RAILROAD ACCIDENT INVESTIGATION

REPORT NO. 4187

SOUTHERN PACIFIC TRANSPORTATION COMPANY

ROSEVILLE, CALIF.

APRIL 28, 1973

FEDERAL RAILROAD ADMINISTRATION

OFFICE OF SAFETY

WASHINGTON, D. C. 20590

Summary

DATE:	April 28, 1973
RAILROAD:	Southern Pacific
LOCATION:	Roseville, Calif.
KIND OF ACCIDENT:	Explosion
EQUIPMENT INVOLVED:	18 cars
SPEED:	Standing
OPERATION:	Yard limit rules
TRACK:	Yard track; tangent; slightly descending westward; yard limits
WEATHER:	Clear
TIME:	8:03 a.m. (initial explosion)
CASUALTIES:	Approximately 350 injured
CAUSE:	Undetermined

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DEPARTMENT OF TRANSPORTATION

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Synopsis

On April 28, 1973, eighteen cars loaded with bombs exploded while standing on a track in the SP's yard at Roseville, Calif., resulting in extensive property damage and injury to approximately 350 employees and inhabitants of the surrounding area.

The cause of the explosions was not determined.

Location and Method of Operation

The SP's Roseville Subdivision extends westward from Sparks, Nevada, to Sacramento, Calif., a distance of 156.4 miles. This is a double-track line over which trains moving with the current of traffic operate by signal indications of an automatic block-signal system. The main tracks are designated as No. 1, westward, and No. 2, eastward.

At Roseville, 17.7 miles east of Sacramento, there are three large systems of yard tracks totaling about four miles in length. From the east, those systems form the "departure yard," the "classification (hump) yard," and the "receiving yard." The main portion of the receiving yard has 21 yard tracks, approximately one mile in length (see Plate 1). From the north, those tracks are numbered from 1 to 21.

A telegrapher's office is housed in a small structure on the north side of the lead tracks at the west end of the receiving yard tracks. About 150 feet east of the telegrapher's office is another small structure known as the Antelope herders shanty. A "herder" is an SP yard-service employee assigned to duties such as lining switches for movements to and from yard tracks, accompanying locomotives to or from trains, etc.

The explosions occurred on the west end of track No. 7 in the receiving yard, in an area of about 800 to 1,700 feet east of the Antelope herders' shanty.

Time and Weather

The initial explosion occurred at approximately 8:03 a.m., in clear weather.

Environment

The explosion site is about 1¼ miles west of the westerly environs of Roseville (pop. 20,000). It is surrounded by generally open and level or slightly rolling terrain.

Antelope, a small unincorporated community, is adjacent to the north side of the railroad at the west end of the receiving yard (see Plate 1). Prior to the explosions, it had a population of about 100 persons. It consisted of a post office-grocery store, a grange hall, and about 30 dwellings, some of which were of the mobile home type.

The area surrounding Antelope and the explosion site is sparsely inhabited within a radius of 6,800 feet, except for a few housing developments totaling about 400 to 500 residences. The nearest housing development is approximately 2,000 feet southeast of the explosion site. Within a radius of three miles from the explosion site, there are several thousand residences and numerous business structures, including those in the westerly environs of Roseville.

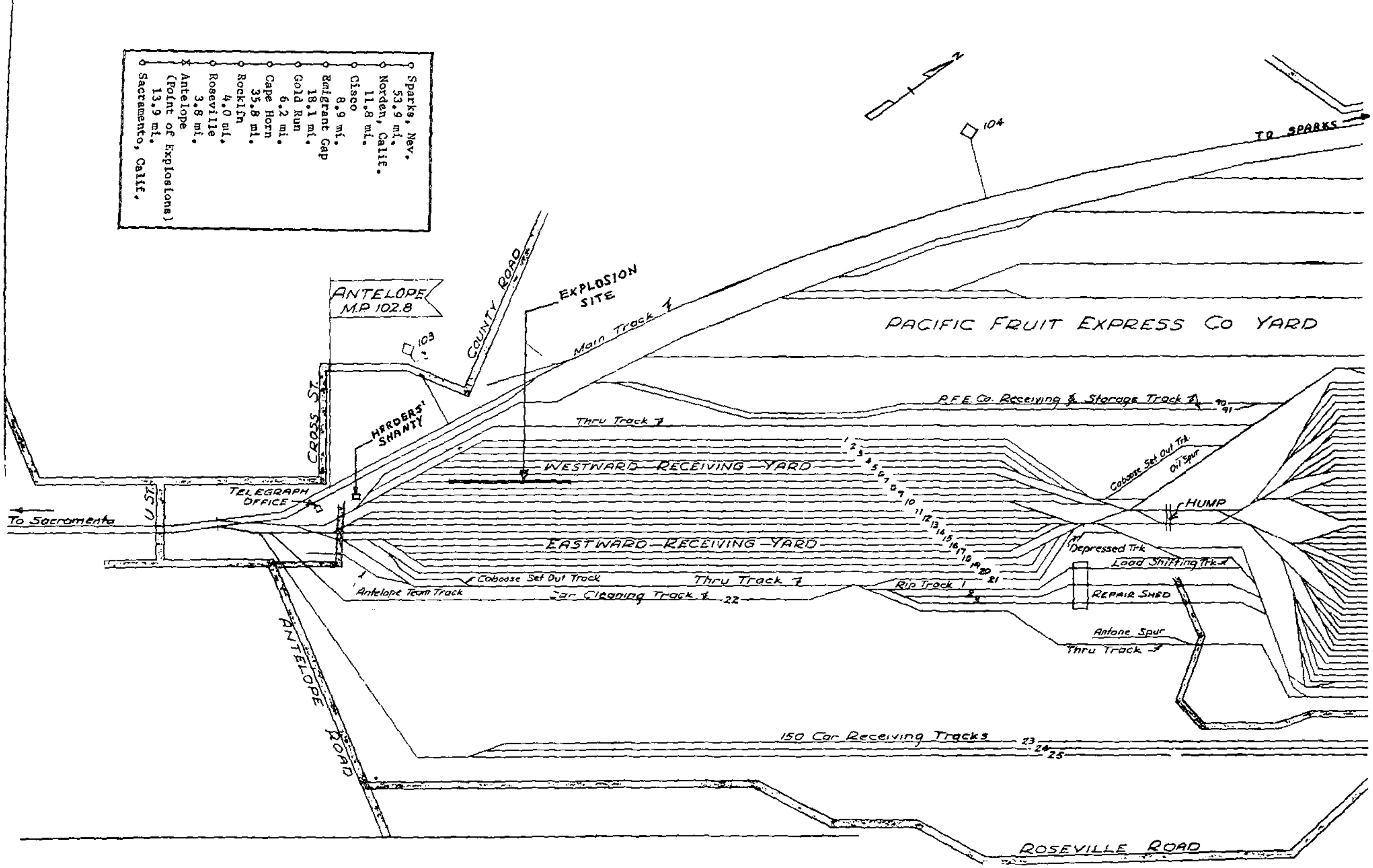
Residences south of the explosion site are in the community of Citrus Heights. An element of the Citrus Heights fire department was stationed at Antelope, in structures located a short distance from the lead tracks at the west end of the yard tracks in the Roseville receiving yard.

Hawthorne Naval Ammunition Depot

Thorne, is the timetable designation for a railroad station serving the Hawthorne Naval Ammunition Depot in Nevada. Local freight trains operating northward by geographical directions stop at Thorne to pick up cars loaded at the ammunition depot. Such trains terminate at Sparks, 138.2 railroad miles from Thorne.

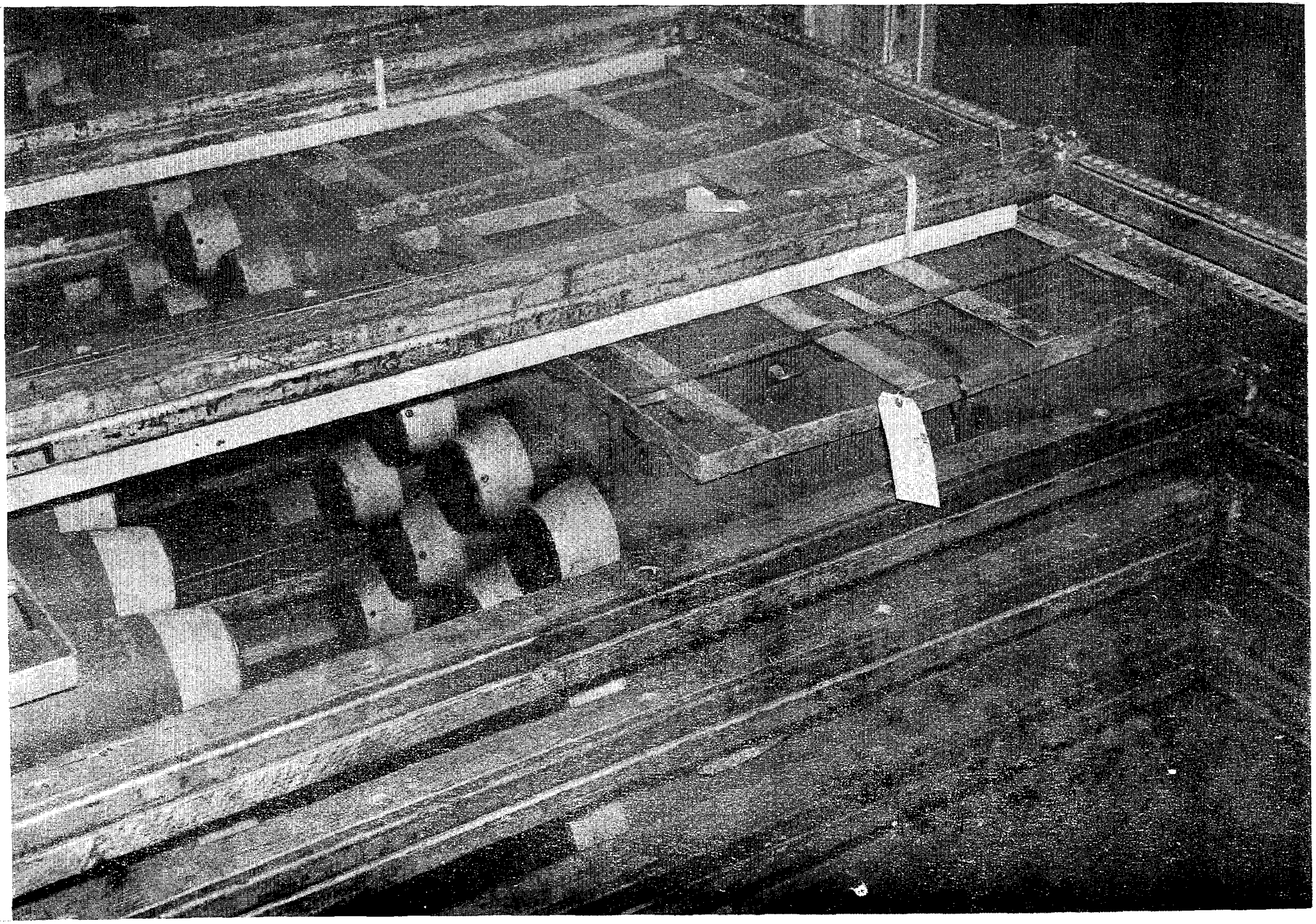
The Hawthorne Naval Ammunition Depot manufactures and ships various types of munitions. Most rail shipments are via DODX (Department of Defense) box cars. Each empty DODX car arriving at the ammunition depot is inspected by both an SP car inspector and a Navy inspector in accordance with 49 CFR, Part 174. Defective DODX cars, including those with defective brake shoes, are sent to a Navy shop in the ammunition depot for repairs. When a DODX car is scheduled to be loaded with Class A explosives, the two inspectors again inspect the car to certify that it is in fit condition for such loading. After the car is loaded, they inspect the lading and bracing, then placard and seal the car. A loaded car may go to a storage area before being dispatched for a railroad movement outside

PLATE No. 1



Sparks, Nev.
53.9 mi.
Norden, Calif.
11.8 mi.
Cisco
8.9 mi.
Emigrant Gap
18.1 mi.
Gold Run
6.2 mi.
Cape Horn
35.8 mi.
Rocklin
4.0 mi.
Roseville
3.8 mi.
Antelope
(Point of Explosions)
13.9 mi.
Sacramento, Calif.
TO SPARKS
104
103
N
ANTELOPE M.P 102.8
COUNTY ROAD
EXPLOSION SITE
Main Track 1
PACIFIC FRUIT EXPRESS Co YARD
CROSS ST.
HERDERS' SHANTY
TELEGRAPH OFFICE
U ST.
To Sacramento
P.F.E. Co. Receiving & Storage Track 1
90
91
Thru Track 1
WESTWARD RECEIVING YARD
EASTWARD RECEIVING YARD
Caboose Set Out Trk.
Oil Spur
HUMP
Depressed Trk
Load Shifting Trk 1
REPAIR SHED
Caboose Set Out Track
Antelope Team Track
Thru Track 1
Rip Track 1
Car Cleaning Track 1
22
Antone Spur
Thru Track 1
150 Car Receiving Tracks
23
24
25
ANTELOPE ROAD
ROSEVILLE ROAD

PLATE NO. 2



250-pound tritonal bombs secured in DODX box car by Evans DF-1 equipment.

the ammunition depot. When removed from the storage area in preparation for a train movement, the two inspectors again inspect the car as well as its contents.

Circumstances Prior to Explosions

Loading of Bombs Involved

Between March 29 and April 2, 1973, the Hawthorne Naval Ammunition Depot manufactured 7056 250-pound general purpose (Mark 81) bombs and loaded them into 21 DODX cars, which were subsequently sealed and stored at various security bunkers. On April 26, a Navy switching crew assembled these 21 cars and placed them on an outbound track for movement by train to the Naval Weapons Station at Concord, California.

Each car carried 336 unfuzed bombs loaded in 28 metal pallets. Each pallet contained 12 bombs. The pallets were loaded in two longitudinal rows inside the car, with the bomb noses facing the car centerline. The bombs were secured to the pallets with steel strapping. Evans DF-1 equipment was used to block and brace the load. Four bars were used to secure each set of two pallets. Each bar extended across the car, alongside a set of two pallets, and was secured at both ends to metal belt rails fixed to the inner side walls of the cars. See Plate 2 for method used to block and brace the load of bombs.

After the 21 DODX cars loaded with bombs were placed on the outbound track at the ammunition depot, an SP car inspector and a Navy inspector jointly inspected the cars. This included breaking of door seals and opening doors for an inspection of the lading in each car, followed by closing and resealing of car doors. The two inspectors took no exception to the condition of the cars and their lading, and signed the prescribed Car Certificates, certifying that the cars were in suitable and safe condition for the transportation of Class A explosives.

Movement of Bombs to Sparks

During the afternoon of April 26, Extra 3369 West, a local freight train operating northward by geographical direction, stopped at the Hawthorne Naval Ammunition Depot (Thorne) and picked up the 21 DODX cars loaded with general purpose bombs. The train departed from the ammunition depot (Thorne) at 4:10 p.m. It arrived at Sparks at 9:30 p.m., the same day.

Sparks

After Extra 3369 West arrived at Sparks, the 21 DODX cars loaded with bombs were inspected by SP security officers, who observed that the car doors were closed and sealed. The DODX cars remained on a yard track opposite the Sparks yard office until approximately 7:45 a.m., April 27, when they were moved to track No. 3 near the west end of the Sparks Yard. Late in the evening of April 27, a yard crew placed the 21 DODX cars in the train of Extra 9117 West.

Extra 9117 West

This train, a westbound freight train, originated at Ogden, Utah. It left Ogden at 10:05 a.m., April 27, and arrived at Sparks, a crew-change point, about 10:10 p.m. the same day. Yard crews at Sparks removed cars from the rear of the train and added cars to the front end, including the 21 DODX box cars loaded with bombs. After the train was reassembled, its brake system was tested by the engineer and car inspectors, and no exceptions were taken.

Extra 9117 West, consisting of a 3-unit road locomotive, 71 cars, a 4-unit helper locomotive, 38 cars and a caboose, in that order, left Sparks at 11:45 p.m., April 27. The road engineer and front brakeman were in the cab of the first unit of the road locomotive; the conductor and flagman were in the caboose. The helper engineer was in the cab of the first helper-locomotive unit.

The 21 DODX box cars were the 17th through 37th cars in the train.

After leaving Sparks, Extra 9117 West proceeded westward on a heavy ascending grade to the railroad summit in the Sierra Nevada Mountains. Near Norden, Calif., 84.8 miles east of Roseville, the train moved off the summit and began to descend a series of heavy and light grades that extend westward to and beyond Roseville. The crew members said that they made frequent observations of the train while moving on the descending grades between Norden and Roseville, and that they observed no unusual condition. The engineer controlled the speed on those grades by use of the dynamic brake and occasional applications of the automatic brake.

In the vicinity of Cisco, 73.0 miles east of Roseville, undesired emergency brake applications stopped the train as a result of separations between the 27th and 28th cars (DODX box cars). These separations were caused by the operating lever for the coupler at the front of the 28th car being bent and thereby preventing the knuckle of the coupler from being properly secured in closed position. The cause of the separations was not determined by the conductor and front brakeman until after the third separation had occurred. They remedied the situation by removing the operating lever from the front of the 28th car and wiring it to the side of the car. The train departed westward from the Cisco area at approximately 3:55 a.m., April 28, after experiencing a delay of 2 hours 5 minutes.

Upon reaching Emigrant Gap, 64.1 miles east of Roseville, Extra 9117 West moved onto a heavy descending grade and the road engineer applied the automatic brake to supplement the dynamic brake in controlling the speed. Some time later, as it moved with the dynamic and automatic brakes still applied in the vicinity of a point approximately 51 miles east of Roseville, the train passed a 20-year old college student camped approximately 30 feet south of track No. 1. The student, an engineering major, had camped at this site on four or five previous occasions. He was highly interested in railroading and, as a hobby, recorded train sounds on a tape recorder. He watched the train pass and noticed the block of 21 DODX box cars loaded with bombs near the front end. According to his statements, he also noticed:

(a) Sparks flying from the wheels of the train as a result of braking action;

(b) The rim of the front wheel on the south side of the leading truck of a DODX box car glowing red throughout its circumference; and

(c) Small flames flickering intermittently on the plate of the aforesaid wheel.

The student did not hear a high pitched (squealing) sound such as that normally produced by an overheated journal, or consider the sparks mentioned in iten (a), or the flames mentioned in item (c), to be unusual as he had observed such sparks and flames when observing other trains during previous stays at his camp site.

The automatic brake of Extra 9117 West was released in the vicinity of Gold Run, 46.0 miles east of Roseville, and was reapplied occasionally during the remainder of the trip to Roseville. About three miles west of Gold Run, the train passed a hot box detector without incident. At Rocklin, 4.0 miles east of Roseville, it passed another hot box detector, which also did not detect any hot boxes on the cars. A station wagon occupied by several persons was stopped short of a rail-highway grade crossing in Rocklin as the train approached that crossing. The occupants of the station wagon observed the north side of the train as it moved over the crossing and took notice of the 21 DODX box cars loaded with bombs. After the train passed, the station wagon proceeded over the crossing and westward on Interstate Highway 80 which parallels the railroad on the north. As the station wagon neared Roseville, it overtook the train, which was stopped at the entrance to the Roseville yard system. The occupants of the station wagon observed the south side of the cars in the train and again took particular notice of the 21 DODX box cars loaded with bombs. According to the driver, the occupants of the station wagon saw no smoke, fire or other unusual condition of the train either at Rocklin or Roseville.

Extra 9117 West stopped at the entrance to the Roseville yard system at 6:05 a.m., April 28. Approximately 25 minutes later, it began to enter the Roseville yard system. The train proceeded through the departure and classification yards, and entered the east end of track No. 7 of the receiving yard. At approximately 7:00 a.m., it stopped on track No. 7 with the front end extending several car lengths beyond the west switch of track No. 7, due to insufficient room on that track to accommodate the entire train. The road locomotive, in cooperation with two of the herders stationed at Antelope, then doubled over the first 19 cars to yard track No. 3. When this was accomplished, at approximately 7:10 a.m., the road locomotive proceeded to the Roseville enginehouse.

Numerous employees observed Extra 9117 West as it moved through the Roseville yard system to track No. 7 of the receiving yard. They saw no unusual condition. The Antelope herders and the road engineer also saw nothing unusual while they were engaged in doubling over the first 19 cars to yard track No. 3. As a result of this double-over movement, three of the 21 DODX box cars in the train of Extra 9117 West were placed on track No. 3. The other 18 DODX box cars remained on the west end of track No. 7.

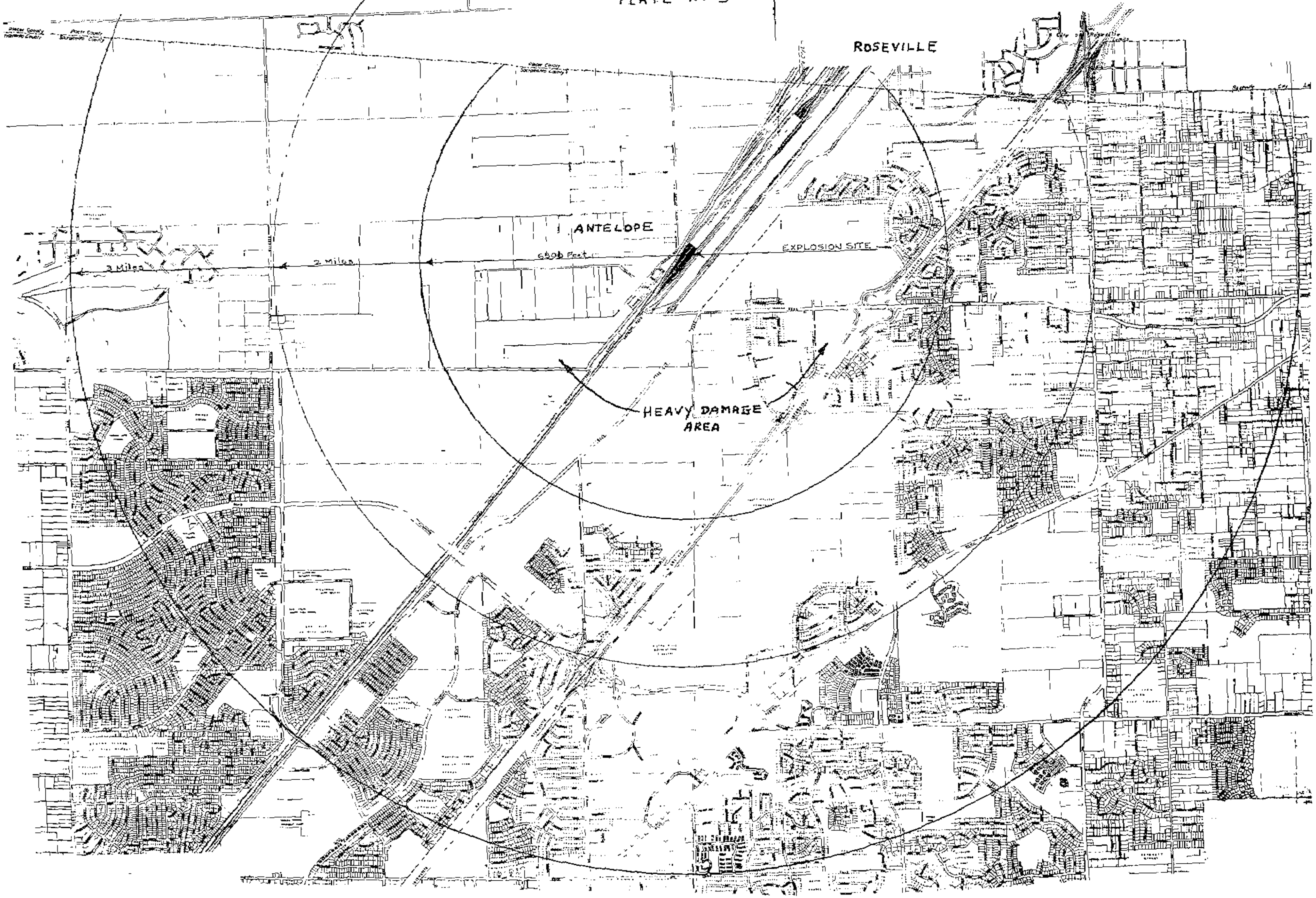
At approximately 7:30 a.m., or about 30 minutes after Extra 9117 West stopped on track No. 7, a car inspector drove a small low-slung vehicle westward along the south side of track No. 8, which was unoccupied in the area where the 18 DODX box cars loaded with bombs was standing on track No. 7. Because of his low vantage point, the car inspector had a good view of the running gear of cars occupying tracks No. 9 and No. 7. The carman stated that he observed the 18 DODX box cars occupying the west end of track No. 7 as he drove his vehicle to the west end of the receiving yard, and that he observed no unusual condition of those cars.

Smoke, Fire and Explosions

About 7:40 or 7:45 a.m., as indicated by their statements, a resident of Antelope and a switchman working in the vicinity of the hump for the classification yard saw a light volume of smoke rising in the vicinity of the west end of track No. 7 in the receiving yard. Because of their view being obstructed by cars, they did not know the source of the smoke. The Antelope resident said the smoke was black when he first observed it. After a short period, according to his statements, he saw the smoke turn white, watched it diminish, then saw flames rising from the end of a box car. Immediately after observing the flames, he heard the "poof" of an explosion.

About 7:59 a.m., while working near track No. 1 of the receiving yard, a car inspector heard the low order explosion referred to immediately above. He described its sound as being similar to that of the explosion of a mortar shell. Looking in the direction of the sound, he saw smoke and fire rising near the west end of the receiving yard. He immediately reported this to a lead car inspector by radio and advised him to call the fire department. The car inspector then ran some distance westward alongside track No. 1, crossed over to track No. 4 by climbing between cars, and ascended a side ladder of a car located a relatively short distance east of the scene of the explosion. On reaching the top of the ladder, he saw a thick column of black smoke mixed with orange-red flames rising into the atmosphere from a rupture in the west end of the roof of one of the 18 DODX

PLATE No 3



ROSEVILLE
ANTELOPE
EXPLOSION SITE
6500 Feet
2 Miles
3 Miles
HEAVY DAMAGE AREA

box cars loaded with bombs that had been left standing on the west end of track No. 7. The car inspector then descended the side ladder, reported what he had observed to a lead car inspector by radio, and began to flee from the scene. Soon thereafter, a high order explosion knocked him to the ground, apparently with stunning force. A few minutes later, he was assisted to safety by his supervisor and employees of a nearby industrial plant.

Two herders were in the Antelope herders' shanty at the time of the low order explosion mentioned above. They promptly left the shanty and, on looking eastward toward track No. 7, observed smoke rising from what appeared to be approximately the 10th DODX box car from the west end of that track. The members of the Citrus Heights Fire Department stationed at Antelope also heard the low order explosion and saw the smoke and flames emanating from the DODX car. A fireman immediately reported this, at 7:59:50 a.m., to the Citrus Heights Fire Department dispatcher, who promptly dispatched elements of the fire department to the scene. The firemen at Antelope then proceeded to the Antelope herders shanty, arriving there within a few minutes after the time of the low order explosion. At 8:03 a.m., while they were discussing the situation with the Antelope herders, most, if not all, of the bombs in the DODX car that was on fire exploded, causing a thick column of black smoke mixed with orange-red flames to rise high into the atmosphere. This high order explosion caused other cars at the west end of the receiving yard to catch on fire. Thereafter, until approximately 10:30 a.m., the other 17 DODX cars at the west end of track No. 7 exploded at various intervals. These high order explosions strewed unexploded bombs about the west end of the receiving yard and the surrounding area. Bombs strewn in burning debris exploded intermittently until 4:05 p.m., the following day.

Casualties

Approximately 15 SP employees and 335 residents in the Roseville, Citrus Heights and Antelope area were injured. For the most part the injuries were of a relatively minor nature, such as that caused by broken glass.

Damages

Of the 32 structures in Antelope, 9 were destroyed, 11 heavily damaged, and 12 slightly damaged.

In all, approximately 5,500 buildings, mostly residential, were damaged by the explosions. The area of heavy damage or destruction was within a radius of 6,800 feet from the explosion site (See Plate 3). Slight damage to structures occurred up to three miles from the site of the explosions.

As a result of the explosions and subsequent fire, 169 freight cars were destroyed; 98 other freight cars and one locomotive unit were damaged.

PLATE NO. 4

Bomb explosion at Roseville

According to the SP's estimate, the cost of damages to on-track equipment, track structures, and signal and communication equipment was about $3,490,000. The cost of all damages and casualty claims resulting from the incident was estimated to be $23 million.

Post-Accident Events

Investigatory Bodies

In addition to the FRA, the Federal Bureau of Investigation; Alcohol, Tobacco and Firearms Division of the U. S. Treasury Department; U. S. Navy, and SP conducted independent investigations of the explosions. None of these found evidence to indicate the explosions occurred as a result of sabotage.

Evacuation

Approximately 18,000 persons were evacuated from the area surrounding the scene of the explosions. Apparently a large number of these persons were evacuated due to ill-founded reports that the explosions had caused release of toxic fumes into the atmosphere.

Emergency Response

The following agencies promptly responded to the emergency situation caused by the explosions:

California Highway Patrol

Placer County Sheriff's Department

Red Cross

548 Ordinance Detachment, U. S. Army, Presidio, San Francisco

Citrus Heights Fire Department

Salvation Army

Sacramento County Sheriff's Department

California Office of Emergency Services

California National Guard

Representatives of the above listed agencies established a central command post about 1½ miles from the site of the explosions, and provided for the care of evacuees; security of evacuated buildings; highway traffic control; food and refreshments; protection of sightseers; extinguishment of fires; disposal of unexploded bombs, etc. The prompt response of these agencies to the emergency in the Roseville area played and important role in alleviating the consequences of the bomb explosions and subsequent fires.

SP

SP employees and officials minimized consequences of the explosions by moving cars, including the three DODX box cars that had been placed on track No. 3, away from fire areas.

A check of all cars in the Roseville yard was made by the SP, utilizing automated data processing techniques. It revealed that the 21 DODX box cars with bombs were the only cars in the explosion area that were loaded with hazardous materials.

Bomb Clean-Up

About 1,200 unexploded or partially deflagrated bombs were recovered by military personnel and returned to the Hawthorne Naval Ammunition Depot.

Post-Explosion Examinations in Receiving Yard

The 18 DODX cars that were on the west end of track No. 7 were completely destroyed by the explosions. In the area where they had been standing, there were eight craters, ranging from 12 to 18 feet in depth. Five were circular-shaped and 20 to 60 feet wide at the top. The other three were oval-shaped and were 40 to 65 feet wide and 80 feet to 100 feet long at the top.

Examination of the three DODX box cars that had been doubled over to track No. 3 revealed they had sustained minor structural damage. The bomb contents of each car were in place and appeared to be well blocked and braced by the Evans DF-1 equipment provided. Sparks shields were provided above every wheel of each car. Each shield was 10 inches wide and 40 inches long and was fixed to floor stringers in such manner that it was suspended about 3 inches below the wooden car floor. The underside of each spark shield was coated with an accumulation of grime and oil thrown up from the wheel and journal box below. The trucks of the three cars were provided with low-friction composition brake shoes, which were in good condition. The wheels of each truck showed no evidence of unusually heavy braking action or flat spots. Stenciling on the three cars indicated that the air brakes had last been in-date tested between August 4, 1972 and March 30, 1973, at the Hawthorne Naval Ammunition Depot, and that the journals had been repacked with ABSCO pads at the same depot between January 1 and August 4, 1972.

Post-Explosion Examination of Hot Box Detectors

Examination of the hot-box detectors and associated equipment at Rocklin and near Gold Run revealed they were functioning properly. Recordings made by associated equipment indicate neither hot box detector detected a hot box in the train of Extra 9117 West. These detectors are designed to scan only the under side of journal boxes. Thus, they do not detect or record heat sources other than journals.

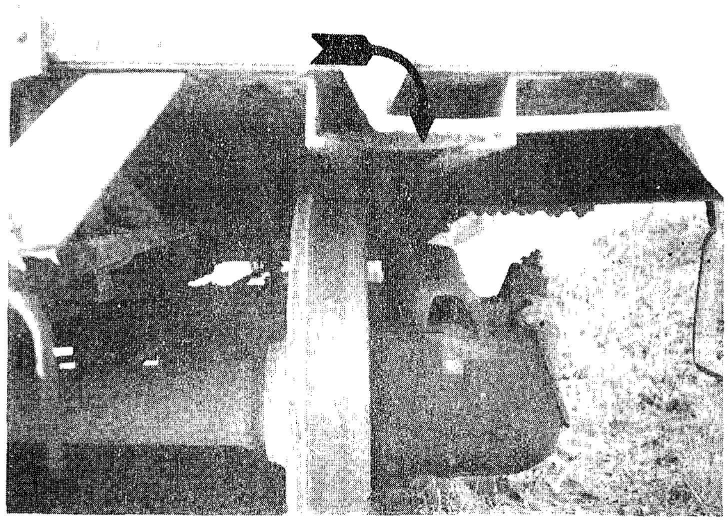
18 DODX Box Cars Involved

These cars were built by Pullman-Standard, Inc., in 1952. Each had a steel superstructure, a 20-inch travel cushion-type steel underframe, and 50-ton capacity Chrysler 4-wheel trucks with 5½ inch plain bearing journals and low-friction composition brake shoes. The swing hanger supported spring plank was stabilized by a shock absorber to reduce lateral impacts to the car and lading.

Each car was 53 feet long, 15 feet 1 inch high, and 10 feet 4 inches wide. It had a lightweight and load limit of approximately 69,600 and 107,400 pounds, respectively.

The single floor of each car was constructed of 2¼" by 5¼" pine, tongue and groove flooring. The sides and ends of the interior were constructed of 25/32" by 3¼" pine, tongue and groove lining painted with non leafing aluminum paint. The interior of the car was equipped with DF-1 adjustable belt rails, and 4" by 4" DF-1 crossbars, to facilitate blocking and bracing of lading.

A metal spark shield was above each wheel as shown in the following photo.



Nature of the Bombs

The bombs involved were 250-pound general purpose bombs loaded with tritonal, a composition containing 80% TNT and 20% flaked aluminum. Tritonal was developed and standardized in the United States during World War II. It is used in bombs for its blast effect. Impact tests indicate tritonal to be slightly more sensitive to impact than TNT and much less sensitive than tetryl. The rifle bullet impact test value for tritonal is more similar to that of tetryl than that of TNT.

The explosion temperature test value of tritonal is 470°C (878°F), which is almost identical with that of TNT. Bombs filled with tritonal have a nominal explosion temperature of 400°F when involved in a liquid hydrocarbon fire. The brisance of tritonal is similar to that of TNT. The rate of detonation of cast tritonal is approximately 97% that of cast TNT. The heat of explosion of tritonal is 59% greater than that of TNT, and tritonal is 124% as powerful as TNT, as measured by the ballistic pendulum test.

A tritonal bomb is quite stable and can withstand impacts of considerable magnitude, such as those experienced as a result of a derailment or collision. Tests have revealed that a Mark 81 tritonal bomb will explode within 2½ to 4 minutes when suspended three feet above a fuel fire producing a temperature of about 500°F. When exposed to a temperature of about 405°F, a tritonal bomb will explode within 3½ to approximately 8 hours, depending on the heating rate.

Construction of Bombs

Bombs for the U. S. Armed Services are constructed at the McAlester, Oklahoma, and Hawthorne, Nevada, Naval Ammunition Depots. The bomb casings and explosives are supplied to the aforesaid depots by various manufacturers. The bomb-making procedure at McAlester is the same as that at Hawthorne. The Navy procedure for the construction of 250-pound general purpose bombs charged with tritonal is summarized as follows:

1. Plastic plugs are removed from the nose and base of an empty bomb casing. A metal plug is screwed into the nose opening.

2. Molten asphaltic material is poured into the bomb casing at the base opening until the bomb cavity is full, after which the asphaltic material is poured out. Thus, the inside of the bomb is coated with a tar-like substance before the bomb casing is filled with explosive material.

3. The outside of the bomb casing is spray painted and dried.

4. The bomb casing, nose down, is placed under a large steam-heated kettle equipped with a stirrer.

5. Approximately 125 pounds of steam heated tritonal in a molten state is poured, via a flexible hose from the kettle, into the empty bomb casing through the base opening.

6. The bomb casing is moved via a cart along the "assembly line" to another station, where additional amount of molten tritonal is poured into the casing to the proper level (a topping off process).

7. Molten wax is poured on top of the tritonal, to seal the tritonal in place and prevent it from coming in contact with a metal shipping cap to be screwed into the base of the bomb casing.

Approximately five minutes after receiving the molten wax, the bomb is placed in horizontal position, after which the threads in the base opening are cleaned, "Lock-Tite" substance is applied to the threads, and a metal plug is screwed into the base opening. When this is completed, the bomb is placed on a pallet for direct loading into a box car. At this stage, it is still warm to the touch.

Incident at Tully, Arizona

During the investigation of the Roseville incident, 12 cars loaded with 500-pound tritonal bombs exploded on May 24, 1973, while moving in an SP train in the vicinity of a siding at Tully, Arizona (near Benson). The bombs involved had been manufactured at the McAlester Naval Ammunitions Depot.

The Tully incident is being investigated by the National Transportation Safety Board. A public report of its investigation, including findings as to cause, will be published by the Safety Board.

Outline of SP's Position as to Cause

As a result of the Roseville and Tully incidents, the SP employed a well known explosive expert as consultant. The SP expert consultant examined unexploded bombs involved in the incidents and the procedures used to manufacture tritonal bombs at the Hawthorne Naval Ammunition Depot. Upon the basis of reports furnished by its expert consultants, the SP considers the Roseville incident was caused by a defective bomb in one of the DODX box cars that were standing on track No. 7 of the Roseville receiving yard.

According to reports of the SP expert consultants, the procedure used by the Navy to assemble tritonal bombs at McAlester and Hawthorne is extremely faulty and enhances sensitivity of the bombs. The reports allege that:

1. The procedure results in approximately 8% of the bomb casing not being filled with tritonal. The void space is partly uniformily distributed within the cast tritonal, but mostly occurs in large voids toward the upper side of the horizontally oriented bomb. Thus, when the bomb is on its side there is a large layer of fairly good, unsegregated tritonal next to the walls, except near the base where the final tritonal topping and wax buffer are placed. Cracks, voids, or column break up in the explosive charge of a bomb is alleged to cause that bomb to be more sensitive to shock, impact and internal friction.

2. The cavitation in the tritonal bomb extends to the region of the wax buffer and threaded base plate. This causes tritonal to migrate on to the plate and into the threads,

upon cooling. Tritonal remains in the threads of the base plate creating pinchpoints which constitute a possible source of ignition or impact. It is alleged that bombs produced with tritonal in threads of base plates are not rejected as required by U. S. Navy specifications.

3. The wax buffer does not remain in proper place after the bomb is put in horizontal position. This permits direct contact of tritonal and/or TNT with iron over practically all of the base plate. Consequently, TNT-on-iron corrosion may take place in the bomb relatively unabated. The SP expert consultant asserts that since the cavitation in the bomb extends into the threaded base plate region, there exists a very likely ignition source as well as a ready channel for explosion buildup from the corrodible and potentially friction-initiated base section of the bomb.

4. The bomb manufacturing procedure can permit moisture to be introduced into the bomb. This produces a potential hazard as aluminum can react slowly with moisture to generate considerable quantities of heat, which could conceivably lead to a runaway decomposition of the tritonal and to a "cook-off." An excessive amount of water is used during the manufacturing process to wash the floor clean of spilled explosive material.

The SP reports also cite six instances in which tritonal bombs apparently detonated while being handled by personnel of the armed services.

It is the SP's opinion that the explosions were not caused by a heat source outside the body of one of the DODX cars involved, and that no car of Extra 9117 West was on fire when the train was yarded in the Roseville receiving yard about one hour before the first explosion. This opinion, the SP feels, is supported by (1) numerous employees and other persons who observed the train after its arrival at Roseville and observed no external sign of any car being on fire, and (2) negative recordings of two hot box detectors passed by Extra 9117 West while approaching Roseville.

For details relative to the SP's position as to cause, see Appendix A.

Outline of Navy's Position as to Cause

On the basis of reports of its explosive experts, the Navy's opinion is that the Roseville incident was caused by a heat source outside the body of one of the 18 DODX cars involved. Thus, it considers that the external heat source was most probably either a hot box on one of the DODX cars involved, or sparks or fire directed to the underside of a DODX car floor during an application of the brake shoes against the car wheels. The Navy states that long experience and testing have proven that MK-80 series bombs are not sensitive to mild impacts. Over seven million tritonal loaded MK-80 series bombs have been produced and shipped over land without incident prior to the Roseville incident. There is no record of auto-ignition of bombs of this type.

Likewise, the Navy believes that the presence of cavities, segregation, crystalline material and migration of wax pads is not unusual. Bombs possessing these characteristics have passed several tests without problems. Similar bombs have been dropped from aircraft and have been sawed in half without exploding. The three surviving carloads of bombs did not explode, nor did numerous bombs hurled out of DODX box cars by the explosion of other bombs.

According to the Navy, testing has shown that the only way MK-80 series, tritonal bombs, can be made to explode unfuzed is through prolonged exposure to intense heat

See Appendix B for details of the Navy's position as to cause.

Analysis

We are unable to make a positive determination as to the cause of the initial explosion. However, two possible causes (a) a fire which exposed a bomb in one of the DODX cars to a high temperature, or (b) an unstable bomb in one of the DODX cars, must be considered.

1. Possibility of Fire as Causal Factor

Inasmuch as our investigation, as well as those conducted by the other investigatory bodies involved, found no evidence of sabotage, it appears most unlikely the explosions were caused by fire due to an act of sabotage.

While en route in the train of Extra 9117 West, the DODX cars passed two hot box detectors located within a relatively short distance of Roseville. Neither detector recorded a hot box on a DODX car or any other car in the train. Because of this and also for the reason no one saw or heard a hot box at any time, there is no evidence to indicate the explosions were caused by a hot box fire on a DODX car.

Two reported elements - the sighting of sparks by a college student on a DODX car when the train was on a descending grade in the Sierra Nevada Mountains, and the smoke and flame sighted shortly before the explosion in the Roseville yard provide the framework for the following analysis:

At one stage of its descent on the western slope of the Sierra Nevada Mountains, the air brakes of Extra 9117 West were continuously applied for a distance in excess of 13 miles. A college student camped near the tracks saw the train while it was moving under this brake application. He stated that he saw (a) sparks flying from the train wheels, (b) the rim of a front wheel of a DODX car glowing red throughout its circumference, and (c) small flames flickering intermittently on the plate of the aforesaid wheel. The student's observations of a glowing wheel of a DODX car would indicate that a brake shoe had been applied heavily against that wheel for a prolonged period and to a degree considerably heavier than that of other brake shoes against their associated wheels. This is not an uncommon event.

The heavy application of the brake shoe against the glowing wheel of the DODX car could have caused very heavy sparks to be thrown upward against the underside of the spark shield above that wheel. All train braking causes some sparking, which looks dangerous but is actually not unusual. Since tests have revealed composition brake shoes infrequently catch on fire when heavily applied against a rotating wheel for a prolonged period, there is a possibility that fire from a burning brake shoe was also directed toward the aforesaid spark shield. Assuming that braking action caused fire and/or sparks to be thrown upward toward a spark shield on a DODX car in the train of Extra 9117 West, there is a possibility such fire and/or sparks was not blocked by the spark shield because of its location and size. In this event, unblocked fire or sparks from the brake shoe and wheel area would have been directed to the underside of the car floor and could have ignited the floor, causing it to smolder. Thus, a possibility exists that the wooden floor of a DODX car was smoldering when Extra 9117 West entered the Roseville receiving yard approximately one hour before the initial explosion. A possibility also exists that the smoldering floor produced little or no smoke. There is a conflict in this theory between sparks causing a fire in an oil and greased coated floor and no smoke. In such fires, especially when smoldering, are usually very smoky. But, this could account for the fact that no one observed smoke emanating from the DODX car until approximately 15 or 20 minutes before the initial explosion, or presumably, under this hypothesis, about the time the smoldering portion of the car floor burst into flames and produced readily visible quantities of smoke.

The foregoing analysis is based on the reported facts of sparks flying from the wheel and smoke and flames before the explosions. The possible chain of events in the time frame between these two events are a plausible explanation of what may have occurred. However, there is insufficient evidence to support a conclusive finding that fire from sparking caused the bombs to explode.

2. Possibility of Unstable Bomb as Causal Factor

To assist in its investigation of the explosions, the SP employed explosive experts as consultants. In essence, it is their opinion that:

(a) The explosions were caused by an unstable bomb in one of the DODX cars involved.

(b) The bomb was unstable due to faulty procedures used by the Hawthorne Naval Ammunitions Depot.

Navy explosive experts disagree with the opinions expressed by the SP explosive experts. They maintain there is no evidence of improper manufacturing and loading on the part of the Navy which contributed to the initiation and proliferation of the explosions at Roseville.

While the Navy maintains that the procedures at Hawthorne are such as to prevent the manufacture of an unstable bomb, there is a clear difference of opinion between SP and Navy experts as to the stability of tritonal bombs produced at Hawthorne. Inasmuch as it is the shipper's responsibility to assure that commodities being offered for shipment meet safety requirements and the allegation of an unstable bomb or unsafe procedures has been made, it is necessary that the possibility of unsafe bombs be fully investigated.

The evidence available is not sufficient to support a conclusion that an unstable bomb or bombs was the causal factor of the accident. However, the critical need to examine all facets of the problem in order to prevent a recurrence prompts us to recommend that the Navy reexamine its manufacturing and loading procedures at Hawthorne and McAlester, where the tritional bombs are produced.

Findings

1. The cause or causes of the explosions at Roseville cannot be identified conclusively because of the widespread destruction and nature of the accident.

2. Lacking conclusive evidence, circumstances and events related to the accident point toward two possible causes:

   (a) Exposure of a bomb to heat, due to the wooden floor of one of the DODX box cars having caught on fire as a result of braking action which directed sparks and/or flames to the underside of the car floor, or

   (b) The presence of one or more unstable bombs in one of the DODX cars involved.

FRA Action

As a result of the incidents at Roseville and Tully (Benson), the FRA issued Emergency Order No. 3 on August 9, 1973. This order provides that each car transporting Class A explosives must be equipped with "low-sparking" type of brake shoes and all brake shoes on the car must be of the same and proper design, in safe and suitable condition for service, and comply with prescribed wear limits. In addition, the order provides that the car must be equipped with a continuous steel sub-floor or metal spark shields of prescribed dimensions or be subject to more frequent inspection requirements.

The FRA has increased its inspections and surveillance of the cars selected for the loading and transportation of Class A explosives.

The FRA is currently in the process of developing a final rule (see Appendix C) covering these matters deemed necessary for the safe transportation of Class A explosives in railroad cars.

Dated at Washington, D. C., this 15th
day of March 1974.
By the Federal Railroad Administration

Mac E. Rogers
Associate Administrator
Office of Safety

APPENDIX A

APPENDIX A

Southern Pacific
Transportation Company
One Market Street • San Francisco, California 94105 • (415) 362 1212
OFFICE OF GENERAL CLAIMS MANAGER

BURTON R. HOWARD
GENERAL CLAIMS MANAGER-SYSTEM

B. G. CHAMBERLIN
H. L. HARDIN
ASST. GENERAL CLAIMS MANAGERS-SYSTEM
J. D CALDWELL
M. J. RADER
E. B. MEADOWS
ASSTS. TO GENERAL CLAIMS MANAGER-SYSTEM

February 28, 1974

AIR MAIL - SPECIAL DELIVERY

Mr. M. E. Rogers
Federal Railroad Administration
Office of Safety
2100 Maryland Street S.W.
Washington, D.C. 20590

Attention: Mr. W. H. McCarthy

Dear Mr. Rogers:

Herewith summary of investigation conducted by Southern Pacific Transportation Company, and conclusions reached in connection with the explosions of bombs in DODX cars at Roseville, California, on April 28, 1973.

Very truly yours,

H. L. Hardin

H. L. HARDIN

SUMMARY OF INVESTIGATION BY SOUTHERN PACIFIC TRANSPORTATION COMPANY OF THE ROSEVILLE EXPLOSION, APRIL 28, 1973

A Chronological Sequence of Events Leading Up to the Explosion:

Between 3:00 p.m. and 4:00 p.m. on April 26, 1973, the Southern Pacific Transportation Company received twenty-one government-owned DODX cars loaded with 7,056 250-pound fragmentation-type bombs, each containing about 125 pounds of tritonal.

These cars were received on the interchange from the United States Navy at Thorne, Nevada. The cars received a joint inspection by the Southern Pacific car inspector and a civilian Naval Ordnance employee.

All twenty-one DODX cars departed Southern Pacific station at Thorne, Nevada, at 4:30 p.m., April 26, 1973, and arrived Sparks, Nevada, 9:30 p.m., April 26, 1973, for placement in a through train.

Between Hazen, Nevada, and Sparks, Nevada, the twenty-one DODX cars passed hot box detectors at MP 255 and MP 265, and the read-outs indicated all cars were running normally.

The cars remained at Sparks, Nevada, until 11:45 p.m., April 27, 1973. Prior to their departure from Sparks, all cars were inspected by Southern Pacific railroad police, and the inspections indicated the door seals were the same as those placed on the cars at the Navy plant at Hawthorne, Nevada. The cars were held in a well-lighted area within the Sparks yard and were observed at frequent intervals by approximately fifty railroad employees. None of the employees who observed these cars noted any condition that would place the cars in jeopardy, nor did they observe any trespassers or other unauthorized persons in the area.

The twenty-one DODX cars departed Sparks, Nevada, at 11:45 p.m., April 27, 1973, and enroute passed hot box detectors at MP 141.55 and MP 110.2, and the read-outs at both locations indicated all cars running normally. These cars arrived Roseville, California, at 6:15 a.m., April 28, 1973, and were placed on Tracks 7 and 3 in the Antelope Receiving Yard at 7:00 a.m.

Between Sparks and Roseville, the DODX cars received at least twelve visual inspections, which did not reveal any condition which could contribute to any hazard to the shipment.

Between 6:15 a.m. and 8:00 a.m., April 28, 1973, while being doubled over or standing in the Antelope Yard, the twenty-one DODX cars received in excess of thirty inspections by experienced railroad personnel, who again did not observe any unusual condition and, specifically, observed no fire or smoke that would alert anyone to the first explosion, which took place at approximately 8:00 a.m. on April 28, 1973.

A Chronological Sequence of Events During and After the Explosion of Eighteen DODX Cars at Antelope Yard, Roseville, California, April 28, 1973:

Shortly before 8:00 a.m. on April 28, 1973, a brief, muffled explosion was heard by civilian fire department employees and railroad employees at the Antelope Yard. At approximately

8:04 a.m., the first major explosion occurred. It was followed by other explosions during the balance of the day which eventually destroyed eighteen of the original twenty-one DODX cars in this shipment, causing extensive property damage and personal injuries. Explosions of varying magnitude continued at frequent intervals until approximately 11:00 a.m., April 28, 1973, and at less frequent intervals thereafter until about 1:00 p.m., April 29, 1973.

Southern Pacific Transportation Company has concluded that the explosion in the government-owned DODX cars was caused by the negligence of the U.S. Navy. Southern Pacific cited defective design, defective manufacture and testing of the bombs, improper loading and bracing of bombs in cars, and defective design, manufacture and maintenance of the government-owned DODX cars used for transportation of the bombs involved. In this connection we are attaching an affidavit of Dr. M. A. Cook which was filed with the Court in connection with a pending matter and explains in detail why we have arrived at the above conclusion.

Until the Roseville explosions, Southern Pacific had safely moved thousands of ammunition shipments to many military installations through World War II, the Korean War and the Vietnam War. The Company has not only complied with but has exceeded all governmental regulations for the movement of bombs and other hazardous shipments.

ireco Chemicals
SUITE 726 KENNECOTT BUILDING • SALT LAKE CITY, UTAH 84111

MELVIN A. COOK
Chairman of the Board

JUN 1? 1973

June 8, 1973

Mr. H. J. Hardin
Assistant General Claims Manager—System
Southern Pacific Transportation Company
One Market Street, Room 942
San Francisco, California 94105

Dear Mr. Hardin:

I am sure you will be most interested in a preliminary report of our examination yesterday of three Mark 81 bombs from Hawthorn sectioned at Tooele Army Depot (TAD) under the direction of Mr. Howard Stonebraker of the Ammunition Command at TAD. It amply confirms our suspicions that these bombs are defective and extremely hazardous by reason of a grossly improper filling procedure.

Those present with me (besides Mr. Stonebraker and the two technicians of TAD who sectioned the bombs) were Col. W. Cameron III, Mr. N. L. Dunn, Dr. R. Scott, and Mr. N. D. Bachtell, DOD Explosives Safety Board, and Dr. H. J. Matsuguna, explosives physicist, Picatinny Arsenal.

Our examination revealed that the filling procedure we saw at McAlester and you also saw at Hawthorn is extremely faulty such as to cause to occur a most hazardous condition in these bombs.

The final wax "buffer" we saw being poured into the Mark 82 bombs at McAlester simply does not perform its intended purpose. Instead of providing an inert buffer to prevent tritonal (and TNT) from coming into contact with the iron end plate, iron base fuse housing, and from penetrating the (iron on iron) threads, this wax was nowhere to be found in the sectioned portions of one bomb, only traces of it were found in the second, and, while mostly present in the immediate vicinity of the end plate in the third bomb, was not serving adequately its intended purpose even in this most favorable case. In other words, the wax supposed to be serving as a buffer had migrated entirely away from the base plate, the fuse housing and their threaded portions at some stage while still molten and had disappeared completely (or almost completely) into the large cavities in two of the three bombs.

As a matter of fact, tritonal, at least partly aluminum depleted (or, alternately stated, TNT enriched), had partially penetrated the threads of the base plate and base fuse housing. Col. Cameron suggested careful microscopic examination of the threads in all cases to assess the magnitude of this penetration. We all agreed that such an examination would be most appropriate.

There was good evidence for the situation I suggested at Mr. Bonner's meeting last Tuesday that unconsolidation of HE would occur in and surrounding the large cavities especially near the base of the charge, i.e., the threaded base end of the bombs. Moreover, the cavities were lined with pure, honeycombed, recrystallized TNT obviously in a much more sensitive condition than in a proper cast by reason of the porosity and partial unconsolidation of the TNT in these regions. The volume of pure, recrystallized TNT was comparable to that of the cavities which theoretically should amount to around 8% of the inside volume of the bomb.

To summarize the meaning of these deplorable conditions:

1. As you know, the Navy goes to great length to make sure there is no TNT-iron contact by coating the inside surface of the bomb with 8.5 pounds of tar. The final wax charge is added to provide the same protection to the base plate, base fuse housing, and threaded sections. All of this is negated by the grossly improper handling of these bombs after the final end plate has been secured onto the bomb. Because the wax does not remain in its proper place in the bomb, there is created a direct contact of tritonal and/or TNT with iron over practically all of the base plate. Thus the potentially dangerous TNT-on-iron corrosion may take place in these bombs relatively unabated.

2. Besides the corrosion propensity of the Mark 81 bombs, the steel threads of the base plate and fuse housing are, no doubt, easily penetrated by HE. Therefore, in jostling about (aggravated by the faulty staying and bracing methods revealed in the car unloaded at McAlester last Tuesday) there is clearly a most hazardous friction hazard of tritonal and/or TNT (as well as potentially more dangerous corrosion products) between iron surfaces in these threads.

3. Since the cavitation in the bomb extended right into this most hazardous threaded end plate region, there exists a potential, in fact very likely, ignition source as well as a ready channel for explosion buildup right from the region of this corrodible and potentially friction-initiated section of the bomb.

4. Adding to the problem is the distinct possibility that the aluminum-water reaction may take place, most likely right in this same dangerous region. However, while this remains a very likely occurrence to add to the hazard, it is nowhere near as great a potential hazard as the other conditions described above suggested by our questioning of Navy personnel in the meeting and confirmed by our examination of the three bombs yesterday at TAD.

The remaining bombs are scheduled to arrive at TAD this weekend. Mr. Stonebraker promised to call me when they have finished sectioning them so that I may complete my examination of the Mark 81 bombs (from Hawthorn) and Mark 82 bombs (from McAlester). This should be either next Monday or Tuesday. I will give you a report promptly following this examination.

Sincerely yours,

M. A. Cook

M. A. Cook

MAC/as

ireco Chemicals
SUITE 726 KENNECOTT BUILDING • SALT LAKE CITY, UTAH 84111

MELVIN A. COOK
Chairman of the Board

June 15, 1973

Mr. H. J. Hardin
Assistant General Claims Manager—System
Southern Pacific Transportation Company
One Market Street, Room 942
San Francisco, California 94105

Dear Mr. Hardin:

Having not heard from Mr. Stonebraker, I called him yesterday myself and asked about the progress on the sectioning of the Mark 82 bombs from McAlester. Several hours later he called me back and invited me to come to TAD to examine them. I did so in his presence and that of three TAD technicians, two being the same men present on my first inspection the week before.

Again the results of my examination were most significant revealing in every case the same hazardous condition wherein the wax buffer was not serving its purpose to protect the base end of the bombs. Clearly the loading procedure used at both Hawthorn and McAlester is defective creating the hazardous condition primarily responsible, no doubt, for the Roseville and Benson accidents.

I made quite a point last week of the hazard involved in permitting tritonal to penetrate the threads of the base plate and booster housing. As a result Mr. Stonebraker had directed his men to section one of the base sections longitudinally into quarters instead of halves in order to permit one to lift off these threads and examine them with a minimum disturbance to any tritonal penetration. This was done in this case in my presence and revealed that tritonal had indeed penetrated the threaded sections.

As a matter of fact, the penetration of the threads by tritonal was so extensive that chunks of cast tritonal, definitely enriched in TNT by segregation, had accumulated in the groove at the base between the outer and inner threads. We asked for careful photographing in color of this most hazardous situation.

A highly significant factor seen so far only in this quartered base sample was the presence of a good deal of white powder, clearly the reaction product of aluminum, i.e., aluminum oxide (Al_2O_3). Going hand in hand with this extensive white powder accumulation were actual cinders of burned tritonal. Mr. Stonebraker insisted that this was caused by the sawing of the bombs. I tend to agree with him on this matter, but if this is the proper explanation, their sawing process itself had the potential of exploding these bombs. Since it had not occurred in any of the other sawings, there remains a distinct possibility, on the other hand, that this is an example of the $2Al + 3H_2O \rightarrow Al_2O_3 + 3H_2$ reaction I talked about in McAlester.

All the McAlester bombs had been cut through radially at least once near the base, but only about a fourth of them had been sectioned longitudinally such as to permit me to examine the crucial threaded base section. In every such case the wax had moved out of this section leaving tritonal in direct contact with bare metal with the good possibility of penetrating into the threads exactly as I described in my June 10 letter. In other words, there was not a single exception to the fact that the wax had failed to accomplish its purpose in any of the Mark 81 and Mark 82 bombs I examined. Thus this extremely hazardous condition is the rule rather than the exception in both the McAlester and the Hawthorn bombs.

The rest of the program suggested to Mr. Benner by Dr. Scott, Dr. Matsuguma and myself will apparently be carried out elsewhere. Photographs and the results of this entire study will apparently not be furnished to me. Therefore, I think you should take whatever steps are necessary with Mr. Benner to obtain the final report by the Explosives Safety Board on this most significant investigation.

Kind regards.

Sincerely yours,

M. A. Cook

M. A. Cook

MAC/as
Encl.

JAMES DIEPENBROCK
DIEPENBROCK, WULFF, PLANT & HANNEGAN
455 Capitol Mall, Suite 800
Sacramento, California 95814
Telephone: 444-3910

Attorneys for Defendant
SOUTHERN PACIFIC TRANSPORTATION COMPANY

IN THE UNITED STATES DISTRICT COURT

FOR THE EASTERN DISTRICT OF CALIFORNIA

----oo0oo----

JOSEPH M. PUJALS, et al., Plaintiffs, v. SOUTHERN PACIFIC TRANSPORTATION COMPANY, Defendant.	NO. Civ. S-2911 AFFIDAVIT BY DR. MELVIN A. COOK IN OPPOSITION TO MOTION FOR SUMMARY JUDGMENT

----oo0oo----

STATE OF UTAH) ss.
COUNTY OF SALT LAKE)

I, MELVIN A. COOK, being sworn, say:

I was born on October 10, 1911, and presently reside at 631 - 16th Avenue, Salt Lake City, Utah. After completing my high school education, I attended the following universities and obtained the following degrees:

B.A.: University of Utah, 1933 - Chemistry
M.A.: University of Utah, 1934 - Physical Chemistry
Ph.D: Yale University, 1937 - Physical Chemistry

I am the founder of IRECO Chemicals and served as its President and Chairman of its Board from 1962 to March, 1972; from March, 1972, to the present time I have served as Chairman of the Board of IRECO Chemicals. My office address is Suite 726 Kennecott Building, Salt Lake City, Utah.

A brief summary of my career is as follows:

Research chemist, Explosives Department, Eastern

Laboratory, E. I. duPont de Nemours & Co., Gibbstown, New Jersey, June 1937 to April 1947.

Professor of Metallurgy, University of Utah, April 1947 to 1970.

Director, Explosives Research Group, University of Utah, 1951 to 1958.

Director, Institute of Metals and Explosives Research, University of Utah, 1958 to 1965.

President and Chairman of the Board of Directors, Intermountain Research and Engineering Company, Inc., 1958 to 1970.

President and Chairman of the Board of Directors, Mesabi Blasting Agents, Inc., Biwabik, Minnesota, 1960 to 1970.

President and Chairman of the Board, IRECO Chemicals, 1962 to March 1972.

Chairman of the Board, IRECO Chemicals, March 1972 to present.

Attached hereto as Exhibit A is a resume of my career, consulting activities, publications, and qualifications.

Officials of Southern Pacific Transportation Company asked me to investigate the explosions which occurred on Southern Pacific Transportation Company trains on April 28, 1973, at Roseville, California, and on May 24, 1973, at Tully, Arizona. My information on these two catastrophes stems from the following: (1) discussions with officials of Southern Pacific Transportation Company, members of the armed services, and others; (2) a visit to the Roseville explosion site on May 2; (3) attendance at a conference convened under the direction of Mr. Ludwig Benner, National Transportation Safety Board, and inspections at McAlester Naval Depot on June 5 and 6; (4) examinations of sectioned Mk 81 (250 lb.) and Mk 82 (500 lb.) tritonal bombs at Tooele Army Depot on June 7 and 14; (5) attendance at meetings and inspections directed by Mr. L. Benner and Capt. M. B. Lechleiter, Ordnance Systems Command, at

Hawthorne Naval Depot on August 21 and at Naval Ordnance Test Station at China Lake on August 22; and (6) a re-examination of sectioned bombs at Tooele Army Depot along with Mr. Benner and several military and Southern Pacific investigators on August 23, 1973.

The Mk 81 and 82 Bombs. The Mk 81 and 82 bombs are filled with "tritonal" in a single pour followed by a top off with a small dipper of molten tritonal and a final pour of a wax buffer through the base section of the bomb with the nose section down. The topping-off operation is conducted some distance from and roughly ten to fifteen minutes after the main pour operation. Shortly after the bombs are sealed and washed clean, operations requiring two or three minutes, they are laid on their sides after which much (but not all) of the solidification of the tritonal takes place.

The density of molten TNT at its melting point is 1.465 g/cc, while its crystal density at ambient temperature is 1.654 g/cc. Thus there is an 11% shrinkage in TNT upon solidification and cooling to ambient. The topping process employed by the Navy at McAlester (I did not observe that used at Hawthorne but understand it is essentially the same) can account for filling of probably less than 10% of this void space in the bomb. This means that the void space in the tritonal bombs (80% TNT) is about 8%. This void space is partly uniformly distributed within the cast tritonal, but most of it occurs in very large voids toward the upper side of the horizontally oriented bombs. Thus, with bombs laid on their sides, there is always a layer of fairly good, unsegregated tritonal next to the walls of the bomb except near the base where the final tritonal topping and wax buffer are poured. The latter part of the filling may not (and often does not) solidify in the short interval prior to laying the bombs on their sides. Thus, when the bombs are laid on their sides, both the wax buffer and the top layer of tritonal may (and often do) flow away from their intended position depending on the time interval and other factors involved.

Because the density of aluminum (2.7 g/cc) is much higher than that of TNT, tritonal tends to segregate rapidly while it is still in the fluid state. Therefore there is a tendency for the aluminum to concentrate in the nose section during filling and topping. On the other hand, TNT tends to concentrate in the region of final cavities of the bomb. In fact, the lower sides of the cavities generally comprise pure TNT in porous, sometimes highly dentritic form.

I visualized this situation apparently much more clearly than any of the Navy technicians who described it at the McAlester meeting on the morning of June 6, 1973, because they claimed they knew with high precision the exact nature of the cavities in the tritonal bombs and that the cavities occurred on the side of the bomb in a safe position. When they claimed such knowledge of the size, shape, and position of the bomb "cavity," I expressed ill-humored disbelief and suggested that the bombs should be sectioned and examined to ascertain the real nature of the cast tritonal in them, especially with respect to the base section. I claimed that this section of the bombs would be where the greatest abnormalities would be found and that it would be here to look for the hazards which I considered inherent in the procedures used by the Navy in filling the Mk 81 and 82 bombs. One must certainly assume at this point in time, bearing in mind our discussions at McAlester, that the Navy personnel in attendance at that meeting did not actually know the actual conditions that existed in these bombs. Nevertheless, I see no excuse for this deplorable state of affairs.

I have been present on four occasions when visual examinations were made of sectioned bombs, three times (June 7, 14, and August 23) at Tooele Army Depot and once (August 21) at Hawthorne Naval Depot. From my examinations, the following significant conclusions can be drawn:

1. The wax "buffer" which comprises the final addition to the bombs (to provide a safety buffer between the tritonal and the base section with its complex thread and therefore "pinch-point" structure) seldom remains in its intended position. Instead, it flows irregularly away from this position permitting tritonal and/or pure TNT to enter this section (also irregularly). As a result, the sectioned base revealed conditions varying almost continuously between a situation in which the wax buffer was found almost in its intended place, through conditions in which the wax buffer was heterogeneously mixed with tritonal and/or TNT, finally to that condition in which the buffer had disappeared altogether from this section of the bomb and became lost apparently somewhere in the main cavities of the bomb.

2. In many cases explosive (TNT or tritonal [no doubt of various aluminum contents]) was found not only in contact with bare metal parts but also in the threads of the base parts of the bomb. In a discussion at Hawthorne Naval Depot, the military personnel present agreed that explosive had come into direct contact with the outer edge of these threads where the male and female threads make their initial contact. In my opinion, that same explosive had actually penetrated the steel threads and constituted extremely dangerous pinch points. During our examination at Tooele Army Depot on August 23, everyone present agreed that explosive had indeed penetrated between the threads in some bombs. As a matter of fact, there had been penetration clear through the threads in at least one case.

Water in Mk 81 and 82 Bombs. In my judgment there is a distinct possibility that water can get into these bombs during their manufacture and cause self-heating upon prolonged storage. Mr. Frank Crist, in charge of munitions at Tooele Army Depot, has the same respect as I do for the hazard of water in tritonal; he mentioned an incident in which a mixture of TNT-Al-water exploded spontaneously when exposed to strong sunlight and described the dangers of sawing aluminumized explosives under a water spray. (He said he could not saw into aluminized explosives safely when the humidity was above a certain critical value.)

I examined a water hose at McAlester Naval Depot that was used to wash down Mk 82 bombs while they are still open to the exterior and standing base end up and open (before the final topping off and sealing had taken place). I did not see the Hawthorne Naval Depot lines, but am informed that the possibility of water getting into bombs there was even greater than at McAlester Naval Depot.

If water gets into these bombs it would tend primarily to migrate into the cavities of the bombs, but some moisture would spread uniformly throughout the tritonal. The precautions necessary to keep water from getting into open bombs before the topping operations, or from getting into the ingredients before the melting process, were entirely inadequate at McAlester Naval Depot. I understand there was also ample opportunity for moisture to get into the bombs by these processes at Hawthorne Naval Depot as well. Aluminum and water can react at first slowly but at an ever-increasing rate (due to increasing alkalinity) and can eventually cause ignition. The rate of the Al-H_2O reaction is increased by alkalinity (as is no doubt present in the desert area surrounding Hawthorne) so that if alkaline water gets into the bombs the reaction may proceed rather rapidly.

<u>Illustrations</u>. Exhibit B attached hereto illustrates a condition that exists all too prominently in the Mk 81 and 82 bombs. Here is sketched illustratively the approximate positions of the cavities in these bombs relative to the nose, center, and base sections of the bombs. Exhibit C attached hereto presents (only qualitatively, of course) the sort of composition changes one expects from visual observations to find across the bombs at

positions AA' and BB' of Exhibit B. The situation at CC' is similar to that at BB', but that at DD' is appreciably different. At DD' the composition and cavity situations are almost random in character.

As tritonal is poured into the bomb, a thin layer quickly solidifies on the cold bomb walls and other steel surfaces. Thus the composition near the extreme outer edges at AA', BB' and CC' is probably nearly always normal tritonal (80/20 TNT/Al). In the approximately ten to fifteen minute interval from the initial filling until the bombs are laid on their side, there has no doubt been considerable aluminum enrichment by segregation into the nose section (i.e., at AA' of Exhibit B) with corresponding concentration of TNT towards the base section. This condition enhances the hazards from pinch points and cannot be appreciably altered later on by laying the bombs on their sides after the filling is complete. This condition is illustrated by the AA' curves of Exhibit C.

As to the BB' cross-section, tritonal should be (nearly) proper (at 80/20) at and near the walls of the bomb. Then as one moves into the bomb along BB' he encounters the cavities where, of course, neither TNT nor aluminum exists. Beneath the cavities there is a layer of TNT, i.e., the last TNT to solidify. (This material contains no aluminum at all.) Going deeper along BB', one arrives at a layer where aluminum suddenly appears and increases rapidly probably to near 20% (the normal value) below this point. This continues until one approaches the bottom of the horizontal bomb. At this point some aluminum enrichment may be encountered before reaching the bomb sidewall where the composition will again be nearly normal due to the initial sudden solidification at the beginning of the primary filling. Conditions at CC' should be essentially the same as at BB' except that here one might more often encounter some of the wax buffer that has migrated away from the base section and disappeared into the cavities.

Along the line DD' the composition obviously differs widely from one bomb to another. Some bombs have no cavities at this position, but others have cavities that extend right into the base. Furthermore, those with cavities at DD' may also have either wax or TNT (or tritonal of various compositions) at this position. It is those bombs with cavities that extend right up to the threaded parts of the base section and in which the buffer has largely disappeared that are most hazardous. Unfortunately such bombs are not at all exceptional.

Threads in the Base Section. Normally the threads of the base section are coated with a protective layer of carbonaceous material, but this is not always the case. I saw several examples of bare threads and other base metal parts lacking this carbonaceous coating. Moreover, the threads were not entirely regular as to the depth of thread in all cases, thus permitting contamination by liquids to enter them irregularly. In any case such threaded sections are not proper seals for liquids; the type of molten liquids involved in Mk 81 and 82 can penetrate these threads fairly easily, even under relatively slight positive pressure. I saw many sectioned Mk 81 and 82 tritonal bombs that were defective by reason of contamination of the TNT or tritonal of such a nature as to produce hazardous "pinch points" and corrosion points not only in the threads but elsewhere in the other base sections of these bombs.

Military Specifications and Standards. A military standard entitled "Sampling Procedures and Tables for Inspection by Attributes" (Mil-Std-105D, 29 April 1963) defines a "critical defect" in Paragraph 2.1.1 as follows:

> CRITICAL DEFECT. A critical defect is a defect that judgment and experience indicate is likely to result in hazardous or unsafe conditions for individuals using, maintaining, or depending upon the product; or a defect that

> judgment and experience indicate is likely to prevent performance of the tactical function of a major end item such as a ship, aircraft, tank, missile or space vehicle. *NOTE:* For a special provision relating to critical defects, see 6.3.

That same standard contains special provisions relating to critical defects as follows:

> 6.3 SPECIAL RESERVATION FOR CRITICAL DEFECTS. The supplier may be required at the *discretion of the responsible authority* to inspect every unit of the lot or batch for critical defects. The right is reserved to inspect every unit submitted by the supplier for critical defects, and to reject the lot or batch immediately, when a critical defect is found. The right is reserved also to sample, for critical defects, every lot or batch submitted by the supplier and to reject any lot or batch if a sample drawn therefrom is found to contain one or more critical defects.

A copy of the military specification for "Bomb, General Purpose, Mark 81, 250 Pound Explosive Loading, Assembling and Packing," (Mil-B-82547, 28 February 1969) is marked Exhibit D and attached hereto. Paragraph 3.6 specifies:

> Radiographic examination of the explosive charge - The loaded bomb shall be subjected to radiographic examination in accordance with 4.4 and 4.6.2. A shrinkage cavity will only be permitted when located 180 degrees opposite from the suspension lug holes, and more than 6 inches from the nose fuze liner, and when not in contact with the base fuze liner. (Underlining added)

> Paragraph 4.6.2 specifies:

> Radiographic examination of the explosive charge - Each bomb selected shall be radiographed in two planes in accordance with the requirements of MIL-STD-746. One plane shall be through the lug and bomb centers and the other at 90 degrees to it. Shrinkage cavities if any, shall be checked for conformance to 3.6. (Underlining added)

Identical provisions appear in the military specification for "Bomb, General Purpose, Mark 82, 500 Pound, Explosive Loading, Assembling, and Packing" (Mil-B-82548, 28 February 1969). I have reviewed some of the pertinent drawings for these bombs. Drawing 1350946 for the Mark 81 bomb lists as "critical":

> Explosive shall be kept out of charging tubes, fuze liners, off all threads and exterior surfaces of bomb case." (Underlining added)

Drawing 1380901 for the Mark 82 bomb lists as "critical":

> Explosive shall be kept out of charging tubes, fuze liners, off aft fuze liner flange and off all threads and exterior surfaces of bomb case. (Underlining added)

Some of the sectioned bombs I examined revealed shrinkage cavities in contact with the base fuze liner and/or the presence of explosive in the threaded area of the base sections. Therefore, they did not meet all the requirements of the specifications and contained "hazardous or unsafe conditions for individuals using, maintaining, or depending" upon those bombs; they contained "critical defects" and should have been rejected prior to shipment.

Attached hereto as Exhibit E is a copy of my report of June 8, 1973; attached hereto as Exhibit F is a copy of my report of June 15, 1973. These reports provide further details of my observations of the hazardous bombs produced at Hawthorne Naval Ammunitions Depot and McAlester Naval Ammunition Depot.

The necessity for the proper installation of adequate wax buffer pads was convincingly established by a series of tests performed by Picatinny Arsenal in 1944 at the Southwest Proving Ground (Reference SPG Report No. 45). The bombs tested were 500 lb. A/NM64 Comp B filled without wax buffer pads; they were dropped from heights of 15' to 50' onto a steel plate. Detonations occurred in bombs dropped onto their tails. The report from that series of tests concludes in part as follows:

> In general unfuzed 500 lb. bombs, filled with TNT or Comp B (with or without TNT nose and tail surrounds), will detonate when dropped onto a hard surface once or successively from heights up to 50 ft. Such detonation may be caused by heat of

> compression generated by shifting of the filler into cavities or more probably from shock caused by "pinching" of explosive between the surface of incipient, interior shell cracks, or of threads. The efficacy of inert tail seals (wax buffer pads) in reducing sensitivity lends credence to the later theory, but it may also be argued that this seal (wax buffer pad) simply acts as a cushion, thereby decreasing the heat of compression.
>
> TNT and Composition B (with TNT nose and tail surrounds) fillers, with inert tail seals, show marked insensitivity upon being dropped onto hard surfaces but exhibit normal high order detonations when tested statically.

Notwithstanding the knowledge that the presence of a wax buffer pad (inert sealer) makes a tritonal bomb less sensitive to impact and rough handling, the Navy has failed to utilize time-honored techniques to ensure the existence of an adequate wax buffer pad. Further, the Navy has admitted some knowledge of prior accidental explosions of tritonal-filled bombs. In a "Test Plan for Evaluation of Safety of General Purpose Bombs MK-82 Involved in Explosive Incident at Benson, Arizona, on 24 May 1973" issued by the Naval Ordnance Systems Command, the following statements are made:

> There have been . . . six handling accidents with tritonal-loaded M-117 series (750 lb.) bombs; these accidents were subsequently attributed to lack of hot-melt coating and possible "pinch points" in the base section of these bombs.

Except for size, which is not a factor, this is precisely the situation we have found in the Mk 81 and 82 bombs. After such a discovery on the M-117 bombs, one would reasonably expect the Navy to discontinue the production of these bombs until their hazardous "pinch points" and their deplorable, hazardous palletizing and staying practices have been rectified. Instead of adopting this logical approach, they are willing to ignore safety in favor of production.

Other Accidental Tritonal Bomb Explosions. I agree that tritonal is one of the least sensitive explosives in use, and if tritonal bombs are properly made, they can be transported safely. However, failure to strictly adhere to proper quality control and manufacturing techniques can cause undesirable sensitivity in tritonal bombs. The limited information published suggests that undesirable and unnecessary sensitivity contributed to the following explosions of tritonal bombs:

(a) May 27, 1967, explosion of a 750-lb. tritonal bomb at Naval Weapons Station, Concord, California.

(b) The "recent accidents" referred to in an August 1967 message, a copy of which is marked Exhibit G and attached hereto, wherein the following statements are made:

> Recent accidents of tritonal-loaded bombs during loading and unloading operations indicate need for special handling requirements.
>
> Although the bombs are unfused and unboostered they have demonstrated a sensitivity to shock and rough handling far above that expected. All addresses involved with any phase of the handling of tritonal bombs will assure that the utmost care is exercised during such handling operations.

(c) The three incidents or accidents referred to in Technical Memorandum 1863 dated October 1968 and authored by Louis Avrami, entitled "Results of Laboratory Studies on the Investigation of M117A1 750-pound Incidents," wherein the introduction to this report contains the following statement:

> Three incidents or accidents have occurred at different installations in southeast Asia (SEA) and one in the United States involving unfuzed M117A1 750 pound bombs. The circumstances under which these events occurred indicate that unexplainable explosions had occurred with unarmed bombs during handling or while in a storage area.
>
> This report deals directly with the explosive material from one of the bombs which was involved with the Korat No. 2 incident on 12 May 1968. The details describing this accident can be found elsewhere (Reference 1).

(d) The "explosive incidents" referred to in the Final Report dated November 1968, published by Ammunition Equipment Office, AMXTE-AEO, Tooele Army Depot, authored by Allan Parkinson, entitled, "Impact and Drop Test of Bombs GP 750 Lb. M117A1 and 500 Lb. MK82." The preface to this report states in part as follows:

> Explosive incidents occurring during bomb handling operations at Korat and "U"-tapao, Thailand storage and revetment locations mandated that the explosive hazard associated with bumping or dropping of M117A1 Tritonal filled GP bombs be definitely established. Investigation of these incidents concluded that bombs involved in the incidents dropped vertical distances of as little as 19 inches to not more than 48 inches to impact either on other bombs or aircraft landing matt (Perforated Steel Plank-PSP) laid directly on cleared ground.

(e) The December 26, 1969 explosion which occurred aboard the Badger State, which vessel was loaded with a cargo of 2,000-pound bombs loaded with tritonal. During a very severe storm the bomb stowage and packaging system proved inadequate to restrain the cargo, and bombs rolled loose. Some bombs even punched small holes in the side of the vessel. A low-order explosion occurred in one of those bombs causing severe structural damage, following which the vessel sank.

(f) The detonations referred to in Technical Report 3830, dated December 1968, concerning Impact Sensitivity (Sled Tests) at the Naval Ordnance Test Station in China Lake, wherein the following statements are made.

> Sled tests were conducted at the Naval Ordnance Test Station in China Lake, California to determine the effect of impact on the 750-lb. M117A1 GP Bomb loaded with MINOL-2 and 80/20 Tritonal. The targets were concrete blocks three feet thick by five feet square reinforced with one-inch diameter steel rods located 11 inches from center to center. The targets were oriented perpendicular (90°) to the line of fire and 75° and 45° from perpendicular. Two bombs each loaded with MINOL-2 and 80/20 Tritonal were tested at each impact angle. Results of the tests are in Table 6. Photographs of the tests with MINOL-2 showing the condition of the bombs and targets after impact are shown in Figure 1-16. No action occurred with the MINOL-2, whereas four of the six bombs with Tritonal detonated low order.

(g) The "six handling accidents" referred to in the July 2, 1973 "Test Plan for Evaluation of Safety of General

Purpose Bombs MK-82 Involved in Explosive Incident at Benson, Arizona, on 24 May 1973"--Promulgated by Naval Ordnance Systems Command. The following statements are made in Paragraph 2 of the general plan on Page 1 of said Test Plan:

> Tritonal has been used as a military explosive since approximately 1943; it was first loaded in bombs in the United States in 1945 (reference (a) refers). Until the Roseville, California explosion on 28 April 1973 there had been no recorded incidents involving Tritonal-loaded MK80 series GP bombs. There had been, however, six handling accidents with Tritonal-loaded M-117 series (750 lb.) bombs; these accidents were subsequently attributed to lack of a hot-melt coating and possible "pinch points" in the base section of these bombs. No further incidents have been reported since the base section was redesigned and the Air Force authorized the use of the Navy hot-melt procedure for coating the interior of these bombs.

(h) The accident referred to in an article published in the September 18, 1968, issue of AEROSPACE MAINTENANCE SAFETY, entitled, "Manhandled Bombs React," wherein the following statements are made on Page 18 concerning a low-order accidental explosion of a tritonal bomb in Thailand:

> Over the years we have learned the hard way that, every so often, rough handling causes an overly sensitive bomb to explode.
>
> * * *
>
> The reason anyone survived is because the initial explosion was low order, and the survivors had time to reach a safe area before the rest of the works exploded high order.

(i) The accidents referred to in an article published in the September 1968 issue of AEROSPACE MAINTENANCE SAFETY, Pages 10-13, entitled, "Selected Statistics," wherein the following statements are made:

> . . . there has been a dangerous rise in bomb-handling accidents since January (1968) this year. Two accidents during the period were catastrophic and produced 6 fatalities, numerous injuries, and property loss.
>
> . . . during the first half of 1968 there were 27 reported occurrences compared

with 8 for the entire preceding year.

. . . during the first 6 months of this year (1968) some 232 bombs exploded and some of our people aren't here any more. Munitions handlers intentionally shoved bombs from stacks.

Bombs look rugged so some people think they are insensitive when not fuzed or boostered. The fact is that a bomb is a container of high explosive . . . and can be detonated more ways than one.

(j) The accidents referred to in an article published in the November 1968 issue of AEROSPACE MATINENANCE SAFETY MAGAZINE, entitled, "Explosives Safety," wherein the following statements are made on Page 18:

It's happened again. In March (1968) 155 bombs exploded accidentally. In may, 40 of these big ones blew. This time there were 288 of the 750-pounders stacked . . . and most of them exploded shortly after a pallet toppled from a stack. This was the biggest of the three blasts but, luckily, there was only one casualty. It was one of those rare occasions when the troops had time to evacuate before a series of low-order explosions set off a high-order detonation. . . .

. . . as in the other two explosions the loaders were removing unfuzed and unboostered M117 bombs from a nodule at the storage area and placing them on a flat bed trailer, using a "rough terrain" forklift. The pallets had been nudged back a little by the heavy tines each time the operation was repeated and eventually this caused a pallet to fall off the rear of the stack . . . two unbanded bombs struck together and caused an initially low-order explosion, followed by several low orders that culminated in a very high-order detonation.

Since the 3 serious accidents occurred there has been a lot of testing and theorizing going on with considerable discussion and debate concerning the possibility of SOME OF THESE BIG BOMBS BEING MORE SENSITIVE THAN OTHERS.

(k) The three accidents referred to in Technical Memorandum 1873, dated November 1968 and authored by John R. Hendrickson, Sr., Picatinny Arsenal, Dover, New Jersey, entitled, "The Tritonal-Water Reaction as a Possible Explanation of M117A1 750-Pound Bomb Incidents." In the introduction to the report on

Page 2, the following statement is made:

> During the past year (1968) there have been three serious accidents involving tritonal-loaded M117 750-pound bombs exploding in storage areas. In all three accidents (Ref. 1,2) unfuzed and unboostered bombs were dropped while operators were removing them from a stack of bombs on pallets.

I have read Title 49, Code of Federal Regulations, Part 173.51, which provides:

> Forbidden explosives (a) The offering of the following explosives for transportation by common carriers by rail, rail express, highway, or water is forbidden. (b) Explosive compositions that ignite spontaneously. . . .

In my opinion, this regulation was violated by the U. S. Navy's shipment of the Mk 81 and 82 bombs involved in the explosions at Roseville, California, and Tully, Arizona, because of critical defects and conditions which existed in those bombs that I have described in this affidavit. Further, I am informed that 49 U.S.C. 1(4) obligates a common carrier to "provide and furnish transportation upon reasonable request therefor." In my opinion, the U. S. Navy made an unreasonable request when it asked Southern Pacific Transportation Company to transport the hazardous and sensitive bombs that blew up at Roseville, California, and Tully, Arizona.

Lastly, the condition of DODX cars similar to those involved in the explosion at Roseville, California, and the condition of the railroad car that survived the Tully, Arizona, explosion eloquently evidences the need for improvements in the quality of the lumber utilized for interior bracing and the bracing techniques themselves. Current loading and bracing practices followed by the U. S. Navy permit excessive movement of the bombs within railroad cars causing the bombs to collide with each other, permit the bombs to impact with the car walls and sides with force and thus expose the public to the unnecessary hazard of a detonation of a sensitive bomb. Further, the friction generated by excessive movement of bombs loaded in cars can initiate fires which can in turn cause a sensitive bomb to detonate.

I am informed that the Commander, Military Traffic Management and Terminal Service, an officer of the United States Government, sent a telegram dated July 4, 1973 to Southern Pacific Transportation Company stating:

> It has been determined by the Department of Defense that Mark 81 and Mark 82 tritonal bombs being produced at McAlester Naval Ammunition Depot and Hawthorne Naval Ammunition Depot are safe for transportation.

This telegram implies that corrective action has been taken to improve the manufacturing techniques utilized in the production of Mk 81 and 82 bombs. If the corrective action necessary to eliminate the causes of the defects and hazards I have described has been taken, these bombs are indeed safe for transportation. However, if the necessary changes have not been made in those production techniques, then these bombs are not safe for transportation by rail, truck or any other mode of transportation.

Melvin A. Cook

MELVIN A. COOK

Subscribed and sworn to before me this 17th day of January, 1974.

Robert A. B...

Notary Public in and for the County of Salt Lake, State of Utah

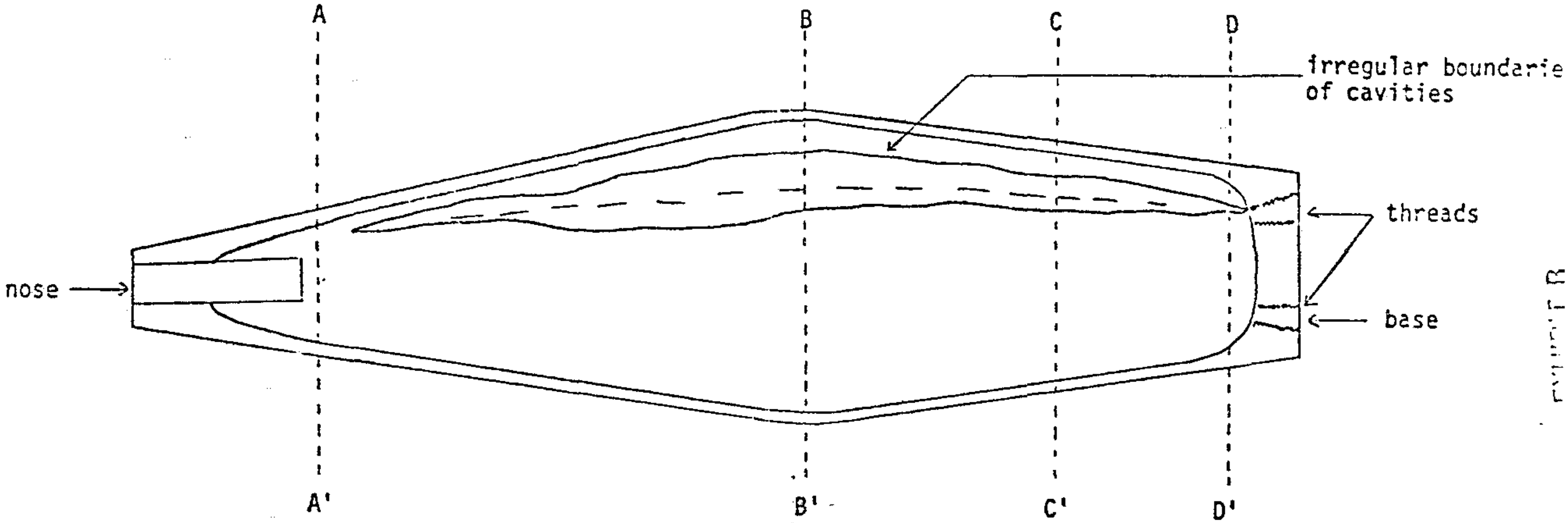


Figure 1. Diametrical Cross-Section Showing Cavities of a Tritonal Bomb.

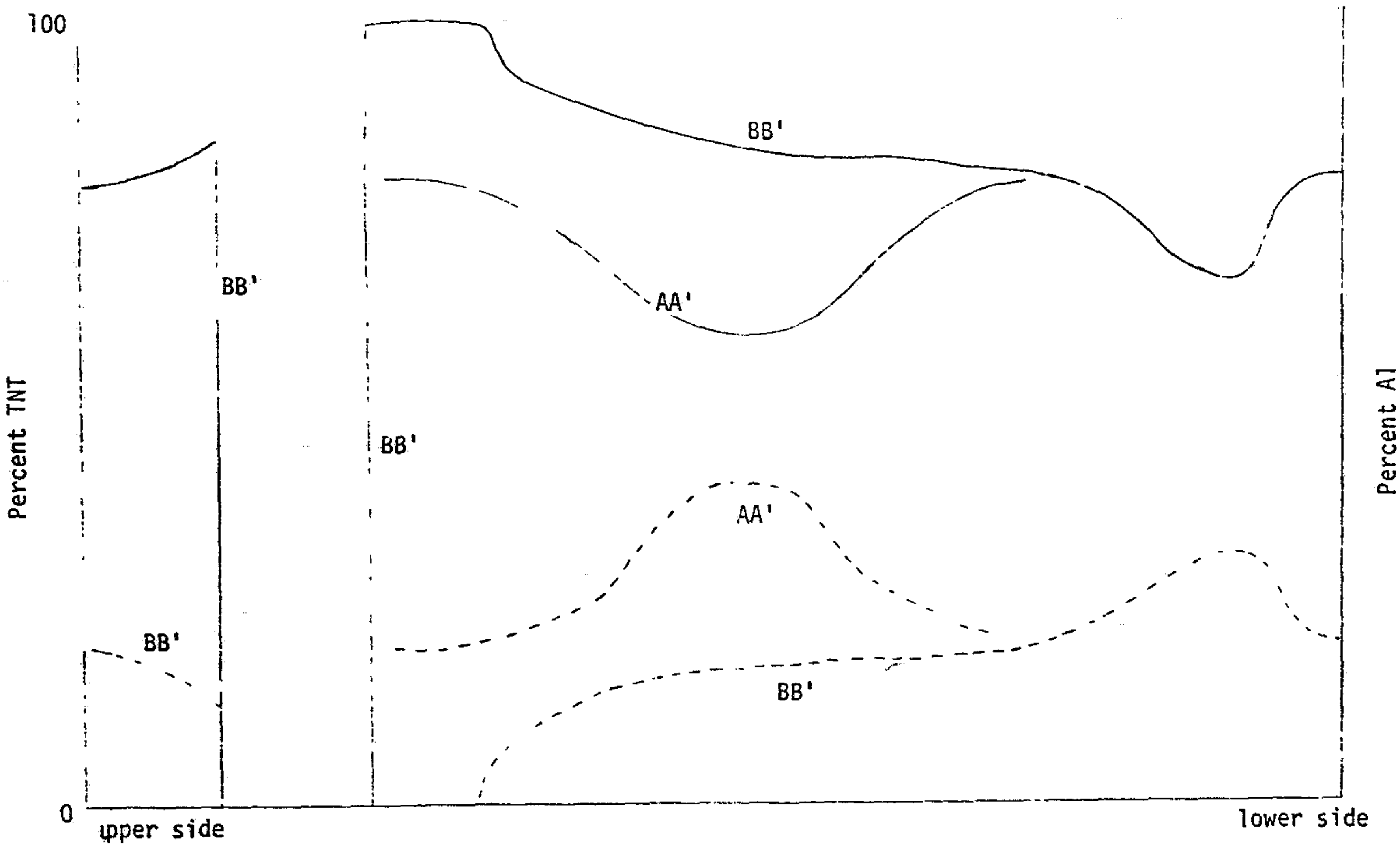


Figure 2. Qualitative Composition Diagrams of Mark 81 and 82 Bombs.
(solid curves - TNT, dashed curves - Al)

EXHIBIT C

APPENDIX B

DEPARTMENT OF THE NAVY
NAVAL ORDNANCE SYSTEMS COMMAND
WASHINGTON, D. C 20360

IN REPLY REFER TO
ORD-04M/15:JEE
8150
March 1, 1974

Mr. William H. McCarthy
Department of Transportation
Federal Railroad Administration
Operations Branch, Office of Safety
2100 2nd Street, N.W.
Washington, D.C. 20591

Dear Mr. McCarthy:

In response to your oral request of February 20, 1974, the following information concerning Mk 80 series Tritonal-loaded bombs is forwarded for your information and possible use:

Following the explosive incidents at Roseville, California and Benson, Arizona, Southern Pacific Transportation Company retained as a consultant, Mr. Melvin A. Cook, Chairman of the Board of IRECO Chemicals, Salt Lake City, Utah. Dr. Cook attended NTSB (National Transportation Safety Board) open hearings at the Naval Ammunition Depot, McAlester, Oklahoma, and observed the bomb loading operations there. Subsequently he examined Mk 81 and Mk 82 bombs produced by the Naval Ammunition Depot, Hawthorne, Nevada and the Naval Ammunition Depot, McAlester, that had been sectioned at Tooele Army Depot, Utah. His observations and evaluations were reported to the Southern Pacific Transportation Company in two letters dated 8 and 15 June 1973, enclosures (1) and (2). The letters allege that the bombs as produced by the Navy are defective and extremely hazardous due to grossly improper loading procedures. The letters have been given wide circulation by Southern Pacific, including the NTSB and numerous citizens organizations in the central California area.

Comments concerning Dr. Cook's allegations were requested from recognized experts in the bomb and explosives fields at the Naval Ordnance Laboratory, White Oak, Maryland, the Naval Weapons Center, China Lake, California, Picatinny Arsenal, Picatinny, New Jersey and the Naval Ordnance Systems Command. The comments received are remarkable in their uniformity and have been used to prepare the response to each of Dr. Cook's allegations provided in enclosure (3).

Long experience and extensive testing have proved that Mk 80 series bombs are not sensitive to mild impacts; in fact, they will sustain amazing abuse. Over seven million Tritonal-loaded Mk 80 series bombs have been produced and shipped overland without incident prior to the Roseville incident. (Tritonal is 80 percent TNT and 20 percent aluminum.) There is no record of auto-ignition of bombs of this type.

The presence of cavities, segregation, crystalline material and migration of wax pads as reported by Dr. Cook is not unusual and is the result of the loading process in use. The quality of the bombs examined by Dr. Cook at Tooele, Hill Air Force Base, Utah, was completely normal for the process in use and is no different from that of millions of bombs previously produced. Further, these and similar bombs have passed numerous severe tests without problems. Thus, it seems reasonable to assume that the presence of cavities and voids, aluminum-rich and aluminum-poor areas and lack of proper wax pads do not really give rise to hazards in handling the bombs as alleged by Dr. Cook; otherwise there would have been numerous previous explosive incidents.

It is possible that Dr. Cook's lack of familiarity with the actual appearance of bombs as loaded at the present time has lead him to erroneous conclusions regarding the safety of the bombs and the hazards involved in their handling.

The foregoing leads to the following conclusions:

a. There is no foundation in fact that the conditions observed by Dr. Cook cause the bombs to be unduly hazardous.

b. That the bombs sectioned at Tooele are no more hazardous than over seven million bombs previously loaded by the same process.

It should be clearly recognized that the alleged deficiencies are based upon hypotheses which have not been supported by past experience; nor can they otherwise be justified. None of the alleged "deficiencies" could occur and present safety hazards so long as existing standard operating procedures are followed. It is further our opinion that the incidents at Roseville and Benson could only have been caused by a transportation related event, e.g., hot box and subsequent fire. The responsibility for eliminating further such accidents must be placed upon those who have responsibility and authority for transportation. To presume that addressing production related "deficiencies" will eliminate explosions, may well divert attention from the real cause with no measurable effect other than to raise costs and reduce production rates. The result will be less rather than greater safety.

ORD-04M/15:JEE
8150
March 1, 1974

Additional documents have been included with this letter which expand upon and further substantiate the information in the preceeding paragraphs.

Sincerely,

J. E. EDMUNDSON
Captain, USN
Special Assistant for Gun Ammunition
By direction of Commander,
Naval Ordnance Systems Command

Encl:
(1) Copy of IRECO Chemicals (Dr. M. A. Cook) ltr of Jun 8, 1973
(2) Copy of IRECO Chemicals (Dr. M. A. Cook) ltr of Jun 15, 1973
(3) Document prepared by J. E. Edmundson (Naval Ordnance Systems Command) of Aug 14, 1973 entitled: "Comments on Allegations Concerning Bomb Safety"
(4) Copy of Dr. Taylor B. Joyner (Naval Weapons Center, China Lake) ltr 6056/TBJ:mtd of Aug 15, 1973 to Mr. Raymond L. Beauregard (0332A), Naval Ordnance Systems Command, Washington, D.C.
(5) Document prepared by Dr. Wm. S. McEwan and Dr. Taylor B. Joyner (Naval Weapons Center, China Lake) of Feb 19, 1974 entitled: "Evidence of Shaped Charge Action in Bombs Recovered from Roseville and Benson"
(6) Copy of Naval Ordnance Systems Command ltr, ORD-048D:EAD, ORD-0332A:RLB ser 03157 of Aug 21, 1973 (UNCLASSIFIED) (w/o enclosures)

DEPARTMENT OF THE NAVY
NAVAL WEAPONS CENTER
CHINA LAKE, CALIFORNIA 93555

IN REPLY REFER TO:
6056/TBJ:mtd
15 August 1973

Mr. Raymond L. Beauregard (0332A)
Naval Ordnance Systems Command
Washington, D. C. 20360

Dear Ray,

The following is a copy of the comments I made in support of Dr. McEwan's response to Dr. Cook's letters to Mr. Hardin. It differs from the less formal notes you received earlier only in that a reference to a Picatinny Arsenal report has been corrected. I have not otherwise altered the text. The reference in paragraph 1 is, of course, to Dr. McEwan's letter of 16 July 1973.

COMMENTS ON DR. COOK'S LETTERS

1. The truly important point is that made by Dr. McEwan. There is a gross inconsistency in Dr. Cook's arguments. An allegedly "extremely hazardous condition" is "the rule rather than the exception." It may be sensibly argued that if this condition is common, it is certainly not extremely hazardous. Long experience has indicated that our bombs are not sensitive to mild impacts. In fact, they can take amazing abuse. The most recent demonstrations are provided by the surviving bombs from Roseville and Benson. They endured the severe conditions of the catastrophes; handling by EOD and other recovery personnel (including commercial wreckers at Benson); and were subsequently trucked to various locations around the country. They have given no trouble. Millions of other bombs have been equally well behaved. This clearly indicates that they are not possessed of an "extremely hazardous condition."

2. A further example of the reliability of our ordnance and the inconsistency of the attacks upon it is provided by the Toelle sawing. In a somewhat confusing paragraph in the June 15 letter Cook says, "their sawing process itself had the potential of exploding these bombs." Certainly it is reasonable to assume that driving a saw through steel and explosive might be a hair-raising activity. That is why, treating the potentialities with due respect, we do our sawing remotely. (The Viet Cong, having great faith in our ordnance did it by hand.) The point of present importance is simply that we used a dry saw (confirmed by Mr. H. Rantala of Toelle, July 11, 1973) to saw through (several times) the precise areas which in Cook's estimation are extremely sensitive. There were no explosions. Surely, this is a telling experiment. It once again provides evidence that our ordnance is inert to very severe attacks--far more severe than would be anticipated on "jostling about" in a boxcar--even when those attacks are directed specifically at the area of the allegedly "extremely hazardous condition."

ENCLOSURE(4)

3. The above reinforces--under extreme, applied conditions--what standard sensitivity tests (impact, friction, etc.) have already told us. Tritonal and the TNT upon which it is based are not sensitive explosives. Rather, they are among our most insensitive fills. We simply do not expect them to go off under mild conditions such as "jostling about." The standard sensitivity tests and the far more drastic events of Roseville, Benson, and the Toelle sawing station clearly demonstrate that we are dealing with very insensitive explosives.

4. None of the above should be taken as suggesting that manufacturing defects are a good idea. They aren't. In particular, they may reduce the bomb's resistance to cook-off in a fire and, also, introduce the possibility of unexpected hazards during long-term storage. Cook's comment that "the Navy goes to great length to make sure that there is no TNT-iron contact" is pertinent to both of these. Clearly, we hope that the insulative value of the liner will postpone the onset of violent reaction--and thus give time for fire-fighting--in the event the bomb is exposed to a fire. If the coating is inadequate, we may sacrifice this added measure of protection. Thus there is good reason to go to "great lengths" to avoid direct exposure of the TNT to the metal.

5. There also is a reported reaction of iron and TNT. Urbansky (Vol. 1, page 305) indicates that heat and 13% HNO_3 will produce a reaction between iron and TNT to yield sensitive compounds. These are obviously far more drastic conditions than would be anticipated in a bomb. Our general knowledge of chemical reaction kinetics makes it entirely reasonable to expect that such a reaction--if it took place at all-would be very slow under the mild conditions of bombs stored at ambient temperatures. It seems unlikely indeed that it would proceed to any significant extent in the short interval of thirty days. On the other hand, in the event of long-term storage--for 25 years or so--there may be reason to worry about the results of very slow reactions. This being so, it is sensible to isolate the iron and TNT. Again, then, there is good reason for the asphalt coating. It's failure, even if it should occur, is unlikely to produce a hazardous condition in thirty days.

6. There appears to be a considerable de-emphasis on the Tritonal-water reaction in the present letters. This is sensible. That reaction was a matter of early concern (for instance OSRD Report No. 5406, July 1945). It was found to be of negligible importance. The resistance of Tritonal to water was one reason for loading it in preference to Minol in 4000 lb. British bombs (Ordnance Committee Minutes-24163, June 1944). The reaction was recently reinvestigated by Hendrickson (Picatinny Arsenal, Technical Memorandum 1873, Nov. 1968) with results which again indicated that it would be entirely negligible under any reasonable conditions that bombs might encounter. Surely, there would seem to be enough stakes in the heart of this particular problem. Undoubtedly, however, research could drive one more if it were really deemed necessary.

ENCLOSURE(4)

7. The Tritonal-in-the-threads argument is really well answered by the arguments of paragraphs 1 and 2. If it is necessary to go further; neither Tritonal nor TNT is a sensitive explosive. We really don't expect them to go off even if they are in the threads. Certainly, if friction initiation is envisioned, it would occur when the plate was screwed in, not after it was locked in place. TNT is even less sensitive than Tritonal; hence, arguments that TNT enrichment near the base plate would lead to a hazardous condition have no merit. Even in the highly unlikely event that initiation occurred, it would have to sustain itself and reach the main charge to do harm. It seems unlikely that a thin thread of Tritonal could sustain reaction in the presence of the massive heat sink provided by the surrounding metal. Finally, in the case of Roseville, the unlikely event of initiation would have to be followed by the unlikely event of propagation through the threads which, in turn, would have to be followed by the unlikely event of a smoldering reaction (of some sort) which would occupy the 30 to 50 minute interval, between the time the train was halted and left motionless and the time that serious evidence of fire was observed. Such a piling up of improbabilities is not convincing. Nevertheless, if it becomes necessary, Tritonal can be introduced into threads and a bomb hammered on. Paragraph 2 and the above arguments lend considerable confidence to predictions of non-reaction.

8. The letters contain confident, undocumented statements. For instance, "The cavities were lined with pure honeycombed, recrystallized TNT obviously in a much more sensitive condition than in a proper cast." It is fair enough to ask: Is it really? How much more sensitive? To what stimuli? What's so obvious about it? For one thing, TNT is less sensitive to impact than Tritonal. Certainly we know that cavities can play a role in the initiation of explosion. In fact, they presumably contribute to the normal, known, rather sluggish sensitivity of TNT and Tritonal. However, is there really any reason to believe a cavity in a bomb in some way increases its sensitivity? In any case, we've been making bombs with cavities and TNT crystals for years and, as discussed in paragraph 1, these have not been showing up as unduly sensitive ordnance.

9. In a similar vein, there are comments on "jostling about", "corrosion propensity", "most hazardous end plate region", easy penetration of HE into threads, "potential, in fact very likely, ignition source", etc. These are highly suggestive phrases. However, they are really only possibilities--and very poor ones at that--rather than the dead-sure certainties that the phraseology implies.

10. There is an important point that can be all too easily lost. We certainly should consider the S.P. arguments and any others that we can think of. That is part of finding out what happened. Nevertheless, we should remember that there are two general theories of initiation:

ENCLOSURE(4)

the bad-bomb theory and the bad-boxcar theory. We have very good reason (re-emphasized in paragraphs 1 and 2) to believe the bad bomb hypothesis is improbable indeed. On the other hand, over the period of the last seven months we have learned of four incidents and five fires involving munitions trains (Hughson, Roseville, Benson, and Rocklin-Davis). Three fires (Hughson and Rocklin-Davis) were unquestionably exterior fires. In addition, we know of a fifth munitions car that underwent wheel repairs, wheel replacements, and brake repairs during a single journey; and then required the attention of the Los Angeles Bomb Squad due to a defective door. Finally, we are becoming increasingly aware that fires on railroad rolling stock carrying civilian cargoes are by no means uncommon.

11. In countering S.P.'s case, we should not neglect to build our own. It is certainly to be recommended that we learn as much as we can about these other events. Ideally, we should know as much about the Hughson and Rocklyn-Davis trains as we know about the Roseville and Benson trains. (The fact that the alertness of two citizens and the expertise and heroism--and that is not too strong a word for it--of the Hughson Fire Department prevented the destruction of a munitions train and a heavy loss of life is no reason to regard this as an event of little consequence.) We should also like to know a good deal more about the frequency and causes of rolling stock fires--whether they are on munitions trains or not. We know from the NFPA Fire Protection Handbook that hot-boxes and sparks from brake shoes are the first and third most common sources of rolling stock fires. (Transients are the second.) If we are to counter the obviously serious threat of boxcar fires, we need to know as much as possible about these fires. There is very good reason to believe that railroad fires that have already happened may provide a veritable mine of information. The trick will be to successfully work it.

12. Needless to say, there is already enough evidence to make some guesses as to the relative probabilities of the bad-bomb and bad-boxcar theory. The latter is clearly far more likely. What is needed now is to so develop the information on hand and plan our own research so as to add to our knowledge of boxcar fires. This will increase the chances of making useful recommendations for their prevention. It seems very probable indeed, that such efforts will make the bad-bomb theory seem even more unlikely.

DR. TAYLOR B. JOYNER
Research Chemist

ENCLOSURE(4)

ORD-04M:JEE
14 Aug 1973

COMMENTS ON ALLEGATIONS CONCERNING BOMB SAFETY

The allegations contained in the following paragraphs have been extracted from Dr. Cook's letters, enclosures (1) and (2). The comments represent a consensus of opinion of experts in the explosives technical community.

1. ALLEGATION: The wax pad was not serving its purpose, to protect the base end of the bomb, thus, creating an extremely hazardous condition that is the rule rather than the exception.

COMMENTS

a. The primary purpose of the wax pad is to add an extra margin of safety during the assembly of the bombs. Secondary purposes are to act as a buffer during rough handling and to prevent exudation of explosive material during long-term storage.

b. Many millions of Mk 80 series bombs in the same condition as observed by Dr. Cook have been loaded, shipped and deployed without incident. Navy bombs produced by this procedure have been subjected to extremely severe testing and no accidental initiation or incidents have been experienced. These tests consisted of a bomb being soaked at 150°F for seven hours and then dropping it on its base from heights of fifteen, thirty and fifty feet. Recent tests conducted at Tooele Army Depot involved impacting the base end of a bomb with the nose end of another bomb dropped from forty-one feet. The results of all these tests indicated that the bombs as produced are not extremely hazardous, as alleged, but quite insensitive to even severe impacts.

2. ALLEGATION: That the absence of a wax pad permits direct contact of Tritonal and/or TNT with iron over the entire base plate and allows a potentially dangerous TNT-on-iron corrosion reaction to take place unabated.

COMMENTS

a. In the absence of a wax pad explosive will not come in direct contact with the iron of the base plate because the base plates are coated with an asphaltic type coating compound, or "cavity paint".

b. It is known that iron and TNT will react at elevated temperatures in a 13 percent nitric acid solution; however, these are obviously more drastic conditions than would be encountered inside a bomb. Furthermore, under normal conditions found inside a bomb, the reaction rate of iron and TNT would be extremely slow (several years under normal storage conditions) and the reaction products would be in general no more sensitive than TNT itself. There would be no heat problem since the extremel slow reaction rate found inside a bomb would allow the minute quantities of heat generated by the iron-TNT reaction to be dissipated over the years through the metal skin of the bomb.

ENCLOSURE (3)

3. ALLEGATION: Steel threads at the base end are easily penetrated by Tritonal which creates an extremely hazardous condition.

COMMENTS

a. Many attempts in the past to demonstrate this danger have failed. However, if Tritonal did penetrate and did initiate in the small quantities that might be found in a thread, the explosive reaction would quench long before it could build up to anything like a detonation. This is because the heat of burning would be transmitted into the large mass of steel rather than to more explosive.

b. NAVORD has conducted tests where Comp A-3, an explosive much more sensitive than Tritonal, was placed in the threads in the base plugs of 5" projectiles and the projectiles were fired at proof pressure. All attempts to initiate a reaction of any type by this mechanism were unsuccessful. Tests were conducted by Picatinny Arsenal in 1968 which demonstrated that explosive in threads is not a sensitive or hazardous condition. In these tests Tritonal was purposely loaded into the threads of the base end and other potentially hazardous joints. Extrusion from some of the bombs was obtained by heat soaking them for a period of time. The bombs were then subjected to a series of four, seven and forty foot drop tests. Since no definitive explosion reaction occurred in these tests, it was concluded that bombs with explosive in the threads were essentially not sensitive to impact.

4. ALLEGATION: Sectioning of the bombs at Tooele revealed that Tritonal had penetrated the threaded sections of the base end and that chunks of cast Tritonal had accumulated in the grooves at the base.

COMMENTS

a. Other observers at Tooele, Dr. H. J. Matsuguma of Picatinny Arsenal and Mr. A. E. Gilmore of NAPEC (Naval Ammunition Production Engineering Center) Crane, Indiana examined the bombs and did not observe that Tritonal had penetrated the threaded areas at the base end.

b. Chunks of cast Tritonal and "cinders" observed by Dr. Cook were products of the rather crude dry-sawing process employed at Tooele. In sawing these bombs without water cooling, the temperature of the metal at and near the cutting surface is more than high enough to melt the TNT (176°F). Molten TNT is very fluid and is free to migrate into cracks, seams, threads, etc.

5. ALLEGATION: That shrinkage cavities in Tritonal-loaded bombs contain TNT crystals that are excessively sensitive to shock and which could cause the bombs to be more sensitive to rough handling, particularly if the crystals become loose.

COMMENTS

a. Shrinkage cavities are a standard occurrence in Tritonal-loaded bombs. Such cavities are apt to be lined with large TNT crystals because the cooling rate is slower inside the charge than it is near the surface. Hence the solidification is slower which leads to the formation of large crystals of pure TNT. TNT produced by slow cooling of a melt is much less shock sensitive than that produced by rapid cooling or quenching. For this reason, the TNT crystals in the cavity are less shock sensitive than the rest of the TNT in the bomb casing.

b. Particles of loose TNT or Tritonal in these cavities are not hazardous nor do they make the bomb more sensitive to rough handling as evidenced by results of numerous drop, bump and drop, and sled tests conducted on Tritonal-loaded bombs with the type of cavities observed by Dr. Cook.

6. ALLEGATION: There is a distinct possibility that the aluminum-water reaction may take place in the dangerous region of the bomb and white powder observed in one or more bombs was the product of this reaction.

COMMENTS

a. The aluminum-water reaction is well known. It is a relatively slow reaction even at 194°F, and the rate depends upon the fineness of the aluminum and the activation of the surface. The aluminum in Tritonal is fairly fine but it is coated with TNT which is not soluble in water. Unless the TNT is molten, only the aluminum in direct contact with the water can react. This reaction was studied as early as 1944 and was reported at that time to be of negligible importance. More recently, in 1968, this reaction was thoroughly investigated at Picatinny Arsenal which confirmed that the water-aluminum reaction in Tritonal at room temperature is negligible.

b. The white powder observed by Dr. Cook was not analyzed; therefore, Dr. Cook cannot be certain of its composition. As stated by Mr. Stonebraker of Tooele Army Depot, the white powder was actually aluminum oxide caused by the heat of the saw decomposing some of the Tritonal during the cutting process. Tooele Army Depot uses a dry saw with no coolant or lubricant.

19 February 1974

EVIDENCE OF SHAPED CHARGE ACTION IN BOMBS
RECOVERED FROM ROSEVILLE AND BENSON

William S. McEwan and Taylor B. Joyner

Inspection of bombs recovered from Roseville and Benson 14 and 15 February 1974 at Hawthorne, Nevada:

Bombs from Roseville, Mk-81's, showed, 1) extensive exposure to fire, 2) subjugation to severe side pressures as evidenced by crushed aft end assemblies, elliptical closure rings and heavily dented bomb bodies, 3) extensive scarification by fragments was seen on some bombs as well as a few that were partially or completely burned out.

Bombs from Benson, Mk-82's, showed some of the types of damage noted for the Roseville bombs, but not nearly as large a fraction of the recovered population possessed those types of damage.

The principal type of damage seen here, and it is very striking considering the high fraction of bombs in which it appeared, was a severe pitting and scarification to the base plates of the bombs with an occasional example of where the base ring was pushed completely into the bomb interior, stripping the threads and deforming the case. This damage was combined with an impact damage to the nose and fuze well. In a number of cases the impression of a bomb nose could be seen in the base plate of another bomb and vice versa - base plate marks in the nose. Few of these bombs had burned out.

Conclusions: It seems quite clear that the damage seen in the Benson bombs was essentially "shaped charge" type jetting coupled with severe nose into tail type impacts. One was struck with the scarcity of bombs with

ENCLOSURE(5)

fragment scars on the side or bombs with bashed in sides. One wonders where are the bombs that were alongside or over and under the bombs which jetted and caused the damage to the bases and noses of the bomb in the rank ahead of them. One is driven to the conclusion that either all these bombs in a single rank of pallets detonated or if not all, those remaining were so severely damaged that they were destroyed at Benson by EOD and were not shipped to Hawthorne.

Because of this characteristic type of damage found in the Benson bombs at Hawthorne, it was decided to reexamine the photographs and sectioned bombs of two bombs of this type which had been members of the group which was sectioned and analyzed by Hawthorne and the Naval Weapons Center. This was done for bombs X-3, X-6, and X-1. In bomb X-6, there was evidence of its having been melted at least twice with about a 45° rotation between melts. (Evidenced by lines of demarcation where aluminum had settled into the lower eighth of the bomb.) Hot melt (Flintkote) had been melted and had filled the normal void occurring in the bomb. The fuze well cap had begun to recurve inwards and the charging tube was partially flattened and showed the intrusion of molten Tritonal from where the tube had pulled loose from the fuze well. In bombs X-1 and X-3, there did not appear to be evidence of pre-melting, but they had been hit very hard in the aft end, enough to strip all the threads in the aft end closure ring. In one case, the ring had been forced back into the wax, in the other the ring had been pushed right into the Tritonal filling. Cracks were seen in the Tritonal filling in the bomb body.

In neither of these two cases was there any evidence of ignition. It seems hard to imagine a more severe test for "pinching" or TNT in the threads than these bombs have already gone through.

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Numerous color photographs were taken and a partial 8 x 10 set of the Hawthorne photos of the sectioned X-6 and X-3 bombs were obtained. These photos will be included as soon as they have been processed.

W. S. McEWAN

T. B. JOYNER

ENCLOSURE(5)

UNCLASSIFIED

ORD-048D;EAD
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SER 03157
Aug 21, 1973

CONFIDENTIAL

[redacted] (UNCLASSIFIED upon removal of enclosures)

Subj: Low Drag Bomb, Mk 80 Series, information concerning

of Ordnance issued instructions for bomb loading requiring the coating of the interior of the cavity with projectile cavity paint and authorizing loading by either the pelleting or single pour technique. Horizontal cooling of bombs that were both base and nose fuzed was required regardless of the loading method to assure proper fuze action in initiating the main charge.

3. From that time to the mid 1960's the choice of loading procedures was the perogative of the loading plant. During the mid 1950's the low drag series of bombs Mk 81 thru 84 were developed. The bombs were loaded using straight pour with crust venting, and several pellet loading techniques, and were cooled in the horizontal position to reduce the cavities around the base fuzes. Safety tests performed to establish the safe handling characteristics of these bombs are reported in many documents and are listed in enclosure (2). They included such severe impact tests as plate penetration, gun firing against reinforced concrete, air drops on concrete, 40' drop, bullet sensitivity, and surveillance tests. Results are not included in this documentation package; however a high degree of safety in loading, shipment and use of the bombs was established for H-6 and tritonal.

4. During the mid 60's the usage rate of the bombs increased considerably as did the dud rate. The Naval Weapons Laboratory, Dahlgren reported, reference (b), on static test series where 23% of the bombs tested either detonated low order or were duds. Poor quality explosive charges were blamed for low reliability of the bombs. In 1965, a team of loading experts was organized by BUWEPS to review means of standardizing the loading processes used by the Ammunition Depots to load bombs, and to improve main charge quality around the base fuze cavity to ensure proper initiation on fuze functioning. Various loading techniques were evaluated; however the straight pour - horizontal cool method used in previous years was selected as the best process for providing bombs meeting performance and safety standards and at the same time allowing production requirements to be met. (See enclosure (3) and (4).

5. The Mk 80 series bombs as now used are loaded with either H-6 (a mixture of TNT/RDX/Aluminum and desensitizer) for the Navy and Tritonal (a mixture of TNT and aluminum) for the Air Force. Tritonal has been in use by the services since 1943 and was adopted as the standard filler for bombs by both the Army and the Navy in 1945, enclosure (5). It is presently the Air Force preferred fill for general purpose bombs. The Navy prefers to use H-6 in aerial bombs

ENCLOSURE(6) UNCLASSIFIED

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DEPARTMENT OF THE NAVY
NAVAL ORDNANCE SYSTEMS COMMAND
WASHINGTON, D. C 20360

IN REPLY REFER TO
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[redacted]

[redacted] UNCLASSIFIED UPON REMOVAL OF ENCLS

From: Commander, Naval Ordnance Systems Command
To: Chairman, Department of Defense Explosives Safety Board

Subj: Low Drag Bomb, Mk 80 Series, information concerning

Ref:
(a) DDESB memo of 5 July 1973
(b) NWL, Dahlgren memo report TEF:VP:ah of 22 Oct 1962
(c) OSRD National Defense Research Committee Report A-337
(d) Office Chief of Ordnance, Wash., D. C. to HQ Army Air Force of 8 Jan 1945
(e) Ordnance Committee Item 31926 (memo to ORD Tech. Com.) of 18 Dec 1947
(f) Picatinny Arsenal TR 2531 the T54E3 (m 117) New Series 750 lbs. FB Bomb Aug 1958
(g) AMCP Pamphlet 706-177, "Engineering Design Handbook, Properties of Explosives of Military Interest"
(h) Hill AFB ltr to NWL, Dahlgren SER 8150 of 17 June 1965

Encl:
(1) NOSC memo ORD-0332A:RLB of 16 July 1973
(2) NOLTR 73-92 (Advanced Copy), A Survey of Tritonal and H6 as Explosive Bomb fills
(3) BUWEPS ltr RMMO-6:EAD of 17 Jan 1966
(4) NOSC ltr ORD-0332:RLB of 1 Aug 1966
(5) NAVORD OCL AV23-45 of 14 June 1945
(6) AIR Proving Ground Center, Eglin AFB, APG-TR-65-68, Suppl. 1 of June 1966
(7) NOTS China Lake TN 4032-3-67 of May 1967
(8) NOL White Oak NOLTR 72-64 of 2 Mar 1972
(9) NWL, Dahlgren ltr TEX:DW:REB 8150 of 6 Mar 1968
(10) Tooele Army Depot Final Report of Nov 1968
(11) NAD Crane ltr X1-2 (3):WRM:REB of 14 Aug 1956
(12) Exerpt from NWL, Dahlgren TR-2869 of Dec 1972
(13) Train/Truck accidents with bombs

1. Reference (a) requested that test data on Mk 81 - 82 LD bombs generated subsequent to the inaugration of the straight pour horizontal cooling process be submitted for your comment and forwarding to the Deputy Assistant Secretary of Defense (Production Engineering and Material Acquisition).

2. The straight pour with horizontal cooling technique for loading munitions is <u>not</u> new and has been used with cast TNT based systems for almost 50 years, commencing in 1926, (See Encl (1)). In 1934 the Bureau

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Subj: Low Drag Bomb, Mk 80 Series, information concerning

because it has proven to be more effective than Tritonal. The sensitivities and cook-off times for H-6 and Tritonal are quite similar. Tritonal is still considered an acceptable alternate filler for Navy bombs when H-6 is not available.

6. Generally, two types of sensitivity tests are required to evaluate the safe handling characteristics of an explosive; small-scale tests to assess the sensitivity of the explosive itself and weapons handling safety tests to obtain data on the sensitivity of the explosive as used in the weapon. Table (1) presents some of the small-scale test data on Tritonal, TNT, H-6 and Composition B. Tritonal and H-6 are shown so that relative sensitivities of these two explosives can be examined in view of their use in Navy and Air Force bombs and the number of tests conducted on H-6 loaded bombs in the past. TNT and Composition B are listed since these were the loads in the A/N M64 old style bombs tested in 1944 which according to some sources led to the use of a wax base pad in bombs.

TABLE I

	TNT	Comp B	H-6	Tritonal
Impact Sensitivity (cm) NOL/WO	157	60	111	100
(IN) PICATINNY	14-15	14	14	13
(CM) BUREAU OF MINES	95-100	75	-	85
Density (g/cc)	1.61	1.70	1.75	1.72
Large Scale GAP Sensitivity (CARDS)	133	201	166	181
Friction Pendulum (Steel Shoe)	Unaffected	Unaffected	Unaffected	Unaffect
Rifle Bullet (% affected)	40%	20%	80%	60%
Slow Cook-off (^{o}F)	419	338	311	428
Susan Test (ft/sec)	425	300	396	258

The sensitivity of Tritonal is not markedly different from that of the other TNT-based explosives used by the services.

7. Full-scale weapons test data available subsequent to use of the current Navy loading method is contained in enclosures (6), (7) and (8).

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Subj: Low Drag Bomb, Mk 80 Series, information concerning

Enclosure (6) reports test results from Eglin Air Force Base comparing H-6, Tritonal and Desensitized Tritonal (Tritonal + D-2 wax). Bombs were loaded by two techniques, one being the current Navy method. The other, controlled cooling technique. No attempt was made to correlate the effect on sensitivity as a function of loading technique; however as seen in Table 2 which was prepared from the data in enclosure (6), loading technique had no effect or impact sensitivity.

TABLE 2

H-6

	3 foot concrete target	5 foot concrete target
6-test bombs* velocities 526-797 ft/sec	2 high order 1 Partial high order 3 no reaction	3 test bombs 2 low order 787-832 ft/sec 1 no reaction
2 pilot bombs** velocities 836-841 ft/sec	1 low order 1 no reaction	5 pilot bombs 1 low order 825-981 ft/sec 4 no reaction

Desensitized Tritonal***

	3 Foot Target	5 Foot Target
7 test bombs 514-810 ft/sec	4 low order 3 no reaction	2 test bombs - 2 low order 835-849 ft/sec
1 pilot bomb 814 ft/sec	1 no reaction	6 pilot bombs - 2 low order 814-965 ft/sec. 4 no reaction

Tritonal

	3 Foot Target	5 Foot Target
7 test bombs 534-838 ft/sec	2 low order 5 no reaction	1 test bomb - 1 no reaction 829 ft/sec
1 pilot bomb 837 ft/sec	1 low order	6 pilot bombs - 2 low order 810-991 ft/sec 4 no reaction

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Subj: Low Drag Bomb, Mk 80 Series, information concerning

*Test Bombs - Controlled cooling loading technique
** Pilot Bombs - Current Navy method
***Tritonal to which 5% D-2 wax desenitizer has been added

Enclosure (7) reports similar rocket sled tests conducted on H-6 and desensitized Tritonal. The H-6 bombs were loaded by five techniques including the current Navy method and all the desensitized Tritonal by the current Navy method. A table indicating the results as a function of explosive filler and loading technique is presented in the summary of that report. Enclosure (8) presents a summary of enclosures (6) and (7) as well as some tests conducted prior to 1966.

8. Enclosure (9) reports the results of 40' drop tests conducted on bombs loaded subsequent to the time the Navy standardized its bomb loading process at all plants. This report indicates no reaction on 12 drops of Mk 81 and 82 bombs loaded with both H-6 and Tritonal. Drops were conducted in 3 attitudes nose down, base down and horizontal.

9. In regard to the use of wax pads in the tail of the LD bombs the following comments are pertinent. The OSRD National Defense Research Committee Report #A-337, reference (c) prepared by the committee on fillings for aerial bombs states "the use of nose and tail pads of TNT and inert sealer at the tail varies with the bomb." The only tests indicating a possible safety benefit to impact sensitivity of bombs from base inert pads are reported as part of enclosure (10). These tests were conducted in 1944 on the thin walled TNT and Comp B loaded AN-M 64 bombs which had auxiliary boosters cast integral to the explosive charge in the tail. In all test data regarding drop testing of Tritonal loaded bombs regardless of type there have been no explosive reactions. For example in reference (d) it was reported that drop test on 500 pound GP bombs Tritonal loaded with nose and tail pads gave no reaction in 12 drops from 50 ft. Comparative data is presented indicating 1 low order detonation out of 6 drops occurred with TNT loaded bombs with the same inert pads. Reference (e) presents additional 50 foot drop test data on TNT, Tritonal and Comp B bombs with inert nose and tail pads. These results are summarized in table 3.

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TABLE 3

	Number of Bombs Tested	Number of reactions on tail
Explosive		
TNT	16	2
Tritonal	18	0
Comp B	34	1

Reference (f) reports the dropping of 5 Tritonal loaded M117 GP bombs with inert pads from heights of 5, 20, 35 and 50 feet on base, nose and side with no explosive reaction.

10. In the straight pour - horizontal cooling loading process used by the Navy, the wax is expected to migrate away from the base section. The melting point of the wax is about 81°C which is only 4°C higher than the pouring temperature of the explosive. The specific gravity of the wax is somewhat lower then the specific gravity of the explosive. Thus the migration of the wax on turning a hot bomb from the vertical position for cooling is not new or unexpected. Documents concerning discussions of this migration date back to 1950. These bombs were designed to be assembled while the explosive is still liquid otherwise, the anti-withdrawal pins built in the base plate would "plow" through solid explosive on the base assembly. The primary purpose for the sealer in these Mk 80 series bombs was to add an extra margin of safety in assembly in the loading plants. Enclosure (11) illustrates the problems encountered. The requirements for anti-withdrawal pins was eliminated some two years ago. The loading process was not changed however.

11. The presence of the wax sealer is listed as a critical defect in loading the Mk 80 series bombs and is required prior to final closure of the bomb. Since it is known that after closure on laydown, the wax pad migrates, no requirement, and thus no effort has ever been made to inspect for the wax pads after final assembly of the bomb.

12. Bombs loaded utilizing the current Navy process wherein the wax pad migration is known to have occurred have been subjected to 40' drop tests and sled impact tests. Enclosure (9) reports of such tests

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results on H-6 and Tritonal loaded Mk 81 and 82 bombs in nose, base and horizontal drops. Futhermore enclosure (10) reports the results of rough handling tests on bombs which included two Mk 82 bombs loaded by the current technique with Tritonal. One bomb was heat soaked at 150°F for 7 hours and dropped on its base 3 times each from heights of 15, 30 and 50 feet. The bomb was cooled overnight and dropped once again from 50 feet. After the third and fourth 50' drop metal parts failures occurred. The second bomb was dropped 3 times each from heights of 15, 30 and 50 feet. No heat soaking was given this bomb. In no instance was there any reaction. The tests conducted on these bombs and the M117 are described in enclosure (10) as being a more severe torture test than could be imagined for munitions and that it is inconceivable that any normal or even careless handling of these items could even fractionally equal the impact values or the repetition of these impacts. Additional drop tests have recently been performed for the Department of Defense Explosives Safety Board by Toole Army Ammunition Plant. Bombs from lots involved in the recent train explosions were dropped 41 feet onto inert bomb nose sections. Eight tests have been conducted and no explosive reactions have occurred.

13. As indicated by the small scale tests mentioned above, Tritonal, like all other explosives, is sensitive to heat. Hill Air Force Base in reference (h) provided the following data on the cook-off characteristics of Tritonal test .

Test Number	Item	Reaction	Time
1	M-117A1	Low Order	12 Min.
2	M-117A1	High Order	5 Min., 35 Sec.
3	M-117A1	High Order	5 Min., 16 Sec.

For these tests, each bomb was placed on a steel stand 3 feet off the ground, with lumber placed beneath and around the stand and saturated with JP-4 fuel. Navy tests with Tritonal loaded bombs suspended 3 feet over JP-4 fuel fires gave cook-off times of 2-1/2 to 4 minutes with temperatures at the explosive/hot melt interface averaging 500°F. (See Enclosure (12). In a recent test at the Naval Weapons Center, China Lake one Tritonal loaded Mk 81 bomb exploded violently after being exposed to a temperature of 405°F for 7.8 hours. In a second test performed at a higher heating rate, an explosion occurred after

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3.5 hours of exposure to a temperature of 405 to 410°F. It has been demonstrated in many tests, that cook-off of bombs in fire is a certainty, given a fire of sufficient temperature and duration.

14. Enclosure (13) is a list of truck/train accidents, which subjected bombs to extremely severe environments. These accidents provide us with a group of impromptu, unscheduled, rough handling tests. No explosive reactions were experienced in the bombs involved in any of these accidents.

R. E. SPREEN

Copy to: CNM (MAT-09) CNO (OP-04) OP-41)
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ORD-0332
ORD-04
ORD-04M
ORD-00N

Prep: E. A. Daugherty, R. L. Beauregard, 8/10/73
Ext: 28250 Ext: 28358
Typed: C. F. Spigone

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ENCLOSURE(6)

UNITED STATES DISTRICT COURT

EASTERN DISTRICT COURT OF CALIFORNIA

JOSEPH M. PUJALS, et al., Plaintiff	)	CIVIL ACTION NO. S-2911
v.	)	
SOUTHERN PACIFIC TRANSPORTATION COMPANY Defendant	)	AFFIDAVIT OF DOCTOR ALBERT LIGHTBODY

ALBERT LIGHTBODY being first duly sworn deposes that:

I was, until 31 December 1973, the head of the Chemistry Research Department at the Naval Ordnance Laboratory, White Oak, Silver Spring, Maryland. I had occupied that position since May 1957. As head of the Chemistry Research Department, I had the responsibility of initiating, approving and directing the work performance of five divisions involved in the chemistry of materials, of importance to the U.S. Navy's research and development programs. Two of these divisions are involved completely with explosives. The Advanced Chemistry Division's work is concerned with the synthesis, decomposition, analysis and general chemical behavior of explosive materials, both as ingredients and as mixtures of materials in use or proposed for possible use as military explosives. Another phase of this division's work involves the study of initiation and the growth from burning into detonation. The other division, The Chemical Engineering Division, whose work is in explosives, carries on research and development in the formulation of new explosives, the fabrication of small quantities (up to 100 lbs) of explosives, and the testing and qualification of explosives for use by the U.S. Navy. This includes all types of tests, such as impact, thermal behavior, exposures to different environments of practical value, and simulated accident conditions as drops, fire, alternate freezing and heating, skids, etc.

During the period of my occupancy of this position, I have had to initiate and approve actions on explosives which have resulted in their approval as Navy accepted explosives. I have investigated accidental initiations of explosions which have caused physical damage to property and personnel. I have supervised personnel who have simulated accident conditions with all types of explosives being used by the U.S. Navy, as well as many explosives which have been proposed and either rejected or placed in abeyance for further evaluation.

Since 1 January 1974, I have been engaged as a consultant by the U.S. Naval Ordnance Laboratory primarily to prepare plans for future work in advancing the technology of explosives.

Four things that Dr. Cook mentions which could be considered faulty bomb construction, filling or handling are (1) absence of the wax "buffer" near the closures in the bombs, (2) presence of explosive in the threads, (3) reaction of TNT with bare iron, and (4) "honeycombed" or low density bombs. We will attempt to discuss each of these separately.

1. The wax "buffer" which is poured on top of the explosive load was provided to assure no inteference with the closing plug and is thus a spacer. This is accomplished under

the present system. It has been shown by the Army that a "pad" of wax in a bomb will make initiation by impact less frequent during attack on a target. However, the many tests conducted by the Air Force using Tritonal filled bombs show that the present bombs filled with Tritonal do not initiate, even when dropped onto lava beds though the cases deformed on impact. Consequently, for these bombs, the fact that the wax has "migrated" appears unimportant, as a possible cause of initiation.

2. It is quite likely that a microscopic examination may find some explosive in the threads of the closure, even though care is taken to prevent this. Many attempts in the past to demonstrate the danger in this have failed, although primary explosives will initiate in the same small quantities in the threads when impacted. If the TNT did initiate in the small quantities that might be found in a thread, the explosive would quench long before it could build up to anything like a detonation because the heat of burning would be transmitted into the large mass of steel rather than to more explosive.

3. We know of no evidence of a "dangerous" TNT reaction with iron. Iron with an acid can reduce TNT but the reduction products are no more and usually less sensitive than TNT itself. So if a reaction did occur, such an occurrence would result in a safer, not more unsafe, condition within the bomb. There have been thousands of instances of TNT on bare steel and to date I can find no records of a "dangerous corrosion" condition.

4. The other item pointed out by Dr. Cook was the "honeycombing" which was observed in the sectioned bomb. The answer to this is well expressed in the Naval Message (DTG 261850Z Jun 73) from the Naval Ordnance Laboratory to the

Naval Ordnance Systems Command. It states that "internal shrinkage cavities are found in most castings of TNT-based explosives such as Tritonal. Such cavities are apt to be lined with large TNT crystals because the cooling is slower there than at exterior locations on the charge; hence, the solidification is also slower leading to the formation of large crystals. TNT produced by slow cooling of a melt is very much less shock sensitive than that produced by fast cooling or quenching. For this reason the TNT lining the cavity would be less shock sensitive than that lining the casing. There is, furthermore, no reason to expect any detached TNT crystals to show excessive sensitivity to rough handling." This condition of "honeycombing" can hardly be considered a hazard.

For an aluminum-water reaction having the possibility of taking place in the threads seems an impossibility as a cause of starting a major reaction. Even if the reaction did occur (which I question) the heat generated would be quickly dissipated into the massive surrounding steel.

It certainly seems that the heating of the bombs by an external fire is far more probable as the cause of the detonations than any of the items mentioned herein. The fact that fires have occurred in railroad cars, that fuel (Butane) fires in tank cars have been initiated due to railway difficulties with disastrous results and that effects with bombs similar to those observed have been produced with controlled "slow cook-offs" make this conclusion most tenable.

DOCTOR ALBERT LIGHTBODY

State of Virginia

County of Arlington

Subscribed and sworn to before me this 22nd day of February 1974.

NOTARY PUBLIC

My commission expires: My Commission [illegible] 7, 1975

UNITED STATES DISTRICT COURT

EASTERN DISTRICT COURT OF CALIFORNIA

JOSEPH M. PUJALS, et al., Plaintiff v. SOUTHERN PACIFIC TRANSPORTATION COMPANY Defendant	CIVIL ACTION NO. S-2911 AFFIDAVIT OF DOCTOR JAMES E. ABLARD

JAMES E. ABLARD being first duly sworn deposes that:

My experience with explosive materials started in February 1942 at the Explosives Research Laboratory of the National Defense Research Committee housed on the property of the Bureau of Mines at Bruceton, Pennsylvania. I left there in December 1945 to go to the research laboratory of General Tire, Akron, Ohio. In March 1949, I was appointed to the Explosives Research Department of the U.S. Naval Ordnance Laboratory, Silver Spring, Maryland. Since 1949 my experience with explosives has been continuous. I occupied various positions in explosives research work ending with Associate Director for Research in Chemistry and Explosives. I retired from full time work on March 31, 1973 and am now a part time employee of the Naval Ordnance Laboratory doing consulting work in explosives. I have examined two letters signed by Dr. Melvin A. Cook, dated June 8, 1973 and June 15, 1973, and make the following comments thereon.

Dr. Cook has claimed in his letters that the Navy "goes to great length to make sure there is no TNT-iron contact... thus the potentially dangerous TNT on iron corrosion may take place..." Compatibility tests with TNT and many metals have been run many times for many years without evidence of any substantial reaction.

To the best of my recollection, hot melt to line warhead cavities was introduced by the Navy to cover up cracks between fittings and cases to prevent explosives from seeping into the cracks and being pinched when the weapon was rough handled. This practice was started for mines and spread to all weapon warheads.

The fact that the wax migrates from its position on top of the fill at the end of the pouring has been discovered in many instances before. The reason for the migration is well known. If the wax is too low melting, it stays fluid beyond the time that the bombs are held on their noses on the loading carts and simply floats away when the bombs are tipped on their sides during inspection and after loading into the railroad cars. However, no one has been able to prove by tests that bombs in such condition are more hazardous to handle. Many drop tests have been run with tritonal loaded bombs without explosions although x-rays have shown that migration of the wax had occurred in similiar bombs.

A hot spot caused by either friction or pinching as Dr. Cook postulates must grow in millseconds to an explosion or else it will die out. In this connection, it must be noted that the Roseville explosion occurred while the train was at rest in the railroad yard.

The possibility of an aluminum-water reaction is also advanced. Again, it would be difficult (I believe impossible) to prove that enough water and enough aluminum could get together to react to cause enough heat to start an explosion a month after the loading took place. The water-aluminum reaction is not very fast at room temperature and also not at 90°C. Its rate at these temperatures depends on the fineness of the aluminum and the activiation or deactivation of the surface. While the aluminum in tritonal is fairly fine, it is surrounded by TNT which is insoluble in water, and unless the tritonal was molten, only that part of the aluminum in contact with the water could react with it. The rest would be protected by a layer of TNT. Thus, while one might expect a small reaction while the bombs were still hot, when they cooled off, and certainly after a month, no rapid reaction could occur.

This reaction has been proposed in the past as the source of "gassing" in mines filled with aluminized explosive and stored. But the rate of this reaction is much too slow to generate a hot spot.

Dr. Cook states that a "good deal of white powder" was found in a quartered base which is "clearly the reaction product of aluminum, i.e., aluminum oxide (Al_2O_3)." Even if, on analysis, the white powder proved to be Al_2O_3, what is not realized (or is ignored) is that a large amount of heat is required to start a spontaneous explosion. The one involved here presumably cooked away slowly for a month which would permit much of the heat to be lost to the surroundings.

Although the aluminum-water reaction produces 3600 cal per gram of aluminum reacting, it can be readily shown that heat losses over periods as long as a month would make it necessary to use up nearly all of the aluminum available in tritonal to even keep the bomb warm, let alone heat a portion of it to ignition temperatures. It must be remembered that over such a long period of time, the usual concepts of hot spots a millimeter or so in diameter which reach 500°C or higher cannot be considered here. The long time permits heat flow to large distances, i.e., to the external surfaces of the bomb. I do not believe it can be shown that any chemical reaction can continue for a month slowly building up to ignition temperatures. The material supporting the reaction would all be used up.

James E. Ablard
DOCTOR JAMES E. ABLARD

State of Virginia

Country of Arlington

Subscribed and sworn to before me this 27th day of February 1974.

[signature]
NOTARY PUBLIC

My commission expires: My Commission [illegible], 1975

IN THE UNITED STATES DISTRICT COURT

FOR THE EASTERN DISTRICT OF CALIFORNIA

JOSEPH M. PUJALS, et al., Plaintiffs,	NO. Civ. S-2911
v.	
SOUTHERN PACIFIC TRANSPORTATION COMPANY, Defendant.	AFFIDAVIT OF RADM. THOMAS J. CHRISTMAN

THOMAS J. CHRISTMAN, Rear Admiral, USN, being first duly sworn, deposes as follows:

1. That I am the Vice Commander of the Naval Ordnance Systems Command;

2. That the Naval Ammunition Depot, Hawthorne, Nevada, (hereinafter called "Hawthorne") is a field activity of the Naval Ordnance Systems Command and is under direction and control of this Command;

3. That, according to records of this Command, Hawthorne produced the following quantities of MK 81 and MK 82 tritonal-loaded bombs during the calendar months after April 1973 to February 1974:

	MK 81		MK 82
1973	4616	May	27,360
	9738	June	21,574
	7144	July	34,384
	11,421	August	30,955
	-0-	September	23,586
	6000	October	24,148
	2727	November	23,667
	-0-	December	15,660
1974	-0-	January	25,391

4 That, according to records of this Command, Hawthorne currently has on hand unfilled orders for production of MK 81 and MK 82 tritonal-loaded bombs as follows:

MK 81 - 67,400

MK 82 - 194,000

APPENDIX C

DEPARTMENT OF TRANSPORTATION
HAZARDOUS MATERIALS REGULATIONS BOARD
WASHINGTON, D C. 20590

[49 CFR Part 174]

[Docket No HM-114; Notice No 74-1]

RAIL CARS USED TO TRANSPORT CLASS A EXPLOSIVES

Selection, Preparation, Inspection, Certification, and Loading

The Hazardous Materials Regulations Board is considering amendment of § 174 525 which prescribes the requirements for selection, preparation, inspection, certification and loading of railroad cars used to transport Class A explosives

As a result of recent rail accidents and incidents involving Class A explosives, the Federal Railroad Administration (FRA) issued Emergency Order No. 3 on August 9, 1973, to supplement the Hazardous Materials Regulations (38 FR 21952). This Emergency Order provides that each car transporting Class A explosives must be equipped with certain "low-sparking" type of brake shoes and all brake shoes on the car must be of the same and proper type and design, in safe and suitable condition for service, and comply with prescribed wear limits In addition, the Order provides that the car must be equipped with a continuous steel sub-floor or metal spark shields of prescribed dimensions However, if the car is not equipped with prescribed steel sub-floor or metal shields, the car may be used to carry Class A explosives only if it is inspected at intervals and in the manner set forth in the Emergency Order

On November 2, 1973, the Association of American Railroads (AAR) filed a request for modification of Emergency Order No. 3 or, in the alternative, for review as provided in section 203 of the Federal Railroad Safety Act of 1970 (45 U.S.C. 432) Some of the modifications requested by the AAR deal with matters that are included in this Notice of Proposed Rule Making They are included in this notice to afford an opportunity for public participation in their resolution. Upon completion of the rule-making proceeding initiated by this notice, FRA intends to terminate Emergency Order No 3

Although the accidents involving Class A explosives which occurred on the Southern Pacific Transportation Company at Roseville, California on April 28, 1973, and at Benson, Arizona on May 24, 1973, are still under investigation, the FRA believes that § 174 525 must be amended to eliminate potential fire hazards on rail cars used to transport Class A explosives These hazards result from overheated friction journal bearings, overheated and "sparking" brake shoes, and the presence of combustible material on the undersides of cars

Interested persons are invited to give their views on these proposals. Communications should identify the docket number and be submitted in duplicate to the Secretary, Hazardous Materials Regulations Board, Department of Transportation, Washington, D C 20590. Communications received on or before March 31, 1974, will be considered before final action is taken on these proposals. All comments received will be available for examination by interested persons at the Office of the Secretary, Hazardous Materials Regulations Board, Room 6215, Buzzards Point Building, Second and V Streets S W , Washington, D C , both before and after the closing date for comments The proposals contained in this notice may be changed in light of the comments received

In addition to assure that all interested persons have an opportunity for oral presentation, the FRA will conduct a public hearing commencing at 10 a m , on March 21, 1974, in Room 2545, Federal Building, 650 Capitol Mall, Sacramento, California

The purpose of this public hearing is to obtain information to assist the FRA in developing a final rule in this proceeding, not to determine the cause or circumstances surrounding any of the recent rail accidents or incidents involving hazardous materials which are still under investigation

The hearing will be an informal not a judicial or evidentiary type of hearing There will be no cross-examination of persons making statements An FRA staff member will make an opening statement outlining the matter set for hearing. Interested persons will then have an opportunity to present their oral statements. At the completion of all oral statements those persons who wish to make rebuttal statements will be given the opportunity to do so in the order in which they made their initial statement Additional procedures for conducting the hearing will be announced at the hearing. Interested persons may present oral or written statements at the hearing All statements will be made a part of the record of the hearing and be a matter of public record. Persons who wish to make oral statements at the hearing should notify the Office of the Chief Counsel, Federal Railroad Administration, Room 5101, Nassif Building, 400 Seventh Street SW., Washington, D C 20590, before March 14, 1974 stating the amount of time requested for their initial statement

The proposed changes in Paragraph (b) of § 174 525 are described below.

Subparagraph (1) It is proposed to delete the words "when available" and "on other". The first deletion would make absolute the present conditional specifications contained in the subparagraph The second is clarifying in nature

Subparagraph (3). It is proposed to substitute "holes" for "loose boards", add "doors" and substitute "which may hold fire from sparks" for "liable to hold sparks and start a fire" The first two changes are merely clarifying in nature while the third change is proposed both for clarification and to conform with the language of subparagraph (4)

Subparagraph (4) It is proposed to delete "or broken boards" to conform with similar changes in other subparagraphs.

Subparagraph (6) It is proposed to amend this subparagraph to require that after December 31, 1975, each car used to transport Class A explosives must be equipped with roller bearings, and to amend the present first sentence of this subparagraph to reflect this proposal by substituting "The roller bearings or journal boxes, and the trucks" for "The journal boxes and trucks "

Overheating of friction journal bearings often resulting in open flames from burning oil and pads, is recognized as a major hazard in railroad operations Since roller bearings are much less likely to overheat and even less likely to generate open flames if they should overheat, virtually all of the new freight cars placed in service as well as older cars rebuilt in recent years are equipped with roller bearings At present, approximately one-half of the national freight car fleet is equipped with roller bearings In these circumstances, FRA believes that cars carrying Class A explosives should be required to be equipped with roller bearings

Subparagraph (11). The FRA proposes to redesignate existing subparagraph (11) as subparagraph (13) and to add a new subparagraph (11) The proposed new subparagraph provides that after December 31, 1974, each car carrying Class A explosives must be equipped with high-friction composition brake shoes and brake rigging designed for these shoes and that until then the car must be equipped with either high-friction composition brake shoes or high-phosphorous brake shoes and brake rigging designed for the type of brake shoe used Proposed subparagraph (11) would also require all brake shoes on the car to be of the same type and in safe and suitable condition for service High-friction composition brake shoes would be required to have a minimum thickness of three-eighths inch and high-phosphorus brake shoes, of one-half inch

Sparks generated by contact between brake shoes and wheels during braking of trains present a serious fire potential which assumes critical dimensions when a car is carrying Class A explosives Cast iron brake shoes produce a heavy shower of sparks during braking which could ignite any combustible material under the car High-phosphorus brake shoes are much less susceptible to this sparking effect but since they are made of metallic material, they do produce some sparks during heavy braking High-friction composition shoes normally generate almost no sparks Low-friction composition brake shoes also generate practically no sparks However, because only a very small portion of the nation's freight car fleet is equipped with low-friction composition brake shoes, this type of brake shoe is virtually unknown to many railroad maintenance employees and is not carried in stock by many railroads Consequently, there is a strong possibility that worn or missing low-friction composition brake shoes may be improperly replaced with high-friction composition brake shoes thereby creating serious fire and safety hazards Mixed types of brake shoes on a car and worn-out brake shoes are also hazardous

Subparagraph (12). The FRA proposes to redesignate existing subparagraph (12) as subparagraph (14) and to add a new subparagraph (12). The proposed new subparagraph provides that a car carrying Class A explosives must have either a metal sub-floor with no combustible material exposed beneath the car or have metal spark shields extending from the center sill to the side sills and from each end sill to at least twelve inches beyond the extreme treads of the inside wheels of each truck. The spark shields must be tightly fitted against the sub-floor so that no vacant space to catch sparks or combustible material is exposed. The new subparagraph also provides that the metal sub-floor or spark shields may not have an accumulation of oil, grease or other debris which could support combustion.

In recent demonstrations using a static wheel dynamometer at speeds up to 45 m.p.h. and blowers to simulate the actual railroad environment, slivers of brake shoe material became embedded in cracks in wood placed at car sub-floor height above the test wheel, at distances of more than thirty-six inches beyond the center of the axle in the direction of rotation. In these demonstrations, radiant heat equivalent to that radiated by an overheated wheel, charred wood subflooring protected by a tightly-fitted metal shield but did not cause the wood to burn. Particles of brake shoes deposited in a catchpan at ballast level continued to glow for minutes Accordingly, metal shielding of the area above each truck is necessary to prevent fire caused by heat radiated from an overheated wheel or by burning fragments of brake shoe material becoming lodged in wood sub-flooring. This shielding is still necessary even when a car is equipped with high-friction composition brake shoes because in the event of "sticking brakes" or sustained heavy braking, the resin in the composition material may ignite and burn freely causing the brake shoe to disintegrate and freely-burning fragments to be propelled and lodged against the bottom of the car This shielding will also minimize fire hazards resulting from high-friction composition brake shoes being mistakenly replaced with cast iron brake shoes, a not uncommon occurrence.

Subparagraphs (13) and (14). In these subparagraphs which presently are numbered (11) and (12), the term "qualified inspector" is proposed to be substituted for "competent employee." This change is proposed to describe more precisely the person required to examine, inspect and certify cars used to transport Class A explosives.

In addition, a number of changes are proposed in paragraph (c) of § 174.525.

Subparagraph (1). The term "qualified inspector" is proposed to be substituted for "competent employee" to conform with proposed subparagraphs (13) and (14) of paragraph (b).

Subparagraph (3). The FRA proposes to delete "or to the side of wooden cars between car initials and the car door". As a result, all car certificates would be required to be attached to the fixed placard boards which are now standard equipment on freight cars. Also, the text of Certificate No 1 would be changed to become a general certification that the car complies with the requirements of the recently issued FRA Freight Car Safety Standards (38 FR 32224) as well as those of this part pertaining to cars used to transport Class A explosives.

Pursuant to the provisions of Section 102(2) (c) of the National Environmental Policy Act (42 U.S.C 4321 et seq), the FRA has considered the requirements of that Act concerning Environmental Impact Statements and has determined that the amendments proposed in this notice would not have a significant impact upon the environment Accordingly, an Environmental Impact Statement is not necessary and will not be issued with respect to the proposed amendments

This notice is issued under the authority of sections 831–835 of Title 18, United States Code, and section 9 of the Department of Transportation Act (49 U.S.C. 1657).

In consideration of the foregoing it is proposed to amend § 174 525 as set forth below.

Issued in Washington, D.C., on January 28, 1974

JOHN W. INGRAM,
Federal Railroad Administrator,
Member, Hazardous Materials Regulations Board.

1. It is proposed to amend § 174.525 as follows:

§ 174.525 Loading packages of explosives in cars, selection, preparation, inspection and certification.

* * * * *

(b) Certified closed cars must be inspected inside and outside, other cars must be inspected as applicable to the type of car, and must conform to the following specifications:

(1) Closed cars of not less than 80,000 pounds capacity, with steel underframes and friction draft gear, must be used except that on narrow-gage railroad explosives may be transported in cars of less than that capacity provided the available cars of greatest capacity and strength are used for this purpose

* * * * *

(3) Must have no holes or cracks in the roof, sides, ends, or doors through which sparks may enter, or unprotected decayed spots which may hold sparks and start a fire.

(4) The roof of the car must be carefully inspected from the outside for decayed spots, especially under or near the running board, and such spots must be covered or repaired to prevent their holding fire from sparks A car with a roof generally decayed, even if tight, must not be used.

* * * * *

(6) The roller bearings or journal boxes, and the trucks must be carefully examined and put in such condition as to reduce to a minimum the danger of hotboxes or other failure necessitating the setting out of the car before reaching destination. The lids or covers of journal boxes must be in place. After December 31, 1975, the car must be equipped with roller bearings.

* * * * *

(11) After (effective date), the car must be equipped with high-friction

composition or high-phosphorous brake shoes and the brake rigging designed for the type of brake shoe used After December 31, 1974, the car must be equipped with high-friction brake shoes and brake rigging designed this type of brake shoe After (effective date) all brake shoes on the car must be of the same type, in safe and suitable condition for service, and in compliance with the following wear limits: High-friction composition brake shoes must be at least three-eighths inch thick and high-phosphorous brake shoes must be at least one-half inch thick

(12) The car must have either a metal sub-floor with no combustible material exposed beneath the car, or metal spark shields extending from center sill to side sills and from end sills to at least 12 inches beyond the extreme treads of the inside wheels of each truck, which are tightly fitted against the sub-floor so that there is no vacant space or combustible material exposed The metal sub-floor or spark shields may not have an accumulation of oil, grease or other debris which could support combustion

(13) The carrier must have the car examined by a qualified inspector to see that it is properly prepared, and must have a "Car Certificate" signed in triplicate upon the prescribed form (see paragraph (c) (2) and (3) of this section) before permitting the car to be loaded

(14) Except as provided in § 174 584 (h), a car must not be loaded with any explosives, Class A, until it shall have been thoroughly inspected by a qualified inspector of the carrier who shall certify as to its proper condition under this section and shall sign Certificate No 1 prescribed in paragraph (c) (2) and (3) of this section

(c) * * *

(1) For all shipments loaded by the shipper, a qualified inspector of the carrier must inspect the finished load and certify to its compliance with this part before the car shall be accepted for transportation; and Certificate No 2 as prescribed by subparagraphs (2) and (3) of this paragraph shall be signed before the car is permitted to go forward When a car is loaded by the carrier, Certificate No 2 must be signed only by the representative of the carrier

* * * * *

(3) Car certificate The following certificate, printed on strong tag board measuring 7 by 7 inches, or 6 by 8 inches, must be duly executed in triplicate by the carrier, and by the shipper, if he loads the shipment; the original must be filed by the carrier at the forwarding station on a separate file; and the other two must be attached, one to each outer side of car to the fixed placard board or as otherwise provided

____________________ Railroad

CAR CERTIFICATE

No 1 __________ Station, __________, 19__

I hereby certify that I have this day personally examined Car Number ____ and that the car complies with the FRA Freight Car Safety Standards (49 CFR Part 215) and with the requirements for freight cars used to transport explosives prescribed by the DOT Hazardous Materials Regulations Board (49 CFR Part 174)

____

(Qualified Inspector)

* * * * *

[FR Doc 74-2967 Filed 2-5-74;8:45 am]