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2d Session } { PART 18

INVESTIGATION OF THE NATIONAL DEFENSE PROGRAM

ADDITIONAL REPORT

OF THE

SPECIAL COMMITTEE INVESTIGATING THE NATIONAL DEFENSE PROGRAM

PURSUANT TO

S. Res. 71

(77th Congress, and S. Res. 6, 78th Congress)

RESOLUTIONS AUTHORIZING AND DIRECTING AN INVESTIGATION OF THE NATIONAL DEFENSE PROGRAM

MERCHANT SHIPPING

1944.—Ordered to be printed

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SPECIAL COMMITTEE TO INVESTIGATE THE NATIONAL DEFENSE PROGRAM

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INVESTIGATION OF THE NATIONAL DEFENSE PROGRAM

———, 1944.—Ordered to be printed

Mr. ———, from the Special Committee to Investigate the National Defense Program, submitted the following

ADDITIONAL REPORT

[Pursuant to S. Res. 71, 77th Cong., and S. Res. 6, 78th Cong.]

MERCHANT SHIPPING

The program of the Maritime Commission for the construction of merchant ships from its inception in 1938 to the end of 1944, as scheduled, contemplates the building of approximately 50,000,000 deadweight tons of merchant ships of all types. This tonnage is the equivalent of two-thirds of all merchant vessels in the world prior to the war, and is the equivalent of the five largest pre-war merchant fleets—those of the British Empire, the United States, Japan, Norway, and Germany.

Before the entry of the United States into the war, steps had been taken to expand the American merchant marine by embarking on a long-range shipbuilding program for the construction of 50 fast merchant ships a year. It was believed that this would give the United States a competitively efficient merchant fleet and replace over a 10-year period the over-age and obsolete vessels under the American flag.

Shortly after the first of these new ships had been delivered into service, war broke out in Europe, resulting in the withdrawal of European ships from many trades and the widespread destruction of vessels sailing under the flags of the belligerents. This placed on the United States merchant marine the larger task of carrying a constantly growing portion of world trade outside the war areas. Even with the ship-production program already enlarged, it was realized that this would not provide adequate tonnage for the Nation's immediate needs.

As the impact of the war increased, the merchant marine was called upon not only to meet unprecedented tonnage requirements but to provide auxiliary vessels for the armed forces. The Navy was then beinge expanded to provide a five-ocean sea-fighting force, instead of the two-ocean naval establishment previously maintained. The result was a proportionate expansion in the auxiliary vessels which would be required to serve adequately that larger Navy.

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After the Japanese attack on Pearl Harbor, the United States became the merchant shipbuilder for the United Nations. Immediately after the United States entered the war, Axis submarines and surface raiders, as well as long-range bombers, launched a most intensive and devastating attack on United Nations shipping. Although the Allied powers had suffered severe losses prior to 1942, this intensified and widespread attack, particularly in Atlantic waters, brought the total of sunken merchant ships to an all-time high. Nothing in World War I or in the earlier stages of the present war had presented such a serious shipping problem for the United States and her allies.

When the war began in September 1939, the United States had a merchant fleet made up for the most part of vessels built during or immediately after World War I. Few of the new ships being constructed under the enlarged program had been delivered. The American fleet totaled at that time approximately 1,150 ocean-going vessels of 3,000 dead-weight tons or over in size, aggregating approximately 10,500,000 dead-weight tons. Although this Nation occupied second position in merchant-marine status, the fleet was inadequate to meet the rapidly growing volume of cargo for our own production requirements and later under our program of aid to the other democracies. Subsequently, our merchant fleet became enlarged by the acquisition of foreign vessels acquired by negotiation, requisition, and seizure in American ports, and had grown to 1,375 ships, aggregating nearly 12,000,000 dead-weight tons. That was our immediate contribution to the merchant-shipping resources of the United Nations at the time we entered the war.

By July 1942, losses through enemy attack had more than offset our production, with the result that our merchant fleet at that time was slightly under 1,300 ships of 2,400 dead-weight tons, or approximately 11,750,000 dead-weight tons.

In 1936, there were only 10 shipyards and 46 ways in this country capable of producing ocean-going vessels of 400 feet or longer. By June 1943, as a result of the expanded shipbuilding program, there were 81 shipyards in virtually full operation with a production capacity of at least 20,000,000 dead-weight tons annually, and there were more than 300 shipways then being used. Most of this expansion in shipbuilding facilities had been financed by the Government. As of June 1943, $552,236,350 had been expended for this purpose.

Only by performing miracles of production could the unrelenting demands of war be met and the national security preserved. Shipbuilders in the United States accepted the challenge of the Axis warlords. Nearly every known world record in shipbuilding was surpassed in American shipyards. It became a race between the forces of destruction and the forces of production. Actually the winning of the war became dependent on our ability to produce ships. Our armed forces were being expanded rapidly and our production of munitions, planes, tanks, and supplies for the fighting forces was increasing at a rapid pace. The bottle neck in the over-all plan of prosecution of the war thus became the merchant tonnage available for the transport of men, munitions, and supplies.

THE LONG-RANGE MERCHANT SHIP PROGRAM

Most of the merchant tonnage has been in the form of Liberty ships. But included in the program for the construction of merchant shipping are a number of types of vessels which are intended not only for war service but which will serve to form the nucleus for a post-war merchant marine. The program for such ships was inaugurated in 1936 and has since been greatly enlarged.

The number of the various types of vessels making up this program scheduled for delivery as of May 1, 1944, and the number actually delivered as of the same date is as follows:

	Scheduled	Delivered
1. Passenger	1	1
2. Standard cargo (C-1, C-2, C-3, C-4, and R-2)	569	371
3. Victory cargo	227	15
4. Combination types	27	27
5. Tankers	484	270
6. Minor types (tugs, barges, and coastal)	532	288
7. Military types	520	203
Total	2,360	1,175

The capacity and speed of the principal types of vessels included in the long-range program are as follows:

	Dead-weight tons	Knots per hour
C-1	3,840- 9,050	11-14
C-2	7,400-10,360	15½
C-3	9,092-12,562	16½
Victory	10,500	15-17
Tankers	[1] 16,655	14½

[1] 135,000 barrels.

One of the principal objectives of the enemy attack on merchant shipping was the destruction of tankers. Petroleum products constituted the veritable lifeblood of the Allied forces, and the Axis submarines concentrated chiefly on the destruction of the ships that carried those highly essential supplies. As the pre-war fleet of approximately 350 tankers was being rapidly depleted in Atlantic waters soon after the entry of the United States in the war and because of the long distances to be covered to the European, the Asiatic, and the South Pacific areas, the tanker building program became particularly vital and was greatly expanded.

During 1942 and 1943, plans and specifications had been completed for a faster type of cargo vessel than the Liberty ship. This new design, known as the Victory ship, is a 15- to 17-knot vessel and will supplant in a considerable degree the production of the slower Liberty ship, which is an 11-knot vessel. Many of the yards formerly producing Liberty ships have finished their contracts for that type of vessel and have already got well under way in the production of this faster type of cargo ship.

The total over-all accomplishments in the program for the building of merchant ships, including the building of Liberty ships described hereinafter, can be summarized as follows:

	Number of vessels	Dead-weight tons
Delivered in 1942	746	8,089,732
Delivered in 1943	1,896	19,238,626
Delivered to May 31, 1944	719	7,247,557
Total	3,361	34,575,915

This astounding figure represents more than 50 percent of the 72,859,400 dead-weight tons of shipping of all types and classifications possessed by all nations on September 1, 1939.

The foregoing figures also reflect the acceleration resulting from the increased efficiency gained by experience of the shipyards participating in the program, wherein, in 5 months in 1944, the number of ships and tonnage delivered approaches the total amount delivered during the 12 months of 1942.

The foregoing figures do not, of course, include the large program for the construction of combat craft nor conversion and repair construction. The figures for both, of course, would show similar spectacular performance. The figures do not include the vessels built under separate contract and delivered directly to other governments of the United Nations. Many of these ships were built in the yards participating in the program, for which the foregoing figures are set out, and if these latter vessels were to be included, the total aggregate tonnage would be substantially increased.

The foregoing accomplishments could not have been attained if the all-welded type of ship construction had not been utilized. The use of welding, aside from the saving in time, has additional advantages by eliminating the overlapping plates necessary in riveted ship construction, making possible a direct means of saving hull weight. The weight thus saved could be devoted to additional cargo capacity.

In the construction of combat vessels, the limitations on displacement prescribed by the Washington and London naval treaties provided additional compelling reasons for adopting methods to save hull weight. The yards to be utilized in constructing the vessels were for the most part, new yards, and in equipping these yards for welding, the need for air compressors, piping systems, rubber air hoses, pneumatic and other tools required for riveting operations was eliminated, thereby contributing toward the relief of manpower, tool-making capacity, and time.

LIBERTY-SHIP PROGRAM

To augment the long-range program and to provide the greatest tonnage capacity within the time limits imposed required the adoption of a standardized design for a vessel the requirements for materials for which would fit more readily into the rapidly expanding defense program without occasioning any hardship by taking essential material and machinery from other programs of equal or more urgent importance. Early in 1941, the Maritime Commission was directed to build 200 vessels of an emergency type, originally referred to as Ugly Ducklings, but now known as the Liberty-type ship.

The Liberty ship is an adaptation from a British coal-burning tramp steamer, developed by the Sands people in England known as the Sunderland Tramp. The fundamental design was between 25 and 50 years old. The ship had been built as a riveted ship. The design was modified only to the extent that a deep ballast tank was added to the No. 1 hold, because double bottoms were necessary for oil, which had not heretofore been required on a coal-burning vessel. In length, beam, and weight-carrying details, the ship is identical with the old British tramp which had been in service with the English for many years and which had also been operated successfully by Canada.

The facts that the plans were available and reciprocating engines could be obtained without encroaching on the turbine and Diesel requirements for combat craft required by the Navy were the two compelling reasons which prompted the acceptance of this design. It was believed that standardization could be adopted, thereby cutting down on the construction time. The most material departure from the method of construction of the original ship was in the adoption of electrical welding instead of riveting. The adoption of assembly line methods and extensive prefabricating of parts also made possible the construction of a greater number of ships than had ever before been contemplated. The policy of "no changes" also played an important part in the construction program.

The Liberty-ship program was expanded subsequently so that as of May 31, 1944, the program embraced scheduled deliveries of 2,690 Liberty ships, or about 10 percent more than the number of vessels of all types included in the long-range program previously referred to. As of May 31, 1944, there had been delivered 2,158 Liberty ships, or almost twice the number of vessels delivered under the long-range program.

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In the foregoing total of 2,158 vessels, there are included 62 Liberty ships which have been converted into a tanker type. These vessels, although not comparable to the fast, modern tankers, will serve as supplemental supply ships, being equipped to carry from 65,000 to 70,000 barrels of petroleum products. To this extent, the Liberty ship has also contributed toward alleviating the shortage of available tanker capacity.

The participation of the Liberty ship in alleviating the critical shortage of troop-carrying capacity should not be overlooked. Upon the entry of the United States into the war, the troop-carrying fleet consisted of a few Army and Navy transports, to which was added a number of passenger ships converted to troop carriers. Realizing that the troop-carrying capacity was inadequate, it was necessary before scheduling the construction of additional ships to maintain a proper balance between troop-carrying capacity and cargo capacity. In such determination, it was realized that troop-carrying capacity could be provided by converting cargo vessels, whereas cargo capacity would have to be built, and the conversion to troop-carrying capacity could be easily reconverted back to commercial cargo operation.

Despite the large tonnage of cargo capacity scheduled for construction in 1943, it was found possible to schedule the construction of 50 transports for delivery in 1943. Had a greater number of troop ships been scheduled for construction, it would have been at the expense of cargo vessels and the military urgency for the movement of cargo was such that the scheduling of additional troop ships would have reduced the number of cargo vessels delivered and the war effort would have accordingly been severely hampered. During 1943 an additional requirement developed when it became necessary to move large numbers of prisoners of war from Africa to the United States.

Consideration was given to the conversion of the fast C-type hulls, but the heavy demands of the Navy program for vessels of this type and providing commissioned naval auxiliaries left only a few of these available. With the resulting situation confronting the War Department, it was decided to meet the troop-lift requirements with converted Liberty type hulls. It was clearly realized at that time that some risk would be involved, but it was planned to employ these vessels in areas where enemy action was at a minimum, with the additional advantage of convoy protection in those areas.

As a result of the acceptance of this conversion policy, the War Department has been able to deploy overseas upward of 800,000 troops that otherwise would not have reached the fighting fronts. There have been no personnel losses that can be attributed to the use of converted troop carriers.

In converting cargo ships into troop-carrying ships, 50 percent of the cargo capacity is retained, which permits the troops to carry the bulk of their fighting equipment with them on the same vessel. The constant shifting pattern of the war, involving as it does a varying length of voyages and varying military requirements, makes it desirable that a certain amount of the flexibility be retained as between cargo and passenger shipping.

The Liberty ships which have been used in meeting the troop carrying requirements are as follows:

(*a*) Six Liberty ships are in process of conversion for use as hospital ships.

(*b*) Twenty-two others have been converted for use in carrying troops and four are being converted to that purpose.

(*c*) The Navy has taken delivery of 15 Liberties, of which 6 are now operating as cargo-troop ships in limited service and 9 are under conversion for that purpose.

(*d*) In addition to those previously mentioned, 235 Liberty ships have been fitted out for transporting 300 to 500 prisoners of war per vessel, and 17 for occasional use in carrying up to 308 troops in limited operations.

During the hearings before the committee, testimony was offered indicating that in performing the necessary conversion to troop-carrying ships, the practice usually followed consisted of completing the vessel entirely at the original shipyard and then, in a yard specializing in repair and conversion work, the vessel would be converted so that it could be used for transporting troops. It was alleged that the cost of this work varied depending on the extent of the conversion, but in most cases approximated $300,000. Because of the amount of tearing out and rebuilding, such procedure presented a large factor of waste. The question, however, is not one which is susceptible to being resolved in an academic fashion without considering some of the other points involved. In this connection, the testimony of Mr. Edgar Kaiser, of the Oregon Shipbuilding Corporation, is believed pertinent:

The first one is that at the time that the Liberty shipbuilding program was at its height, the main need was for as many cargo ships as possible. Now, the way that the large mass-production yards are organized and have organized the work being done on the basis of repetitive operations and for handling certain specifications in line production, they are not set up for performing other operations or bringing in another operation in that line. Your hull, of course, on a ship might be substantially the same, but when you get to the outfitting dock, you are going to make a troop ship or a hospital ship or any change in the ship, you then have to break the change of repetitive sequence, first, in order to do that, a major change of that nature, if you are to do that in the beginning. When you get out of sequence, and you have some thirty or forty thousand people working in the yard, you have that effect going down the line, and you will have people without something to do because one ship is held up somewhere. Therefore, if you are going to continue on mass production, this making the change at the yard or even on the ways, you will throw out five or six thousand, or even more, men and women out of employment where they are doing nothing.

So it is cheaper in the long run in our judgment to take that ship to another yard, another smaller yard prepared for that purpose and doing only that type of work, to do that alteration.

I believe if the Chiefs of Staff had decided that they wanted troop ships or hospital ships—or the powers that be—as such, any one of the yards or the other yards could put it in production and they could have paid them for that type of work and had whatever they wanted built, they could have built them and gone through with the job.

Testimony was also advanced before the committee indicating that on the basis of dollar cost greater troop-carrying capacity could have been provided by the C type of boat, rather than the Liberty ship conversion. While this point undoubtedly possesses considerable merit, it should be realized that any of the C-type ships scheduled for construction as troop ships would be at the expense of the cargo-carrying program.

After a consideration of all the testimony developed and the arguments advanced on both sides of the question, the committee is of the opinion that the Liberty ships could have been built originally to accommodate troops if proper advance scheduling had been made. No difficulty was encountered in incorporating some modification in the design of the Liberty ships in order that they could be used as tankers and to transport Army tanks. Similar provision could have been made to produce ships to accommodate troops if such determination was made sufficiently prompt enough to permit proper scheduling by the construction yards. In the absence of such proper early determination, the resultant expense in converting Liberty ships to troop ships, in the opinion of the committee, does present a considerable factor of waste.

During World War I, a similar type of vessel, although not more than two-thirds the size of the Liberty ship, required 10 to 12 months for construction at the peak of the program during that war when all yards were in full swing and workers had obtained their maximum of skill and experience. During the present war, the original contracts for Liberty ships had set 210 days as the estimate of time required for construction. The first Liberty ship, the *Patrick Henry*, required 244

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days from keel laying to delivery into service. By July 1942, the shipyards had reduced the average construction time to approximately 105 days. By June 1943, the average construction time on the Liberty ship in all yards had been reduced to a little more than 50 days, and, since that time, the time has been reduced to approximately 42 days. Speed records have been established by the various yards on particular ships, and in one instance the Oregon Shipbuilding Corporation delivered the *Joseph N. Teal* in 14 days, only to be surpassed by the Permanente No. 2 yard in delivering the *Robert E. Peary* in 8 days.

The Liberty ship is not designed along the trim lines of the C type or Victory type cargo ships, and has the comparatively slow speed of 11 knots per hour. It provides, however, a carrying capacity of approximately 10,800 dead-weight tons and is referred to by the operators as the "sea-going work horse of this war," or "the pack horse of the sea." The capacity afore-mentioned can best be visualized when it is realized that it would take four 4 trains, each consisting of 75 cars, to carry an equal load. One Liberty could lift 440 light tanks or 2,840 jeeps, or it could transport in a single voyage sufficient C rations to feed 3,440,000 men for ———.

A computation with respect to the carrying capacity of all the Liberty ships delivered to May 31, 1944, would indicate that a cargo capacity has been added to our merchant fleet of nearly 25,000,000 dead-weight tons by the Liberty ship alone.

As a part of its study of the Liberty ship program, the committee has received replies to questionnaires addressed to 54 operators of Liberty ships. These operators, operating 1,419 Liberty ships, are estimated to have delivered up to January 1, 1944, a total of approximately 30,000,000 tons of cargo, exclusive of cargo carried in shuttle service for the Army and Navy in combat areas, for which information is not available. The average voyage involved was several thousand miles. The extent of this performance can best be understood by comparing it with 732,000,000,000 ton-miles of freight carried by our railroads in 1943 and the 47,000,000,000 ton-miles carried by our trucking industry in 1943. Moreover, the above results represent carrying capacity of only 1,419 of the 1,840 Liberty ships delivered to January 1, 1944, and many of them had been in operation for only a short time.

The foregoing details present a brief picture of the accomplishments to date of the Liberty-type ship and some indication as to what might be expected of it in the future.

In building the ships which have made this accomplishment possible, 17 yards, operated by 15 shipbuilding companies, have participated. The local conditions under which these yards operated, prevailing wage rates, experience and efficiency of the operator vary with respect to each of the yards participating in the program. Many of the yards use slightly different techniques in prefabrication and assembly and many resort more extensively to subcontracting, so that the best index of the yards' performance is the comparison of the average man-hours expended by each yard for the ships constructed and the dollar cost incurred by the respective yards per ship.

Information obtained from the various yards in response to the committee's inquiry is reflected in the following tabulation:

Insert on construction to be supplied

The Liberty ship, despite its performance, has little of the glamour usually attendant to other ships designed from an appearance standpoint. The Liberty ship has been designed from a utilitarian standpoint only.

One of the outstanding draw-backs to the Liberty type of vessel will be its status in post-war shipping competition. This has been summarized by Admiral H. L. Vickery as follows:

> But, however many Liberties may be built, when peace and competitive conditions in ocean commerce return, our dependence must be placed on fast ships and, for all its glory, the Liberty ship is not one of these.

Realizing the shortcomings of the Liberty ship, the Maritime Commission has already embarked on a program for the construction of the faster type Victory ships, of which 15 have been delivered to May 31, 1944. Many of the yards formerly building Liberty ships already have completed their program and have changed over to the construction of Victory ships.

In the operation of any type of ship, damage is normally expected from operations and heavy weather. This is usually taken as a normal factor by the various ship operators, and periodic drydocking of a ship has for one of its purposes a check-up on the damage incurred. Stresses are imposed on a ship by its working or flexing in heavy weather. In the older type ships, this required numerous rivets to be renewed or redriven and other similar types of repairs. Because of the large number of Liberties which have been delivered into use and the manner in which they have been used in carrying supplies to the combat areas, normal damage incidents reasonably would be expected to be numerous, although percentagewise should be comparable to the incident rate during peacetime operation.

Present operation, however, is not normal. Ships are being loaded as rapidly as possible, and a resultant disregard for the careful stowage of cargo must be expected. The distribution of the weight throughout the ship has a very material bearing on its operation, particularly in heavy seas. Because of the slow speed of the Liberty, it has for the most part been used in convoy operation. However, in convoy operation an attempt is made to keep the time required for the convoy at a minimum. This renders it impossible for the captain of a Liberty ship to pamper the ship in a storm or run before it, and the Liberties operated in convoy have steadfastly plowed through seas which have occasioned stresses far above normal peacetime operation.

In carrying cargoes to the combat zones, it is not practical or possible to give full consideration to obtaining a return cargo, such as would be necessary in competitive commercial operation. The result of this is that the ships return in ballast and in such condition they ride high in the water with the major portion of the hull above the water line. In that condition they suffer more severely from operating stresses and heavy weather. Uniform methods of ballasting have been hard to prescribe for the far-flung ports to which the ships operate, and undoubtedly there have been countless causes of improper ballasting as well as improper loading under the stress of conditions in which these ships are operated.

Capt. Walter Brunnick, San Pedro, Calif., has been captain of the Cal-Ship-built *Henry Ward Beecher*, which traveled over 63,000 miles. He sailed his new Liberty out from a Pacific port in October 1942 loaded with 9,300 tons of bombs, shells, and gasoline. He circled Australian waters so low as to see ice, shuttled back and forth to India, rode out a hurricane off Madagascar, then his ship survived a collision with another during a submarine attack off Brazil, an attack which he said cost the convoy nine vessels. Finally the *Beecher* made three trips from New York through the Mediterranean. With respect to Liberty ships, Captain Brunnick is quoted as follows:

> I think their performance has been wonderful. But then, we all heard the same carping about the 8,800 tonners built during the last war. Yet many of these same ships still are steaming along in convoys today, just as many of today's new Liberties will be plowing the sea 25 years from now. Off Madagascar, I hit the stormiest weather in 45 years as a sailor. Heavy seas smashed our gun mounts, rails, and deck cargo. Yet, 20,000 miles later in drydock my vessel showed no structural damage to the hull whatsoever. Further, I saw Liberties wherever I went disgorging vital war supplies.
>
> Many things can break a ship, including improper stowage of cargo. The best and sturdiest, even the world's great liners, sometimes break. The sea's no millpond, and it's hardly fair to malign a type of ship, which, rushed together in such hectic times, has contributed so much to the cause.

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The foregoing is outlined to present some picture of the abnormal conditions under which the ships are operated and which have a very material effect on the damage incidents which naturally result from such operation over and above normal peacetime operation. Although the Liberty type of ship, despite the public attention which has been focused on damage incidents, has suffered more individual damage incidents in number than other ships of similar all-welded construction, but, in proportion to the number delivered, the incident rate compares favorably.

A board, consisting of representatives of the Navy, Maritime Commission, Coast Guard, and American Bureau of Shipping, was created to investigate the design and methods of construction of welded steel merchant vessels and has compiled the following figures showing the casualties occurring to all of the various types of all-welded ships reported to May 1, 1944:

Type	Total casualties	Percent of number launched
C-2 refrigerated cargo	36	327.27
C-4 cargo	1	100.00
L-6 ore carrier	12	75.00
T-3-A-1 tanker	6	27.27
T-3-BF-1 tanker	1	25.00
EC-2 Liberty	[1] 496	23.46
T-2 tanker	50	21.19
ET-1 Liberty tanker	[1] 13	20.96
Tanker MC	2	18.18
EC-2 Liberty conversion	[1] 1	12.50
N-3 coastal cargo	8	11.76
C-3 passenger and cargo	2	11.11
C-1 cargo	12	8.39
C-2 cargo	13	8.02
C-3 cargo	5	5.10
Other types	21	
Total	679	

[1] Liberty types, total, 510.

The following tabulation with respect to the 679 casualties occurring to all types of welded vessels regroups the foregoing to show the apparent contribution to the casualty rate by the heavy weather encountered during the winter months of December, January, February, and March. It should be noted that 424 of the total of 679 incidents or, in other words, 64.4 percent of all casualties have occurred during that 4-month period in 1942 and 1943:

Number of casualties by month of occurrence

Month	Casualties	Winter total
Before 1942	2	
To October 1942	13	
November 1942	8	
December 1942	16	107
January 1943	18	
February 1943	36	
March 1943	37	
April 1943	25	
May 1943	29	
June 1943	25	
July 1943	21	
August 1943	20	
September 1943	19	
October 1943	36	
November 1943	30	
December 1943	67	317
January 1944	95	
February 1944	77	
March 1944	78	
April 1944	27	
Total	679	424

The foregoing relates to the all-welded type of ship constituting the present ship-construction program. However, the Liberty ship even compares favorably with the known records of the riveted type of ship. Admiral Emory S. Land, Chairman of the Maritime Commission, has informed the committee that he believes the over-all performance of the Liberty ship is good, especially if consideration is given to the great number of Liberty ships which are in service and the conditions under which they have been used. Admiral Land stated that:

> A relatively few fully welded ships were built prior to the present emergency, and the Commission has no record of any failures in form of cracked plates on such vessels.
>
> On the Hog Island type of vessel, which was fully riveted, the cracking of deck plates in way of hatch corners was reported on all vessels until remedial steps were taken to reinforce the deck by the fitting of doubler plates. The *Independence Hall*, a vessel of this type, recently broke in two during a severe storm at sea.

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Vessels of the Baltimore Mail Line developed cracks in the fashion plate at the forward end of the bridge in way of the bulwarks. These cracks extended into the deck house. The *Manhattan* and *Washington* also developed similar cracks. The vessels of the Good Neighbor Fleet all cracked in way of the windows in the superstructure deck.

Among the best known failures of recent years were the cracking of the deck plating and sheerstrake of the *Leviathan* and *Majestic* which were sister ships. The detailed account of the damage is to be found in volume 38 of the Transactions of the Society of Naval Architects and Marine Engineers for the year 1930.

A number of naval vessels have developed cracks in deck plating of more or less serious nature. A British torpedo boat of the Viper class went to sea, broke her back in a storm and was lost.

In evaluating the all-welded type ship against the outmoded riveted type ship, and quite aside from the very material savings in manpower and dollars resulting from a simpler assembly technique, the Liberty enjoys other advantages over the riveted type ship, which are summarized by Admiral Land as follows:

Every time a riveted ship goes into dock, you have a lot of repairs to do. You do not have them in welded ships. You do not have leakages. You do not have openings in your hulls with dozens and dozens of leaks, nor do you have to redrive rivets. Even if we have these fractured plates, it is not a handful compared with the casualties that go in riveted ships every time they go in for voyage repairs, something that everybody else seems to have forgotten.

On combat damage, comparing Liberty ships and others, everything is all in favor of the Liberty ships. A lot of them have broken into sections due to combat damage; in Liberty ships, the percentage is entirely in favor of the Liberty because the riveted ships are apt to go to the bottom when they are bombed or mined or torpedoed. It is truly remarkable the salvage we have obtained from these Liberty ships in combat damage. Never mind about the fractures or cracks—they get into port.

In considering the riveted ship versus the all-welded ship, particularly with respect to cracked plates, the riveted ship can be best considered as somewhat analogous to a patchwork quilt, consisting primarily of an assembly of small components. When a crack starts in one particular plate or component, it continues until it reaches a discontinuance in the metallurgical structure; viz., in the patchwork quilt, it would be the end of a particular piece of material. Such, however, is not the case with welded ships and a crack is not interrupted by a discontinuance in the metallurgical structure, with the result that a crack may start under the same conditions that it started in the case of a riveted ship, but very little stress is necessary to keep the tearing tendency in motion. Such a factor is believed to have had a very material bearing on the break-up of several ships, including the *Joseph P. Gaines*, which broke in half and sunk with a loss of 11 lives. This is the only incident wherein a Liberty ship has sunk as a result of structural casualties wherein a loss of life was involved. Such an incident, however, occasioned considerable public discussion and newspaper comment.

Many complaints were forwarded to the committee and resulted in the committee undertaking an investigation and study of the structural casualties to Liberty ships.

CASUALTIES OCCURRING TO LIBERTY SHIPS

In developing details with respect to the casualties occurring to Liberty ships, the committee held hearings in Washington, D. C.; New York, N. Y.; Seattle, Wash.; San Francisco, Calif.; and Los Angeles, Calif. At these hearings, officials of the Maritime Commission, the American Bureau of Shipping, shipyard companies engaged in Liberty-ship construction, and operating companies engaged in operating Liberty ships, testified. Testimony was also received from inspectors employed in the various shipyards, seamen employed on Liberty ships (including several seamen who had witnessed major casualties which had occurred to the ships), and captains presently operating the ships.

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In addition thereto, questionnaires were addressed by the committee to the various companies presently operating Liberty ships requesting information as to the damage incidents suffered by the ships operated by each company, the performance of the Libery ships operated by them, and their opinion with respect to the operating qualities of the ship and the cause of such damage incidents as they had encountered. The replies received from these operators were predominantly favorable with respect to the performance of the ship, and in the opinion of the operators, the damage incidents encountered, with few exceptions, were not materially greater than those which could be reasonably expected under the conditions in which the ships are operated at the present time.

The American Bureau of Shipping is a private organization comprised of shipowners, shipbuilders, and marine operators. It is somewhat comparable to the British Society of Lloyds Register of Shipping and performs the primary function of classifying merchant vessels pursuant to the warranty clause of maintenance of seaworthiness in the insurance contracts. In performing this function, it is necessary for the American Bureau of Shipping to ascertain that the design of the vessel is proper, that materials of construction are satisfactory for the purpose intended, that the vessels are constructed in a manner satisfactorily in compliance with the rules and requirements of service, and thereafter that the vessel is maintained in the seaworthy condition in which it was found upon entering service. To accomplish this function, design requirements are reviewed, materials are inspected and a yard inspection service in the construction of ships is maintained. The completed ship is inspected and a classification is assigned as to the type of work it can do and the purpose for which it is best fitted. Inspections are thereafter made on the occasion of any damage or trouble that may arise effecting the seaworthiness, and at certain intervals well-defined examinations are required.

With reference to any casualties occurring to Liberty ships, the American Bureau of Shipping has a force of surveyors in the various ports throughout the world, and upon the arrival of any ship suffering such incident, a surveyor examines the damage, makes recommendations as to the method of repair, and determines whether the seaworthiness of the vessel has been affected thereby. In this connection, the American Bureau of Shipping has advised the committee as follows:

> Except for those ships which have been lost from whatever cause, none of the Liberty ships had any change in their classification with this Bureau, nor have any of the Liberty ships been assigned a class other than the usual classification assigned to vessels of this type.

A report prepared by the American Bureau of Shipping regarding the casualties to Liberty ships which occurred prior to February 15, 1944, segregates the incidents into three classifications, defined as follows:

> *Group I.*—Casualties which result in either the actual loss of the vessel or which have progressed to such an extent in the strength deck or shell to make a definitely unsafe condition.
>
> *Group II.*—Casualties which occur in the strength deck or shell or in members attached directly thereto such as in bilge keels or bulwarks and which in their present state are not serious in extent but which experience has shown could easily progress to such an extent as to result in a group I casualty.
>
> *Group III.*—Casualties which occur in relatively unimportant parts of the hull structure from a longitudinal strength standpoint and which, due to their nature, would not be expected to progress into the main-strength deck or shell.

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The committee has tried to obtain as much factual material with respect to casualties as it is possible to do. In this connection, it has obtained information not only from the American Bureau of Shipping, but from the Maritime Commission and the Navy Department, each of which attempts to keep track of the casualties and the reasons therefor. In addition, a special Board was established on April 20, 1943, by the Secretary of the Navy consisting of one member from the Navy, the Coast Guard, the Maritime Commission, and the American Bureau of Shipping. This Board was charged with the responsibility of investigating the design and methods of construction of welded merchant vessels. Figures compiled by this Board as of May 1, 1944, and classified in accordance with the three classifications established by the American Bureau of Shipping are set forth in the following tabulation:

Shipyard	Total Liberty ships delivered to May 1, 1944	Total incidents to May 1, 1944	Group I	Group II	Group III
Bethlehem-Fairfield	326	24	1	9	14
Permanente No. 2	324	37	10	17	10
California	335	114	20	48	46
Oregon	330	138	23	45	70
New England	138	31	3	9	19
Permanente No. 1	136	10	4	5	1
Houston	129	32	15	4	13
North Carolina	126	37	5	8	24
Delta	109	35	12	7	16
J. A. Jones	72	12	1	4	7
Southeastern	48	11	3	3	5
St. Johns	38	5	2	-------	3
Alabama	20	16	3	5	8
Marinship	15	3	-------	1	2
Walsh-Kaiser	10	4	1	1	2
Kaiser-Vancouver	2	1	-------	1	-------
Total	2,158	510	103	167	240

In considering the foregoing tabulation, it is pointed out that of the foregoing 510 incidents, 240 of them (or 47.1 percent ot the total) fall into the minor grouping, corresponding to a large degree to those that would be encountered in normal ship operation. One hundred sixty-seven incidents (or 32.7 percent) fall into a group II classification or a borderline classification for incidents which could have become serious, leaving only 103 incidents (or 20.2 percent) of the total number) which could be considered in the group I or serious classification.

In relating the 103 group I incidents to the total number of ships delivered (2,158), it is found that the incident rate of group I casualties is only 11.1 percent.

In order to obtain a worth-while picture, it is desirable to exclude from the 2,158 ships delivered to May 1, 1944, 403 ships as to which casualty records comparable to those kept by the American Bureau of Shipping are not available. These 403 ships include 89 lost from causes other than ship failures (such as enemy sinkings or foundering upon rocks), 117 ships delivered to the Army and Navy which do their own repairs and are not required to clear through the American Bureau of Shipping for insurance purposes, and 197 ships delivered to other governments. There are reports as to some of these 403 ships indicating 43 incidents of all classifications, but the reports are known to be incomplete—particularly so with respect to the ships delivered to the British, concerning which there is no established basis for interchange of information. After excluding these 403 vessels, there remain 1,655 ships delivered to May 1, 1944, which are being operated by approximately 54 United States shipping concerns.

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Of the 1,655 ships, 346 have sustained a total of 467 casualties. The ratio of casualties to ships delivered is 28.2 percent, and the ratio of ships which have had casualties to ships delivered is 20.9 percent.

Of the 20.9 percent of the 1,655 ships which sustained casualties, a further break-down of this figure for the individual shipyards indicates that 9 of the 16 shipyards were below this rate and 7 were above it. The committee has studied carefully the record of casualties from fractures with respect to the Liberty ships constructed by each of the several different shipyards for the purpose of making comparison of their respective operations. Figures with respect thereto reflect the following:

1. Henry J. Kaiser, Permanente No. 1 yard, Richmond, Calif. — This yard has the best record, and of the 116 ships delivered, only 8 had fractures, resulting in a rate of 6.9 percent.
2. Henry J. Kaiser, Permanente No. 2 yard, Richmond, Calif. — Of the 288 ships delivered by this yard, only 23 had fractures, resulting in a rate of 7.9 percent.
3. Bethlehem-Fairfield Shipbuilding Co., Baltimore, Md. — This yard also made a splendid record, delivering 204 Liberty ships with only 20 ships being involved in casualties, resulting in a rate of 9.8 percent.
4. St. Johns River Shipbuilding Co., Jacksonville, Fla. — This company likewise made a splendid record producing 30 ships, of which only 3 were involved in casualties, resulting in a rate of 10 percent.
5. Marin Ship Corporation, Sausalito, Calif. — This yard produced a very much smaller number of ships but attained an equally good record. Out of 13 ships delivered, only 2 had a fracture, resulting in a rate of 15.4 percent.
6. Southeastern Shipbuilding Corporation, Savannah, Ga. — This shipyard was sixth, with 44 ships delivered, of which 7 had casualties, resulting in a rate of 15.9 percent.
7. J. A. Jones Construction Co., Brunswick, Ga. — This shipyard was seventh in rank, having delivered 62 ships, of which 10 had casualties, resulting in a rate of 16.1 percent. In this connection, 8 of the foregoing ships were constructed to carry Army tanks and there was a platform deck below the usual second deck, and the bulkheads have been arranged to provide only 4 holds with 2 hatches forward and 2 hatches aft. Additional girders and stanchions have been fitted to carry the heavy cargo. No casualties were reported with respect to these 8 vessels, which, by virtue of their additional structural features, result in advantage to the yard constructing this type of vessel.
8. Houston Shipbuilding Corporation, Houston, Tex. — This shipyard was eighth, with 116 ships, of which 25 had casualties, resulting in a rate of 21.5 percent.
9. New England Shipbuilding Corporation, South Portland, Maine. — This yard was ninth, with 104 ships delivered, of which 23 had casualties, resulting in a rate of 22.1 percent.
10. North Carolina Shipbuilding Corporation, Wilmington, N. C. — This shipyard was tenth, with 104 ships, of which 25 had casualties, resulting in a rate of 24 percent.
11. Delta Shipbuilding Co., New Orleans, La. — This shipyard was eleventh, with 86 ships delivered, of which 25 had casualties, resulting in a rate of 29.1 percent. It should be noted that of the foregoing number, 32 of the ships built by this yard were of the tanker conversion type, in which a centerline bulkhead and 6 transverse bulkheads have been added, and with respect to the 32 ships of this type, only 4 have had casualties. The additional structural factors embraced in this type of ship results in an advantage to the yard building ships of this kind, and the records of Delta should have been better by virtue thereof.
12. Walsh-Kaiser Co., Providence, R. I. — This shipyard was originally the Rheem Manufacturing Co. and was taken over by the Walsh-Kaiser Co. in March 1943. It has delivered 10 Liberty ships, of which 3 had casualties, resulting in a rate of 30 percent.
13. Henry J. Kaiser Oregon yard, Portland, Oreg. — This shipyard was thirteenth, with 284 ships delivered, of which 86 had casualties, resulting in a rate of 32.8 percent.

14. California Shipyard Corporation, Los Angeles, Calif. — This shipyard delivered 173 ships, of which 75 had casualties, resulting in a rate of 43.4 percent. In this connection, 30 of the ships delivered were tanker type conversions, and similarly built to those built by the Delta shipyard, incorporating additional bulkheads. With respect to the 30 ships of this type delivered, 7 suffered casualties, and accordingly the foregoing over-all percentage includes the advantage obtained in constructing vessels of this type.

15. Alabama Dry Dock & Shipbuilding Co., Mobile, Ala. — This shipyard delivered 19 ships, of which 10 suffered casualties, resulting in a rate of 52.6 percent. Except for the Kaiser Vancouver yard, which delivered only 2 Liberty ships, 1 of which had a casualty, the over-all performance of the Alabama shipyard is the poorest of all those involved.

If the percentage of incidents to the total number of ships delivered to May 1, 1944, is considered, instead of the percentage of ships involved in incidents, the rating of the various shipyards would be as follows:

	Deliveries	Incidents	Group I	Group II	Group III
Total all yards	2,158	510	103	167	240
Eliminations	403	43	10	15	18
Balance	1,655	467	93	152	222
Distribution:					
Bethlehem-Fairfield	204	23	1	8	14
Permanente No. 2	288	33	8	16	9
California	173	102	19	45	38
Oregon	284	122	17	37	68
New England	104	27	3	8	16
Permanente No. 1	116	10	4	5	1
Houston	116	30	14	4	12
North Carolina	104	34	5	8	21
Delta	86	35	12	7	16
J. A. Jones	62	12	1	4	7
Southeastern	44	11	3	3	5
St. Johns	30	5	2	-----	3
Alabama	19	16	3	5	8
Marinship	13	2	-----	-----	2
Walsh-Kaiser	10	4	1	1	2
Kaiser-Vancouver	2	1	-----	1	-----
Total	1,655	467	93	152	222

The above figures give effect to the fact that some of the ships have had two or more fractures.

INTERPRETATION OF THE FOREGOING CASUALTY PERCENTAGES

The rapidly accelerating construction program for the construction of Liberty ships embracing, as it did, the adaptation of a relatively new all-welded type of construction and superimposing its vast material requirements on an already overcrowded supply program, created some difficulties and conflict at the outset. From its basic concept, the program started by utilizing steel which was in critical short supply, and also making use of the type of steel which the steel mills could produce with their established production methods. This steel was essentially the steel which had heretofore been designed and developed for use in all-riveted ships. There was not sufficient time to conduct extensive metallurgical research to determine the type of steel best adapted to the all-welded ship type of construction. It is believed that the steel industry will ultimately produce a type of steel better suited for this purpose. Starting with the best type of steel then available, it was found that the heat of the cutting torch and, later, the heat of the welding torch set up an annealing tendency which is not encountered in the riveted type of ship construction.

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The metallurgical content of the ship plates was affected thereby. It was also found that the heat from the welding torch set up an expansion and contraction factor which when multiplied by the number of plates entering into the assembly of a ship hull, became a serious factor which had to be provided for or surmounted.

The usual method of surmounting such difficulty consists of following a welding sequence or procedure. If this procedure contemplated working from the bow and stern of a vessel, it would result in a material difference by the time the midship section was reached, and any forcing of plates at that point would result in locking up stresses in the vessel, which might later relieve themselves by causing the particular plates under stress to crack. It was found that by following a welding sequence from the midship section working progressively toward the bow and stern, the stresses are worked out of of the bow and stern before final assembly and result in improved welding techniques. Due to the absence of experience records on all-welded ships, these factors had to be established by experiment and correction.

Much has been said on the subject of locked-up stresses. In the assembly of a ship, it is the desired objective not only to keep the portion of the hull below the water line in a smooth or "fair" condition, but also to assemble that portion above the water line with a minimum of distortion or buckling. Otherwise an unsightly appearance would be presented and a loss of strength would result from the stresses which may later cause the ship to crack at the particular point where the stress is concentrated. A concentration of stress, particularly in the midship section of a vessel, is of major importance.

While welding is the principal cause of a concentration of stress, there are other causes which all contribute, such as the stress which was set up in the plates at the time of the rolling and galvanizing operation, stresses which arise from the storing and the handling of the plates, and the stress which arises from the heat of the gas cutting torch, and from the heat from the sun's rays, or due to changes in atmospheric temperatures. Stresses may also be placed in the hull by the construction yard through loose or forced fitting of the various components and by attempting to shrink the metal in a particular location after buckling has occurred.

In eliminating the stress occasioned by welding, it is found that such stress could be occasioned by the amount of heat the welder uses for a given size weld and using a given size welding rod. The speed of the welding, the size of the opening, the size of the weld, and the particular procedure followed in making the weld all contribute to the stress factor. Among the most important items which affects the fairness of a welded vessel or assembly is the size of the weld. While it is true that the designer has specified the proper weld sizes to meet the requirements, it was found that the manner in which the welder completed the joint contributed a stress factor not considered by the designer. A tendency to make oversized welds (too much metal) or a slowness of operation in making the weld have a material bearing on the expansion and contraction of the metal, with the resultant stress. Welded joints made instantaneously, if that were possible, would contain very little distortion or stress.

For the foregoing reasons, it was necessary to prescribe an erection or welding sequence in order that the shrinkage resulting from welding would not produce unfair structures and the residual or locked up stresses that sometimes result in fracture would be kept at a minimum and over-all dimensions could be properly controlled.

There was no real practical experience record on which welding procedures and sequences could have been established. The shipbuilding industry had been comparatively inactive since the last war, whereas welding in other lines of manufacture had made considerable progress. With the sudden growth of the shipbuilding industry, as a result of the war effort, men with a knowledge of welding, as well as steel ship construction, were very few. The shipyards faced with this situation employed experienced shipfitters who had little or no knowledge of the welding technique or else employed experienced welders with practically no knowledge of ship construction.

In addition to the difficulty imposed in surmounting the many factors which tend to put stress in a hull, the task resolved itself to one of performing the advancement in welded ship construction techniques with employees who were at that time obtaining their knowledge and experience in the problem. A natural tendency toward up-grading in the efficiency of the shipyard workers has resulted and this country now enjoys not only the ability and knowledge to fabricate all-welded ships in a minimum of time, but also the necessary skilled workers to implement that requirement. A tendency on the part of the shipyards to place particular emphasis on the speed of delivery, thereby disregarding many of the small items previously deemed inconsequential, has been to a large degree eliminated. Experience has taught them that particular attention to what had heretofore been considered only detail resulted in the long run in time-saving precautions and the over-all speed of construction was improved thereby.

The Board to Investigate the Design and Methods of Construction of Welded Steel Merchant Vessels, previously referred to, issued a report dated June 3, 1944, containing the following comment with respect to the foregoing:

> At the beginning of the war emergency there was general disregard by the yards of planned procedures and sequences wherever they appeared to interfere with rapid production. Subsequent to January 1943 there has been considerable improvement in this attitude through education and recognition of the serious consequences resulting from unplanned work. Further coordination of the efforts of shipfitters and welders will contribute to additional improvements. Where production pressure makes departure from the plan mandatory a new plan for local application should be developed to avoid violation of fundamental principles. A sufficient number of competent supervisors, inspectors, and workers is essential for the execution of the plan.

From time to time, improvements have been made in welding sequences and methods of prefabrication, indicated by experience gained under the present program. As these improvements were made, all-welded ship construction, as a whole, was constantly improved and is now believed to incorporate countless refinements which were unknown at the outset of the program.

In addition to improving the assembly procedures, improvments were made in the design of the Liberty ship. For the most part these were made during the latter part of 1943. An illustration of this type of change is the determination that the accommodation ladder as originally located resulted in making an opening in some of the deck plates. The change in the location of this ladder undoubtedly has increased the strength. It was also found that cracks starting in deck plates had a tendency to continue down the side of the ship, with the result that the deck assembly has been cut free from the shell of the hull and is now attached thereto by means of angle bars. This provision gives an interruption in the continuity of metal and serves as a crack stopper. In the bilge keels, the plates are serrated so as to avoid all frames and shell butts.

It previously was pointed out that the basic design for the Liberty ship utilized a ship design which previously called for riveted construction. Ships must be designed for welding. Merely substituting welded connections in a structure designed on the basis of riveted construction will not do. Some design features acceptable for riveting may not be permissible with welding. Square hatch corners and abrupt breaks in the continuity of strength members were found to contribute somewhat to the tendency to crack. A square corner, such as the corners of the hatch openings and particularly No. 3 hatch amidships, was found to aggravate the tendency of the plate to tear at that point. On August 12, 1943, instructions and plans were issued requiring the fitting of rounded corners on the hatches.

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On February 10, 1944, if was found that the cutting of a slot in the deck plates and welding a supplemental plate over the crack to provide the necessary structural strength introduced into the deck assembly a crack stopper which would interrupt any crack starting in the deck plates.

The huge ship-construction program required a very large number of experienced welders. To obtain a sufficient number, extensive training programs had to be inaugurated. Just as a chain is no stronger than its weakest link, a single local defective weld may cause the beginning of a major failure. It took time and patience to obtain the required working force of experienced welders.

The ship plates are beveled where they are joined in order that the proper amount of metal can be deposited in the weld to make the best bond between the plates. Welding seams consist of several different types of weld. Experience has shown the various shipyards the best type of beveling welding to use for the various assemblies and this, in turn, dictates the size of the electrode used on the welding torch and the procedure to be followed in making the weld. If the particular weld is to be made by machine welding in lieu of hand welding, the speed of the welding machine is determined.

The ships were built in shipyards from Florida to Maine and California to Oregon throughout the entire four seasons of the year. Atmospheric temperatures prevailing at the particular time the ship was constructed, in turn, added a factor which only experience can overcome. Even a sudden drop in temperature while the ship is still on the ways can cause the extreme end of the stern and bow to curl up and raise off the keel blocks, only to go down into position as the heat of the day increases. In addition to having a bearing on the stress attendant to the construction of a ship, atmospheric temperature also relates to conditions under which the ship is operated. As previously pointed out, the metallurgical content of the plate is disturbed by the heat from the cutting and welding torches, and if some means were available to put the entire ship into an annealing oven, it would relieve some of this factor of stress. Accordingly, ships delivered into South Pacific operations where torrid temperatures prevail would not have as serious a concentration of stress brought about by atmospheric temperatures as those delivered into Alaskan or North Atlantic operations. This factor should be considered in evaluating the incident rates of the various yards, inasmuch as some of them have delivered a greater number of ships to the theaters of operation where adverse atmospheric temperature conditions materially affect the rate of damage incidents, and in fact the more serious incidents have occurred in those particular areas.

All of these problems for the most part were encountered and surmounted after the program got underway. Accordingly, the figures previously set forth showing the number of damage incidents for the entire construction program include those incidents to ships built in the early stages of the program. The committee cannot determine whether all of the factors which contributed to the damage incidents suffered by Liberty ships have now been removed or corrected. However, the results with respect to the ships built and delivered subsequent to June 1943 indicate that substantial progress has been made in this direction. While it is true that these particular ships have not seen as much service as the ships delivered during the earlier part of the program, it is believed that even after considering this factor, progress has been made toward eliminating some of the contributing causes of damage incidents.

A tabulation with respect to all types of all-welded ships delivered, in accordance with the delivery date, is as follows:

Delivery dates	Number delivered	Percent of total	Vessels launched	Percent number launched
Before 1942	29			
January, February, March 1942	14			
April, May, June 1942	52			
July, August, September 1942	104			
October, November, December 1942	131			
January, February, March 1943	111			
April, May, June 1943	112			
	553	81.4	To June 30, 1943, 1,733	31.9
July, August, September 1943	67			
October, November, December 1943	39			
January, February, March 1944	14			
	126	18.6	June 30, 1943, to May 1, 1944, 1,342.	9.4
April 1944	6			
Total	679			

It is believed significant to point out in connection with the foregoing tabulation that 81.4 percent of all incidents have occurred to those ships delivered prior to June 1943. In comparing the volume of deliveries for the same period of time against the number of incidents occurring to those ships, results in an incident rate of 31.9 percent. The incident rate with respect to ships delivered after June 30, 1943, is only 9.4 percent.

Of the foregoing total of 126 incidents occurring subsequent to June 30, 1943, 96 incidents relate to the Liberty-type ship, and in analyzing the 96 incidents according to shipyards results in the following tabulation:

Shipyard	Delivered	Incidents	Group I	Group II	Group III
Bethlehem-Fairfield	172	5		3	2
Permanente No. 2	186	1		1	
California	124	28	3	10	15
Oregon	116	14	1	5	8
New England	82	16	1	6	9
Permanente No. 1	66	1		1	
Houston	61	6	2		4
North Carolina	17	3	1	1	1
Delta	47	5			5
J. A. Jones	60	5		2	3
Southeastern	35	9	3	2	4
St. Johns	34	2			2
Alabama					
Marinship	2				
Walsh-Kaiser	4	1			1
Kaiser-Vancouver					
Total	1,006	96	11	31	54

In connection with the foregoing tabulation, it is pointed out that the rate of incidents to ships delivered has been reduced to 9.5 percent, and, further, 88.5 percent of all incidents reported were in the two subordinate classifications of groups II and III.

It should be noted that in assembling a ship, involving as it does the many contributing factors which would tend to set up stresses within the hull itself, there is no way of determining the extent or location of these stresses after the hull has been completed. Accordingly, a particular ship or a type of ship should not be too seriously condemned by virtue of any structural casualties which it might suffer. In this connection, the testimony of Mr. J. Lyell Wilson, assistant chief surveyor of the American Bureau of Shipping, is as follows:

> There is a considerable amount of research activity going on, much of which shows that after failure, there is a release of an internal condition which has been there and is a factor in the failure. * * * I believe—at least we have been advised—that information is being developed that proves a contention that has been in existence for over a year, that these internal conditions will wash out in service by being stressed and relaxed alternately until they disappear or are reduced to such a value that they won't be serious. That is part of the idea that I expressed that having failed and having been repaired, ships should be better than they were before.

The committee has received complaints involving most, if not all, of the shipyards producing Liberty ships to the effect that they have not followed contract specifications, and the Maritime Commission inspectors have not been permitted full freedom to carry on their activities and, thereby, to insure that the vessels were constructed in accordance with the instructions of the Maritime Commission. The committee has investigated these complaints, and, in one case—that involving Oregon shipyard—has held public hearings. The committee also has examined transcripts of hearings and proceedings before the Maritime Commission. From its examinations, the committee is of the opinion that inspection often was not as rigid and strict as it should have been, and that the inspectors of the Maritime Commission sometimes were not supported by their superiors and were not able to do the job for which they were hired. To some extent, this was due to the lack of competent chief inspectors who knew how to supervise their inspection staffs and how to cooperate with the shipyards to achieve a maximum of production without sacrifice of quality. To some extent, the difficulties also were increased by the fact that the inspection service is ill paid, which would make it difficult to draw into it inspectors with experience and a general character suited to the work involved. As the shipyards, through experience, improved their production, and as the inspectors became more experienced, these difficulties were reduced.

CONCLUSION

The Liberty ship has been the truck horse of the sea. Because of the simplicity of its design, and because it is all welded, it has been possible to build enormous numbers of the ships in a short time and thereby to carry the cargo essential to the war effort. It would not have been possible to build an equal cargo-carrying capacity of other types of ships, which otherwise would have been preferred, such as the C-3 and the Victory ship.

The designers of the Liberty ship, on the whole, did a good job, but experience indicated a number of respects in which the design could be improved so as to better enable the ship to sustain the stresses which would be placed upon it. These were incorporated into the construction of Liberty ships in the latter part of 1943 and early in 1944, and have produced results.

The shipyards constructing Liberty ships were new yards because the old shipyards were almost entirely preempted for the Navy and for more complicated types of merchant vessels. Construction methods of such yards, in the early months of the program, frequently were not up to the standards that otherwise would have been required to be maintained. As such yards became more experienced and as the nature of the difficulties likely to be encountered with Liberty ships became known, construction methods in welding sequences were improved.

Similarly, the loading of Liberty ships with heavy war material and their operation in stormy weather and in convoy involved somewhat different problems than regular commercial operation. With experience, it has been possible to improve these conditions and, thereby, to lessen the possibility of casualties to the ships.

In evaluating the statistics set forth with respect to casualties occurring to Liberty ships, it should be noted that the committee has been advised by Admiral Land that incomplete records available to the Maritime Commission definitely indicate that more riveted ships than Liberty ships have completely failed structurally.

The committee as a result of its study of the Liberty ship construction program, and after a full consideration of all the testimony and statistics, is in general concurrence with the summary of findings issued by the board to investigate the design and methods of construction of welded-steel merchant vessels dated June 3, 1944:

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* * * without early and general adoption of welded construction in the merchant shipbuilding program, as well as in the naval shipbuilding program, the results in speed and volume of construction which have been accomplished would have been impossible.

* * * * * * *

* * * Analysis of the fractures indicates the existence of phenomena in welded construction which may be of importance and to which a long and satisfactory experience of riveted construction affords no reliable guide. They include such factors as shrinkage stresses built into the hulls by the welding process, the behavior of steel at low temperatures, and the stress strain characteristics inherent in the locally more rigid welded structure. A large number of research projects have been initiated and are now under way in order to determine the relative importance of these factors and with a view to determining what steps should be taken in design and in construction methods to eliminate or reduce such deleterious effects as may be found. Basically, the abnormal conditions of wartime shipbuilding and ship operation, construction practices largely incidental to speed of production, and structural design details, are factors which in large measure have contributed to the occurrence of fractures. Appropriate steps have been taken to improve the two latter conditions where control is feasible, but such corrective measures have not been in effect long enough to be able to state definitely at this time that they will prove completely effective.

Since the Liberty ship has limitations and possibilities of casualties from fractures, it is the opinion of the committee that the Liberty ship ought not to be used as a troop or hospital ship except in cases of very great emergency, and then only after special precautions are taken to strengthen the ship and to provide adequate convoy protection both in case of enemy attack of relatively slow ships and, in case of disastrous sea, from fractures.

PUBLISHED REPORTS

The Special Committee Investigating the National Defense Program, United States Senate, pursuant to Senate Resolution 71 (77th Cong.), authorizing and directing an investigation of the national defense program.

Report No. 480 (77th Cong., 1st sess.):

- Part 1—Aluminum.
- Part 2—Camp and Cantonment Construction.
- Part 3—Priorities and the Utilization of Existing Manufacturing Facilities.
- Part 4—Statement of Committee Policy.

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Report No. 480 (77th Cong., 2d sess.):

- Part 5—Annual Report of Committee Investigations.
- Part 6—Light Metals, Aircraft, and Other Matters.
- Part 7—Rubber.
- Part 8—Conversion to War Production Program of War Production Board.
- Part 9—Conversion Program, War Production Board. (Accompanies pt. 8.)
- Part 10—Investigation in Connection With Senator Albert H. Chandler's Swimming Pool in Kentucky.
- Part 11—Manpower.
- Part 12—Shipbuilding at the South Portland Shipbuilding Corporation.
- Part 13—Gasoline Rationing and the Fuel Oil Situation.
- Part 14—Lumber.

* * * * * * *

Report No. 10 (78th Cong., 1st sess.):

- Part 1—Barges.
- Part 2—Farm Machinery and Equipment.
- Part 3—Interim Report on Steel.
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