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U.S.ARMY AND MARINE CORPS DEVELOPMENT PROGRAMS FOR ASSAULT AND TACTICAL BRIDGES

by

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U.S. ARMY AND MARINE CORPS DEVELOPMENT PROGRAMS FOR ASSAULT AND TACTICAL BRIDGES

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Military bridging is employed to defeat natural and enemy emplaced obstacles. The battlefields of today and those of the future are characterized by sophisticated sensor mechanisms for acquiring targets and by highly lethal and accurate munitions that can effectively produce one-shot kills of personnel and weapons. To survive in this environment, U.S. military forces must be able to move rapidly to engage enemy forces, to gain postional advantage, and to avoid detection.

Bridging that is mobile and can be rapidly emplaced allows the momentum of the battle to be sustained rather than bogging down or being forced to change direction when confronted with natural or enemy created gaps such as rivers, ravines, tank ditches, and so forth.

Military bridging for vehicle crossing is categorized by the conditions under which it is emplaced and the purpose for which it is intended.

Assault bridging involves the transport and emplacement of bridge structures in the face of an active defense of the obstacle by the enemy. These bridges are capable of moving with units coming under direct enemy fire, and of being emplaced rapidly while being fired upon. Because of the size and weight of these bridges, they are generally carried on heavy tank chassis or large trucks that offer a degree of protection from small arms and shell fragments. Janes book on military support weapons lists some 25 variations of this type bridging world-wide in lengths varying from 10 meters to 26 meters and capable of carrying loads up to 60 metric tons.

The current version of assault bridge in use by the U.S. Army and the U.S. Marine Corps is the "Armored Vehicle Launched Bridge" or AVLB as it is called. This bridge has been in service since the early 1960's. The bridge is mounted on a specially configured main battle tank of the M48 or M60 series. It is 63 feet in length, can cross 60 ton loads, and weighs 31,000 pounds. It is hydraulically operated with a single hinge point to enable it to fold back on top of the tank chassis for transport. Two of the bridge programs I will discuss today are designed to replace the existing AVLB.

The second category of military bridging is called tactical bridging. This type of bridge functions to provide temporary bridging in support of tactical operations. It differs from assault bridging primarily because it is not emplaced in the face of direct enemy fire or in an area that is under enemy observed artillery fire. It is characterized by having a capability to cross longer gaps; it may use intermediate supports under the bridge; and it may require some significant site preparation and require support equipment such as boats and cranes.

The U.S. Army currently has one tactical bridge for crossing dry gaps. This is the Medium Girder Bridge, a panel bridge with tension reinforcement that can span 160 feet and carry 60 ton loads. This bridge replaced the famous Bailey Bridge that was widely used in World War II. The Medium Girder Bridge was developed by the United Kingdom and adopted by the U.S. in the early 1970's. There is an ongoing Army program to develop a replacement bridge that can carry 70 ton loads and be emplaced more rapidly.

The U.S. Army's principal tactical bridging for crossing wet gaps is the Ribbon Bridge. This is a floating bridge that can be built to any length by connecting a sufficient number of sections. Alternately 3 and 5 section rafts can be assembled and powered across rivers using a bridge erection boat. This bridge was copied by the U.S. from a Russian design, and was put into service in the mid 1970's. The time to emplace the ribbon bridge is highly dependent on site chosen, but crossing 100' gaps in 30 to 45 minutes is possible. The third bridge program I will discuss today relates to the improvement of the existing ribbon bridge.

The last category of military bridging is called Line of Communication bridging. This type of bridging provides major permanent bridging for both road and railroad use in the theater of operations. These bridges are constructed using a variety of sets of prefabricated semi-standard construction components tailored for rapid erection by semiskilled labor. I will not discuss this catagory of bridging as there are no on-going Army or Marine Corps development programs in this catagory.

There are three bridge development programs that BMY is currently working on, two for the Army and one for the Marine Corps. All of these programs are oriented to correct deficiences in the current systems. The principal new requirement for the bridges under development is in increase their load carrying capacity from the present 60 ton to 70 ton to handle the heavier vehicles now in use. This applies to both the assault and tactical bridging. A second requirement is to increase the lengths of the assault bridges to allow passage of a higher percentage of the gaps expected to be encountered. A third consideration in the design of these assault bridges is that of mobility. For this they must be transported on vehicles that can keep pace with the newest battle tanks and personnel carriers. The other changes to be incorporated into the three bridge systems we are developing I will discuss as I go through each program.

HEAVY ASSAULT BRIDGE

The Heavy Assault Bridge (HAB) is under development at BMY for the U.S. Army. It will be the standard Army assault bridge and will replace the existing Armored Vehicle Launched Bridge (AVLB). Work began on the HAB bridge system in 1983. BMY is to produce three prototype systems. Two of these will mount and launch the bridge from an M1 Main Battle Tank chassis. One will be similarly mounted on an M60 tank chassis. The bridge represents a major improvement over the present AVLB. The bridge is longer (32 m vs 19 m), can carry heavier loads (70 T vs 60 T), and is lighter in weight (22,400 lb vs 31,000 lb). The launcher can pick up and launch the bridge from either end, and the launcher can also be used to carry, launch, and retrieve both the existing AVLB and the Trailer Launched Bridge I will discuss next. The overall dimensions and weights of the HAB system are such that they do not degrade the mobility of the M1 chassis or detract from its performance in terms of speed, ability to climb over obstacles or to cross ditches. Also, because the system's weight and center of gravity are within the same limits as the basic M1 tank with its turret, there are no modifications to the M1 chassis required.

The launcher is basically a hydraulically operated mechanism that first tilts forward placing a foot on the ground. This foot acts as the fulcrum of the launching system. The tilt frame and the tongue of the launcher cause the bridge to rotate through a vertical position to a fully extended horizontal position over the gaps to be crossed.

The bridge is built in several sections. There are two treadways connected by transverse beams and lifting beams. The lifting beams are engaged by the launcher tongue through quick-disconnect hydraulic couplings that allow hydraulic pressure to be applied to the bridge's hydraulic system. The bridge is further anchored to the tongue by means of hydraulically activited locking pins. Each treadway consists of a center section, two ramp sections, and two bell cranks at the hinge points.

The hydraulic system is powered by the tank engine which drives a variable displacement, torque-limited pump operating at pressures up to 4,000 psi. Movement of the launcher and bridge are controlled from a control box that provides electric signals to activate the system's directional control valves. As a back-up there is a manual override system. In addition to the directional control valves there are overcenter valves and motion control valves incorporated to smooth out the motions of system, to provide thermal protection, to lock loads in desired positions, and to prevent loads from running ahead of the pump. Finally, relief valves are incorporated to provide individual circuit protection.

Filters are provided to minimize the possibility of system contamination. These are located at the pump inlet and outlet and on the return line. The return line filter is necessary since the hydraulic lines from the launcher to the bridge are connected and disconnected routinely during launch and retrieval cycles.

There are 21 hydraulic cylinders in the TLB system. These perform three basic functions: bridge launching and retrieval, launcher tongue to bridge connecting and disconnecting, and bridge folding and unfolding.

The launcher has two launch cylinders for raising and lowering the tilt frame, two intermediate cylinders, and one tongue cylinder that rotate the bridge through a predetermined geometric path from stowed to launch postion and return.

In the tongue itself are two locking cylinders that firmly position the tongue and bridge together and two ejection cylinders that separate the tongue from the bridge after the launch sequence is completed.

The bridge assembly consists of two folding hinge points with three identical subassemblies. Each subassembly contains two cylinders for a total of twelve. The cylinders act through the bell cranks of the bridge. Extending the cylinders causes the bridge section to fold closed. Retracting the cylinders opens the bridge. To conserve weight, these twelve cylinders are uniquely constructed from aluminum.

The Government of the United States, United Kingdom, and the Federal Republic of Germany entered into an agreement in January 1986 governing the design of military bridging. This agreement is titled "Trilateral Code for Military Bridging and Gap Crossing Equipment". The code specifies design parameters, loading criteria, safety factors, and testing requirements. Since most of you are involved in commercial applications of movable bridges, I should point out several areas of this code that cause our military designs to differ significantly from your civilian applications. First, the code very specifically directs that the bridges will be designed to minimize weight. Secondly, the safety factors for these bridges vary from 1.33 to 1.53. Finally, the life of the bridge is very short, with 200 to 300 cycles of launching, crossing and retrieving being somewhat the mode.

To give you an idea of the status of the HAB program, here are some key milestones.

Contractor Test System 1	January 1988
Contractor Test System 2	February 1988
Contractor Test System 3	June 1988
Government Operational Tests	October 1988 - September 1989
Production Start	December 1990

TRAILER LAUNCHED BRIDGE

The U.S. Marine Corps has a requirement for assault bridging similar to that of the U.S. Army. However, their force structure and mission dictates that their bridge systems be somewhat unique. The Marine Corps does not possess tanks in the same large quantity as does the Army. They are reluctant to dedicate a tank chassis that can carry a gun to the task of carrying a bridge. They therefore selected a trailer that can be pushed or pulled by a tank or heavy truck as the perferred mode for transporting and launching their assault bridges. Also, because the Corps' mission is to rapidly deploy anywhere in the world, they want a bridge system that can be airlifted in C130 cargo aircraft rather than requiring the larger C5A used by the HAB.

Other than accommodating to these two design restrictions, the Trailer Launched Bridge is very similar to the Heavy Assault Bridge. The bridge is shorter by some 8 meters, and is lighter by some 8,600 pounds. It is a class 70 bridge capable of crossing the same loads as its larger counterpart.

The construction of the bridge in two treadways consisting of two ramps, a center section and two bell cranks is the same as the Heavy Assault Bridge. The hydraulic system is virtually a carbon copy of the HAB. The differences appear in the trailer, which is unique to the TLB, and in the mechanisms that allow the TLB to be squeezed into a C130.

The trailer is some 40 feet long. It incorporates its own power system for driving the hydraulic pumps. There are two two-cylinder diesel engines and two hydraulic pumps that operate in parallel. Normal operation is done using both engines and pumps, but can be accomplished with one. The trailer is principally aluminum. The frame is made in two sections that can be telescoped so that the length of the trailer can be matched to the particular bridge being handled (i.e. the TLB, HAB or AVLB). Like the HAB launcher the TLB incorporates a tilt frame that rotates the bridge to a near vertical position at the same time as it places a foot on the ground. A tongue cylinder, actually two cylinders, move the bridge past vertical and, after the bridge is unfolded, to the horizontal position over the gaps. Once the bridge is across the gap, there are ejection cylinders that decouple the tongue from the bridge's lifting beam and allow the launcher to be moved away.

The material used in the TLB is almost entirely aluminum. It was not necessary to use composites to get the weight down, nor did the Marine Corps wish to risk a design based on composites or incur the added costs of developing and procuring this material. There are some steel plates in the ramp ends to take the wear of vehicles impacting this area, and there are some steel components in the hinge areas.

In order to make the TLB narrow enough to fit into a C130 and yet be wide enough to accommodate all types of military traffic, two design features were incorporated. First, one treadway was made as narrow as possible. The width of the wide treadway was then determined by aligning the various vehicles tires or treads on the inside curb of the narrow treadway and measuring across the length of their axle to the other tire or tread. However, even this reduction in width is not entirely sufficient. To compress the bridge to 115 inches (the maximum allowed in a C130) it is necessary to move the two treadways together. This is done by removing pins and bolts from one side of the transverse beams and lifting beams and physically jacking the treadways together until they touch. To further accommodate to the C130 cargo compartment, the wheels of the trailer are removed, and the towing tongue is folded back.

The TLB program is about one year ahead of the HAB program as the following schedule of milestones indicates:

Complete System 1	September 1987
Complete System 2	November 1987
Government Test, System 1	September 1987 - February 1988
Government Operational Test of Systems 1 and 2	March - June 1988
Production	July 1989

IMPROVED RIBBON BRIDGE

The Ribbon Bridge is the principal tactical bridge used by the U.S. Army to cross wet gaps (e.g. rivers and streams). Developed by the U.S. in the late 1960's, the Ribbon Bridge was reverse engineered from a Russian design. In our Army it replaced the M4T6 floating bridge which was a very labor intensive and time consuming bridge to install, involving as it did two and four men teams carrying individual pieces that had to be pinned together to create bridge sections. The Ribbon Bridge comes in folded sections that are literally dumped into the water, unfold by themselves and can be joined section to section to create bridges or rafts.

The development of an Improved Ribbon Bridge by BMY is designed primarily to provide increased flotation in the event the shell of the bridge is penetrated, to increase the bridge's load carrying capacity to 70 tons in 10 foot per second currents, to provide longer ramp to access higher banks, and to mount the system on a new carrier.

The principal bridge components are the interior bay consisting of roadway and bow sections, the ramp bay, and the transporter. The bays fold in four sections to sit on the truck in a "W" shape. They are launched and retrieved using an hydraulically operated tilting boom mechanism that is integral to the truck.

In order to gain the increased performance of the bridge in fast water, BMY engineers investigated some 18 variations for a new bow. These variations looked at the bow angle, the shape of the bottom, and the length of the bow. None of these elements can be considered independently, however, since the folded bridge on the transporter must fit through an envelop whose size is determined by european tunnels. It was determined very early that a dam or wall on the tip would be required on all models. Using the facilities of Stevens Institute in New Jersey, these models were tested in a water tank. The shape selected exceeded the criteria of carrying 70 tons in 10 foot per second currents.

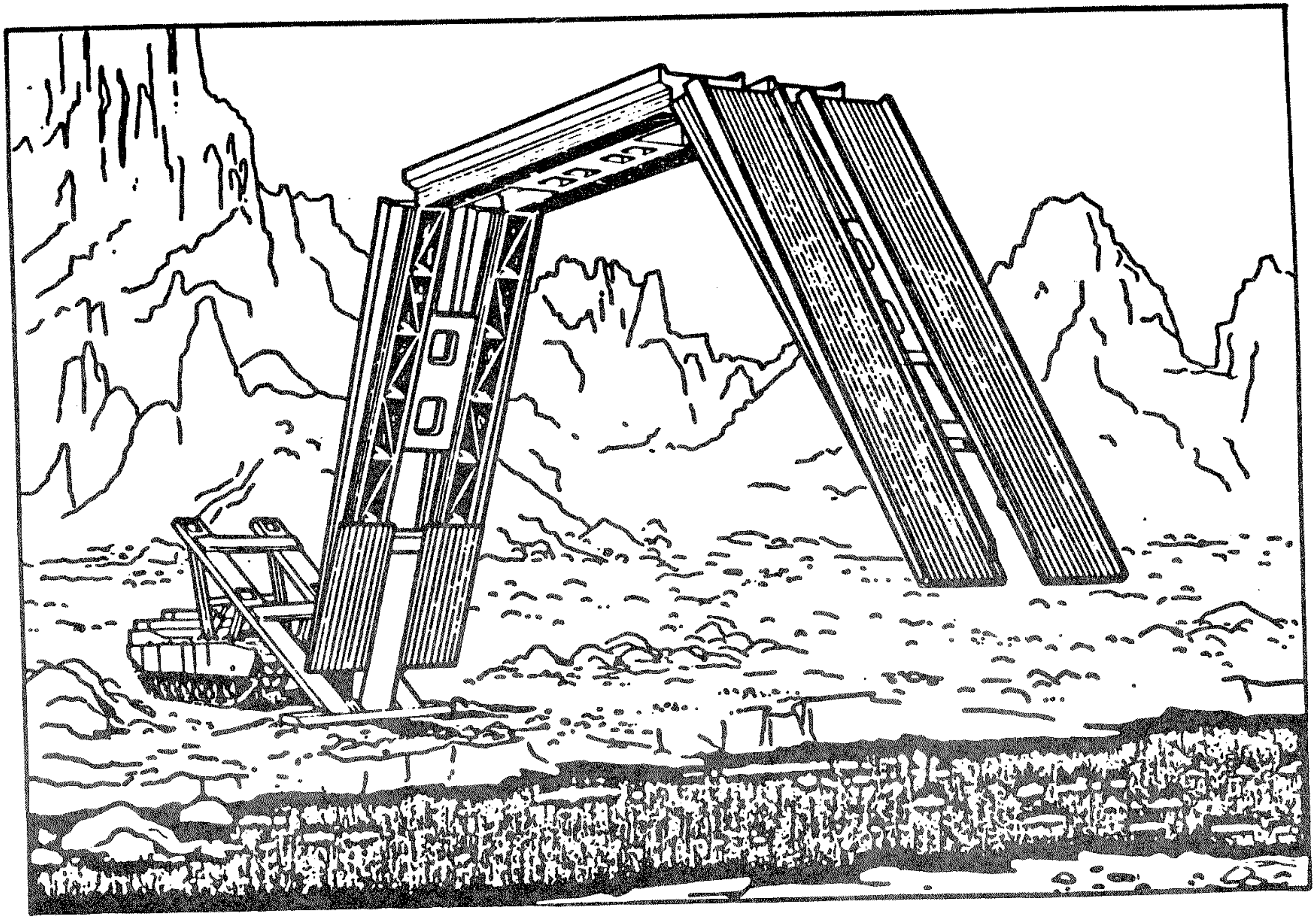
This program is proceeding at a very deliberate pace at the present time. This has been dictated largely by funding constraints within the Army. Presently they have a lot of bridge programs competing for limited resources. We have constructed the new bows for one interior section and have just started testing. Beginning in December we will do the final design of the ramp bay and transporter. We will then fabricate one ramp bay and one transporter. These components will be tested and, based on their success, we will undertake the fabrication of some 11 additional interior bays, another ramp bay, and five transporters. These prototypes will then undergo a year-long evaluation leading to eventual procurement beginning in 1991.

These are the three developmental bridge programs at BMY. I hope they are of interest to you and perhaps even have some application to your work. Mr. Walter Gill, the Programs' Chief Hydraulic Engineer, and I will be here through the end of this conference if you would like to discuss these programs further. Thank you.

BMY

BRIDGING SYSTEMS
FOR THE
U.S. ARMY & U.S. MARINE CORPS

- HEAVY ASSAULT BRIDGE
- TRAILER LAUNCHED BRIDGE
- IMPROVED RIBBON BRIDGE



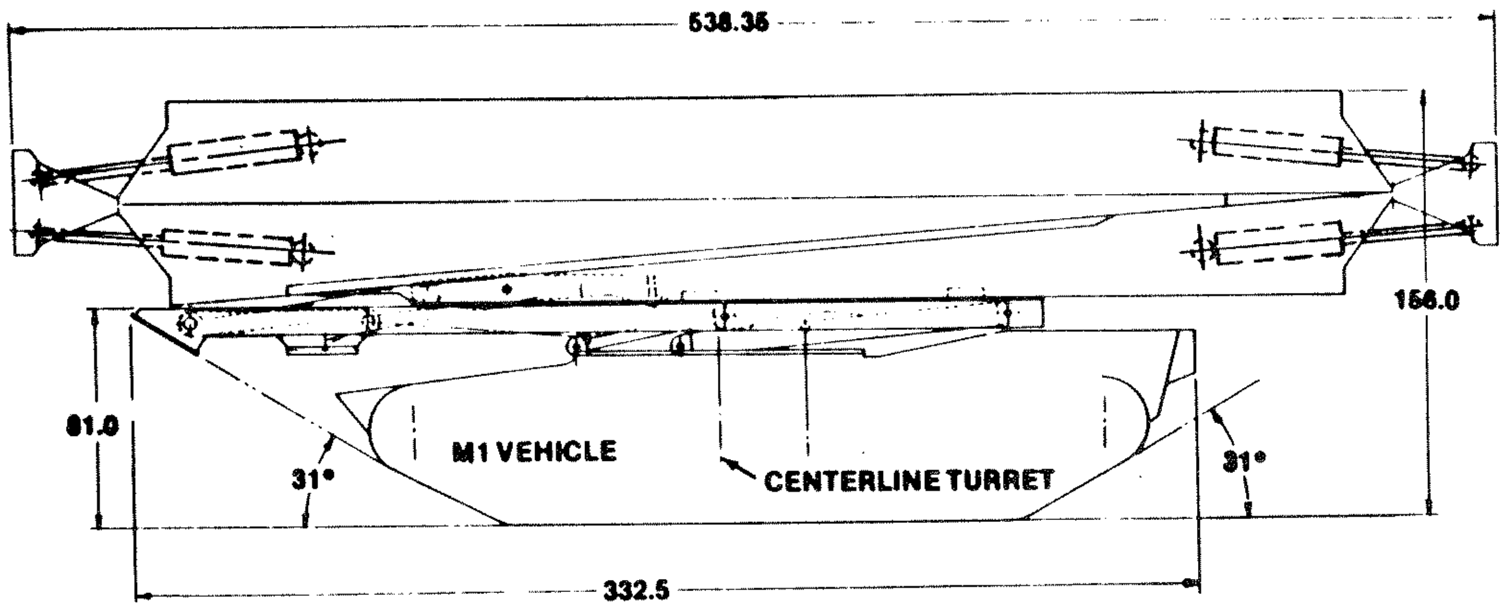
HEAVY ASSAULT BRIDGE SYSTEM

HEAVY ASSAULT BRIDGE SYSTEM

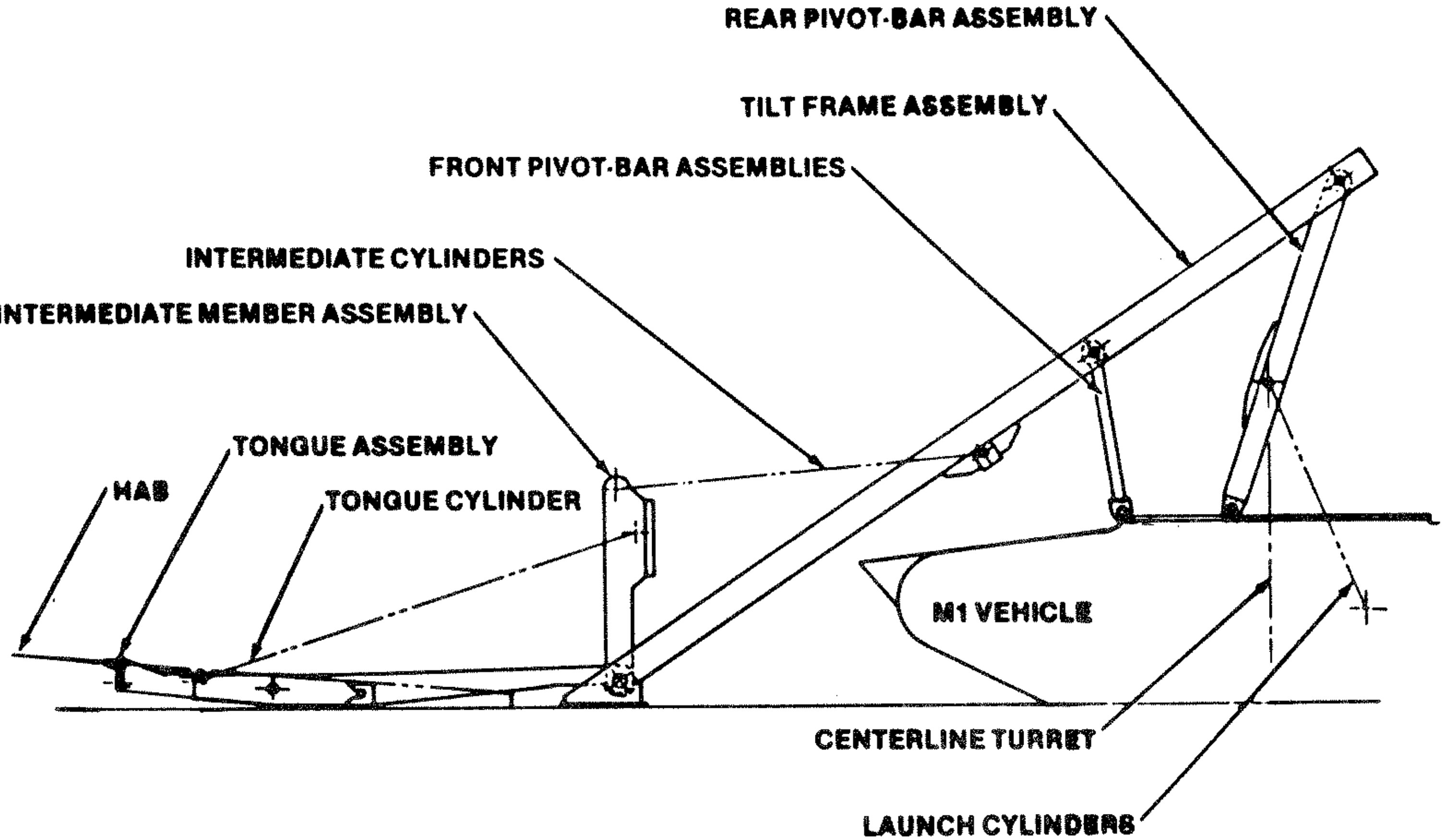
- 32 METER SPAN, MLC 70 BRIDGE
- LAUNCHER MOUNTED ON M1 AND M60 TANKS
- LAUNCH AND RETRIEVE FROM EITHER END
- WEIGHT

M1 LAUNCHER	99,000 LBS
M60 LAUNCHER	93,100 LBS
BRIDGE	22,400 LBS

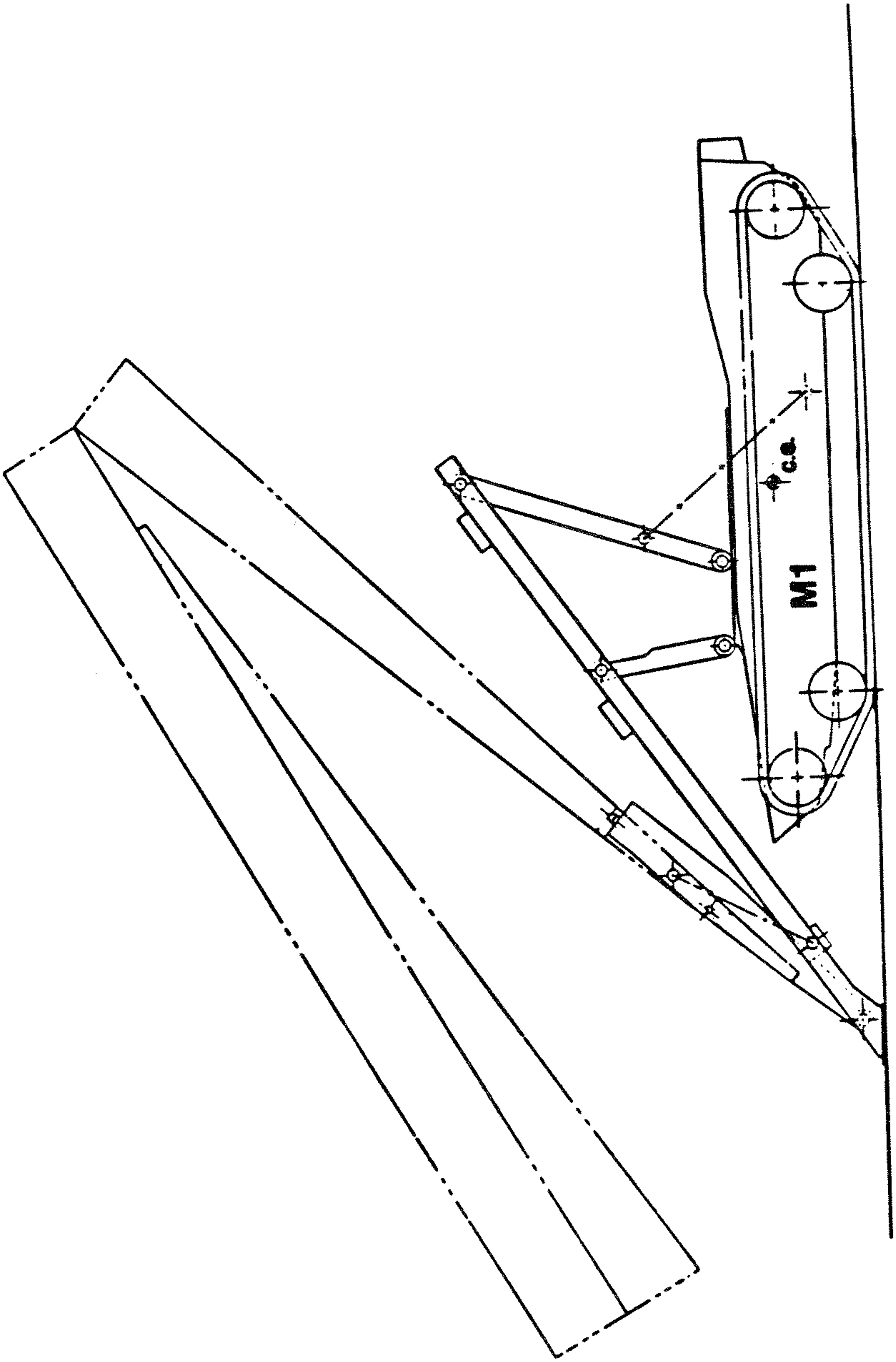
- TRANSPORTABLE IN C5A
- CAN TRANSPORT, LAUNCH, AND RETRIEVE
  - AVLB, 19 METER, MLC 60, 31,000 LBS
  - TLB, 24 METER, MLC 70, 14,000 LBS
  - HAB, 32 METER, MLC 70, 22,400 LBS

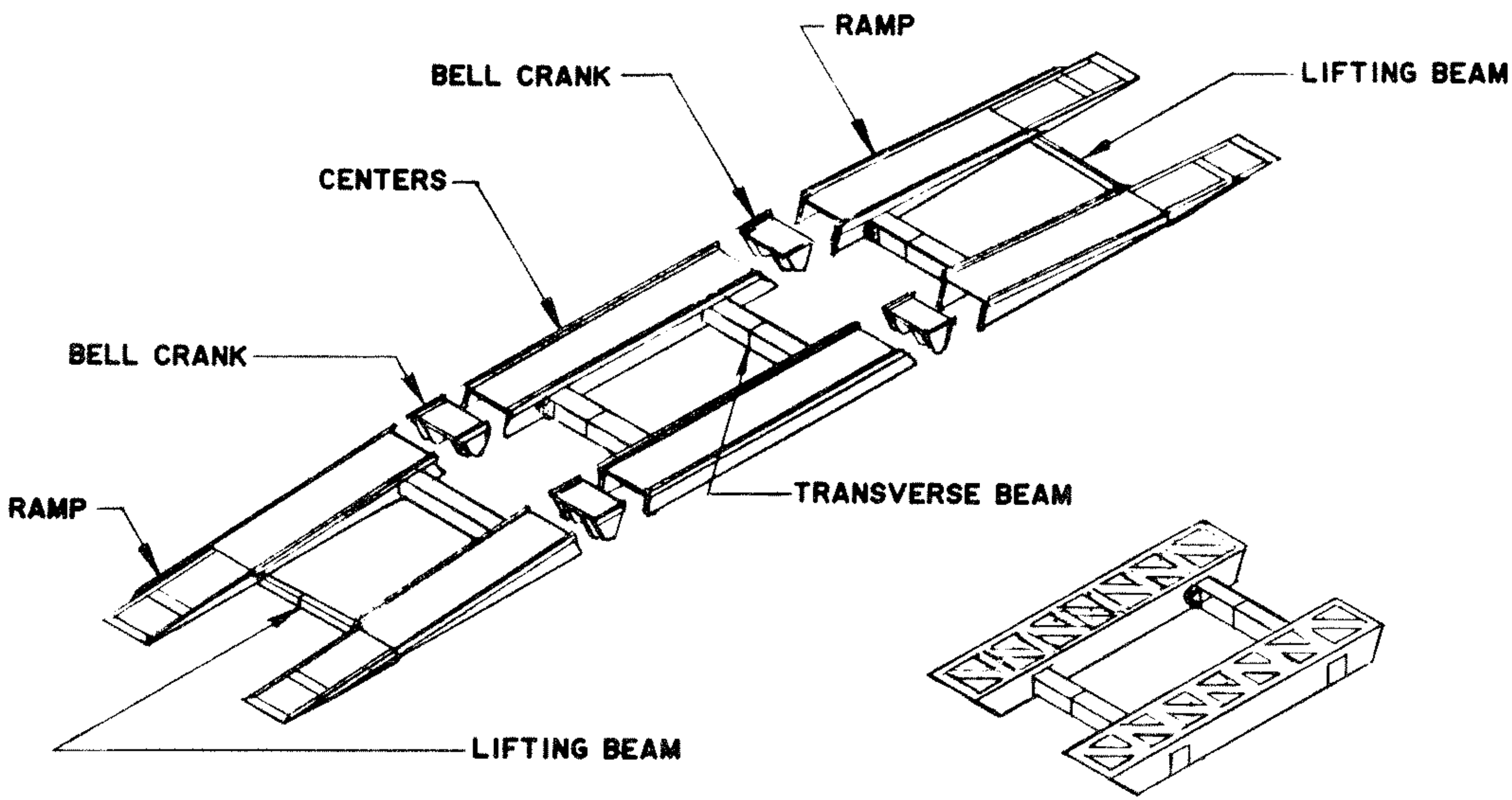


SYSTEM DIMENSIONS



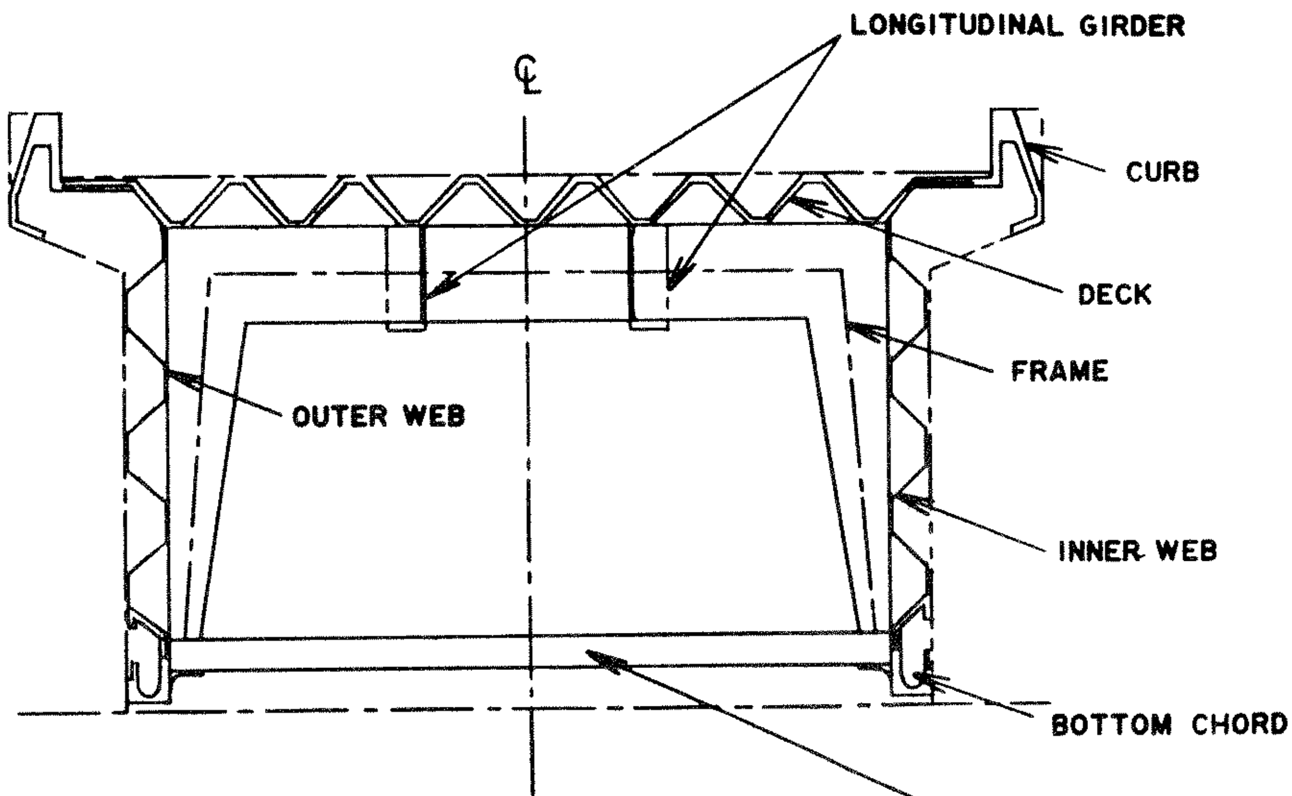
- LAUNCH COMPLETED
- LOADS TRANSMITTED THROUGH LAUNCH BEAMS


c.e.
M1

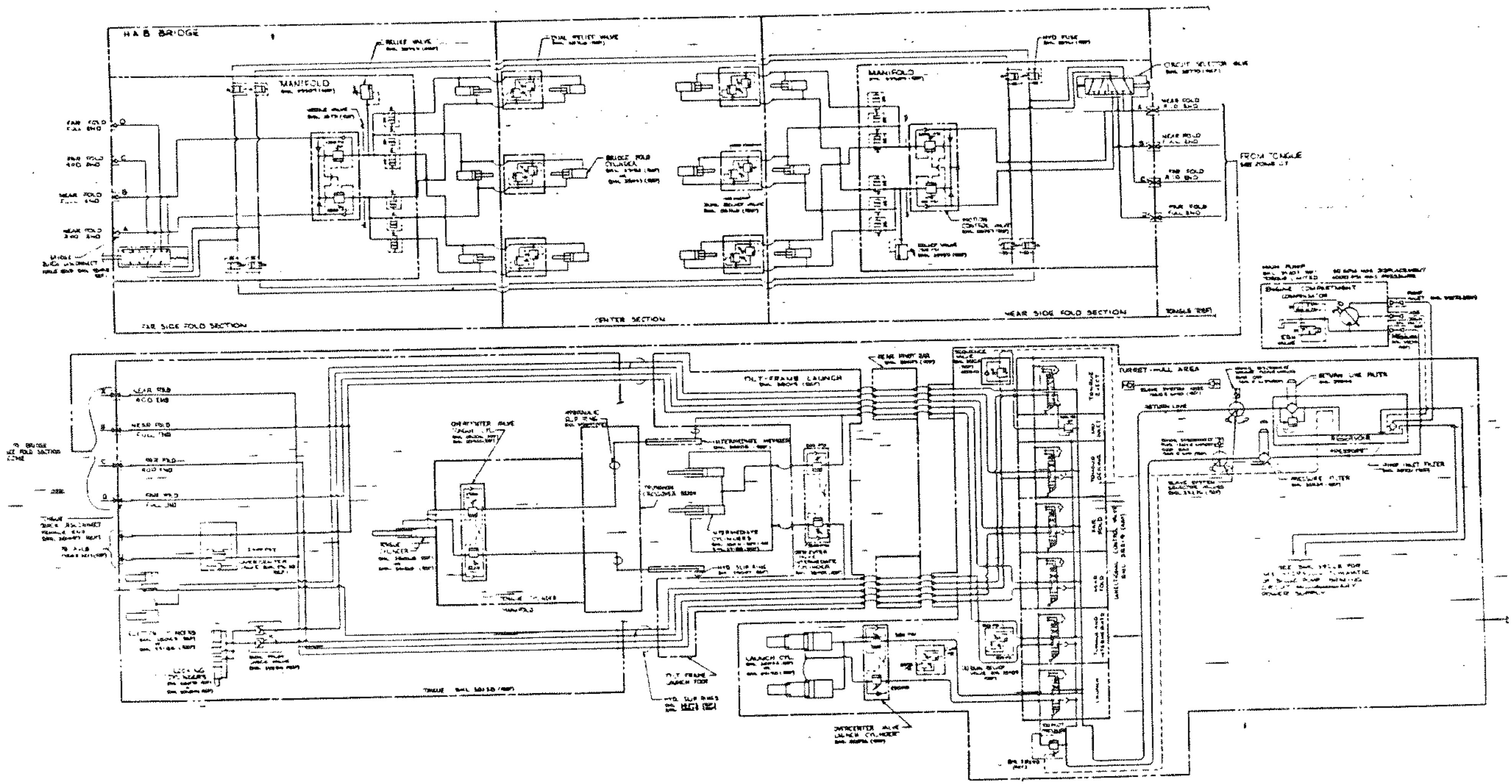


CENTER SECTION
BOTTOM VIEW

STRUCTURE
HEAVY ASSAULT BRIDGE



TRANSVERSE CROSS SECTION
HEAVY ASSAULT BRIDGE



HEAVY ASSAULT BRIDGE SYSTEM

BMY

LEAD TIME CHART

PREPARED BY DATE

APPROVED BY DATE

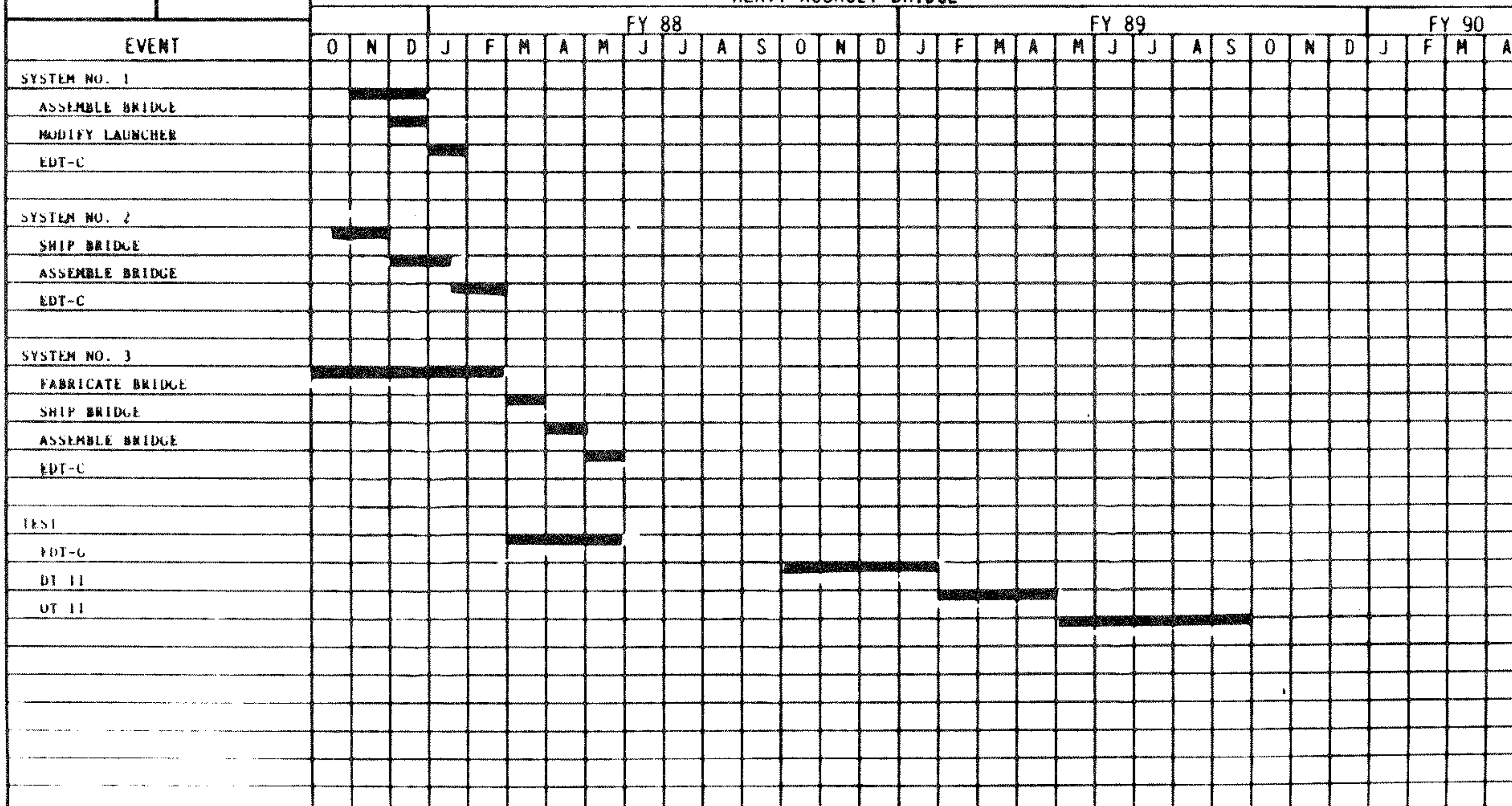
PROJECT

SECTION DSO - BRIDGING/ENGINEERING

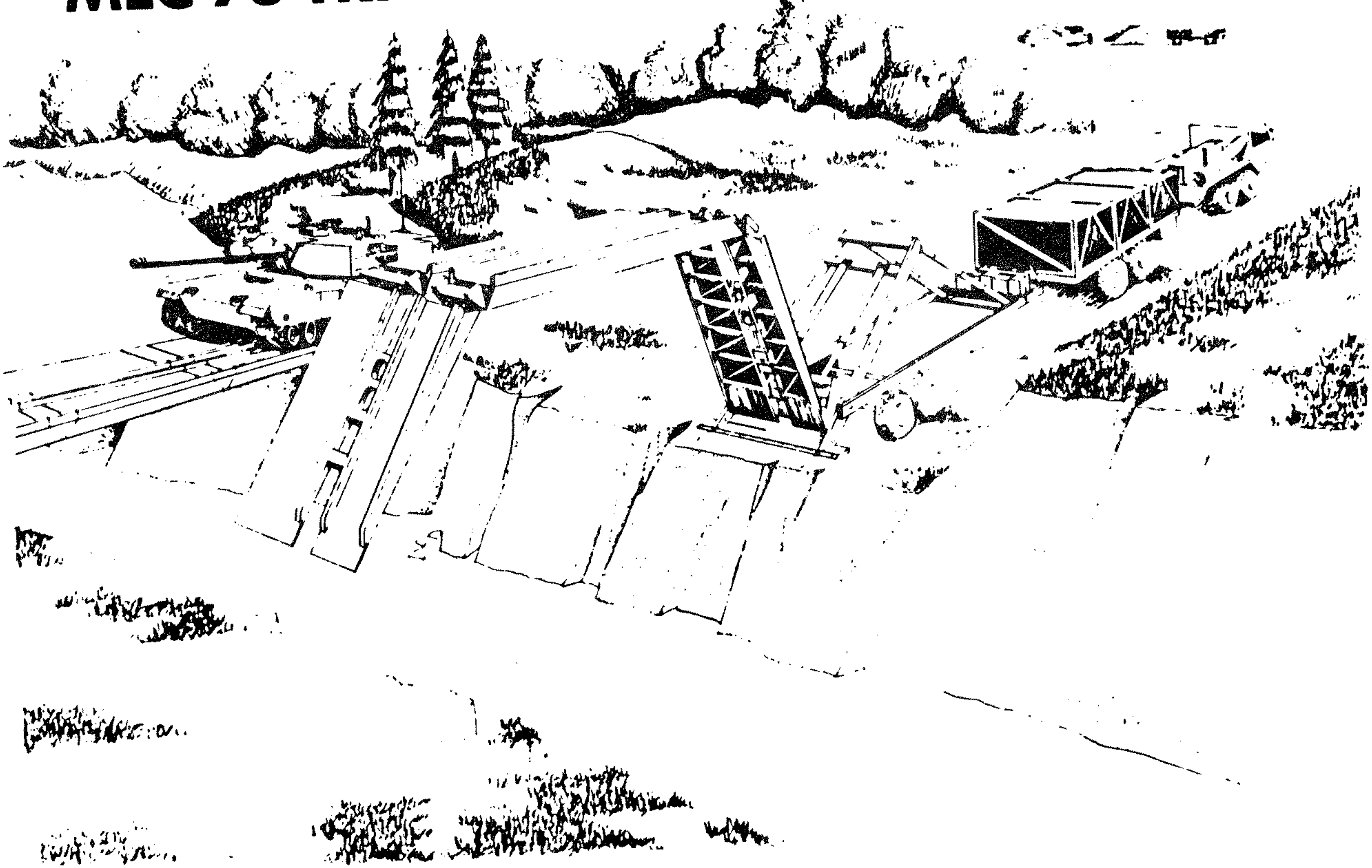
SHEET NO. OF

ISSUE NO.

HEAVY ASSAULT BRIDGE

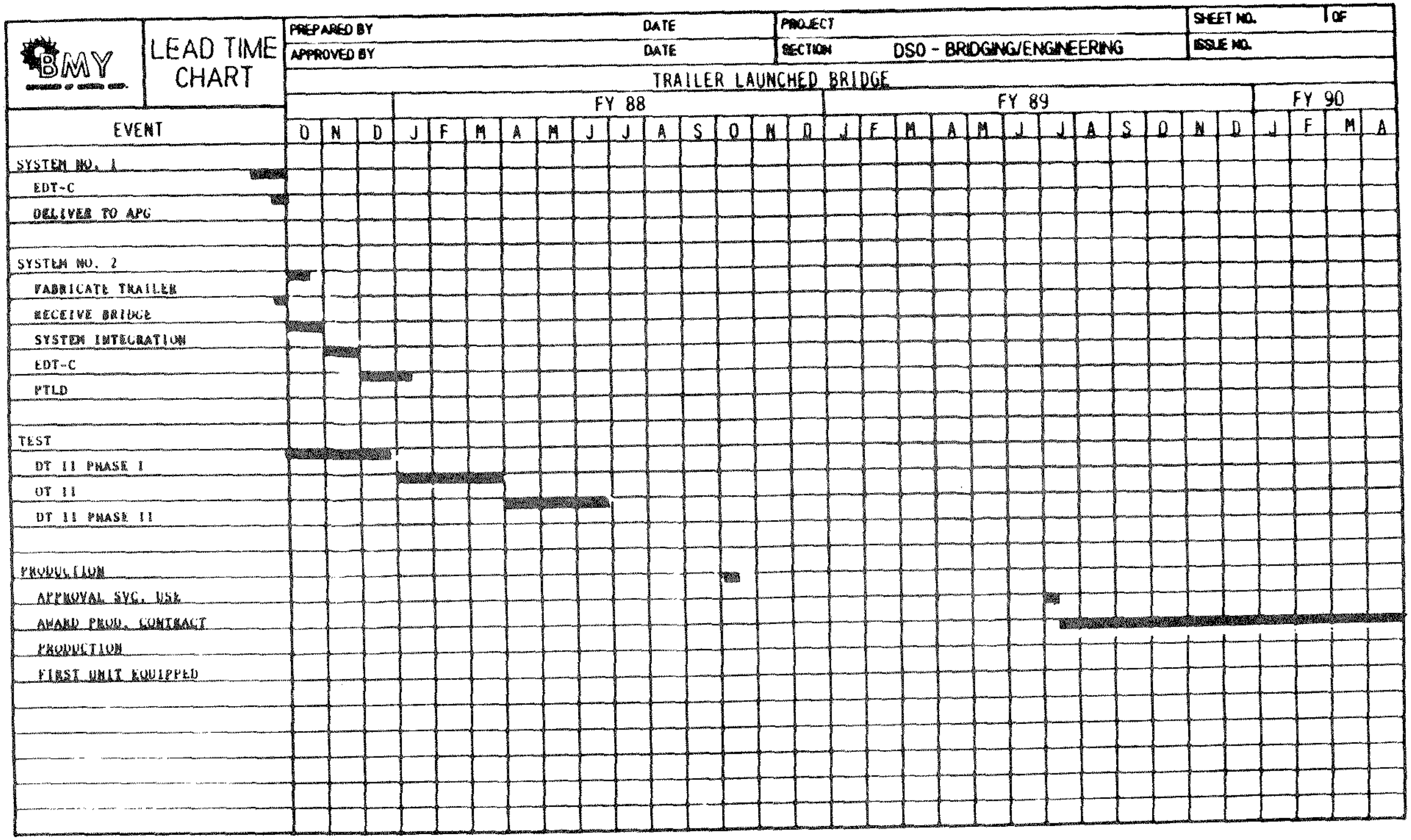


MLC 70 TRAILER LAUNCHED BRIDGE (24 m)



TRAILER LAUNCHED BRIDGE SYSTEM

- 24 METER SPAN, MLC 70 BRIDGE
- TOWED AND OPERATED USING
  - M1, M60, M48 TANKS
  - M88 TANK RECOVERY VEHICLE
  - MK48/14 LVS TRUCK
- WEIGHT
  - BRIDGE 14,000 LBS
  - TRAILER/LAUNCHER 17,000 LBS
- TRANSPORTABLE IN C130 AND C141 (DISASSEMBLED & TELESCOPED)
- CAN TRANSPORT, LAUNCH, AND RETRIEVE
  - AVLB, 19 METER, MLC 60, 31,000 LBS
  - TLB, 24 METER, MLC 70, 14,000 LBS
  - HAB, 32 METER, MLC 70, 22,400 LBS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ISSUE NO.
TRAILER LAUNCHED BRIDGE
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FY 89
FY 90
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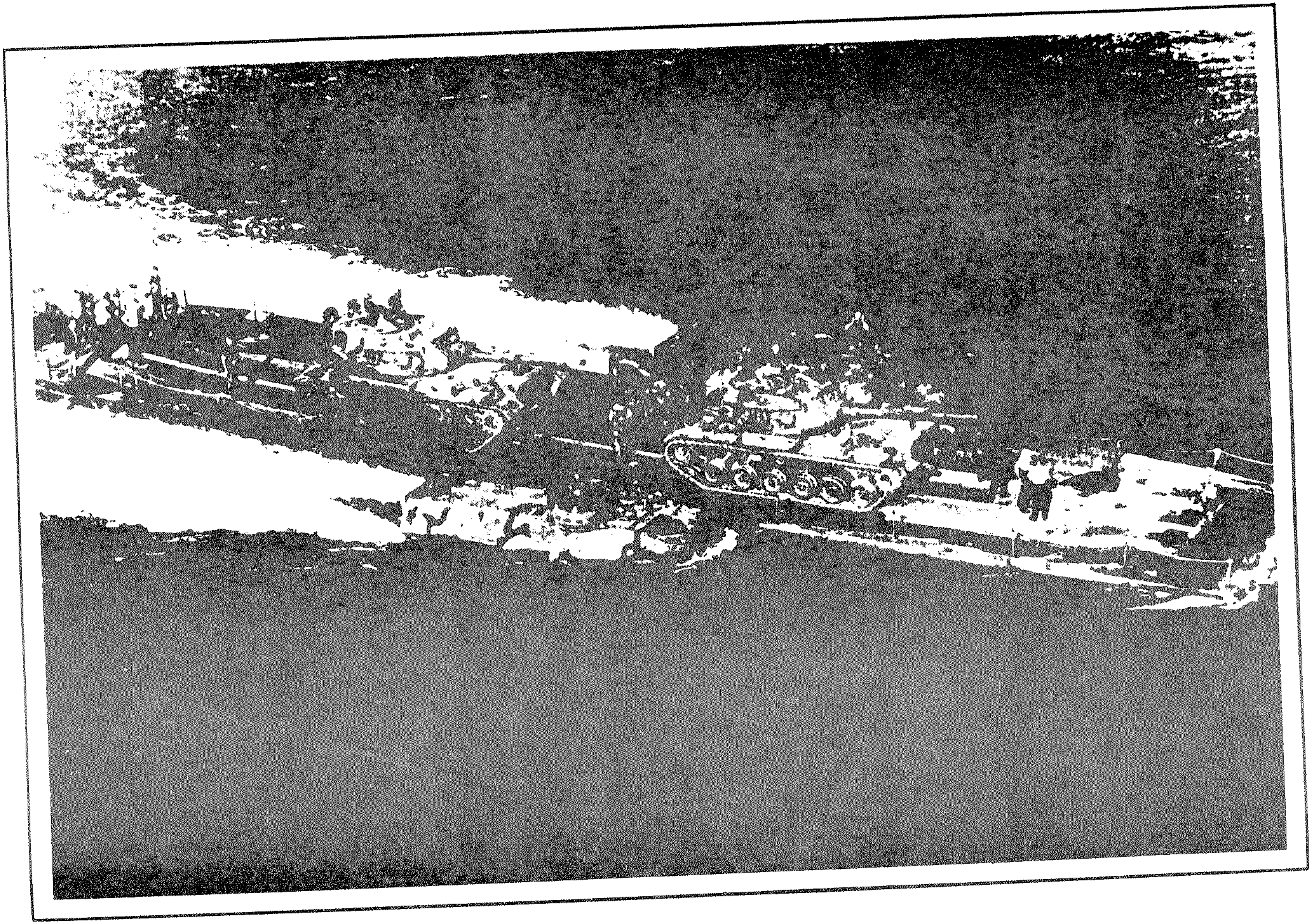
SYSTEM NO. 1
EDT-C
DELIVER TO APG
SYSTEM NO. 2
FABRICATE TRAILER
RECEIVE BRIDGE
SYSTEM INTEGRATION
EDT-C
PTLD
TEST
DT II PHASE I
OT II
DT II PHASE II
PRODUCTION
APPROVAL SVC. USE
AWARD PROD. CONTRACT
PRODUCTION
FIRST UNIT EQUIPPED



Ribbon Bridge System

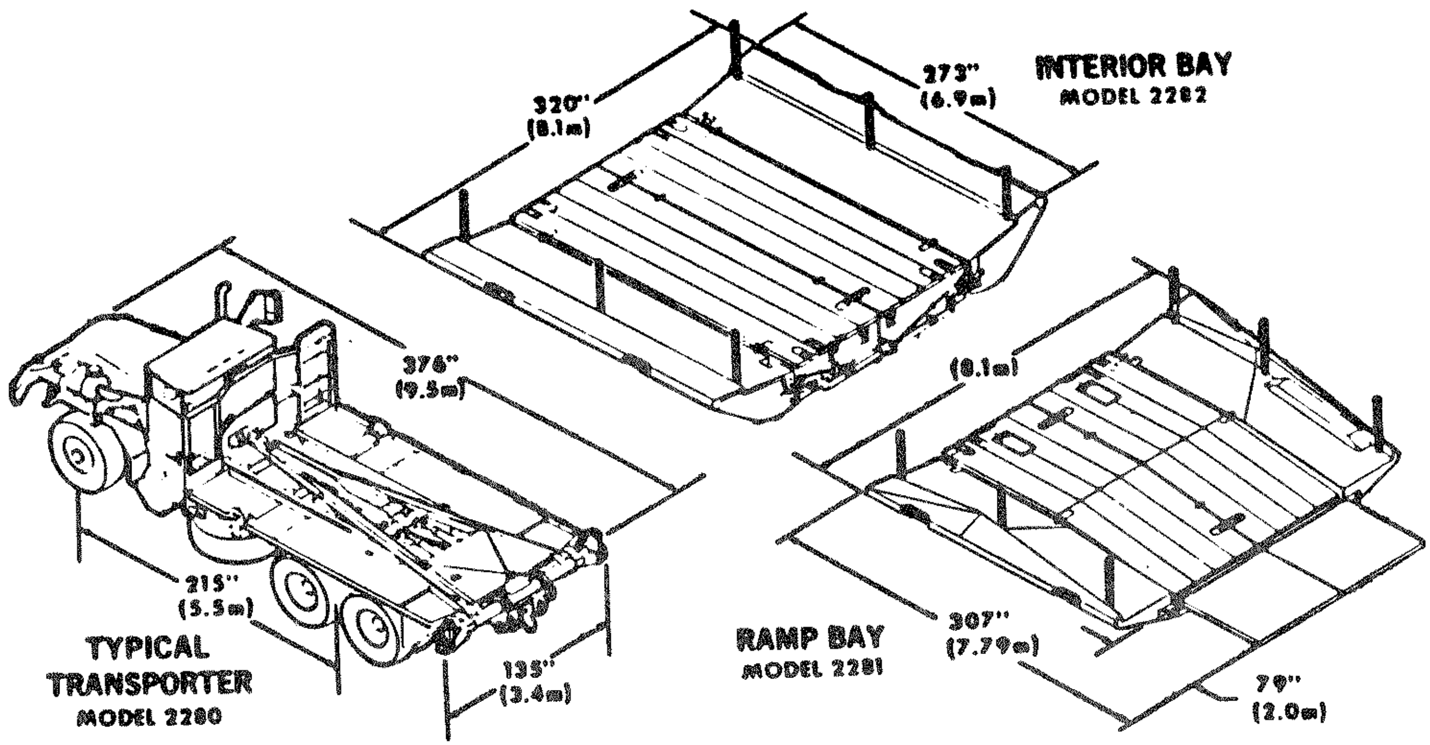
RIBBON BRIDGE CHARACTERISTICS

- EXISTING SYSTEM DEVELOPED LATE 1960'S
- MAIN WET GAP TACTICAL BRIDGE
- DEVELOPED FROM SOVIET DESIGN OBSERVED
- IN FIELD SINCE 1976
- VARIANTS WITH GERMAN AND SWEDISH ARMIES
- BRIDGE IS 2 RAMPS + "n" INTERIORS TO SPAN GAP
- CAN ALSO BE USED AS RAFT
- BAYS 22 FT LONG, 26 FT WIDE DEPLOYED, 12,000 LBS
- CARRIED ONE PER TRUCK (CURRENTLY 5 TON M984)
- BRIDGE ASSEMBLY AND RAFTING USES BOATS FOR MANEUVERING

IMPROVED RIBBON BRIDGE

DEVELOPMENT PROGRAM TO DESIGN AND FABRICATE PROTOTYPES RESULTING IN IMPROVEMENTS TO THE CURRENT RIBBON BRIDGE. IMPROVEMENTS INCLUDE:

- INCREASED FLOTATION
- INCREASED LOAD CAPACITY IN FASTER CURRENTS
- RAMPS CAPABLE OF REACHING HIGHER BANKS
- ADAPTATION OF THE HEMTT 1O-TON TRUCK AS A BRIDGE CARRIER



Ribbon Bridge System

INTERIOR BAY IMPROVEMENTS.

- IMPROVE HYDRODYNAMICS OF BOW PONTON: CURRENTLY TIPS AND FLOODS AT 7 FT/S STREAM WITH MLC 70 LOAD. MUST IMPROVE TO 10 FT/S.
- PROVIDE POSITIVE FLOTATION TO OFFSET BALLISTIC DAMAGE.
- IMPROVE STRUCTURE/HANDLING DAMAGE RESISTANCE IN VARIOUS AREAS.

RAMP BAY IMPROVEMENTS.

- LENGTHEN TO ACCOMMODATE 2M HIGH BANKS: CURRENTLY ACCOMMODATES 1.25M MAXIMUM.
- PROVIDE LESS DAMAGE-PRONE TRANSITION TO BANK: CURRENTLY, VEHICLES BREAK UP THE TRANSITION RAMPS.
- PROVIDE POSITIVE FLOTATION TO OFFSET BALLISTIC DAMAGE.
- REDESIGN UNFOLDING MECHANISM TO REDUCE VULNERABILITY TO HANDLING DAMAGE (WOULD BE APPLICABLE LATER ALSO TO INTERIOR BAY).
- VARIOUS OTHER STRUCTURAL IMPROVEMENTS.
- IMPROVE HUMAN FACTORS OF RAMP BAY ELEVATION PROCESS: CURRENT HYDRAULIC PROCEDURE TAKES UP TO 8 MINUTES. MUST BE POSSIBLE FOR ONE MAN IN 3-4 MINUTES.

TRANSPORTER IMPROVEMENTS.

- NEW TRANSPORTER TRUCK: 10 TON HEMTT. BAYS TOO HEAVY FOR 5 TON M984.
- IMPROVE LOGISTICS AND HUMAN FACTORS/SAFETY OF BAY RETRIEVAL PROCESS: PERHAPS PALLETIZED LOADING SYSTEM (PLS) MECHANISM.

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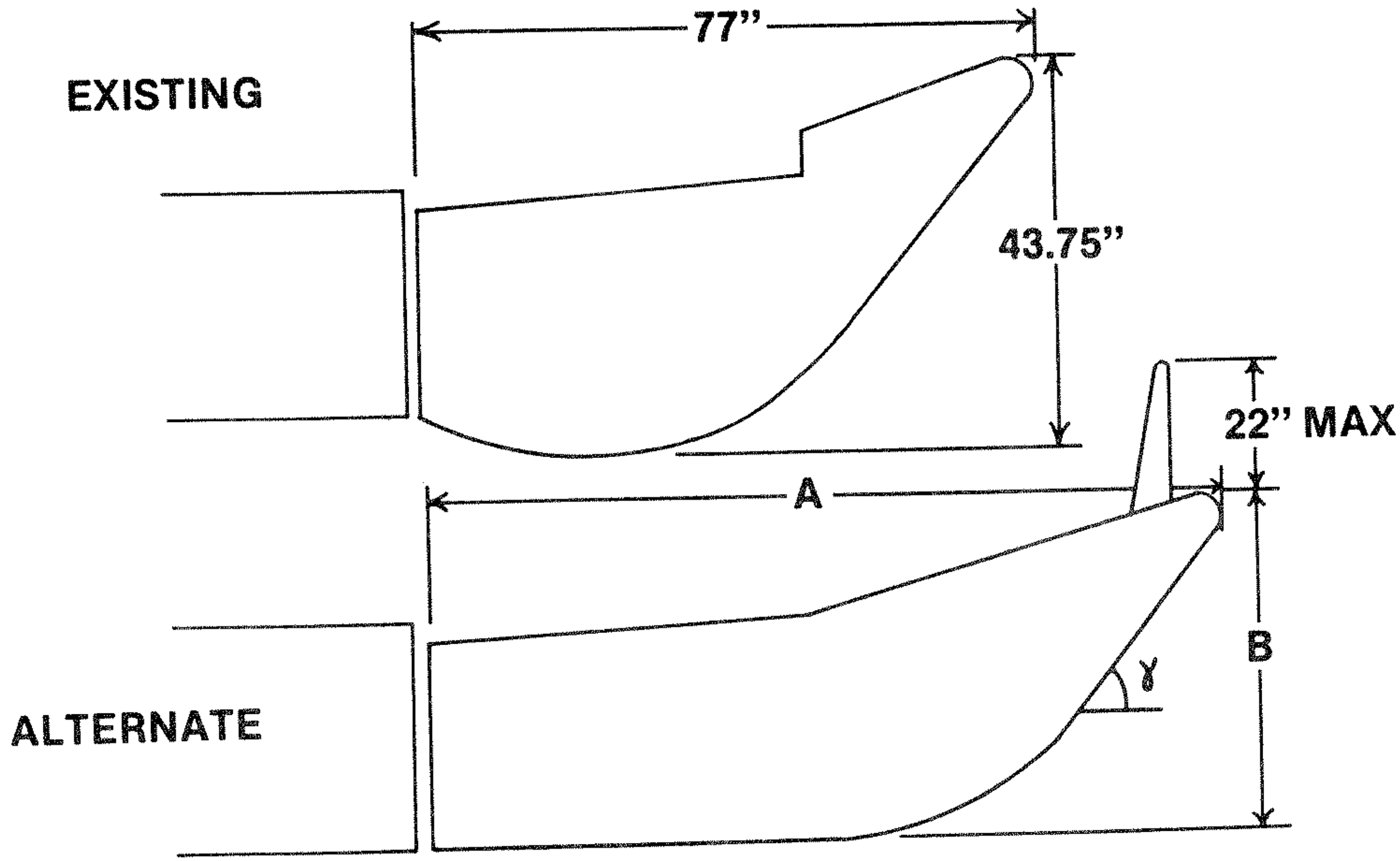
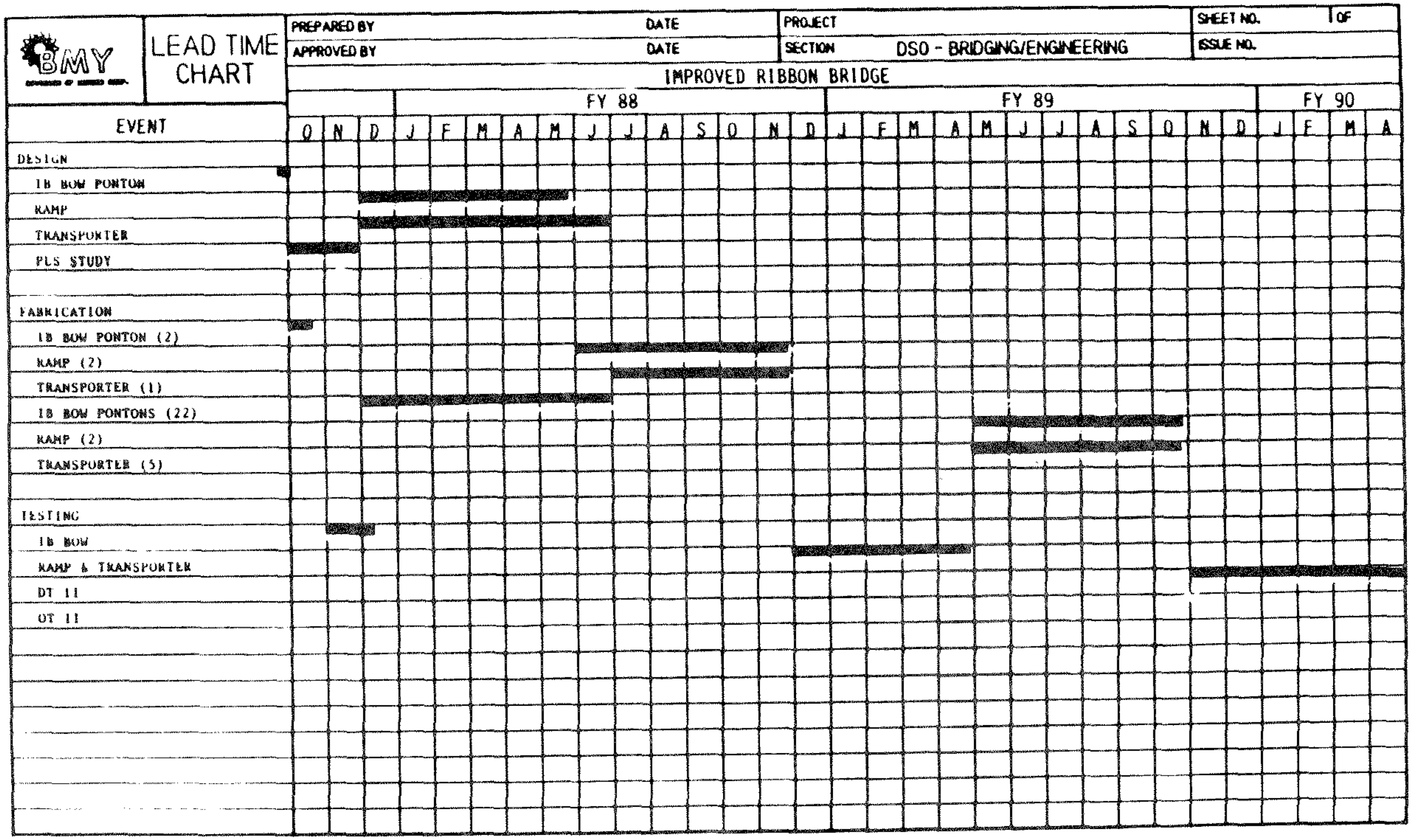
IRB BOW PROFILES

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DESIGN
IB BOW PONTON
RAMP
TRANSPORTER
PLS STUDY
FABRICATION
IB BOW PONTON (2)
RAMP (2)
TRANSPORTER (1)
IB BOW PONTONS (22)
RAMP (2)
TRANSPORTER (5)
TESTING
IB BOW
RAMP & TRANSPORTER
DT II
OT II