

**SALVAGE OF THE
BATTLESHIP
USS *UTAH*
FOLLOWING THE
ATTACK ON PEARL
HARBOR
1942-44**



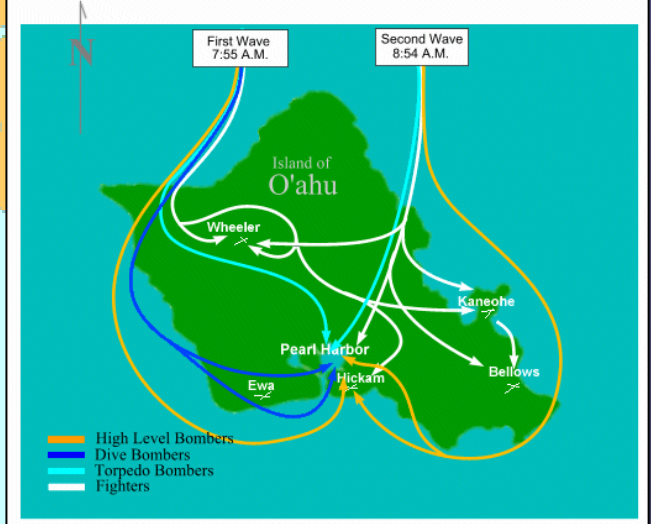
- **USS UTAH built at Camden, NJ in 1909-10**
- **-21,825-ton Florida Class battleship**
- **-Served in Atlantic Fleet during World War I**
- **-Extensively modernized in 1925**
- **-Converted to a radio-controlled target ship in 1931**



- **Being down-graded to a target ship in 1931, the Utah was not retrofitted with torpedo bilges like the other older battleships at Pearl Harbor**

Pearl Harbor Anchorage

7:55 A.M. Dec. 7, 1941

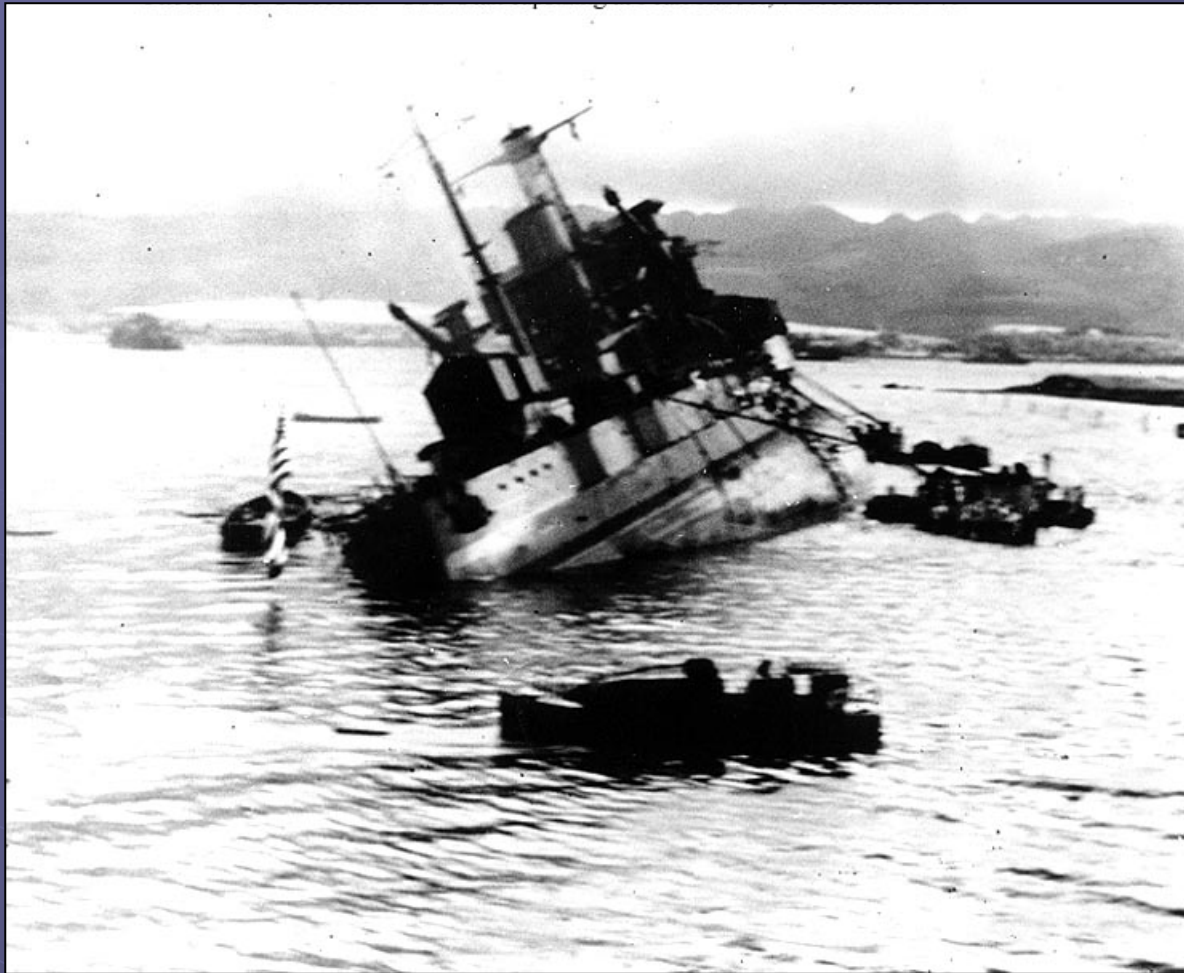


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JAPANESE ATTACKED NORTHWEST SIDE OF FORD ISL



- The *Utah* was targeted *because* she was berthed where aircraft carriers were usually tied up on the weekends. She received two torpedoes



The Utah was situated on the northwest side of Ford Island, where American carriers were usually berthed. Her decks were planked with heavy timbers because she was used as a target ship for the battle fleet. Efforts to prevent her capsizing failed and 58 were killed. Note ensign on fantail which was never fully raised.

**Captain Homer N. Wallin,
USN Naval Academy
Class of 1917 Served
initially on battleships
Post graduate degree in
Naval Architecture from
MIT**

**Prior to Pearl Harbor
attack he was the Material
Officer on staff of the
Commander, Battle Force
– Pacific**

**ADM Nimitz promoted him
to Captain and made him
the Fleet Salvage Officer
and Salvage
Superintendent**



Situation when salvage began-1942



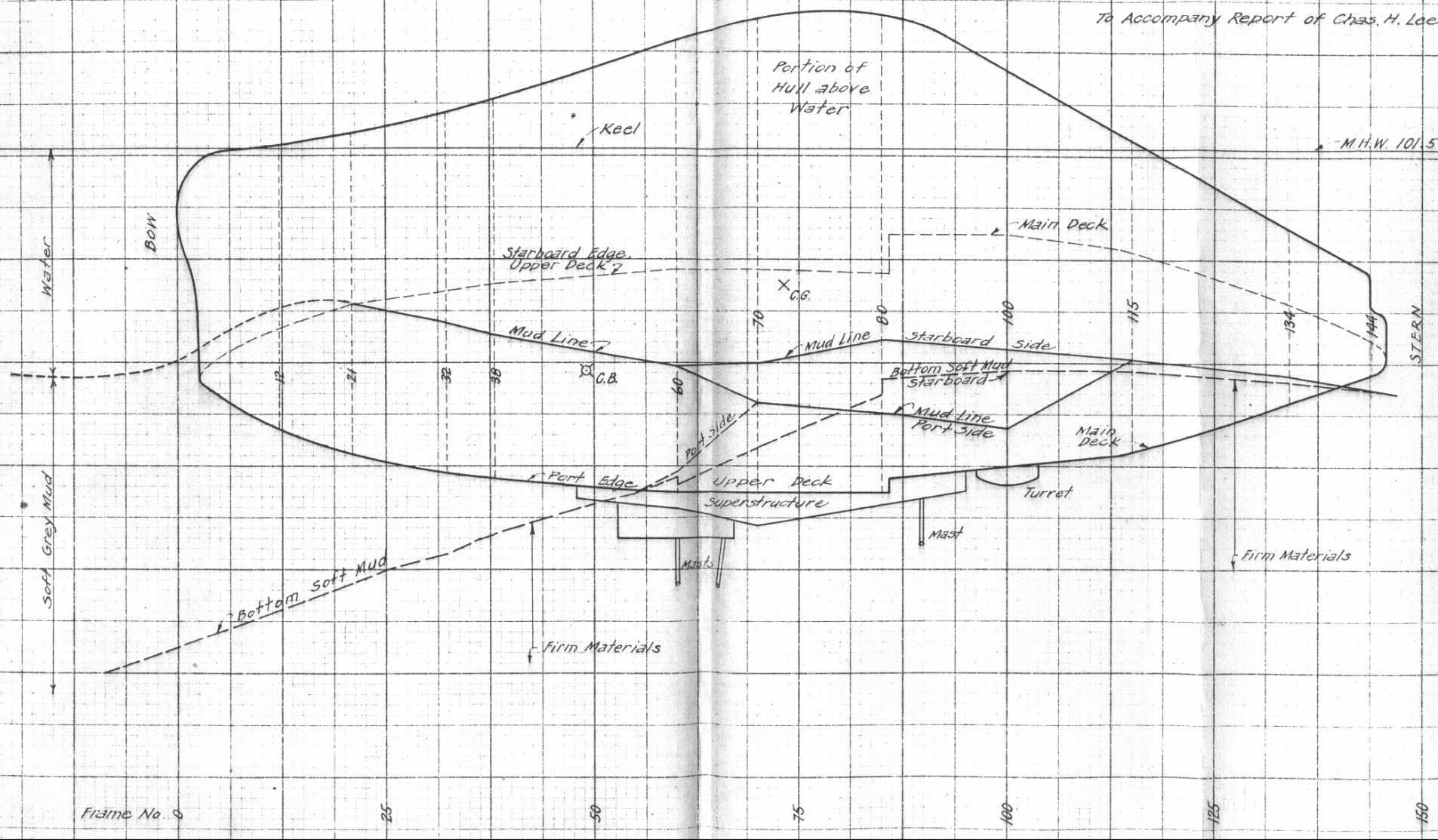
Capsized hull of USS Utah

Salvage efforts concentrated on the least damaged ships first, the *Oklahoma* and *Utah* were the last ships to receive serious attention

The Navy contracts with Pacific Bridge Company of San Francisco

- **Refloating Methods Considered**
 - Sealing the holes
 - Pontoons
 - Counterweight
 - Floating Dry Docks
 - Power winches on shore and rigging direct to the ship; This technique was previously employed to recover an overturned 19,000 ton caisson during construction of the Mid-Hudson suspension bridge at Poughkeepsie, NY in 1930-31

VIEWED FROM OFFSHORE SIDE
To Accompany Report of Chas. H. Lee



Plan view of Utah hull, viewed from offshore side

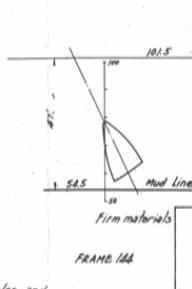
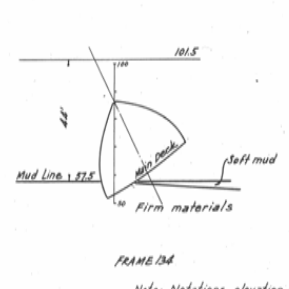
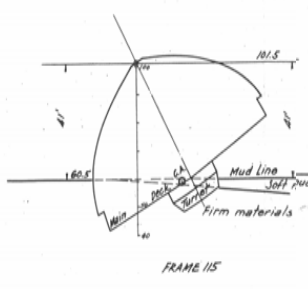
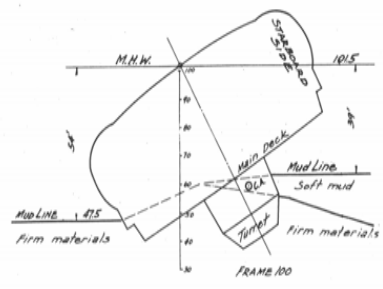
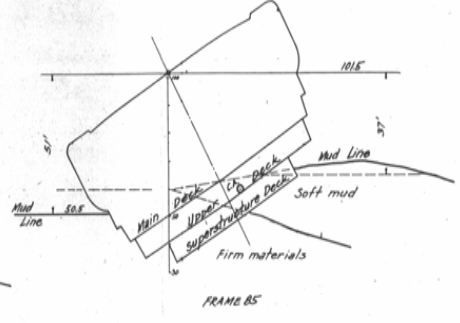
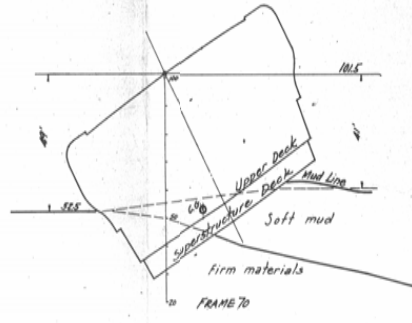
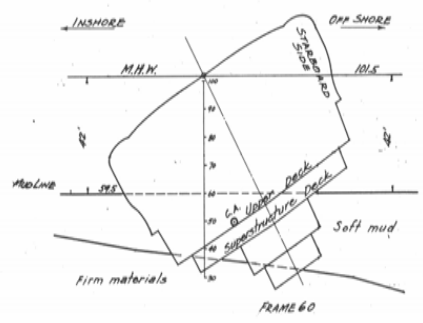
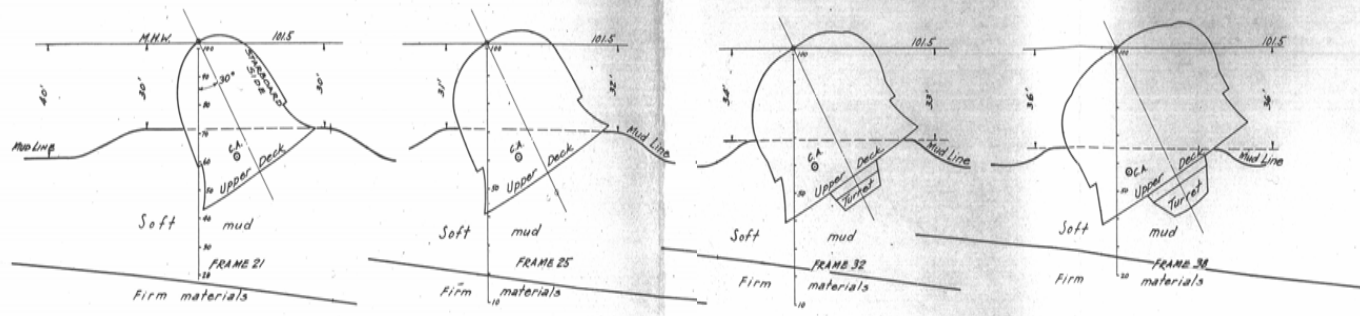


DIAGRAM 4
 FRAME LINE DIAGRAMS SHOWING
 WATER, MUD AND FIRM MATERIAL
 LINES
 TO ACCOMPANY REPORT OF CHARLES H. LEE

Note: Notations, elevation scales, and division lines between soft and firm materials are additions to original drawing made by C.H. Lee.

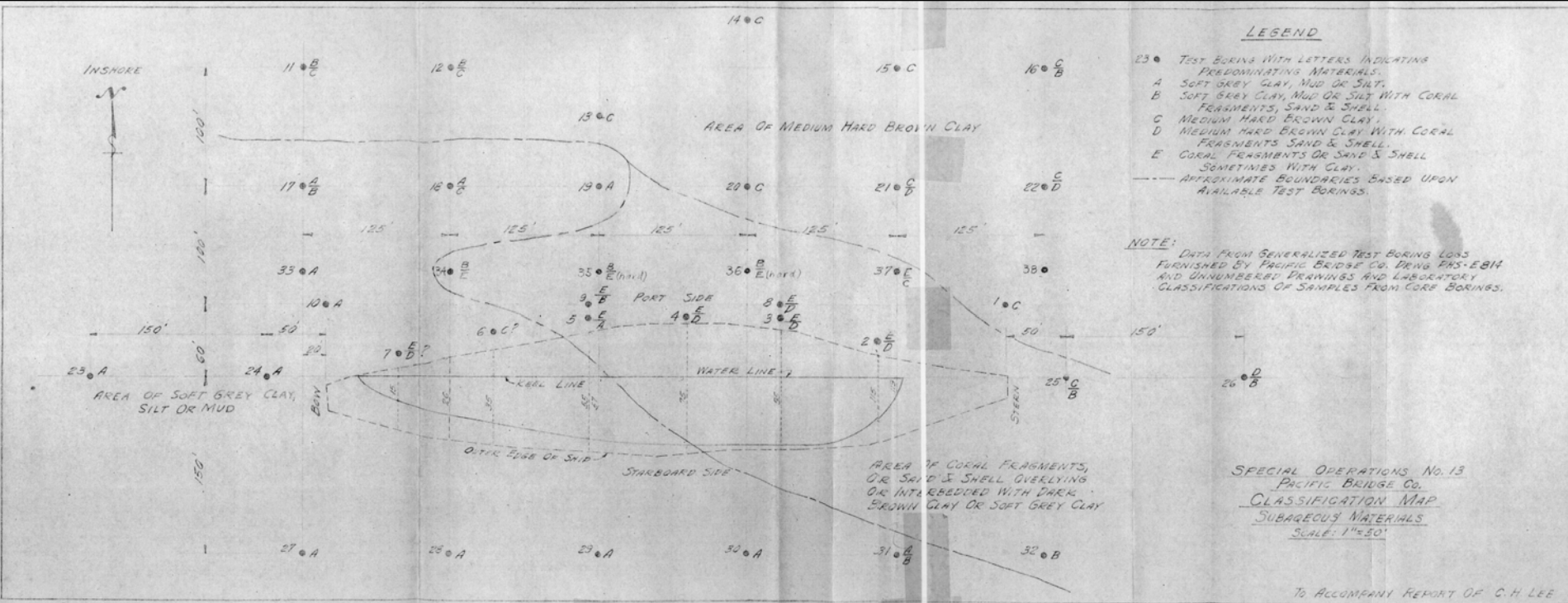
REVISIONS	PACIFIC BRIDGE COMPANY ESTABLISHED 1888 CONTRACTORS - ENGINEERS	
	MUD LOCATION	
SCALE 1" = 20'-0"	DATE	
DRAWN BY	CHECKED BY	
		Drawing No. PHS-528

Cross sections through the Utah's hull to verify overturning forces and anchor pull loads

Soil Mechanics Tests

- 1. Can sufficient passive resistance be developed under the ship to prevent sliding?
- 2. Recommend methods of stabilizing the soil to prevent sliding.
- 3. Can preliminary dredging be conducted without reducing friction to the point of sliding?
- 4. Will hull sink deeper in 120 and 90 degree positions?
- 5. Asked to perform model tests to confirm the assumed loads

Soil Conditions in Pearl Harbor

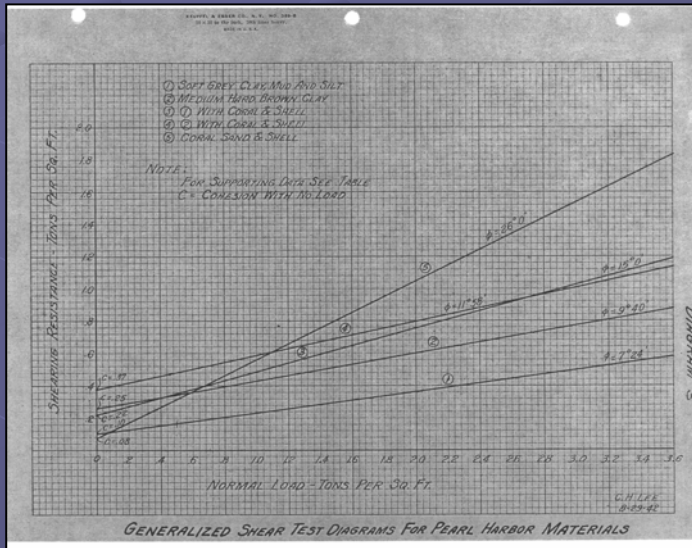


Legend

- A Soft Grey Clay, Mud or Silt
- B Soft Grey Clay, Mud or Silt with Coral Fragments, Sand & Shell
- C Medium Hard Brown Clay
- D Medium Hard Brown Clay with Coral Fragments, Sand & Shell
- E Coral Fragments or Sand & Shell sometimes with Clay

Modeling Results

Exhaustive tests were conducted on a 1/96 scale model in a tank with soil from San Francisco Bay



PROJECT (13B) LINE PULL

MODEL TEST No.	SOIL TYPE	MAX. LINE PULL	ANGLE °
Model Test No. 4-Test #1	A	7880	130°
* - - - - - #8	A	10,600	140°
- - - - - #14	B	6,480	120°
- - - - - #21	B	6,625	124°
<u>AVERAGE</u>		<u>7,900</u>	<u>128°</u>

* NOTE: SEE DRG 13B-G300 FOR SAMPLE CALCULATIONS OF ABOVE DATA. IF AIR PRESSURE IS USED TO REDUCE EFFECTIVE WEIGHT OF SOIL, ABOVE PULLS WILL BE REDUCED 10 TO 20%.

DATE	REVISIONS	DATE	REVISIONS
DATE <u>May 27/41</u>			

PACIFIC BRIDGE COMPANY
CONTRACTORS ESTABLISHED 1918
333 MARKET STREET SAN FRANCISCO, CAL.

ENGINEERS
PROJECT No. 13B HULL - BASED ON MODEL
MAXIMUM LINE PULL DATA No. 13B-G301

METHOD USED TO DETERMINE REQUIRED PULLS FOR CATCHING BRIGG'S 13B HULL - BASED ON MODEL TESTS SEE DRG TEST #8

SUB. 0 = PROJECT 13
SUB. U = PROJECT 13B

W₁₀ = WORK DONE BY PULL OF WINCHES (AT TANK)
W₁₄ = WORK DONE TO RAISE WT OF HULL (AT TANK)
W₁₆ = WORK DONE TO COMPRESS SOIL (AT TANK)
W₁₈ = WORK DONE FRICTION SOIL ON HULL (HULLS)

W₂₀ = W₁₀ - (2 W₁₄)
W₂₄ = W₂₀ + W₁₆ = $\frac{28.9}{2.90} \times W_{20}$
W₂₈ = LENGTH UTM SHANK CORRECTED WITH SOIL LENGTH DATA, 5-240 EXIST. MADE 28 DNG. 304

W_{TU} = W₂₄ + W₂₈
P = PULL ON UTM = W₂₄ + W₂₈

SAMPLE CALCULATION FOR 110° POSITION DWS.
W₁₀ = 5849 x 2.12 = 123,000' T
W₁₄ = 28000 x 1.17 = 47,600' T
W₁₆ = 123,000 - 47,600 = 75,400' T
W₂₀ = $\frac{28.9}{2.90} \times 47,600 = 40,550' T$
W₂₄ = $\frac{480}{580} \times \frac{2.50}{1.90} \times 75,400 = 110,000' T$
W_{TU} = 40,550 + 110,000 = 150,550' T
P = 150,550 ÷ 2.1 = 71,693 TONS.

DATE	REVISIONS	DATE	REVISIONS
DATE <u>5-27-41</u>			

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ENGINEERS
PROJECT No. 13B HULL - BASED ON MODEL
TESTS SEE DRG TEST #8 No. 13B-G301

Soil shear testing results

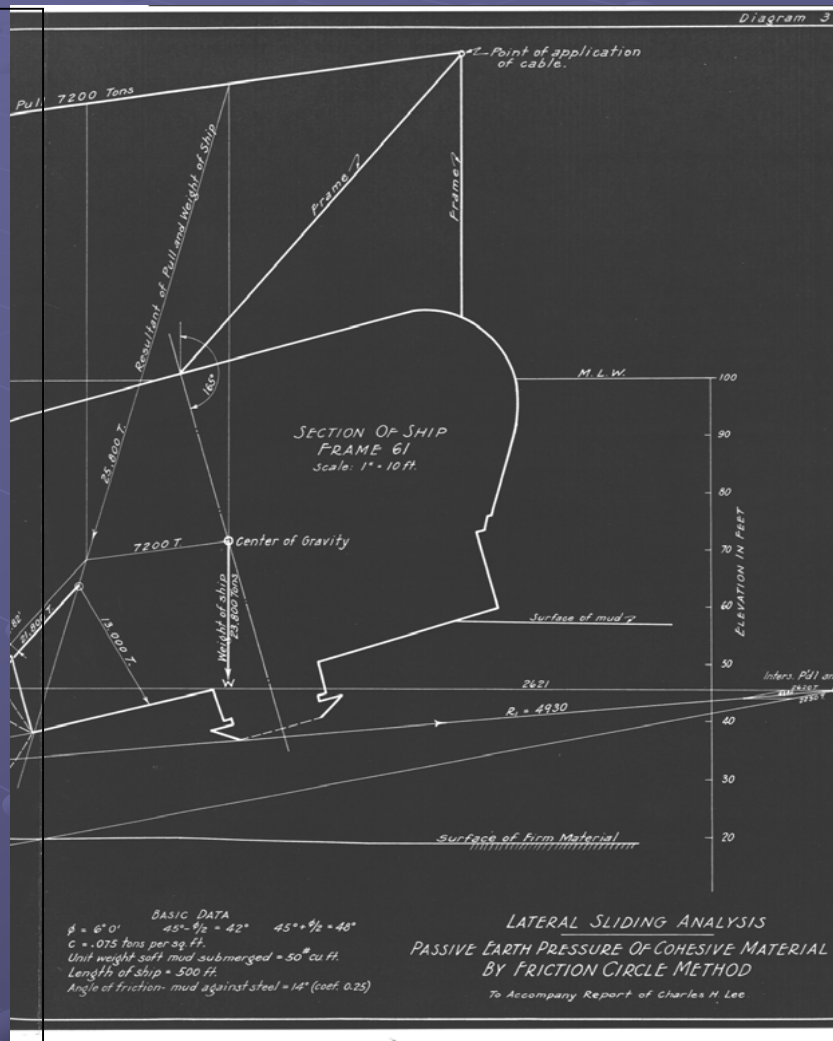
Line Pull Calculations

Actual pull was within 5 percent of calculations

Soil mechanics test results

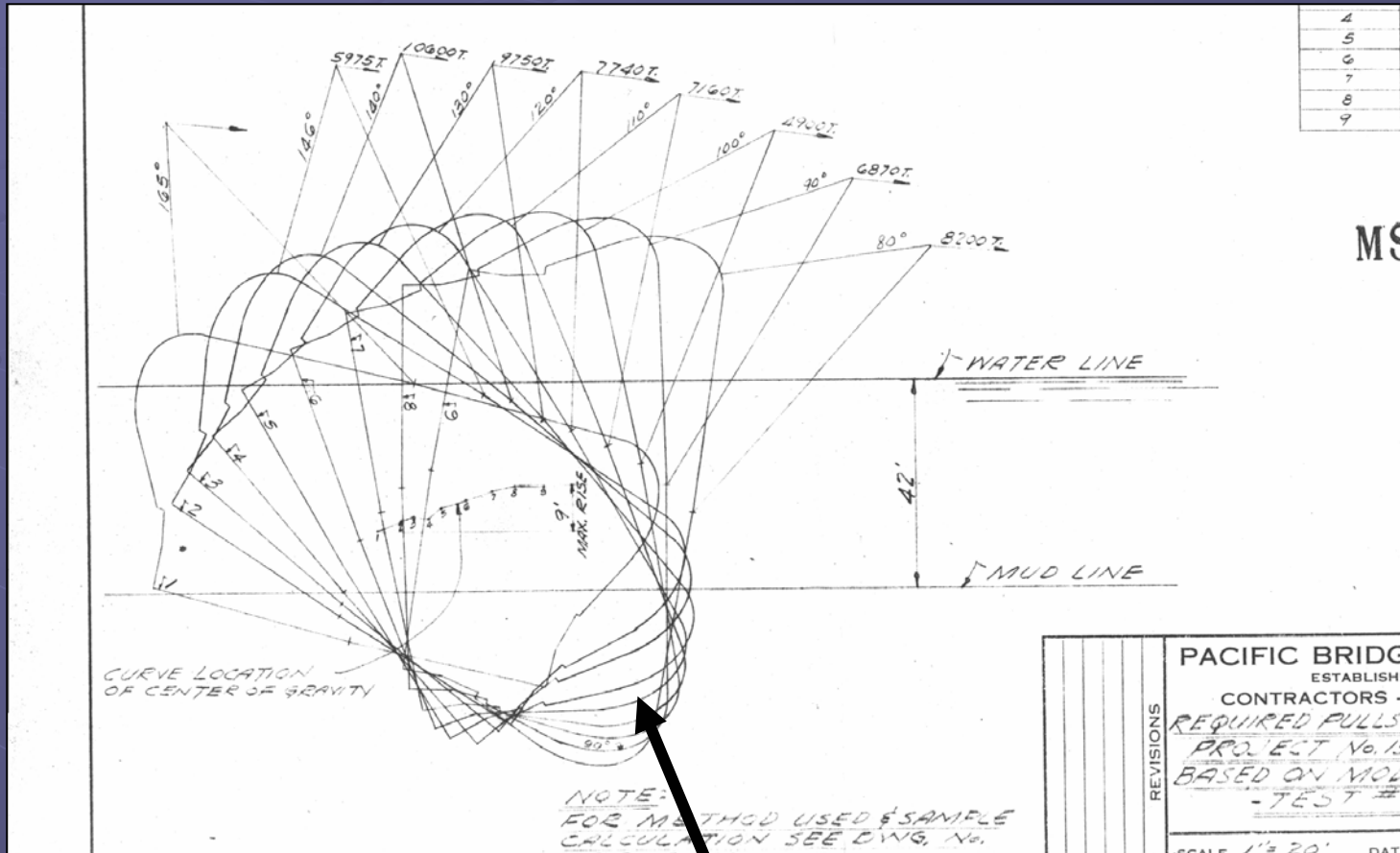
- Skin friction in mud= 400lbs/ft²
- Skin friction in silty sand= 500 lbs/ft²
 - Concerns for bow sliding
 - A max winch pull of 8,000 lbs

Passive Soil Pressures Controlled the Extraction Methodology



The model studies indicated rolling of the riveted hull rather than sliding on the soft bay muds, but there was concerns about frame distortion of the riveted hull

Final design of A-frame attachments to the overturned hulls



Soil from this area had to be progressively removed to allow final righting

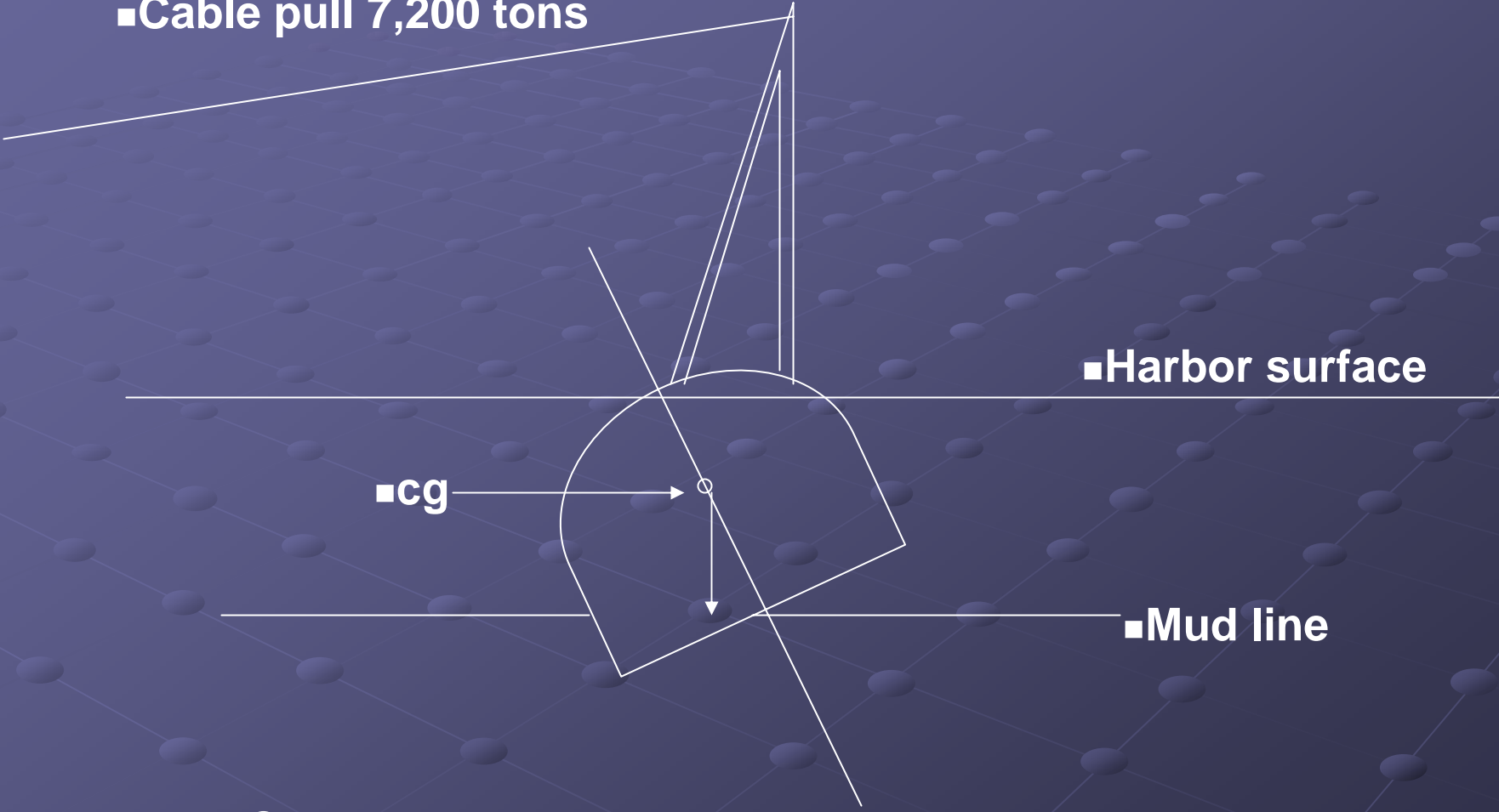
■ Cable pull 7,200 tons

■ Harbor surface

■ cg

■ Mud line

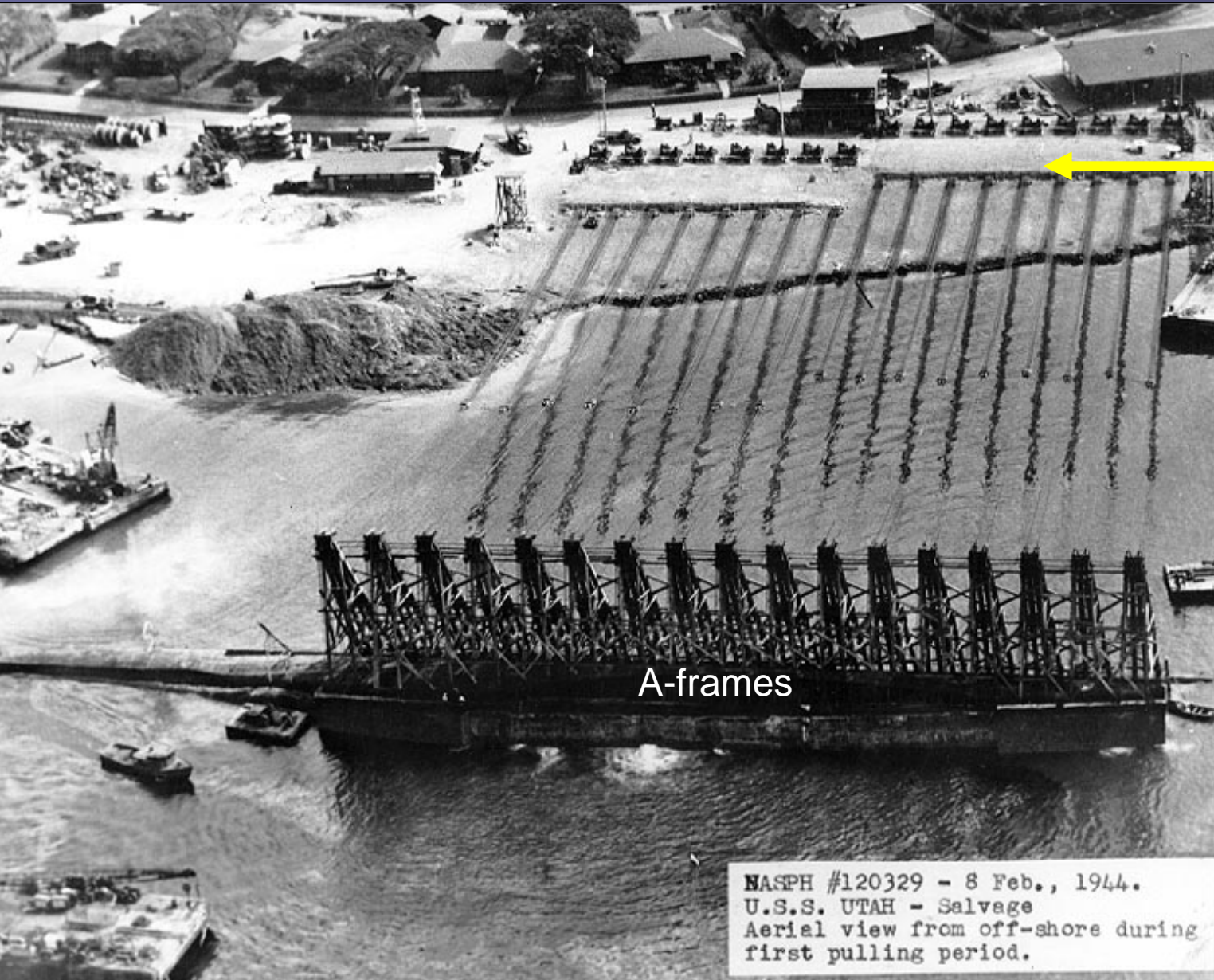
■ Cg = 23,800 tons



Physical Factors that had to be modeled

- **Naval Architecture – ship is not a rigid body**
- **Construction of A-frames, winches and pump systems**
- **Engineering – buoyancy considerations**
- **Skin friction of hull against harbor floor, whether mud or sand. Soil passive pressures**
- **Metallurgy of riveted frame and plate hull**

Attempted Righting of the USS Utah



Fixed shore anchorages with power winches

A-frames

NASPH #120329 - 8 Feb., 1944.
U.S.S. UTAH - Salvage
Aerial view from off-shore during
first pulling period.

Winch Design

- 21 Compound pulleys
429 ton capacity each
- Motors had to respond precisely to individual control
- Operator stationed at each winch
- Variable-voltage drives
- 3" cable between the sheaves and the ship
- 1" steel cable on the winches

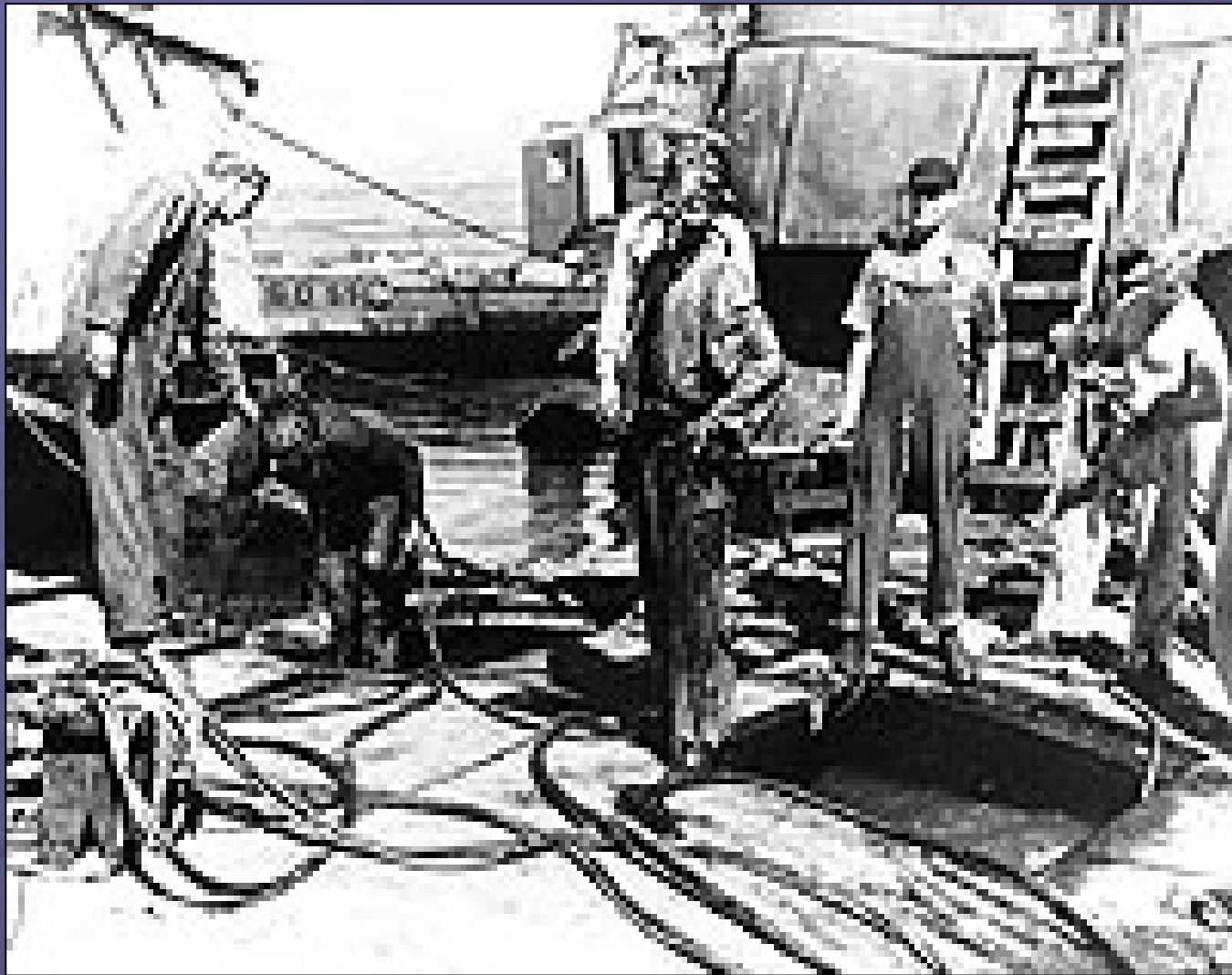


Salvage Choices

- Refloat hull using external floatation, similar to S-51 salvage in 1925-26
- Plug leaks and blow air into hull, similar to WW1 German fleet scuttled at Scapa Flow
- Scrap hulk in place by torching hull frames and plates
- Leave hulk as is, lose berth space
- Drag hull to deeper area or another part of Pearl Harbor and sink it

Mk V Deep Sea Diver rig was used in much of the underwater salvage work. Many of the salvage techniques used today were developed by these divers during World War II, who spent 2 to 3 years at Pearl Harbor; such things as arc welding underwater with 440 amps and using hydraulic jets to excavate tunnels beneath sunken hulls.





- In the salvage of the Utah divers made 437 dives involving 2, 227 man hours under pressure. There were only two diving supervisors.



All the diving and decompression on the sunken battleships never killed a military diver, but one diver lost his arm on the Oklahoma because the pumps were not under direct control of the diving supervisor.

**Attempted
righting of the
USS Utah in
1944. The Utah
was rotated
back to within
35 degrees of
horizontal, but
left in place
without being
removed**



References

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- **Engineering files of LCDR J. David Rogers, USNR**
- **Military History Quarterly; Autumn, 1991; Vol 4; #1**
- **Pearl Harbor- The Day of Infamy: An Illustrated History**
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- **nps.gov**