Staging Systems for Ships During New Construction and Repair

U.S. DEPARTMENT OF THE NAVY
DAVID TAYLOR RESEARCH CENTER

in cooperation with
National Steel and Shipbuilding Company
San Diego, California

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THE NATIONAL SHIPBUILDING RESEARCH PROGRAM
THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
SHIP PRODUCTION COMMIITEE
PANEL SP-1

STAGING SYSTEMS FOR SHIPS DURING NEW CONSTRUCTION AND REPAIR

FINAL REPORT
TASK 1-85-4

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PROGRAM MANAGEMENT

This report is one of the many projects managed and cost shared by the National Steel and Shipbuilding Company, under the auspices of the National Shipbuilding Research Program. The program is a cooperative effort between the Maritime Administration's office of Advanced Ship Development, the U.S. Navy and the U.S. shipbuilding industry.

Executive administration and supervision was provided by Mr. Lynwood P. Haumschilt, Program Manager of IWRP, NASSCO.

Project definition was provided by the members of the Society of Naval Architects and Marine Engineers, Panel SP-1, Facilities and Environmental Effects, and the author of the technical paper presented.

FOREWORD

The Maritime Administration under its National Shipbuilding Research Program sponsored the subject study. National Steel and Shipbuilding Company (NASSCO) administered the program for the Maritime Administration with Ms. Judie Blakey acting as Project Manager. All of the experimental work described in this report was conducted at National Steel and Shipbuilding Company.

The subject study is an investigation of the most recent state-of-the-art scaffolding system in worldwide use today. The erection and dismantling of scaffolding, and its associated stage planking, is a highly labor intensive operation in most shipyards. The overall objective of this NSRP project is to develop a cost effective scaffolding approach, with the use of state-of-the-art scaffolding material and equipment.

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INTRODUCTION

The U.S. Shipbuilding industry is facing a major market change. The change, rather than involving an increase of tonnage output, is in the direction of reduction. The U.S. Navy, due to its reduced budgetary forecast, will not be able to sustain the industry at its current level, and the American commercial market is expected to produce orders for only five to ten ships per year. It is imperative that we upgrade our shipbuilding methodology if we are to become competitive in the world-wide market place. One area that could have significant impact in reducing costs is scaffolding and other mechanical equipment used to complement scaffolding requirements.

Present scaffolding methods used by most shipyards are costly, and in general, inefficient. The need to develop innovative scaffolding methods and to use state-of-the-art scaffolding systems and equipment is imperative.

Although the samples presented and methods described in this report are limited, they have been used and evaluated by NASSCO. Our active involvement in this phase of shipbuilding construction provides us with enough material and information to be applicable to any shipyard. The scope of this report will concentrate on scaffolding systems devoted primarily to exterior hulls and the use of other equipment utilized to make this operation more cost efficient.

The traditional method used to gain access to working areas of the ship's hull is by building a framework around the ship using clamps, pipe, quick-locking tubes, flames, and other scaffolding components. All of this scaffolding material is eitier hung from the hull or built up from the ground. Most shipyards conform their scaffolding setups to their yard conditions, requirements, ship size, vessel type and other conditions specific to each operation. Almost all such methods use loose planks, supports, clamps, bolts, brackets, etc. This method is used widely in the shipbuilding industry with corresponding high labor costs.

SCAFFOLDING SYSTEMS EXAMINED

The following is a list of scaffolding system utilized by the construction and shipbuilding industry. Their use advantages or disadvantages will be listed in the following pages:

1. FRAME SCAFFOLDING
2. TUBE AND CLAMP SCAFFOLDING
3. MODULAR SCAFFOLDING SYSTEM
4. SWIFTSTAGE
5. PERMANENT SCAFFOLDING STRUCTURES
6. SUSPENDED AND MECHANICAL AERIAL PLATFORMS
7. PRE-ERECTION (STATIONARY) “MODULAR” OR “SCAFFOLDING BLOCKS"
8. PRE-FABRICATED "MOBILE" OR “ROLLING" TOWERS
9. STRUCTURAL TOWERS
10. BUTTON-LOK STAGE SYSTEMS

FRAME SCAFFOLDING

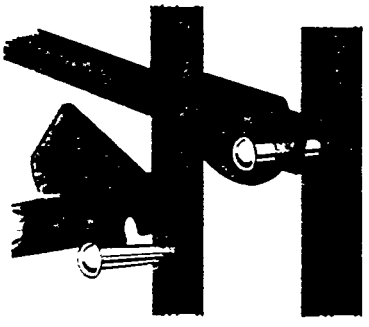
Frame Scaffolding System is composed of these basic components: two end frames. two cross braces, two horizontal guard ralls and planking per unit of assembly. The End Frames in construction are normally substituted by the "Walk-Through End Frames." but in both instances (shipbuilding and construction) these basic elements are combined in various positions or lengths to meet user's requirements. Additional components such as: brackets. goosers. ladders, couplings, saddle connector bases. base plates, screw-jack adjustable plates are utilized on a regular base.

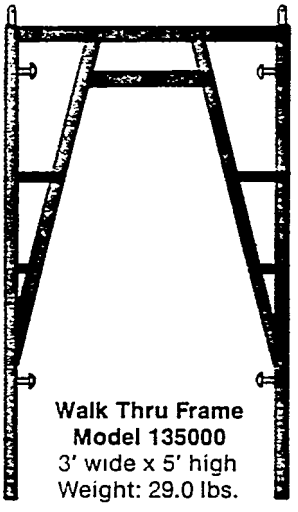
The draw-back of this system is the large quantities of components required when medium and large size projects are handled.

The use of frame scaffolding is labor intensive because large numbers of components are handled. Materials is another key element is selecting this system. Rentals or purchase of these scaffolding items could drive costs up. Therefore. it is important to evaluate these conditions in determining what type of scaffolding will be selected.

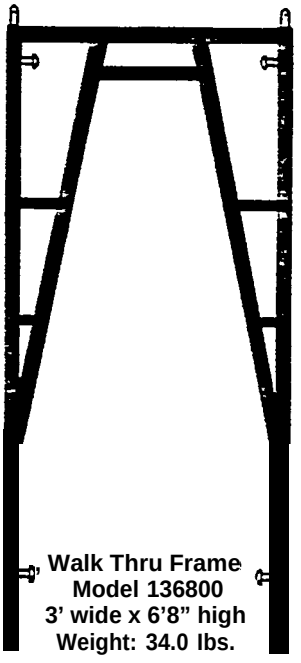
On the other hand, this system is relatively simple and quick to handle and to erect. Expertise and ability will definitely reduce labor costs.

Snap-On Locks are standard. Other locks available upon request.





Walk Thru Frame
Model 135000
3' wide x 5' high
Weight: 29.0 lbs.



Walk Thru Frame
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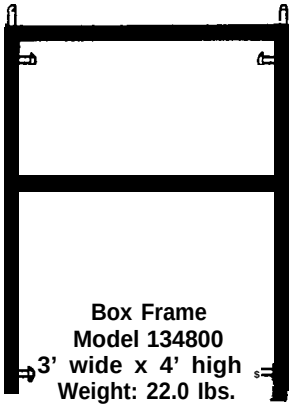
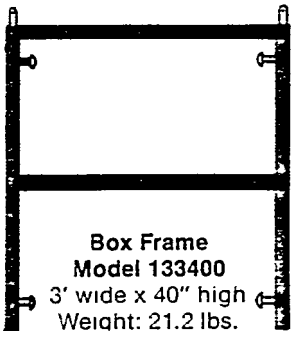
Weight: 34.0 lbs.



Box Frame
Model 134800
3' wide x 4' high
Weight: 22.0 lbs.



Box Frame
Model 133400
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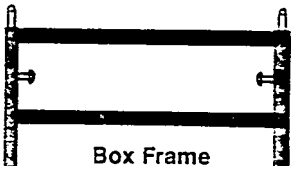
Weight: 21.2 lbs.



Box Frame

TUBE AND CLAMP SYSTEM

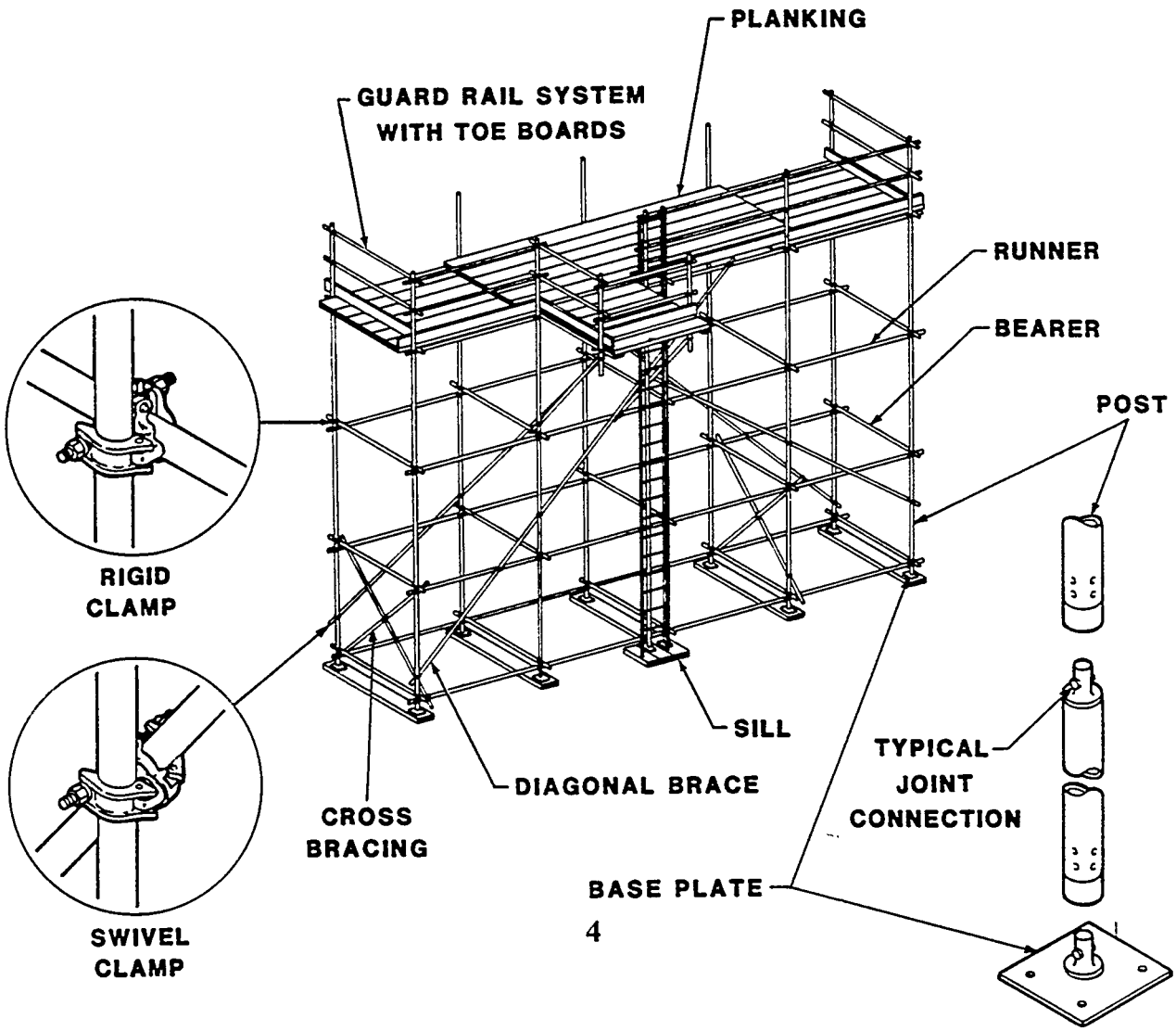
Tube and Clamp Scaffolding System is the general approach selected in forming a rigid structure with the use of 2" diameter tubes clamped together. This system needs to be properly connected and adequately braced to be safe.

This system has three basic structural elements: posts, bearers and the runners interconnected with double couplers. These elements repeated in the horizontal and vertical planes will provide the desired structure.

Other components found in this system are: diagonal braces, horizontal and cross bracing, right angle clamps, swivel clamps, base plates, end fitting for each tube, adjustable jack bases, planking.

Tubular and Frame Scaffolding systems are two types of systems that imply the use of a large number of components when selected. Expertise and skills are required in handling, erecting and dismantling this system. It is very labor intensive.

The main advantage of this system is the adaptability to all forms or shapes needed to scaffold.



MODULAR SYSTEMS SCAFFOLDING

The present approach that is picking up momentum is the utilization of Modular System Scaffolding. This system is relatively new in the U.S.A. However, this approach has been utilized in other countries for many years. Modular Systems are useable under most conditions of declivity, terrain structural and other conditions where the regular framing setup will not be cost effective.

Modular System does not require a high degree of expertise. Fewer components are involved, and once the base is set the scaffoding goes Up rather quickly. Modular Systems are designed for easy handling and, erecting in rectangular, circular and odd vessel shapes. Horizontal members can be disassembled from lower levels without disturbing adjacent members. In general, the versatility and practical applicatiom, make this system very cost effective.

Savings in erecting modular scaffolding have been significant became, the tube couplers are omitted, the components fit together simply and quickly, there is no multiplicity of small components and most horizontal joints are linked together with wedges, cams, latched studs, clamping bolts, oversize sleeves and many more, designed with the speed of operation in mind.

Other perspective in this type of scaffolding, is standardization of the material. Although it has unique fixtures developed for each system, the use of the same pipe size is more and more frequent therefore making the modular system adaptable to other systems in the market.

Among some of the advantages of this modular system

a) The rosette, nodle, cup or any other connection to the post provides 4, 8, or more angle positions to erect scaffolding.

b) The variety of positions makes this system more versatile than any other conventional scaffolding systems.

c) The speed to erect and dismantle with experienced personnel could almost cut in half the labor costs.

d) Durability is another factor in this system that reduces costs. Fewer parts means less maintenance.

e) Can be used on even or uneven ground.

f) Faster to erect

Advantages of Modular System Scaffolding - continued

g) In Modular Systems, generally one unit could be removed without disturbing the rest.

h) No tubular, clamps and other loose parts required.

i) Can be crane handled in case of providing towers.

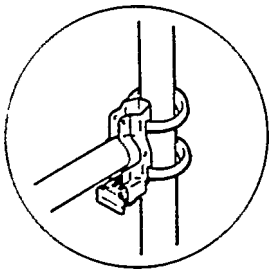
j) Interchangeable or compatible with other existing systems.

k) Outrigger and widening base easy with standard components.

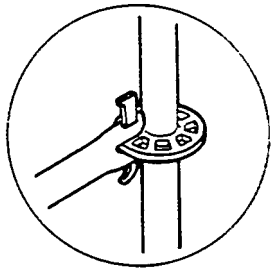
l) Weight of components is kept at a minimum for easy handling.

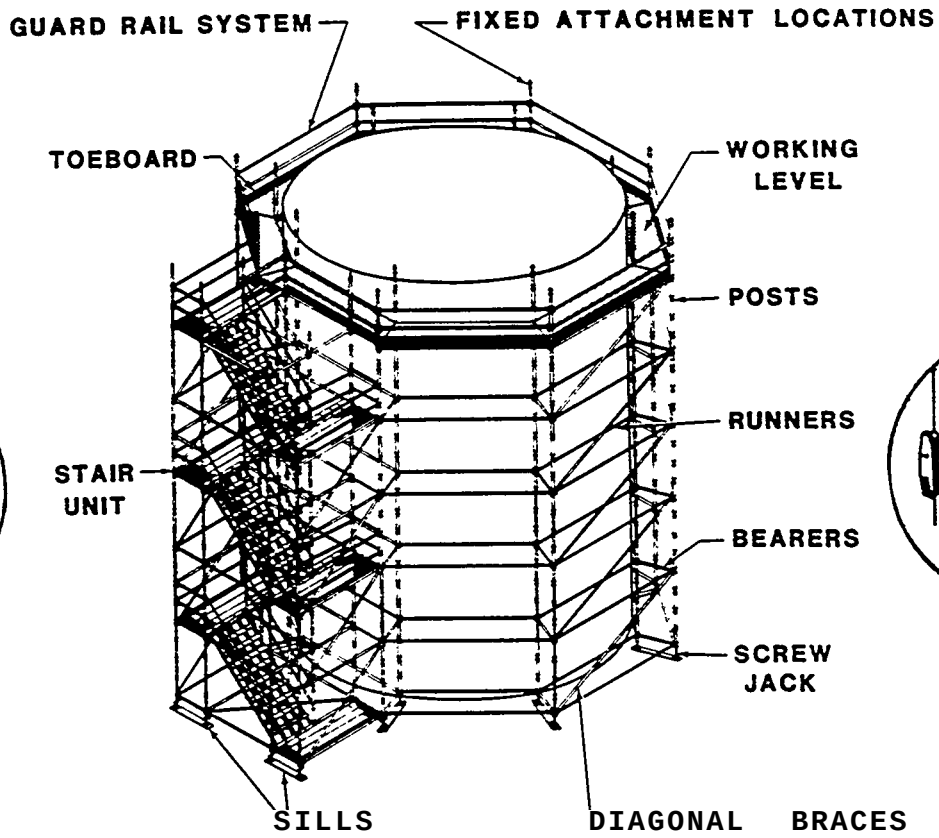
m) Safety is an important feature or Modular Systems. A minimal chance of error is assured with preset modules and positive lock joints, making it very sturdy and safe.

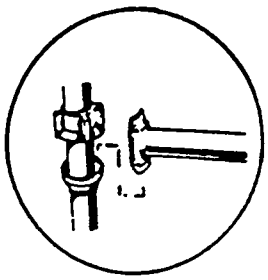
MODULAR SCAFFOLDING SYSTEM

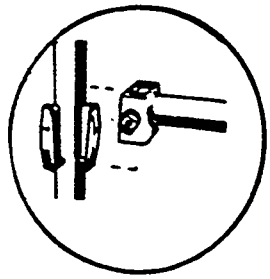


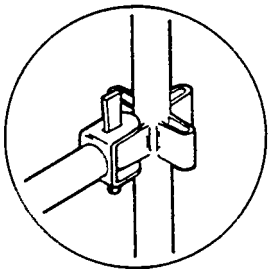
VARIOUS INDUSTRY
JOINT CONNECTIONS



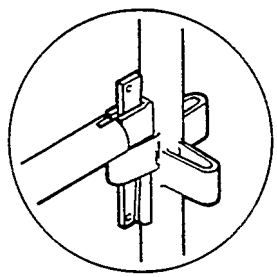








VARIOUS INDUSTRY
JOINT CONNECTIONS



SWIFTSTAGE SYSTEMS

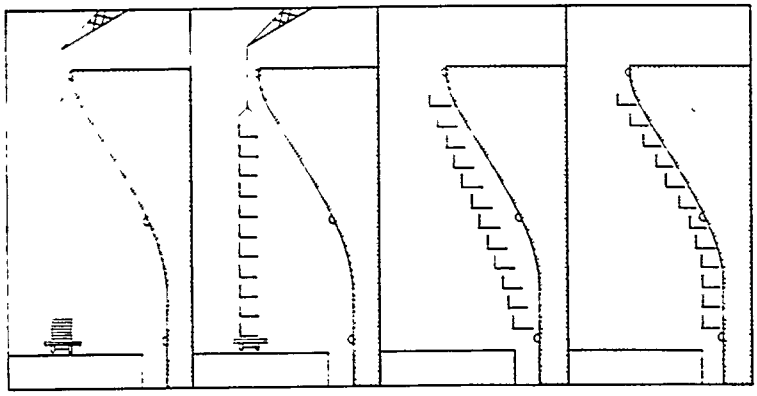
An innovative suspended scaffolding method was recently introduced in England and other countries such as: Holland, Norway, Sweden Denmark West Germany and France. The suspended scaffolding was called “Swiftstage System”.

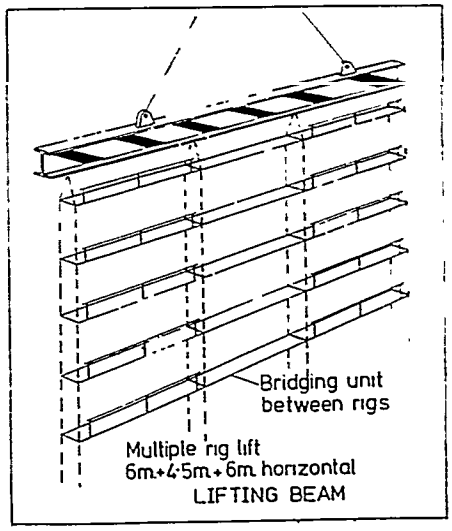
This system consists of an array of platforms suspended and interconnected by high strength alloy steel chains. Suspension could be done from clamped-on attachment devices, anchoring plates or permanent fixed rigging points. Each platform is equipped with deployable guardrails, kickplates, hatches and ladders. SwiftStage System conforms to flat surfaces as well as convex or concave surfaces.

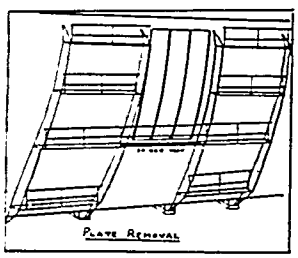
This system has significant advantages over other more conventional systems: lower costs in materials and labor, speed in deployment and recovery, a flexible system major load capacities and a safety oriented and designed system. Mounting, dismantling and re-location could be done in a fraction of time compared to other conventional systems.

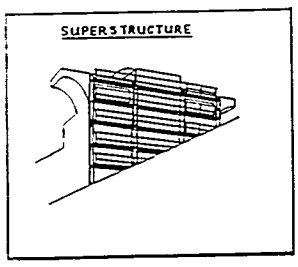
Today, usage of this collapsible-retractable system has extended to Japan Canada and the United States with excellent results in the shipbuilding, repair and construction industries. See attached sketches of the system for your own evaluation.

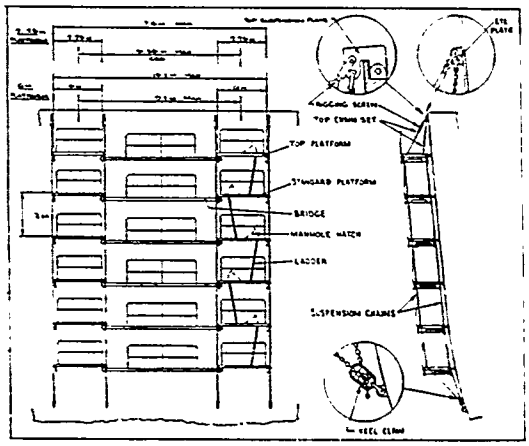
In summary, the design handling and operational characteristics of SwiftStage System scaffolding. has made this a safe, reliable, cost effective, adaptable and responsive system to the challenges of today’s shipbuilding industry.











SWIFTSTAGE, TUBULAR AND MODULAR COMBINATION COMPARISON

On March of 1978, Govan Shipbuilders Limited conducted a manhour comparison between swiftstage and tubular staging. One side of a 30,000 ton Bulk Carrier was utilized in that comparison.

NASSCO'S staging personnel conducted a similar comparison using square footage as unit of measurement and the same ship breakdown (Mid Aft and Fwd) utilized by Govan Shipbuilders Limited.

In NASSCO's comparison a third category was included. It is called "Modular Combination." The overall length and draft used was that of the AOE Combat Support Ship. Dimensions could be observed on the following pages.

It is almost impossible (and not advisable) to us only one type of scaffolding in present market conditions. Therefore, the introduction of this new staging, it was felt was more representative of today's trend. The calculated results obtained from our comparison were as follows:

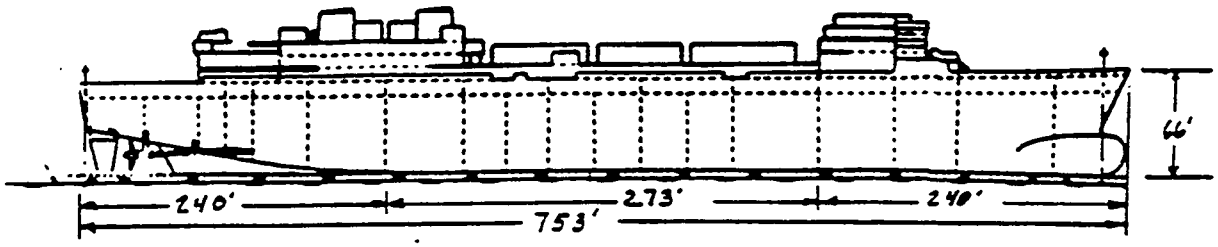
a) One side total square footage of 31,798 (Govan).

b) Installation of one 60' tubular tower in 44 hours* vs installation of one 60' modular tower in 30 hours.

c) A consistent ratio in a scaffolding cycle for:

1. Pre-stage = 8% of total hours used.
2. Install = 64% of total hours used.
3. Removal = 20% of total hours used.
4. Storage = 8% of total hours used.

MID = 1300 -- 21 towers = 61 hours per tower.
AFT = 1080 -- 24 towers = 45 hours per towers.
FWD = 1000 -- 39 towers = 25 hours per tower.
AVERAGE = 61 + 45 + 25 = 131 -- 3 = 44 hours per tower.



TOTAL WORK SURFACE AREA SCAFFOLDED AND SERVED

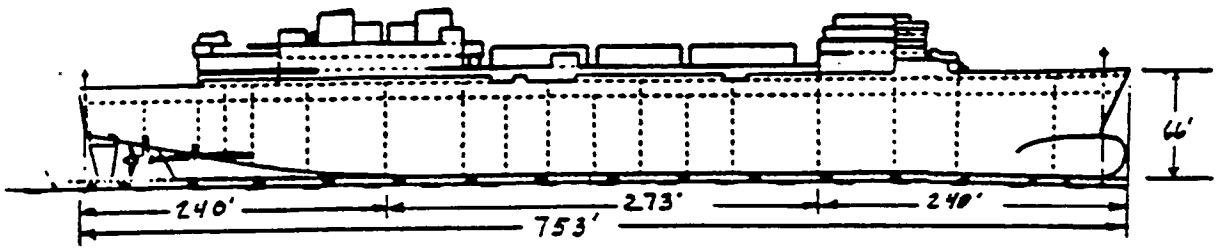
FORWARD END PER SIDE	240' LONG X 66' HIGH:	15,840
MIDSHIP SECTION PER SIDE	273' LONG X 66' HIGH:	18,018
AFT END PER SIDE	240' LONG X 66' HIGH:	15,840

TOTAL AREA PER SHIP SIDE:	49,698
TOTAL SURFACE ARE SCAFFOLDED:	99,396

TYPE OF SYSTEM USED:
MODULAR COMBINATION

IN HOURS

DESCRIPTION	MID	AFT	FWD	TOTALS	TOT %
1. STAGE MATERIAL	98	250	195	543	8%
2. INSTALL SCAFFOLDING	782	1998	1564	4344	64%
3. DISASSEMBLE SCAF	244	624	489	1357	20%
4. STAGE MATERIAL	98	250	195	543	8%
A SUMMARY TOTAL	1222	3122	2443	6787	100%
ONE SIDE	18%	46%	36%		
TWO SIDES	2444	6244	4886	13574	



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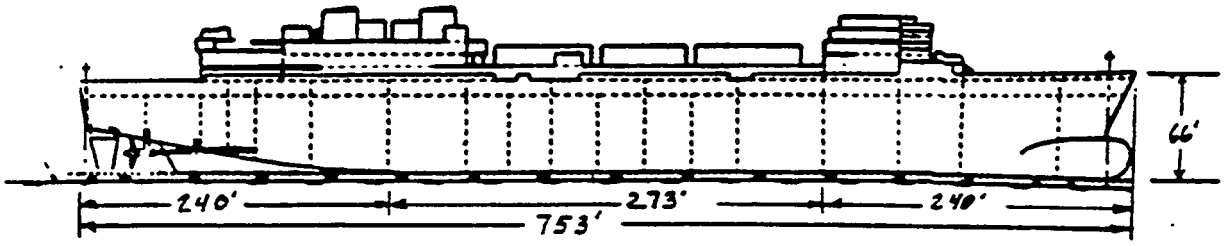
TOTAL AREA PER SHIP SIDE:	49,698
TOTAL SURFACE ARE SCAFFOLDED:	99,396

TYPE OF SYSTEM USED:
TUBLUAR STAGING IN HOURS

DESCRIPTION	MID	AFT	FWD	TOTALS	TOT %
1. STAGE MATERIAL	162	276	327	765	8%
2. INSTALL SCAFFOLDING	1300	2207	2619	6126	64%
3. DISASSEMBLE SCAF	406	735	818	1959	20%
4. STAGE MATERIAL	162	275	327	764	8%
A SUMMARY TOTAL	2030	3493	4091	9614	100%
ONE SIDE	21%	36%	43%		
TWO SIDES	4060	6986	8182	19228	



TOTAL WORK SURFACE AREA SCAFFOLDED AND SERVED

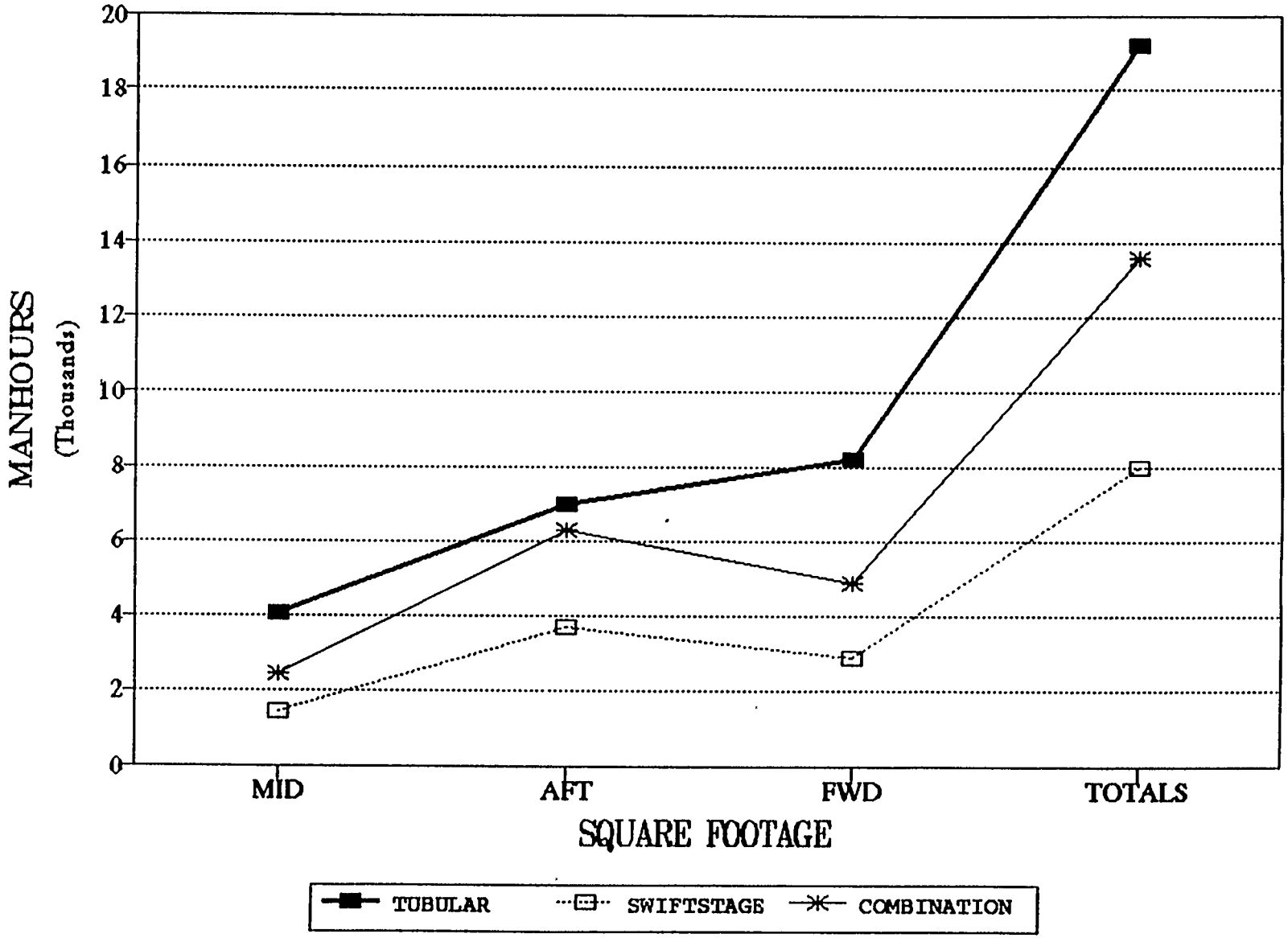
FORWARD END PER SIDE	240′ LONG X 66′ HIGH	15,840
MIDSHIP SECI′ION PER SIDE	273′ LONG X 66′ HIGH:	18,018
AFI′ END PER SIDE	240′ LONG X 66′ HIGH	15,840

TOTAL AREA PER SHIP SIDE	49.698
TOTAL SURFACE ARE SCAFFOLDED:	99.396

TYPE OF SYSTEM USED:
SWIFSTAGE COMBINATION **IN HOURS**

DESCRIPTION	MID	AFT	FWD	TOTALS	TOT %
1. STAGE MATERIAL	58	168	115	341	9%
2. INSTALL SCAFFOLDING	466	1179	918	2563	64%
3. DISASSEMBLE SCAF	146	327	287	760	19%
4. STAGE MATERIAL	58	168	115	341	9%
A SUMMARY TOTAL	728	1842	1435	4005	100%
ONE SIDE	18%	46%	36%		
TWO SIDES	1456	3684	2870	8010	

SCAFFOLDING SYSTEMS COMPARISON



PERMANENT SCAFFOLD STRUCTURES

When a series of ship sections or similar ships are built, the use of “Permanent Scaffolding Structures” is worth evaluation. These structures, once erected, will remain as long as they are needed. They will include power, lighting, air, ventilation welding, blast and paint hookups for equipment and finally office complexes on top. The early design and investment in materials and labor has to be evaluated against the overall size of the contract to make this approach cost effective. The benefits of using this approach are significant such as: reduced the number of rigging lifts, reduced the handling of materials, reduced storage facilities for scaffolting materials, quick access to job site, no waiting time for trades to start their operations, and availability of all services. This approach is utilized in Europe Japanese and a few U.S.A. shipyards such as: Norfolk Naval Shipyard, Bath Iron Works, Litton/Ingalls, to list a few, with excellent saving results.

The “Permanent Scaffolding” aallows all trades to concentrate their efforts in other aspects of the shipbuilding. This approach should be given a careful analysis when cutting costs is demanded to be competitive in the shipbuilding market. (See picture #15 in picture section at end of report.)

SUSPENDED AND MECHANICAL AERIAL PLATFORMS

The use of skyclimber powered scaffolding systems is one of the innovative ways the shipbuilding industry has become more efficient. This approach, mainly for the flat outside hull, has the following advantages;

Reduces capital expenditure for scaffolding,

Eliminates cost of scaffold stripping and restaging,

Positions the worker where needed,

Reduces manhour costs.

This equipment could be suspended from powered rails to give horizontal mobility or hung from brackets to manually transfer the baskets from one point to the next.

The use of air powered baskets in most flat outside hull areas have provided the industry with very significant savings. We all know mat conventionl scaffolding is: labor intensive, large inventories are also required and the overall cost is very high.

Air powered scaffolding systems, such as baskets, used on exterior hulls, have rendered savings up to 90% of labor costs, as shown by Fairfields of Glasgow and 50% scaffolding material savings as show by J.L. Thompson of sunderland. Suspended scaffold platforms in a large variety of shapes or sizes are utilized, where short periods of time, repeated intervals or vertical activities are involved.

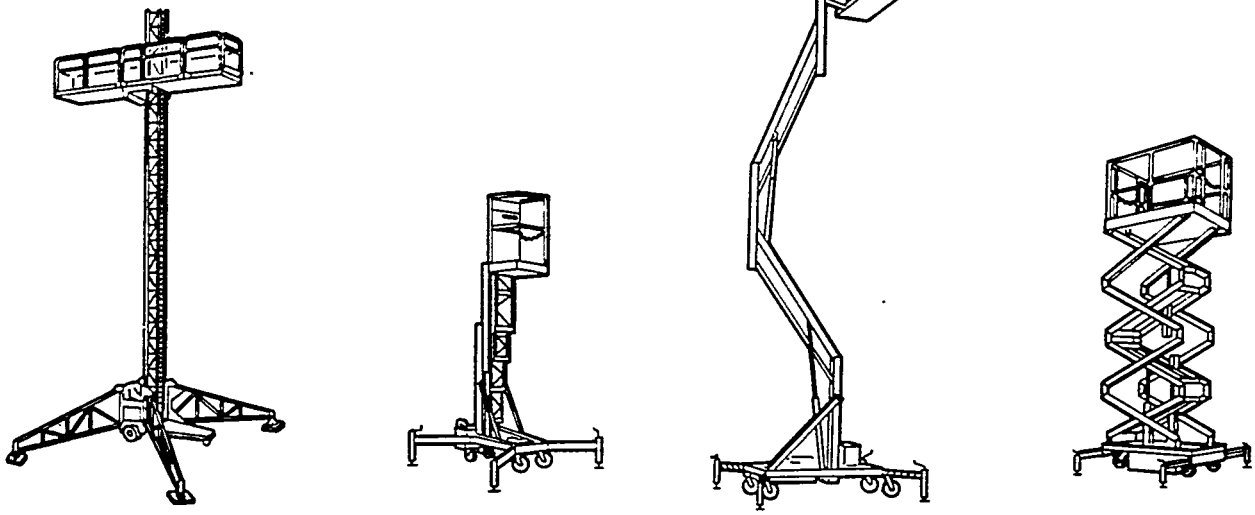
A labor cost comparison done in one tank of a product Tanker built in NASSCO, provided the following figures. When the skyclimber approach utilized and compared against the scaffolding's costs of a similar tank it took 44 hours to build, maintain, install and remove two 40 foot baskets from a "ship side tank and 226 hours to weld scaffold clips, erect and dismantle scaffolding components on a similar "ship side tank." If we use a $20.00 per hour rate, we are considering $3,640 cost difference just in this specific instance as a sample.

Another aggressive approach in the services provided by scaffolding, is the introduction of a variety of mechanical means such as: Rotating Aerial Services, Boom Supported Work Platforms, Self-Propelled Work Platforms and Scissorlifts. The use of this equipment to reach up and over obstacles has been a successful event in the shipbuilding industry. The equipment has proven reliable, yet at a low cost when usage and down time are well coordinated and controlled. Utilization of this type of equipment is optimized when production personnel (users) and the department providing the service coordinate this effort.

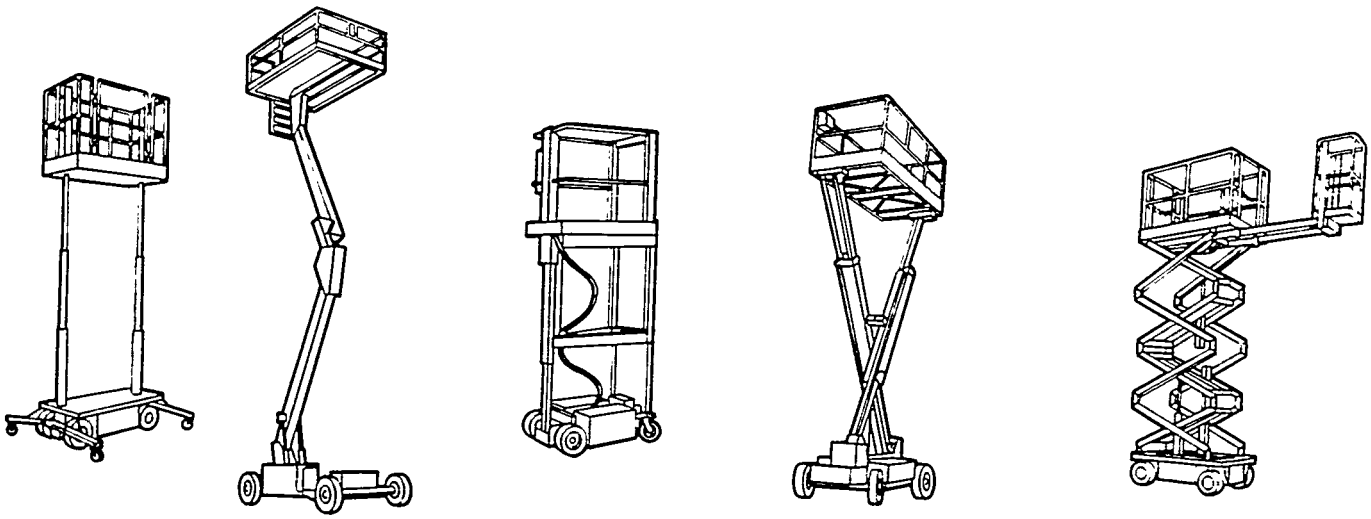
The equipment needs to be tailored to specific operations and conditions, preparation is very insignificant but the end results of this self-propelled equipment is very significant. A good example is in our current paint operations in NASSCO, where under ideal conditions, the entire AOE hull exterior was painted (several application) in one week by use of 80 foot boomlifts. The variety in sizes, types, shapes of equipment will fit in most cases of job requirements, and also will propel itself in different types of terrain.

Types of aerial platforms

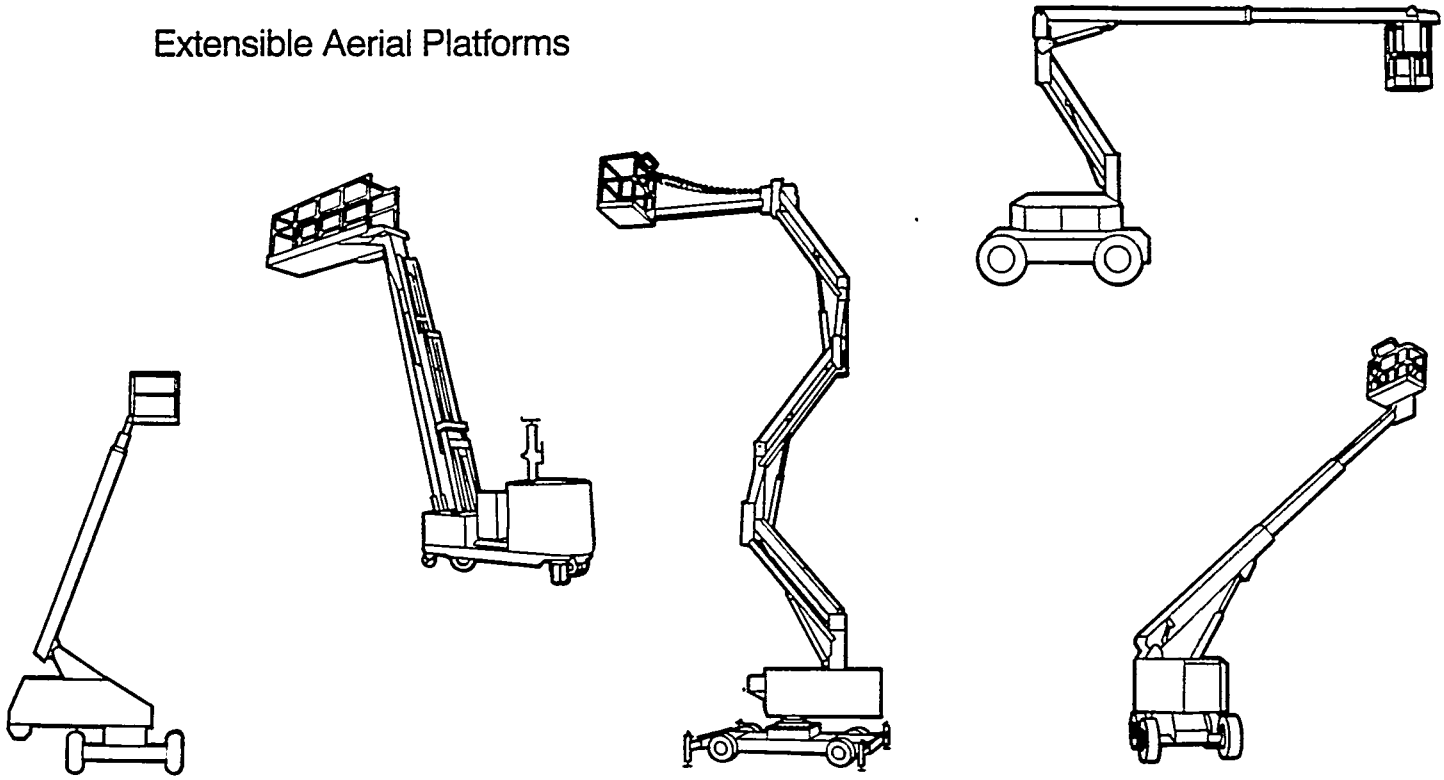
Manual Vertical Aerial Platforms



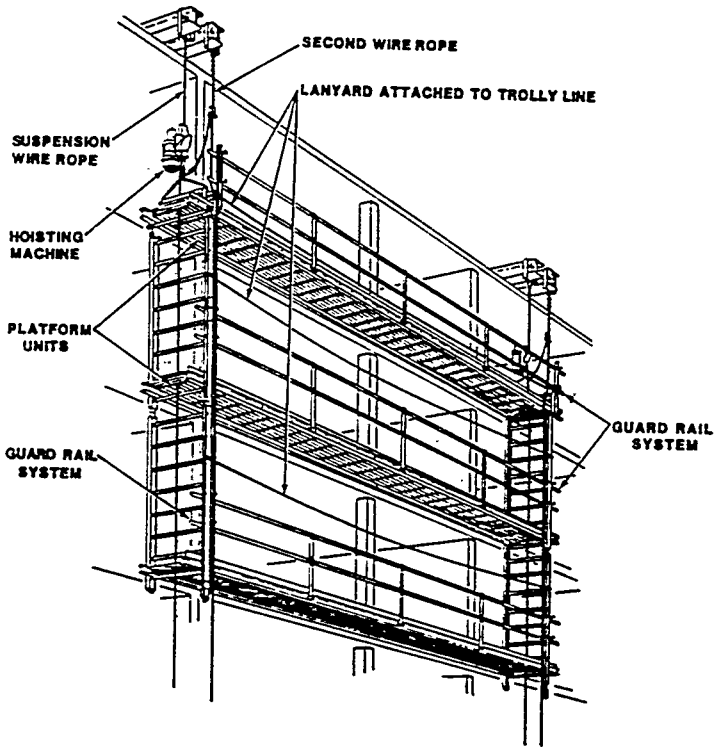
Powered Vertical Aerial Platforms



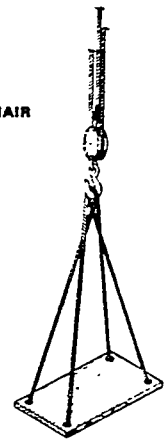
Extensible Aerial Platforms



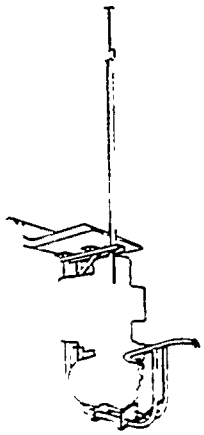
MULTI-LEVEL SUSPENDED SCAFFOLD WITH POWERED HOISTS



BOATSWAIN'S CHAIR

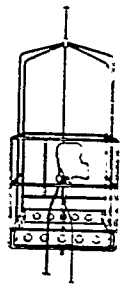


BOATSWAIN CHAIR (MANUAL)

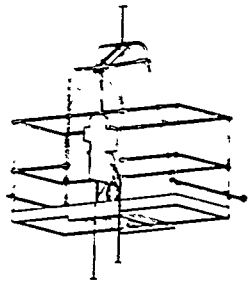


BOATSWAIN CHAIR (POWERED)

WORK CAGES



POWER TRACTION HOIST WORK CAGE



POWER TRACTION HOIST WORK CAGE WITH EXTENSIONS

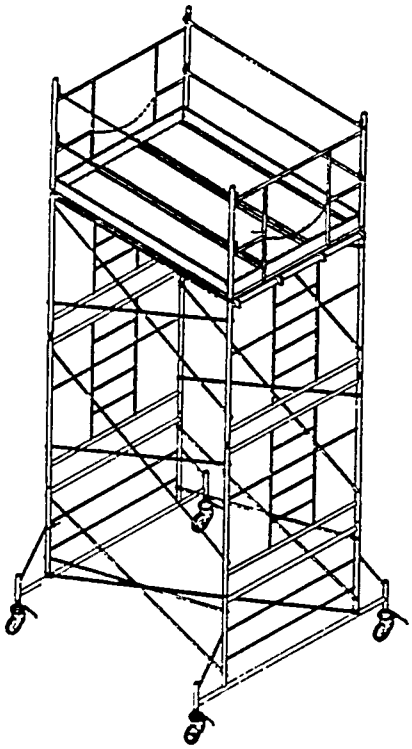
SINGLE POINT SUSPENSION SCAFFOLD WINDING DRUM HOIST

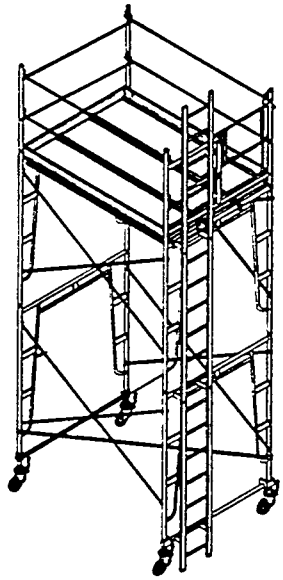
PRE-ERECTED "MODULAR" PACKAGES

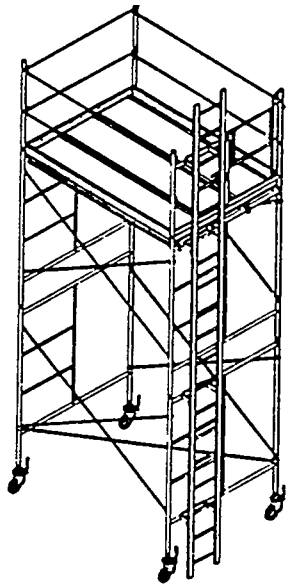
In this procedure, the concept is the prefabrication of scaffolding sections of similar dimensions, let’s say three “A” frames high and two sets in length. The number of sections required are built near the construction area and then moved to the required location. Sections are then interconnected; thus reducing the time to build. Removal is done in a similar approach. Sections are used over again as many times these sections are needed. This concept eliminates the single staging concept every time scaffolding is needed and reduces scaffolding erection costs because those sections remain in place, as long as they are needed.

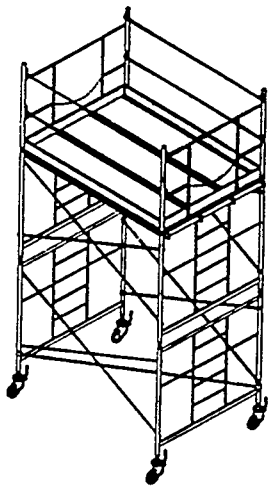
PRE-FABRICATED MOBILE TOWERS

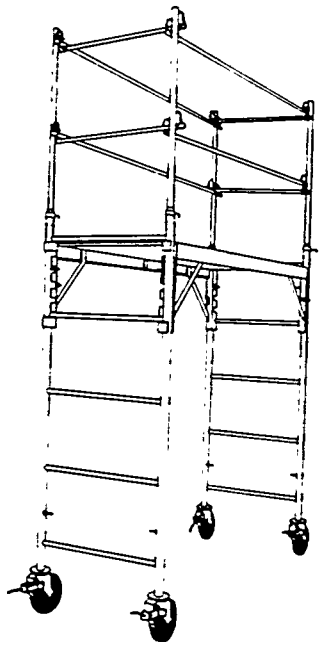
Medium size pre-fabricated mobile (rolling) towers have also proven to be cost effective in many instances where time constraints are a factor and heights are not excessive. This type of equipment can be moved as needed. Areas most benefitted from this approach are "On-block" ground operations. A combination of small scissor lifts and these rolling towers have Proven to be a successful way of reducing labor costs. Trades move these scaffolding aids themselves to outfit their systems when and where needed.

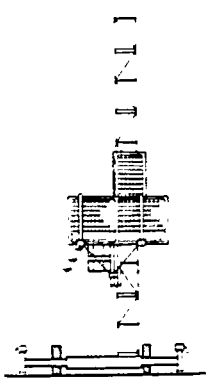


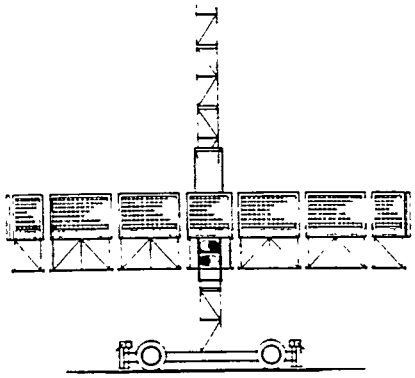










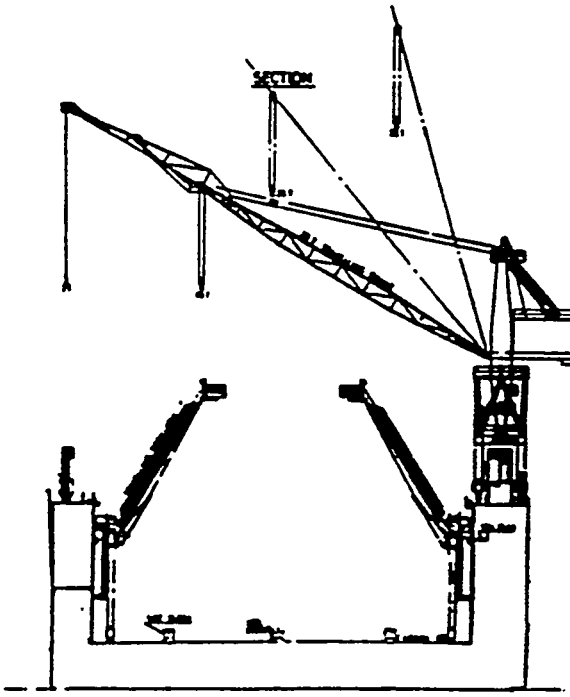


STRUCTURAL TOWERS

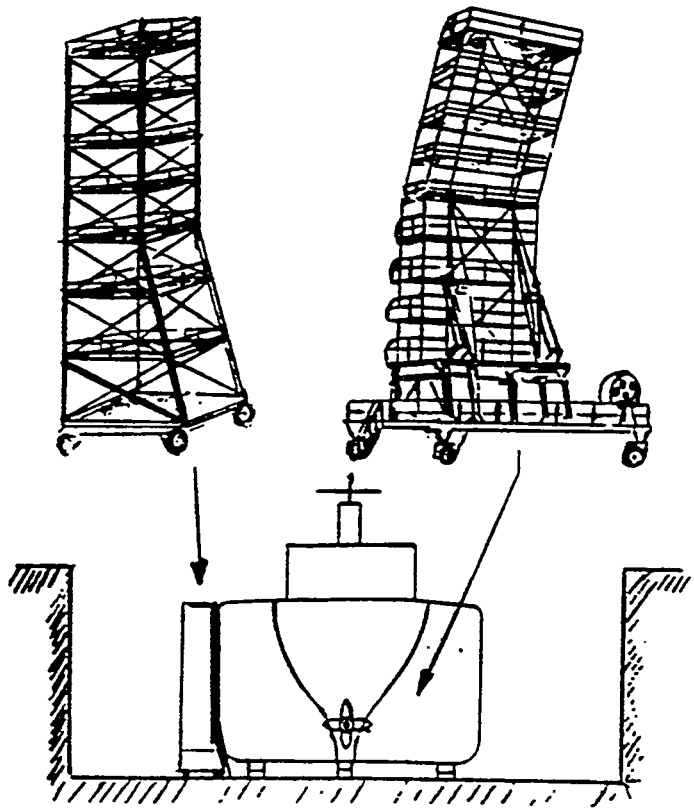
In today's shipbuilding methodology, extensive scaffolding around ships is being replaced by structural towers. This method has eliminated the large amount of scaffolding components that otherwise would be needed for side shell seams as well as bow areas.

The towers are designed to be lifted in some instances, but the trend is to provide motorized towers that will move in and out forward or aft as needed. Usage of this type of equipment implies in most cases, flat surfaces and areas large enough to effectively use this approach.

In cases where space is limited, some modification to docks could be accomplished by adding rolling cranes, traveling dock arms or vertical rigging hoists to the existing structures as shown in the picture below.



DOCK WITH TRAVELLING CRANE & DOCK ARMS USED IN NASSCO



MECHANIZED ROLLING TOWERS USED AT IHI OF JAPAN

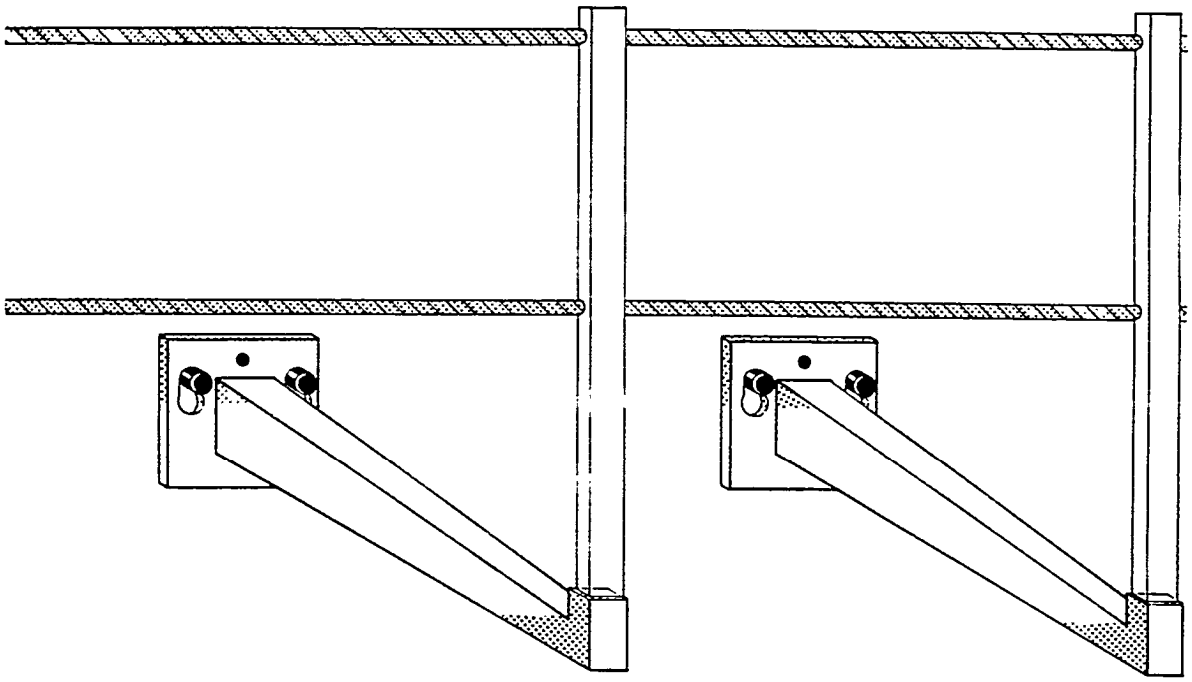
THE BUTTON-LOK STAGE BRACKET SYSTEM

One of the most recent innovations in the scaffolding business, was the introduction of the called “Button-Lok” System.

In this system platforms are supported by brackets mounted on headed anchors and secured with locking bolts.

The headed anchors are studs made of special alloys that will stand up to 10,000 lbs of load. The installation is done with a Stud Welding Machine Gun Once the studs are installed and tested, staging brackets with slotted holes in the base plate are fitted in place. The bracket is then locked in place by tightening the base plate against the locking bolt welded to the ship. For removal simply reverse the above steps and list off the brackets. It has been estimated by the “Button-tik” stage system supplier that about 5 minutes is all the time required to complete one cycle or bracket.

An estimated comparison using a 50/50 utilization of this new system and the standard scaffolding was conducted in National Steel and Shipbuilding Company. A Product Tanker with an overall length of 620 feet and a molded depth of about 55 feet was used in our comparison with the following results:



IT'S AS SIMPLE AS IT LOOKS . . .

The platforms are supported by "Button-Lok Stage Brackets" mounted on Headed Anchors as described below.

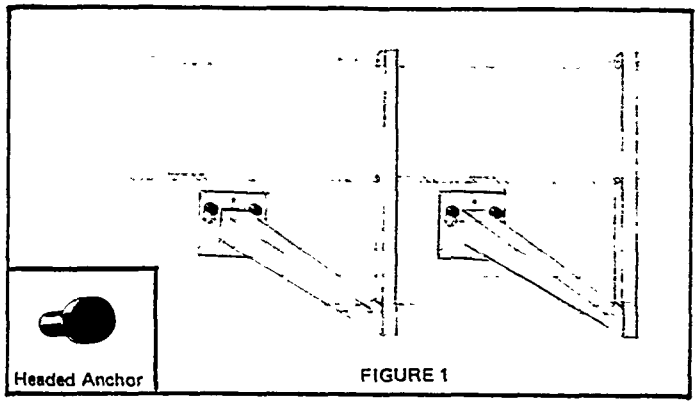


FIGURE 1

Once the desired location of the platform is identified, the Anchors are accurately positioned with a magnetized template, and welded instantly in place with standard stud welding equipment. (Figure 1)

With a Tension Tester, the Anchors are proof-tested on the spot, to twice working load.

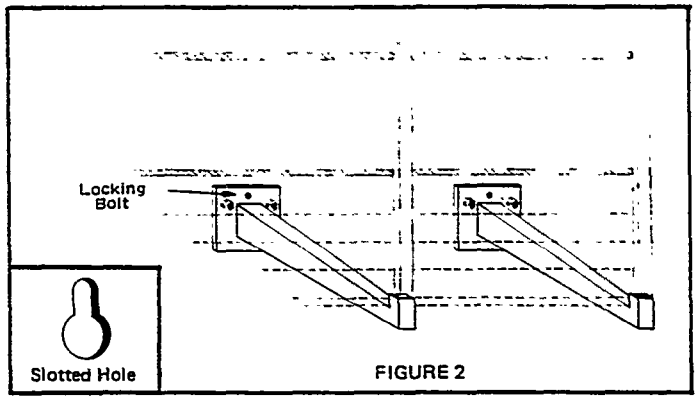


FIGURE 2

The Stage Brackets are hung on the Headed Anchors and secured with locking bolts. (Figure 2)

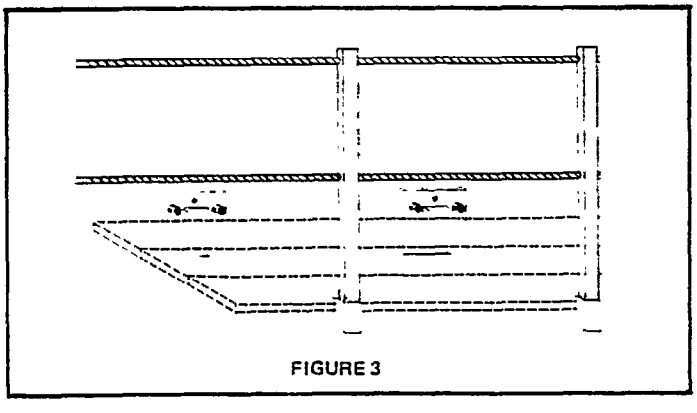
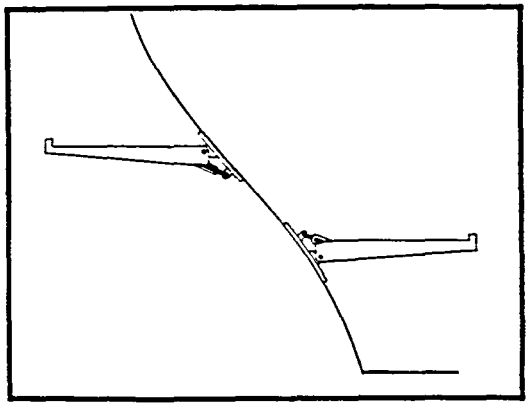


FIGURE 3

Now, install the stage boards, stanchions, and hand rails. (Figure 3)



Two types of Adjustable Brackets are also available. They are infinitely adjustable through 40° up or down to accommodate all normal staging installations.

Removing the platform is as fan and simple as putting it UP. Remove the stage boards and stanchions - lift off the Stage Brackets - and burn or cut off the Anchors where required.

COMPARISON OR BUTTON-LOK AND STANDARD SCAFFOLDING SYSTEMS

STAGE OF CONSTRUCT.	SCAFFOLD USED	SHIP SECTION, HRS SCAFFOLD SUPPORT REQD PER SHIP SECTION, % OF SCAFF. UTILIZED & % EFFORT REQD				
		BOW EXTERIOR	MIDSHIPS EXTERIOR Inc Hing Ts	AFT EXTERIOR	INTERNAL HULL <Cargo, F.O. Ts	TOTAL HOURS
o - PRODUCTION PLANNING	NONE	N/A	N/A	N/A	N/A	- o -
1- FABRICATION	STANDARD	100% X 127 =127	100%X 445=445	100% X 191=191	100% X 1355=1355	2118
2 - SUBASSEMBLY	NONE	N/A	N/A	N/A	N/A	- o -
3 - ASSEMBLY	50% STANDARD * 50% BUTTON-LOK	50% X 537=269 50%X537X17%=46	50% X 1880=940 [illegible]	50% X 805=403 50%X805X17%=68	50% X 5728=2864 50%X5728Xli?3=487	5237
4 - ON-UNIT	NONE	N/A	N/A	N/A	N/A	- o -
5- ON-BLOCK	50% STANDARD *50% BUTTON-LoK	50% X 276=138 50%X276X17%=23	50% X 964=482 50%X964X17%=82	50% X 413=207 50%X413X17%=35	50% X 2939=1470 50%X2939X17%=250	2687
6 - ON-BOARD	STANDARD *BUTTON-LOK RIGID TOWERS	50% X 907=454 50%X907X17%=77 N/A	- o - - o - 100%X2995X42%=1257	50% X 1342=671 50% X342X17%=114 N/A	5% X 9363 = 468 95%X9363X17%=1512 N/A	4553
					GRAND TOTAL HRS USING SYSTEMS RECOMMENDED	14595

The savings that would be realized by using the percentages indicated above would be approximately 14,595 hours per product tanker

*** NOTE: The percentage (%) of scaffolding hours required for the Button-Lok system compared to the "Standard Scaffolding" is about 17%. For every 100 hours used on regular scaffolding we used only 17 hours when this system was utilized.**

50/50 SUPER STRUCTURE

The following data shows the addition Support necessary to support the Tanker's Super Structure.

SOC	SCAFFOLD USED	HRS RQD,% UTIL, & % EFFORT		TOTAL*
0	NONE			
1	50% Standard	50% x 21=		11
	50% Button-Lok	50% x 21 x 17%=		2
2	NONE			
3	50% Standard	50% x 90=		45
	50% Button-Lok	50% x 90 x 17%=		8
4	NONE			
5	50% Standard	50% x 45=		23
	50% Button-Lok	50% x 45 x 17%=		4
6	(Port/Stb & Aft House)			
	50% Standard	50% x 145=		73
	50% Button-Lok	50% x 145 x 17%=		12
	(House Fwd)			
	100% Skyclimbers	100% X 197 X 42%		83
			Total Hrs	261

* If conventional scaffolding had been used, the following Hours would have been utilized, taken from the data on Page 25:

SOC	HOURS
0	NONE
1	21
2	NONE
3	90
4	NONE
5	45
6	342
Total	498

Material costs to support the House Scaffolding follows:

SECTION	SQ FT	SCAFFOLD (SOC 0- 6)	SHIP 1	SHIP 2	SHIP 3	SHIP 4
HOUSE	1505	50% STD @ $9.54	(Already Aboard)			
		50% B.LK @ $7.77	$6016	$169	$169	$169
		(SOC 6)				
	985	Skyclimbers	Already Aboard			$6523. Total

NASSCO'S SYSTEMS EVALUATION

The scaffolding Department in National Steel and shipbuilding Company has utilized most of the systems presented with the exception of the "Permanent Scaffold Structures" and the "Structural Towers." NASSCO has experimented with Swiftstage and Button-Lok. Therefore, the suggested scaffolding hours or percentage of effort listed below are indicative of NASSCO's operational conditions. These percentages, never-the-less, could be used by the reader as a reference and draw their own conclusions based on their needs, design facilities, configuration and ship requirements. (Efficiency, rework and training are not included in the figures given below.)

A) A-FRAME (Stage, Build Maintain Remove & Storage)
Approx 3 Hrs/Sq Ft

B) TUBE & C CLAMP (Stage, Build, Maintain Remove & Storage)
Approx 3 Hrs/Sq Ft

C) MODULAR SYSTEM (Stage, Build, Maintain Remove & Storage)
Approx 2 Hrs/Sq .Ft

D) SWIFTSTAGE (Stage, Build, Maintain Remove & Storage)
Approx 30 Min/Sq Ft

E) PERMANENT SCAFFOLD (lst Ship)
Approx 3 Hrs/Sq Ft

F) SUSPENDED BASKET (Maintenance, Installation & Removal)
Approx 22 Hrs/40' Basket

G) PRE-ERECTED "MODULAR" PACKAGES (lst Ship)
Stage & Build Scaffolding Modules. 3 A-Frames high and
2 sets lengthwise. (Stage and Install)
Approx 14 Hrs/Module

H) MOBIL (Rolling) TOWERS (WxLxH) 3'x1O'X25'
Approx 2 Hrs/Tower

I) STRUCTURAL TOWERS (1st Ship)
Approx 30 Min/Sq Ft

J) BUTTON-LOK SYSTEM
Approx 30 Min/Sq Ft

SCAFFOLDING ACTIVITIES AT NASSCO

One of the goals initiated at NASSCO is to make scaffolding an efficient task. Several steps have been instituted and are currently in use.

Scaffolding is the only system of its magnitude in shipbuilding that is designed by production. Staff engineers and scaffolding supervisors initiate the design activity with a realistic perspective of the other trades requirements and constraints, facility availabilities, equipment and material inventories.

The "Macro to Micro" approach, where the overall requirements are analyzed down to the block level, has been utilized extensively at NASSCO on the AOE program. This advance knowledge of block breakdown and configuration location of pipe runs, cableways, ventilation and ducting provides the scaffolding group with an early start. This makes their planning effort more effective. This approach allows the scaffolding group to be pro-active rather than reactive and, in most cases, will help in forecasting scaffolding material usage and duration.

Another key element of this effort is proper scheduling and adherence to those schedules. This is necessary to maintain proper manning and better utilization of scaffolding materials and equipment.

Scaffolding material forecasting is another successful ingredient in this effort. Planning and scheduling has been a contributing factor in reducing high scaffolding inventories and unnecessary expense. Better scaffolding material tracking and handling has also been achieved with the use of a color coded system for lengths and types of material.

Very important in our effort to reduce cost has been the change in methodology and design. About 80% of all scaffolding is done prior to block erection. Small permanent clips are welded around seams, brackets are bolted and scaffolding material is attached before moving the block. This method has reduced our costs considerably, because less crane service is required and our scaffolding personnel can perform their tasks a few feet off the ground instead of the higher, more costly and risky conditions used in the past. This combination of efforts has provided us with a 22% cost reduction in scaffolding erection costs.

Engineering has created the best design to have the fewest number of scaffold structural breakdowns and to locate the horizontal seams at the lowest possible point to eliminate scaffolding on the side shells. They have also replanned and designed 'off-the-ship' machinery spaces, thus, redutig a significant amount of scaffolding that would otherwise be required on-board.

Finally, the recent acquisition of the Modular System has proven to be a step forward in our cost reduction efforts. New ideas, methods and equipment must be constantly tested and evaluated to minimize costs and to keep the shipbuilding industry productive in today's competitive marketplace.

SUMMARY

In today's shipbuilding market, cost reduction are essential to remain competitive and in business. One of the key issues in the scaffolding savings rationale, is to stay away from a multiple components system These system are very labor intemive and high labor costs are the end result.

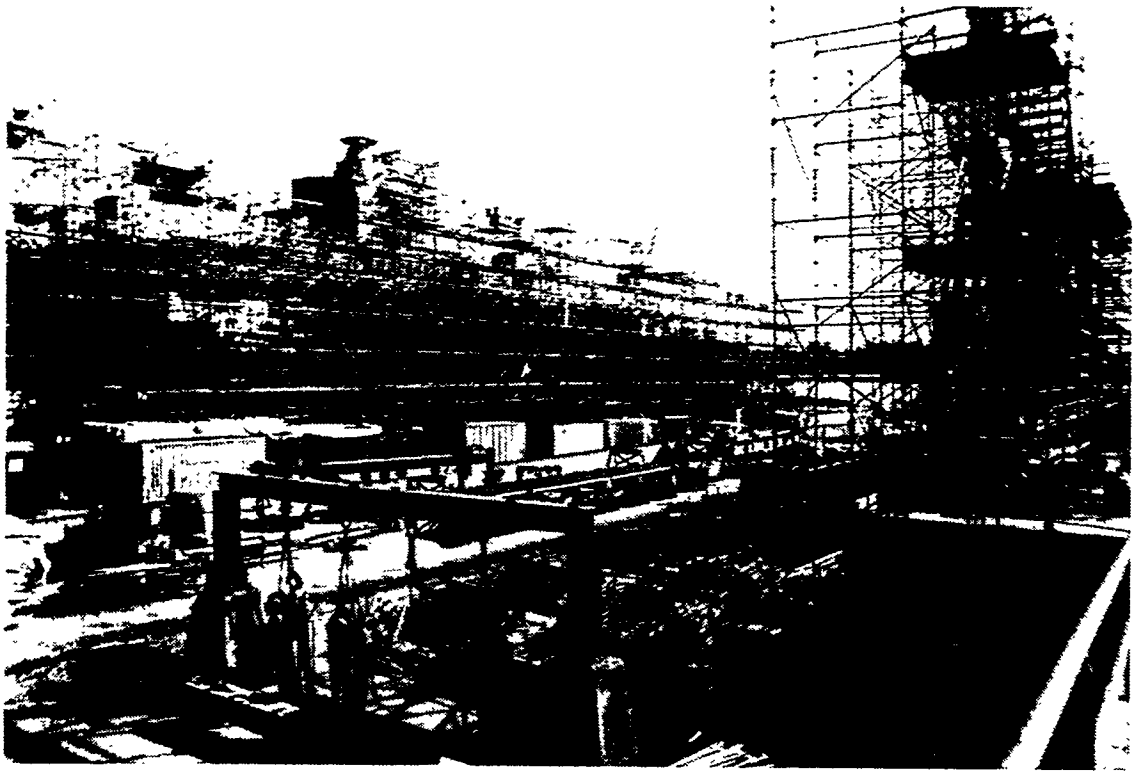
There is not a magic formula that will phase out or will eliminate scaffolding expenses. In addition there is not a single system that will meet and resolve all scaffolding requirements and conditions. A conscious study on those requirements, environmental, facilities and working conditions, will dictate in most instances, the best or most efficient way of providing scaffolding services. An early active participation in the design and planning, and then the incorporation of plans, suggestion, ideas, will prove to be a sound method to look for cost savings.

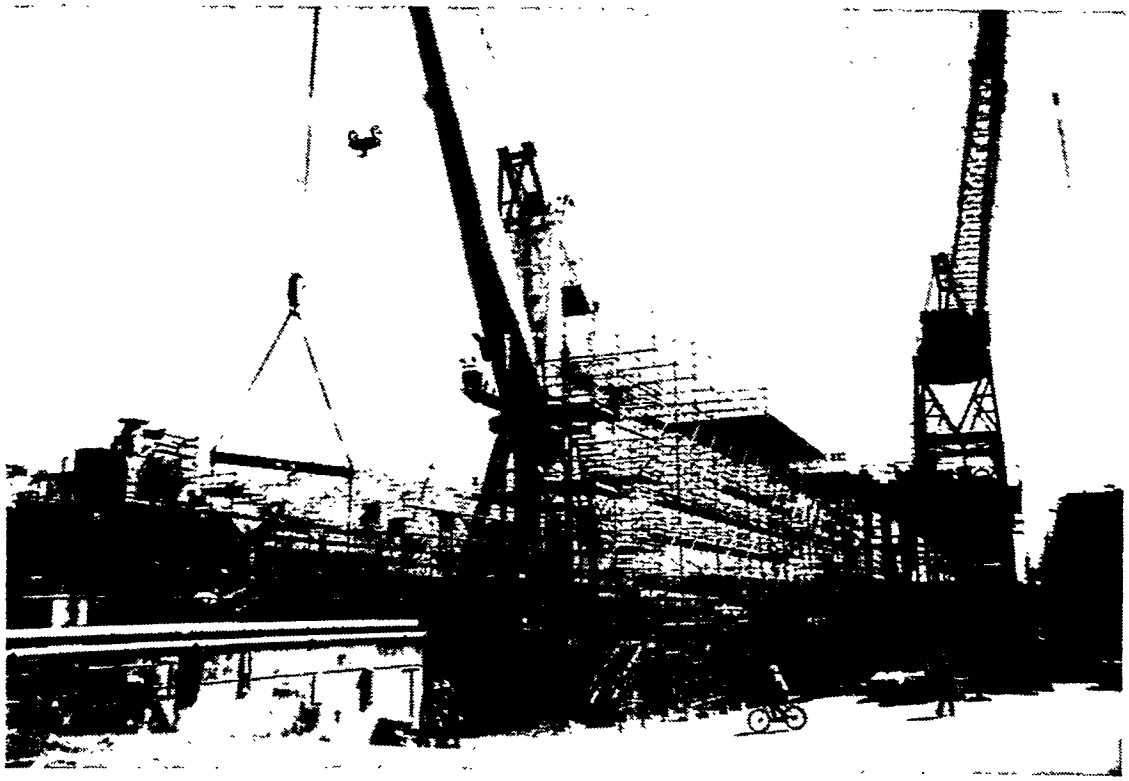
Comments from consultants shipbuilders and scaffolding suppliers that have discussed this matter all suggest the use of a combination of modular, mechanical and in some cases even tubular systems, will be the best scaffolding approach.

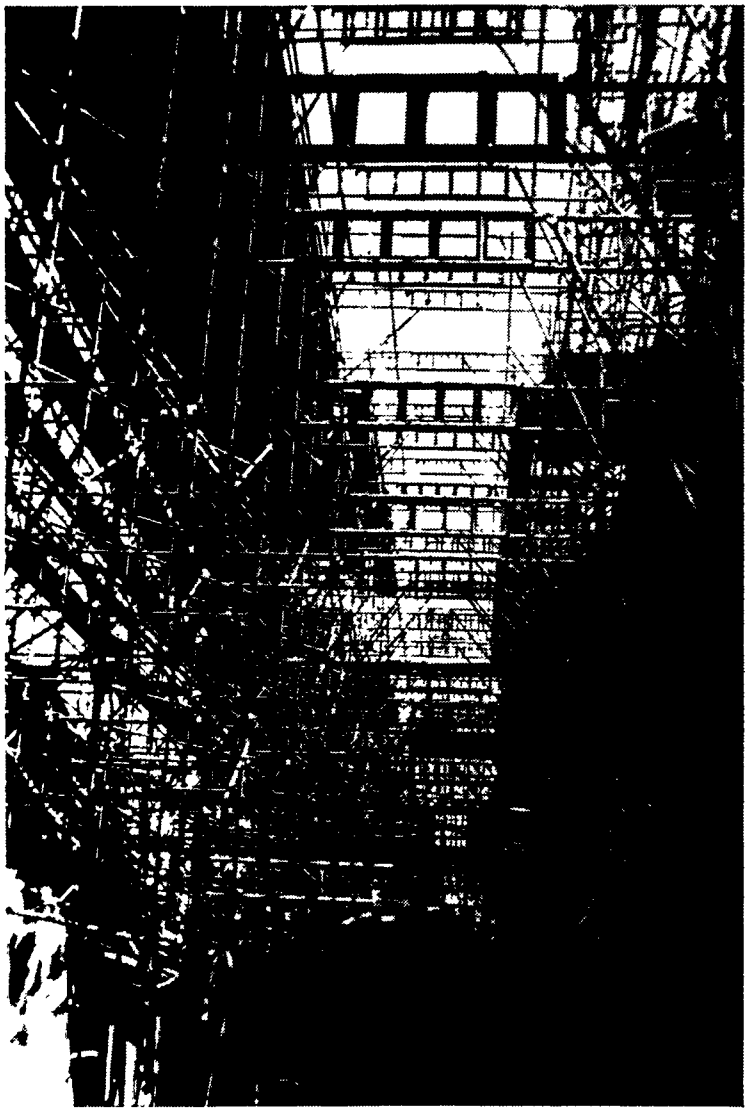
The modular system such as the "Quick Release system" has not only reduced the amount of components, but also has reduced the erection time due to its unique locking devices. A relative newcomer on the scaffolding scene is the Button-Lok System which shows great promise as a way of reducing costs.

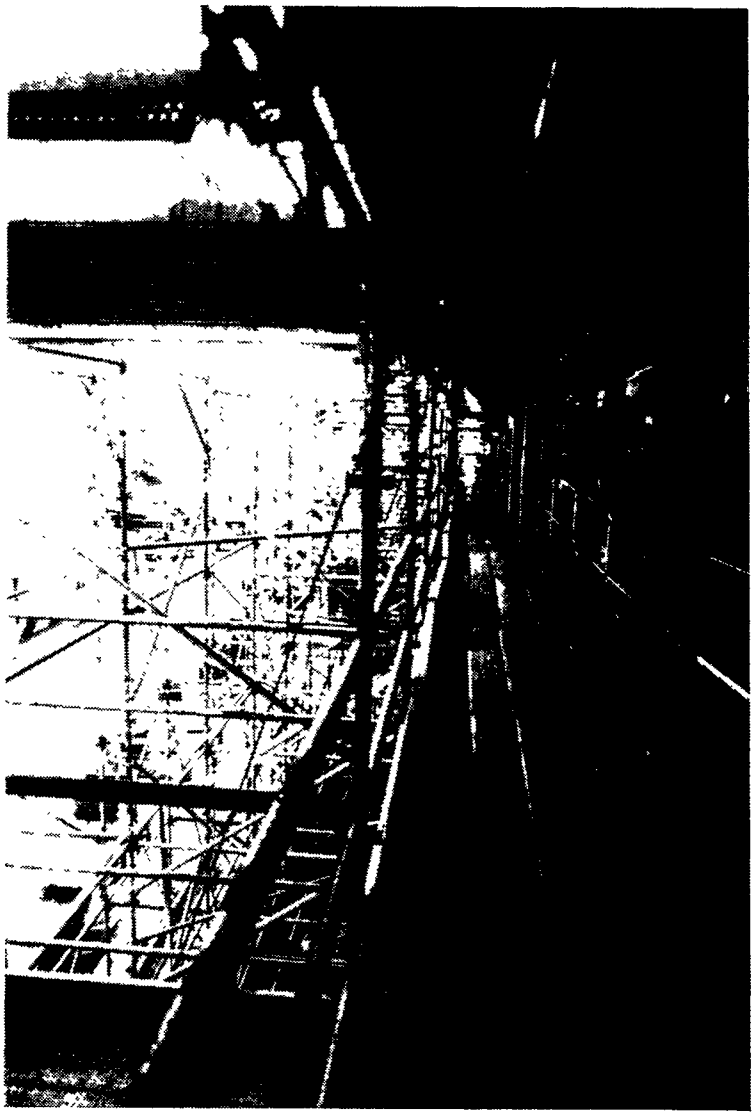
There are also some shipyards that are using fixed structural scaffolding systems. Nevertheless; the success in the reduction of labor cost remains the minds and hands of the people designing, fabricating and building scaffoldting to meet each unique or standard scaffolding condition.

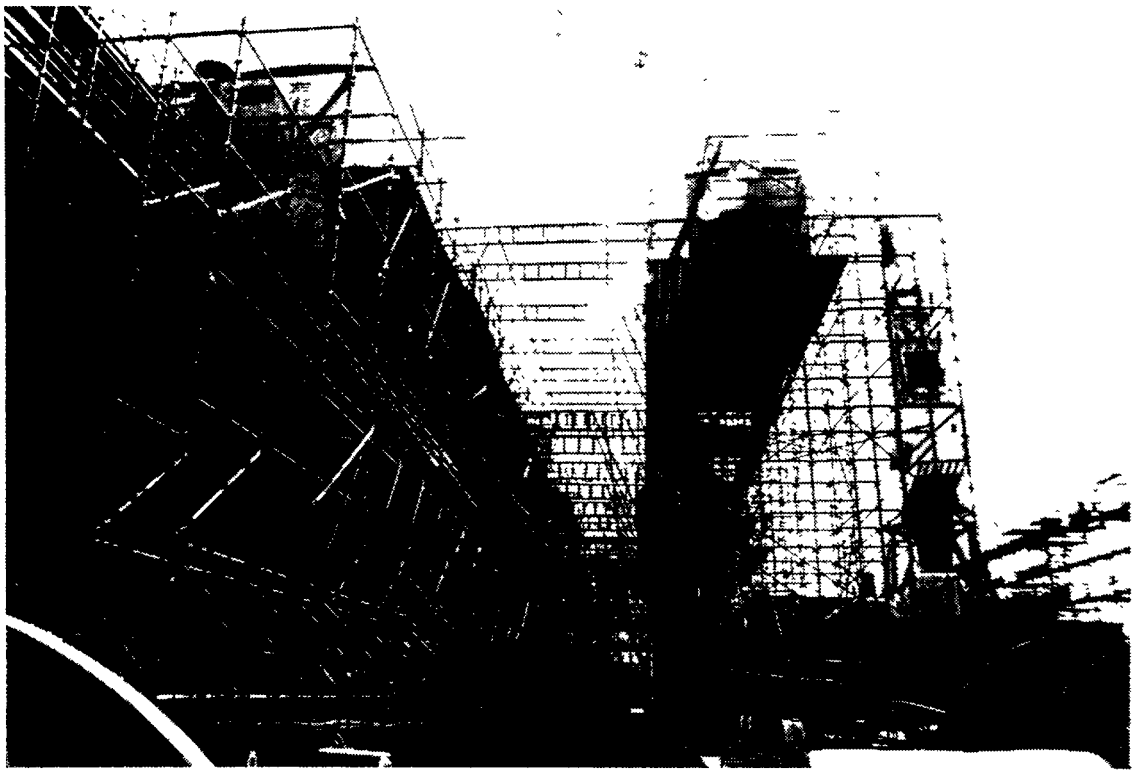
PICTURE SECTION











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l *Usefulness to You/four Organization*

q Very Useful q Moderately Useful ☐ N/A

• *Did/Will your organization implement the results of this project?* ☐ Yes ☐ No

If not, why? _____

l *How Did You Receive Report?*

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q Referred to you by someone else

Ž *Did/Will You Pass Report On To Someone Else?*

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