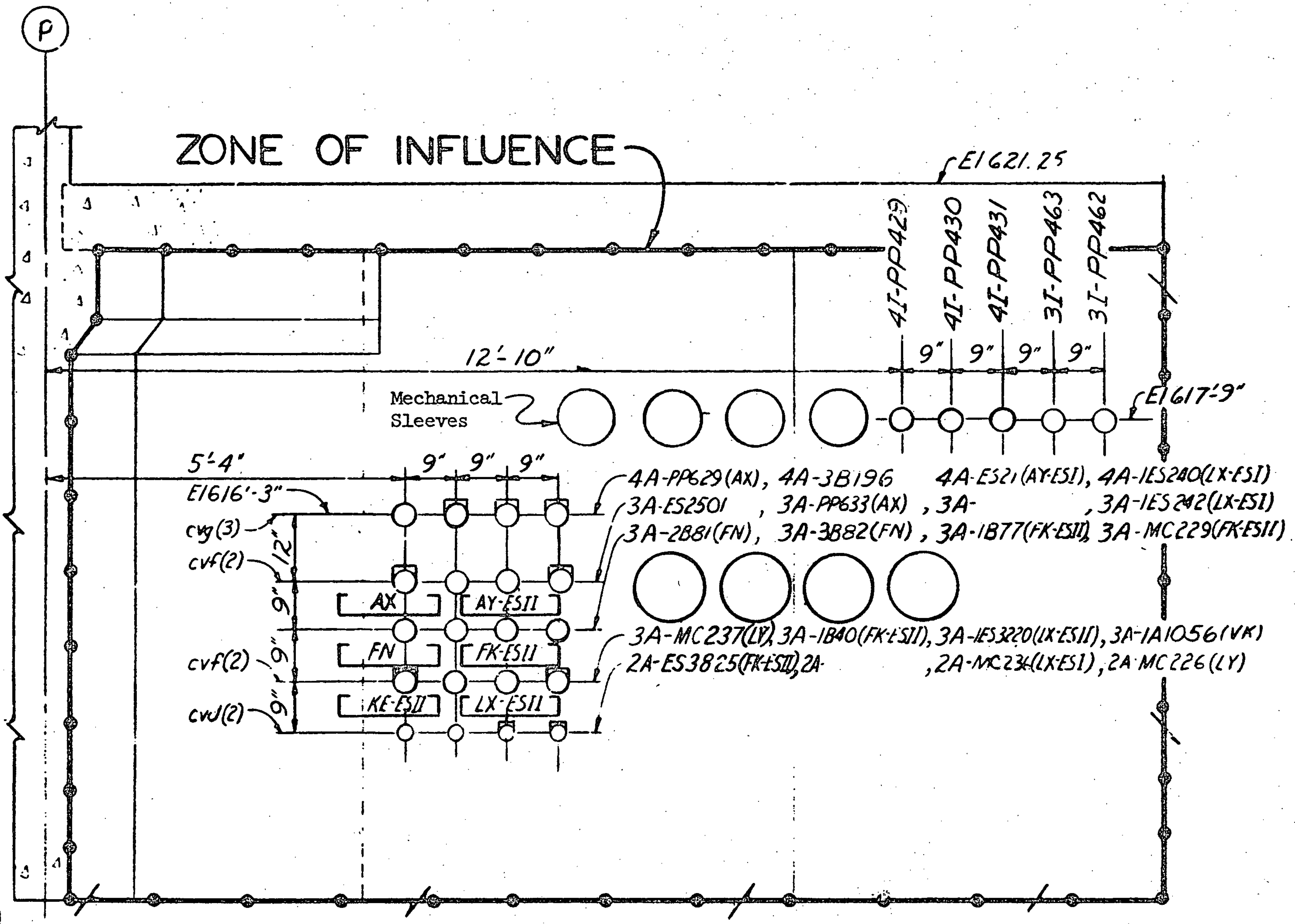


FIGURE 11
ELEVATION VIEW LOOKING NORTH TOWARD CONTROL BAY
FROM REACTOR BLDG UNIT 1 EL 593 SHOWING CONDUITS
AND TRAYS IN ZONE OF INFLUENCE

FIG. 11



ELEVATION VIEW LOOKING EAST TOWARD UNIT 2
(cable trays run to wall and stop and cables are fed into unit 2 through conduits.)

FIGURE 12

FIG. 12

DESCRIPTION OF SPECIALTY ITEMS ASSOCIATED WITH PENETRATIONS*

	Item	Description	Manufacturer
1.	Froth Pak	Insta-Foam	Insta-Foam Products Company Joliet, Illinois

Froth Pak Insta-Foam is the trade name for a kit using an aerosol dispensing unit which contains the chemical components for making rigid polyurethane foam. When the unit is activated, high-quality froth foam is dispensed from two pressurized containers, forming a rigid cellular polyurethane product in less than 1 minute.

2.	Polyurethane	Pourable type Part A No. 0293A Pourable type Part B No. 67010	Witco Chemical Company New Castle, Delaware

Polyurethane, pourable type, produces a rigid cellular polyurethane product similar to that produced by the Froth Pak Insta-Foam. The liquids, part A and part B, are mixed equally by pouring back and forth between two containers until mixed and reaction starts. Before it expands, it more readily flows into small crevices to effect a better seal upon expansion.

3.	Flamemastic	71A	Dyna-Therm Corporation 598 West Avenue Los Angeles, California

Dyna-Therm Flamemastic coatings are compounded of thermoplastic resinous binders, flame-retardant chemicals, and inorganic incombustible fibers. They have a gray fibrous appearance when dry.

4.	Marinite panels	No. 36, type B	Johns-Manville

Marinite panels are composed of incombustible asbestos fibers, diatomaceous silica, and a hydrothermally-produced inorganic binder. They were originally developed to isolate and prevent the spread of shipboard fires. They are hard, dense boards.

5.	Resilient polyurethane foam		Hickory Springs Manufacturing Company 2200 Main Avenue, SE. Hickory, North Carolina

Resilient polyurethane foam is a preformed, resilient, cellular polyurethane foam material which was developed primarily to make furniture cushions.

6.	Styrofoam	---	Unknown

Styrofoam is a lightweight, preformed thermal-insulating material and packing material. It is commonly used for making ice chests. It is readily found on construction sites since it is also used as protective packing material for fragile equipment.

Item	Description	Manufacturer
7. RTV 102 white	Silicone rubber	General Electric Company Silicone Products Department Waterford, New York

RTV (room temperature vulcanizing) silicone rubber is a liquid "rubber" (not a natural rubber) which cures at room temperature to a resilient, tough adhesive. It was originally developed for sealing space vehicles. It is commonly used in the home to seal around bathtubs.

Item	Description	Manufacturer
8. Ty-Rap cable ties	TY-525M	Thomas and Betts Elizabeth, New Jersey

Ty-Rap cable ties are small straps about 1/32 inch thick and 1/8 inch wide, of varying lengths, with a loop in one end for binding cables together. They are generally made of nylon or similar plastic.

9. Other materials may have been used in construction penetration seals.

*These "descriptions" are provided by the committee to assist the laymen in understanding the various materials. The descriptions should not be construed as definitions or precise technical descriptions.

Checkpoint 102
(Looking North)

VE

TE

KS-ESII

KT

TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
VE	WVA	67	.353	6.566
	WVA-1	38	.333	3.306
	WVB	3	.371	.324
	WVC	14	.401	1.764
	MFR	1	.242	.046
TOTAL		123		12.006
TE	WUB	117	.231	4.914
	WUB-1	25	.339	2.250
TOTAL		142		7.164

TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
KS-ESII	WFB	1	.490	.189
	WFE	2	.659	.684
	WGB	40	.425	5.68
	WGC	3	.444	.465
	WGD	2	.484	.368
	WGE	1	.559	.246
	WGG	3	.660	1.026
	WGI	1	.710	.396
	WGK	1	.789	.490
	WHB	6	.384	.696
	WHC	2	.405	.258
	WHE	4	.480	.608
	WHG	1	.519	.212
	WHI	3	.640	.966
	WHJ	1	.710	.396
	WLB	1	.509	.204
TOTAL		72		12.884
KT	WGB	1	.425	.142
	WGG	1	.660	.342
	WHB	2	.384	.232
	WHD	7	.439	1.064
	WHG	1	.519	.212
	WTO	1	.340	.091
	WTR	1	.360	.102
	WVE	1	.461	.167
	WVG	1	.587	.271
	WVI	11	.834	7.205
	WVJ	8	1.012	6.440
	WVR	101	.650	33.532
	WVU-1	2	.439	.304
TOTAL		138		50.104

Checkpoint 127
(Looking North)

FO-ESII

ME-ESII

VK

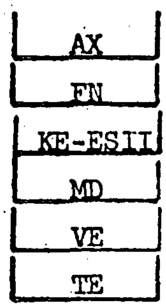
TL-ESIIL | TL-ESIIC *

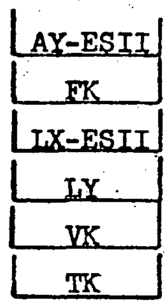
TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
FO-ESII	WDD	3	.340	.273
	WDF	4	.429	.580
	WDG	7	.485	1.295
	WDH	3	.619	.903
	WDI	3	.660	1.026
	WLB	1	.509	.204
	WLC	4	.539	.916
	WLN	1	.559	.245
	WLO	4	.627	1.236
TOTAL		30		6.678
ME-ESII	WDE	2	.379	.226
	WDD	4	.340	.364
	WFB	1	.490	.189
	WGB	27	.425	3.834
	WGD	3	.484	.552
	WGE	4	.559	.984
	WGG	1	.660	.342
	WGI	35	.710	13.860
	WGK	5	.789	2.450
	WGM	1	.874	.600
	WHB	6	.384	.696
	WHC	9	.405	1.161
	WHD	4	.439	.608
	WHE	5	.480	.905
	WHG	4	.519	.848
	WHI	4	.640	1.288
	WHJ	7	.710	2.772
	WHL	1	.781	.479
	WLB	1	.509	.204
	WTO	8	.340	.728
	WTR	1	.360	.102
	WVU-1	2	.439	.304
	WWN	2	.0172	.0344
TOTAL		137		33.530

TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
VK	WVA	8	.353	.784
	WVA-1	20	.333	1.740
	WVB	9	.371	.972
TOTAL		37		3.496
TL-ESIIC	WFB	8	.490	1.512
	WFD	1	.600	.283
	WGB	21	.425	.284
	WGC	5	.444	.775
	WGD	1	.484	.184
	WGE	2	.559	.492
	WGI	2	.710	.792
	WGK	3	.789	.147
	WHB	6	.384	.696
	WHD	1	.439	.152
	WHE	1	.480	.181
	WHG	4	.519	.848
	WTO	9	.340	.819
	WTR	1	.360	.102
	Belden 8213	1	.405	.129
TOTAL		70		7.396
TL-ESIIL	WUB	40	.231	1.680
	WUB-1	4	.339	.360
	WVA	8	.353	.784
TOTAL		52		2.824

* C - indicates control level portion of TL
L - indicates low level portion of TL

Checkpoint 128
(Looking East)





TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
AX	WNB	6	.915	3.942
FN	WLC	1	.539	.229
	WLS	1	.817	.524
	WDG	12	.485	2.220
	WDN	13	.940	9.022
	WGD	5	.484	.920
TOTAL		32		12.915
KE-ESII	WHE	2	.480	.362
	WHJ	3	.710	1.188
	WDD	2	.340	.182
	WFE	1	.659	.342
	WGB	4	.425	.568
	WGG	1	.660	.342
	WHB	22	.384	2.552
	WWN	1	.148	.0172
TOTAL		36		5.708
MD	WHD	7	.439	1.064
	WHE	1	.480	.181
	WHG	1	.519	.212
	WGB	9	.425	1.278
	WGE	1	.559	.246
	WGG	1	.660	.342
	WHB	2	.384	.232
	WVA-1	2	.333	.174
	WVI	1	.834	.655
	WVJ	8	1.012	5.240
	WVU-1	1	.439	.152
TOTAL		34		9.776

TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
AY-ESII	0			
FK	WDF	8	.429	1.160
	WDG	10	.485	1.850
	WDH	5	.619	1.505
	WDI	3	.660	1.026
	WDK	1	.769	.465
	WDN	8	.940	5.552
	WDO	4	1.029	3.332
	WFB	2	.490	.378
TOTAL		41		15.268
LX-ESII	WHC	1	.405	.129
	WHE	1	.480	.181
	WTO	7	.340	.637
	WGC	1	.444	.155
	WGD	1	.484	.184
	WGE	2	.559	.492
	WGG	1	.660	.342
	WGI	1	.710	.396
	WGK	2	.789	.980
TOTAL		17		3.496
LY	WTD	1	.638	.320
	WTO	24	.340	2.184
	WTR	2	.360	.204
	WDD	2	.340	.182
	WFB	1	.490	.189
	WFD	4	.600	1.132
	WGB	10	.425	1.420
	WGC	2	.444	.310
	WGD	1	.484	.184
	WGE	4	.559	.984
	WGG	5	.660	1.710
TOTAL		56		8.819

Checkpoint 128
(Looking East)
(Continued)

TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
VE	WVA	94	.353	9.212
	WVA-1	85	.333	7.395
	WVB	12	.317	1.296
	WVC	4	.401	.504
TOTAL		195		18.407
TE	WUB	80	.231	3.360
	WUB-1	23	.339	2.070
	WVA	3	.353	.294
TOTAL		106		5.724

TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
LY	WGK	1	.789	.490
	WHB	6	.384	.696
TOTAL		7		1.186
VK	WVA	29	.353	2.842
	WVA-1	91	.333	7.917
	WVB	9	.371	.972
TOTAL		129		11.731
TK	WUB	16	.231	.672
	WVA	6	.353	.588
TOTAL		22		1.260

Checkpoint 129
(Looking East)

AX	AY-ESII
FN	FK-ESII
KE-ESII	LX-ESII
MD	LY
VE	VK
TE	TK-ESIIL | TK-ESIIC *

TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
AX	Same as checkpoint 128			
FN	Same as checkpoint 128			
KE-ESII	WDD	2	.340	.182
	WFB	1	.490	.189
	WFE	1	.659	.342
	WGB	43	.425	6.106
	WGC	3	.444	.465
	WGD	6	.484	1.104
	WGE	1	.559	.246
	WGG	4	.660	1.368
	WGI	1	.710	.396
	WHB	26	.384	3.016
	WHC	2	.405	.258
	WHE	4	.480	.724
	WHG	2	.519	.424
	WHI	2	.640	.644
	WHJ	4	.710	1.584
	WLB	1	.509	.204
	WWN	1	.0172	.0172
TOTAL		104		18.024
MD	Same as checkpoint 131			
VE	Same as checkpoint 131			
TE	Same as checkpoint 131			

TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
AY-ESII	0	0	0	0
FK-ESII	WDF	10	.429	1.45
	WDG	7	.485	1.295
	WDH	2	.619	.602
	WDK	4	.769	1.860
	WDN	8	.940	5.552
	WDO	4	1.029	3.332
	WFB	2	.490	.378
	WHB	1	.384	.116
	WLB	1	.509	.204
	WLN	1	.559	.245
	WLO	2	.627	.618
	WVA	2	.353	.196
TOTAL		44		14.544
LX-ESII	WDD	4		.364
	WDE	2		.226
	WFB	1	.490	.189
	WGB	25	.425	3.550
	WGD	3	.484	.552
	WGE	5	.559	1.230
	WGG	2	.660	.684
	WGI	36	.710	14.256
	WGK	5	.789	2.450
	WGM	1	.874	.600
	WHB	6	.384	.696
	WHC	9	.405	1.161
	WHD	4	.439	.608
	WHE	5	.480	.905
	WHG	3	.519	.636
	WHI	4	.640	1.288
	WHJ	7	.710	2.872
	WHL	1	.781	.479
	WLB	1	.509	.204
	WTA	1	1.139	1.020
	WVU-1	2	.439	.304
	WWN	2	.0172	.034
TOTAL		123		33.718

* C - indicates control level portion of TL
L - indicates low level portion of TL

Checkpoint 129
(Looking East)
(Continued)

TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA	TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
					TK-ESIIC	WFB	8	.490	1.512
						WFD	1	.600	.283
						WGB	16	.425	2.272
						WGC	6	.444	.930
						WGD	2	.484	.368
						WGE	2	.559	.492
						WGI	2	.710	.792
						WGK	4	.789	1.960
						WHB	4	.384	.464
						WHC	1	.405	.129
						WHD	1	.439	.152
						WHE	2	.480	.362
						WHG	4	.519	.848
						WTO	1	.340	.091
						WTR	1	.360	.102
						Belden 8213	1	.405	.129
					TOTAL		56		10.886
					TK-ESIIL	WHB	1	.384	.116
						WUB	34	.231	1.428
						WUB-1	4	.339	.360
						WVA	4	.353	.392
					TOTAL		43		2.296
					LY	Same as checkpoint 128			
					VK	Same as checkpoint 128			

AX
FN
KE-ESII

AY-ESII
FK-ESII
LX-ESII

TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
AX	Same as checkpoint 129			
FN	WDN	4	.940	2.576
	WLS	1	.817	.524
TOTAL		5		3.100
KE-ESII	WLB	1	.509	.204
TOTAL		1		.204

TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
AY-ESII		0		
FK-ESII	WDF	8	.429	1.160
	WDG	8	.485	1.480
	WDH	2	.619	.602
	WDK	1	.769	.465
	WDN	8	5.552	.940
	WFB	2	.490	.378
	WLO	1	.627	.309
TOTAL		30		5.334
LX-ESII	WGB	4	.425	.568
	WGD	1	.484	.184
	WGG	1	.660	.342
	WGK	2	.789	.980
	WHB	2	.384	.232
TOTAL		10		2.306

Checkpoint 131
(Looking North)

FM
MX-ESII
MD
VE
TE

FL
MW-ESII
LY
VK
TK

TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
FM	WDF	2	.429	.290
	WDG	12	.485	2.220
	WDK	3	.769	1.395
	WDN	3	.940	2.082
	WDO	4	1.029	3.332
	WLC	1	.539	.229
TOTAL		25		9.573
MX-ESII	WDD	2	.340	.182
	WDE	2	.379	.226
	WFB	1	.429	.145
	WFE	2	.659	.684
	WGB	58	.425	8.236
	WGC	1	.444	.155
	WGD	3	.484	.552
	WGE	4	.559	.984
	WGG	4	.660	1.026
	WGI	37	.710	14.652
	WGK	3	.789	1.47
	WGM	1	.874	.600
	WHB	26	.384	3.016
	WHC	10	.405	1.290
	WHD	4	.439	.608
	WHE	7	.480	1.267
	WHG	4	.519	.848
	WHI	4	.640	1.288
	WHJ	4	.710	1.584
	WHL	1	.781	.479
	WVU-1	2	.439	.304
	WWN	1	.148	.0172
TOTAL		181		38.290
MD	WGB	1	.425	.142
	WGE	1	.559	.246
	WHB	1	.384	.116
	WHD	2	.439	.304
	WHE	1	.480	.181
	WTO	1	.340	.091
	WTR	1	.360	.102
	WVE	1	.461	.167

TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
FL	WDN	6	.940	4.164
	WLB	1	.509	.204
	WLN	1	.559	.245
	WLO	1	.627	.309
TOTAL		9		4.922
MW-ESII	WFB	9	.490	1.701
	WFD	1	.600	.283
	WGB	23	.425	3.266
	WGC	6	.444	.930
	WGD	3	.484	.552
	WGE	2	.559	.492
	WGI	3	.710	1.188
	WGK	3	.789	1.47
	WHB	14	.384	1.624
	WHE	5	.480	.905
	WHJ	1	.710	.396
	WLB	1	.509	.204
	WTA	1	1.139	1.020
	Belden 8213	1	.405	.129
TOTAL		73		11.919
LY	WDD	2	.340	.182
	WFB	1	.490	.189
	WFD	3	.600	.849
	WGB	8	.425	1.136
	WGC	2	.444	.310
	WGD	2	.484	.368
	WGE	5	.559	1.230
	WGG	5	.660	1.710
	WGK	1	.789	.490
	WHB	6	.384	.696
	WHC	1	.405	.129
	WHI	3	.640	.966
	WVA-1	2	.333	.174
TOTAL		41		5.783

Checkpoint 131
(Looking North)
(Continued)

TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
MD	WVG	1	.587	.271
(Continued)	WVI	11	.834	7.205
	WVJ	16	1.012	12.880
	WVR	101	.650	33.532
	WVU-1	3	.439	.456
TOTAL		141		55.693
VE	WVA	52	.353	5.096
	WVA-1	61	.333	5.307
	WVB	15	.371	1.620
	WVC	10	.401	1.260
	MFRS	1	.242	.046
TOTAL		139		13.329
TE	WUB	37	.231	1.974
	WUB-1	47	.339	4.230
	WVA	3	.353	.2940
TOTAL		87		6.498

TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
VK	WVA	41	.353	3.332
	WVA-1	46	.333	4.002
TOTAL		87		7.334
TK	WUB	34	.231	1.428
	WUB-1	25	.339	2.250
	WVA	2	.353	.196
TOTAL		61		3.874

(Looking North)

FO-ESII
ME-ESII
VK
TL-ESII L | TL-ESII C *

TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
FO-ESII	WDD	3	.340	.273
	WDF	2	.429	.290
	WDG	6	.485	1.110
	WDH	1	.619	.301
	WDI	1	.660	.342
	WLB	1	.509	.204
	WLC	1	.539	.229
	WLN	1	.559	.245
	WLO	4	.627	1.236
TOTAL		20		4.230
ME-ESII	WDE	2	.379	.226
	WDD	4	.340	.364
	WFD	1	.600	.283
	WGB	27	.425	3.834
	WGD	3	.484	.552
	WGE	4	.559	.984
	WGG	1	.660	.342
	WGI	35	.710	13.860
	WGK	3	.789	.147
	WGM	1	.874	.600
	WHB	5	.384	.580
	WHC	8	.405	1.032
	WHD	4	.439	.608
	WHE	5	.480	.905
	WHG	4	.519	.848
	WHI	4	.640	1.288
	WHJ	7	.710	2.772
	WHL	1	.781	.479
	WLB	1	.509	.204
	WTA	1	1.139	1.020
	WTO	8	.340	.728
	WTR	1	.360	.102
	WVU	2	.376	.222
	WWN	2	.0172	.034
TOTAL		134		32.014

TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
VK	WVA	10	.353	.980
	WVA-1	22	.333	1.914
	WVB	9	.371	.972
TOTAL		41		3.866
TL-ESIIC	WFB	8	.490	1.512
	WFD	1	.600	.283
	WGB	29	.425	4.118
	WGC	5	.444	.775
	WGD	1	.484	.184
	WGE	4	.559	.984
	WGI	2	.710	.792
	WGK	3	.789	.147
	WHB	6	.384	.696
	WHC	1	.405	.129
	WHD	1	.439	.152
	WHE	2	.480	.362
	WHG	4	.519	.848
	WTO	8	.340	.728
	WTR	1	.360	.102
	BELDEN 8213	1	.405	.129
TOTAL		77		11.941
TL-ESIIL	WUB	50	.231	2.100
	WUB-1	4	.339	.360
	WVA	8	.353	.784
TOTAL		62		3.244

* C - indicates control level portion of TL
L - indicates low level portion of TL

Note: Tray loading for vertical tray connecting trays MW-II and TK-II south of checkpoint 131

SAI-ESII

TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA	TRAY DESIG	CABLE TYPE	QTY	CABLE OD	TOTAL AREA
SAI-ESII	WFB	8	.490	1.512					
	WFD	1	.600	.283					
	WGB	19	.425	2.698					
	WGC	4	.444	.620					
	WGD	2	.484	.368					
	WGE	2	.559	.492					
	WGI	2	.710	.792					
	WGK	3	.789	1.470					
	WHB	6	.384	.696					
	WHC	1	.405	.129					
	WHD	1	.439	.152					
	WHE	2	.480	.362					
	WHG	4	.519	.848					
	Belden 8213	1	.405	.129					
TOTAL		56		10.551					

COMPUTED BY CABLE TRAY DATE FO-ESII CHECKED BY BU-BU DATE 128 & 145

CABLE	PURPOSE	FROM	TO	SCHEM	TYPE	WHERE TO DISCONNECT OR DE-ENERGIZE AND OTHER COMMENTS
B331	Diesel Gen Air Compr Back up Mot Alternate feed	Batt Bd 1 Pnl 7 bkr 712 45N701-1	DC throwover Sw 45N786-11	45N771-6	wdg	Open breaker 712, BATT BD 1, panel 7
ES3825-II	Battery & Bd Rm exhaust fan 1B Supply	480 Cont Bay Vent Bd B Pnl 6C 45N788-2	Fan Motor 1B 45N788-4	45N769-7	wlo	Open breaker compartment 6C, 480V Cont Bay Vent Bd B
ES3900-II	Bd Rm Emer Supply fan 1B Supply	480V Reac MOV Bd 1B pnl 17A 45N1750-6	Fan Motor 45N783-4	45N769-7	wdd	Open breaker compartment 17A, 480V REAC MOV Bd 1B
PL478	Reactor Bldg elevator No. 1 supply	Common Bd 1 Pnl 7B 45N781-2	Mfr's JB 45N781-2	45N769-1	wdg	Open breaker compartment 7B, 480V Common Bd 1
PLR1975	Clean-up Backwash Transfer Pump 1A Supply	480V R.B. Vent Bd 1B Pnl 6A 45N1756-2	Pump Motor 45N1756-9	45N777-15	wlo	TRIP BKR 480V REACT BLDG VENT BD 1B, COMPT 6A
K321	SEE SHEET 9					
1B89-1E	Alternate Supply, 250V CONTROLS	Batt Bd 2 Pnl 7 bkr 708 45N702-1	480V Shutdn Bd 1A Pnl 4 45N1748-2	45N749-1	wdf	TRIP BKR 708, BATT BD 2, PNL 7
1B93-1E	Alternate Supply, 250V CONTROLS	Batt Bd 3 Pnl 7 Bkr 709 45N703-1	480V Shutdn Bd 1B Pnl 4 45N1748-3	45N749-2	wdf	TRIP BKR 709, BATT BD 3, PNL 7
1ES3000-II	Core Spray Sys II outboard disch valve (FCV-75-53) Supply	480V R. MOV Bd 1B Pnl 7E 45N1750-3	FCV-75-53 45N1750-11	45N751-3	wlo	TRIP BKR 480V REACT MOV BD 1B, COMPT 7E
1ES3013-II	Core Spray Sys II outboard disch valve (FCV-75-51) Supply	480V Reac MOV Bd 1B Pnl 8E 45N1750-3	FCV-75-51 45N1750-11	45N751-3	wlo	TRIP BKR 480V REACT MOV BD 1B, COMPT 8E
1K575	Evacuation Alarm System	480V fuse Pnl A 45N785-12	Local Starter in JB 3612 55N2779	55N2779	wlb	PULL FU 2AX & 2AY EVAC ALARM FUSE PNL A EL 606, COL PR11
1K606	Evacuation Alarm system	480V fuse Pnl B 45N786-12	Local Starter in JB 2886 55N2779	do	wln	PULL FU 1BX & 1BY EVAC ALARM FUSE PNL B EL 606, COL PR12
1PC504-II	Reactor water Clean-up Sys isol valve (FCV-69-12) supply	480V Reactor MOV Bd 1B Pnl 17E 45N1750-6	FCV-69-12 45N1750-7	45N751-3	wTC	TRIP BKR 480V REACT MOV BD 1B, COMPT 17E
1PL474	Unit Preferred MMG Set 1, nor fdr supply	480 Shutdn Bd 1A pnl 7D 45N1748-1	Unit Preference MMG Set Control Cab. 45N708-2	45N749-1	wdh	TRIP BKR 480V SHTDN BD 1A COMPT 7D

TABLE 3
SHEET 1 OF 1

SAMPLE CABLE TABULATION SHEET

Number of each class of safety related cables routed in fire zone.

Plant Usage	Number	Safety Classification	Channel or Division*
Common	20	Engineered Safeguard - ECCS	I
	20	Engineered Safeguard - ECCS	II
	13	Engineered Safeguard - Diesel A	IA
	33	Engineered Safeguard - Diesel C	IIC
	5	Engineered Safeguard - Diesel D	IID
	7	Load Shedding - Diesel A	A1
	9	Load Shedding - Diesel C	B1
	7	Supporting Auxiliaries - Electrical	IE
Subtotal	114		
Unit 1	6	Engineered safeguard - ECCS	I
	182	Engineered Safeguard - ECCS	II
	4	Load Shedding - Diesel A	A1
	5	Load Shedding - Diesel C	B1
	1	Load Shedding - Diesel D	B2
	52	Neutron Monitoring (also activates	IA
	52	Neutron Monitoring RPS)	IB
	52	Neutron Monitoring	IIA
	52	Neutron Monitoring	IIB
	14	Primary Containment Isolation	I
	39	Primary Containment Isolation	II
	2	Reactor Protection (control rod	IA
	2	Reactor Protection scram)	IB
	2	Reactor Protection	IIA
	2	Reactor Protection	IIB
	3	Reactor Protection	IIIB
	12	Supporting Auxiliaries - Electrical	IE
Subtotal	482		
Unit 2	15	Engineered Safeguard - ECCS	I
	3	Engineered Safeguard - ECCS	II
	4	Supporting Auxiliaries - Electrical	IE
Subtotal	22		
Unit 3	4	Engineered Safeguards - ECCS	I
	3	Engineered Safeguards - ECCS	II
	3	Supporting Auxiliaries - Electrical	IE
Subtotal	10		
TOTAL	628		

*See sheets 2 & 3 for channel or division definitions.

TABLE 4
SHEET 1 OF 3

SUMMARY OF CABLE SUFFIX DEFINITIONS

1. Cables in the PP series with an A or B suffix are to be separated from each other. They are not engineering safeguard cables, but a separate routing is desirable. They involve off-site power.

2. The following suffixes apply to all cable series:

   I - Division I engineering safeguard or Primary Containment Isolation cables

   II - Division II engineering safeguard or Primary Containment Isolation cables

   IA - Diesel generator A shutdown logic cables (may be routed in cable tray with Division I cables)

   IB - Diesel generator B shutdown logic (routed in conduit)

   IIC - Diesel generator C shutdown logic (may be routed in cable tray with Division II cables)

   IID - Diesel generator D shutdown logic cables (routed in conduit)

3. The following suffixes apply to LS series:

   A1 - 480V load shedding logic channel A1: (routed with IA-Diesel A)

   A2 - 480V load shedding logic channel A2: (routed with IB-Diesel B)

   B1 - 480V load shedding logic channel B1: (routed with IIC-Diesel C)

   B2 - 480V load shedding logic channel B2: (routed with IID-Diesel D)

4. The following suffixes apply to RP (Reactor Protection) or NM (Neutron Monitoring) series:

   IA - RPS logic channel A1

   IIA - RPS logic channel A2

   IB - RPS logic channel B1

   IIB - RPS logic channel B2

5. The following suffixes apply to RP (Reactor Protection) series:

   IIIA - RPS manual and back-up scram solenoid channel A.

   IIIB - RPS manual and back-up scram solenoid channel B

   A - 120V a-c RPS channels A1, A2, and A3 supply (RPS MG set A)

   B - 120V a-c RPS channels B1, B2, and B3 supply (RPS MG set B)

   G1 - RPS scram solenoid Group 1

G2 - RPS scram solenoid Group 2

G3 - RPS scram solenoid Group 3

G4 - RPS scram solenoid Group 4

6. Suffix 1E - Applies to supporting auxiliaries needed for safe shutdown of plant.

Summary of cable types involved in fire.

CABLE TYPE (MARK)	DESCRIPTION: NO. & SIZE OF CONDUCTORS	INSULATED*	NO. CABLES DAMAGED
WBB	1/c # 12	1	11+
WCA	1/c # 14	1	2+
WDD	1/c # 8	2	4+
WDE	1/c # 6	2	1+
WDF	1/c # 4	2	7+
WDG	1/c # 2	2	13+
WDH	1/c #1/0	2	2+
WDI	1/c #2/0	2	2+
WDK	1/c #4/0	2	2+
WDN	1/c #300	2	6+
WDO	1/c #400	2	1+
WFB	2/c # 10	3	16
WFC	3/c # 10	3	1
WFD	4/c # 10	3	6
WFE	5/c # 10	3	1
WGB	2/c # 12	3	157
WGC	3/c # 12	3	18
WGD	4/c # 12	3	37
WGE	5/c # 12	3	13
WGG	7/c # 12	3	14
WGI	9/c # 12	3	45
WGK	12/c # 12	3	18
WGM	16/c # 12	3	2
WGN	19/c # 12	3	2
WHB	2/c # 14	3	62
WHC	3/c # 14	3	15
WHD	4/c # 14	3	18
WHE	5/c # 14	3	13
WHG	7/c # 14	3	10
WHI	9/c # 14	3	8
WHJ	9/c # 14	3	7
WHL	16/c # 14	3	1
WHT	7/c # 16	3	8

* Numbers listed correspond to insulation of cable type as shown below.

\+ Number of individual cable designations. Actual number of conductors appear on checkpoint sheets showing tray fill.

Summary of cable types involved in fire.

CABLE TYPE (MARK)	DESCRIPTION NO. & SIZE OF CONDUCTORS	INSULATED*	NO. CABLES DAMAGED
WLB	2/c # 12	4	8
WLC	3/c # 12	4	5
WLG	7/c # 12	4	1
WLN	2/c # 10	4	1
WLO	3/c # 10	4	5
WLS	7/c # 10	4	1
WNB	1/c #2/0	5	6+
WNC	1/c #4/0	5	2+
WNF	1/c #500	5	3+
WTA	50 pr #19	6	1
WTD	12 pr #19	6	1
WTJ	COAX	7	22
WTK	COAX	8	212
WTK-1	COAX	9	8
WTK-2	COAX	10	4
WTO	2 pr #18	11	42
WTR	2 pr #14	12	4
WUB	Thermocouple	13	167
WUB-1	Thermocouple	14	51
WVA	2/c # 16	15	154
WVA-1	2/c # 18	15	206
WVB	3/c # 16	15	33
WVC	4/c # 16	15	10
WVE	7/c # 16	15	1
WVG	12/c # 16	15	1
WVI	27/c # 16	15	11
WVJ	37/c # 16	15	16
WVR	29/c # 20	16	101
WVU	5/c # 18	16	4
WVU-1	8/c # 18	16	5
BELDEN 8213	COAX	7	1
MFR'S TV CABLE (BELDEN 8212)	COAX	7	1

* Numbers listed correspond to insulation of cable type as shown below.

\+ Number of individual cable designations. Actual number of conductors appear on checkpoint sheets showing tray fill.

1. Single conductor power or control cable with polyethelene insulation and a nylon jacket over the polyethelene. (Termed "PN" per TVA Specification)

2. Single conductor power or control cable with cross-linked polyethelene insulation and a polyvinyl-chloride insulation jacket over the cross-linked polyethelene. (Termed "CPJ" per TVA Specification)

3. Multiple-conductor cable with a core of the specified number of single conductors as in 1 above covered by a polyvinyl-chloride outer jacket. (Termed "PNJ" per TVA Specification)

4. Multiple-conductor cable with a core of the specified number of single conductors as in 2 above covered by a polyvinyl-chloride outer jacket. (Termed "CPJJ" per TVA Specification)

5. Single conductor high-voltage (5000 volts) power cable with extruded stand and cross-linked polyethelene insulation with metallic electrostatic shielding and polyvinyl chloride jacket overall. (Termed "CPSJ" per TVA Specification)

6. Telephone cable with high density polyethelene over each conductor, mylar backed rubber cable tape, aluminum shield, and high density polyethelene jacket overall. Some of these had polyvinyl chloride jacket overall.

7. Coaxial signal cable with both conductor and overall jacket insulated with polyethelene.

8. Coaxial signal cable with conductor insulated with polyethelene and polyvinyl chloride jacket overall.

9. Coaxial signal cable with conductor and overall jacket insulated with irradiated blend of polyolefins and polyethelene and noise free. Some of these types had cross-linked polyethelene over both.

10. Same as 8 but made noise free by a carbon suspension.

11. Same as 6 except without shield.

12. Twisted pair cable with polyethelene over each conductor and polyvinyl chloride jacket overall.

13. Thermocouple cable with high density polyethelene over each conductor, aluminum foil/mylar type laminated shield, and high density polyethelene overall.

14. Thermocouple cable with heat and light stabilized cross-linked polyethelene over each conductor, aluminum foil/mylar tape shield, and chlorosulfonated polyethelene jacket overall.

15. Signal cable with heat and light stabilized cross-linked polyethelene over each conductor, aluminum foil/mylar tape laminated shield, fiberglass reinforced silicone tape assembly wrap, and chlorosulfonated polyethelene jacket overall.

16. Multiple-conductor cable with core of specified number of single conductor cables insulated with cross-linked polyethelene and a neoprene jacket overall.

BROWNS FERRY UNIT 1

SEQUENCE OF
SIGNIFICANT OPERATIONAL EVENTS
AT TIME OF FIRE

Time	Event	Action	Response or Nonresponse
3/22/75 Prior to 1235	Initial Condition	Routine Operation	Unit Load 1,100 MWe
1235	Report of fire received by assistant shift engineer from public safety officer.	Assistant shift engineer set off fire alarm and proceeded to fire. Fire alarm sealed in by unit operator who then used paging system to inform plant personnel of fire location.	Operating personnel fire brigade reported to fire and began fire-fighting activities (described elsewhere in investigation report).
~ 1240	Received the following alarms in unit 1 control room: 1. RHR or core spray pumps running/ auto blowdown permissive 2. Reactor level low/auto blowdown permissive 3. Core cooling system/diesel initiate	Unit operator observed control board and determined normal reactor water level and steam pressure, drywell pressure normal at 0.45 psig, and emergency core cooling system (ECCS) equipment aligned in normal standby status. (Reactor water level instrumentation activates the emergency core cooling systems, this being normal, indicated a lack of need for these systems.) (Normal drywell pressure indicated that piping was intact inside the primary containment.)	All diesel generators (D/G's) started from ECCS logic signal which started the core spray pumps.
~ 1242	Residual heat removal (RHR) and core spray (CS) pump running alarm received. High-pressure coolant injection pump (HPCI), reactor core isolation coolant pump (RCIC) started.	Unit operator observed pumps running and RHR aligned to reactor in low-pressure coolant injection (LPCI) mode. Verified reactor water level normal and stopped pumps. Operator attempted to reset alarm. (All four of these systems are ECCS and with normal level were not required.)	Pumps stopped. Alarm would not reset with reactor pressure and level normal.
~ 1244	RHR and core spray pumps restarted with no apparent reason.	Operator observed reactor level normal and attempted to stop RHR and core spray pumps. Pumps could not be stopped from benchboard.	Operator did stop pumps at ~ 1248 from benchboard.
~ 1248	Reactor recirculation pumps ran back for no apparent reason. Began losing electrical boards. Indicating lights over valve and pump control switches on panel 9-3 were glowing brightly, dimming, and going out. (Panel 9-3 is the control board location for all ECCS equipment.) The lights being lost on control circuits for ECCS pumps and valves precluded reliable operation from that control board.	Operator observed reactor power decreasing and average power range monitors (APRM) responding. Also noted reactor level 2 to 3 inches high. Operators observed smoke from control wiring under panel 9-3.	Unit power decreased from 1,100 MWe to 700 MWe.

Time	Event	Action	Response or Nonresponse
~ 1248 (Contd.)	Lost 1/2 of reactor protection system (RPS).		
	Lost remote manual control of a number of relief valves.		
	Numerous alarms occurred on all control panels and unit in unstable swing.		
~ 1251	Shift engineer instructed operator to zero recirculating pump loading and scram the reactor.	Operator reduced loading signal to recirculating pumps and manually scrammed the reactor and placed reactor mode switch in the shutdown position.	Recirculating pumps tripped by unknown cause at approximately 20 percent loading. Reactor scrammed and all rods inserted.
		Shift engineer reported plant conditions to supervisors by phone.	
~ 1253	Confirmed that all control rods were fully inserted.	Operator tripped B and C reactor feed pumps (RFP), B and C condensate booster pumps, and C condensate pump. Reduced loading on reactor feed pump subpanel to prevent "over shoot" on reactor level return. RCIC started manually as backup.	Pumps responded to trip signal and reactor level was maintained by reactor feed pump A and RCIC.
~ 1254	Unit conditions indicated need for tripping turbogenerator.	Assistant shift engineer (ASE) initiated turbine trip upon observing generator load at 100 MW. Also opened generator field breaker and motor-operated disconnects (MOD's).	Turbine bypass valves opened to compensate for turbine valve closure and maintain pressure normal. The main-steam isolation valves (MSIV's) remain open allowing reactor pressure control through the turbine bypass valves to main condenser heat sink.
		Unit operator inserted source range and intermediate range neutron monitors and observed reactor power decrease.	Neutron monitoring responded normally.
	HPCI started.		HPCI automatically aligned in normal injection mode to reactor vessel.
	Reactor water level restored to approximately normal range.	Operators shut down HPCI and RCIC.	HPCI and RCIC shutdown. Problems incurred upon shutdown with valve operation associated with these systems.
~ 1255	Lost 120-V unit preferred power. One of the feeds from this source is the unit control rod position indication on panel 9-5 (reactor control panel).	Operator placed reactor mode switch in "Refuel" mode to verify one rod withdraw permit. (All rods must be fully inserted or the indicating light for one rod withdraw in refuel mode will not illuminate.)	Received white permit light.
	Lost all neutron monitoring.	Operator observed no indication on average power range, intermediate range, or source range monitor.	Capability to monitor core was lost.

Time	Event	Action	Response or Nonresponse
~ 1256	By this time the following electrical boards were lost: 1A 250-V D.C. Reactor MOV board* 1B 250-V D.C. Reactor MOV board 1A 480-V A.C. Reactor MOV board 1B 480-V A.C. Reactor MOV board 1C 480-V A.C. Reactor MOV board 1A 480-V A.C. Shutdown (SD) board 1B 480-V A.C. Shutdown board 120-V A.C. unit preferred	Indication from the unit control room as to electrical sources feeding the various equipment and as verified by ASE as he checked the individual boards.	This caused the loss of vital equipment being fed from these electrical boards. Loss of power to MSIV's caused them to go closed (all 4 outboard valves), placing the unit in isolation from the main condenser heat sink and cutting off the steam supply to the reactor feed pump turbines. All emergency core cooling systems were lost with the exception of 4 relief valves which could be operated from the unit control board.
~ 1258	Reactor pressure rapidly increased to 1,100 psig.	ASE was unsuccessful in opening MSIV's from backup control center.	Relief valves opening and closing to maintain pressure between 1,080 and 1,100 psig. Relieving to the suppression pool (torus).
		Operator manually opened main-steam relief valves; then closed as pressure came back to desired range.	Pressure decreased to 850 psig; then rapidly increased to 1,080 psig.
		Attempts to place RCIC in service were unsuccessful from control room or backup control panel.	Valve 71-2 (steam supply to turbine) was apparently the only valve loss on RCIC but rendered it inoperable...This valve was later opened by use of temporary power. The HPCI was previously rendered inoperable by loss of valve controls.
~ 1259	Reactor water level decreasing due to almost constant blowing down to the torus.	The only water input left with the capability to overcome a pressure above ~ 350 psig was the control rod drive pump; it was increased to the maximum.	
	Torus cooling became essential.	ASE was unsuccessful in placing emergency power on RHR valves at local MOV board. (Those valves required for torus cooling.)	RHR system was unavailable for torus cooling as a result of electrical board losses.
		Shift engineer and two electricians making attempts to restore 480-V 1A and 1B reactor MOV boards and 250-V D.C. boards.	
1300	4-kV SD board C undervoltage shutdown bus 2 undervoltage. (As noted on electrical printer.)		4-kV voltage continued to be supplied to SD boards A and B by shutdown bus 1. Shutdown boards C and D transferred to D/G's C and D.

*MOV - Motor operated valve

Time	Event	Action	Response or Nonresponse
1320	SD bus 1 undervoltage.		A and B D/G's tied onto their respective boards. The A and B diesel generators were running and up to speed prior to this but had not received an undervoltage signal to close them onto their boards until this event. This placed all the 4-kV shutdown board equipment upon the diesel generators.
1321	Process computer lost.		No further printout until ∿ 1600 hours.
∿ 1330	Decision made to depressurize reactor by blowing down to torus.	Manually opened 4 main-steam line relief valves. Checked condensate booster pumps running. Reactor feed pump bypass valve 3-53 checked opened ready to admit water from condensate system.	Reactor pressure decreased; water level decreased. Reactor water level dropped from normal 201 inches above top of active fuel to 48 inches above top of active fuel.
∿ 1334	Shutdown bus 2 transferred. (In maintaining a normal configuration on the plant electrical system, the 4-kV shutdown boards will be lined up to feed from the unit or offsite source feed. This allows the diesel generators (D/G's) to be a highly reliable backup, giving two sources of voltage should the need arise.)	Manually initiated by ASE by normal procedure of synchronizing the D/G's with the SD bus; then dropping off D/G feed to the SD board.	Bus 2 energized from unit 2. A,B, and D SD boards transferred to SD bus 2. D/G's remained on running standby.
	Shutdown bus 1 continued to be deenergized.	ASE was unsuccessful in an attempt to manually energize.	
	Shutdown board C remains energized from C D/G.	ASE was unsuccessful in an attempt to manually change C SD board feed from D/G to shutdown bus 2.	Breaker stayed closed for 5 to 10 seconds; then opened. Feed transferred back to D/G.
	D shutdown board deenergized for ∿ 5 minutes.	ASE reenergized D board.	D board remained feeding from shutdown bus 2.
∿ 1345	Restored unit preferred from unit 2.	ASE manually transferred.	Unit preferred back on both units.
	Reactor steam pressure decreased to 350 psig.	From continued manual operating of relief valves.	Reactor water level increasing as a result of condensate booster pump input.
∿ 1355	Water level approaching normal.	Attempted to throttle the feedwater bypass valve 3-53.	No response on feedwater bypass valve 3-53.

Time	Event	Action	Response or Nonresponse
~ 1357	Water level going high.	AUO dispatched to bypass valve. Manually closed down on valve.	Restored level to approximately normal.
	Outgoing (PAX) phones and page inoperable for some time.	All operations requiring control room monitoring set up on a periodic in-call basis.	
~ 1400	Reactor steam pressure at 200 psig.	Operator maintaining reactor steam pressure through four relief valves and level control through RFP bypass and CRD pumps. This had to be controlled via phone communication since the paging system was inoperative.	
	480-V SD boards A and B restored.	ASE manually initiated.	Boards appeared heavily loaded as indicated by loud "humming." Boards remained in service.
		ASE tried to restore reactor 480 MOV boards A and B and reactor 250 MOV boards A and B.	Initially unsuccessful.
	Off-duty maintenance personnel began reporting.	Electricians and operators working to restore these electrical boards by isolating faulted circuits.	Restored approximately two hours later.
~ 1448	Voltage lost to 4-kV shutdown board C.		There was no control room indication of this condition.
	B D/G found tripped with field breaker open.	ASE closed field breaker on B D/G and brought back to running standby.	
~ 1500	Attempt made to align one RHR system up for torus cooling and the other for SD cooling.	Four AUO's working in pairs using breathing air packs. Made two entries, but insufficient air supply aborted attempts.	
~ 1527	Voltage restored to C shutdown board.	ASE found C D/G running at approximately 1/2 speed. Brought D/G to synchronous speed and closed breaker to board.	C shutdown board was deenergized. C shutdown board was also lost from 1545 to 1557. However, at ~ 1630 C D/G was tied onto the board, its breaker tripped, and prevented C D/G from being used.
~ 1600	RHR system 1 aligned for torus cooling.	Decision made not to start in this condition since it could not be established that system was charged with water.	This system was subsequently checked for proper alignment and charge and placed in service later.

Time	Event	Action	Response or Nonresponse
~ 1630	480-V reactor MOV board 1A reenergized.	Result of electrician and operator action.	Energized electrical board allowed main turbine to be placed on turning gear and reactor protection system MG set A to be placed in service which energized trip channel A. Restored power to 1/2 of the process monitoring. Restored power to those ECCS valves feeding from that board, etc.
	Valve restoration to ECCS equipment.	By operator interview, it has been established that the following procedure was used in valve operation where valves were not operable from the control room. Placed select switch in emergency position at the electrical board, ran valve to desired position, reopened breaker, immediately returned to control room and established fact that level was not affected by possible electrical fault misalignment. Tagged valve control switch on unit control board showing valve position. This was a safeguard against draining the vessel down.	Level remained normal.
		ASE observation of conditions as appeared on panel 9-3 in control room.	Core spray loop I A and C pumps appear operable from unit control board. All valves and both pumps had indicating lights. Core spray loop II had a few valves that were inoperable. RHR loop II had a few valves available. RHR loop I--same.
~ 1640	Request to start reactor building exhaust fan to remove smoke and fumes.	Started locally from 480-V reactor building vent board.	Fan responded normally. Dampers controlled manually at the damper.
~ 1700	Request to stop reactor building exhaust fan as airflow appeared to aide fire.	Stopped locally by operator.	Fan stopped.
~ 1800	Relief valves inoperable by remote manual control from benchboard due to loss of instrument and control (I&C) voltage to solenoid in air supply to diaphragm valve in air header to primary containment.	Operator observed lights indicated relief valves open. Other indications suggested that valves were closed. Restarted drywell air compressor. Craftsmen bypassed solenoid valve to provide control air supply to primary containment equipment.	Reactor pressure increasing from 200 psi. The compressor started but discharge isolation prevented airflor to primary containment and relief valve control. Allow relief valve remote manual operation at 2150 hours.

Time	Event	Action	Response or Nonresponse
~ 1900	Decision made to restart the reactor building exhaust fan.	Manually initiated.	Remained in service.
	PAX telephones restored to unit control room.	ASE cleared problem on phones.	Gave control room the capability to call out.
~ 2008	High torus level from earlier blowdown.	Manually aligned and started RHR drain pump to main condenser hotwell.	Torus level decreased. Hotwell level increased.
~ 2040	Venting drywell via standby gas treatment systems to plant stack. Pressure was about 2.5 psig.	Steamfitters manually opened 2-inch vent to standby gas treatment system.	Drywell pressure decreasing.
~ 2150	Relief valves operable by remote manual control.	Switch left in open position anticipating voltage return. Manually operated relief valves to reduce reactor pressure.	Reactor pressure decreasing from 550 psig maximum.
~ 2200	Secondary containment reestablished.	Operator stationed at reactor building entrance.	Shift engineer approval before entering required. Breathing apparatus required.
~ 2230	ASE made attempt to prove D D/G operable from electrical control board in the control room.		Could not be operated from control room.
		ASE synchronized to D 4-kV shutdown board, locally, picked up load, placed on standby.	Could be used if needed by operating from D shutdown board.
3/23/75 ~ 0000	Need for flushing RHR system II prior to placing in shutdown cooling.	Existing procedures could not be used under present circumstance. Two senior reactor operators approved temporary flushing procedure.	System flushed and placed in service at 0410.
~ 0100	Two source range monitors placed in temporary service located on the reactor side of the fire.	Licensed reactor operator stationed at these monitors in the area of unit 1 drywell continuous air monitor unit.	Established capability to monitor core. 10 counts per second reading on monitors.
~ 0130	Torus cooling continues to be a necessity as blowdown continues.	Valves aligned manually by operators and system placed in service.	Decreasing torus temperature.
~ 0212	Torus level instrumentation in service.		Level indicated +1". (Normal level is indicated as 0 with a deviation of + or - 5".)
~ 0245	Restoration of equipment had progressed to the point that A and C core spray pumps could be tested from panel 9-3 in unit control room.	Operator action from unit control room.	Pumps and injection valves operable, thus giving part of the ECCS equipment available if needed.
~ 0410	Shutdown cooling achieved by normal flow path.	Manually aligned system.	Allowed operator control of vessel temperature.

BROWNS FERRY UNIT 2

SEQUENCE OF
SIGNIFICANT OPERATIONAL EVENTS
AT TIME OF FIRE

Time	Event	Action	Response or Nonresponse
3/22/75 Prior to 1300	Initial Condition	Routine Operation	Unit Load 1,100 MWe
~ 1300	4-kV Shutdown bus 2 deenergized (relay action).		Lost reactor protection system (RPS) motor generator (MG) set 2B; 1/2 scram on RPS giving red lights on panel 9-5; reactor recirculation pump automatically decreasing reactor power. Lost voltage to instrument and control bus B. Lost indicating lights on system I residual heat removal (RHR) and system I core spray - alarms on RHR and core spray "start," "overcurrent," "pump trip."
	Operator observed decreasing reactor power indication and many scram alarms on control panel.	Operator placed reactor mode switch in "shut-down" and inserted nuclear instrumentation (source and intermediate range).	Reactor scrammed inserting all control rods.
~ 1301	Reactor water level dropped and returned to normal (normal reaction from trip).	Tripped reactor feed pumps A, B, and C - Tripped turbine. Tripped exciter field breaker and opened generator motor-operated disconnects (MOD's).	Equipment response normal.
1308	Main-steam isolation valves (MSIV) closed.	Operator initiated reactor core isolation cooling (RCIC) for level control; initiated high pressure cooling injection (HPCI) for heat sink. Manually initiated relief valves for pressure control.	Equipment response normal. After this start and before ~ 1415 RCIC and HPCI tripped several times from high reactor water level. Neither of these could be restarted with the controller in "manual." Operator was unable to get any signal from the subpanel control in "manual." Pumps would start with controller in "automatic." At ~ 1345 HPCI was restarted and brought to ~ 3/4 speed. It held for about 1 minute. The speed then dropped off with no further response from HPCI; thereafter it was unavailable.

Time	Event	Action	Response or Nonresponse
~ 1320	Lost remote manual operability of relief valves depriving operator of ability to reduce reactor pressure below set point. Torus temperature increasing due to relief valve discharge into torus.	Unit 2 assistant shift engineer made an attempt to operate relief valves from backup control panel but was unsuccessful. Placed the following pumps in service to establish torus cooling: D RHR pump, D2 RHR service water pump, and D1 emergency equipment cooling water pump.	Relief valves continued to lift on pressure. Maintaining reactor pressure at 1030 psig and below. Torus cooling established at ~ 1330. Torus temperature did not exceed 135° F.
~ 1400	Reactor depressurizing apparently from a relief valve that had lifted on pressure and stuck open.	No indication of coolant leak, and pressure decreasing at desired rate.	Reactor pressure decreasing at desired rate: 150 psig at 1500 65 psig at 1900 10 psig at 2040
~ 1415	Pressure starting to decrease. Remote manual operability of relief valve restored.	Placing the condensate system in service. Maintenance and operations personnel working during this period of non-operation checking the instrument and control (I&C) voltage to solenoids, drywell air compressor for proper operation and cutting in the backup control air supply. It is uncertain which of these operations reestablished remote operability of relief valves.	Anticipating the pressure level that reactor vessel could be supplied from that source. Gave operator discretion on relief valve operation.
~ 1430	Loss of some reactor water level instrumentation.	Determined that level indicator 362 appeared to be reliable and that 2 Yarway level indicators in backup control center corresponded with this indication.	Reactor water level never decreased below 160" above the top of the active fuel. Other level indication began to respond at ~ 1450.
~ 1450	Torus level increasing due to relief valve discharge.	Manually aligned RHR drain pump to transfer torus water to condenser hotwell.	Torus level never increased above + 5".
~ 1557	Voltage restored to C shutdown (SD) board.	Restored power to 480-V SD board 2A by manual operator action. Started B2 RHR service water pump on. Started B RHR pump on. Placed turbine on turning gear (T.G.)	These power supplies allowed turbine to be placed on T.G. and B RHR pump to be tested.
~ 2010	Condenser heat sink available. Allowed use of turbine bypass valves to reduce pressure.	Cleared up electrical trouble with mechanical vacuum pumps and established vacuum in main condenser.	Vacuum above 7" Hg allowing opening of turbine bypass valves for steam admission.
~ 2020	Torus temperature within limits; shut down torus cooling to allow flushing of lines for reactor shutdown cooling.	Aligned valves and flushed system II priot to placing system II in reactor shutdown cooling mode.	
~ 2045	Reactor pressure at 10 psig.	Opened reactor headvents.	
~ 2240	Reactor in shutdown cooling using RHR system II.	Manually aligned system.	Shutdown cooling achieved by normal flow path.

TABLE 7
SHEET 2 OF 2

TVA 64 (OS-9-68)

UNITED STATES GOVERNMENT

Memorandum

TENNESSEE VALLEY AUTHORITY

TO : Preliminary Investigation Committee for Fire at Browns Ferry Nuclear Plant

FROM : James E. Watson, Manager of Power, 818 PRB-C

DATE : March 31, 1975

SUBJECT: ESTABLISHMENT OF COMMITTEE TO INVESTIGATE THE MARCH 22, 1975, FIRE AT BROWNS FERRY

This memorandum will confirm and formalize the establishment on March 23, 1975, of a preliminary committee to investigate the fire at Browns Ferry on March 22, 1975. The committee reported to the site on March 24, 1975. It is composed of the following members:

H. S. Fox, Chairman	- Division of Power Production
M. N. Sprouse	- Division of Engineering Design
Charles Bonine	- Division of Construction
David G. Powell	- Division of Law
Felix A. Szczepanski	- Power Manager's Office, Safety Review Board Staff
Harry S. Collins	- Secretary, Safety Review Board

Your participation on this committee is greatly appreciated and while we recognize that it will in all probability cause you personal hardships, we believe it is extremely important to give the committee your full effort for the immediate future.

Attached is an outline of the committee's assignment. Many of the points covered in the outline have already been addressed but this will confirm the assignment to the committee.

Again, I appreciate your serving on this committee and if I can help you in any way, please let me know.

Attachment

CC: R. H. Davidson, 303 PRB-C
J. E. Gilleland, 831 PRB-C
G. H. Kimmons, 607 UB-K
R. H. Marquis, 629 NSB-K
Nuclear Safety Review Board, 210 PRB-C
H. G. Parris, 403 PRB-C
E. F. Thomas, 716 EB-C

PRELIMINARY INVESTIGATION

of

BROWNS FERRY FIRE

Preliminary Incident Evaluation Committee

Scope

Conduct an early fact-finding investigation into events leading up to, during and after the incident until plant conditions were stabilized. Consider actions of people involved, applicable administrative controls, response and nonresponse of plant systems, alternative measures taken, utilization and adequacy of plant firefighting equipment, assessment of extent of damage, status of plant and plant systems; determine if there were any radioactive releases, radioactive exposure and/or injury to plant personnel, and if so, determine the extent thereof; ensure preservation of adequate incident documentation; and provide a point of reference for other evaluations.

Other Considerations

The committee should:

- Use its discretion in extending its scope and in carrying out its functions to achieve its objectives.
- Recommend and seek approval for additional committee members (i.e., consultants or other TVA members); consider qualifications.
- Make preliminary report to the Manager of Power within two weeks (by April 7).

Membership

Harry Fox (Chairman)	- DPP
F. A. Szczepanski	- NSRB
C. Bonine	- DEC
M. Sprouse	- DED
D. Powell	- Law
H. S. Collins	- NSRB Staff

APPENDIX B

KEY PHOTOGRAPHS OF FIRE AREA

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1. Photograph 86940P - Penetration, Spreading Room Side
2. Photograph 86940A - Penetration, Reactor Building Side
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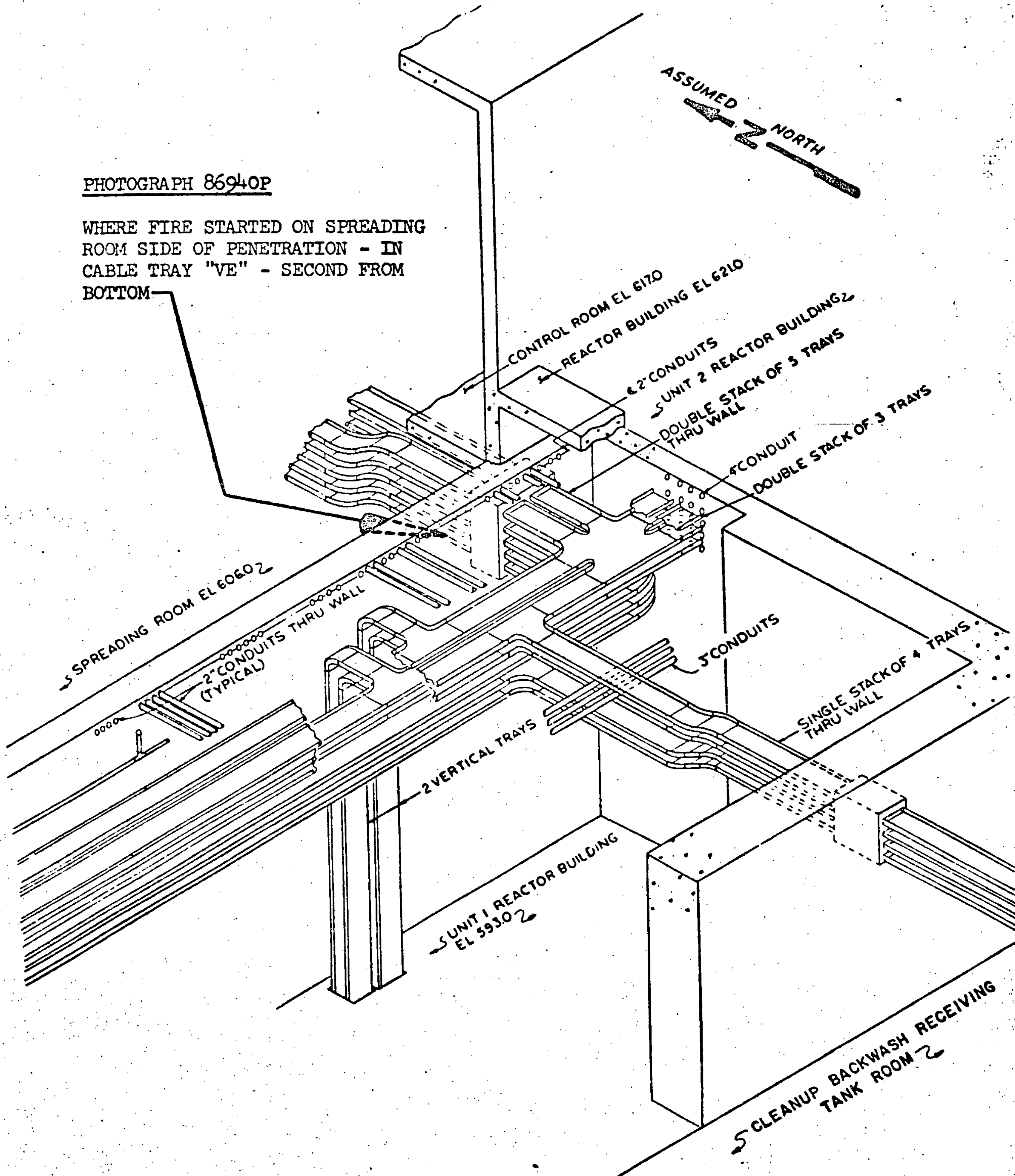
4. Photograph 86940H - Horizontal Trays in Reactor Building, Westward
5. Photograph 86575P - Horizontal Trays in Reactor Building, Eastward
6. Photograph 86575N - Horizontal Trays in Reactor Building at Intersection
7. Photograph 86940I - Horizontal Trays in Reactor Building, Southward
8. Photograph WH-K-86577-B - Penetration at South Wall
9. Photograph 89438K - Conduit Damage
10. Photograph WH-K-86577-C - Penetration, Reactor Cleanup Tank Side


PHOTOGRAPH 86940P
WHERE FIRE STARTED ON SPREADING ROOM SIDE OF PENETRATION - IN CABLE TRAY "VE" - SECOND FROM BOTTOM
ASSUMED NORTH
CONTROL ROOM EL 617.0
REACTOR BUILDING EL 621.0
6 2" CONDUITS
UNIT 2 REACTOR BUILDING
DOUBLE STACK OF 5 TRAYS THRU WALL
4" CONDUIT
DOUBLE STACK OF 3 TRAYS
SPREADING ROOM EL 606.0
2" CONDUITS THRU WALL
2" CONDUITS (TYPICAL)
3" CONDUITS
SINGLE STACK OF 4 TRAYS THRU WALL
2 VERTICAL TRAYS
UNIT 1 REACTOR BUILDING EL 593.0
CLEANUP BACKWASH RECEIVING TANK ROOM

AREA OF FIRE

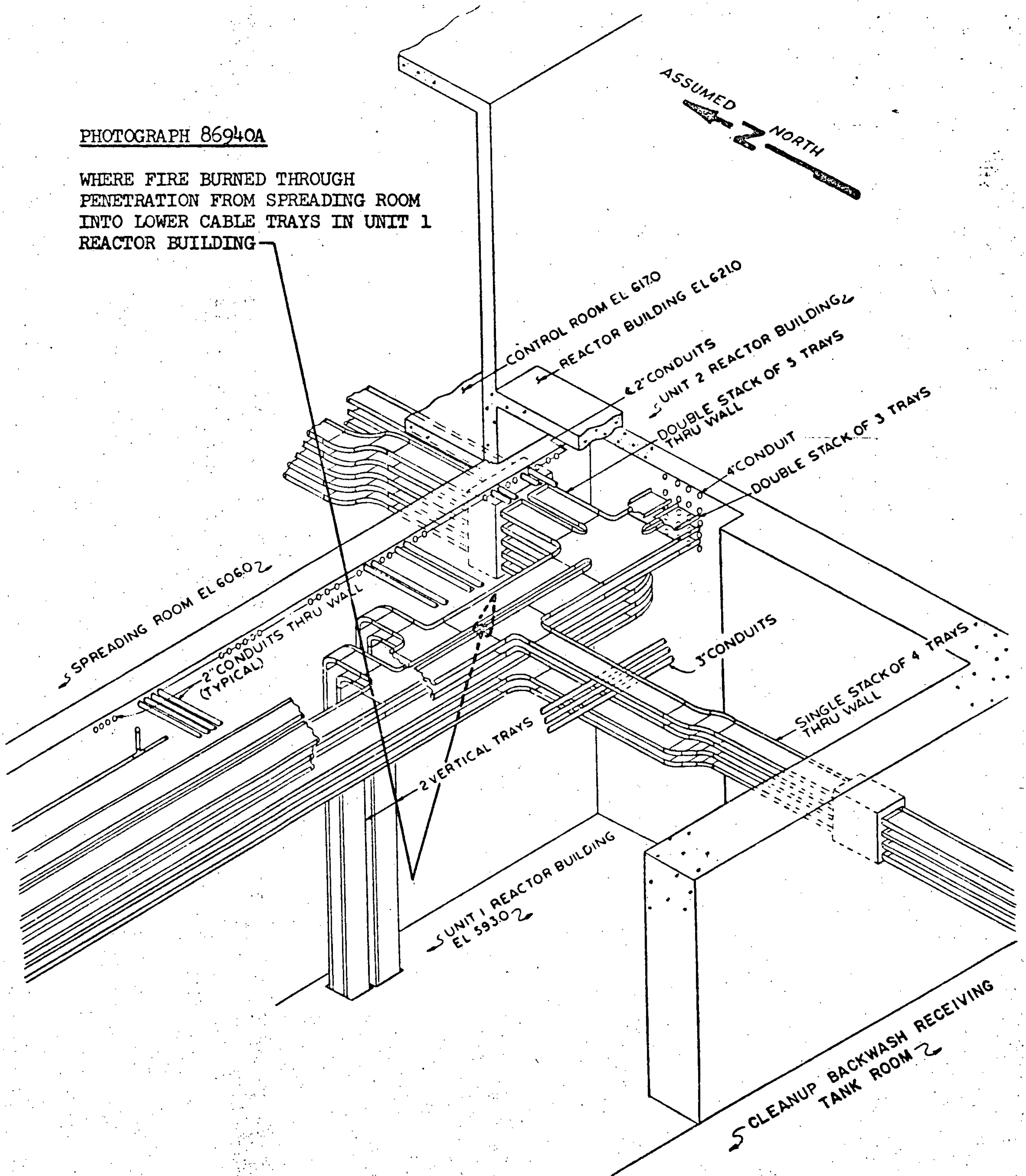
UNION CARBIDE — Y-12 PLANT

Oak Ridge, Tennessee

SEP 2 1975

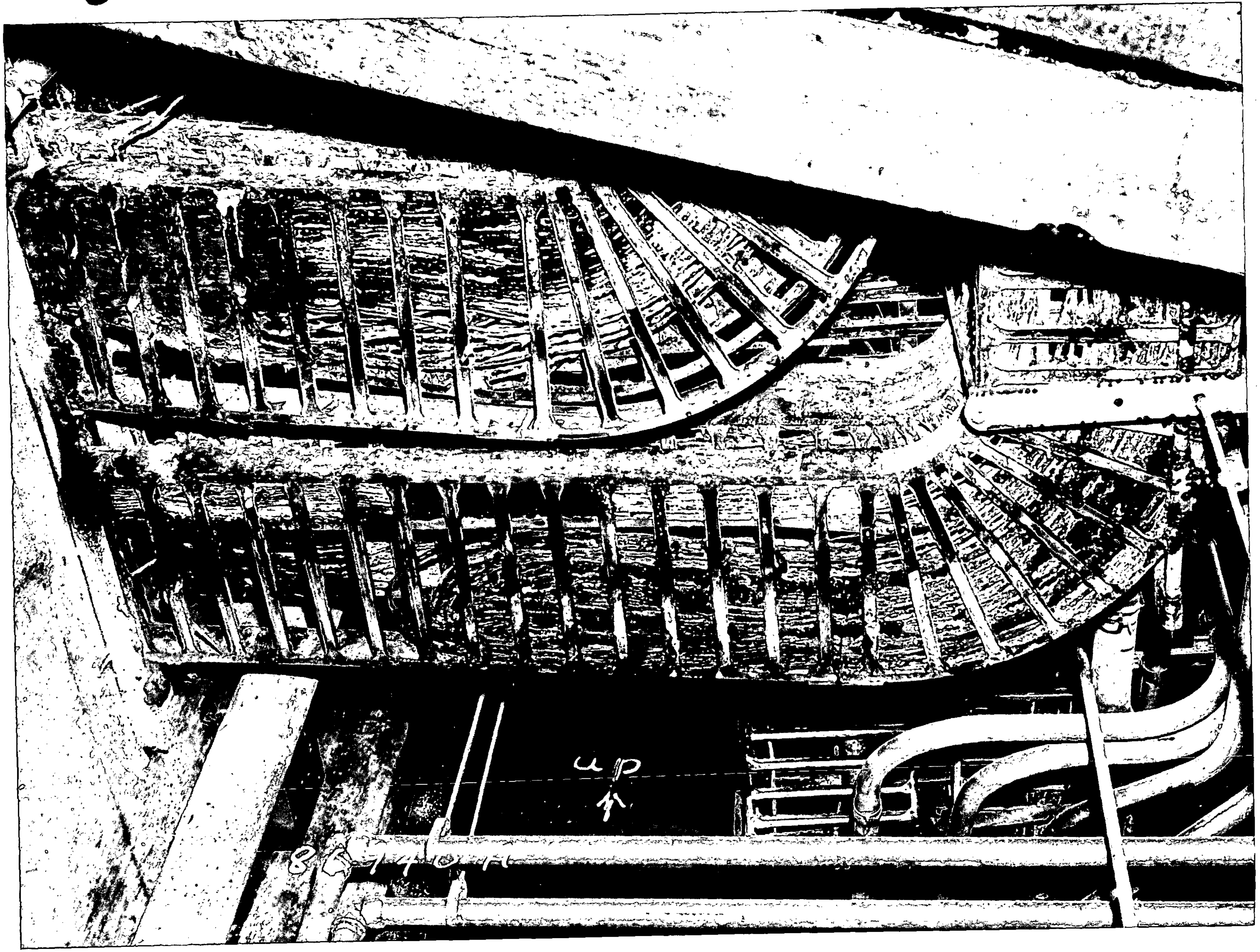
PHOTOGRAPH NO. 162536

AVAILABLE IN: BLACK & WHITE ☑ COLOR ☐



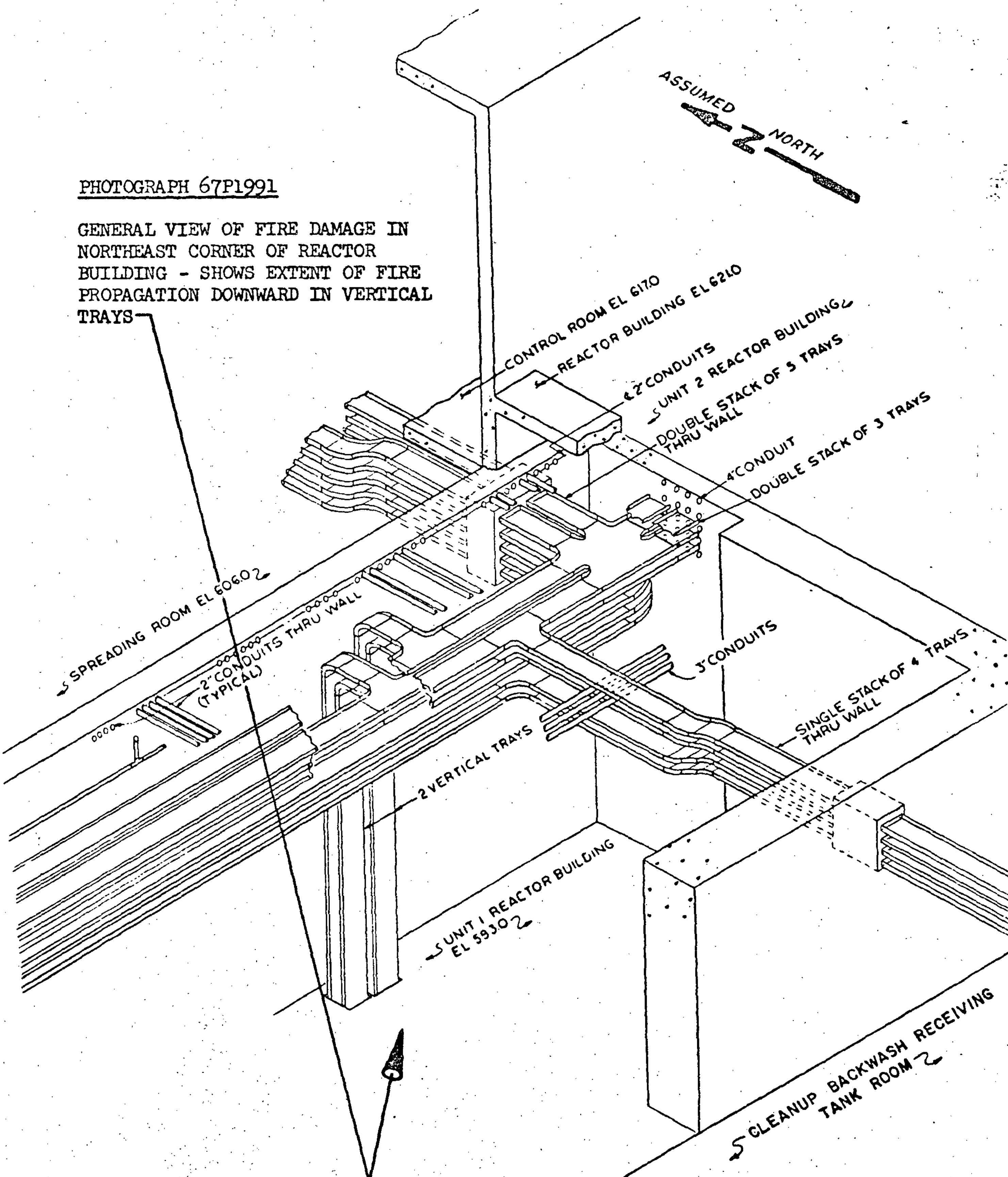
PHOTOGRAPH 86940A
WHERE FIRE BURNED THROUGH PENETRATION FROM SPREADING ROOM INTO LOWER CABLE TRAYS IN UNIT 1 REACTOR BUILDING
ASSUMED NORTH
CONTROL ROOM EL 617.0
REACTOR BUILDING EL 621.0
2-2" CONDUITS
UNIT 2 REACTOR BUILDING
DOUBLE STACK OF 5 TRAYS THRU WALL
4" CONDUIT
DOUBLE STACK OF 3 TRAYS
SPREADING ROOM EL 606.0
2" CONDUITS THRU WALL
2" CONDUITS (TYPICAL)
3" CONDUITS
SINGLE STACK OF 4 TRAYS THRU WALL
2 VERTICAL TRAYS
UNIT 1 REACTOR BUILDING EL 593.0
CLEANUP BACKWASH RECEIVING TANK ROOM

AREA OF FIRE

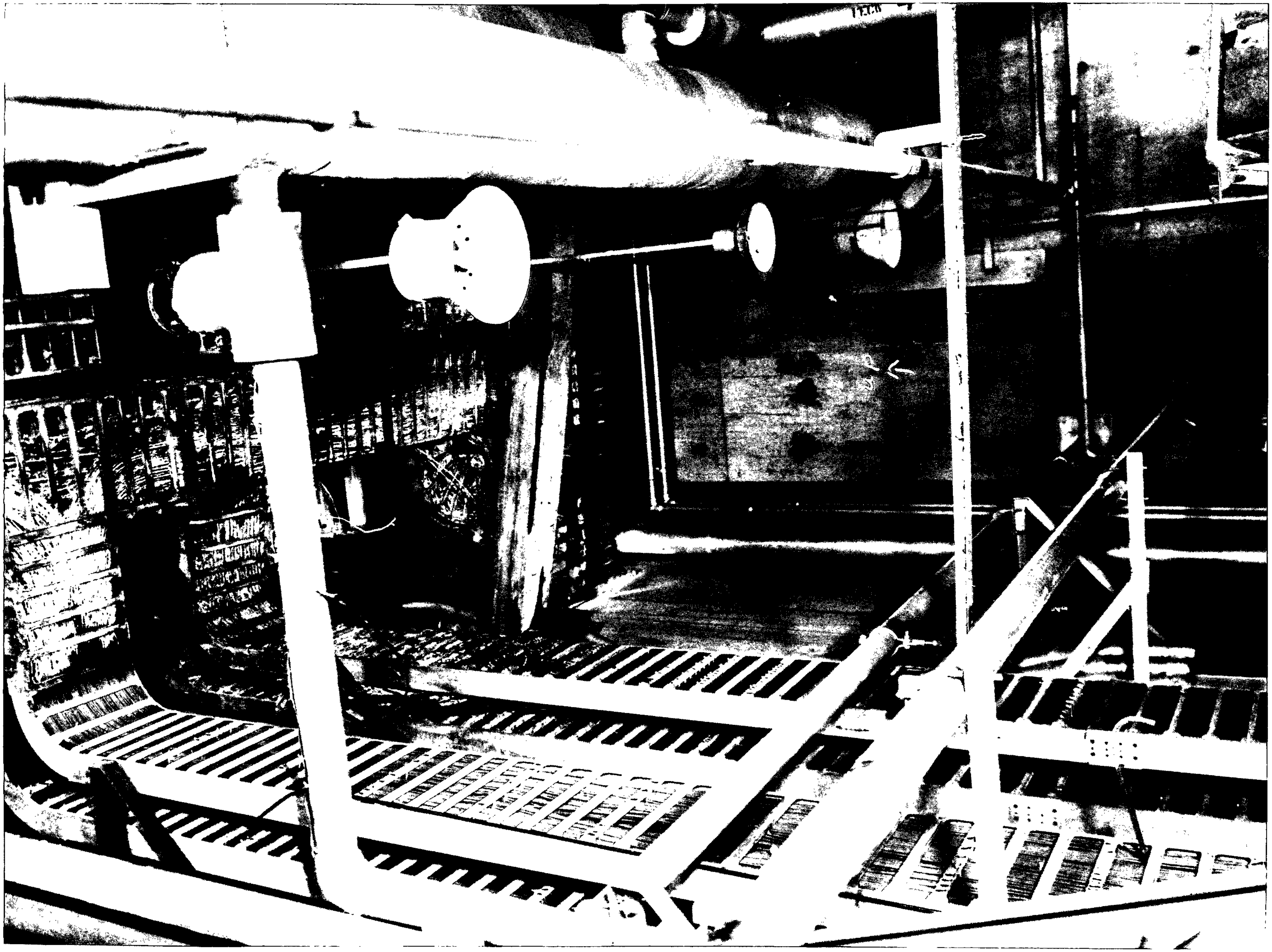

up

PHOTOGRAPH 67P1991

GENERAL VIEW OF FIRE DAMAGE IN NORTHEAST CORNER OF REACTOR BUILDING - SHOWS EXTENT OF FIRE PROPAGATION DOWNWARD IN VERTICAL TRAYS



AREA OF FIRE



UNION CARBIDE — Y-12 PLANT — Oak Ridge, Tennessee

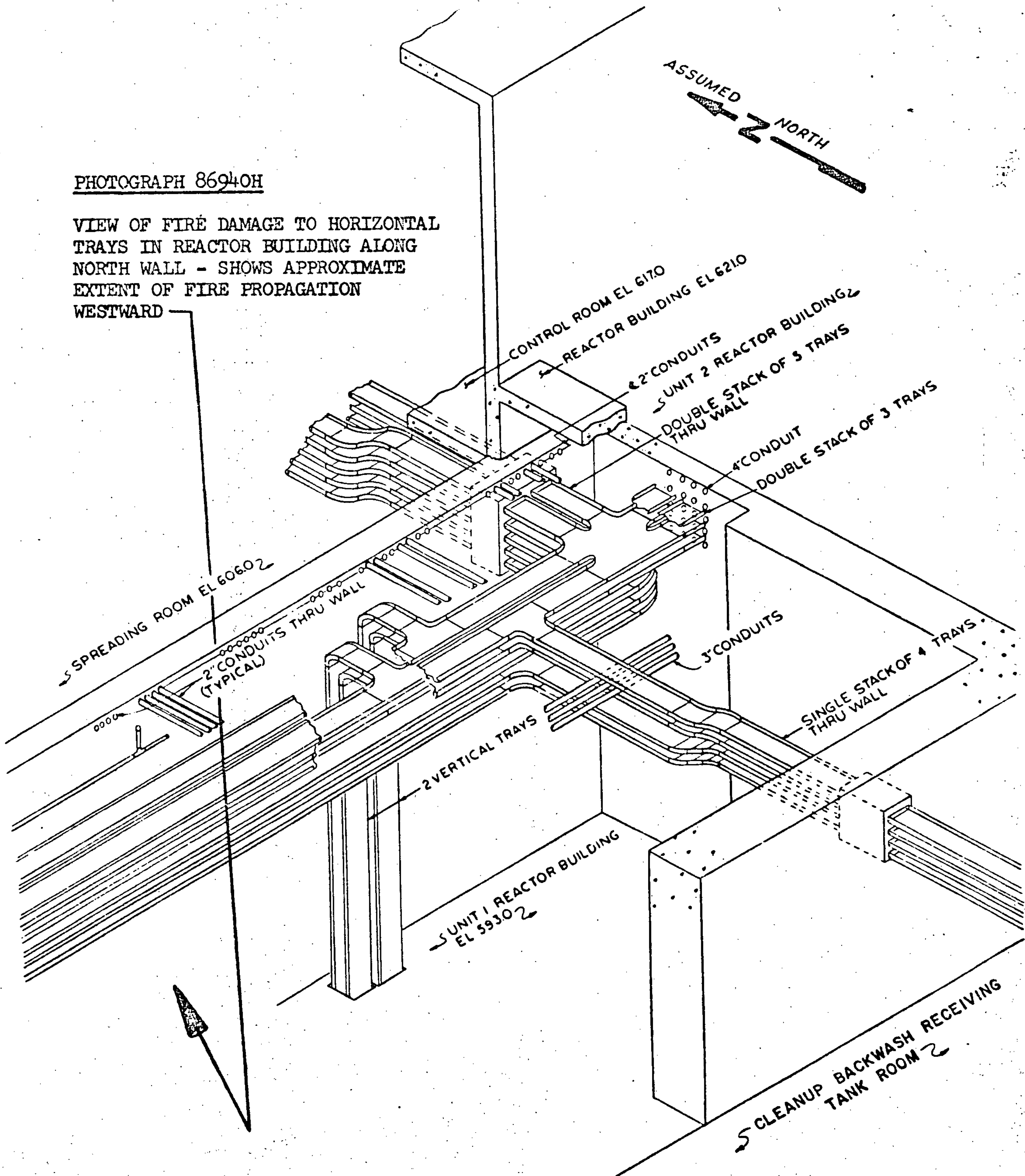
SEP 23 1975

PHOTOGRAPH NO. 162529

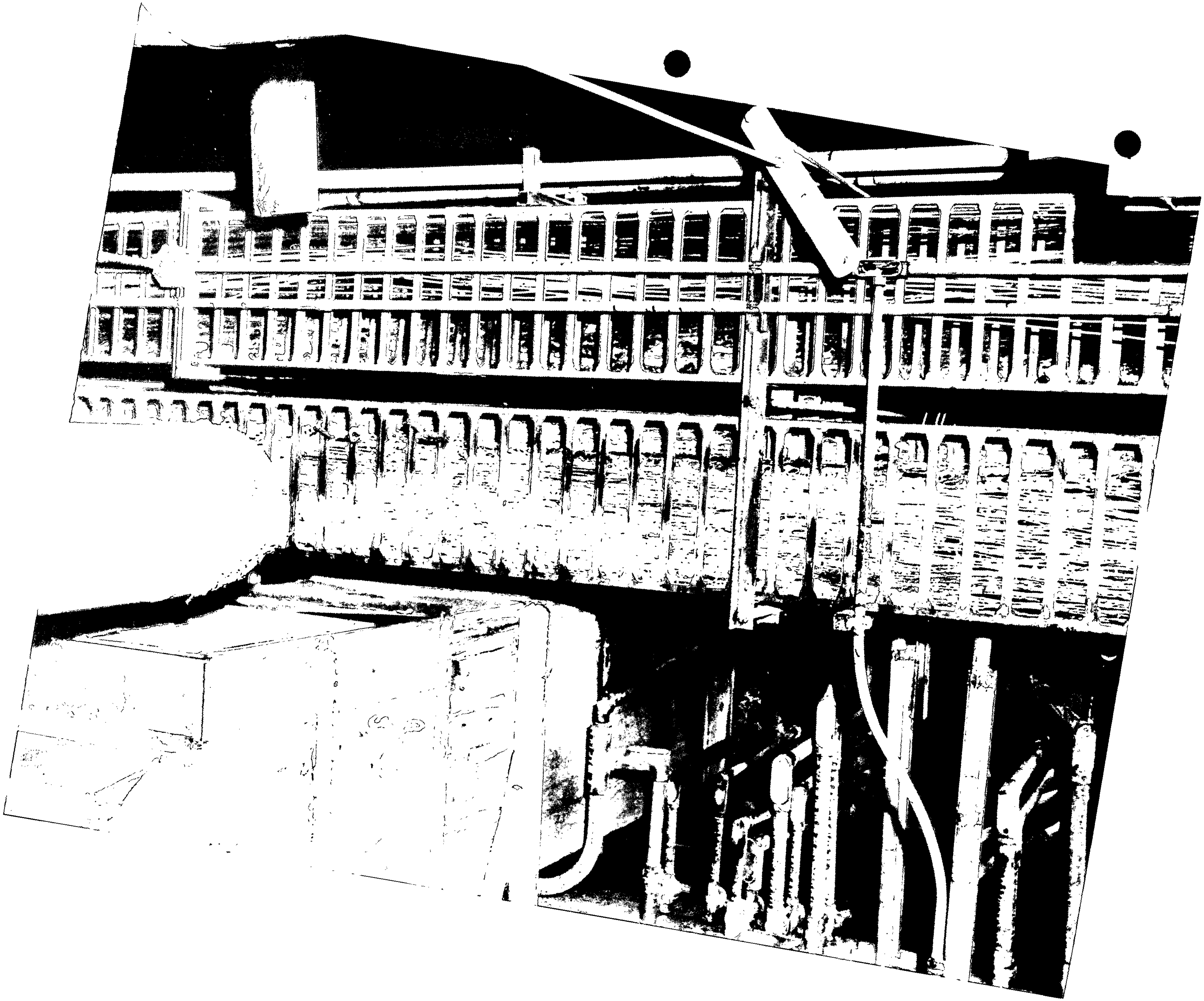
AVAILABLE IN: BLACK & WHITE ☐ COLOR ☐

PHOTOGRAPH 86940H

VIEW OF FIRE DAMAGE TO HORIZONTAL TRAYS IN REACTOR BUILDING ALONG NORTH WALL - SHOWS APPROXIMATE EXTENT OF FIRE PROPAGATION WESTWARD



AREA OF FIRE



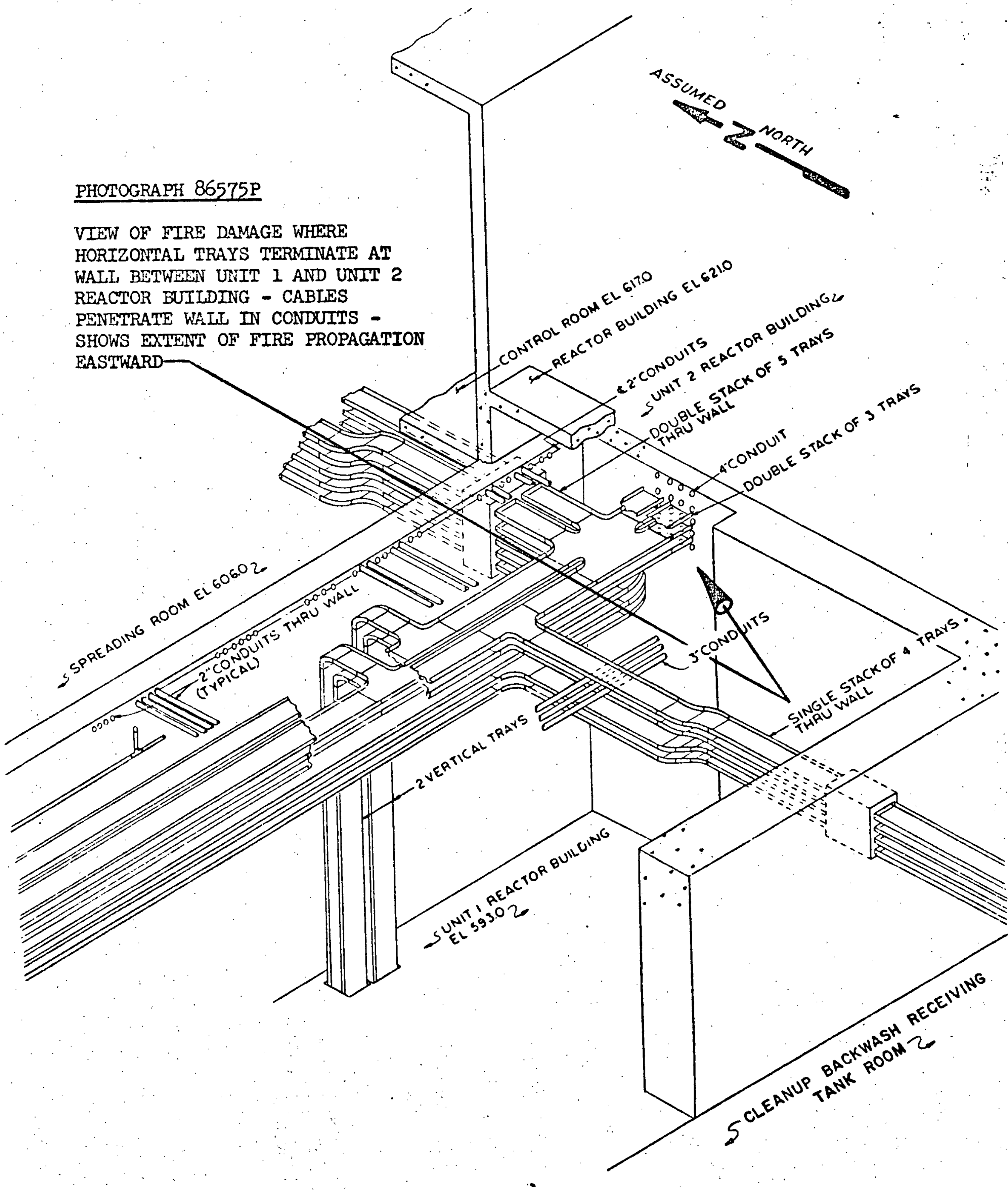
PLANT

Tennessee

SEP

PHOTOGRAPH NO. 162538

AVAILABLE IN: BLACK & WHITE ☐ COLOR ☐


ASSUMED
NORTH
PHOTOGRAPH 86575P
VIEW OF FIRE DAMAGE WHERE HORIZONTAL TRAYS TERMINATE AT WALL BETWEEN UNIT 1 AND UNIT 2 REACTOR BUILDING - CABLES PENETRATE WALL IN CONDUITS - SHOWS EXTENT OF FIRE PROPAGATION EASTWARD
CONTROL ROOM EL 617.0
REACTOR BUILDING EL 621.0
2" CONDUITS
UNIT 2 REACTOR BUILDING
DOUBLE STACK OF 5 TRAYS THRU WALL
4" CONDUIT
DOUBLE STACK OF 3 TRAYS
SPREADING ROOM EL 606.0
2" CONDUITS THRU WALL (TYPICAL)
3" CONDUITS
SINGLE STACK OF 4 TRAYS THRU WALL
2 VERTICAL TRAYS
UNIT 1 REACTOR BUILDING EL 593.0
CLEANUP BACKWASH RECEIVING TANK ROOM

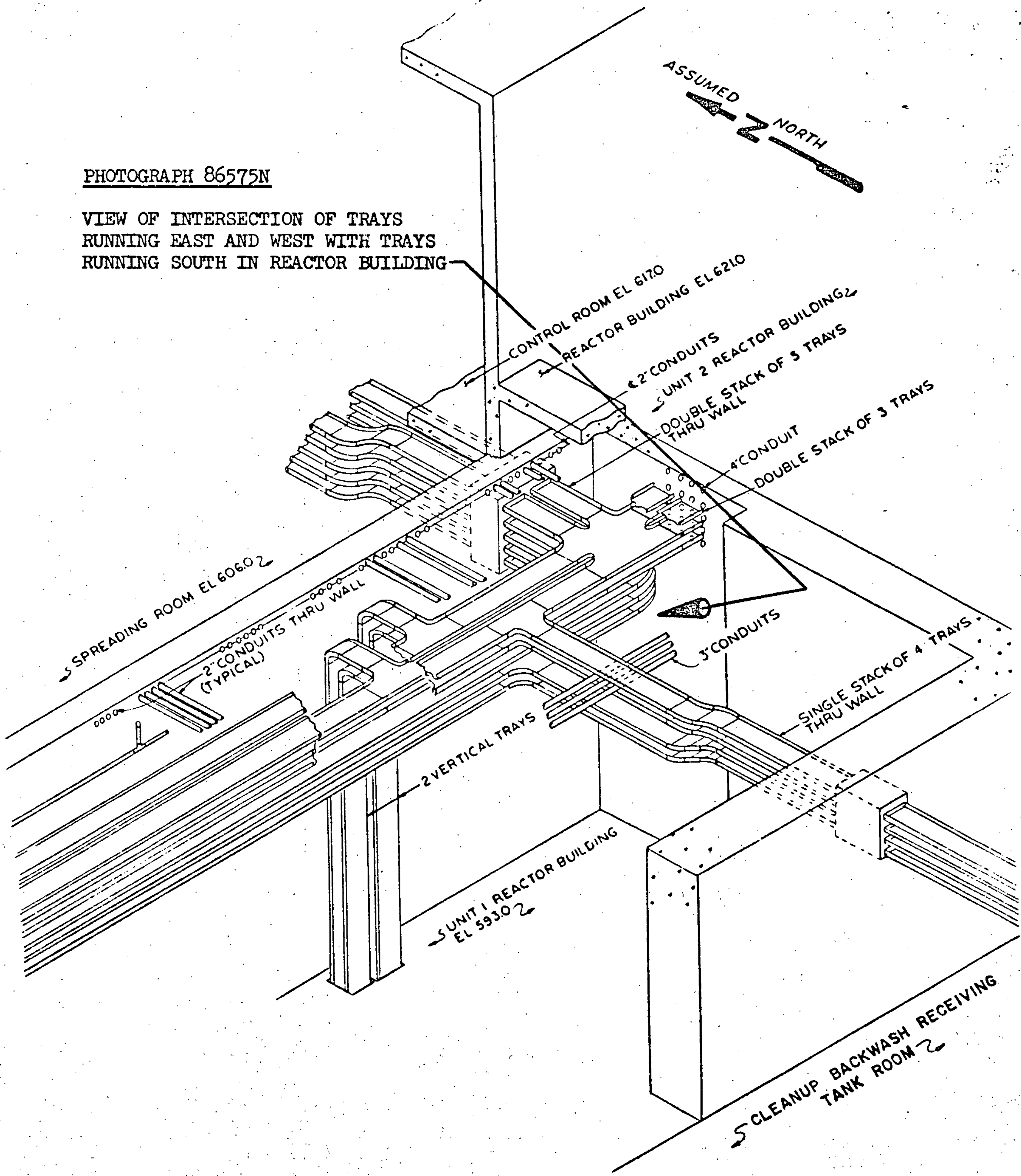
AREA OF FIRE

Y-12 PLANT

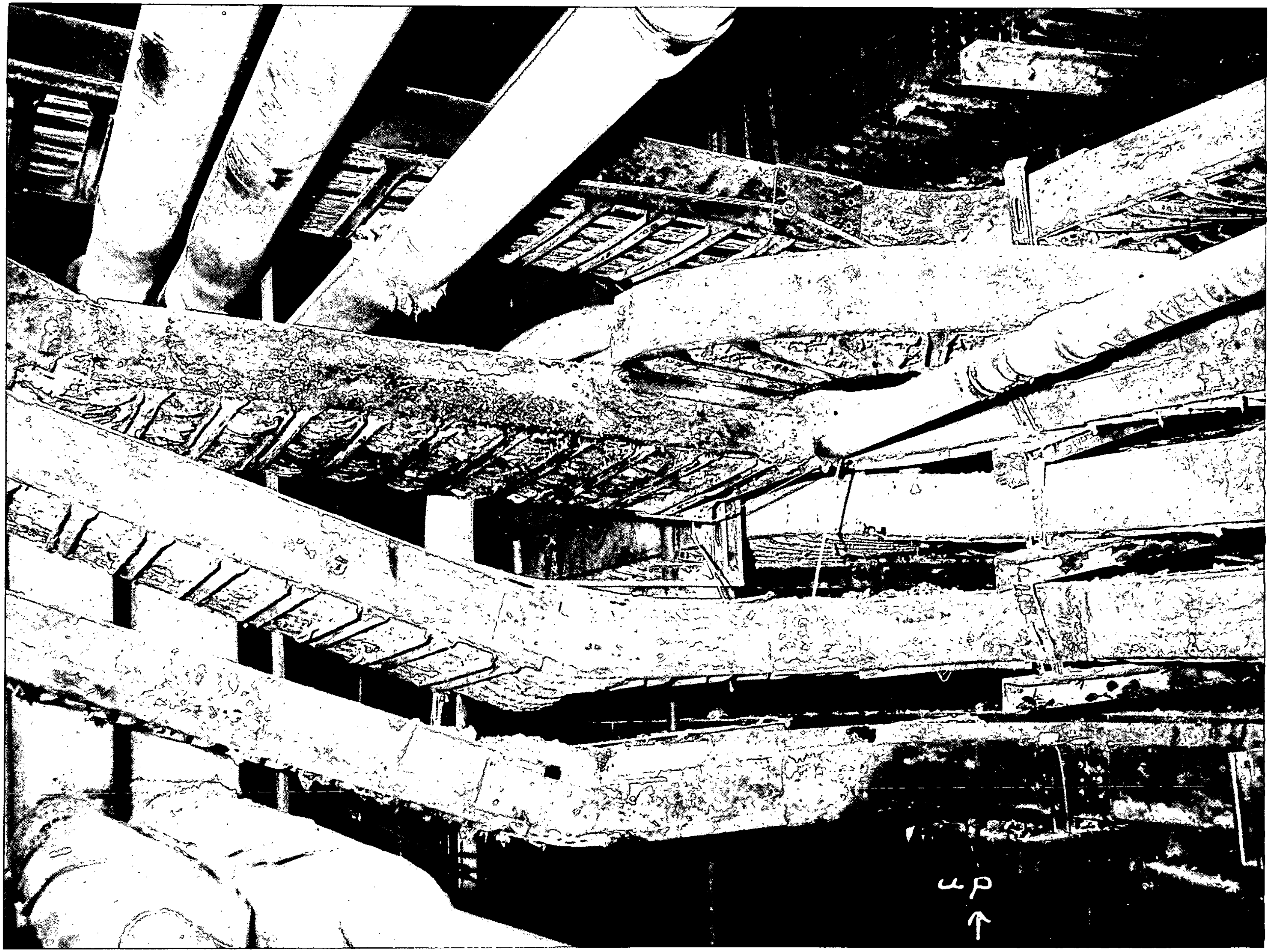
Oak Ridge, Tennessee

PHOTOGRAPH NO. 162530

AVAILABLE IN: BLACK & WHITE ☐ COLOR ☐


PHOTOGRAPH 86575N
VIEW OF INTERSECTION OF TRAYS RUNNING EAST AND WEST WITH TRAYS RUNNING SOUTH IN REACTOR BUILDING
ASSUMED
N
NORTH
CONTROL ROOM EL 617.0
REACTOR BUILDING EL 621.0
UNIT 2 REACTOR BUILDING
℄ 2" CONDUITS
DOUBLE STACK OF 5 TRAYS THRU WALL
4" CONDUIT
DOUBLE STACK OF 3 TRAYS
SPREADING ROOM EL 606.0
2" CONDUITS THRU WALL (TYPICAL)
3" CONDUITS
SINGLE STACK OF 4 TRAYS THRU WALL
2 VERTICAL TRAYS
UNIT 1 REACTOR BUILDING EL 593.0
CLEANUP BACKWASH RECEIVING TANK ROOM

AREA OF FIRE

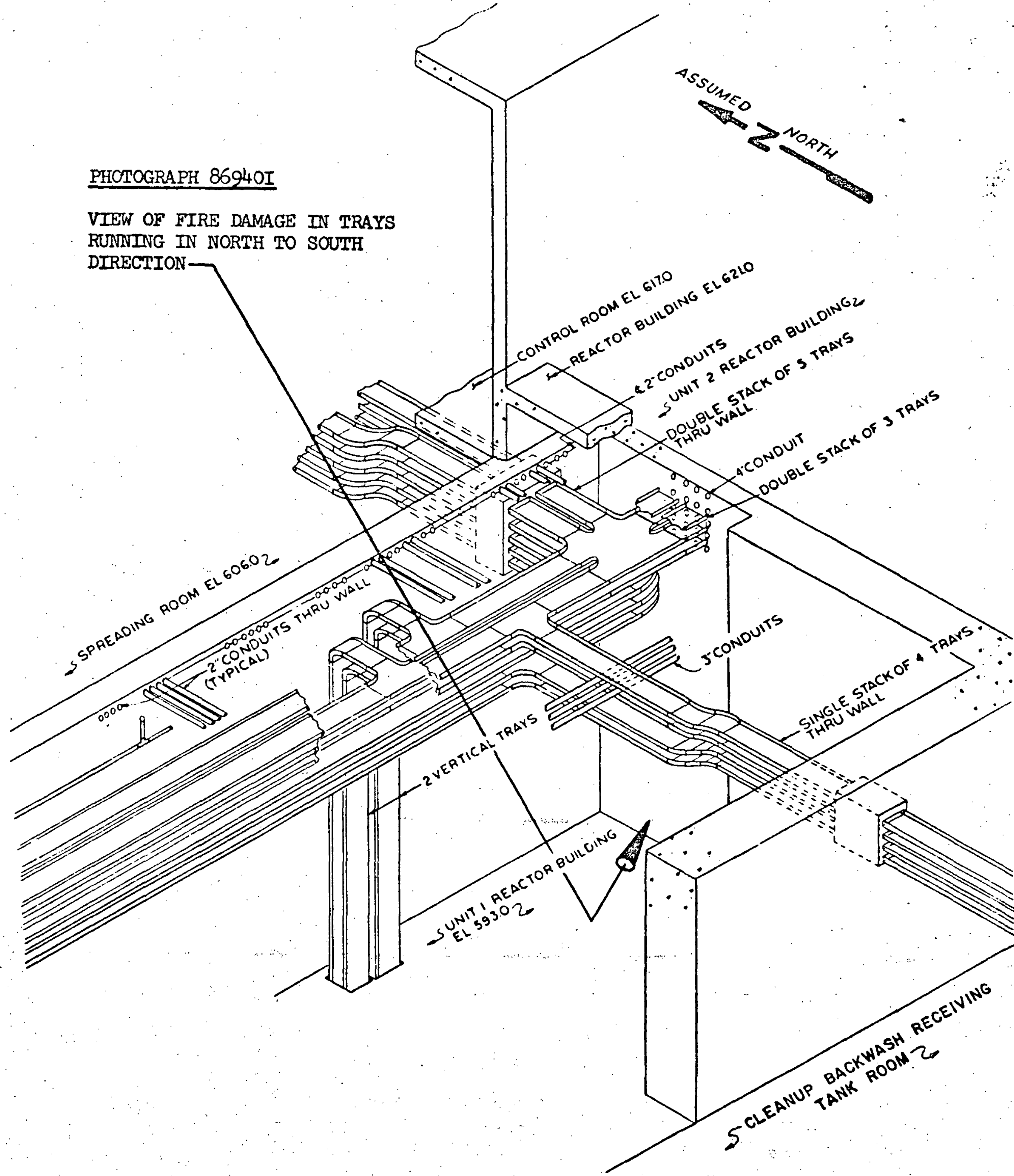

up

UNION CARBIDE — Y-12 PLANT — Oak Ridge, Tennessee

PHOTOGRAPH NO. 162531

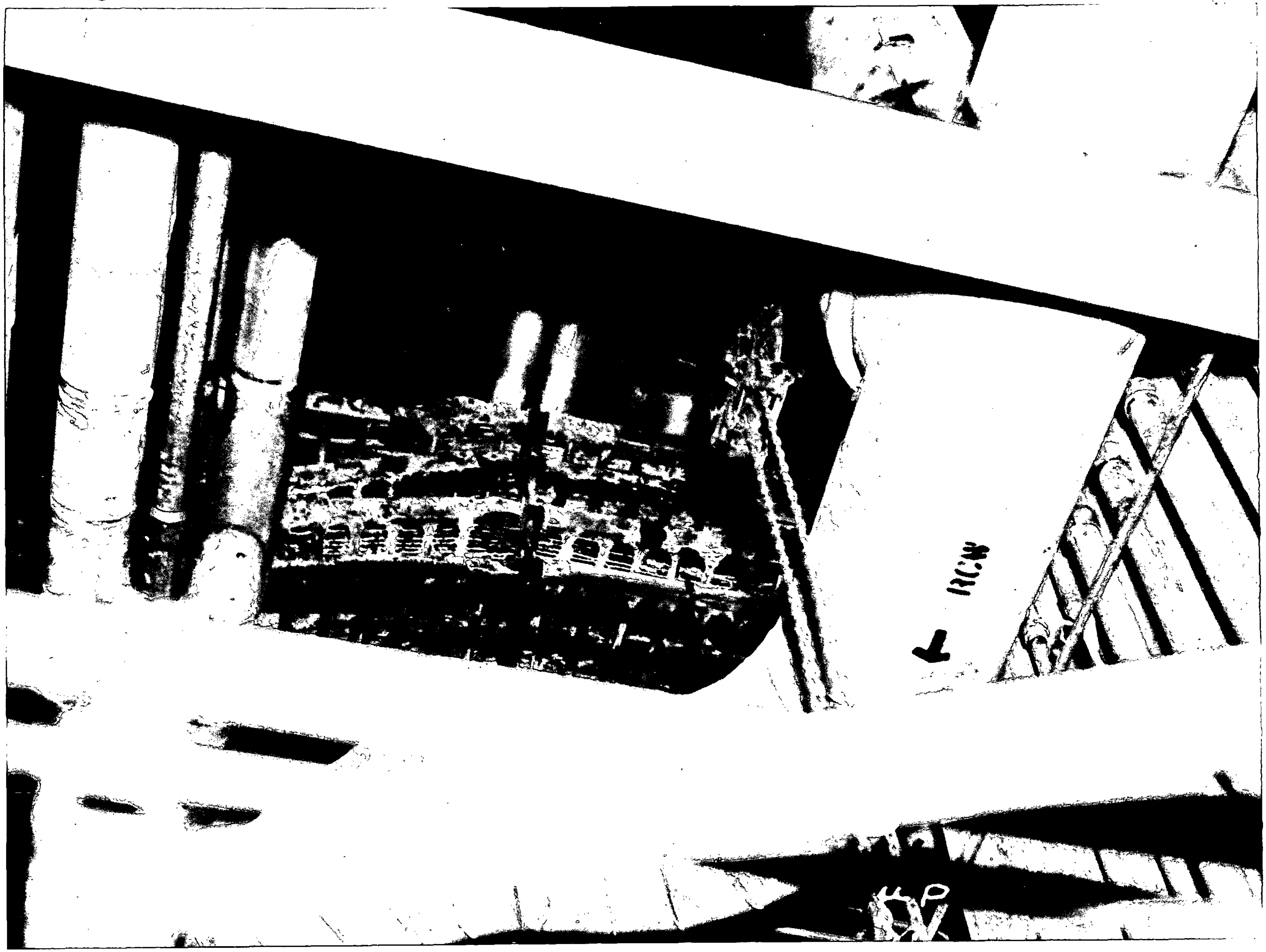
AVAILABLE IN: BLACK & WHITE ☐ COLOR ☐

SEP



PHOTOGRAPH 869401
VIEW OF FIRE DAMAGE IN TRAYS RUNNING IN NORTH TO SOUTH DIRECTION
ASSUMED NORTH
CONTROL ROOM EL 617.0
REACTOR BUILDING EL 621.0
2" CONDUITS
UNIT 2 REACTOR BUILDING
DOUBLE STACK OF 5 TRAYS THRU WALL
4" CONDUIT
DOUBLE STACK OF 3 TRAYS
SPREADING ROOM EL 606.0
2" CONDUITS THRU WALL (TYPICAL)
3" CONDUITS
SINGLE STACK OF 4 TRAYS THRU WALL
2 VERTICAL TRAYS
UNIT 1 REACTOR BUILDING EL 593.0
CLEANUP BACKWASH RECEIVING TANK ROOM

AREA OF FIRE


RCW

Y-12 PLANT

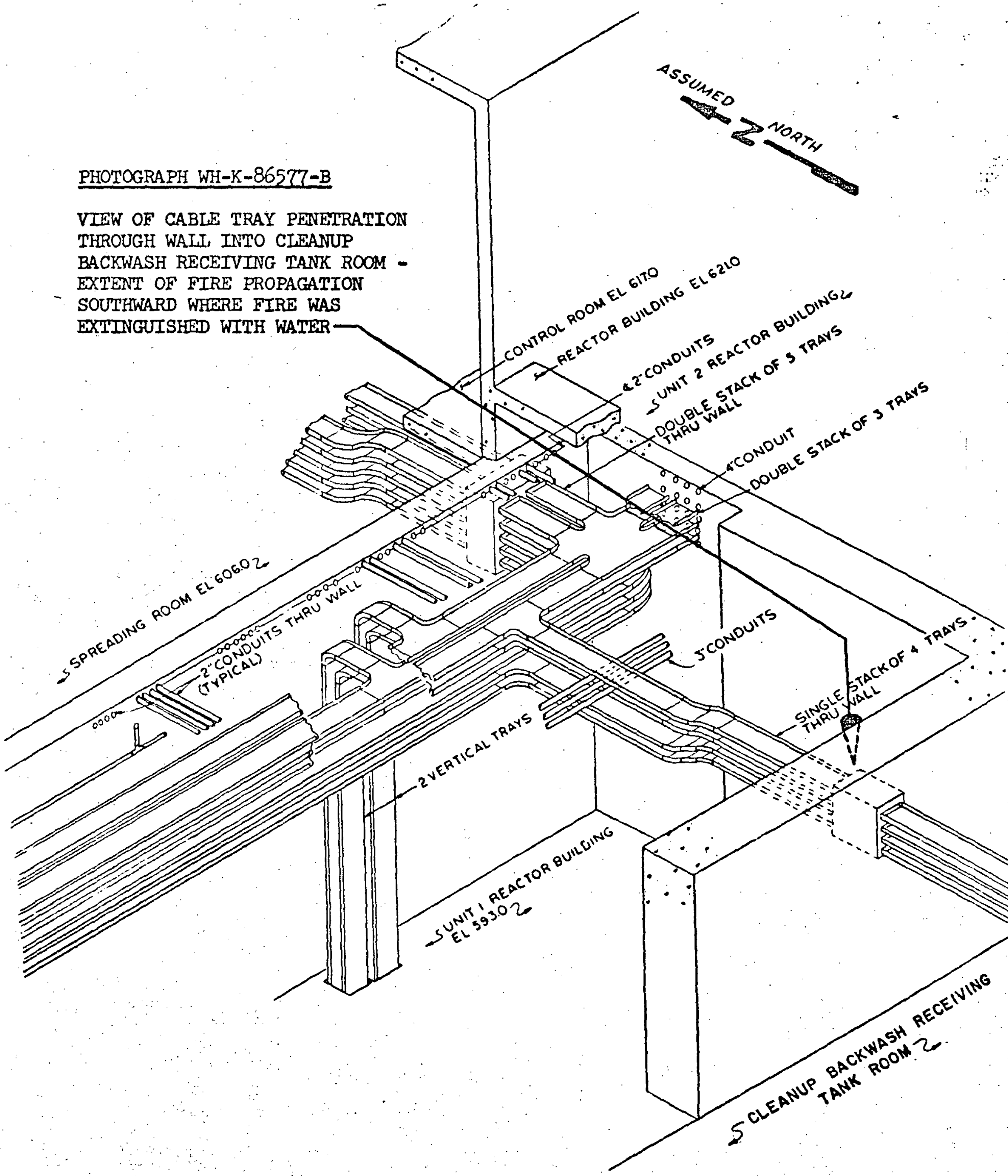
Oak Ridge, Tennessee

PHOTOGRAPH NO. 162532

AVAILABLE IN: BLACK & WHITE ☐ COLOR ☐

PHOTOGRAPH WH-K-86577-B

VIEW OF CABLE TRAY PENETRATION THROUGH WALL INTO CLEANUP BACKWASH RECEIVING TANK ROOM - EXTENT OF FIRE PROPAGATION SOUTHWARD WHERE FIRE WAS EXTINGUISHED WITH WATER



AREA OF FIRE


up

UNION CARBIDE — Y-12 PLANT — Oak Ridge, Tennessee

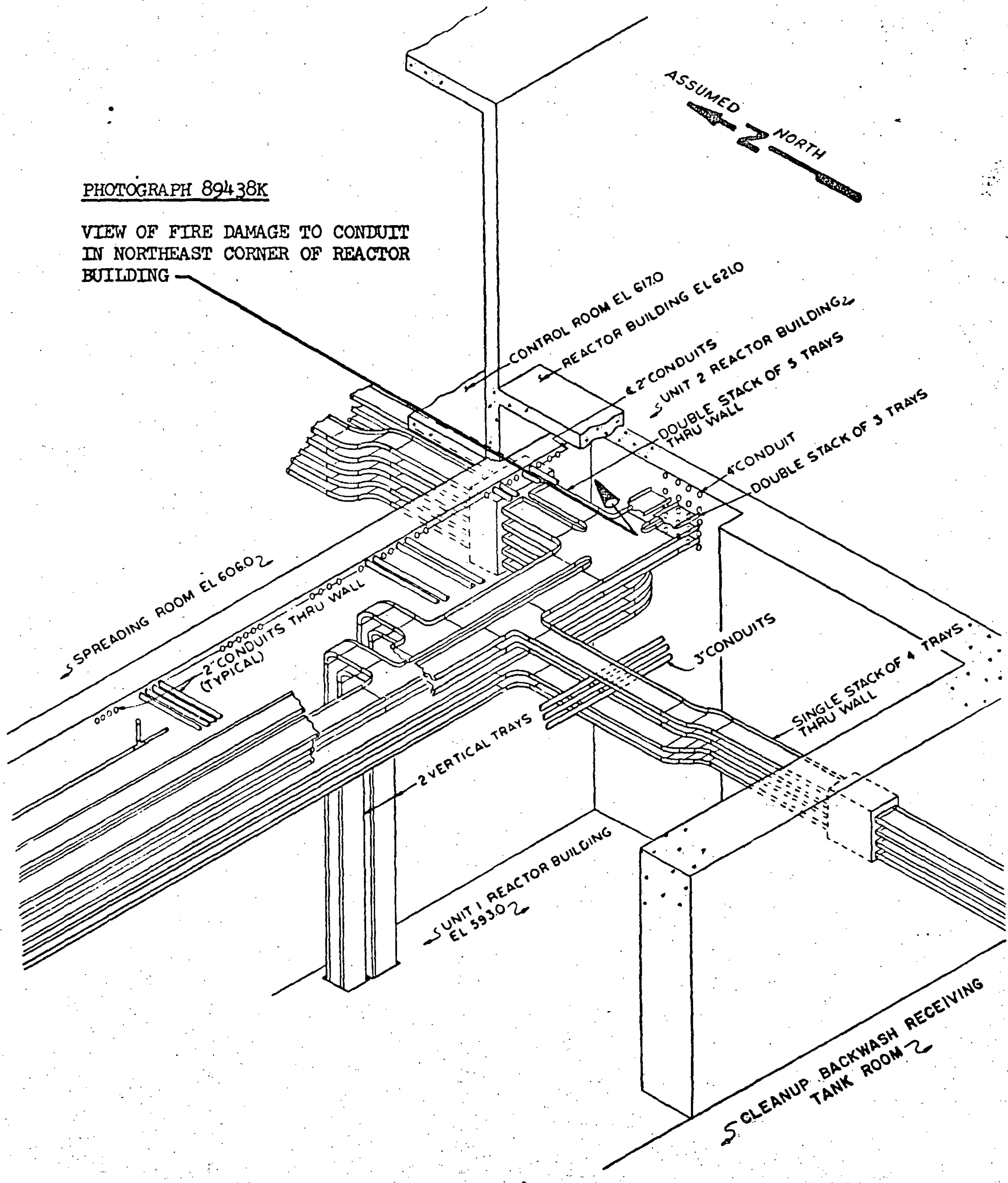
PHOTOGRAPH NO. 162537

AVAILABLE IN: BLACK & WHITE [ ] COLOR [ ]

SEP 26 1975

PHOTOGRAPH 89438K

VIEW OF FIRE DAMAGE TO CONDUIT IN NORTHEAST CORNER OF REACTOR BUILDING



AREA OF FIRE


up

UNION CARBIDE — Y-12 PLANT —

Oak Ridge, Tennessee

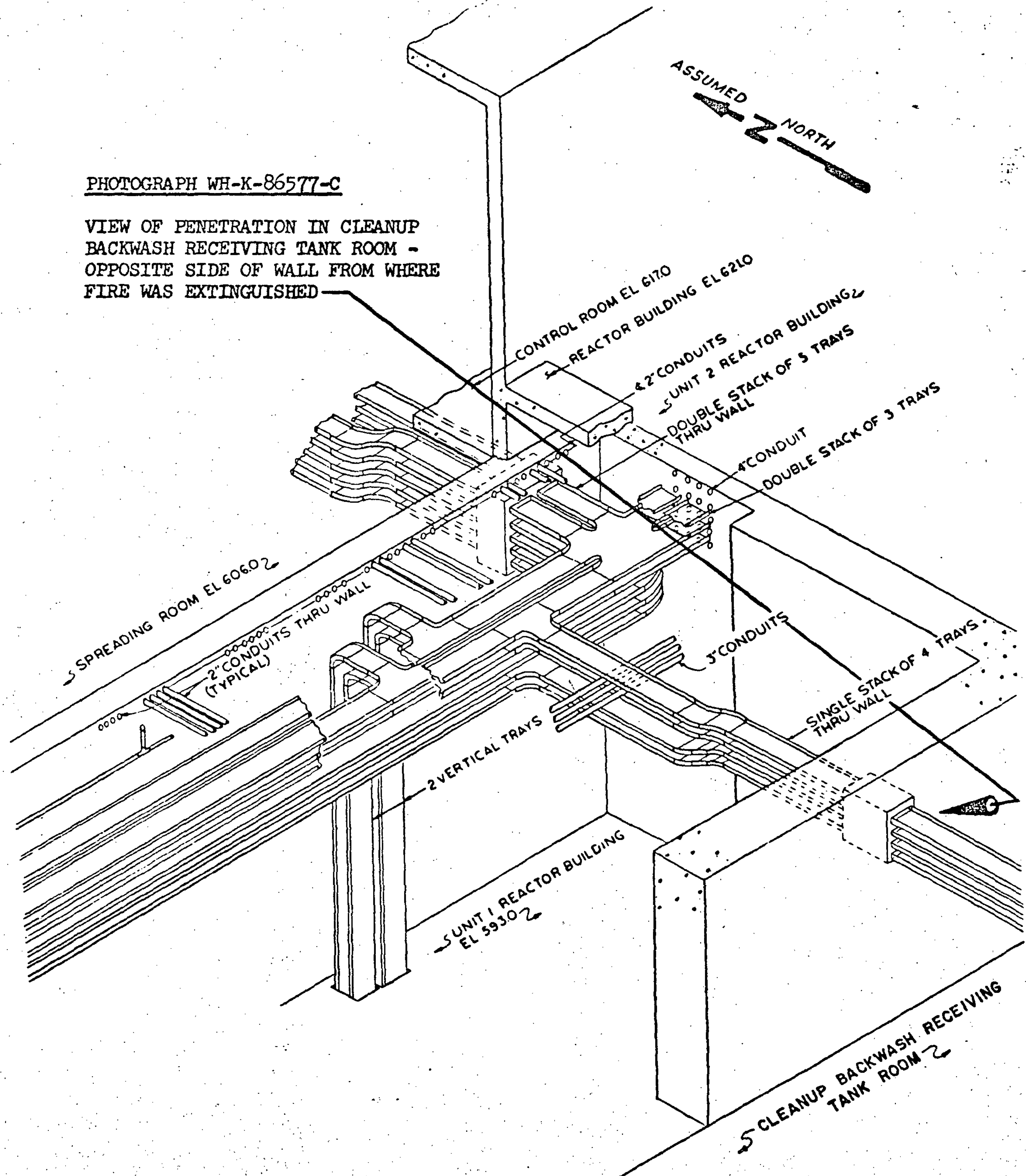
PHOTOGRAPH NO. 162534

AVAILABLE IN: BLACK & WHITE ☐ COLOR ☐

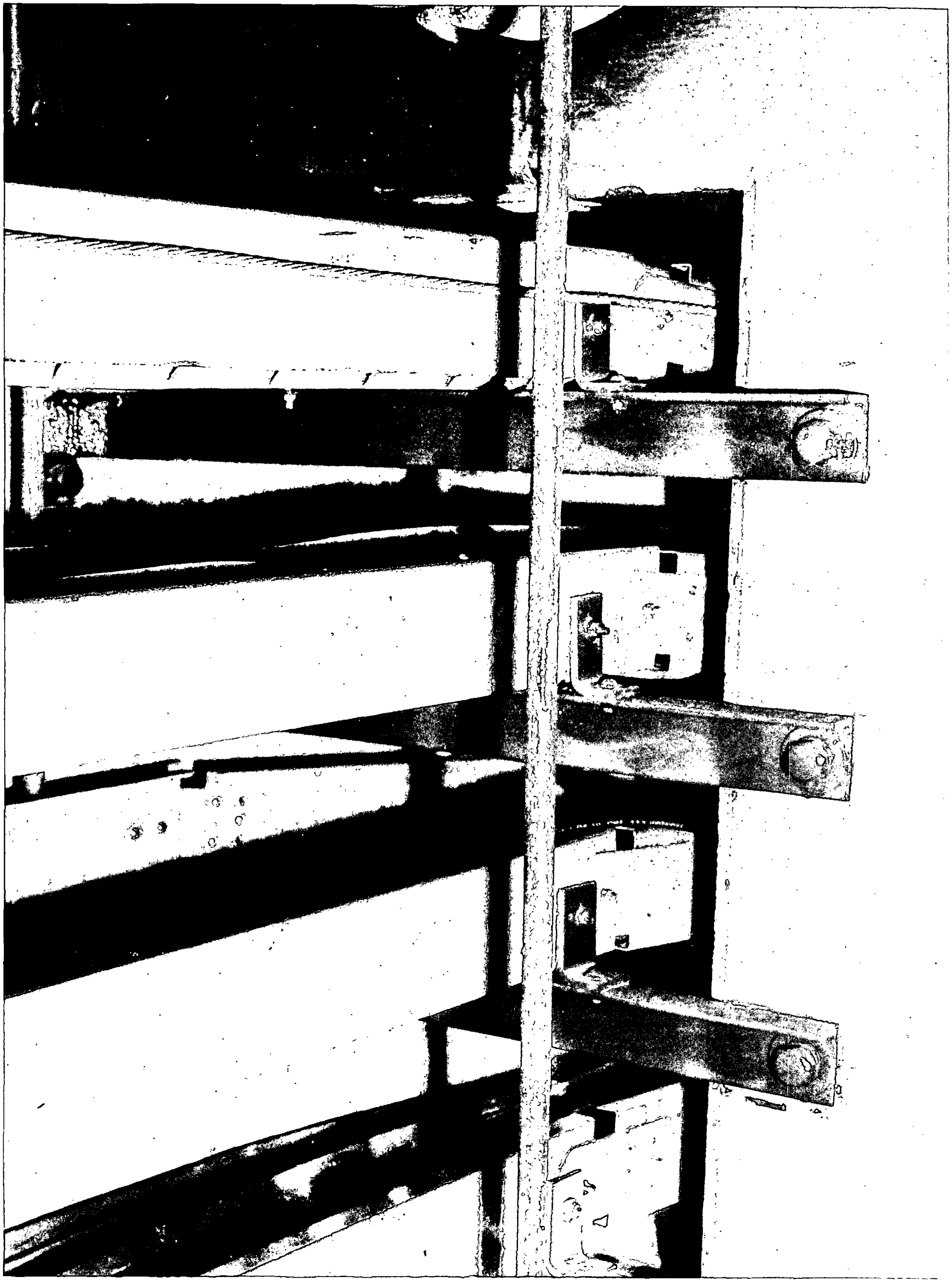
SEP 1975

PHOTOGRAPH WH-K-86577-C

VIEW OF PENETRATION IN CLEANUP BACKWASH RECEIVING TANK ROOM - OPPOSITE SIDE OF WALL FROM WHERE FIRE WAS EXTINGUISHED



AREA OF FIRE



UNION CARBIDE — Y-12 PLANT —
Oak Ridge, Tennessee

PHOTOGRAPH NO. 162535

AVAILABLE IN: BLACK & WHITE [X] COLOR [ ]

SEP 23 1975