CHAPTER 3

MISSILE LAUNCHING SYSTEMS

The last chapter dealt with the parts of the ship's missile system that were used in handling and storing the weapons. You already know a good deal about launching systems from study and experience. What additional information or skills must you gain to qualify as a GMM 1 and C? Look at the quals that apply to the missile launcher system.

Notice that most of the knowledge factors are placed at the GMM 3 level. In the practical factors, note that the GMM 3 must be able to make operational tests. To advance to GMM 2, you had to be able to man any station in the launching system on your ship, use special test equipment, interpret the test results, and record and report the results. You learned to inspect and disassemble, clean, lubricate, and reassemble many of the launching system components, and the missile handling and dud-jettisoning equipment.

Now you must be able to train individuals and teams in the operation of the launching systems on your ship. If there is more than one type of system on your ship, you have to train on ALL of them. You must learn to perform ALL tests of the equipment and to locate trouble in any part. Overhaul, repair, and adjustment of all mechanical, electrical, electronic, and hydraulic equipment in the missile launching systems are part of the job of the GMM 1I and C. As you are aware, that includes a large array of complicated equipment,

Not only must you be able to do all these different kinds of work, but you must be able to teach others, to plan programs for getting the work done, and to conduct classes to carry out the programs. Planning of work and supervision of men doing the work will be important parts of your job.

PREPARATION OF LAUNCHER FOR FIRING

Practice sessions in preparing a launcher for firing are necessary to develop coordination, speed, and skill in carrying out the steps in order. Rotate the men to different positions so each man can be come proficient in the different operations. This is cross-training, described in chapter 1. Shifting the men to different positions undoubtedly will slow down the team for the time being, but it is much more valuable training than training each man to become an expert at only one position. Each man should be able to take over any other position in an emergency.

The types of missile launchers and their major components were described in *Gunner's Mate M (Missiles) 3&2*, NAVTRA 10199 and additional information is given in this course. The care and 'repair of launching systems are discussed in chapter 10, on maintenance. It is assumed that all checks and tests required after repair or maintenance have been performed and the launching system is ready for firing a missile. Tests and checkoffs to be performed in the process of preparing for a firing or firing exercise are given some attention in this chapter but are described more specifically in chapter 10. Alignment of missile batteries is covered in chapter 9.

Although different missile systems differ in the details of preparation of the launcher for firing, the general steps in the operation of the system are very similar. For the missile system these steps are:

1. Search radar detection
2. Fire control radar tracking
3. Missile launching
4. Guidance and target intercept

Your special concern is with the third step, but you need to have some knowledge of how the whole system operates, so the work will be coordinated. This knowledge will also help you in operating control stations. Figure 3-1 shows the main components at different stations of a Terrier weapons system on a DLG, and the flow of information and instructions among the components.

When a target is detected by the ship's search radars (or sonar), radar information concerning the target's range, azimuth, and height is supplied to the ship's Combat Information Center (CIC). The data is evaluated in CIC and the target (or targets) assigned to the Weapons Control Station (WCS). Further target evaluation is made by WCS and a director radar is assigned to track the target. If the target is considered to be an enemy, General Quarters is sounded and all men take their stations. Power is turned on to activate the system. The Launching System Captain activates the EP-I power panel and takes his station at the EP-2 (Launcher Captain's) panel. Decisions as to the type of weapon to use and, if and/or, when to fire are made by the Antiaircraft Warfare Commander on the basis of information from CIC and WCS, and the decisions are relayed to the various control stations of the weapons system. The operators of the control panels push the buttons to set in operation the mechanisms to carry out the decisions.

NTDS/WDS

A newer and more advanced Terrier guided missile weapon system installed on the DLG's consists of Naval Tactical Data System/Weapon

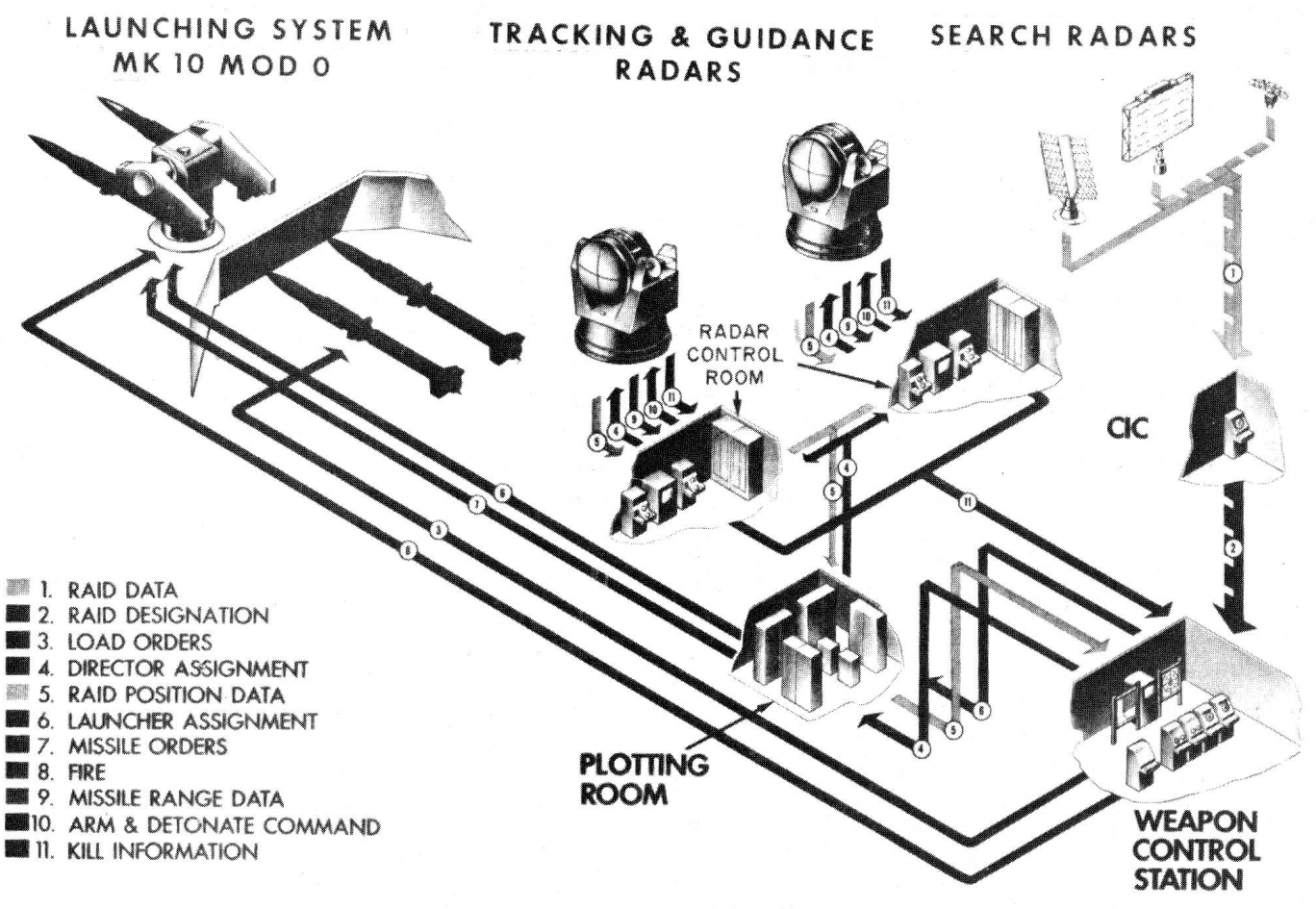

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Figure 3-1.—Terrier weapon system on a DLG; flow of information and directions.

Direction System (NTDS/WDS). The NTDS/WDS is a high speed digital data processing, display and communication system that provides for a more effective fleetwide defense against all types of enemy targets encountered at sea. Target information can be received from and transmitted to remotely located units of the fleet. NTDS/WDS is the primary source of target assignment and target tracking is accomplished using the NTDS/WDS displays. If a particular target is to be engaged, the WDS is assigned. The NTDS/WDS comprises data processing equipment, data display equipment, and data transmission and communication equipment which are located within the CIC area.

MANNING THE CONTROL PANELS

As a GMM 2 you had to be able to take over the operation of any of the launcher control panels; to advance to GMM 1 and C you should be able to supervise the panel operators and teach others the panel operation techniques. The number and types of panels vary with the system and the names may differ, but all systems have at least three types (table 3-1):

1. Power panels
2. System control or launcher captain's panel
3. Test panels

Older systems have many small control panels for control of components of the system. In newer mods, the tendency is to enclose several panels in two or three large panels (table 3-1). This requites fewer operators but the operators must. be alert to many things. The small individual panels are used mostly for unloading and maintenance.

The dud-jettisoning panel is associated with the launching system controls. It is discussed in the next chapter.

Power Panels

All launching systems have one or more power panels by which the system is connected to ship's power. Some, such as the Mk 12 launching system, have separate power panels for the launcher and feeder components. All the electrical power is supplied from the ship's electrical system, but the voltage has to be stepped down for many applications. The power panel contains circuit breakers, contactors, and overload relays for the launcher power drives, missile warmup, train and elevation motors, blower motors, and loaders and/or feeders.

In automatic operation, the power panels usually are activated from the launcher captain's station. In step Qperation, which is used for strike down for stowage, strikeup for checkout, unloading the launcher, or loading the launcher, some of the power panels are activated from other control stations.

Launcher Captain's Panel

Figure 3-2 shows one type of launcher control panel. The launcher control panel will vary with the mark and mod of the launching system, the type of shipboard installation, and other factors, so it is not possible to tell you just which buttons to push. After you have turned on the power, set the EP-2 panel (EP-3 on the Mk 11 launching system) on STANDBY and watch and listen for signals that will indicate what to do next. An ALERT signal from the weapons control station will cause a flashing signal on all the launcher system panels and also will give an audible signal. When all the panel operators have set their panels on READY, the signal goes to the launcher captain's panel; he then sets his panel on READY, and this signals WCS that all parts of his launcher system are ready.

Four types of orders are transmitted from the weapons control station to the launching system, and these go through the launcher captain's panel:

1. Missile order-determines the type of round(s) to be loaded
2. Load select order-distinguishes between simultaneous operation of "A" and "B" sides or separate operation of either side
3. Loading order-distinguishes between hold, single, or continuous loading of the type missile ordered .
4. Unloading order-distinguishes between "unload launcher" or "unload assembly area"

Table 3-1.—Launching Systems

	TALOS			TERRIER						TARTAR					
	MARK 7	MARK 12		MK 9	MARK 10					MARK 11			MARK 13		MARK 22
	MOD 0	MOD 0	MOD 1	Mod 0	Mod 0	Mods 1 & 2	Mods 3 & 4	Mods 5 & 6	Mods 7 & 8	Mod 0	Mod 1	Mod 2	MOD 0	Mods 1, 2, 3	Mod 0
PARTS OF LAUNCHING SYSTEM	Mk-Mod	Mk-Mod	Mk-Mod	Mk-Mod	Mk-Mod	Mk-Mods	Mk-Mod	Mk-Mod	Mk-Mod	Mk-Mod	Mk-Mod	Mk-Mod	Mk-Mod	Mk Mod	Mk-Mod
1. LAUNCHER	7 0	7 0	7 1	5 2	5 3	5 4,5	5 6	5 7	5 8,9	8 0	8 1	8 2	116 0	126 1	123 0
a. Stand	5 0	5 0	5 0	3 0	3 1	3 1,2	3 1	3 2	3 2	6 0	6 1	6 2			
b. Carriage	5 0	5 0	5 1	3 1	3 2	3 2	3 2	3 3	3 3	6 0	6 1	6 2	8 0		9 0
c. Guide	5 0	5 1	5 1	3 2	3 3	3 4,5	3 4	3 4,5	3 6,7	6 0			8 0	113 0	8 0
d. Power drive, train	50 1	50 2	50 2	46 0	46 1	46 1	46 1	46 1	46 1	55 0			65 0	65 1	67 0
e. Power drive, elevation	50 1	50 2	50 2	46 0	46 1	46 1	46 1	46 1	46 1	56 0			66 0	66 1	68 0
f. Slipring assembly	6 0	6 1		4 0	4 2	4 2	4 2	4 2	4 2	8 0					
g. Emergency igniters		1 0													
2. LAUNCHER FEEDER	6 0	11 0	11 0	9 0	10 2	10 1,2	10 3,4	10 5,6	10 7,8						9 0
a. Magazine "A" side	2 0	7 0	7 0	4 0	5 0	5 2	5 6,8	5 10,12	5 12	6 0	6 1	6 2	8 0	108 mods 1,2,3	9 0
"B" side	2 1	7 1	7 1	4 1	5 1	5 3	5 7,9	5 11,13	5 13 C 14						
b. Loader					8 0										
"A" side	5 0	5 2	5 2	7 0	8 0,1	8 2,3	8 6,8	8 10,12,14	8 14,16						
"B" side	5 1	5 3	5 3	7 1		8 4,5	8 7,9	8 11,13,15	8 15,17						
c. Assembler	5 0	9 0	9 0	4 1	8 0	8 1,2	8 3,4	8 5,6	8 6						
d. Feeder	6 0	11 0		9 1	10 0	10, 1,2	10 3,4	10 5,6	10 7,8						
3. SYSTEMS CONTROL	5 0	10 0	10 1	7 0	8 0	8 1,2	8 3,4	8 5,6,7	8 7,8	9 0	9 1	9 1	13 0	13 1	21 0
a. Power panel	163 0 164 0	163 1 164 1	163 1 164 1 EP-1A&B	180 1	193 0	193 0,2 EP-1	193 3 (2 of these)		193 1 EP-1	208 0 EP-1	208 0	208 1 EP-1	253 0 EP-1	EP-1	EP-1
b. Launcher panel	165 0	EP-2 201 0	201 0 EP-2	EP-2 179 0	190 0	EP-2 190 1,2	190 3,4		190 8 EP-2	204 1 EP-3	204 1	204 1 EP-3	254 0 EP-2	EP-2	
c. Amplifier panel				181 0											
d. Feeder panel	166 0 EP-3		203 0 EP-3	EP-3 182 0					191 0 EP-3						
e. Feeder power panel				183 0											
f. Loader panel		239 0 239 1	239 0,1 EP-9 & 10 Local Cont.	185 0,1						206 1 EP-2	206 1	206 1 EP-2			
g. Loader power panel				186 0,1											
h. Assembler panel	167 0,1 EP-4 & 5	167 2,3 A&B side	167 2,3 EP-4 & 5	184 0,1	192 0,1	192 2,4 EP-4 192 3,5 EP-5	192 6,8 192 7,9		192 0 EP-4 192 1 EP-5						
i. Ready service panel	168 0,1 EP-6 & 7														
j. Power relay panel	169 0 EP-8	169 1 EP-8													
k. Relay control panel			169 1 EP-8							205 1, 2 RC 1, 2, 3	205	205 0,2,3 RC 1,2,3			
l. Test panel	187 0 EP-9	203 0 EP-3	203 0 EP-3	EP-12	191 0	EP-3 191 0	191 0 (2 of these)	191 0	191 0				255 0 EP-3 Incl. Local Cont.	EP-3	EP-3
m. Magazine control panel			173 0,1 EP-6 & 7												
n. Magazine loading indicator										209 0 IP-1	209 0	209 0 IP-1			
o. Missile latch indicator										210 0 IP-2	210 0	210 0 IP-2			
p. Local control panel										211 0 EP-5	211 0	211 0			
q. Hoist local control		240 0,1 EP-11 & 12	240 0,1 EP-11 & 12												
4. DUD JETTISON UNIT				107 0,1 EP-12	108 0	Not part of control system			108 0	109 0	109 0	109 0		nitrogen booster pump added	Part of guide

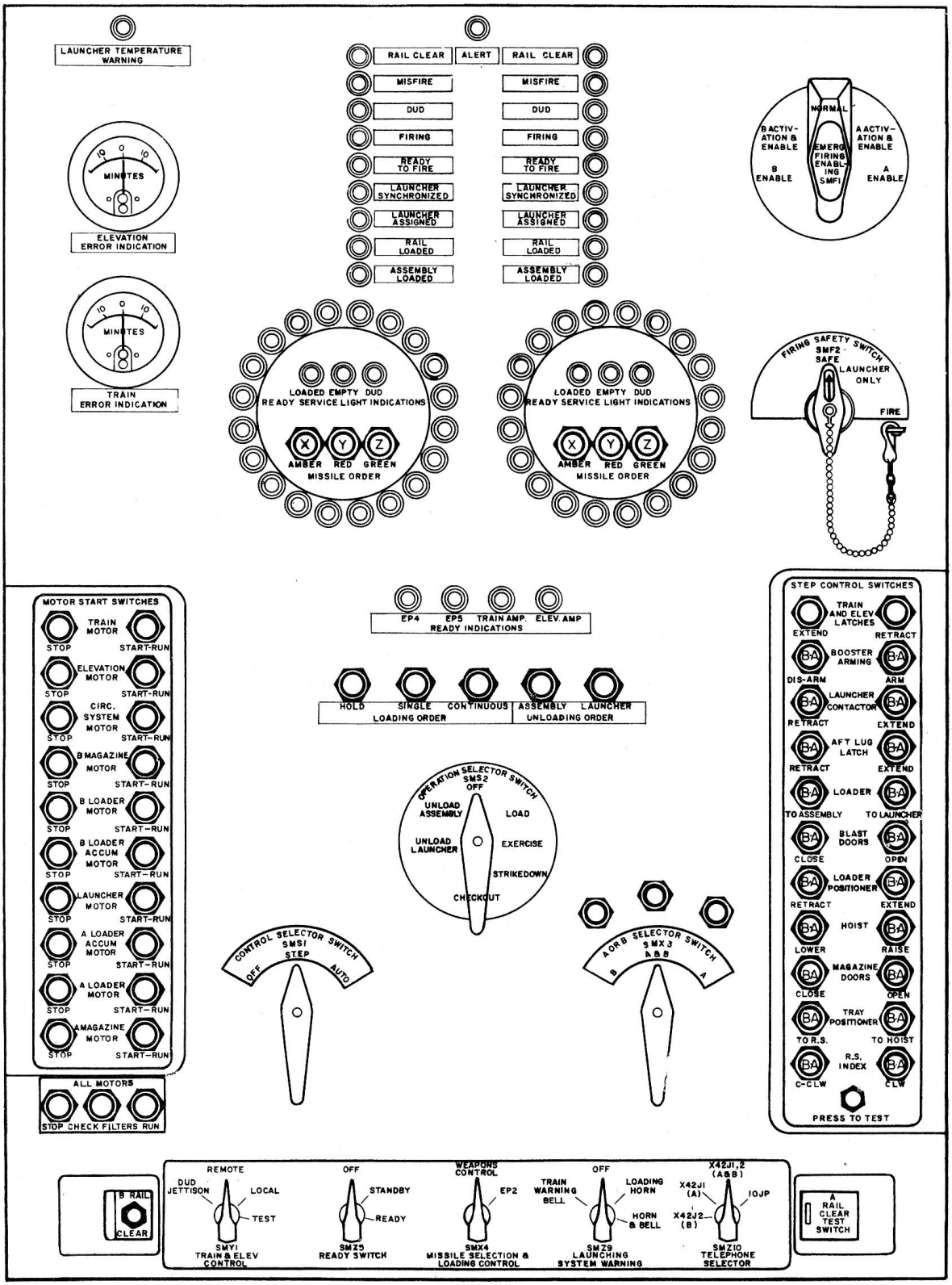

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Figure 3-2.—Launcher control panel, EP-2, for Terrier weapon system Mk 10.

Pushing the correct buttons on the panels causes the launching system to load automatically the type of round ordered. A few manual operations are required, and these differ with the type of round. For example, the Terrier BT -3A(N) requires actuation of the warhead manual disabling safety switch. All Terrier rounds require installation of aerodynamic surfaces (wings and fins), followed by operation of the safety foot (or hand) switch by each assembler at his station.

MISSILE ORDER.-The type of round(s) to be loaded will be ordered by the WCS when the system is activated. Although verbal orders may be given in some systems, the order is usually indicated by signal lights on the EP-2 Panel (EP-3 in Mk 11 systems). The operator of the EP-2 panel pushes the button that will cause the selected type round to be indexed to the loading position. if the order comes to HOLD, the round is held at the hoist position until the next order is received.

LOAD SELECTOR ORDER.-At the weapons control station the load select switch is set to either SINGLE or CONTINUOUS, the corresponding light signal on the EP-2 panel lights up, and the loading operation is started.

LOADING ORDER.-If the loading order is CONTINUOUS, the system will continue to select the same type of round, and hoist it to the loader rail each time the empty loader pawl returns to the load position. On SINGLE, one missile will be hoisted and loaded on the launcher. On HOLD, the launching system is held in READY condition, but no round is loaded.

UNLOADING ORDER.-When rounds are to be returned to the magazine, WCS will indicate UNLOAD LAUNCHER, or UNLOAD ASSEMBLY, which will cause a corresponding light on the EP-2 panel to be illuminated. The launcher captain will then initiate automatic unloading operations. (Not all systems can be unloaded automatically.)

The order for cessation of operation of the launching system is transmitted from the weapons control station to the launching system captain via telephone.

Look again at figure 3-2 and note the designations of the push buttons and lights. Some panels have a great many more buttons and lights than the model shown. The operator of the launcher captain's panel has to be alert to everything that is taking place in the launching system. He needs to know the system so he can picture in his mind's eye what is taking place on the launcher as each signal lights up or when he pushes a button in response to orders from the weapons control station. In automatic operation, the launcher slews to position in response to train and elevation orders from the computer in missile plot. In local operation, train and elevation orders have to be set in at the launcher captain's panel after receiving the computation from WCS. The firing key is on the Weapons Assignment Console (WAC) in the weapons control station. The WAC operator does not close the firing key until the launcher captain signals that all safety firing interlocks are closed. If a salvo is ordered, the second missile will be launched very soon after the first, following a similar program of orders.

Test Panels

One test panel is used for both port and starboard components of some systems, while other systems have separate test panels for port and starboard. The test panels are used only during launcher test operations and are unmanned during automatic loading operations. The test panel contains switches, synchros, and connections required to perform complete tests on the train and elevation systems. Auxiliary equipment connected to the EP-3 panel for testing include directors, signal generators, and oscillographs. This is not the test equipment used to test the weapon components; that equipment is in the missile checkout area.

The EP-3 panel of the Mk 13 launching system is used during local control of the launcher. At each panel, checklists should be posted for each type of procedure. Figure 3-3 shows part of a checklist posted at the EP-2 panel of a Mk 13 Mod 0 launching system. Use the checklist as a verification that all steps are performed in the correct sequence each time the launching system is operated.

Other Control Panels

Instead of one power panel for all of the launching system, several mk/mods have separate power panels for parts of the launching system, such as feeder power panels (one lor each side), loader power panels, assembler power panels, and power relay panels. Usually, each of these is activated from a control panel for that part of the launcher. Each control panel is manned by a captain, as feeder captain, assembler captain, or loader captain. Figure 34 shows an example of a feeder control panel. The one shown controls both the "A" and "B" sides. It contains switches for controlling the missile loading operations as directed by the weapons control station, and indicator lights for displaying the status of the loading operation. The operator of each feeder control panel activates the feeder power panel on his side of the launching system.

ASSEMBLER CONTROL PANELS.Launching systems such as the Mk 9 have two assembler panels, one each for the "A" and "B" sides of the launcher. Each assembler control panel contains switches for operation of blast doors, magazine doors, stage 1 and 2 rammers, and indicator lights for displaying the status of the loading operation. They are operated by assembler captains. (On the Mk 12 launching system, blast doors cannot be operated from the assembler control panel but are controlled from the EP2 panel).

LOADER CONTROL PANELS.-Loader captains man these panels, and activate the loader power panels from them. The loader control panels contain switches for controlling the operation of the transfer car, for stowing or extracting missiles from cell racks (Mk 9 system), and for loading or unloading the rammer rail and strike down rail. Light displays indicate the status of loading operations. Each cell rack is represented by a light which indicates whether the cell is loaded or empty, or is storing a dud, and also indicates the missile type.

MAGAZINE PANELS.-Several types of panels are associated with missile magazines on shipboard. The Mk 11 system has a magazine loading indicator and a magazine latch indicator panel. The Mk 12 has two magazine panels. The Mk 7 has two ready service panels. They all serve to control the operation of the missile magazine, bringing the missiles up to the launcher, or returning them to the magazine.

A system that has many control panels, each controlling a comparatively small part of the launching system, requires more men to operate .the panels than a system that consolidates several panels into a large one, Each man has fewer pushbuttons that he is responsible for but coordination of effort is required between a greater number of men, and. one man may be responsible for more than one panel.

MANNING OF OTHER STATIONS

Because much of the operation of a launching system is automatic, the number of men required is small. The number varies with the mark and mod of the system, the type of ship, the type of round, the type of warhead, and the type of operation (automatic, step control, or manual). The mark and mod of the launching system is related to the ship or class of ship on which it is used. The Mk 9 Terrier launching system is installed on CLG ships. The Mk 10 Mod 0 is placed on DLGs; Mods 1 and 2 are on CGNs, and Mods 3 and 4 are on CV As. The Mk 10 Mods 7 and 8 are placed on DLG-26 and later ships. Future changes, revisions, and modifications will assign new marks and mods.

Checkout Area

Weapons that require mating of the missile and booster before stowage (Terrier, Talos) and unmating for checkout, require a minimum of two men in the checkout area during replenishment and checkout operations. The Tartar and Asroc arrive aboard completely assembled and are not disassembled for checkout. Asroc missiles that are to be stowed in the Terrier magazine must be attached to an adapter. This is done in the checkout area. In preparation for firing, the checkout area is not manned. The Tartar system does not have a checkout area.

Wing and Fin Assembly Areas

Weapons that require the assembly of wings and fins before loading on the launcher require the most men to prepare them for firing. A Talos launching system, either Mk 7 or Mk 12, requires 24 wing and fin assemblymen at their stations in the wing and fin assembly areas. An assembly c3;ptain is in charge of each assembly area. When a nuclear missile is being readied, he removes the green SAFE plug and inserts the red (or magenta) ARM plug.

Terrier missiles also require wing and fin assemblymen, but the number differs with the type of missile. The Terrier missile requires 12 to 14 wing and fin assemblymen for the Terrier BT-3. On the Terrier BT-3 and the HT-3, the tail control surfaces are folded (not removed) during s towage, and need only to be erected at assembly. The booster fins are installed during assembly.

On Tartar weapons, the fins also are folded. They are erected automatically when the missile is on the launcher in automatic operation, and by pushing the FIN OPENER pushbuttons on the launcher control panel in step operation. When the Tartar missile is to be returned to the magazine, the fills have to be folded manually while the missile is on the launcher.

WARNING: Before folding missile fins, turn the -firing safety switch on the launcher control panel to SAFE. Then remove the switch handle and give it to the crew member going out to the launcher to fold the fins.

When the firing safety switch is set on SAFE, the launching system cannot be activated; removing the switch handle from the panel and placing it in the custody of the person working on the launcher prevents accidental activation.

DIFFERENCES IN LAUNCHING SYSTEMS

In the preceding pages, differences were brought out regarding the number and type of control panels, personnel needed, amount and type of assembly before loading, and some differences in the panels themselves. The steps in the operation of each station differ with the mark and mod of the equipment, the ship's installation, and other factors, so each station must have its own checkoff lists for the operator to follow. Table 3-1 brings together mark-mod information on the important components of launching systems in current use. Where two mods are listed for a component, it usually means that one mod is used on the starboard (right) side and the other on the port (left) side of the system.

Magazines

Most missile systems in present use have the mated or assembled rounds stowed in magazines, in close proximity to the launchers, so the rounds can be transferred automatically from the magazine to the launcher. The magazines are unmanned in automatic and step operation. In case of power failure, manual operation is necessary. Manual operation is also used for maintenance, checking, and installation purposes. Handcranks are used instead of pushbuttons. When using handcranks, remember that the electric and hydraulic interlocks are ineffective. If the unit seems to bind or is difficult to move, stop cranking and investigate.

The magazines below decks, where spare parts and components are stowed, are serviced by hoists. Manpower is necessary to transfer these components to the hoist, and the components have to be assembled into a round in the checkout area before the round can be used, or placed in the launcher magazine. Spare nuclear warheads are stowed in security areas the same as for mated rounds. If a nuclear warhead must be assembled into a missile, or disassembled from it, GMMs do that work.

The only time personnel are permitted in a Tartar magazine is when it is inactivated, as during maintenance. No assembly is required on the missile, the checkout is done on the launcher arm, and the control panels are outside the missile magazine, adjacent to it.

SAFETY CHECKS TO BE MADE

Safety checks have to be made frequently in all systems, methods, types, or modes of operation, and areas of operation. Many safety devices are built into each system to safeguard the men working with it, and to prevent damage to the missiles, machinery, or ship. They were placed in

At EP1 panel:

1. 440 Volts Power-On lights . . . . . On
2. All circuit breakers . . . . . ON
3. All switches . . . . . ON
4. All Power-Available lights . . . . . On
5. All Fuze-Blown lights . . . . . Off

At EP2 panel:

1. Man station; plug headset into receptacle at right-hand side of panel.
2. SMZ4 (Telephone Selector switch) 10JP
3. SMWI (Missile Warmup Selector switch) . . . . . Required position
4. Warmup Status indication light . . . . . On
5. Toggle switch in circular light pattern . . . . . NORMAL
6. Report from Safety Observer . . . . . "All Clear"
7. SMS1 (Control Selector switch) . . . . . STEP
8. SMS2 (Operation Selector switch) . . . . . OFF
9. SMF2 (Firing Safety switch) . . . . . FIRE ENABLE
10. SMY1 (Train And Elevation Control switch) . . . . . REMOTE
11. SMX4 (Loading Control switch) . . . . . WEAPONS CONTROL
12. Ready Indications (3 lights) . . . . . On
13. SMY2 (Launching System Warning switch) . . . . . BELL
14. Open left-hand switch cover
15. Start motors by depressing START-RUN pushbuttons.
    (START-RUN pushbutton lights) . . . . . On
16. All Motors CHECK FILTERS light . . . . . Off
17. All Motors Run light . . . . . On
18. Open right-hand switch cover
19. Check Step Control Switches. If necessary, use Step pushbuttons
    to obtain following light indications:
    a. Dud Jettison RETRACT light . . . . . On
    b. Launcher Rail EXTEND light . . . . . On
    c. Train Positioner EXTEND light . . . . . On
    d. Elevation Positioner EXTEND light . . . . . On
    e. Arming DISARM light . . . . . On
    f. Fin Opener Cranks RETRACT light . . . . . On
    g. Contactor And Fin Opener Cranks DISENGAGE light. . . . . On
    h. Aft Motion Latch RETRACT light. . . . . On
    i. Hoist TO MAGAZINE light . . . . . On
       (Hoist TO INTERMEDIATE and TO LAUNCHER lights off)
    j. Blast Door CLOSE light . . . . . On
    k. Ready Service Index CCW and CW lights . . . . . On
20. Close rightand left-hand switch covers.
21. SMS1 (Control Selector switch) . . . . . AUTO
22. SMS2 (Operation Selector switch) . . . . . LOAD
23. SMS3 (Ready switch) . . . . . READY
24. SMS1 (Control Selector switch) . . . . . OFF
25. SMS3 (Read switch) . . . . . STANDBY

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Figure 3-3.Checkoff list, activation procedures, Mk 13 Mod 0 launching system.

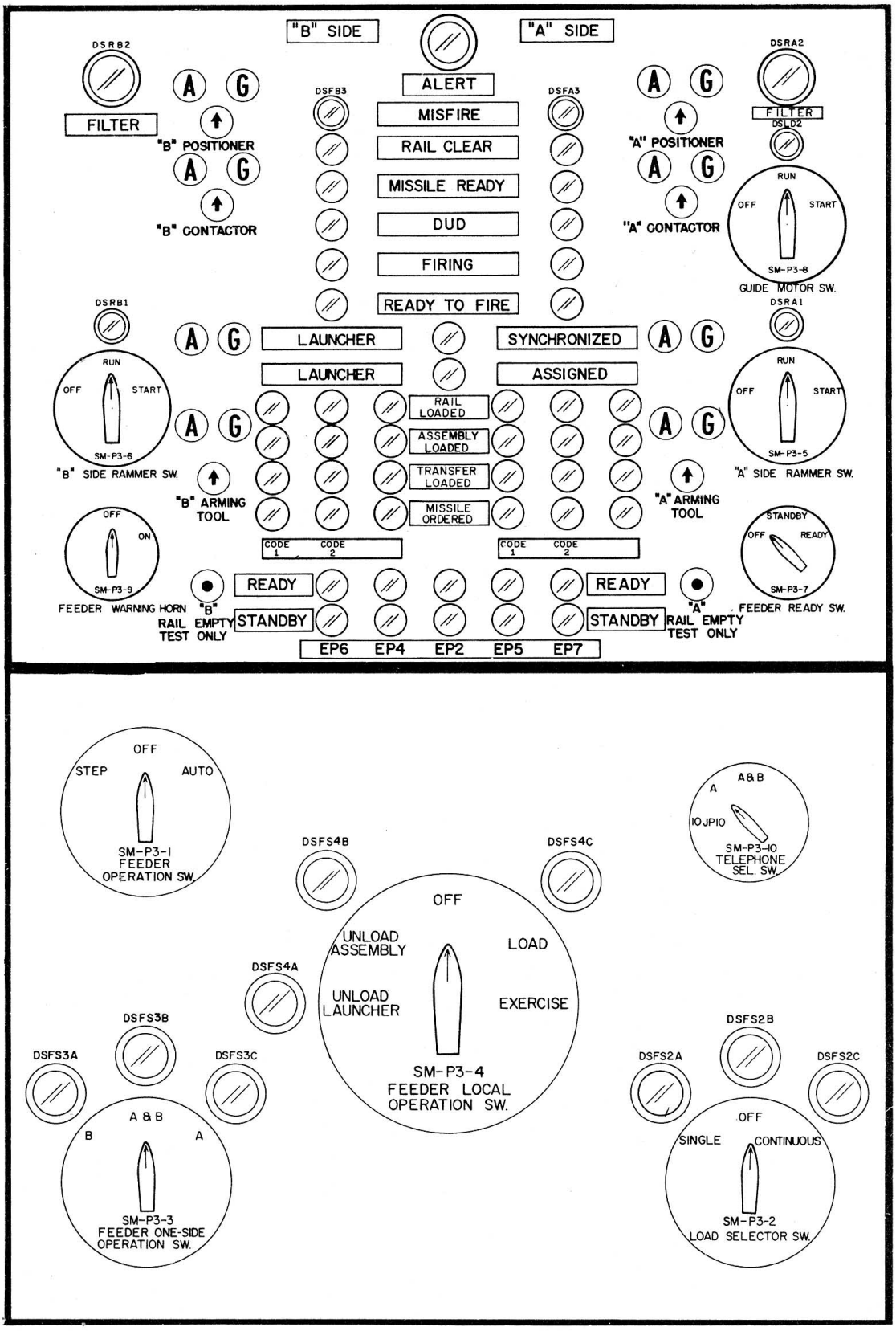

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Figure 3-4.—Feeder control panel for Terrier Launching System Mk 9.

the system because they were found to be necessary; do not inactivate or bypass a safety device for any reason, and do not permit your men to do it. During preparation for firing, a safety observer must be stationed in a position where he can observe the work, including the men and machines or equipment involved. The safety' observer must be an officer or a GMM I or C.

The checkoff lists posted at each station have the applicable safety precautions listed next to the operational steps to which they apply. The same safety precaution may be given several times on one list, each time it applies to a step in the operation to be performed. When you prepare a checkoff list, as you will be required to do, insert safety precautions in the same manner, next to each step to which they apply. Some of the technical manuals place the safety warnings throughout the text, wherever applicable, and also include a summary listing of all the safety precautions given in the book. Review this safety summary frequently.

Commanding officers may issue additional safety precautions. Observance of the safety precautions is mandatory. If you fail to enforce safety rules, you can be held responsible.

Types of Danger

Dangers may be classified according to the type of material or the object causing the danger, such as machinery, explosives, gases, liquids, irritants, pressure, fire, or electricity. A material that is dangerous in itself may be used only under prescribed conditions or circumstances. The caustic electrolyte in missile batteries, for example, will always burn the skin, so the problem is simple-don't let any get on the skin. Safe use of other materials may require compliance with special conditions. Particular conditions necessary for each type of explosive used in missiles are described in *Gunner's Mate M (Missiles) 3&2,* NAVTRA 10199. You Should know what types of explosives are used in the different parts of your missiles and the specific precautions for handling of each type. As all the explosives used in the missiles are enclosed by some form of container, there is little danger of skin contact with explosives that can cause dermatitis. The bulk and weight of the units present more, of a problem in safe handling.

MACHINERY.-Before any machinery is set in operation, the area must be checked to be sure no one is in a place where he could be injured by moving machinery. The launcher captain must sound the warning bell before he pushes a button to activate any machinery, and the safety observer must warn away anyone he sees in the area. Grisly experience has shown the need for this caution before operating any powered machinery such as a missile launching system.

If the safety observer sees any violation of safety rules or any dangerous situation, it is his duty to correct the situation immediately. If you are operating the launcher captain's panel, it is up to you to turn off the power if so ordered or if you see a situation that requires quick stoppage of any part of the launcher system.

Checking the launching system equipment and machinery for safe operating condition is part of routine maintenance performed by you and the men you supervise. The equipment is cycled without a load; any fault in the operation is corrected before the equipment is used with a load.

EXPLOSIVES.The "safe-distance" lines are the equivalent of the safety training circle lines painted on the deck around each gun mount. Their purpose is to remind all personnel that the area is covered by movement of the launcher with loaded guide arms. Personnel inside these safety lines are in a danger area where they could be struck by the moving guide arms and/or missiles. Also present is the possibility of accidental ignition during assembly, mating, handling, strikedown, or strikeup operations. Remind your men, if necessary, never to place themselves where they would be in the path of the blast if the missile or booster were ignited.

The smoking lamp must be out at all times in missile handling, test, checkout, and stowage areas.

Whenever an exercise head is assembled into a missile, flash signal units (smokepot type) are installed. Flash signal units are not tested or checked aboard ship; a safety lanyard indicates that the flash unit is in the unarmed condition. The lanyard is removed just before firing; do not remove it $ead of time. Flash signals must not be dropped and they may not be exposed to RF

energy from radars or communication transmitters. Do not stand in front of a flash signal while working on an exercise head. A flash signal and the detonator in the S&A device can be set off by a radar beam, static electricity, or a spark. The S&A device is not tested, disassembled, or repaired aboard ship.

NUCLEAR DANGERS.-With nuclear warheads assembled into missiles, there is always the POSSIBILITY of nuclear radiation. Probably the chief cause of nuclear incidents and accidents is careless handling-dropping a weapon with a nuclear warhead, or dropping the warhead itself. Prevention therefore means making sure that the weapon or component is securely fastened to the hoist, crane, trolley, or other lifting machinery .

"SAFE" POSITIONS OR DEVICES TO CHECK

Each launching system has numerous safety devices, some of them entirely automatic in operation. The position of some components or devices is checked on the control panels by means of lights or other signals. Because control panels may be widely separated and on different decks, telephone communications must be established between the panel operators, the safety observer, and the men at work in the different areas. A loudspeaker announcement and/or a warning bell Should .warn people away from the topside loading area before operation begins. Only the persons actually needed for the work are permitted to remain there. No persons are required within the launching system to operate it, and signs should be posted to keep personnel out of the assembly and checkout areas. If anything goes wrong with the launcher or other part of the system and someone has to work on any part to correct the fault, disable the component so no one can start it accidentally. On the power panel, turn off the switch that activates the component, remove the handle of the switch and give it to the man who is going to do the repairs. Only when he is finished does he return the handle to the switch. The unit can then be activated again "and its operation tried out. No one may enter a magazine while a loading or unloading operation is in process. If you are in charge at a control panel, check carefully before you push a button that starts the machinery moving. The operator at each control panel signals the launcher captain when his part of the system is ready.

The SAFE-FIRE switches must remain at Launcher Only (fig. 3-2) position throughout all the daily operational checkout. (On the control panel of the Mk 12 launching system, the switch is labeled SAFE, RUN, FIRE.) There are safety switches for the magazine, the loader, and the loader accumulator. Each of these switches has two positions, SAFE and RUN. When in the SAFE position, the handle can be removed, to be retained by the person doing the maintenance on the equipment until he has finished his work.

Before activating a launching system, after receiving the order to do so, the operator of the EP2 panel must receive the "All Clear report from the safety observer, who is stationed where he can overlook the whole launcher area.

Lights on the operating panels indicate various conditions that need to be checked and corrected before proceeding. A light on the EPI panel, labeled with a warning sign, indicates that there is a blown fuse that inactivates the magnetic door lock. This must be corrected at once. A monitor on the 115-volt power supply triggers an alarm if there is a grounded circuit.

The safe positions or devices on the missile rounds will be discussed later.

ELEVATION AND TRAINING CHECK

The firing cutout cams are designed for each! installation of a launcher so the launcher cannot be trained where it could fire into any part of the ship. The installation is tested and checked at the shipyard and rechecked and tested after, any change or modification of the launcher. The: positioning of the launcher in response to train' and elevation orders is checked each time the: launcher is used during training, preparation for firing, or during and after maintenance work. The angle. of train and elevation necessary for target intercept is calculated by the computers in the weapons control station from the data obtained by radar or sonar tracking of the target and the computations made in CIC. In automatic operation, the train and elevation synchro signals cause the launcher to slew to the position

ordered. In local control the launcher is moved to the computed train and elevation position at the launcher.

Train systems and elevation systems contain similar electric, hydraulic, and mechanical equipment. Each system receives and responds to order signals independently of the other. In normal operation, remote orders are supplied by the launcher computer. These signals determine the flight path of the missile during the "boost phase" of its flight.

The systems of different launchers are very similar in operation. The principles of operation are the same in all of them. Names and locations of units or components, details of wiring, pushbuttons to operate, etc., can vary considerably, depending on the complexity and size of the system, the location of the launchers on the ship and in relation to the control components, and other factors.

The voltages used by train and elevation systems are dangerous, and may be fatal if contacted. If electrical trouble develops, consider all circuits dangerous until the trouble is located and corrected.

LAUNCHER PREPARATION STEPS IN DIFFERENT SYSTEMS

The steps in preparation of a launcher for firing of a particular launching system vary with the mode (surface-to-surface, surface-to-air, surface-to-underwater), the type ship on which it is installed, the type of missile (conventional warhead, nuclear warhead), the purpose of firing (intercept, destruction, etc.), and other factors. Preparation for an exercise firing may require a number of steps different than in preparation for a live shot. Considering all the possibilities of difference, a complete and exact list of steps in preparation for firing cannot be made to cover all situations. The checkoff list you prepare must be made to fit your launching system and must be complete in detail.

TERRIER LAUNCHING SYSTEM

As you can see from table 3-1, the Mk 9 Terrier launching system has more control and power panels than the Mk 10 system. The Mk 9 system has Power Panels EP-I A, EP-I B, EP-I C, and EP-ID, besides Amplifier Panels EP-8, EP-9, and EP2A. The Mk 10 launching system has only the EP-I power panel. A similar consolidation is effected for the control and test panels. Improvement in the other components of the Terrier launching system has resulted in mod changes and some mark changes. All Terrier systems use a Mk 5 launcher, with mods ranging from 0 to 8. The latest change modifies the launching system so it can be used for Terrier and Asroc missiles.

In the Mk 9 launching system, a transfer area located between the forward and aft magazine service areas contains two transfer cars. These are used to transfer rounds athwartship from storage cell racks to the first stage rammer rail. In the Mk 10 launching system, the ready service ring is rotated to bring the selected round in position to be raised by the hoist, instead of the hoist being brought to the round as in the Mk 9 system.

Mk 9 Launching System

The operating cycle of a launching system is meant to cover only that part of the overall launching system that is concerned with removing a missile from stowage and ultimately placing it on the launcher for firing. If the system is unmanned and deenergized, the first step is to man all stations and energize all power motors. Upon receiving the load order, the cycle begins. The following steps in the cycle take place. See figure 3-5.

1. Movement of the transfer car to a preselected rack and cell. The transfer car is a part of the loader. It runs athwartship on tracks.
2. An extractor beam can be raised or lowered on the car, to extract a round from a magazine cell or insert it into the magazine.
3. The transfer car and extractor beam deposit the round on the overhead rammer rail.
4. Lifting and securing the round to the rammer rail. The first stage rammer rail, which receives the round from the transfer car extractor beam, is a component of the first stage rammer. Continuous grooves the length of the

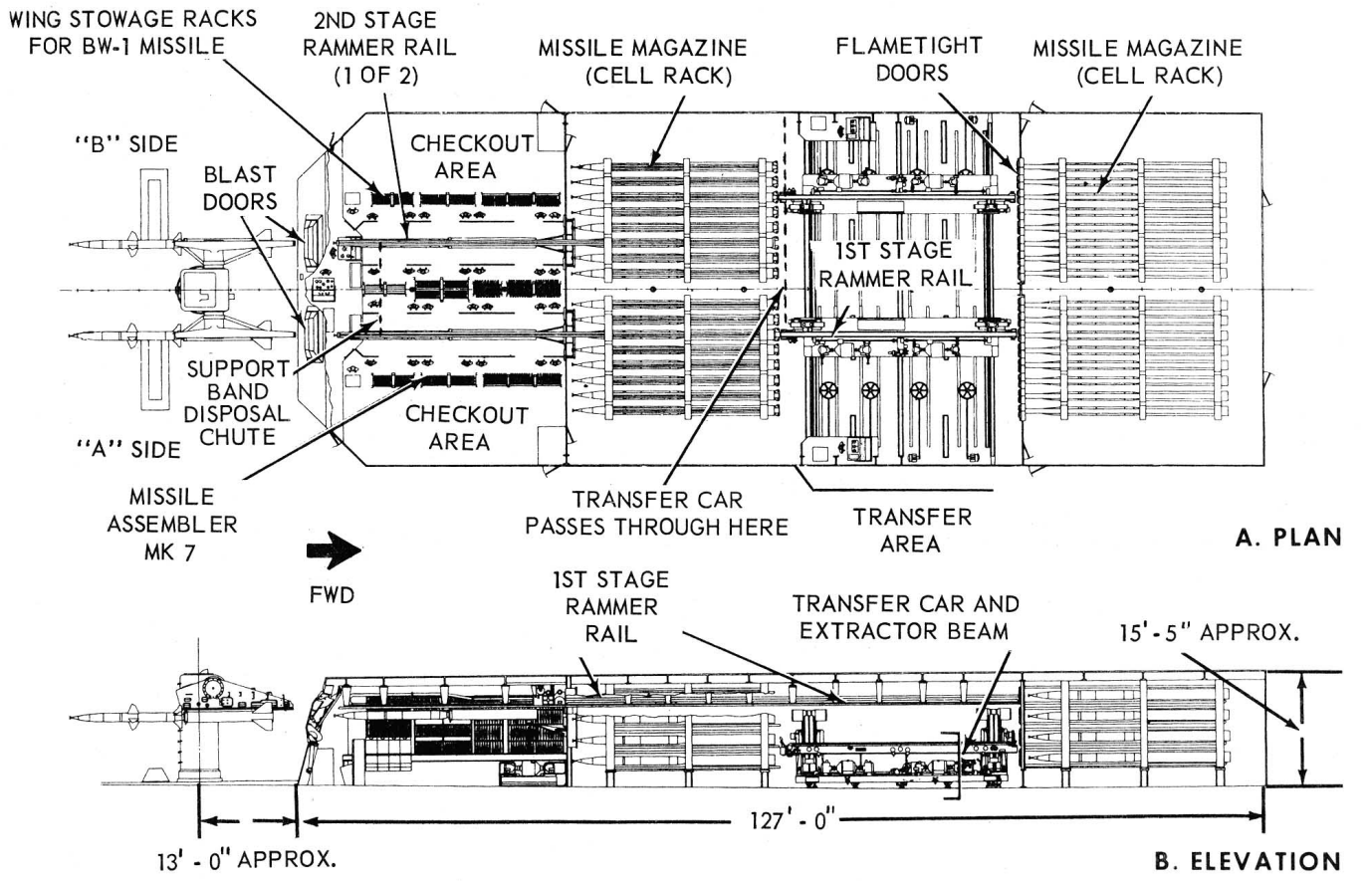

Figure 3-5.—Guided Missile Launching System Mk 9: A. Plan; B. Elevation.

rammer rail serve as tracks in which the booster slides. In the rail interior is a continuous lengthwise slot in which a continuous sprocket-driven rammer rail chain rides. This chain engages the after booster shoe by a rammer head pawl and transports the round to the assembly area through the magazine door assembly.

5. When a round is rammed into the assembly area, the first stage rammer head, which is part of a sprocket-driven chain, withdraws from the booster shoe and the second stage rammer head attaches.

6. Wings and fins are installed by the assemblymen in the assembly area. Missile support bands are removed, and are disposed of through chutes that convey them to the checkout area.

7. Second stage ramming. The second stage rammer, which also has a sprocket-driven chain, is generally similar to the first stage. Linkages and camming surfaces at the point where the first and second stage rammers interchange prevent interference in the ramming operations. On the second stage, a contractor on the rammer head mates with the warmup connector on the booster to provide warmup power during the second stage ramming to the launcher. Warmup power is applied continuously by the rammer until the round is received at the launcher.

The two stages have separate and independent hydraulic drives located in the overhead above the loader rails. Each drive is equipped with a power-off brake to hold moving parts stationary when the drive is not in operation. The electrohydraulic units (not shown in figure 3-5) also supply power for the blast and magazine door mechanisms.

In figure 3-5 you can see the tiers of cells in the magazine. Figure 3-6 illustrates the numbering system of the cells. A light (on the loader

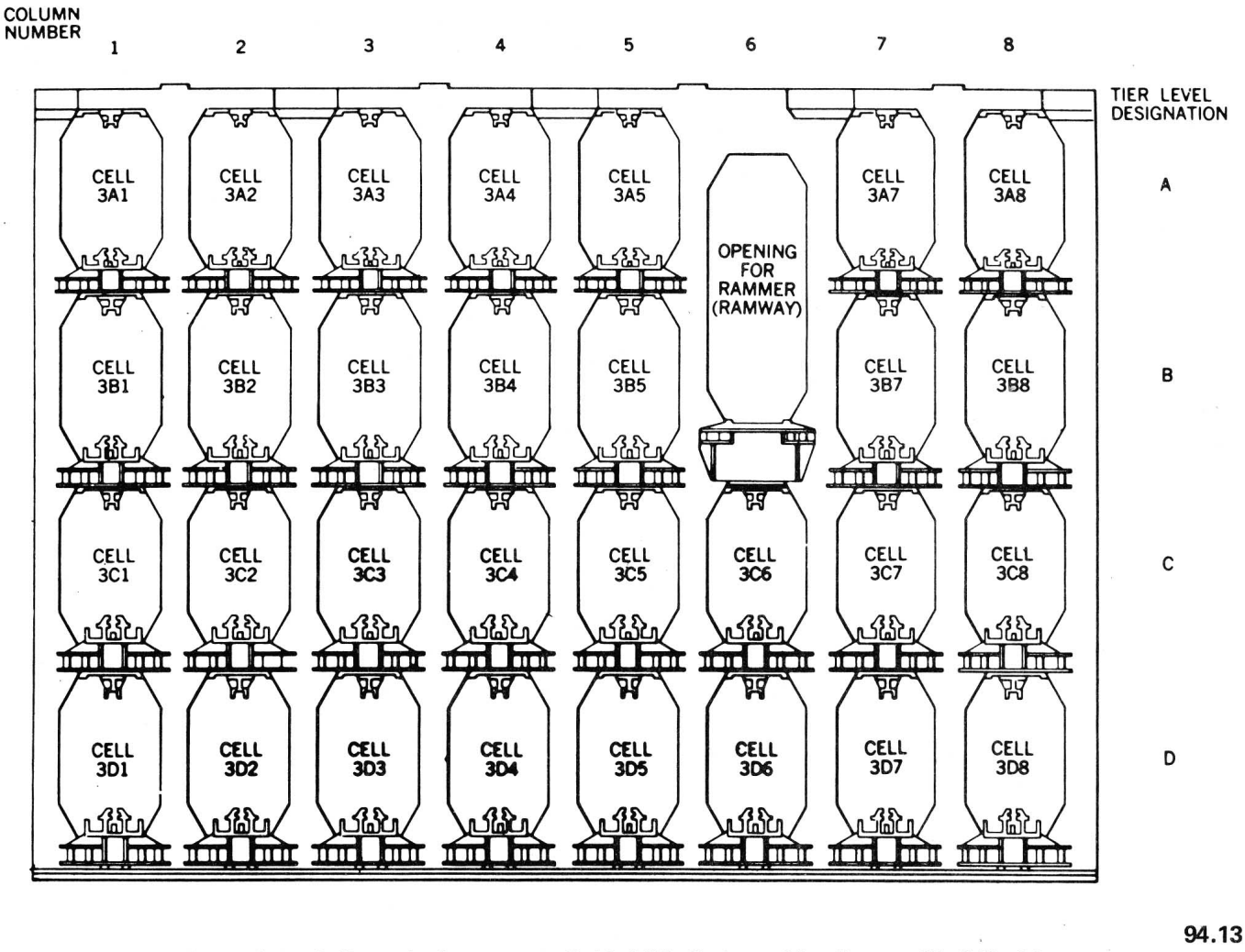

Figure 3-6.—Cell numbering system, Guided Missile Launching System Mk 9 Mod 0.

captain's control panel) for each cell indicates the type of missile that is loaded in each cell, enabling the loader captain to select by pushbutton the type of missile ordered for the operation.

The two forward magazine racks have a continuous bank of flametight doors in their after ends, one for each cell, in effect forming a bulkhead. In the bulkhead, aft of the after magazine racks, are two magazine doors. These doors are automatically and hydraulically operated, and interlock so that under normal conditions they cannot be opened while the deckhouse blast doors are open. The blast doors each have two halves that open vertically. "A" and "B" blast doors may be operated independently or concurrently. Heating facilities prevent trouble with icing. Interlocking with other system functions ensures that the doors will effectively isolate the system's interior while rounds are on the launcher, yet open during ramming of rounds to the launcher.

8. Placing and securing missile on launcher. As each assemblyman completes his work in assembling wings and fins to the missile, he moves out of the path of the -missile and closes his safety switch. Only when all the men have closed their safety switches is the missile moved to the launcher. The spanner rail, a component of the second stage rammer, bridges the gap between the launcher guide rails and the fixed second stage rammer rail. The spanning rail rotates into position as the blast doors open, and latches to the launcher rails. Interlocks ensure

proper coordination. The launcher rails or "arms" contain the missile positioner, locating stop, safety latch, arming tool, warmup contactor, firing contacts, and associated electric-hydraulic systems. The arms hold the missile in position during warmup and launcher synchronization to the train and elevation orders. They also maintain the position of the missile after firing until sufficient thrust has been built up for proper takeoff.

The complete launching cycle has been divided into various cycle events and the unit cycles timed in seconds and fractions of seconds. This timing information is useful when checking to locate the cause of a slowdown in the launching operation. Figure 3-7 lists the launching steps in detail but without the time information. An electronic timer properly connected into the circuitry through test panels provided can be used to measure operating speed of the individual units. A stopwatch can also be used for timing a launching cycle, but is not as accurate as an electronic timer.

Mk 4 Launching System

The general arrangement of the magazine, ready service ring, and the wing and fin assembly area in relation to the launcher were shown in *Gunner's Mate M (Missiles) 3&2*, NAVTRA 10199. It is capable of handling BW and BW-l Terrier missiles, which are now used as training and target missiles. With the missiles stowed in the vertical position, . the method of moving them to the launcher is different than with other launching systems in which the missiles are stowed in a horizontal position. There are only two ships with the Mk 4 system and both are now assigned to the inactive fleet.

Mk 10 Launching System

Mods of the Mk 10 launching system in current use are Mods 0 through 8. The dual mods 1 through 6 differ only in the adaptations necessary for use on opposite sides of the ship, or fore and aft location on the ship (fig. 3-8). Mod 0 is used on DLGs; Mods 1 and 2 on CLGs or CGNs; Mods 3 and 4 on CV As or CVNs; mods 5 and 6 on DLGs class 16; and Mods 7 and 8 on DLGs class 26 and later.

A difference between the Mk 9 and Mk 10 launching systems that is immediately evident from the illustrations is the difference in the stowage arrangement of the missiles. In the Mk 10, instead of each missile being in a separate cell, each magazine contains a ready service ring that holds numerous missiles. The ready service ring is rotated (by pus-button at the launcher captain's panel) to bring the selected weapon to the loading or No. I position, from which it is raised to the assembly area by the hoist. The loader-positioner rams the missile into engagement with the loader rail, the empty hoist lowers, and the magazine doors close. While the wings and fins are being assembled by the assemblymen, and warmup is applied to the missile, the ready service ring indexes another missile to the No. 1 position.

When the wings and fins are assembled, the twelve operators move to a safe area and depress foot switches, indicating that assembly is completed. This illuminates a light on the assembly captain's panel; he, in turn, operates a switch which indicates to the launcher captain that assembly is completed. If the missile is the correct one, it is brought to the launcher by the loader, which positions it on the guide arms. (If the missile is not the one ordered, a flashing indication appears on the EP4 (or EPS) panel; this situation must be corrected immediately.) , Then the launcher aft-shoe latches extend, thereby transferring the missile from the loader pawls to the aft-shoe latches. The launcher connectors extend and continue warmup of the missile after the loader pawls retract. When the booster contactors are fully extended, the arming tools extend. After the loader pawls have retracted clear of the spanning rails, the spanning rails retract and the blast doors close. When both blast doors are closed, the train and elevation latches retract, and. the launcher synchronizes with the remote order from the assigned director. The loader pawls and loader positioners move back to position, ready to receive the next weapon from the hoist. Before the launcher slews to the ordered train and elevation position, the panel operator must receive an all clear from the safety observer to be sure that no one is in the path of the launcher.

The firing safety switch is on the launcher captain's panel, and he operates it as ordered

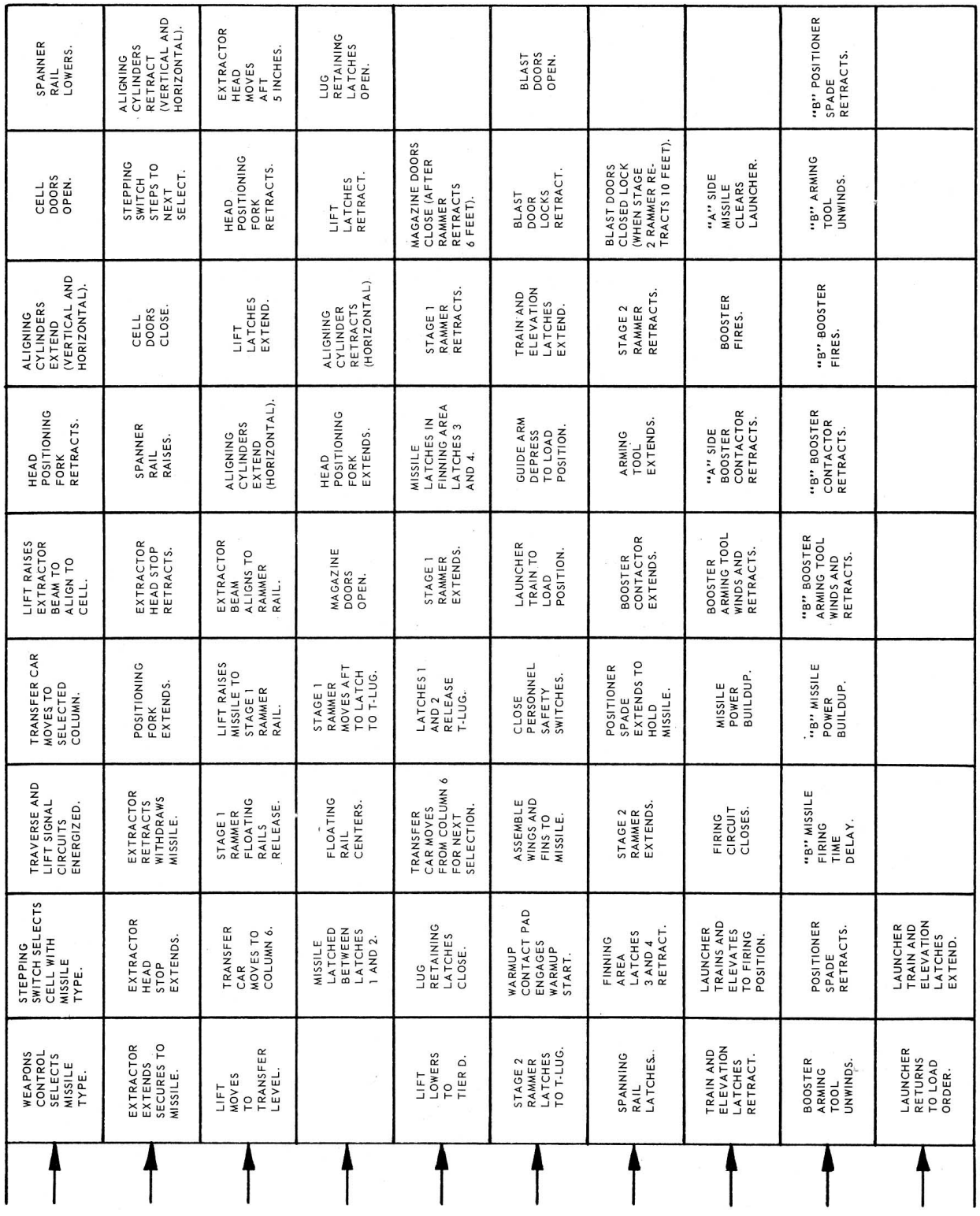

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Figure 3-7.–Operational flow diagram for Guided Missile Launching System Mk 9 Mod 0.

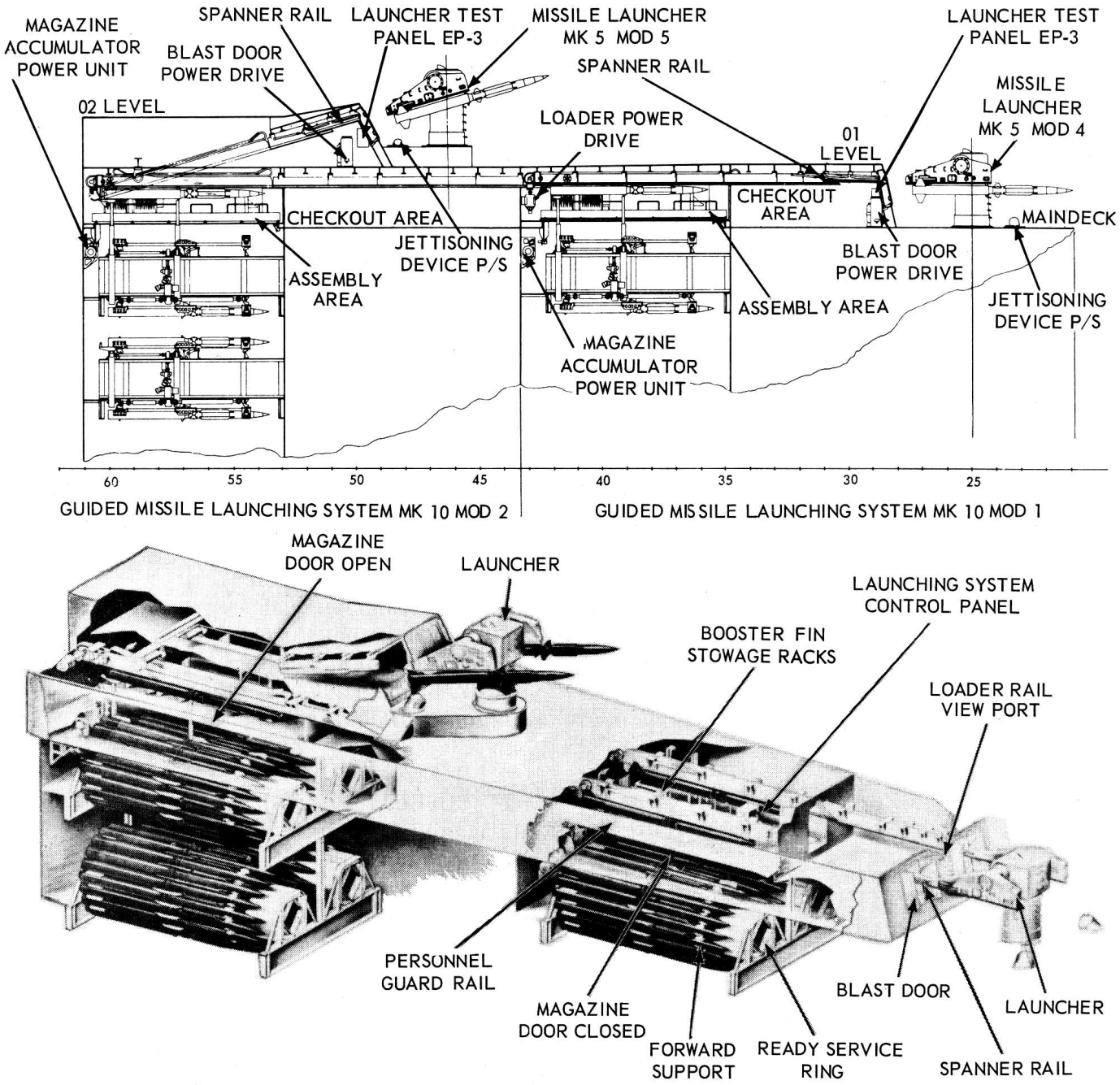

Figure 3-8.—Guided Missile Launching System Mk 10 Mods 1 and 2, for Terrier missiles.

from the weapons control station. If the weapons control operator has his load-selector switch on. CONTINUOUS, the weapons are hoisted each time the loader returns to the assembly area, and the loading and firing sequence is repeated. If the load switch is on SINGLE, only one weapon will be loaded until further orders from the weapons control station.

MK 10 MODS 7 AND 8 LAUNCHING SYSTEMS.- The outstanding innovation in the Mods 7 and 8 is provision for stowing Asroc

missiles alternately with Terrier missiles in the Terrier ready service magazine. *Gunner's Mate M (Missiles) 3&2*, NAVTRA 10199, has several pictures of this arrangement and describes it. OP 3114 PMS/SMS is the OP for the Mod 7, and Mod 8.

Guided Missile Launching System Mk 10 Mod 8 is an aft installation aboard a DLG(N)35-class ship. The loading and firing operations are identical with the Mod 7 system. However, the Mod 8 has no tilting rail in its feeder system. The increased length of its loader rail causes the load and unload cycles to be somewhat longer than on a Mod 7 system. The absence of the tilting rail also affects step operation. There are no pushbutton switches for Tilting Rail RAISE and LOWER on the EP2 panel. But there is an 8-second delay before the blast doors open, which gives time for attaching the fins to the weapons in the assembly area. The ready service mechanisms are identical to those of the Mod 7, having two upper ones, each designed to hold twenty missiles, alternating Terrier and Asroc missiles, and one lower ring that holds Terrier missiles only.

TARTAR LAUNCHING SYSTEM

Launching systems used with Tartar missiles are the Mk 11 Mods 0, 1, and 2, Mk 13 Mods 0, 1, 2, and 3, and Mk 22 Mod 0. In all these systems, the magazine is a compact metal structure and the launcher is placed on top of it. As the missiles are stowed completely assembled, there is no need for an assembly room nor a transfer room. The Tartar missile launching system serves as the primary armament of the DDG. The Mk 13 Mod 3 is placed on CV As, and the Mod 2 is designed for placement on converted DLs. Mods 1, 2, and 3 have flanges so they can be installed either entirely above deck or with the magazine partially below the deck.

The Mk 13 launching system has a single-arm launcher, in which the dud-jettison unit is integral with the launcher arm, a missile magazine, and missile launching system control equipment. The Mk 11 is a twin-rail launcher designed to handle two missiles simultaneously.

In automatic control, the launching system control initiates and controls the loading cycle, but the launcher is positioned and the missile is fired by the ship's fire control system.

Mk 11 Launching System

The Mod 0 is in use on DDG-2 class ships, and Mods 1 and 2 are installed on CGs. Two panel designations on the Mk 11 system are different than in other systems and this may lead to confusion if you have become accustomed to other systems. On the Mk 11 the EP-2 panel is the loader control panel and the EP-3 is the launcher control panel. The Mod 0 has several relay control panels in special cabinets, "RCl, RC2, RC3. Mods 1 and 2 place the relay controls in one panel, the Mk 205 relay control panel.

If the launcher is to be trained or elevated by local control, the operator of the launcher control panel uses the Mk 211 local control panel (EP-5) to train and elevate the launcher manually. The EP-5 panel also displays an error indication to assist the launcher captain in making the necessary corrections in training and elevation.

The Mk 11 system has other special indicating panels, the IP-l, IP-2 and the IP-5.

Magazine Loading Indicator Panel Mk 209 Mod 0 (IP-l), located above the loader control panel (EP-2), is an illuminated replica of the launcher, magazine, and magazine cover. It indicates the launcher position, the magazine cover and blast door positions in relation to the launcher, and indicates if cells are loaded or unloaded (fig. 3-9). The blast doors are represented by four colored discs in a clear plastic disc. The numbered discs in the illustration are . the indicating lights for the individual missile cells. The four corner lights indicate the cell location of the magazine cover doors, whether the cell is in the inner or the outer circle of the magazine, if the warmup power is on, and if the missiles are latched or unlatched.

The Missile Latch Indicator Panel (1P-2) is located in the center of the missile magazine. It is used chiefly during missile replenishment and readying for sea. As the missile latches cannot be checked visually to be certain the missiles are secured in the magazine, the unlatched missiles are indicated on the panel. This is an unsafe condition and must be corrected, as the missiles could slide (vertically) in the magazine. Of course the launching system must be inactivated while anyone is down inside the magazine.

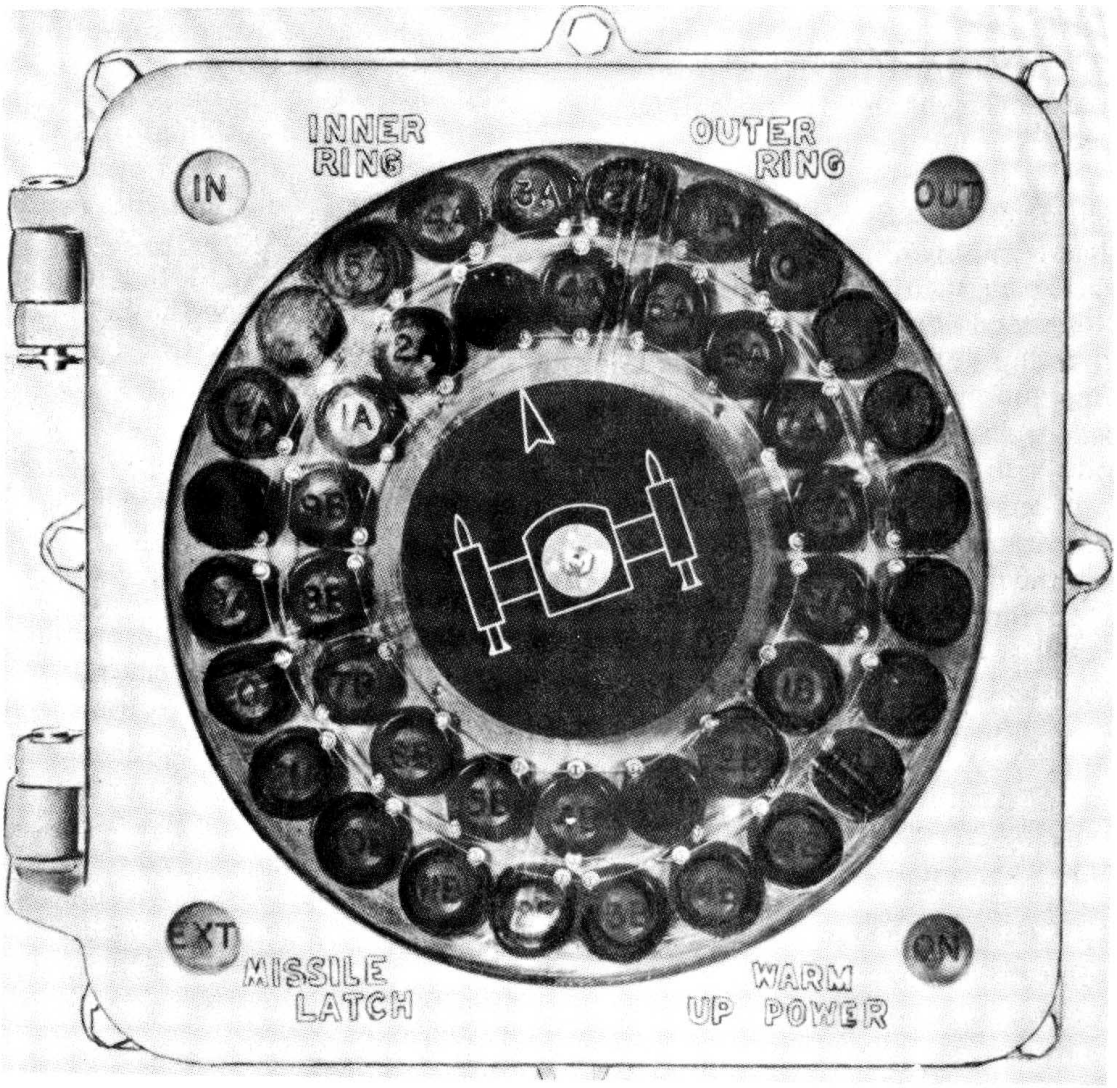

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Figure 3-9.—Magazine loading indicator panel IP-1, Mk 11 launching system.

The Missile Mode Order and Compliance Panel (IP-5) displays the launcher mode order (flashing), compliance (steady), and type of missile (X, Y, or Z) in position under the A and B blast doors.

Mk 13 Mod 0 Launching System

The Mk 13 launching system follows the trend in combining several control panels into one. This system has three control panels: EP-l, power control; EP-2, launcher control; and EP-3, test panel. The local control panel is made a part of the EP-3 panel. In automatic operation, the launcher captain operates EP-2 panel; EP-l and EP-3 are unmanned. The safety observer watches the launcher area and keeps the launcher captain informed on all phases of launcher operation.

The compact unit construction of this launching system makes it usable on a variety of ships. It may be mounted entirely above decks, or the magazine may be placed below deck level. The most noticeable difference between the Mk 11 and Mk 13 systems is the difference in the launchers Mk 11 has two launcher arms and the Mk 13 has only one, figure 3-10. This, of course, eliminates all operational steps that involve loading or unloading, or jettisoning for a second side. The Mk 13 is an extremely high speed system. The steps in operation are very similar

for the Mk 11 and Mk 13 systems. In automatic control there are four large steps:

1. Warmup
2. Loading
3. Assignment
4. Firing

Steps 3 and 4 are performed by remote control from the weapons control station.

WARNING: Do not energize the launching system until communications have been established between the safety observer and the launcher captain, and the safety observer has reported that the launcher area is all clear.

As soon as the launching system is activated after receiving the order from the weapons control station, warmup power is applied to four missiles in the magazine of the Mk 11 system, and in the Mk 13 system, to three missiles in sequence, not simultaneously (fig. 3-10). Missile Warmup Selector Switch SMWI can be positioned to AUTO 1, AUTO 2 or AUTO 3. The position of SMWI determines how many missiles are put on warmup in the magazine. For normal automatic operation, AUTO 3 is selected. As missiles are loaded, warmup is applied to succeeding missiles in the magazine. If for any reason, the rust missile is not loaded within 14 minutes after start of warmup, this missile is automatically removed from warmup and another is placed on warmup. The warmup status light on the launcher control panel will turn red after 15 minutes. The circuit for the application of warmup power is established during strikedown; a warmup contactor enters a socket in each missile as it is placed in a cell in the ready service ring.

The operators at the control panels push the buttons in sequence according to the chart posted at each station and in response to orders from the weapons control station. In the Mk 13 system, the EP2 panel operator takes care of all the push buttons, but on the Mk 11 system, the work must be coordinated between the EP-2 and EP-3 operators, who must also operate the EP-5, IP-l, and relay panels. The safety observer keeps in contact with the panel operators, so any part of the system can be stopped quickly if necessary.

If the load order (from the weapons control station) is for continuous loading, the launching system will continue to load missiles until the magazine js empty (of the type ordered), beginning with the outer ring of missiles (if the outer ring was initially selected) and, when those cells are empty, loading missiles from the inner ring. If the inner ring was initially selected, then when the inner ring is depleted, loading will automatically be shifted to the outer ring. Warmup is applied to the missiles automatically at the successive stations in the" outer ring (fig. 3-10), and then in the inner ring (or in the opposite order if the inner ring WilS selected first). This assumes that every cell is loaded and there are no dud missiles among them. If the load order is for one missile, the launching system will stop after one missile has been loaded. With the Mk 11 system, a 2-missile salvo may be ordered.

As soon as the panel operator receives the load order, he indexes the magazine cover to the missile selected, and synchronizes the launcher to the loading position, for inner ring or outer ring position (Mk 11 only). If the missile selected' is not at the hoist position, the ready service ring rotates clockwise to bring the missile to that position. After the minimum warmup time has been applied to the missile, hydraulic power is transferred to the hoist and the hoist rises to the intermediate position. As the missile is moved from station at the hoist position, the warmup contactor at the base of the missile breaks contact.

At the intermediate level, the hoist pawl engages the missile aft shoe, and the magazine retractable rail extends to complete the missile track to the spanning rail, which is attached to the blast door. Then the blast door opens, extending the spanning rail, the elevation positioner extends into the open blast door, and the hoist with the missile raises to the launcher. When the loader hoist completes its raise cycle, the launcher aft motion latch secures the missile to the guide arm and the hoist returns to the magazine. The launcher warmup contactor engages the missile and warmup is again applied. The fin openers engage the fins on the missile for opening. The train and elevation positioners retract and the blast door closes, retracting the spanning rail.

When the missile is in position on the launcher, the missile aft shoe contacts the forward motion latch and at the same time

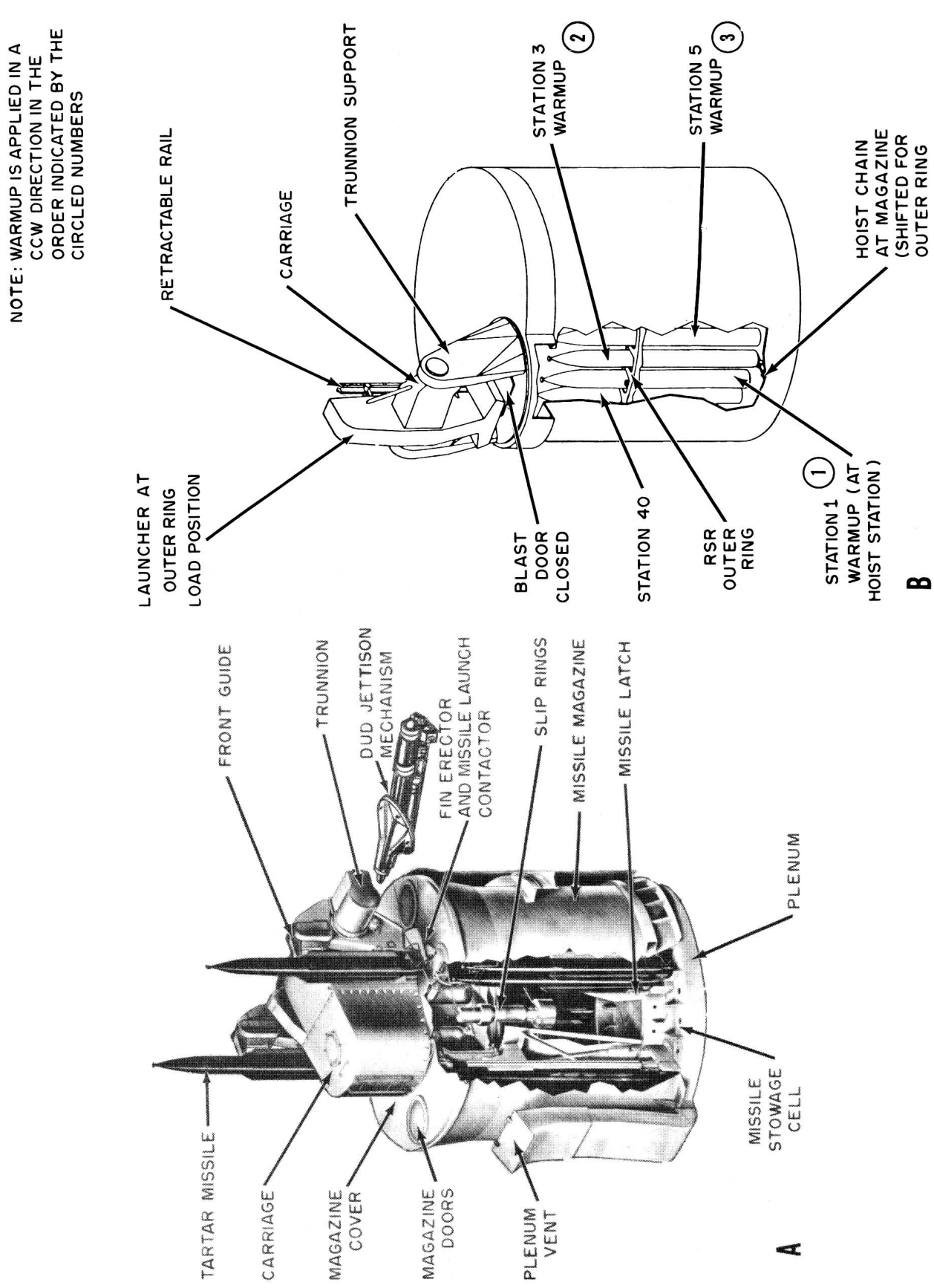

Figure 3-10.—Types of Tartar launching systems: A. Mk 11 (two launcher arms); B. Mk 13 (one launcher arm).

actuates the rail-loaded indicator plunger. This plunger actuates the launcher-rail-loaded switch; this lights up an indicating light in the weapons control station and also on the launcher captain's panel. The weapons control station assigns a target to the launcher, at which time the missile fills are automatically extended. The launcher slews to the train and elevation positions ordered. The automatic tracking cutout system prevents the launcher from pointing into certain areas where a flfed missile would be hazardous to the ship's structure. The cutout system opens the firing circuit when the launcher points into an area unsafe for missile firing (non-pointing zones). The launcher synchronized light on the launcher control panel and an indicator in the weapons control station show when the launcher guide and carriage are positioned so the missile can be launched in the proper flight attitude (azimuth and elevation). The blast door must remain closed and the fins on the missile must be unfolded before the ready-to-fire signal is given. These two operations can be going on while the launcher is moving in train and elevation to the ordered and corrected position. The FINS UNFOLDED light on the launcher panel goes on when the fins are unfolded.

All these actions of the launching system components should have taken place in less than 6 seconds from the time minimum warmup elapsed in the magazine to launcher synchronization. A pre firing evaluation is made by the launcher captain and the weapons control officer. The firing safety switches must be closed at the launcher control panel and at the safety observer's position. The FIRING ZONE CLEAR light must be on (launcher control panel). Launcher warmup must have been applied after the fin opener was engaged, and the launcher was assigned. Time delay relays close after the minim um time has elapsed. The launcher warmup switch on the power panel must be on for the minimum number of seconds. The code set in the missile must correspond with the code of the assigned fire control system. The CODE SELECTED light on the launcher panel will go on if the codes match.

Only if all conditions are met, will the missile firing be ordered. The READY-TO-FIRE light will go on in the weapons control station and on the launcher control panel. The fin opener and contactor must be engaged at the time the firing key is pressed in the weapons control station. The circuit to the hot gas generator squibs (in the missile) leads through the launcher contactor. After the hot gas generator squibs have fired, the contactor and the fin opener cranks retract and all circuits through the contactor are broke.

Beneath the closed blast door, the hoist was lowered, and the ready service ring has indexed another missile to the hoist position. Warmup has been applied and the missile is ready to be loaded on the launcher. If only one missile was ordered, no further loading takes place.

This assumes that every valve, switch, etc., works perfectly. If any part fails to perform as expected, repairs must be made by the GMMs. As most of the smaller ships have only one launcher, a failure can be a critical matter. You need to become thoroughly familiar with the system on board so you can locate trouble quickly and remedy it. It is expected that application of the Planned Maintenance Subsystem will reduce such failures to a minimum.

MK 13 MODS 1, 2, AND 3.-A number of changes have been made to improve the performance of the Mk 13 launching system. The base structure of the magazine is completely redesigned. The water injectors (see ch. 8) have been extended below the bottom plates of the "base structure. The missile restraint rings now have vertical mounting brackets and are made of heavier material. The magazine rail assembly in each cell now has a latch lock on the magazine rail latch to prevent the latch from being jarred open. The hoist assembly has changes in the hoist pawl unit, the curved track assembly, the retractable rails, and the retractable rail valve blocks. A hand-operated nitrogen-booster pump has been added to boost the ship-supply pressure for charging the jettison accumulator. It is mounted inside the stand assembly just below the center hatch (fig. 3'-11).

Pressure-cutout switch assemblies and their associated valves and orifices have been relocated from the safety relief valve to the tank cover of the header tank for the train and elevation drives, and the header tank of the magazine power supply.

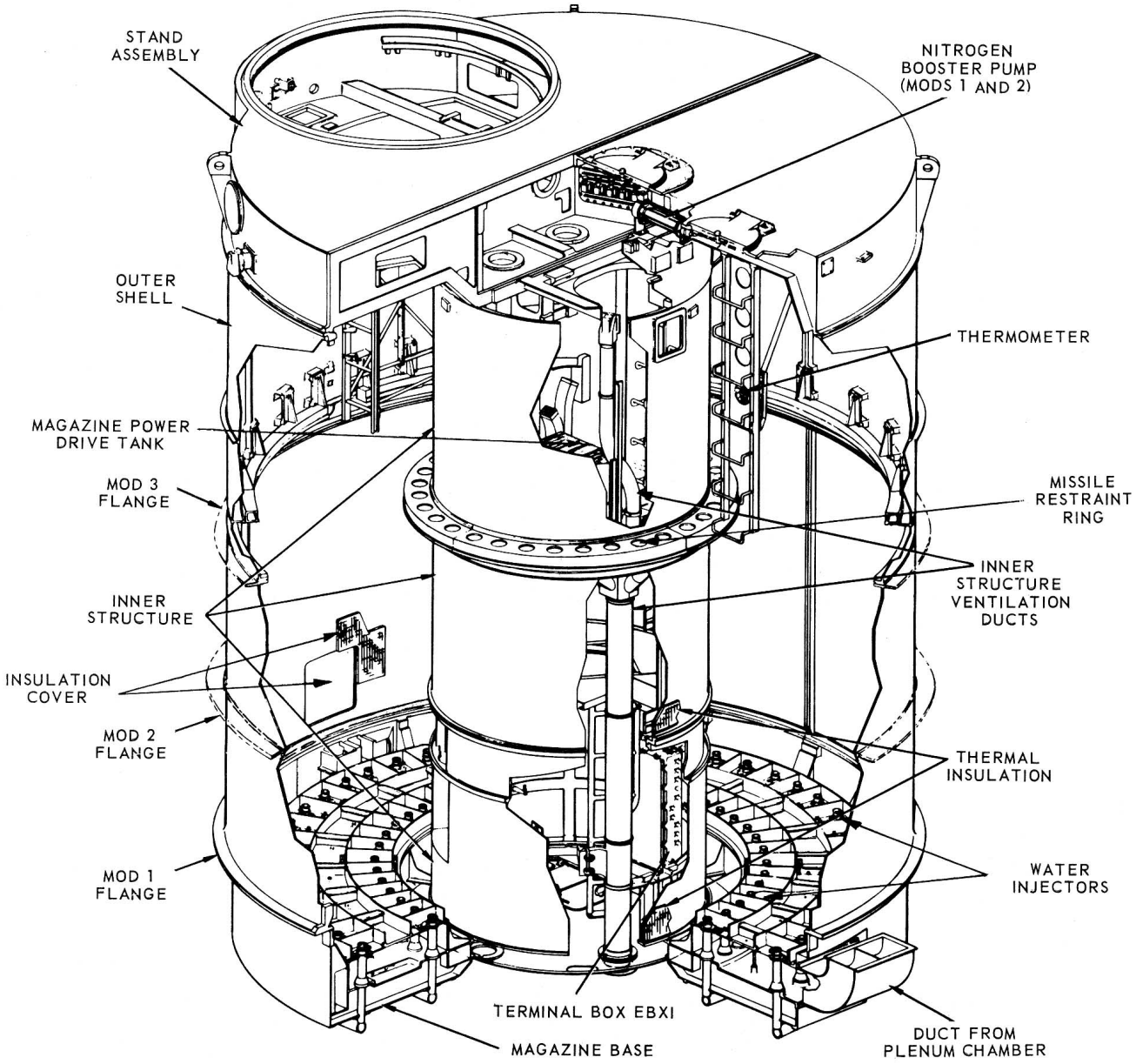

Figure 3-11.—Magazine structure, GMLS Mk 13 Mods 1, 2, and 3.

The launcher guide, too, has some changes. These are changes in the forward motion latch and lock, the igniters, the fm openers, and the fin opener and contactor assemblies. A :key-operated lock on the arming device permits the launcher captain to lock the arming device as a safety precaution during checkout of missiles on the guide arm. The forward motion stop latch has been changed from a movable stop to a fixed one. The igniters have been modified so they contact the missile only when the missile is armed. The changes in the fin opener and contactor assemblies are minor and do not change the operation of the assemblies. The fin opener housing is slightly smaller and shaped slightly differently than on the Mod 0.

The principal change in the train and elevation systems is the redesign of the electronic

servo control units. There are also some changes in the train and elevation drive motors, the servo and supercharge hydraulic systems, and in the receiver regulators.

Some of the changes were necessary because of the larger size of the Improved Tartar. The magazine was modified to allow stowage of a mixture of X, Y, or Z type Tartar missiles. The Missile Station Assignment Switches are on the inside of the EP2 panel. To assign the missiles to their stations in the magazine, the EP2 operator unlocks the missile type assignment switch cover and assigns each empty station to the missiles to be on-loaded. Loaded stations are not changed by the operator.

Mk 22 Launching System

Guided Missile Launching System Mk 22 is installed on small ships (DDGs) where space, weight, and other considerations require a smaller and lighter system than the Mk 13. The Mk 22 is an extremely compact single-arm launching system designed to stow, load, and fife Tartar missiles, and may be adapted for handling, loading, and firing other missiles. It is attached to the ship's structure with a single mounting ring like that of the 5" /54 Gun Mount Mk 42. The missiles are stowed vertically in a single ready service ring, which is nonrotatable. The launcher rotates to the loading position over the selected cell. Figure 3-12 shows structural elements of the system in a cutaway view. The train/hoist and elevation power drives and their associated receiver-regulators and miscellaneous controls are supported on the launcher's center . column. The control panels are remotely located.

The launcher is bearing-mounted to the upper magazine section, and forms the top of the magazine. The launcher arm assembly provides the guide rail and latches which support and secure the missile, the fin erectors which unfold the missile tail fins, the launcher-to-missile electrical connector which feeds the pre firing intelligence to the weapon, mechanical input to arm the rocket motor, and firing contacts to ignite the rocket motor. The rail guides the missile for the first 20 inches of travel, then retracts, moving away from the. flight path. This gives extra clearance so that the missile will not strike the forward end of the guide under severe ship roll, wind, and other conditions. A dud-jettisoning device is provided in the guide arm to boost a faulty missile overboard if necessary.

Many of the components are the same as on the Mk 13 launching system. The guide arm in its entirety is interchangeable. A major difference is in the power drive. Both loading and training are tied to one power unit. The two operations cannot take place. simultaneously. The elevation power drive is a separate unit.

The operational characteristics and controls are similar to the Mk 13, and personnel training does not present unique problems. At General Quarters, three crewmen are required: an operator at the main control panel, a safety observer, and an emergency repair technician.

Operation of the system is normally automatic, and the crew merely monitor the system. At LOAD order, the launcher automatically trains and elevates to the selected loading position, the magazine blast door opens, the hoist chain engages the missile from below and pushes it into position on the launcher. The fin erectors engage the missile fins (opening them if the launcher has been assigned a target) and at the same time the contractor makes electrical contact with the missile. The hoist chain is then retracted and the blast door closes. If the launcher has been assigned, it synchronizes in train and elevation with' the computer signal. The missile may be fired any time after synchronization. An automatic warmup system ensures that enough missiles are kept on warmup to permit firing continuously but that any missile approaching a condition of excessive warmup will be taken out of sequence and allowed to cool. Indicators provide continuous information on orders received, status of launching system operations, number of missiles in the magazine, and missile warmup in the magazine.

Step control is used for system maintenance, exercise, strikedown, and missile checkout. Safety interlocks, firefighting installations, vents to limit magazine pressure, a plenum chamber under the missiles, and a wafer injection system are very similar to those in the Mk 13 Mod 0 system. If a missile should accidentally ignite in the magazine~ the plenum chamber receives the

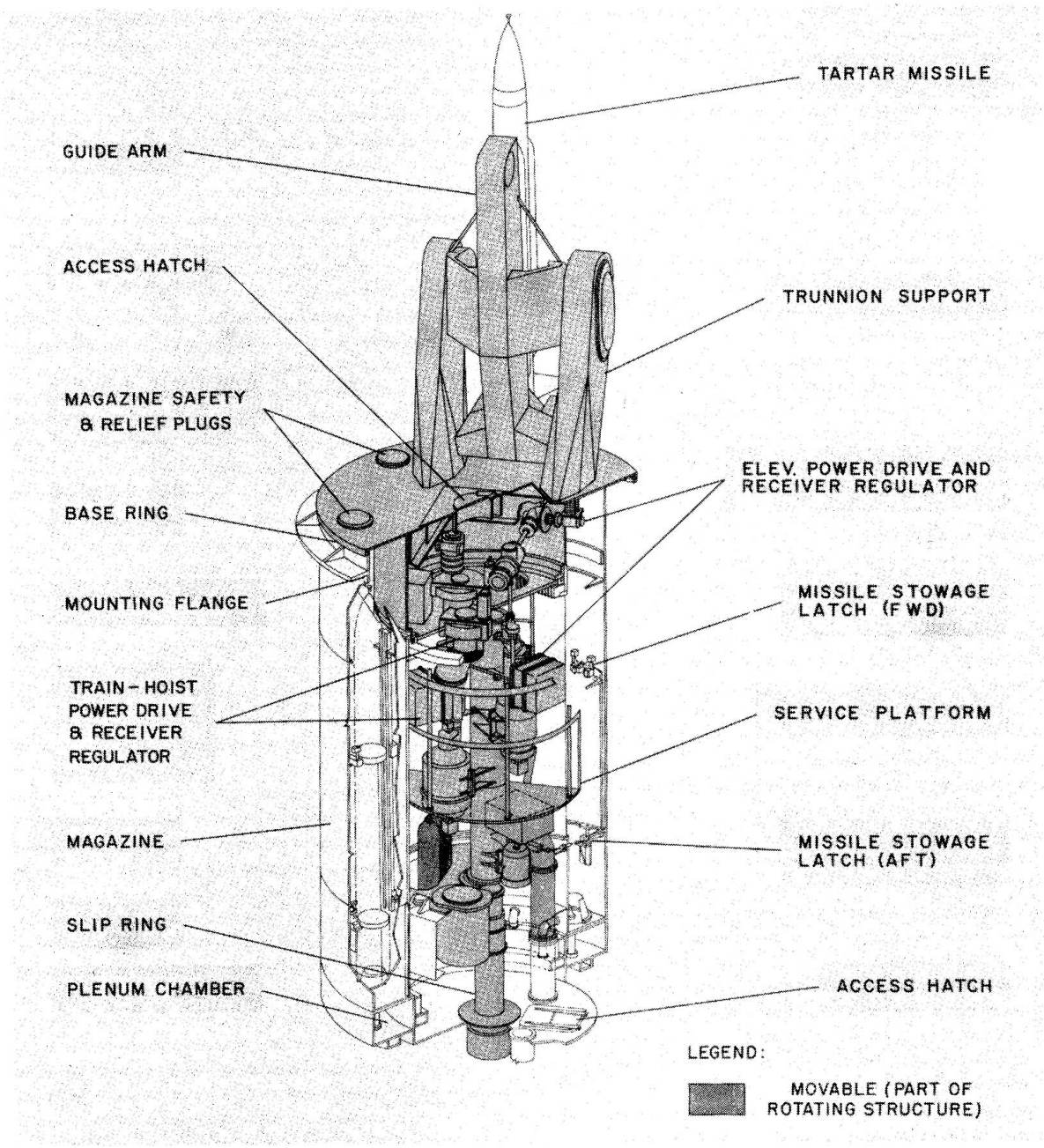

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Figure 3-12.—Guided Missile Launching System Mk 22 Mod 0 for Tartar missile.

exhaust gases and conducts them to an elbow: shaped duct at the edge of the chamber, where the gases escape to the atmosphere.

TALOS LAUNCHING SYSTEM

The Talos launching systems are capable of firing Talos weapons with conventional warheads (Talos S) and also those with nuclear warheads (Talos W). Talos S missiles may be fired in salvos from the dual-armed launcher, or singly, but Talos W must always be fired singly. The unique destruct capabilities of the Talos W make salvos unnecessary. The preparation for firing procedure is different because of the difference in the warhead.

The original launching system for the Talos, the Mk 7 Mod 0 launching system, has undergone some changes to become the Mk 12 launching system. Refer to table 3-1 and note

which components have different mark numbers: launcher-feeder, magazines, assembler, feeder and control system. In the launcher and its components, there are only mod changes.

The Mk 7 and the Mk 12 launching systems both use a Mk 7 launcher.

Mk 7 Launching System

The early Talos launching systems were placed on converted CL-55 class cruisers. The entire system except for the launcher is enclosed in a deckhouse located on the after end of the ship. The deckhouse is divided into three compartments (fig. 2-13) by two athwartships bulkheads. The area nearest the launcher is the wing and fin assembly area. The ready service compartment, in the center, is where mated missiles are stowed, ready to be loaded on the launcher except for the wings and fills. The last compartment is the magazine where missiles are stowed, mated or unmated. The magazine is not considered a part of the launching system, as transfer of missiles and boosters from it is not normally part of the launching system's operating cycle in loading weapons.

When preparing for an attack (real or simulated), an alert signal is sent throughout the weapon system from CIC or the weapons control station. This signals the various equipment operators to place their equipment from STANDBY to READY status. Alert bells sound in the ready-service compartment and in the wing and fill assembly area of the launching system. Power is turned on to operate the system. The feeder system is fully energized and set up for automatic operation. The launcher train and elevation control is set up for remote operation. At the launcher captain's panel (EP-2) the Launcher Ready Switch is placed in . the READY position and the Firing Safety Switch in the FIRE position.

As soon as the launching system is ready, the Launcher Station Ready switch lights up on the launcher direction console in the weapons control station. The console operator then checks the number and type of missiles stowed in the ready service compartment, as indicated by numerals on his console, and double checks by sound-powered telephone to personnel on the launcher.

He resets numbers to agree. Then he places his warmup switches to ON. The operator of the feeder panel (EP-3) in the deckhouse places his Area 1 Warmup and Launcher Warmup switches in NORMAL or INTERNAL position.

The load order is received from the weapons control station, where the console operator pushes the button to start the selected rounds moving from the ready-service ring to the wing and fin assembly room. The wing and fin assemblymen attach the wings and fins, apply warmup power to the missile, and, on a nuclear missile, the assembly captain installs the missile arming plug. All this takes a. few seconds. As soon as the missile is ready, the blast doors open, and the missile is rammed on the launcher rails. The blast doors close and the launcher is ready for assignment of the target. Safety interlocks prevent firing while the blast doors are open.

The operators of the ready service panels (EP-6 and EP7) have to be alert to any delay in the loading or a change in loading orders. The ready service hoist can bring any selected round to the hoist position, but if the selected round is one or more stations away from the transfer station (hoist position), it takes longer. Only a few seconds are required to bring a missile to the transfer position. Suppose an "S" missile is wanted and there is an empty tray at the transfer position, then a "W" missile, and the third contains an "S" missile. It would take about three times as long for the "S" missile to reach the transfer station, ready to be hoisted to the loader rail and then rammed to the wing and fin assembly room.

Usually both rails are loaded simultaneously, but never with "W" missiles. Before anything can be done about loading a "W" missile, the weapons officer (or officer designated by him) must unlock the box in the weapons control station and position the "W Enable" switch to ON. Then launcher personnel are ordered by sound-powered telephone to remove the locked antiloading devices from the "W" missile booster shoes (fig. 3-13), and to unlock the safe (in the wing and fin assembly room) containing the "W" arming plugs. Notice that the antiloading device is locked with a key. This key is kept in the custody of the weapons officer.

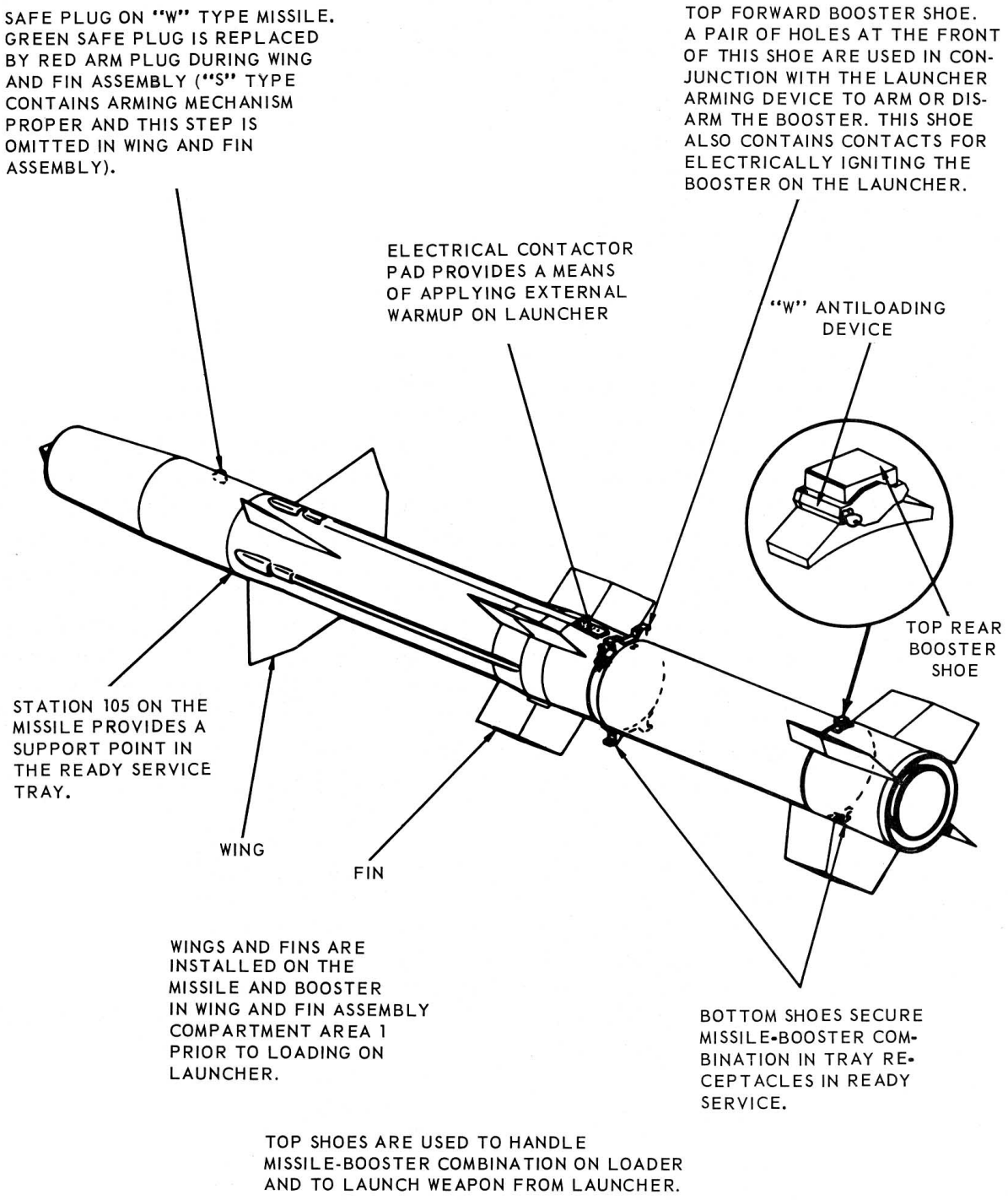

Figure 3-13.—Talos weapon in outline, showing locations of wings, fins, contactors, safe and arming plug, antiloading device, and support points.

The Mk 7 launching system is similar to the Mk 12 launching system in many respects. The applications of basic principles of hydraulics and electricity are similar in both systems. The same mechanical and hydraulic aspects are found in both systems for the span track, the blast doors and the loader (excluding the power drive). The area 1 accumulator is the same in both systems, On these topics, OP 3590 volumes 2 and 3 applies equally well to both systems.

In the Terrier and Tartar systems, except the Mk 22 Tartar system, ready service rings are mechanisms that can be rotated to bring the selected missile to the loading position. The Talos ready service rings are not really rings either in appearance or functionally. Each is actually a horizontal rectangular assembly containing 8 trays, arranged in two layers. Each tray can hold one missile with assembled booster. Two pairs of end hoists in each ring can raise or lower the end trays in each row. A pair of center hoists in each ring can hoist the center tray high enough so that shoes on the booster can engage the loader rail. The trays in the ring can be translated laterally. Thus trays in the bottom row can be shifted to the upper row; those in the upper row can be shifted to the center of the row and hoisted by the center hoists to transfer their missiles to the loader rail.

The ready service compartments hold a total of 16 missiles in the A and B sides and the magazine holds an additional 30 missiles, mated or unmated. The Mk 12 launching system has 26 missiles in each side of the magazine, a total of 52 missiles, all assembled (except for wings and fills). For effective operation, one tray support must be empty of trays. In both systems, the missile (in its tray) is raised by a hoist, operated by a hoist power drive. A tray transfer mechanism provides for transferring a tray from the tray support to the hoist or from the hoist to the tray support. The loader receives the missile-booster combination from the tray via the loader rail. In the Mk 7, each tray holds one missile; in the Mk 12, each tray support holds two trays and the tray support remains in position when a tray with its missile is hoisted.

Mk 12 Launching System

As pointed out earlier, the location of the magazines and the resultant changes in the launcher-feeder mechanisms is the biggest area of difference between the Mk 7 and the Mk 12 launching systems. How does this affect the sequence of operations in preparation for firing? Several of the launching system control panels (table 3-1) are the same mark and mod as in the Mk 7 launching system, which means they have the same circuits and pushbuttons, and therefore the same steps in operation. The Mk 12 does not have a ready service ring (fig. 3-14), and there-fore has no need for ready service panels (EP-6 and EP7 in the Mk 7 system). Panels EP-6 and EP7 in the Mk 12 launching system are magazine control panels located on the mezzanine just above the magazines. The Mk 12 system has ten "'additional control panels located throughout the system; most of them are not manned in automatic operation. These provide for auxiliary and local control of the equipments for emergencies and also for checking equipment after maintenance or overhaul. They provide for extremely slow operation, not intended for tactical use. The number of men required for the launching crew is the same as for the Mk 7 system. No men are stationed in the magazine area below decks. In the Mk 12 launching system, all the missiles are stowed assembled into Magazines Mk 7 Mods 0 and 1; there is no additional magazine beyond this for unmated missiles as in the Mk 7 launching system.

As in the Mk 7 launching system, the orders come from the weapons control station; the operator at the EP-2 panel monitors his panel and operates the switches to comply with the orders. The order from the weapons control station causes a blinking light indicator on the EP-2 panel; turning the ordered switch changes the blinking light to a steady light. While the method of bringing the selected missile to the assembly area is different because of the magazine location and its design, the work of the men on the launching system is no different. There are only two manual operations, the attachment of the win~ and fins, and the installation of the red arming plug on! W type missiles. Operation checklists should be posted at each station in the launching system. The man (or men) at each station should follow the checklist to ensure that steps will be performed in proper sequence.

Safety switches in the wing and fin assembly area have been mentioned several times, sometimes as foot switches and sometimes as hand switches. In the Mk 7 launching system, each assemblyman has a foot switch which he presses when he has completed his assembly work and has stepped behind the safety screen. In the Mk 12 launching system, hand switches have replaced the foot switches. There is less likelihood of unintentional actuation of a hand switch. When the lights on the assembler panel

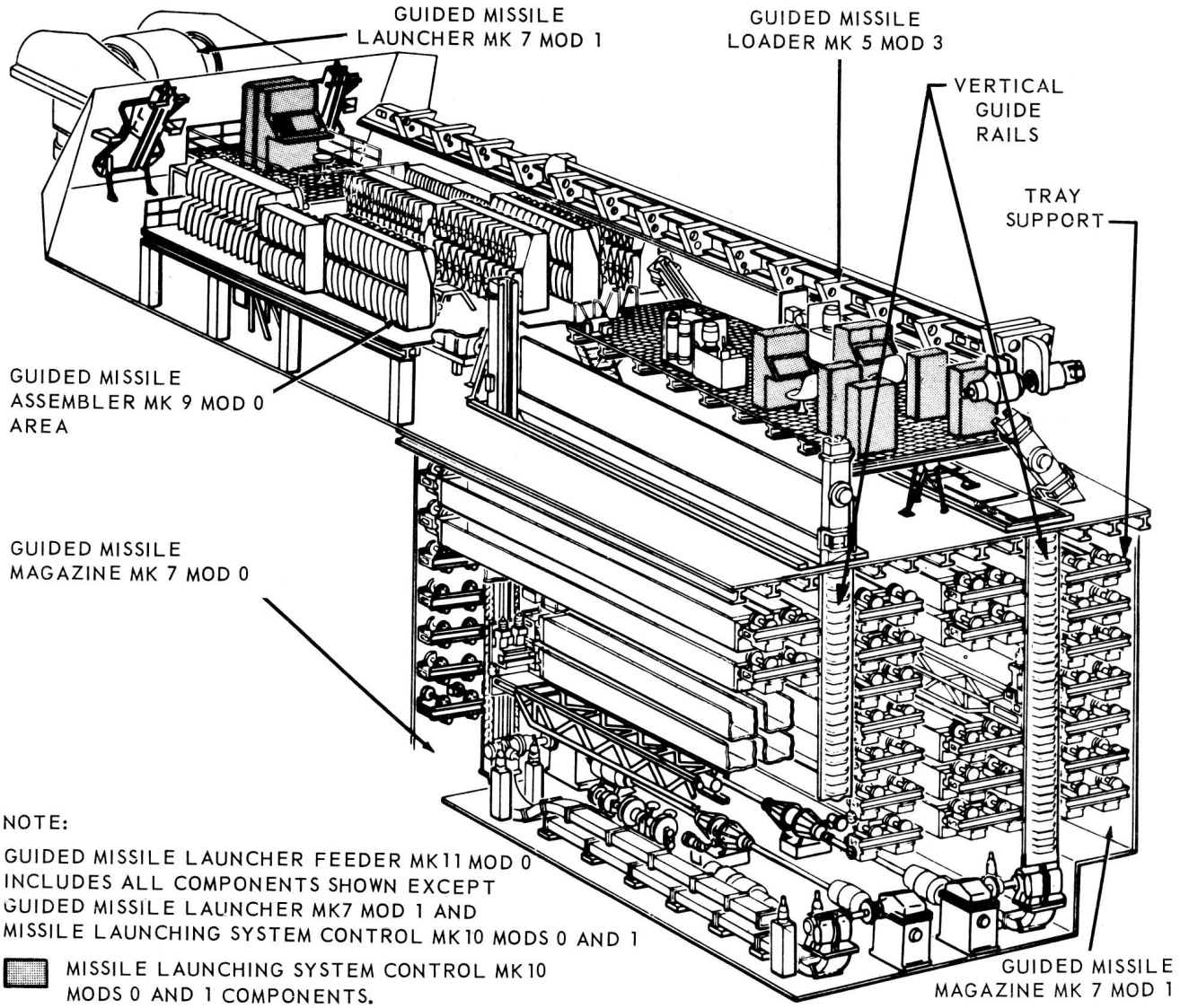

Figure 3-14.—Guided Missile Launching System Mk 12 Mods 0 and 1.

(EP-4 or EP-S) indicate that all the safety switches have been actuated, the assembler captain arms th~ missile (if required) and lets it move on through the blast doors, which open 10 seconds after assembly begins. It takes 5 seconds for the blast doors to open; assembly of wings and fins has to be completed in 10 seconds.

STANDARD MISSILE LAUNCHING SYSTEM

The already installed Terrier and Tartar launching systems will be used to launch the Standard missile when it is placed in service on ships. Modifications will be made to the existing launching systems to accommodate the two types of Standard missiles, the medium range (MR) and the extended range (ER).

To make the Standard missiles compatible with existing shipboard systems, some minor modifications must be made. Actually, two comparisons must be made: (1) between Terrier missile systems and Standard (ER) missile systems; and (2) Tartar missile systems and

Standard (MR) systems. On some ships, either the Terrier or the Standard (ER) missile can be used, and on some Tartar ships, either the Tartar or the Standard (MR) missiles can be used.

Relatively minor changes to launching systems include: (1) Missile identification ~ circuits, (2) Warmup time delay bypass circuits, (Standard missiles need No warmup), (3) Circuits to delay missile firing until its one shot batteries are ready for use (stabilized) and (4) a signal comparison network to identify the Standard missile illuminator frequencies.