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FRONT COVER

Looking aft on the starboard side of the SS *Makawao* as she took a "Kona" beating loaded to her marks with sugar and molasses. This photograph was taken several years ago as the Matson freighter was enroute from Hilo to San Francisco. Photograph by Chief Mate Elvin C. Hawley.

BACK COVER

SS *America* takes time out for drydocking. A national holiday was the occasion for the flag decorations.

DISTRIBUTION (SDL 62)

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"I predict that by the early 1960's all major naval vessels authorized for construction will be propelled by nuclear power."

—*Rear Admiral H. G. Rickover, U. S. N.*

"If it is inevitable that, in maritime war, the actions fought by warships and aircraft gain most attention, it must never be forgotten that the purpose of those actions is, nearly always, the protection of the merchant men; and without the steady devotion of the men who man those ships the whole structure of maritime power must crumble."

—*Captain S. W. Roskill, RN*
Royal Navy Historian, World War II

This very week, we have invited proposals and prices from manufacturers covering a nuclear propulsion plant for a merchant ship. We are asking them, contingent on congressional approval and funds, to furnish us with a nuclear propulsion plant to be fitted in a tanker type vessel by June 195[illegible]. We are also asking them to submit other proposals for design studies and developments for a nuclear propulsion plant which may offer greater ultimate technical and economic advantages with the purpose of having a second ship in operation by June 1961.

—*Clarence Morse, Maritime Administrator*
Society Naval Architects and Marine Engineers' Convention, New York. November 11, 1955

ADMIRAL SHEPHEARD RETIRES

ON February 1, 1956, Rear Admiral Halert C. Shepheard retired from active duty as Chief, Office of Merchant Marine Safety, U. S. Coast Guard, after more than 30 years of Federal service.

His numerous friends in the shipping world, international and national, realize that his departure is far from being an ordinary retirement for, in the course of his long service, an indelible record has been left with the U. S. Merchant Marine.

In reviewing the Admiral's career, the outstanding feature immediately apparent is that so many of the important advances made in the field of marine safety since the turn of the century parallel the Admiral's career; and, from the record, it would appear that this parallel was more than mere coincidence.

Admiral Shepheard assumed a senior position in the Bureau of Marine Inspection and Navigation in 1935, the year following the tragic *Morro Castle* disaster—the nadir of American merchant marine safety. In many respects this disaster marked an end to an era of unregulated and unrestricted sea commerce, insofar as safety was concerned, and the beginning of an era which has seen the U. S. Merchant Marine surpass all other nations in maritime safety.

The *Titanic* disaster in 1912 which took a toll of 1,517 lives, the *Empress of Ireland* loss in 1914, taking a toll of 1,012 passengers, and the *Vestris* sinking in 1928 with loss of 110 lives, had focused the world's attention on watertight compartmentation—subdivision. However, until 1936 there were no requirements for compartmentation of United States passenger ships either in the law or in the regulations. Today the degree of subdivision applicable to American ships is recognized as the world's highest.

Following the *General Slocum* fire in 1904, in which 985 lives were lost, there was a hue and cry for the use of fire-retardant materials for ship construction and furnishings. However, it was not until 1936 that the first regulations requiring fire-retardant construction were promulgated. Today the United States is the only country extensively using fireproof materials in the construction of passenger and cargo ships.

Perhaps even more outstanding than the high safety standards now inherent in United States merchant ships was the method by which they were derived. This is a real story of Democracy at work—of Government-Industry cooperation.

Our present civilization has become most complex. There is now a complete dependence on mechanisms, processes and products, so that, with respect to industrial regulation, it is utterly impossible for any except those so engaged to be constantly informed of the proposals encountered. This is particularly true with the shipping industry.

This means that if there must be regulation—if there are statutes which require it in the public interest—then our complex system will admit of but one solution: *Effective regulation must be the result of Government-Industry cooperation.*

All maritime regulations promulgated during Admiral Shepheard's tenure of authority have been predicated upon this proposition—a policy the Coast Guard will continue.

In the foregoing, just a few of the regulations and changes that have come about during Admiral Shepheard's career have been enumerated. These, however, will suffice to indicate the enormous strides that have been taken to improve maritime safety. It is no idle boast to say that the ships of the U. S. Merchant Marine are the safest in the world.

We in the Coast Guard join with the leaders and men of the U. S. Merchant Marine in saluting Admiral Halert C. Shepheard and wishing him Godspeed on his retirement from active duty in the U. S. Coast Guard. His accomplishments will be a lasting and fitting tribute to a truly great Maritime leader.

REAR ADMIRAL HALERT C. SHEPHEARD

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A NEW APPROACH TO GAS-FREEING

By C. M. Lynch, Safety Manager, Sinclair Refining Company

As we in the steamship business all know, gas-freeing is one of the most hazardous tasks normally performed on board a tankship. From the time this task is started until the vessel is absolutely gas-free, there are explosive vapors present, which being heavier than air, may find their way into the crew's quarters, engineroom, fireroom, galley, etc., endangering the safety of the ship and its crew. We are of the opinion, therefore, that in the interest of safety we should endeavor to complete this task in the minimum of time, thereby reducing the risk to the men and the ship.

The problem of gas-freeing and cleaning may be divided into five main parts, as follows:

1—Removal of all liquid.
2—Cleaning metal surfaces.
3—Removal of vapors.
4—Removal of scale and sediment.
5—Cleaning of pipelines.

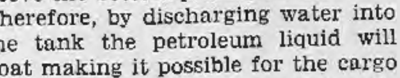
1—Inasmuch as the liquid petroleum is the danger source, it is imperative that we remove this first. In most cases tanks will contain small amounts of liquid even after they are "stripped" as dry as possible, because of the suction bell being slightly above the bottom plating in the tank. Therefore, by discharging water into the tank the petroleum liquid will float making it possible for the cargo pump to remove it. At this time sufficient water should also be discharged into the tanks to displace the petroleum products in the cargo system.

2—Certain types of petroleum products will vaporize so rapidly that it is unnecessary to wash the vertical plating in the cargo tanks. However, in some cases, when for example the last cargo carried in the tank was kerosene, diesel oil, heating oil, or some other similar oil product, the vertical bulkheads should be washed.

3—The scale and sediment in any cargo oil tank is a potential source of extreme danger, because:

First, it is permeated with oil which is very difficult to remove;

Second, inasmuch as there is almost certain to be some gas regeneration unless the tank is free of sediment, it is extremely dangerous to the man employed in cleaning the tank because of the highly toxic vapors unless adequate ventilation is provided.



4—Having removed the original source of the explosive vapors it is now a relatively simple matter to remove the vapor by any one of several accepted methods, such as power blowers, eductors, etc.

5—Cargo oil lines and cargo pumps can be a source of danger to any tank vessel and its crew when vessel is in shipyard undergoing repairs, as there may be dead ends, valve bonnets, etc., where pockets of oil may remain. Therefore, these pipelines and pumps must be very thoroughly and completely cleaned.

For the benefit of dry cargo and passenger ship operators who may not be familiar with tankship operation, I would at this time like to briefly describe the history of the gas-freeing of tank vessels.

PETROLEUM VAPORS

If we go back far enough we can find where petroleum vapors were considered to have only an "intoxicating" effect on men and were not considered dangerous. From the book *The Marine Transport of Petroleum*, by Charles Herbert Little, printed in 1890, we find the following:

"The fumes of Petroleum produce on many people the effects of intoxication similar to those produced by remaining long in a spirit vault; and one or two accidents have occurred by sending a man into a tank without keeping a watch to see that he does not be overcome by vapor."

At that time tanks were merely ventilated naturally, and with the vapors still in the tank, men entered and washed the sides and bottoms with hand hoses.

As time went on, the seriousness of petroleum vapors was slowly discovered. Other methods of cleaning tanks were developed. Wind sails were used to force air into the tanks. This method is only effective when the vessel is proceeding at a fair speed and preferably into the wind, which forces a good flow of air down into the tanks. However, this method too has its limitations, since it cannot be effective unless the vessel is moving, or if in port, only when a strong wind is blowing. From a safety standpoint it can be counted on only for limited service. The windsail method is still used by some tanker operators.

MECHANICAL CLEANING

In the late twenties a machine was introduced for washing cargo tanks. This machine was constructed so that it would revolve on two planes, thus the water from the nozzles would wash all parts of the tank. Prior to this time the method of cleaning tanks with steam was considered very good. Steam was used with the thought that heat would cause the liquids to vaporize, thus rising and escaping through the tank hatch. So it was only natural to assume that the use of hot water with the machine would have more effect than the use of cold water in cleaning cargo oil tanks on tankships. This method is still widely used by tank ship operators today.

One very important factor that cannot be overlooked when tank washing with hot water is the possibility of crew members getting burned or scalded. As we all know the water heaters are not infallible. Occasionally, the controls will fail and the water will overheat, creating a safety hazard to the men employed on deck. Needless to say, we have not had a single accident of this type since we started washing with cold water.

EXPERIMENTS CONDUCTED

Approximately seven years ago, we started conducting a series of experiments in tank washing in the hope of lessening the time ordinarily required to gas-free a tankship, thereby reducing the risk to the vessel and its crew during this crucial job.

One of the first experiments conducted eliminated the use of hot water and instead washed the tanks with cold water. No doubt this procedure is quite contrary to what some of you gentlemen have been taught throughout the years.

From the book *College Physics* by John A. Eldridge, Professor of Physics, University of Iowa, I will quote the following paragraphs:

"When a glass of water has remained for sometime in a warm room, we see bubbles of air separated out on the glass. Fish depend upon the oxygen dissolved in water for this respiration. During the summer months water loses much of this dissolved air, and fish in shallow ponds suffocate. When water is heated on the stove, bubbles of air form and rise, and the water appears to boil at temperatures much below that at which true boiling occurs.

"This shows that gasses are dissolved in liquids, and that the solubility decreases with a rise in temperature."

From the above it can readily be seen that cold water will absorb more gasses than heated water. By absorbing most of these gasses and discharging them along with the wash water we avoid the hazard of having the gasses heated and expanded in the cargo tank, thereby escaping through the tank openings on deck and finding their way into some area whereby the safety of the ship and crew would be endangered.

The only problem now at hand was, whether or not the cold water wash would be as effective as the old hot water method formerly used. Our experiments have shown that we could completely gas-free an average tank of about 30,000 to 40,000 cubic feet volume within 2 hours. Our method would follow this pattern:

1—Machine wash the tank with cold sea water for approximately 30 to 60 minutes.

2—Then apply the blower to the tank for 30 minutes. At this point take a reading on the explosimeter which would run from 10 to 40 percent explosive, depending on the condition of the tank. If the tank had a considerable amount of sediment we would remove it. About 30 minutes after the sediment was removed we would find that the tank would have a zero reading on the explosimeter. The blower would be left running while the men were in the tanks and for the above mentioned 30 minutes afterward.

Thus far we have discussed some of the history and a few of the conditions we encounter when gas-freeing a tankship. Also, we have attempted to briefly outline the procedure we have been following in gas-freeing a tank. Now we will give a short description of the equipment we are using.

EQUIPMENT REQUIRED

To wash the top and sides of a cargo tank, we use a conventional type tank cleaning machine. However, for bottom washing only we use a bonded wash down hose.

To remove the vapor, we use a fan driven by a steam turbine. It is so constructed as to fit directly over the tank cleaning access opening and is explosion-proof. The turbine is supplied with steam by a ¾-inch flexible rubber-covered steam hose and exhausts through a 1¼-inch rubber-covered hose. (We formerly used the conventional flexible metal steam hose, but experience has shown that rubber-covered hose is much safer to handle and reduces the "burn" risk for the men.) This fan supplies 2,500 c. f. m. of air at 1-inch static pressure with 125 pounds steam. Inasmuch as the largest of our cargo tanks is approximately 50,000 cubic feet we get a complete change of air every 20 minutes. The force of the air from the fan is strong enough to be felt at the bottom of the tank, and the turbulence created aids in removing the vapors from the various sections within the tank whereby, they, being heavier than air, could otherwise remain.

To remove the drainage from the cargo tanks after they have been completely cleaned and the pipelines drained we have supplied each vessel with a portable jet pump.

TYPICAL REPORT

The following is a gas-freeing report of one of our vessels enroute from New York to a shipyard in Jacksonville, Florida:

Vessel—SS *Flagship Sinco*
Tonnage—Net 6356, Gross 10803, Deadweight 17229
Number of cargo oil tanks—24
Speed—14.5 knots
Last cargo carried—No. 2 Fuel—1-2-3-4 P. C. & S. and 5-6-7-8 P; Gasoline—5-6-7-8 C. & S.
Sailed from—New York 1340, 5/2/55
Departure—Ambrose Light Vessel 1645, 5/2/55
Commenced washing cargo tanks—0830, 5/3/55
Commenced forcing air into cargo tanks—0915, 5/3/55
Finished washing cargo tanks—2015, 5/3/55
Vessel gas-free according to the deck logbook—2100, 5/4/55
Vessel arrived at Jacksonville Bar—0024, 5/5/55
Pilot and chemist aboard—0057, 5/5/55
Chemist's first examination completed—0255, 5/5/55. All tanks except those containing ballast, No. 2-4-6 Centers, were reported as SAFE FOR MEN—FIRE.
Transfer of ballast completed—0700, 5/5/55
Chemist's second examination completed—0830, 5/5/55. All tanks except No. 1 Port, Center and Starboard were SAFE FOR MEN—FIRE. These contained water ballast and were SAFE FOR FIRE ONLY.
Vessel placed on drydock—0830, 5/5/55
Average speed for voyage—14.24 knots.

It should be interesting to note from the above report that the total washing time was but 12 hours, and the vessel maintained her normal cruising speed from bar to bar, averaging 14.24 knots. This is a great improvement over any method formerly used.

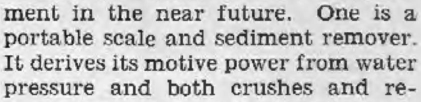
OTHER PROBLEMS

We are of the opinion that our method is one of the best in use today, but it is not the answer to all problems. For example, when carrying "black or lube oils," the use of the hot water machine wash is necessary. Problems also arise when attempting to gas-free on a very humid day. In this case the blower carries moisture into the tanks. In order to overcome this problem we are attempting to change the temperature of the air and hope to report at a future date our findings.

We are also developing new ideas with regard to tank cleaning and gas-freeing, with which we hope to experiment in the near future. One is a portable scale and sediment remover. It derives its motive power from water pressure and both crushes and removes the scale from the tank through an eductor. If and when this machine is perfected it should also contribute to the reduction in time necessary to remove the foreign matter from tanks, thereby eliminating the gas regeneration problem and also greatly reducing the accident rate on seamen required to perform this dangerous task.

Another is an exhauster for use on the main cargo manifold, in conjunction with the power-blowers on the tanks. This combination should still further reduce the time required to gas-free a tankship.

EDITOR'S NOTE: This paper was presented to the Marine Section, National Safety Council at the annual meeting held in Chicago, Ill., on October 18, 19, and 20, 1955.



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BRIDGE AGAINST BRIDGE

"33 U. S. Code 494: Obstruction of Navigation—No bridge erected or maintained under the provisions of this chapter, sections 491 to 498, inclusive, shall, at any time, unreasonably obstruct the free navigation of the waters over which it is constructed, * * *"

ALL mariners are aware of their responsibility to call attention to dangers or obstructions to navigation. On the high seas a common danger might be a derelict or a drifting mine. On inland waters a buoy out of position would probably be the most common occurrence requiring a master to exercise this responsibility.

Recently, a collision between a tanker and a bridge dramatically pointed out the responsibility of masters and pilots to call attention to such dangers or obstructions.

This collision occurred October 5, 1955, on the Ashley River near Charleston, S. C. The SS *Fort Fetterman*, a T–2 tanker, was upbound in light draft. She drew 14 feet 10 inches forward and 14 feet 10 inches aft.

At 0920 when the tanker was one mile below the Ashley River Bridge, proceeding at half speed, the pilot signalled the bridge to open. At 0923 speed was reduced to slow ahead. A second signal to open the bridge was given when one-half mile away. For the next few minutes, the vessel maneuvered with various stop and slow bells to take her way off. At 0933 a third signal to open the bridge was sounded and simultaneously it began to open.

Five minutes later, as she passed through the draw, the tanker breasted against the fenders which protect the west abutment and in doing so the ship's upper structure struck and carried away the west bascule.

Although the bridge was completely opened at the time of collision the bascules hung at an approximate 20° angle and extended out over the protecting abutments some 10 feet. The west projection was sufficient to catch on the forward port bridge wing as the ship passed by.

The bridge was originally designed to open to a near vertical position with abutment fenders to be located outboard of any projection. Photographs show, however, that the bascules were not protected by the fenders.

One interesting sidelight to the accident, which tied up New York-to-Miami traffic, was the excellent series of pictures which were taken. By chance, Mr. Richard Burbage, a newspaper photographer was out in a small boat that morning to take routine pictures of river traffic. As the *Fort Fetterman* approached the bridge, he snapped a picture. A few minutes later the sound of steel against steel was heard and he realized a collision was taking place. He immediately turned his camera on the scene and his once-in-a-lifetime pictures resulted.

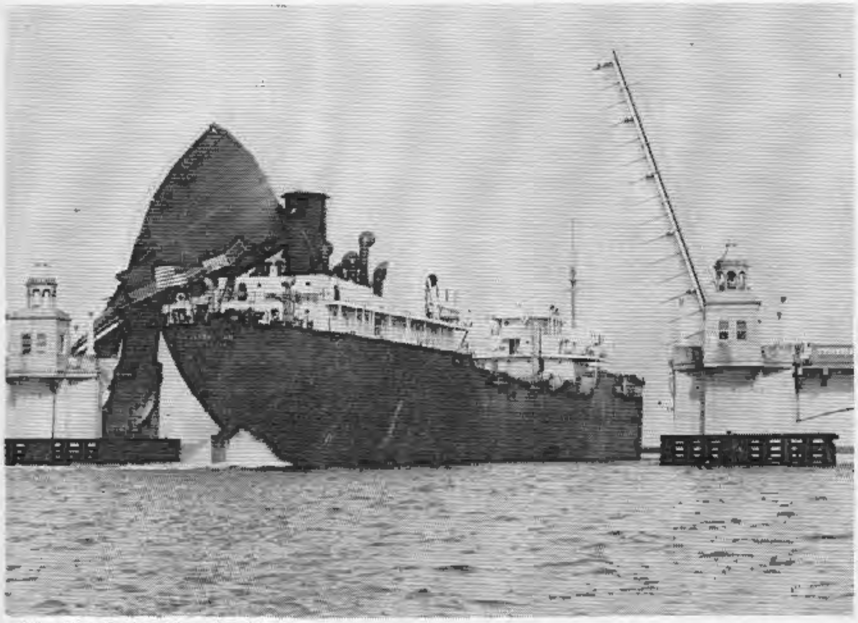
In the final analysis it would appear that had this accident not befallen the *Fort Fetterman*, some other vessel eventually would have been involved in a similar accident. The owners and

The Charleston Evening Post

Figure 1. SS Fort Fetterman approaches Ashley River Bridge.

The Charleston Evening Post

Figure 2. Immediately after contact with ship's port bridge wing, mainmast about to be carried away.



The Charleston Evening Post

Figure 3. Mainmast down.

operators of the bridge, presumably not otherwise connected with river navigation, possibly were not aware that the fenders gave protection only to the bridge abutments and not the bascules. Accordingly, some of the responsibility for this obstruction to navigation rests with the hundreds of masters and pilots who traveled this particular stretch of river over the years and could see from their vantage point that the bascules were unprotected, yet never called attention to the fact.

Fortunately, no lives were lost and the ship experienced only relatively minor damage. Perhaps this accident will alert all seafarers to their unwritten but, nevertheless, important responsibility to report all dangers and obstructions to navigation wherever they are found.

The Charleston Evening Post

Figure 4. One down—one to go.

⚓ TRADITIONS OF THE SEA

The roll of American seafarers who have performed their duties in an outstanding and meritorious manner in accordance with the highest traditions of the sea is long but never completed.

The names of Capt. Victor E. Raymond, his officers, and crew in the SS *Steelore* have recently been added to this roll.

While enroute from Venezuela to Baltimore the SS *Steelore* encountered a severe storm on January 10, 1955. During the course of the storm, heavy damage was sustained and for 5 days the vessel was in imminent danger of sinking. On December 16, 1955, the Commandant of the Coast Guard commended the officers and crew as follows:

> The United States Coast Guard is pleased to commend you, Captain Raymond, and the officers and crew of the SS *Steelore* for the successful effort to prevent the loss of the vessel when it became damaged and was in imminent danger of sinking off the Atlantic coast between January 13 and January 18, 1955.
>
> From the time the vessel was found to be taking water on the 13th day of January, through the rough and stormy weather encountered for the next 5 days, the excellent seamanship and unremitting efforts on the part of the officers and crew resulted in the vessel reaching a safe place of refuge in the vicinity of Cape Lookout. During this period, the handling of the vessel, the attempts made to stop the ingress of water, and the alertness and close attention to duty by all hands indicate a ship's crew which reflects credit on the United States Merchant Marine.
>
> The Coast Guard board of investigation which investigated this casualty, in reporting on the excellent conduct of the officers and crew during the time the *Steelore* was in danger, commented particularly concerning the performance of duty of the Master, Victor E. Raymond, the Chief Mate, Edward P. Chelchowski, the Chief Engineer, William J. Noonan, the First Assistant Engineer, Joseph A. Cadden, and the Second Assistant Engineer, Delmar J. McCleery.
>
> Your performance of duty under hazardous conditions is worthy of the highest praise and in keeping with the finest traditions of the United States Merchant Marine. ⚓

LESSONS FROM CASUALTIES

KEROSENE BARGE BLAST

DANGEROUS explosions and fires continue to occur from time to time in operations involving tank barges, and each new explosion adds knowledge to the general science of safety in the handling of petroleum products. One such explosion, which did approximately $40,000 damage to a tank barge, occurred recently at a southern oil terminal. The circumstances under which this explosion occurred were readily apparent and could be reconstructed in the minutest detail for thorough analysis and investigation. In spite of this, no concrete conclusion could be reached as to the exact cause of ignition. However, a recital of the facts may be of value to persons concerned with handling petroleum products, and it is quite possible that the answer to the explosion may be discernible in the telling, although expert investigators on the scene could not pinpoint the cause at the time.

This 1,096-ton tank barge, built in 1951, arrived at the terminal on a warm summer afternoon having been towed down the river from an inland port in a light condition. The previous cargo was gasoline which had been discharged several days before. En route all cargo lines were air blown. A mixed cargo was to be loaded including 2,400 barrels of kerosene which was to be loaded first.

COMMENCE LOADING

Following an examination by an independent oil inspector, No. 1 starboard tank was determined ready for loading. It was also visually examined by a terminal dockman and a certificated tankerman on duty. They noted that the tank was "damp wet," but attributed the cause to water. However, there is no evidence that the tank was ever washed down with water following the discharge of the gasoline cargo. A few minutes before 6 p. m. the go-ahead signal was given and terminal workmen opened the valves to gravitate the kerosene into the tank. At that time the kerosene temperature was 90° F.

Cargo had run by gravity alone for 8 or 9 minutes when the terminal dockman passed the word to the pumphouse to commence pumping. The distance from the storage tank to the barge was about one-half mile by pipeline. Line pressure at the pump was 60 p. s. i., which meant that discharge pressure at the barge was probably 40 to 50 p. s. i. Approximately 1 minute after the pumping commenced, there was a tremendous explosion and parts of the barge flew through the air. A terrific fire raged on the barge, fed by the 268 barrels of kerosene which had been loaded.

The tankerman, most fortunately, had just departed to check on another barge which was under his supervision. Except for this fortuitous circumstance, he might easily have been killed. Parts of the barge were found a considerable distance away on the dock, but luckily no person was injured.

Within minutes of the explosion, the alert fire brigade from the terminal arrived on the scene and quickly rigged five 2½-inch hose lines. Using pressure from the terminal fireboat, which was equipped with a 750-gallon-per-minute fire pump, firemen tackled the burning kerosene with fog nozzles and one chemical foam proportioner. Within 30 minutes the fire was under control and extinguished.

BLAST DAMAGE

The violent force of the explosion is well illustrated by figure 1. The entire deck plating above the loading tank was ripped cleanly away and hurled clear of the barge. The centerline bulkhead and the bulkhead to No. 2 starboard tank were also badly damaged. The side plating in the vicinity of this tank was blown almost entirely off. All structural strength members of the tank and the adjacent bulkheads were badly distorted or fractured. While the barge was afire, a tug shifted it away from the loading dock and beached it at a safe distance from the terminal.

Since there was no eyewitness on the barge at the moment of explosion, clues as to the source of ignition could only be determined by reconstruction of the material factors known to have existed. Prior to loading, the hose connection to the header on the barge had been found to be tight and no leakage was noted anywhere in the vicinity of the barge. A bonding cable of 19-strand, ⅜-inch copper wire, covered with heavy rubber insulation, had been grounded to the top of the Morrison pressure vacuum valve on the No. 4 port tank expansion trunk. The connection was made by a C-clamp. Markings on the pressure vacuum valve caused by the tight connection of the C-clamp were clearly apparent after the explosion and fire. The bonding cable was not disturbed by the explosion and the connection was found intact after the fire. The cargo hose itself had been recently tested for electrical resistance to insure sufficient conductivity to prevent dangerous static charges from building up in the hose. At the time of test, the resistance was approximately 0.4 ohms per foot.

TANK OPENINGS

Each cargo tank on the barge was fitted with a round expansion trunk measuring 3 feet in diameter which extended 2 feet above the main deck. The top of each trunk was fitted with a manhole with dogged cover and gasket, the handwheel for the remote control of the suction valve, and the tank vent which consisted of a 7½-inch length of 3-inch steel pipe capped by a pressure-vacuum valve. In addition, each tank was fitted with an access manhole, with dogged cover and gasket, located on the main deck at the diagonally opposite corner from the expansion trunk. The coaming for these manholes extended 10 inches above the main deck.

The manhole cover in the expansion trunk of No. 1 starboard tank had been opened, prior to loading, for visual inspection of the tank. It remained open until the explosion, but the tankerman testified that a flamescreen covered this opening when the explosion occurred. The evidence did not indicate whether the other opening, the access manhole, was open or closed at the time of explosion and the terrific damage to the entire deck section made it impossible to deduce this factor. However, the normal assumption would be that this manhole cover was closed and dogged when loading began, with all venting taking place through the pressure-vacuum valve and the open expansion trunk cover.

The 6-inch suction line in No. 1 starboard tank, was used for loading and it had a bellmouth facing the bottom plating. Clearance between the bellmouth and the bottom plating was approximately one-half inch. This would tend to prove that turbulence caused by the flow of cargo from the bellmouth to the bottom of the tank would be a factor only while there was less than two inches of cargo in the tank. With 268 barrels in this tank, the depth would have been approximately 14½ inches.

Although the pump aboard the barge was equipped with an internal combustion engine, it was not in operation at the time of the explosion nor were there any live connections to the batteries in the battery box. There were no vessels in the vicinity which could have provided a source of ignition. There was no evidence of open lights or flames of any type in the immediate vicinity.

This casualty was the third explosion at this terminal of a tank barge loading kerosene within 4 years. In each case, kerosene was being pumped in under pressure at the time of explosion.

STATIC SPARK

The lack of any indication of ignition by an open flame, electrical failure, or the heat of friction, leads to the conclusion that ignition must have resulted from a static spark. The question of where the static discharge could have taken place in the vicinity of kerosene vapors is not so easy to determine. Some question could be raised by the method of connecting the bonding cable to the top of the pressure vacuum valve, but this apparently provided a good ground since there was a solid metallic path from the point of contact to the hull of the barge. The possibility of static discharge from or to the fill pipe inside the tank is exceedingly remote. The fill pipe was well grounded to the barge and the surface of the kerosene cargo was in continual contact with the pipe after the liquid level rose above the bellmouth. Even if it is conceded that there is a remote possibility of static discharge from or to the bellmouth, under the surface of the nonconductive kerosene, this point was immersed approximately 13 inches at the time of the explosion, and therefore such a discharge could not have triggered an explosion as there could be no oxygen in the presence of the spark. This would tend to rule out ignition of the explosion due to static discharge within the cargo tank but would leave the possibility of ignition due to static spark *above* the main deck.

Witnesses who heard the explosion described it as a sort of "whoosh" followed by a "boom." This description would be consistent with the ignition of a flash-fire in the vapors above the main deck and the transmission of such a flash-fire to the cargo tank through the open cover in the expansion trunk. Several explosions of this nature, where the original ignition took place in emitted vapors as a flash-fire and the flash then traveled back to the tank, are on file in the Coast Guard's casualty records. However, such an explanation of the cause of the explosion in this case still lacks any source of ignition, such as a flame, open light, or electrical circuit in the vicinity of the barge.

One logical possibility in the flash-fire theory would be a static discharge at some point above the main deck, outside the expansion trunk, and not grounded by the bonding cable. Such a point could have existed on the rubber cargo hose, especially at the coupling flanges, if there was any flaw in the continuity of the metal wire built into the hose. A slight movement of the hose, such as would occur when the first pulses from the pump reached the hose, or due to the motion of the vessel, could cause a make-and-break contact between hose (or coupling) and vessel and thereby create ideal conditions for a static discharge. Again, if the coupling flanges were steel rather than bronze, such a movement could conceivably cause a metal-to-metal friction or striking spark. However, there is a considerable difference of opinion among petroleum and tanker safety engineers as to whether any such friction spark could ever have sufficient heat to ignite a mixture of petroleum vapors and air.

Assuming that the manhole cover of the small access trunk was closed, the flash-fire theory would then depend upon the transmission of the fire to the cargo tank through the open manhole of the expansion trunk. Although the tankerman testified that a flame-screen was in position over this manhole at the time of the explosion, the possibility of transmission of flame past this flame-screen due to a flaw in the screen, an imperfect fit, or a momentary lifting or "chattering" due to a violent expulsion of fumes under a forced filling rate is still a plausible possibility. The possibility of an "error" in the tankerman's memory as to whether the flame-screen was in position cannot be entirely ruled out.

Figure 1. Showing section of deck plating ripped from No. 1 starboard tank.

LOADING PRECAUTIONS

As a consequence of three similar explosions within 4 years at the terminal, the Coast Guard conducted an inquiry at another oil terminal where barges are frequently loaded with kerosene, and where there has been no serious fires or explosions. At this terminal, the determination as to whether a barge tank is ready for loading is always made by specially trained chemists who check the barge and loading equipment all the way from the cargo tank to the storage tank ashore. The first check is on the type of cargo last carried. If it was gasoline or another light petroleum product, a thorough water washing of the tank is required before anything else is done. Fire hoses carrying a pressure of from 100 to 125 p. s. i. are used to wash the tanks after which the tanks are completely stripped of water and cargo residue.

The bonding line is made fast to a pipeline flange on the barge. Discharge pressure is not allowed to exceed 30 p. s. i. Atmospheric humidity conditions are watched closely and when the relative humidity is less than 60 percent, extreme caution is exercised. A megger test of all hoses is made every four months. When hose resistance reaches more than 0.5 ohms per foot, the hose is discarded.

The filling hose is never allowed to touch or rub on the deck, rail, or other parts of the barge other than the filling flange connection. When loading, hatches are *closed* and flame-screens are placed over any open sounding pipes or ullage openings. No small craft or other possible sources of ignition are allowed in the area during loading. This terminal has a separate dock area for loading barges.

HAZARDOUS CARGO

Safety engineers at this terminal consider *kerosene and jet fuel to be among their most hazardous cargoes.* They are convinced that the explosive hazards involved are centered principally upon the possibility of static discharge, and precautions are directed especially toward the elimination of electrostatic accumulation. This terminal gave serious consideration to carbon dioxide flooding of tanks before loading, but this idea was discarded in view of the expense involved. There are also certain flaws in carbon dioxide flooding which prevent a positive prevention of ignition.

To return to the casualty, it was the consensus of the company management, the operating personnel, and the investigators, that the explosion was triggered off by a discharge of static electricity, although the exact cause or location of the spark could not be determined. A review of this and similar cases would indicate the necessity of good bonding practices whenever a petroleum cargo is to be loaded or discharged. The practice of preventing unnecessary contacts of the cargo hose with the deck, rail, or other parts of the vessel while cargo is flowing would also seem to be desirable. The importance of maintaining a tight closure of manhole openings or ullage openings with an effective flame-screen whenever it is necessary for the covers to be off, is obvious. That flames, open lights, smoking, galley fires, or any other potential sources of ignition not be permitted within range of the fumes generated by cargo transfer is beyond argument. *Eternal vigilance is the price of freedom from dangerous and costly explosions.*

APPENDIX

AMENDMENTS TO REGULATIONS

[EDITOR'S NOTE.—The material contained herein has been condensed due to space limitations. Copies of the Federal Registers containing the material referred to may be obtained from the Superintendent of Documents, Washington 25, D. C.]

TITLE 46—SHIPPING

Chapter I—Coast Guard, Department of the Treasury

[CGFR 55-46]

Subchapter F—Marine Engineering

EDITORIAL CHANGES REGARDING MATERIAL SPECIFICATIONS

The material specification standards prescribe requirements covering materials for use in the construction of boilers, unfired pressure vessels, piping, valves, fittings, and appurtenances. Coast Guard regulations require that materials shall comply with standard specifications issued by the American Society for Testing Materials (A. S. T. M.), 1916 Race Street, Philadelphia 3, Pennsylvania, subject to certain described limitations. During the last year this Society reissued certain specifications referred to in Coast Guard regulations, which are designated: A31–55, A53–55T, A72–55, A83–55T, A84–55, A105–55T, A106–55T, A135–55T, A178–55T, A179–55T, A181–55T, A182–55T, A192–55T, A193–55T, A194–55T, A209–55T, A210–55T, A213–55T, A217–55, A226–55T, A307–55T, A312–55T, A335–55T, A339–55, B11–55, B13–55, B42–55, B43–55, B75–55, B88–55, B111–55, B169–55, and B171–55.

The cancellation of 46 CFR 51.01–95, regarding emergency alternate provisions for material specifications, is made because the Government restrictions on use of critical materials have been removed and the American Society for Testing Materials discontinued the use of these emergency alternate provisions to the A. S. T. M. Standards.

The amendments to 46 CFR 51.07–1, 51.13–1, 51.25–1, 51.34–1, 51.46–1, 51.49–1, 51.58–1, 51.61–1, 51.67–1, 51.70–1, and 51.73–1 revise and bring up to date the references to A. S. T. M. specifications.

The amendments to 46 CFR 52.05–10, 55.07–1, and 55.07–5, cancel references to obsolete A. S. T. M. specifications.

The amendments to 46 CFR 52.70–10 and 52.70–25 transfer the text of one paragraph from one section to another in order to have a better arrangement of requirements.

The amendment to 46 CFR 56.01–20, regarding arc welding electrodes, editorially corrects the title of the pamphlet "Equipment Lists" in which are published acceptable brand names of arc welding electrodes.

Because the amendments in this document are editorial in nature and bring references to material standards up to date, it is hereby found that compliance with the Administrative Procedure Act respecting notice of proposed rule making, public rule making procedures thereon, and effective requirements thereof is unnecessary.

PART 51—MATERIALS

SUBPART 51.01—GENERAL

Section 51.01–95 *Emergency alternate provisions* is canceled.

SUBPART 51.07—STAYBOLT AND RIVET STEEL

Section 51.07–1 *Scope* is amended by revising the reference to A. S. T. M. specification designation (column 1) in Table 51.07–1 from "A31–52T" to "A31–55."

SUBPART 51.13—STAYBOLT AND RIVET IRON

Section 51.13–1 *Scope* is amended by revising the reference to A. S. T. M. specification designation (column 1) in Table 51.13–1 from "A84–52T" to "A84–55".

SUBPART 51.25—CARBON AND ALLOY-STEEL AND WROUGHT IRON TUBES

Section 51.25–1 *Scope* is amended by revising the references to A. S. T. M. specification designations (column 1) in Table 51.25–1 from "A83–54T" to "A83–55T"; from "A178–54T" to "A178–55T"; from "A179–54T" to "A179–55T"; from "A192–54T" to "A192–55T"; from "A210–54T" to "A210–55T"; from "A226–54T" to "A226–55T"; from "A209–54T" to "A209–55T"; and from "A213–54T" to "A213–55T".

SUBPART 51.34—CARBON AND ALLOY-STEEL, AND WROUGHT IRON PIPE

Section 51.34–1 is amended by revising Table 51.34–1 to read as follows:

§ 51.34–1 *Scope.* * * *

TABLE 51.34-1—MATERIAL SPECIFICATIONS

A. S. T. M. designation	A. S. T. M. grade	Coast Guard grade
Carbon-steel and iron:		
A53-55T	Lap-welded steel	P53-LW.
A53-55T	Butt-welded steel	P53-BW.
A53-55T	A (seamless steel)	P53-A.
A53-55T	B (seamless steel)	P53-B.
A53-55T	A (electric-resistance-welded steel).	P53-RW-A.
A53-55T	B (electric-resistance-welded steel).	P53-RW-B.
A106-55T	A (seamless steel)	P106-A.
A106-55T	B (seamless steel)	P106-B.
A135-55T	A (electric-resistance-welded steel).	P135-A.
A135-55T	B (electric-resistance-welded steel).	P135-B.
A72-55	Lap-welded wrought iron.	P72-LW.
A72-55	Butt-welded wrought iron.	P72-BW.
Alloy-steel:		
A335-55T	P1 (C-Mo)	P1.
A335-55T	P2 (0.50 to 0.70 Cr-0.50 Mo).	P2.
A335-55T	P3 (1.75 Cr-0.70 Mo).	P3.
A335-55T	P3b (2 Cr-0.50 Mo)	P3b.
A335-55T	P11 (1.25 Cr-0.50 Mo)	P11.
A335-55T	P12 (1 Cr-0.50 Mo)	P12.
A335-55T	P21 (3 Cr-0.90 Mo)	P21.
A335-55T	P22 (2.25 Cr-1 Mo)	P22.
A312-55T	TP321 (18 Cr-8 Ni +Ti).	TP321.
A312-55T	TP347 (18 Cr-8 Ni +Co).	TP347.

SUBPART 51.46—STEEL FORGINGS

Section 51.46–1 *Scope* is amended by revising the references to A. S. T. M. specification designations (column 1) in Table 51.46–1 from "A105–46" to "A105–55T"; from "A181–49" to "A181–55T"; and from "A182–53T" to "A182–55T".

SUBPART 51.49—CARBON AND ALLOY-STEEL BOLTING AND NUT MATERIAL

Section 51.49–1 *Scope* is amended by revising the references to A. S. T. M. specification designations (column 1) in Table 51.49–1 from "A307–53T" to "A307–55T"; from "A193–53aT" to "A193–55T"; and from "A194–53" to "A194–55T".

SUBPART 51.58—STEEL CASTINGS

Section 51.58–1 *Scope* is amended by revising the reference to A. S. T. M. specification designation (column 1) in Table 51.58–1 from "A217–54T" to "A217–55".

SUBPART 51.61—MALLEABLE IRON AND GRAY IRON CASTINGS

Section 51.61–1 *Scope* is amended by revising the reference to A. S. T. M. specification designation (column 1) in Table 51.61–1 from "A339–51T" to "A339–55".

SUBPART 51.67—COPPER AND COPPER-ALLOY PLATE

Section 51.67–1 *Scope* is amended by revising the references to A. S. T. M. specification designations (column 1) in Table 51.67–1 from "B11–54" to "B11–55"; from "B171–54" to "B171–55"; and from "B169–52" to "B169–55".

SUBPART 51.70—SEAMLESS COPPER AND COPPER-ALLOY PIPE

Section 51.70–1 *Scope* is amended by revising references to A. S. T. M. specification designations (column 1) in Table 51.70–1 from "B42–54" to "B42–55" and "B43–54" to "B43–55".

SUBPART 51.73—SEAMLESS COPPER AND COPPER-ALLOY TUBES

Section 51.73–1 *Scope* is amended by revising references to A. S. T. M. specification designations (column 1) in Table 51.73–1 from "B88–54" to "B88–55"; from "B13–49" to "B13–55"; from "B75–54" to "B75–55'; and from "B111–54" to "B111–55".

PART 52—CONSTRUCTION

SUBPART 52.05—CYLINDRICAL SHELLS

Section 52.05–10 *Computation* is amended by revising Table 52.05–10 (a) by canceling in column 2 (A. S. T. M. designation) the references in parentheses, which are "(A206), (A280), (A158), and (A315)," opposite specification subpart 51.34 for "seamless alloy steel".

SUBPART 52.70—BOILER MOUNTINGS AND ATTACHMENTS

1. Section 52.70–10 *Detail requirements* is amended by canceling paragraph (f). (The text of this paragraph transferred to § 52.70–25 (b).)

2. Section 52.70–25 is amended by adding a new paragraph (b) reading as follows:

§ 52.70–25 *Feed connections.* * * *

(b) Feedwater nozzles of boilers designed for pressures of 400 pounds per square inch, or over, shall be fitted with sleeves or other suitable means employed to reduce the effects of metal temperature differentials.

PART 55—PIPING SYSTEMS AND APPURTENANCES

SUBPART 55.07—DETAIL REQUIREMENTS

1. Section 55.07–1 *Material* is amended by revising Table 55.07–1 (b) by canceling in column 2 (A. S. T. M. specification) the references in parentheses, which are "(A206), (A280), (A158), and (A315)," opposite material specification subpart 51.34 for seamless-alloy steel pipe.

2. Section 55.07–5 *Design pressures and thickness of pipes* is amended by revising Table 55.07–5 (a) by canceling in column 2 (A. S. T. M. designation) the references in parentheses, which are "(A206), (A280), (A158), and (A315)," opposite specification subpart 51.34 for seamless alloy-steel.

PART 56—ARC WELDING, GAS WELDING AND BRAZING

SUBPART 56.01—ARC WELDING AND GAS WELDING

Section 56.01–20 *Arc welding electrodes* is amended by changing the pamphlet title from "Equipment List for Merchant Vessels," to "Equipment Lists."

(Federal Register of Wednesday, Nov. 2, 1955)

ARTICLES OF SHIPS' STORES AND SUPPLIES

Articles of ships' stores and supplies certificated from 1 December to 30 December 1955, inclusive, for use on board vessels in accordance with the provisions of Part 147 of the regulations governing "Explosives or Other Dangerous Articles on Board Vessels" are as follows:

CERTIFIED

Curran Corporation, South Canal Street, Lawrence, Mass., Certificate No. 196, dated 14 December 1955, BOOST.

Virginia Smelting Co., West Norfolk, Va., Certificate No. 230, dated 27 December 1955, LETHALAIRE V–23.

CANCELED

Curran Corporation, South Canal Street, Lawrence, Mass., Certificate No. 196, dated 14 December 1955, V. S. S. (VOLATILE SAFETY SOLVENT).

AFFIDAVITS

The following affidavits were accepted during the period from 16 October 1955 to 15 December 1955:

Kerotest Manufacturing Co., Division of Miller Printing Machinery Co., 2525 Liberty Avenue, Pittsburgh 22, Pa., VALVES AND FITTINGS.

Watts Regulator Company, Lawrence, Mass., VALVES AND FITTINGS.

Waterman Engineering Company, 725 Custer Avenue, Evanston, Ill., VALVES.